16.1.1 Standorte der Anlagen

Betriebsinterne Bezeichnung der Anlage	ETRS-89/UTM Koordinaten		WGS-84-Koordinaten						Gemarkung	Flur	Flurstücke	Richtfunk-strecke verläuft durch den Einflussbe-reich der Anlage	AZ /Vorgangsnr. der Bundes-netzagentur zur Voranfrage "Mögliche Richtfunkbe-einträchtigung"
			Breitengrad (Latitude)			Längengrad (Longitude)							
	Ostwert	Nordwert	Grad °	Minuten '	Sekunden " (Nord)	Grad °	Minuten '	Sekunden " (Ost)					
1	2	3	4	5	6	7	8	9	10	11	12	13	14
2 Windenergieanlagen WEA06 und WEA07 im Windpark Willerstedt Gebstedt - Vestas EnVentus V162-7.2MW 169m NH	32673607	5660479	51	4	10.3368	11	28	40.7028	Zottelstedt	4	337/2	☐	
WEA06	32673607	5660479	51	4	10.3368	11	28	40.7028	Zottelstedt	4	337/2	☐	
WEA07	32674222	5660340	51	4	5.1708	11	29	12.03	Zottelstedt	4	376	☐	

16.1.2 Raumordnung/Zielabweichung/Regionalplanung

Die geplanten Windenergieanlagen werden auf den Flurstücken Nummer 337/2 und 376, Flur 4, der Gemarkung Zottelstedt errichtet und betrieben. Der Standort der geplanten Windenergieanlagen befindet sich im ehemals festgesetzten Vorranggebiet Windenergie mit der Wirkung von Eignungsgebieten W-9 Willerstedt / Zottelstedt des Sachlichen Teilplans Windenergie Mittelthüringen vom 24.12.2018.

Mit Urteilsverkündung vom 22.11.2022 hat das Oberverwaltungsgericht Weimar den Sachlichen Teilplan Windenergie 2018 für unwirksam erklärt. Gegen dieses Urteil wurde beim Bundesverwaltungsgericht der Antrag gestellt, die Entscheidung des Oberverwaltungsgerichtes über die Nichtzulassung der Revision gegen das Urteil aufzuheben und die Revision zuzulassen. Am 14.12.2023 ist der abschlägige Beschluss des Bundesverwaltungsgerichtes der Regionalen Planungsgemeinschaft Mittelthüringen zugegangen. Somit hat der Sachliche Teilplan Windenergie 2018 keine Rechtswirksamkeit mehr.

Die Regionale Planungsgemeinschaft Mittelthüringen hat am 12.12.2023 beschlossen, den Entwurf des 2. Sachlichen Teilplanes Windenergie Mittelthüringen zu veröffentlichen und die Beteiligung gemäß § 9 Abs. 2 ROG i.V.m. § 3 ThürLPlG durchzuführen. Die Beteiligung fand vom 26.02.2024 bis einschließlich 25.04.2024 statt.

Die geplanten Standorte befinden sich innerhalb des im Entwurf vorgeschlagenen Gebietes W-9 "Willerstedt bis Zottelstedt".

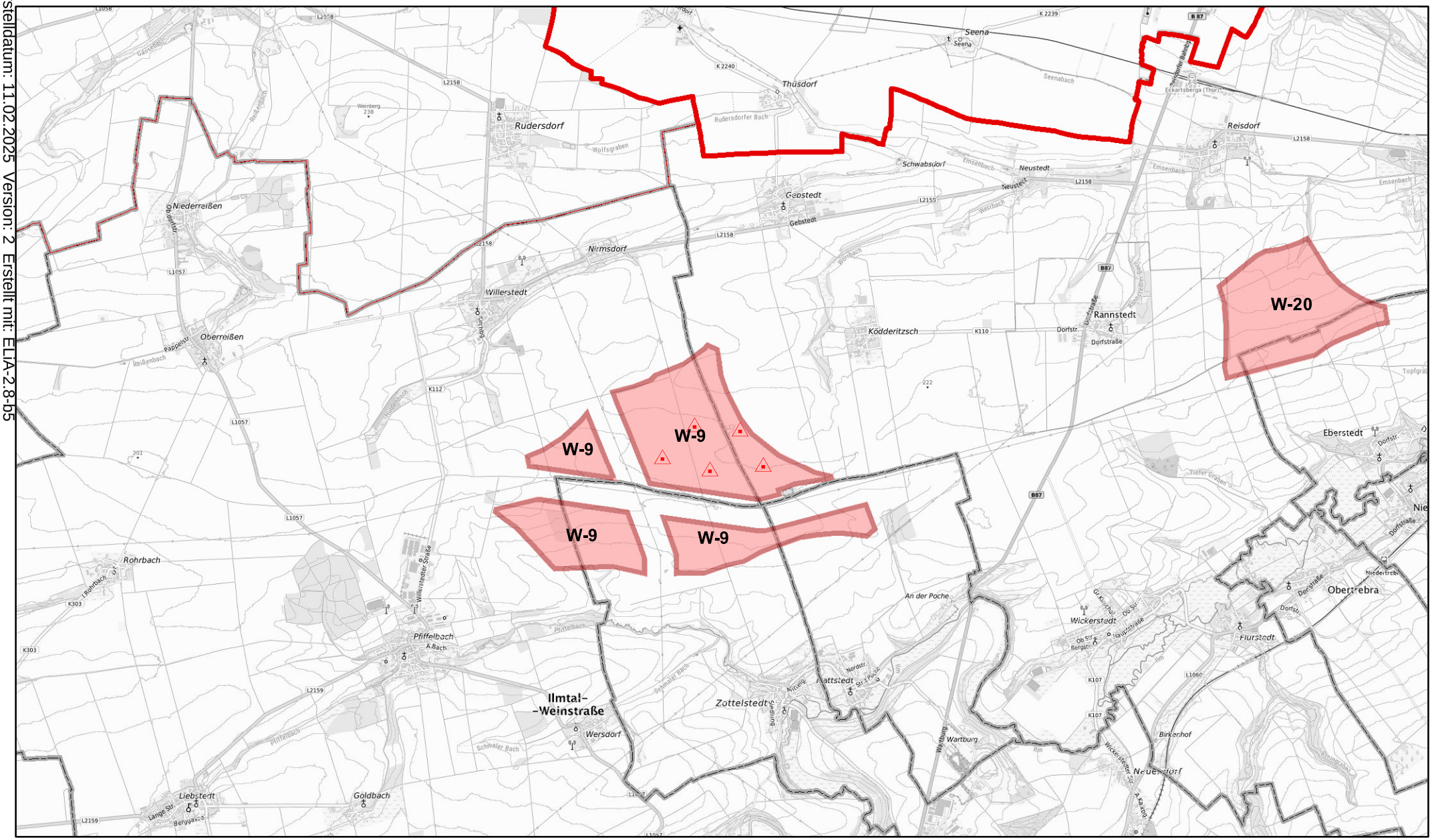
Aufgrund der zuvor beschriebenen Ausgangssituation ist das Vorhaben gem. § 35 Abs 1 BauGB, als privilegiertes Vorhaben im Außenbereich, einzuordnen und zu bewerten.

Anlagen:

- #16-1-2-1_RPM14-2STP-1Bet-02-FestlKarte.pdf

2. Sachlicher Teilplan "Windenergie" Mittelthüringen (Entwurf) - Karten der Vorranggebiete Windenergie

Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: ELiA-2.8-b5



W-9 **Willerstedt bis Zottelstedt**

Nr. Vorranggebiet "Windenergie" mit Nummer

Nr. Vorranggebiet "Windenergie für Gewerbe/Industrie" mit Nummer

Windenergieanlage (Bestand, Genehmigungen und erteilte Vorbescheide)

Regionsgrenze

Kreisgrenzen

Gemeindegrenzen

N

0 0,5 1 2 3 4

Kilometer

EDV und Kartografie: Thüringer Landesverwaltungsamt, Abteilung III: Bauwesen und Raumordnung, Referat 300: Regionale Planungsstelle Mittelthüringen, November 2023

Topografische Grundlage: Thüringen - ATKIS Basis-DLM (Stand: 30.12.2022) / TLBG © GDI-Th, Copyright: Regionale Planungsgemeinschaft Mittelthüringen, Vervielfältigung nur mit Genehmigung des Herausgebers

16.1.3 Sicherheitstechnische Einrichtungen und Vorkehrungen

Anlagen:

- #16-1-3-1_Blitzschutz-und-elektromagnetische-Vertraeglichkeit-EnVentus.pdf
- #16-1-3-2_Vestas-Erdungssystem.pdf
- #16-1-3-3_Allgemeine-Spezifikation-Vestas-Eiserkennung.pdf
- #16-1-3-4_Stellungnahme-zur-Oeption-Eiserkennungssystem-fuer-Deutschland.pdf

Blitzschutz und elektromagnetische Verträglichkeit

Dokumentennr.: 0077–8468 v05

Klassifizierung: EINGESCHRÄNKTE WEITERGABE

Typ: T09

Datum: 30.11.2022

Windenergieanlagentyp
EnVentus

Inhaltsverzeichnis

1 Abkürzungen und Fachbegriffe 2
2 Einführung 2
3 Blitzschutz 2
3.1 Schutzklasse 3
3.2 Definition von Blitzschlagpunkten 3
3.3 Überblick über das Blitzschutzsystem 5
3.3.1 Blitzschlagpunkte 5
3.4 Rotorblattschutz 6
3.5 Schutz des CoolerTop® 7
3.6 Hauptlagerschutz 8
3.7 Ableitung vom Maschinenhaus zum Turm 9
3.8 Turmkonstruktion 10
3.9 Das Ableitungssystem vom Turmfuß zum Erdungssystem 10
3.10 Schutz der Elektrik und der Steuerungssysteme 10
3.11 Erdungssysteme 11
3.11.1 Onshore-Windenergieanlage 11
3.11.2 Offshore-Windenergieanlage 13
3.12 Verifizierung 15
4 EMV 16
4.1 Rechtsvorschriften 16
4.1.1 Grundlegende EMV-Anforderungen 17
4.2 Konformität der Windenergieanlagen 18
4.3 Anerkannte Regeln der Technik 18
4.4 Komponentenübergreifende Konformität 18

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

Uncontrolled when printed. Document is only valid for the day of printing. © Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

RESTRICTED

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

1 Abkürzungen und Fachbegriffe

Tabelle 1-1: Abkürzungen

Abkürzung	Erklärung
EMV	Elektromagnetische Verträglichkeit
IEC	International Electrotechnical Commission
LCTU	Lightning Current Transfer Units (Blitzstromableiter)

Tabelle 1-2: Begriffserklärung

Laufzeit	Erklärung
Mittelwert	Der arithmetische Durchschnitt einer Reihe von Werten oder Mengen, der durch Division der Summe aller Werte durch die Anzahl der Werte errechnet wird.

2 Einführung

In diesem Dokument werden der Zweck der Bauweise des Blitzschutzsystems sowie der Schutz vor unerwünschten elektromagnetischen Umwelteinwirkungen beschrieben.

EMV und Blitze fallen in dieselbe Kategorie unerwünschter elektromagnetischer Einwirkungen. Die zur Beurteilung der Konformität herangezogenen Normen unterscheiden sich jedoch deutlich. Aus diesem Grund wurde die Themen Blitzschutz und EMV in zwei eigenständige Hauptkapitel aufgeteilt.

3 Blitzschutz

Alle Vestas-Windenergieanlagen sind mit einem Blitzschutzsystem ausgestattet, um Schäden an mechanischen Komponenten, Elektrik und Steuerungen möglichst gering zu halten.

Das Vestas-Blitzschutzsystem umfasst äußere und innere Blitzschutzsysteme.

Das äußere Schutzsystem nimmt einen direkten Blitzschlag auf und leitet den Blitzstrom in das Erdungssystem unterhalb des Turms. Beispielsweise zählen der Blitzkontakt an der Rückseite des Maschinenhauses und die Blitzrezeptoren der Blätter zu den äußeren Blitzschutzkomponenten.

Das innere Schutzsystem leitet den Blitzstrom sicher in das Erdungssystem. Außerdem beseitigt es die durch Blitzschlag verursachten magnetischen und elektrischen Induktionsfelder. Beispiele für innere Blitzschutzkomponenten sind EMV/Blitzschutzabdeckungen, abgeschirmte Kabel und Überspannungsschutzgeräte.

Potenzialausgleich und Überspannungsschutz sind die wichtigsten Maßnahmen, um den Schutz der Elektronik in der Windenergieanlage sicherzustellen.

Blitzeinschläge gelten als höhere Gewalt. Das bedeutet, dass Vestas nicht für Schäden durch Blitzeinschläge aufkommt.

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

VESTAS PROPRIETARY NOTICE

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

3.1 Schutzklasse

Vestas-Windenergieanlagen werden weltweit in Küstenbereichen und Berggegenden installiert, in denen die Blitzhäufigkeit groß ist. Um lokale Gefährdungsbeurteilungen zu vermeiden und die unterschiedlichen Blitzschutzanforderungen verschiedener Standorte besser verwalten zu können, hat Vestas ein Standard-Blitzschutzsystem entwickelt, das der höchsten in der Norm IEC 61400-24 Ed. 2 angegebenen Schutzklasse entspricht, wie in Tabelle *Numerische Werte des Blitzstroms*, Seite 5 angegeben.

Die Schutzklasse 1 entspricht der Norm IEC 61400-24 Ed. 2, d. h. Vestas-Windenergieanlagen sind für Blitzschläge mit hoher Energie ausgelegt.

Tabelle 3-1: Numerische Werte des Blitzstroms

Blitzparameter			**Schutzklasse 1**
Scheitelwert des Blitzstroms	I_{max}	[kA]	200
Gesamtladung	Q_{total}	[C]	300
Spezifische Energie	W/R	[kJ/Ω]	10.000
Durchschnittliche Steilheit	$di/dt_{30/90\ \%}$	[kA/µs]	200

3.2 Definition von Blitzschlagpunkten

Mit dem „Rollkugelverfahren“ werden gemäß IEC 61400-24 Ed. 2 Blitzschlagpunkte definiert. Studien haben gezeigt, dass die Blattspitzen und die Wetterstation (und, sofern vorhanden, die Gefahrenfeuer) am hinteren Ende des Maschinenhauses die Bereiche mit der höchsten Blitzschlaggefahr darstellen.

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

VESTAS PROPRIETARY NOTICE

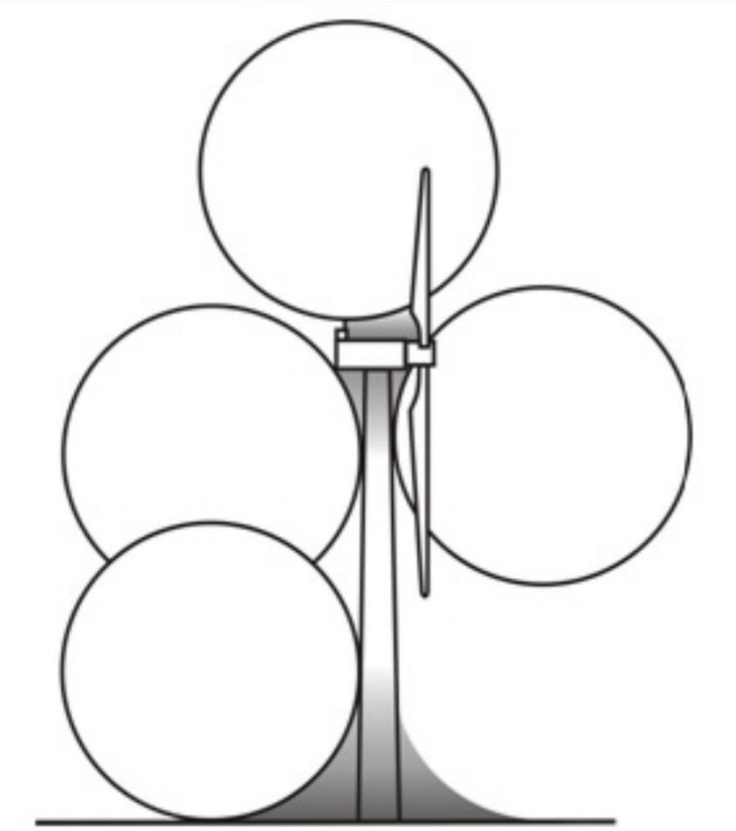


Abbildung 3-1: Das Blitzkugelverfahren

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

3.3 Überblick über das Blitzschutzsystem

Die Windenergieanlage ist darauf ausgelegt, direkte Blitzeinschläge auszuhalten.

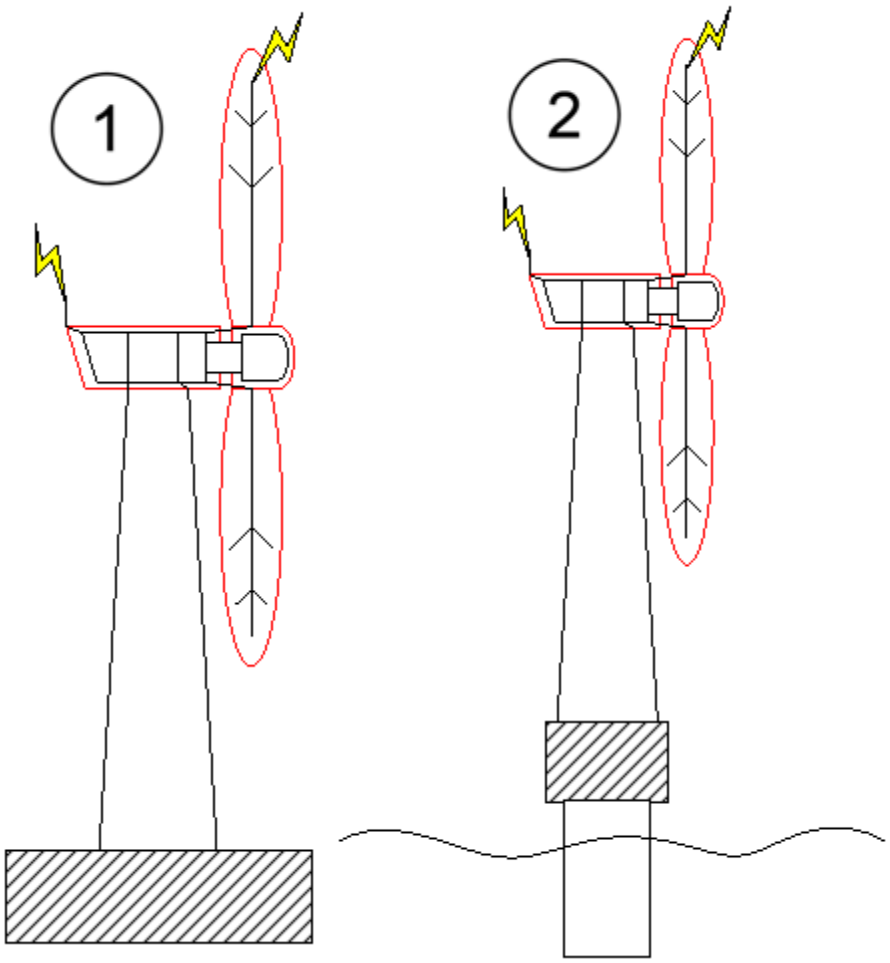


Abbildung 3-2: Blitzschlagpunkte und Blitzableitungssystem

1	Onshore-Windenergieanlage	2	Offshore-Windenergieanlage

3.3.1 Blitzschlagpunkte

Bereiche auf der Windenergieanlage, in denen mit Blitzschlägen zu rechnen ist.

Maschinenhaus

Die Konstruktionsteile des Maschinenhauses sind so ausgelegt, dass sie Blitzströme sicher zum Turm ableiten. Die Komponenten im Maschinenhaus sind so ausgelegt, dass sie hohen magnetischen und elektrischen Feldern bei Blitzschlägen standhalten.

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

RESTRICTED

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

Turm

Der Turm bildet den primären Weg für die Ableitung des Blitzstroms nach unten in das Erdungssystem.

Rotorblätter

Die Rotorblätter sind die empfindlichsten Komponenten, die Blitzschlägen ausgesetzt sind. Die Rotorblätter sind standardmäßig so ausgelegt, dass sie diesen extremen Blitzschlagbedingungen standhalten.

Blitzstromableiter (LCTU)

Das Blitzstromableiter (LCTU)-System schützt Blattlager, Hauptlager und Azimutlager vor hohen Blitzspannungen. Aufgabe des Blitzstromableitersystems ist es, die Blitzspannung sicher von den Blättern zum Maschinenhaus, vom Maschinenhaus zum Turm und dann in das Erdungssystem zu leiten.

Erdungssystem

Aufgabe des Erdungssystems ist die sichere Entladung des Blitzstroms in den umgebenden Boden.

Blitzableitungssystem

Der schwarze Teil der Windenergieanlage ist das Blitzableitungssystem. Die Rotorblätter der Windenergieanlage werden häufig von Blitzen getroffen. Wenn ein Blitz in ein Rotorblatt einschlägt, wird der Strom über den Blattableiter und über die Blitzstromableiter der Rotorblätter/des Maschinenhauses zu den Strukturteilen des Maschinenhauses geleitet. Von dort aus wird die elektrische Energie des Blitzes weiter zum Blitzstromableiter des Maschinenhauses/Turms geführt, wobei eine Ableitung am Turm herab erfolgt. Abschließend wird der Blitzstrom über das Erdungssystem entladen.

3.4 Rotorblattschutz

Blatt EnVentus V150/V162

Das Blitzschutzsystem des Blatts besteht aus vier Hauptelementen: Spitzenschutz-Rezeptoren, Oberflächenschutz, Ableitungssystem und Blitzableiterband.

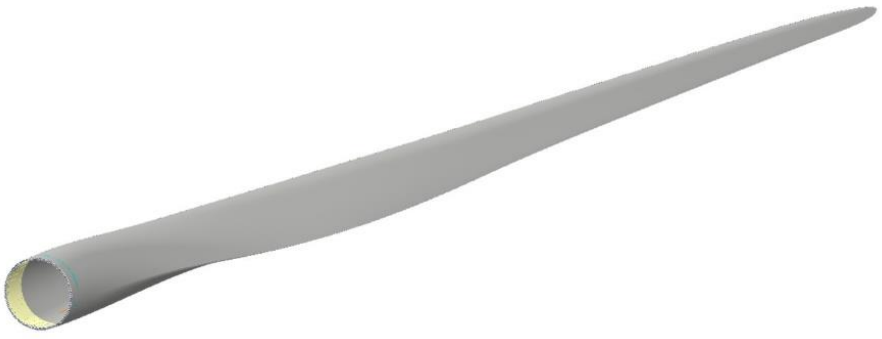


Abbildung 3-3: Blatt mit Blattband

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

Die Spitzenschutz-Rezeptoren verfügen über eine massive Metallspitze und mehrere Blitzrezeptoren. Die massive Metallspitze und die Blitzrezeptoren ziehen Blitze an, sodass die Glasfaserschalen oder der Hauptteil des Rotorblatts seltener von Blitzen getroffen werden. Die massive Metallspitze und die Rezeptoren sind mit einem isolierten Mittelspannungskabel verbunden.

Ein Teil der druck- und saugseitigen Schalen zwischen Blitzrezeptorengruppe und Blattwurzel ist mit einer Streckmetallfolie bedeckt. Ebenso wie die massive Metallspitze und die Blitzrezeptorengruppe bietet die Streckmetallfolie einen bevorzugten Blitzschlagpunkt und schützt so den unbedeckten Teil des Blatts vor direkten Blitzschlägen. Die Streckmetallfolie ist mit der Blitzrezeptorengruppe und dem Ableitungssystem verbunden.

Das Ableitungssystem enthält ein isoliertes Mittelspannungskabel, das durch den Hinterkanten-Hohlraum des Blatts verläuft. Das Mittelspannungskabel wird gemäß IEC 61400-24 Ed. 2 ausgewählt.

Das Ableitungssystem endet am Rotorblattband an der Blattwurzel. Das Blattband dient als Schnittstelle zum Blitzstromableiter. Weitere Informationen zum LTCU sind in Abschnitt 3.6 Hauptlagerschutz, Seite 8, enthalten.

Blatt EnVentus V172

Das Blatt der EnVentus V172 ist mit einem Kohlefaser-Pultrusion-Blitzschutzsystem (PLPS) ausgestattet. Das PLPS erfüllt die neue Version der Norm IEC 61400–24:2019, gemäß der alle Hauptkomponenten Labortests unterzogen wurden, in denen die Auswirkungen und das Verhalten des Systems bei einem Blitzschlag simuliert wurden.

Das Blitzableitersystem ist so ausgelegt, dass es den Wartungsbedarf senkt, da die Blitzrezeptoren und Ableiter die einzigen Blitzableiterteile sind, die gewartet werden müssen.

Neben dem Spitzenrezeptorpaar befinden sich zusätzlich vier Rezeptorpaare entlang des Blattes, drei Paare in der Spitze und zwei in der Wurzel. Der Potenzialausgleich erfolgt auf Grundlage der Simulationsergebnisse an den Rezeptorenpositionen zwischen den Schalen und dem Ableitungssystem.

Das PLPS besteht aus fünf Blitzableiterpaaren, die in den Blitzableiter und die Blattspitze sowohl an der Luv- als auch an der Lee-Fläche integriert sind.

Blitzrezeptoren fangen Blitzeinschläge ab, leiten den Blitz durch den integrierten Blitzableiter und von dort zur Blattwurzel in den Nabenanschluss.

3.5 Schutz des CoolerTop®

Die Geräte auf dem Kühlsystem werden durch Blitzableiterstangen und Rezeptorringe geschützt. Alle Metallteile sind über einen Potenzialausgleich mit der internen Stahlkonstruktion des Maschinenhauses verbunden.

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

VESTAS PROPRIETARY NOTICE

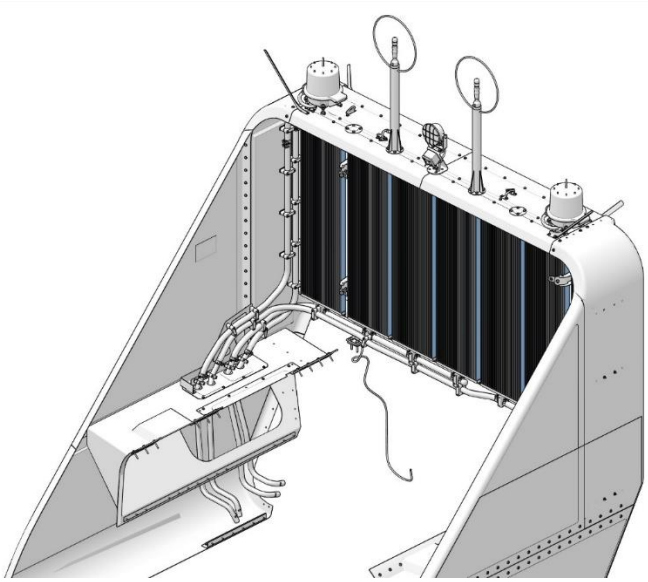


Abbildung 3-4: Darstellung von Ultraschall-Anemometer und Gefahrenfeuer am CoolerTop® an der Rückseite des Maschinenhausdaches

3.6 Hauptlagerschutz

Um den Blitzstrom von den einzelnen Rotorblättern zur Maschinenhausstruktur zu leiten, ohne dass dabei Strom durch die Rotorblattnabe und die Hauptlager fließt, ist ein drehbarer Blitzstromableiter zwischen den Rotorblättern und dem Maschinenhaus vorgesehen.

Die Ableitungssysteme der einzelnen Rotorblätter werden vom Nabengehäuse getrennt gehalten und sind über den Blitzstromableiter mit der Maschinenhausstruktur verbunden.

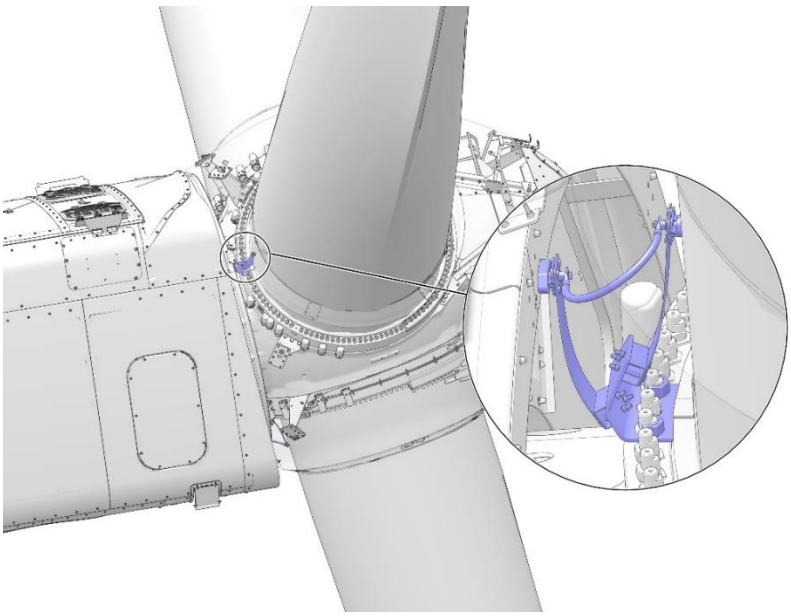


Abbildung 3-5: Darstellung eines Blitzstromableiters zwischen den Rotorblättern und der Maschinenhauskonstruktion

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

3.7 Ableitung vom Maschinenhaus zum Turm

Es gibt strukturelle Verbindungen vom Maschinenhaus zum oberen Azimutflansch. Um eine Stromführung durch die Azimutgetriebe und -lager zu vermeiden, sind Blitzstromübertragungskontakte aus Messing im Azimutlager installiert.

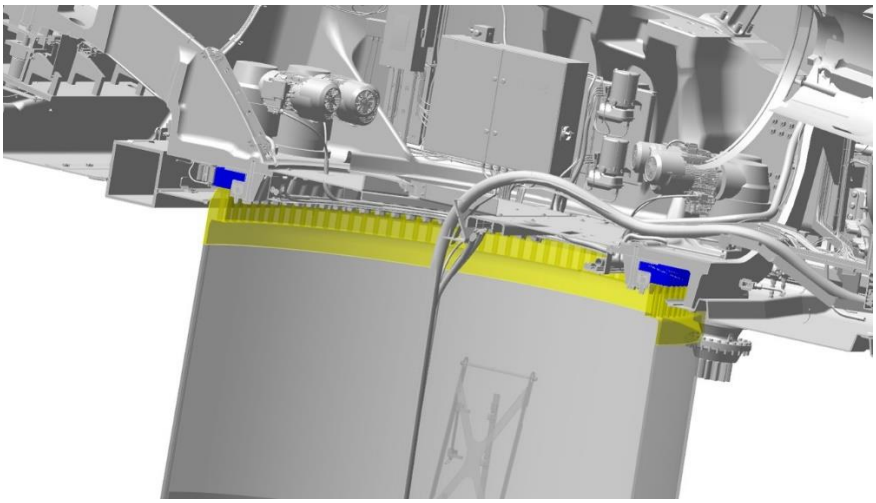
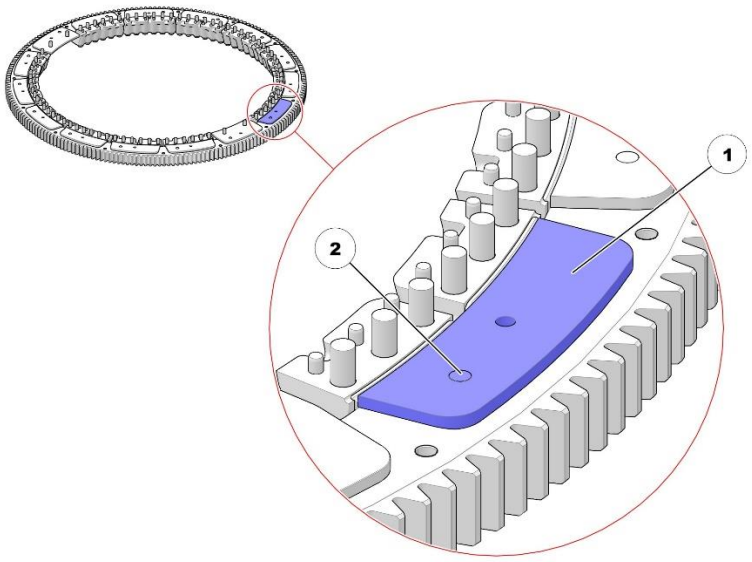


Abbildung 3-6: Darstellung des Azimutlagerschutzes



1 Gleitplatte 2 Bronzeelemente

Abbildung 3-7: Darstellung eines Bronzeelements in einer Nylon-Gleitplatte, welches das Maschinenhaus elektrisch mit dem Turm verbindet

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

3.8 Turmkonstruktion

Es gibt zwei Arten von Türmen:

- Stahlrohrturm
- Hybridturm (Oberteil aus Stahl und Betonsockel)

Der Turm fungiert als Ableitungssystem mit sehr großem Querschnitt, wodurch der Spannungsabfall im Turm gering ist.

3.9 Das Ableitungssystem vom Turmfuß zum Erdungssystem

Im Turmsockel sind alle Erdungskabel und Erdungsverbindungen mit der Haupterdungsschiene verbunden.

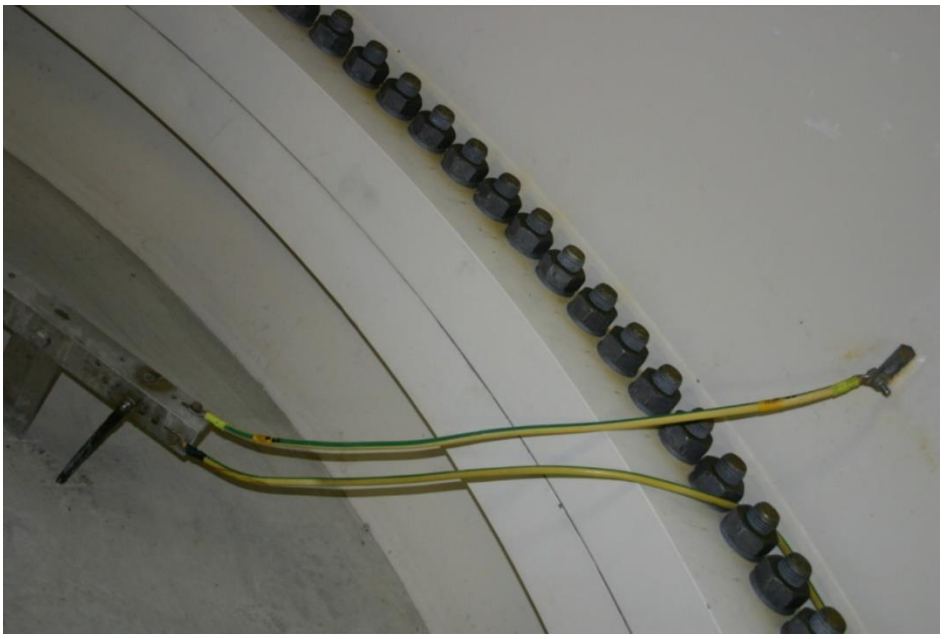


Abbildung 3-8: Verbindung zwischen Turm und Haupterdungsschiene

3.10 Schutz der Elektrik und der Steuerungssysteme

Der Mittelspannungstransformator muss unbedingt gegen Blitzschlag geschützt werden. Vestas gewährleistet dies durch den Einbau von Mittelspannungsableitern an den Mittelspannungsanschlüssen und am Überspannungsschutz auf der Niederspannungsseite.

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

3.11 Erdungssysteme

3.11.1 Onshore-Windenergieanlage

Es gibt 2 Arten von Erdungssystemen: Erstens das Erdungssystem von Vestas und zweitens das bei der Hybridturmlösung eingesetzte extern bereitgestellte Erdungssystem.

Das Hybridturm-Erdungssystem ist eine Kombination aus dem Erdungssystem von Vestas und dem Erdungssystem des Lieferanten. Ein Hybridturm besteht aus einem Oberteil aus Stahl und einem Betonsockel. Für die Erdungssysteme von Hybridtürmen ist der Lieferant zuständig (nicht Vestas). Die erforderlichen Zertifikate für den Hybridturm und die zugehörigen Erdungssysteme werden vom Lieferanten erworben.

Die nachfolgende Beschreibung gilt sowohl für das Erdungssystem von Vestas als auch für das Hybridturm-Erdungssystem:

Das Erdungssystem ist als Sicherheitserdung und Funktionserdung in einer „Typ-B-Anordnung“ konzipiert.

Aus Sicht einer einzelnen Windenergieanlage besteht das Erdungssystem prinzipiell aus drei einzelnen Erdungssystemen. Die erste Einheit ist die Fundamenterdung. Die zweite und die dritte Einheit sind die Erdverbindungskabel zwischen den einzelnen Windenergieanlagen und der horizontalen Erdungselektrode.

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

VESTAS PROPRIETARY NOTICE

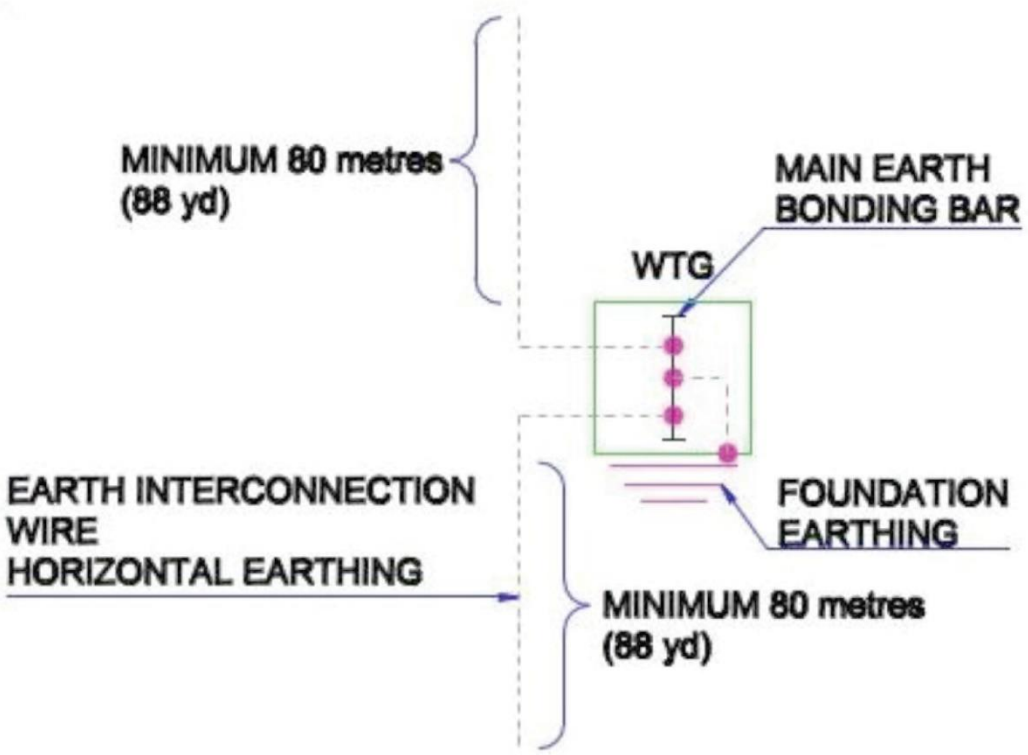


Abbildung 3-9: Prinzipdarstellung des Vestas-Erdungssystems

Im Erdungssystem sind die Windenergieanlagen in einem Windpark oder einem Netz von Windenergieanlagen zusätzlich mit einem Erdverbindungskabel zu einem gemeinsamen Erdungssystem verbunden.

Das Erdungssystem ist das Erdungssystem für das Mittelspannungssystem, das Niederspannungssystem und das Blitzschutzsystem für jede Windenergieanlage. Es ist darüber hinaus das Erdungssystem für die Mittelspannungsverteilung innerhalb des Windparks.

Bezüglich des Blitzschutzes der Windenergieanlage fordert Vestas für dieses System keinen bestimmten, in Ohm gemessenen Widerstand zur Bezugserde. Die Erdung der Blitzschutzsysteme basiert auf dem Aufbau und der Konstruktion des Vestas-Erdungssystems und entspricht den IEC-Normen.

Ein Teil des Erdungssystems ist die Hauptpotenzialausgleichsschiene, die am Kabeleintritt aller Zuleitungen zur Windenergieanlage montiert ist. Alle Erdungselektroden sind mit dieser Hauptpotenzialausgleichsschiene verbunden. Zusätzlich sind Potenzialausgleichsverbindungen an allen Zu- oder Ableitungen der Windenergieanlage installiert.

Die Anforderungen der Spezifikation und der Arbeitsanweisung für das Vestas-Erdungssystem entsprechen den Mindestanforderungen von Vestas und der IEC. Lokale und nationale sowie projektspezifische Anforderungen können gegebenenfalls zusätzliche Maßnahmen erforderlich machen.

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

RESTRICTED

3.11.2 Offshore-Windenergieanlage

Das Vestas-Erdungssystem ist als „Typ-B-Anordnung“ basierend auf Fundamenterdung (Monopile) konzipiert. Der Monopile fungiert als zusätzliche vertikale Erdungselektrode, damit das Erdungssystem die im Vergleich zum Blitzschutzsystem erforderliche Größe und Länge aufweist. Im Vestas-Erdungssystem sind die Windenergieanlagen in einem Windpark oder einem Netz von Windenergieanlagen zusätzlich mit einem Verbindungskabel zu einem gemeinsamen Erdungssystem verbunden.

Ein Teil des Vestas-Erdungssystems ist die Hauptpotenzialausgleichsschiene, die am Kabeleintritt aller Seekabel zum Turm der Windenergieanlage montiert ist. Die Erdungselektrode selbst ist mit der Hauptpotenzialausgleichsschiene verbunden. Potenzialausgleichsverbindungen an allen Zu- oder Ableitungen der Windenergieanlage am Kabeleintritt sind mit der Hauptpotenzialausgleichsschiene verbunden. Die Hauptpotenzialausgleichsschiene wird direkt an die Fundamentsektion des Turms geschweißt/geschraubt. Sie ist somit direkt mit dem Turm und allen anderen metallischen Teilen der Windenergieanlage verbunden.

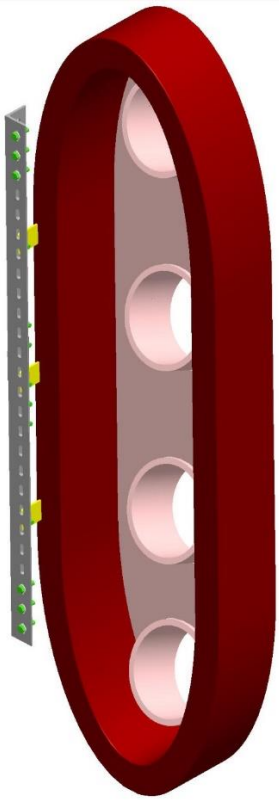


Abbildung 3-10: Mögliche Einbaulage der Hauptpotenzialausgleichsschiene

Lichtwellenleiter mit Metallkabelschirmen oder anderen metallischen Komponenten müssen ebenfalls direkt mit der Hauptpotenzialausgleichsschiene am Eintrittspunkt verbunden werden.

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05
T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

VESTAS PROPRIETARY NOTICE

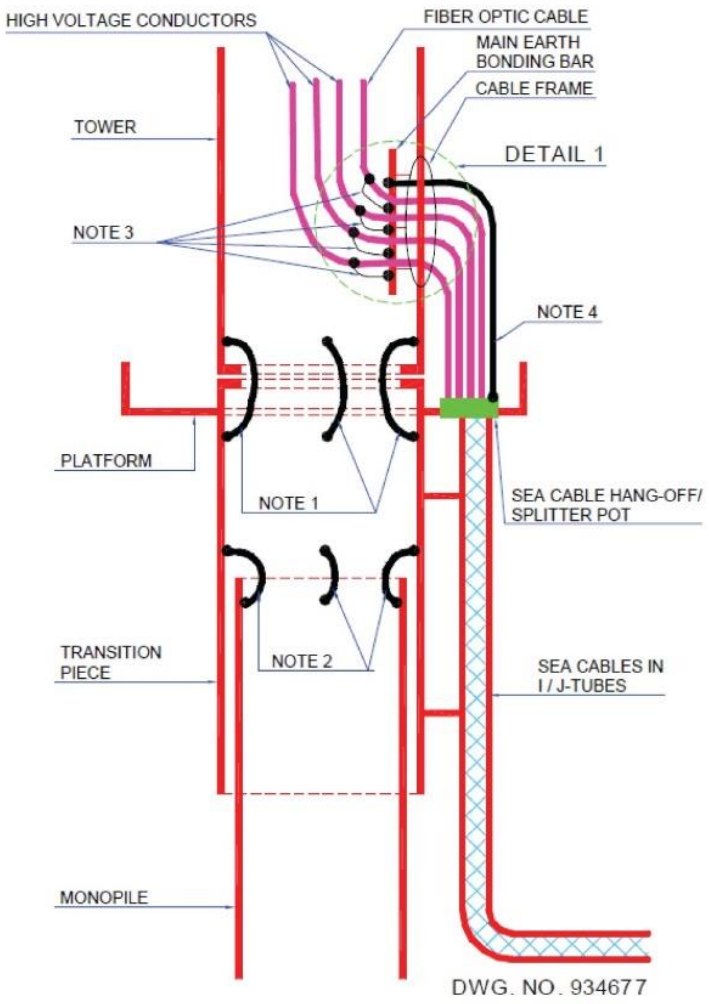


Abbildung 3-11: Prinzipdarstellung des Vestas-Erdungssystems bei J-Rohr-Aufstellung

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

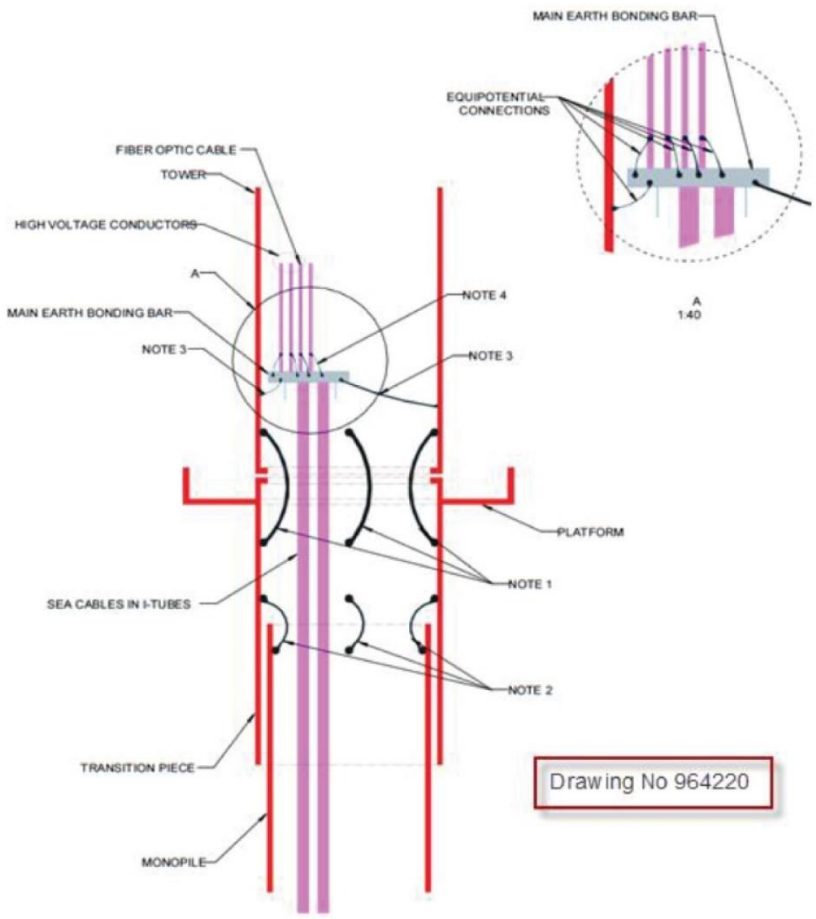


Abbildung 3-12: Prinzipdarstellung des Vestas-Erdungssystems bei I-Rohr-Aufstellung

Generell sind alle metallischen Teile in und in unmittelbarer Reichweite der Windenergieanlage miteinander und mit dem Erdungssystem verbunden. All dies hat zur Folge, dass alle Teile sowie das umgebende Erdreich und Wasser beim Auftreten von Strömen im Erdungssystem auf dasselbe Potenzial gehoben werden. Wenn alle metallischen Teile sowie das umgebende Erdreich und Wasser auf das gleiche Potenzial gehoben werden, kann keine Berührungsspannung oder Schrittspannung entstehen.

3.12 Verifizierung

Die Überprüfung des Blitzschutzsystems erfolgt gemäß IEC 61400-24 Ed. 2.

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

4 EMV

Vestas-Windenergieanlagen müssen die EMV-Richtlinie 2014/30/EU sowie alle EMV-bezogenen Aspekte der Maschinenrichtlinie 2006/42/EG zur funktionalen Sicherheit erfüllen.

Motivation für die EMV-Richtlinie ist die Gewährleistung der elektromagnetischen Verträglichkeit zwischen elektrischen Geräten. Eine detaillierte Beschreibung ist im Abschnitt „Grundlegende EMV-Anforderungen“ zu finden.

Vestas konzentriert sich auf drei Bereiche, um die Anforderungen der europäischen EMV-Richtlinie zu erfüllen:

- Konformität der Windenergieanlagen
- Anerkannte Regeln der Technik
- Komponentenübergreifende Konformität

4.1 Rechtsvorschriften

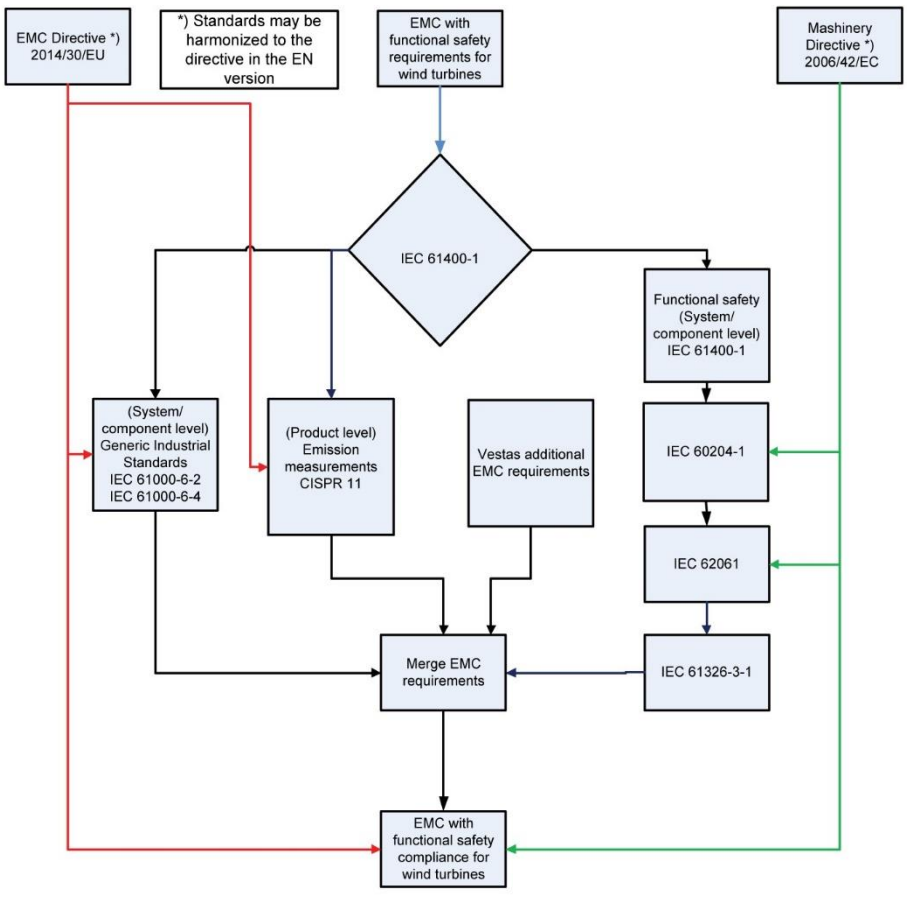


Abbildung 4-1: Rechtsvorschriften

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

Vestas entwickelt und produziert unter Einhaltung der EMV-Anforderungen gemäß den in der EMV-Richtlinie und in der Maschinenrichtlinie festgelegten Anforderungen des Europäischen Rates im Hinblick auf die funktionale Sicherheit.

RICHTLINIE 2014/30/EU des Europäischen Parlaments und des Rates vom 26. Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die elektromagnetische Verträglichkeit (Neufassung)

Richtlinie 2006/42/EG des Europäischen Parlaments und des Rates vom 17. Mai 2006 über Maschinen und zur Änderung der Richtlinie 95/16/EG (Neufassung)

Die Einhaltung der EMV-Richtlinie und der Maschinenrichtlinie wird durch die in der Norm für die Produktebene genannten Prüfungen belegt:

IEC 61400–1 Ed. 4 Windenergieanlagen – Teil 1: Auslegungsanforderungen“ behandelt Sicherheitsaspekte, Integrität von Qualitätssicherung und Konstruktion und legt die Sicherheitsanforderungen bei Entwicklung, Aufstellung und Betrieb von Windenergieanlagen-Generatorsystemen fest.

IEC 61400–1 nennt die grundlegenden Auslegungsanforderungen zur Gewährleistung der Konstruktionsintegrität von Windenergieanlagen. Ziel ist der angemessene Schutz vor Schäden durch unterschiedlichste Gefahren während der gesamten geplanten Lebensdauer. Diese Norm gilt für alle Untersysteme von Windenergieanlagen, darunter Steuer- und Schutzmechanismen, interne elektrische Systeme, mechanische Systeme und Trägerkonstruktionen. Diese Norm gilt für Windenergieanlagen jeder Größe.

CISPR 11 Ed. 6 „Industrielle, wissenschaftliche und medizinische Geräte – Funkstörungen – Grenzwerte und Messverfahren“.

CISPR 11 definiert den Messaufbau und die Messverfahren sowie die zulässigen Grenzwerte für Funkstörungen durch Industriegeräte.

4.1.1 Grundlegende EMV-Anforderungen

Die grundlegenden EMV-Anforderungen sind in ANHANG I der EMV-Richtlinie 2014/30/EU unter „Schutzanforderungen“ und „Besondere Anforderungen an ortsfeste Anlagen“ aufgeführt.

Die Windenergieanlage muss nach dem Stand der Technik so konstruiert und gefertigt sein, dass

- die von ihr verursachten elektromagnetischen Störungen den Pegel übersteigen, bei dem ein bestimmungsgemäßer Betrieb von Funk- und Telekommunikationsgeräten oder anderen Betriebsmitteln nicht möglich ist;
- die Windenergieanlage gegen die bei bestimmungsgemäßem Betrieb zu erwartenden elektromagnetischen Störungen hinreichend unempfindlich sind, um ohne unzumutbare Beeinträchtigung bestimmungsgemäß arbeiten zu können.

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

4.2 Konformität der Windenergieanlagen

Der Nachweis über die Erfüllung der grundlegenden Anforderungen der EMV-Richtlinie wird durch Durchführung einer Messung der *endgültigen Emissionsmenge* erbracht.

Die Messungen der *endgültigen Emissionsmenge* sind verschiedene *in-situ*-Messungen, die an der repräsentativen Windenergieanlage der jeweiligen Mk-Version durchgeführt werden.

Die Zuverlässigkeitsanforderungen umfassen zusätzliche EMV-Testfälle, welche die in Abschnitt 3 *Blitzschutz* auf Seite 4 beschriebenen Auswirkungen von Blitzschlägen behandeln.

In situ kommt aus dem Lateinischen und bedeutet wörtlich „vor Ort“.

4.3 Anerkannte Regeln der Technik

Zur Einhaltung der anerkannten Regeln der Technik hat Vestas einige individuelle Richtlinien entwickelt, die sich besonders mit der Aufstellung spezieller Bauteile in einer Windenergieanlage befassen.

Die Beurteilung der EMV- und Blitzschutz-Installationsmethoden erfolgt auf Systemebene.

4.4 Komponentenübergreifende Konformität

Zur Gewährleistung komponentenübergreifender Konformität müssen alle elektronischen Bauteile aufgrund der anspruchsvollen Blitzumgebung die generischen EMV-Konformitätsanforderungen sowie die Zuverlässigkeitsanforderungen von Vestas erfüllen.

Hinsichtlich der Immunität gegenüber ausgestrahlten und leitungsgeführten Störungen erfüllen alle in der Windenergieanlage verbauten Komponenten die jeweiligen Produktnormen oder zumindest die Vorschriften von IEC 61000-6-2 Ed. 3 und IEC 61400-24 Ed. 2. Für elektronische Komponenten gilt im Hinblick auf die Beurteilung der funktionalen Sicherheit die Norm IEC 61326-3-1 Ed. 2.

Für die interne Umgebung gelten die Emissionsanforderungen aus der Norm IEC 61000-6-4 Ed. 3 oder die entsprechenden Produktnormen für Komponenten.

Übersetzung der Originalbetriebsanleitung: T09 0077-8468 VER 05

T09 0077-8468 Ver 05 - Approved- Exported from DMS: 2022-12-19 by INVOL

Vestas-Erdungssystem

Windenergieanlagentyp	Mk-Version
Alle Vestas-CTR	Alle Mk-Versionen

Dokumentenhistorie

Rev.-Nr.	Datum	Änderungsbeschreibung
12	08.04.2015	Vorlage und Dokumenttyp aktualisiert

Inhaltsverzeichnis

1 Abkürzungen und technische Begriffe 2
2 Zweck 2
3 Einleitung 2
4 Systembeschreibung 3
5 Referenzdokumente 5
5.1 Liste der IEC-Normen 5
5.2 Liste der zugehörigen Dokumente 5
5.3 Referenzdokumente 7
5.3.1 Dokumente für Standardfundamente Typ 1 7
5.3.2 Dokumente für Standardfundamente von Patrick & Henderson 8
5.3.3 Dokumente für in Nordamerika verbreitete Fundamente 9
5.3.4 Dokumente für Offshore-Einzelpfahlgründung 9
5.3.5 Dokumente für Pfahlgründungen von Patrick & Henderson 10
5.3.6 Dokumente für Felsgründungen 10
5.3.7 Dokumente für Ankerkorbfundamente 11

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: ELiA 2.8-05

Uncontrolled when printed. Document is only valid for the day of printing. This document contains valuable Vestas Wind Systems A/S information. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

1 Abkürzungen und technische Begriffe

Abkürzung	Erläuterung
Keine	

Tabelle 1-1: Abkürzungen

Begriff	Erläuterung
Keine	

Tabelle 1-2: Erläuterung von Begriffen

2 Zweck

Dieses Dokument enthält die technische Beschreibung des Vestas-Erdungssystems

3 Einleitung

Das Vestas-Erdungssystem besteht aus einzelnen Erdungselektroden, die zu einem gemeinsamen Erdungssystem verbunden sind.

Das Vestas-Erdungssystem ist als Sicherheitserdung und Funktionserdung konzipiert.

Das Vestas-Erdungssystem besteht aus den folgenden Untersystemen:

- Mittelspannungssystem,
- Niederspannungssystem,
- Blitzschutzsystem,
- Fundamenterdung,
- Erdung zwischen Windenergieanlagen.

In jedem Erdungsdokument werden je nach verwendetem Fundamenttyp verschiedene Arbeitsanweisungen angegeben. Siehe Kapitel 5.2 Liste der zugehörigen Dokumente, S. 5.

Die Blitzschutzfunktion ist in das Vestas-Erdungssystem integriert.

Ein Teil des Vestas-Erdungssystems ist die Haupterdungsschiene, die sich am Kabeleintritt aller Zuleitungen zur Windenergieanlage befindet. Die Erdungselektroden werden mit der Haupterdungsschiene verbunden. Zusätzlich sind an allen ankommenden und abgehenden Kabeln der Windenergieanlage Potenzialausgleichsverbindungen installiert.

Die Spezifikationen und die Arbeitsanweisung für das Vestas-Erdungssystem entsprechen den Mindestanforderungen von Vestas und den IEC-Normen. Regionale und nationale Anforderungen können zusätzliche Maßnahmen erforderlich machen.

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

4 Systembeschreibung

Das Vestas-Erdungssystem für einzelne Windenergieanlagen besteht aus den folgenden beiden einzelnen Erdungsmethoden:

1. Fundamenterdung,
2. Erdverbindungskabel (horizontale Erdungselektrode).

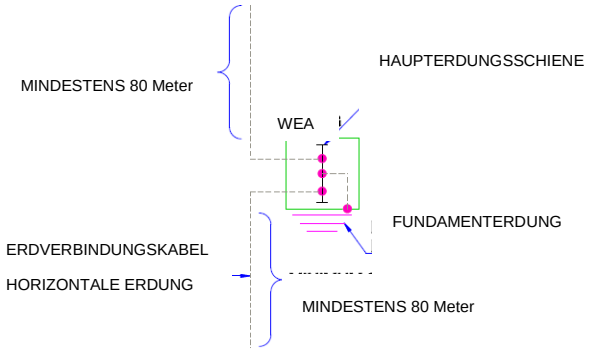


Abbildung 4-1: Vestas-Erdungssystem für eine einzelne Windenergieanlage (Zeichnungsnr.: 934675)

Die Windenergieanlagen in einem Windpark oder Netz von Windenergieanlagen sind zusätzlich mit Erdverbindungskabeln verbunden.

Dieses Erdverbindungskabel ist sowohl Teil des Erdungssystems als auch Teil des Blitzschutzes. Zwischen den einzelnen Windenergieanlagen und dem Umspannwerk verlaufen Mittelspannungskabel.

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

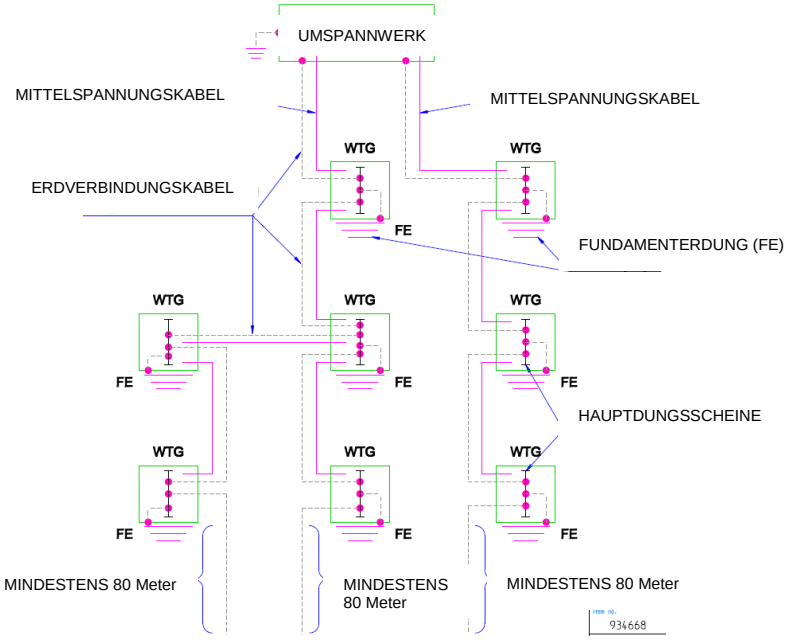


Abbildung 4-2: Erdungssystem in einem Netz (Transformator und Schaltanlage in der Windenergieanlage) (Zeichnungsnr.: 934668)

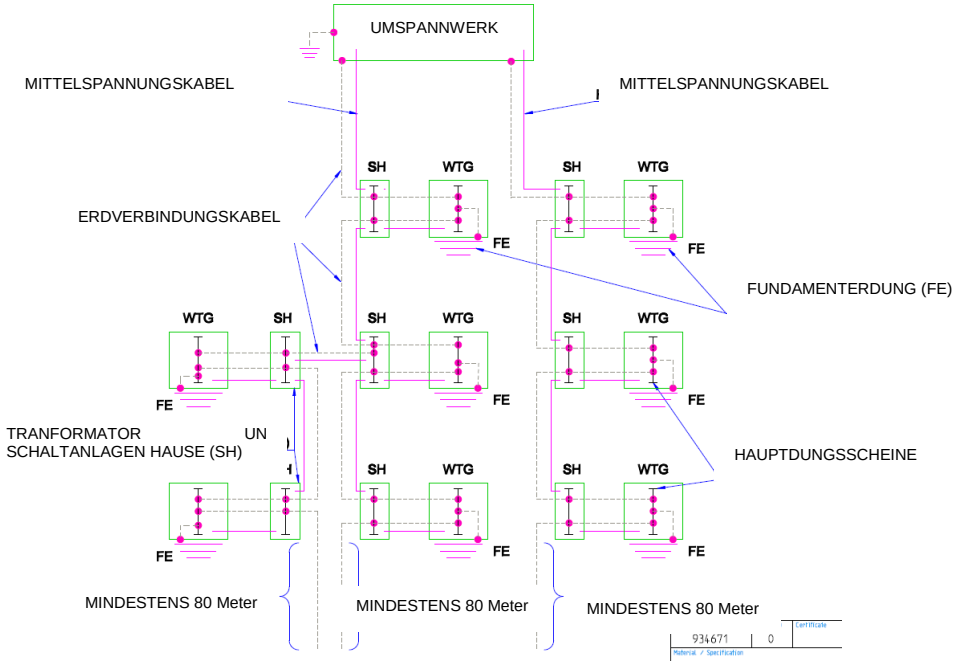


Abbildung 4-3: Erdungssystem in einem Netz (Transformator und/oder Schaltanlage außerhalb der Windenergieanlage) (Zeichnungsnr.: 934671)

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

PUBLIC

5 Referenzdokumente

5.1 Liste der IEC-Normen

Die Bauweise des Vestas-Erdungssystems basiert auf und entspricht den Anforderungen der folgenden internationalen Normen und Richtlinien:

Dokumentennr.	Titel
IEC 61400-24	Windenergieanlagen - Teil 24: Blitzschutz
IEC 60364-5-54	Zweite Ausgabe 2002-06. Elektrische Anlagen in Gebäuden – Teil 5-54: Auswählen und Montieren von elektrischer Ausrüstung – Erdung, Schutzleiter und Potenzialausgleichsleiter
IEC 61936-1	Erste Ausgabe 2002-10. Starkstromanlagen mit Nennwechselspannungen über 1 kV - Teil 1: Allgemeine Bestimmungen

5.2 Liste der zugehörigen Dokumente

In den im nachfolgenden Diagramm aufgeführten Dokumenten wird eine ausführliche Beschreibung des Erdungssystems gegeben. Die Dokumente werden in Abhängigkeit vom Fundamenttyp in verschiedene Modelle eingeteilt.

Nach der Auswahl des zu verwendenden Fundamenttyps sind die zum jeweiligen Fundamenttyp gehörigen Dokumente mit der ausführlichen Beschreibung des Erdungssystems einzusehen. Diese Liste von Dokumenten enthält Arbeitsanweisungen und Spezifikationen zur Qualitätskontrolle.

Im Erdungsüberblickdiagramm sind die zum Vestas-Erdungssystem gehörigen Dokumente angegeben. Siehe Abbildung 5-1, S. 6.

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

VESTAS PROPRIETARY NOTICE

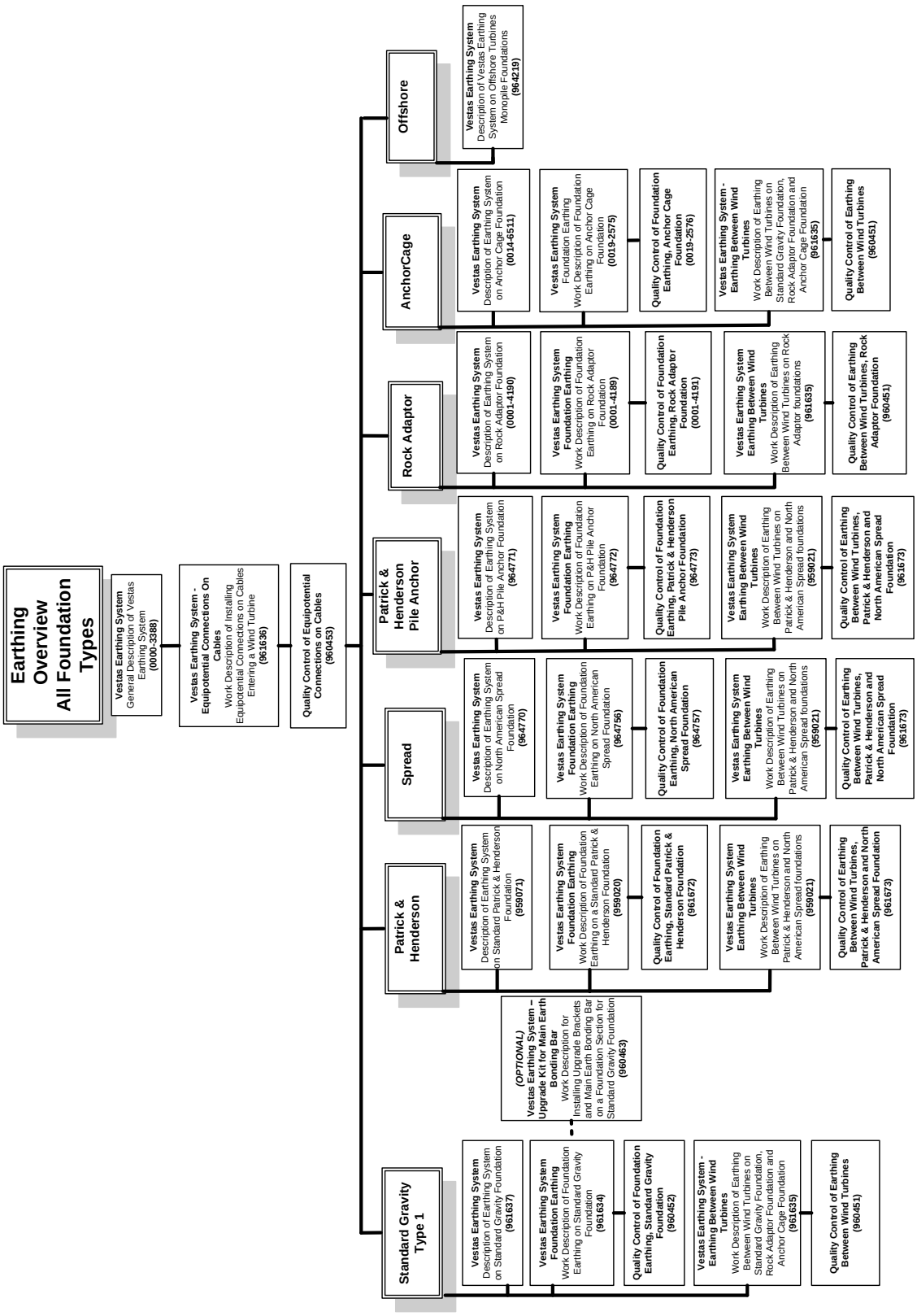


Abbildung 5-1: Erdungsüberblick

5.3 Referenzdokumente

5.3.1 Dokumente für Standardfundamente Typ 1

Dokumentennr.	Titel
961637	Vestas-Erdungssystem Beschreibung des Erdungssystems bei Standard-Schwerkraftfundamenten
961634	Fundamenterdung. Arbeitsanweisung für die Fundamenterdung bei Standard-Schwerkraftfundamenten vom Typ 1
960452	Qualitätskontrolle der Fundamenterdung, Standard-Schwerkraftfundament
961635	Erdung zwischen Windenergieanlagen. Arbeitsanweisung für die Erdung zwischen Windenergieanlagen.
960451	Qualitätskontrolle der Erdung zwischen Windenergieanlagen
961636	Potentialausgleichsverbindungen bei Kabeln. Arbeitsanweisung für die Installation von Potenzialausgleichsverbindungen von Kabeln, die in Windenergieanlagen eingeführt werden.
960453	Qualitätskontrolle der Potentialausgleichsverbindungen bei Kabeln
961699	Vestas-Erdungssystem, Erdungswiderstandsberechnung

Tabelle 5-1: Referenzdokumente für Standardfundamente vom Typ 1

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

5.3.2 Dokumente für Standardfundamente von Patrick & Henderson

Dokumentennr.	Titel
959071	Vestas-Erdungssystem Beschreibung des Erdungssystems bei Standardfundamenten von Patrick & Henderson
959020	Fundamenterdung. Arbeitsanweisung für die Fundamenterdung bei Standardfundamenten von Patrick & Henderson
961672	Qualitätskontrolle der Fundamenterdung, Standardfundamente von Patrick & Henderson
959021	Erdung zwischen Windenergieanlagen. Arbeitsanweisung für die Erdung zwischen Windenergieanlagen bei Fundamenten von Patrick & Henderson und in Nordamerika verbreiteten Fundamenten
961673	Qualitätskontrolle der Erdung zwischen Windenergieanlagen
961636	Potentialausgleichsverbindungen bei Kabeln. Arbeitsanweisung für Potentialausgleichsverbindungen von Kabeln zu Windenergieanlagen
960453	Qualitätskontrolle der Potentialausgleichsverbindungen bei Kabeln
961699	Vestas-Erdungssystem, Erdungswiderstandsberechnung

Tabelle 5-2: Referenzdokumente für Standardfundamente von Patrick & Henderson

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

5.3.3 Dokumente für in Nordamerika verbreitete Fundamente

Dokumentennr.	Titel
964770	Vestas-Erdungssystem Beschreibung des Erdungssystems von in Nordamerika verbreiteten Fundamenten
964756	Fundamenterdung. Arbeitsanweisung für die Fundamenterdung von in Nordamerika verbreiteten Fundamenten.
964757	Qualitätskontrolle der Fundamenterdung, in Nordamerika verbreitete Fundamente
959021	Erdung zwischen Windenergieanlagen. Arbeitsanweisung für die Erdung zwischen Windenergieanlagen bei Fundamenten von Patrick & Henderson und in Nordamerika verbreiteten Fundamenten
961673	Qualitätskontrolle der Erdung zwischen Windenergieanlagen.
961636	Potenzialausgleichsverbindungen bei Kabeln, Arbeitsanweisung für die Installation von Potenzialausgleichsverbindungen von Kabeln, die in Windenergieanlagen eingeführt werden
960453	Qualitätskontrolle der Potentialausgleichsverbindungen bei Kabeln
961699	Vestas-Erdungssystem, Erdungswiderstandsberechnung

Tabelle 5-3: Referenzdokumente für in Nordamerika verbreitete Fundamente

5.3.4 Dokumente für Offshore-Einzelpfahlgründung

Dokumentennr.	Titel
964219	Vestas-Erdungssystem Beschreibung des Vestas-Erdungssystems für Offshore-Windenergieanlagen mit Einzelpfahlgründung.
961636	Potentialausgleichsverbindungen bei Kabeln. Arbeitsanweisung für Potentialausgleichsverbindungen von Kabeln zu Windenergieanlagen
960453	Qualitätskontrolle der Potentialausgleichsverbindungen bei Kabeln

Tabelle 5-4: Referenzdokumente für Offshore-Einzelpfahlgründung

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

5.3.5 Dokumente für Pfahlgründungen von Patrick & Henderson

Dokumentennr.	Titel
964771	Vestas-Erdungssystem Beschreibung des Erdungssystems bei Pfahlgründung von Patrick & Henderson
964772	Fundamenterdung. Arbeitsanweisung für die Fundamenterdung bei Pfahlgründung von Patrick & Henderson
964773	Qualitätskontrolle der Fundamenterdung, Pfahlgründungen von Patrick & Henderson
959021	Erdung zwischen Windenergieanlagen. Arbeitsanweisung für die Erdung zwischen Windenergieanlagen bei Fundamenten von Patrick & Henderson und in Nordamerika verbreiteten Fundamenten
961673	Qualitätskontrolle der Erdung zwischen Windenergieanlagen
961636	Potentialausgleichsverbindungen bei Kabeln. Arbeitsanweisung für Potentialausgleichsverbindungen von Kabeln zu Windenergieanlagen
960453	Qualitätskontrolle der Potentialausgleichsverbindungen bei Kabeln

Tabelle 5-5: Referenzdokumente für Pfahlgründungen von Patrick & Henderson

5.3.6 Dokumente für Felsgründungen

Dokumentennr.	Titel
0001-4190	Vestas-Erdungssystem Beschreibung des Erdungssystems für Felsgründung
0001-4189	Fundamenterdung. Arbeitsanweisung für die Fundamenterdung einer Felsgründung
0001-4191	Qualitätskontrolle der Fundamenterdung, Felsgründungen
961635	Erdung zwischen Windenergieanlagen. Arbeitsanweisung für die Erdung zwischen Windenergieanlagen
960451	Qualitätskontrolle der Erdung zwischen Windenergieanlagen
961636	Potentialausgleichsverbindungen bei Kabeln. Arbeitsanweisung für Potentialausgleichsverbindungen von Kabeln zu Windenergieanlagen
960453	Qualitätskontrolle der Potentialausgleichsverbindungen bei Kabeln

Tabelle 5-6: Referenzdokumente für Felsgründungen

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

5.3.7 Dokumente für Ankerkorbfundamente

Dokumentennr.	Titel
0014-6511	Vestas-Erdungssystem Beschreibung des Erdungssystems bei Ankerkorbfundamenten
0019-2575	Vestas-Erdungssystem Fundamenterdung Arbeitsanweisung für die Fundamenterdung für Ankerkorbfundamente
0019-2576	Qualitätskontrolle der Fundamenterdung, Ankerkorbfundament
961635	Vestas-Erdungssystem – Erdung zwischen Windenergieanlagen, Arbeitsanweisung für die Erdung zwischen Windenergieanlagen
960451	Qualitätskontrolle der Erdung zwischen Windenergieanlagen
961636	Potentialausgleichsverbindungen bei Kabeln. Arbeitsanweisung für Potentialausgleichsverbindungen von Kabeln zu Windenergieanlagen
960453	Qualitätskontrolle der Potentialausgleichsverbindungen bei Kabeln

Tabelle 5-7: Referenzdokumente für Ankerkorbfundamente

T09 0000-3388 Ver 12 - Approved- Exported from DMS: 2022-01-14 by INVOL

Eingeschränkte Weitergabe
Dokumentennr.: 0049-7921 V15
13. Oktober 2022

Allgemeine Spezifikation

Vestas Eiserkennungssystem (VID)

V105/V112/V117/V126/V136-3.45/3.6 MW 50/60 Hz
V117/V136/V150 – 4.0/4.2/4.5 MW 50/60 Hz
V150-5.6/6.0 MW 50/60 Hz
V162- 5.6/6.0/6.2 MW 50/60 Hz
V162/V172 – 7.2 MW 50/60 Hz



Übersetzung der Originalbetriebsanleitung: T05 0049-7921 VER 15

T05 0049-7921 Ver 15 - Approved- Exported from DMS: 2022-11-15 by INVOL

Document owned by Vestas Wind Systems A/S. This document contains valuable confidential information owned by Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Übersetzung der Originalbetriebsanleitung: T05 0049-7921 VER 15

Inhaltsverzeichnis

1 Referenzen ... 3
2 Allgemeine Beschreibung ... 4
3 Mechanische Konstruktion ... 5
3.1 Rotorblätter ... 5
3.2 NABE ... 5
4 Elektrisches System ... 5
4.1 Stromversorgung ... 5
4.2 Elektrische Daten des VID-Systems ... 5
4.3 Unterbrechung der Stromversorgung ... 5
5 WEA-Schutzsysteme ... 6
5.1 Blitzschutz von Rotorblättern, Maschinenhaus, Rotorblattnabe und Turm ... 6
5.2 EMV-System ... 6
6 Betriebsstrategie, Betriebsbereich und Leistungsmerkmale ... 6
6.1 Aktivierung des VID-Systems ... 6
6.2 Betriebsstrategie ... 6
6.3 Über VestasOnline® SCADA verfügbare Daten ... 7
7 Allgemeine Einschränkungen, Hinweise und Haftungsausschlüsse ... 8

Siehe allgemeine Einschränkungen, Hinweise und Haftungsausschlüsse (einschließlich Abschnitt 7 Allgemeine Einschränkungen, Hinweise und Haftungsausschlüsse) der vorliegenden allgemeinen Spezifikation

T05 0049-7921 Ver 15 - Approved- Exported from DMS: 2022-11-15 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0049-7921 VER 15

1 Referenzen

Ref.	Dokumenttitel
[1]	13. Windenergieprojekte in kalten Klimagebieten. IEA Wind – Studie der Expertengruppe zu empfohlenen Maßnahmen, 22. Mai 2012
[2]	RISK ANALYSIS OF ICE THROW FROM WIND TURBINES (Risikoabschätzung des Eisabwurfs von Windenergieanlagen). Henry Seifert u. a., DEWI, Deutsches Windenergie-Institut GmbH
[3]	0047-7240 „GL75172_BR_BLADEControl_Vestas_GA“ von Germanischer Lloyd Industrial Services GmbH
[4]	„MERKBLATT für Vorhaben zur Errichtung von Windenergieanlagen hinsichtlich immissionsschutzrechtlicher und arbeitsschutzrechtlicher Anforderungen an die Antragsunterlagen in Genehmigungsverfahren nach dem BImSchG“ von Struktur- und Genehmigungsdirektion Nord, Rheinland-Pfalz.
[5]	0050–7583 V01 Beschreibung des Weidmüller-Eiserkennungssystems

T05 0049-7921 Ver 15 - Approved- Exported from DMS: 2022-11-15 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0049-7921 VER 15

2 Allgemeine Beschreibung

Bei dem optionalen Vestas Eiserkennungssystem (VID) handelt es sich um ein vollständig in die Windenergieanlage integriertes System, das den Anlagenbetrieb (Stromerzeugung) unterbricht, wenn sich auf den Rotorblättern eine Eisschicht bildet (Eisansatz) und bestimmte weitere Bedingungen erfüllt sind. Dies dient zur Verringerung der Gefahr von Eisabwurf [2]. Erst wenn die Vereisung beseitigt ist, geht die Windenergieanlage wieder in Betrieb oder kann manuell wieder in Betrieb gesetzt werden.

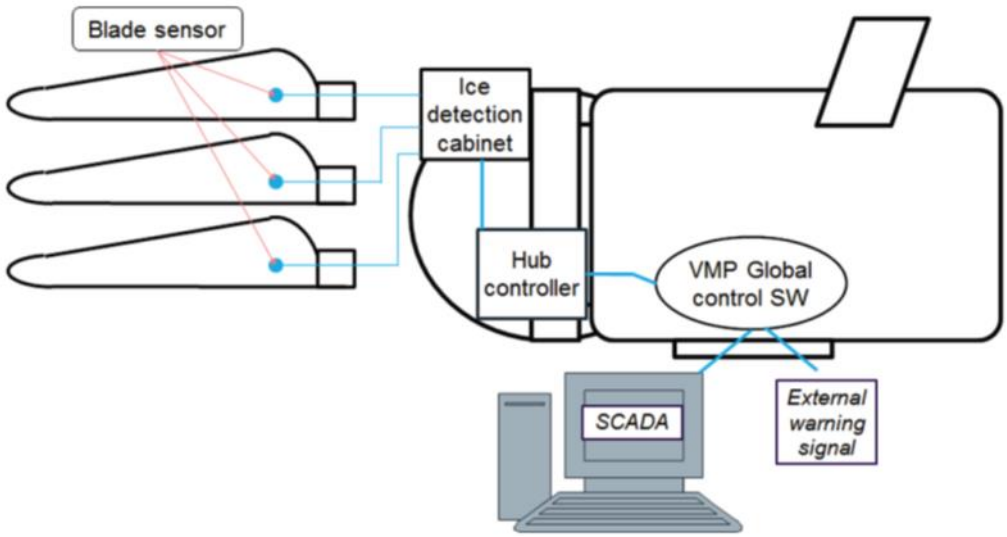


Abb. 1 Systemübersicht

Das VID-System besteht aus zwei Beschleunigungsmessern in jedem Rotorblatt, die mit einem in der Nabe angeordneten Steuerschrank (Schaltschrank der Eiserkennung) verbunden sind, der seinerseits mit der Nabensteuerung der Windenergieanlage verbunden ist.

Der Rotorblattsensor misst die Schwingungsfrequenzen des Rotorblatts, diese werden vom System überwacht. Eisansatz verändert die Grundfrequenzen.

Das System liefert Daten zum Eisansatz und unterbricht den Anlagenbetrieb (Stromerzeugung), sobald bestimmte Bedingungen erfüllt sind. In erster Linie muss der in [5] festgelegte Schwellenwert für den Eisansatz überschritten sein und die Temperatur weniger als 5 °C betragen.

Eisabwurf findet statt, wenn durch die Fliehkraft Eis von den Rotorblättern geschleudert wird, Eissturz hingegen, wenn die WEA stillsteht. Als Drehung gilt > 2 U/min.

Die Daten des Schaltschranks des Eiserkennungssystems werden an die WEA-Steuerung übertragen.

T05 0049-7921 Ver 15 - Approved- Exported from DMS: 2022-11-15 by INVOL

Copyright © - Vestas Wind Systems A/S, Hedeager 42, DK-8200 Aarhus N, Dänemark, www.vestas.com
Klassifizierung: Eingeschränkte Weitergabe

VESTAS PROPRIETARY NOTICE

Übersetzung der Originalbetriebsanleitung: T05 0049-7921 VER 15

Das Vestas Eiserkennungssystem (VID) leitet nach erfolgreicher Inbetriebnahme automatisch eine Kalibrierung ein, um das Vestas Eiserkennungssystem an die spezifische Windenergieanlage anzupassen. Die Kalibrierung läuft normalerweise zwei Tage lang im Hintergrund, bis sie vollständig durchgeführt wurde. Nach diesem Zeitraum ist das Vestas Eiserkennungssystem vollständig einsatzbereit. Die normale Kalibrierung kann nur bei einer Umgebungstemperatur von über +5 °C durchgeführt werden. Falls eine Kalibrierung erforderlich ist, die Temperaturen jedoch unter 5 °C liegen, muss gemeinsam mit dem Lieferanten des Vestas Eiserkennungssystems eine manuelle Kalibrierung durchgeführt werden.

3 Mechanische Konstruktion

3.1 Rotorblätter

Die Versionen der Standardrotorblätter für die VID sind V105/112/V117/ V126/V136 /V150 und V150/V162/V172.

3.2 NABE

Der Schaltschrank der Eiserkennung ist innerhalb der NABE angeordnet und mit dem Steuerschrank der NABENSTEUERUNG sowie mit den Sensoren in den Rotorblättern verbunden.

4 Elektrisches System

Das VID-System ist optional und basiert auf der standardmäßigen Elektrik der Windenergieanlage.

4.1 Stromversorgung

Das VID-System wird mit 24 V DC aus dem Steuerschrank der NABENSTEUERUNG versorgt. Siehe auch Abbildung 1.

4.2 Elektrische Daten des VID-Systems

Elektrische Daten des VID-Systems	
Versorgungsspannung	24 VDC
Nenn-Energieverbrauch des VID-Systems	<21 W

Tabelle 1: Elektrische Daten des VID-Systems

4.3 Unterbrechung der Stromversorgung

Die Stromversorgung kann durch Abziehen des Steckers in der Nabensteuerung unterbrochen werden.

T05 0049-7921 Ver 15 - Approved- Exported from DMS: 2022-11-15 by INVOL

Copyright © - Vestas Wind Systems A/S, Hedeager 42, DK-8200 Aarhus N, Dänemark, www.vestas.com
Klassifizierung: Eingeschränkte Weitergabe

VESTAS PROPRIETARY NOTICE

5 WEA-Schutzsysteme

5.1 Blitzschutz von Rotorblättern, Maschinenhaus, Rotorblattnabe und Turm

Die VID-Sensoren sind nahe der Blattwurzel angebracht, um die Wahrscheinlichkeit eines Blitzeinschlags in das Rotorblatt zu minimieren.

5.2 EMV-System

Das VID-System erfüllt die Anforderungen an die elektromagnetische Verträglichkeit (EMV) genau wie die Windenergieanlage.

Die Integration des VID-Systems in die folgenden Windenergieanlagen entspricht den Anforderungen der DNV-GL-Richtlinie [3] und des Merkblatts [4].

6 Betriebsstrategie, Betriebsbereich und Leistungsmerkmale

6.1 Aktivierung des VID-Systems

Während der Installation des Vestas Eiserkennungssystems verbindet der Monteur seinen PC mit dem Schaltschrank der Eiserkennung und konfiguriert das System. Bis zum Abschluss der Inbetriebnahme ist eine Kalibrierung des VID-Systems pro Windenergieanlage erforderlich, da das Rotorschwingungsmuster einzigartig ist. Die Kalibrierung läuft normalerweise einige Tage lang im Hintergrund, bis sie vollständig abgeschlossen ist. Nach Ablauf des Kalibrierungszeitraums kann die endgültige Inbetriebnahme des VID-Systems erfolgen.

Die automatische Kalibrierung kann nur bei einer Umgebungstemperatur von über +5 °C durchgeführt werden. Bei einer Umgebungstemperatur unter +5 °C muss eine manuelle Kalibrierung mit Unterstützung von Weidmüller durchgeführt werden, was zusätzliche Kosten verursacht. In diesem Fall muss der Rotor manuell auf Eisbildung überprüft werden. Nach Erfassung eines ausreichenden Datenbestands und der manuellen Prüfung ist der Kalibrierungszeitraum abgeschlossen und die endgültige Inbetriebnahme des Vestas Eiserkennungssystems kann erfolgen. Dabei wird die automatische Erkennung aktiviert.

6.2 Betriebsstrategie

Die Betriebsstrategie des VID-Systems beruht im Wesentlichen auf der kontinuierlichen Messung von Eis. Eisansatz an den Rotorblättern (jenseits des Schwellenwerts) und bestimmte weitere Parameter einschließlich Temperaturen unter 5 °C lösen eine Abschaltung der Windenergieanlage (Stromerzeugung) aus. Das Eiserkennungssystem setzt die Messungen an den Rotorblättern fort. Sobald kein Eis mehr erkannt wird (Unterschreitung des Schwellenwerts), nimmt die Windenergieanlage den Betrieb wieder auf. Der Schwellenwert ist einstellbar, alle Änderungen werden entsprechend protokolliert.

Übersetzung der Originalbetriebsanleitung: T05 0049-7921 VER 15

T05 0049-7921 Ver 15 - Approved- Exported from DMS: 2022-11-15 by INVOL

Copyright © - Vestas Wind Systems A/S, Hedeager 42, DK-8200 Aarhus N, Dänemark, www.vestas.com
Klassifizierung: Eingeschränkte Weitergabe

VESTAS PROPRIETARY NOTICE

Es stehen zwei Konfigurationsvarianten für die Eiserkennung zur Verfügung:

1. Variante Eis-Alarm/Eis-Sicherheitsstopp
   Wenn das VID-System Eis erkennt oder nicht in der Lage ist, den Eisansatz zu messen (etwa aufgrund eines Systemausfalls), wird die Windenergieanlage abgeschaltet, sobald die Temperatur unter 5 °C sinkt.

   Diese Konfiguration bietet drei Modi, die definieren, wie die Windenergieanlage nach einem Alarm neu gestartet wird, d. h. *automatisch*,*manuell aus der Ferne* oder *manuell vor Ort*.

2. Variante Eis-Warnung.
   Wenn das VID-System Eis erkennt oder nicht in der Lage ist, den Eisansatz zu messen (etwa aufgrund eines Systemausfalls), sendet es eine Warnmeldung.
   Diese Variante ist nicht in der Lage, die WEA abzuschalten.

Eine optionale E/A-Lösung für den Benutzer ist verfügbar, um ein 24-VDC-Signal in der Turmsteuerung bereitzustellen. Das 24-VDC-Signal wird auf niedrig gesetzt, wenn das VID Eis auf den Rotorblättern feststellt. Das E/A-Signal kann verwendet werden, um eine externe Auslösevorrichtung (Warnton, Licht usw.) anzuschließen, wenn das VID Eis auf den Rotorblättern feststellt. Die Benutzer-EO-Lösung für den Turmschaltschrank ist als Option für 4-MW-Windenergieanlagen erhältlich und in verschiedenen Versionen der EnVentus-Turmsteuerung erhältlich.

6.3 Über VestasOnline® SCADA verfügbare Daten

Die folgenden Daten sind über SCADA verfügbar:

- Ausfallzeit infolge von Eisansatz [hh:mm:ss]
- Produktionsausfall infolge von Eisansatz [kWh]
- Daten zum Eisansatz

Übersetzung der Originalbetriebsanleitung: T05 0049-7921 VER 15

T05 0049-7921 Ver 15 - Approved- Exported from DMS: 2022-11-15 by INVOL

Copyright © - Vestas Wind Systems A/S, Hedeager 42, DK-8200 Aarhus N, Dänemark, www.vestas.com
Klassifizierung: Eingeschränkte Weitergabe

VESTAS PROPRIETARY NOTICE

7 Allgemeine Einschränkungen, Hinweise und Haftungsausschlüsse

- © 2015 Vestas Wind Systems A/S. Dieses Dokument wurde von Vestas Wind Systems A/S und/oder einer der Tochtergesellschaften des Unternehmens (Vestas) erstellt und enthält urheberrechtlich geschütztes Material, Marken und andere geschützte Informationen. Alle Rechte vorbehalten. Das Dokument darf ohne vorherige schriftliche Erlaubnis durch Vestas Wind Systems A/S weder als Ganzes noch in Teilen reproduziert oder in irgendeiner Weise oder Form – sei es grafisch, elektronisch oder mechanisch, einschließlich Fotokopien, Bandaufzeichnungen oder mittels Datenspeicherungs- und Datenzugriffssystemen – vervielfältigt werden. Die Nutzung dieses Dokuments über den ausdrücklich von Vestas Wind Systems A/S gestatteten Umfang hinaus ist untersagt. Marken-, Urheberrechts- oder sonstige Vermerke im Dokument dürfen nicht geändert oder entfernt werden.
- Die allgemeinen Spezifikationen, die in diesem Dokument beschrieben werden, gelten für die aktuelle Version des VID-Systems. Neuere Versionen des VID-Systems, die ggf. zukünftig hergestellt werden, haben unter Umständen hiervon abweichende allgemeine Spezifikationen. Falls Vestas dem Empfänger eine neuere Version des VID-Systems liefern sollte, wird das Unternehmen dem Empfänger hierzu eine aktualisierte allgemeine Spezifikation für das VID-System bereitstellen.
- Dieses Dokument, die allgemeine Spezifikation, stellt kein Verkaufsangebot dar und enthält keinerlei ausdrückliche oder stillschweigende Gewährleistungen, Garantien, Versprechen, Verpflichtungen und/oder Zusicherungen von Vestas. Diese werden hiermit ausdrücklich von Vestas ausgeschlossen, es sei denn, es liegt eine ausdrückliche schriftliche Zusicherung von Vestas gegenüber dem Empfänger vor.
- Bilder und Illustrationen im vorliegenden Dokument können von der tatsächlichen Ausführung/Bauweise abweichen.
- Die Windenergieanlage muss an das Stromnetz angeschlossen und eingeschaltet sein, damit das VID-System betrieben werden kann.
- Das VID-System trägt zur Minderung der Gefahr von Eiswurf bei, ist jedoch nicht für die Minderung der Gefahr von Eissturz oder Eisabfall und/oder Eissturz vorgesehen. Sollte der Empfänger das System für solche Zwecke benutzen oder sich diesbezüglich darauf verlassen, tut er dies auf eigene Gefahr. Die Gefahr von Eiswurf oder Eisabfall infolge des Betriebs der Windenergieanlage und des VID-Systems liegt in der alleinigen Verantwortung des Kunden. Die tatsächlichen Standortbedingungen weisen viele Variablen auf, entsprechend kann die Vereisung in unterschiedlichen Formen auftreten (z. B. Eisstürme oder Vereisung durch Reifansatz). Diese Unterschiede können sich je nach eingestelltem Schwellenwert auf die Leistung des VID-Systems auswirken.
- Angaben zur Verfügbarkeit sind der Betriebs- und Wartungsvereinbarung zu entnehmen.

Übersetzung der Originalbetriebsanleitung: T05 0049-7921 VER 15

T05 0049-7921 Ver 15 - Approved- Exported from DMS: 2022-11-15 by INVOL

Classification: **Restricted**

An den Planer / zukünftigen Betreiber
einer Vestas-Windenergieanlage

Datum
Hamburg, 12.04.2023

Stellungnahme zu der Option „Eiserkennungssystem“ an Vestas Windenergieanlagen
(gültig für Standorte innerhalb Deutschlands)

Sehr geehrte Damen und Herren,

an Standorten innerhalb Deutschlands, wo eine Ausrüstung mit einem Eiserkennungssystem erforderlich ist, bietet die Vestas Deutschland GmbH (VESTAS) standardmäßig dem Kunden die Installation und Integrierung des BLADEcontrol Ice Detector System (BID) der Firma Weidmüller an.

Das in VESTAS Windenergieanlagen (WEA) gemäß [1] integrierte BLADEcontrol Ice Detector System wird unter der Produktbezeichnung Vestas Ice Detection (VID) vertrieben. Das bedeutet, dass das Eiserkennungssystem VID identisch mit dem BID-System ist.

Folgende Gutachten liegen sowohl über das BID-System als auch über die Integrierung des Systems in VESTAS Windenergieanlagen vor und sind ggf. bei einem Antrag gemäß Bundes-Immissionsschutzgesetz (BImSchG) einzureichen:

Ref.	Vestas DMS-Nr.	Berichts-Nr. und Datum	Bezeichnung
[1]	0047-7240.V07	75172, Rev.6 erstellt am 18.10.2021	Gutachten Vestas Ice Detection System (VID), Integration des BLADEcontrol Ice Detector BID in die Steuerung von VESTAS Windenergieanlagen Ersteller: DNV – Energy Systems Certification (Deutsch)
[2]	0080-9248.V06 (Seite 1-2)	TC-DNV GL-SE-0439-04314-2 erstellt am 20.10.2022	Typenzertifikat Eiserkennungssystem BLADEcontrol Ice Detector (BID) Ersteller: DNV GL - Energy, Renewables Certification (Deutsch)
[3]	0080-9248.V06 (Seite 3-7)	75138, Rev.8 erstellt am 24.11.2022	Gutachten Ice Detection System BLADEcontrol Ice Detector BID Ersteller: DNV GL - Energy, Renewables Certification (Deutsch)
[4]	0049-7921.V15	13.10.2022	Allgemeine Spezifikation Vestas Eiserkennung (VID) (Deutsch)

Das Typenzertifikat [2] des VID Zertifikats TC-DNV GL-SE-0439-04314-2 vom 20.10.2022 ersetzt das abgelaufene Zertifikat TC-DNV GL-SE-0439-04314-1 vom 20.10.2020.
Die Zertifizierungsberichte können aus Gründen des Intellectual Property Rights (IPR) nicht geteilt werden und wurden daher aus den Unterlagen entfernt.

Mit freundlichen Grüßen

Technical Sales Management

Vestas Northern & Central Europe
Vestas Deutschland GmbH

Vestas Deutschland GmbH
Klostertor 1, 20097 Hamburg, Deutschland
Tel: +49 40 467785000, Fax: +49 40 467785080, vestas-centraleurope@vestas.com, www.vestas.com
Handelsregister: Hamburg HRB 154968, Umsatzsteueridentifikationsnummer: DE 134 657 783,
Geschäftsführer: Cornelis de Baar, Emma Bergman, Daniel Fröhling
Company reg. name: Vestas Deutschland GmbH

T05 0047-8035 Ver 12 - Approved- Exported from DMS: 2023-04-13 by INVOL

Restricted - 2023-04-13 - This document contains valuable Vestas Wind Systems A/S intellectual property. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

16.1.4 Standsicherheit

Anlagen:

- #16-1-4-1.1_250130_I17-SE-2025-055_Gebstedt_ENTWURF.pdf
- 0136-0~1.PDF
- A_0128~1.PDF
- 0131-8~1.PDF
- A_0146~1.PDF
- 0131-8~1_1.PDF
- A_0146~1_1.PDF

Gutachten zur Standorteignung von Windenergieanlagen

nach DIBt 2012 für den Windpark Gebstedt

Deutschland

Bericht-Nr.: I17-SE-2025-055 ENTWURF

I17-Wind GmbH & Co. KG --- Robert-Koch-Straße 29 --- 25813 Husum

Gutachten zur Standorteignung von WEA nach DIBt 2012 für den

Windpark Gebstedt

Bericht-Nr.:	I17-SE-2025-055 ENTWURF
Auftraggeber:	Pavana GmbH Peter-Henlein-Straße 2 - 4 D-27472 Cuxhaven
Auftragnehmer:	I17-Wind GmbH & Co. KG Robert-Koch-Straße 29 D-25813 Husum Tel.: 04841 – 87596 – 0 E-Mail: mail@i17-wind.de Internet: www.i17-wind.de
Datum:	30. Januar 2024

Haftungsausschluss und Urheberrecht

Das vorliegende Gutachten wurde unabhängig, unparteiisch und nach bestem Wissen und Gewissen nach derzeitigem Stand der Technik erstellt. Für vom Auftraggeber und vom Anlagenhersteller bereitgestellte Daten, die nicht von der I17-Wind GmbH & Co. KG erhoben oder ermittelt wurden, kann keine Gewähr für deren Korrektheit übernommen werden. Diese werden als richtig vorausgesetzt.

Urheber des vorliegenden Gutachtens zur Standorteignung von WEA nach DIBt 2012 ist die I17-Wind GmbH & Co. KG. Der Auftraggeber erhält nach § 31 Urheberrechtsgesetz das einfache Nutzungsrecht, welches nur durch Zustimmung des Urhebers übertragen werden kann. Eine Bereitstellung zum uneingeschränkten Download in elektronischen Medien ist ohne gesonderte Zustimmung des Urhebers nicht gestattet.

Akkreditierung

Die I17-Wind GmbH & Co. KG ist nach DIN EN ISO/IEC 17025:2018 durch die Deutsche Akkreditierungsstelle GmbH (DAkkS) für die Bereiche „Erstellen von Schallimmissionsprognosen für Windenergieanlagen; Erstellen von Schattenwurfimmissionsprognosen für Windenergieanlagen; Prüfung der Standorteignung von Windenergieanlagen mittels Berechnung (Turbulenzgutachten)“ akkreditiert. Die Registriernummer der Urkunde lautet D-PL-21268-01-00. Diese kann angefragt, oder in der Datenbank der akkreditierten Stellen der DAkkS eingesehen werden.

Die I17-Wind GmbH & Co. KG ist Mitglied im Sachverständigenbeirat des Bundesverbandes WindEnergie (BWE) e.V.

Anmerkung zu Typenprüfung und Anlagenparametern der WEA

Wenn zum Zeitpunkt der Gutachtenerstellung die Typenprüfung oder Einzelprüfung für die geplanten WEA noch nicht vorlag, wurde der Vergleich auf Basis vom Hersteller übermittelter Auslegungswerte der geplanten WEA durchgeführt. Es besteht die Möglichkeit, dass die im Genehmigungsverfahren eingereichten Dokumente bezüglich der Auslegungswerte der betrachteten WEA nicht mit den im vorliegenden Gutachten zitierten Dokumenten übereinstimmen. Die zitierten Dokumente entsprechen dem aktuellen Stand zum Zeitpunkt der Gutachtenerstellung. Bei abweichenden Dokumenten behält das vorliegende Gutachten dennoch seine Gültigkeit, wenn die im Gutachten berücksichtigten Auslegungswerte durch die im Rahmen des Genehmigungsverfahrens eingereichten Auslegungswerte abgedeckt sind. Im Folgenden ist der Begriff Einzelprüfung stets durch den Begriff Typenprüfung mit abgedeckt, auch wenn dies nicht explizit erwähnt wird.

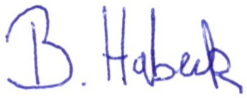
Änderungen der berücksichtigten Anlagenparameter wie c_t-Kurve und Schnelllaufzahl λ sind dem Anlagenhersteller vorbehalten und bedürfen einer neuen Berechnung und Bewertung. Bei einer Änderung der Anlagenparameter gegenüber dem Stand zum Zeitpunkt der Gutachtenerstellung verliert das vorliegende Gutachten seine Gültigkeit.

Revisionsnummer	Datum	Änderung	Verfasser
0 - Entwurf	30.01.2024	Entwurfsbericht zur Lastrechnung	Habeck

Verfasser:

B. Eng. Benjamin Habeck, Sachverständiger

Husum, 30.01.2025



Geprüft:

B. Eng. Heiko Pauls, Sachverständiger

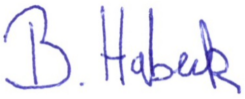
Husum, 30.01.2025



Freigegeben:

B. Eng. Benjamin Habeck, Sachverständiger

Husum, 30.01.2025



Dieses Dokument wurde digital signiert und die Integrität des Dokuments wurde überprüft. Das zugehörige Zertifikat kann von der I17-Wind GmbH & Co. KG auf Anfrage gerne zur Verfügung gestellt werden.

Inhaltsverzeichnis

1 Vorbemerkung 7
1.1 Allgemeines 7
1.2 Geführte Nachweise 7
1.2.1 Vergleich der Windbedingungen an topografisch nicht komplexen Standorten 8
1.2.2 Vergleich der Windbedingungen an topografisch komplexen Standorten 8
1.2.3 Verfahren bei Überschreitungen – Nachweis durch Vergleich der Lasten 9
1.3 Hinweise zu den zu Grunde gelegten Richtlinien 10
1.4 Qualität der zu Grunde gelegten Daten und Modelle 12
2 Aufgabenstellung und Standort 13
2.1 Umfang des Gutachtens 13
2.2 Standortbeschreibung 13
2.3 Auslegungswindbedingungen der geplanten WEA 13
3 Vergleich der Windbedingungen 16
3.1 Grundlagen 16
3.2 Vergleich v_{ave} und v_{m50} 17
3.2.1 Vergleich der mittleren Windgeschwindigkeit v_{ave} 17
3.2.2 Vergleich der 50-Jahres-Windgeschwindigkeit v_{m50} 17
3.3 Vergleich der effektiven Turbulenzintensität I_{eff} 18
3.3.1 Auslegungswindbedingungen hinsichtlich der Turbulenzintensität 18
3.3.2 Ermittlung der Umgebungsturbulenzintensität 20
3.3.3 Ermittlung der effektiven Turbulenzintensität I_{eff} 22
3.4 Schräganströmung δ 28
3.5 Höhenexponent α 28
3.6 Luftdichte ρ 29
3.7 Extreme Turbulenzintensität I_{ext} 30
4 Zusammenfassung 31
4.1 Neu geplante WEA 31
4.2 Bestehende WEA 32
5 Standortbesichtigung 33
Abkürzungs- und Symbolverzeichnis 34
Literaturverzeichnis 36

Abbildungsverzeichnis

Abbildung 2.1: Zu untersuchende Windparkkonfiguration; Kartenmaterial: [19.1, 19.2] 15

Tabellenverzeichnis

Tabelle 2.1: Zu untersuchende Windparkkonfiguration 14
Tabelle 2.2: Auslegungswindbedingungen der neu geplanten WEA 14
Tabelle 3.1: Windverhältnisse am Standort WV 1/1 [22.1] 16
Tabelle 3.2: Vergleich der mittleren Windgeschwindigkeit v_{ave} auf Nabenhöhe der geplanten WEA.. 17
Tabelle 3.3: Vergleich der 50-Jahres-Windgeschwindigkeit v_{m50} auf Nabenhöhe der geplanten WEA 18
Tabelle 3.4: Richtlinienabhängige Auslegungswindbedingungen hinsichtlich der Turbulenzintensität19
Tabelle 3.5: Komplexitätskriterien und C_{CT} nach DIN EN IEC 61400-1:2019 [6] 21
Tabelle 3.6: Repräsentative Turbulenzintensität für einen Standort 22
Tabelle 3.7: Ermittelte effektive Turbulenzintensitäten I_{eff} (vor Zubau) 25
Tabelle 3.8: Ermittelte effektive Turbulenzintensitäten I_{eff} (nach Zubau) 26
Tabelle 3.9: Geforderte Betriebsbeschränkungen zum Schutz von W3 27
Tabelle 3.10: Geforderte Betriebsbeschränkungen zum Schutz von W12 27
Tabelle 3.11 Standortmittelwert der Schräganströmung δ_{NH} der neu geplanten WEA 28
Tabelle 3.12 Standortmittelwert des Höhenexponenten α_{NH} der neu geplanten WEA 28
Tabelle 3.13: Standortmittelwert der Luftdichte ρ_{NH} der neu geplanten WEA 29
Tabelle 3.14: Ermittelte extreme Turbulenzintensitäten $I_{ext, NH}$ 30
Tabelle 4.1: Zusammenfassung der Ergebnisse geplante WEA 31
Tabelle 4.2: Zusammenfassung der Ergebnisse Bestands-WEA 32

1 Vorbemerkung

1.1 Allgemeines

Das Deutsche Institut für Bautechnik DIBt hat Anfang des Jahres 2013 die Fassung Oktober 2012 der *„Richtlinie für Windenergieanlagen – Einwirkungen und Standsicherheitsnachweise für Turm und Gründung“* veröffentlicht und im März 2015 eine korrigierte Fassung herausgegeben [1.1], auf deren Grundlage das vorliegende Gutachten erstellt wurde.

Aufgrund fehlender Kriterien für einen Immissionsgrenzwert für die durch benachbarte Windenergieanlagen verursachten erhöhten Turbulenzbelastungen an einer WEA, können ersatzweise die Kriterien der Standorteignung bezüglich der effektiven Turbulenzintensität für eine Turbulenzimmissionsprognose im Rahmen eines Antrages nach dem Bundes-Immissionsschutz-Gesetz (BImSchG) herangezogen werden. Eine Reduktion der Lebenszeit und der zusätzliche Verschleiß der WEA sind zumutbar, solange die Standorteignung hinsichtlich der Auslegungswerte der Turbulenzintensität oder hinsichtlich der Auslegungslasten gewährleistet bleibt. Somit stellt das vorliegende Gutachten zur Standorteignung von WEA zusätzlich eine Turbulenzimmissionsprognose im Sinne des BImSchG dar und kann als Bestandteil der Antragsstellung nach dem BImSchG verwendet werden.

1.2 Geführte Nachweise

Die Richtlinie DIBt 2012 [1.1] fordert in Kapitel 16 ein alternatives, vereinfachtes Verfahren zum Nachweis der Standorteignung von WEA, das jedoch nur angewendet werden darf, wenn die Standorte der geplanten WEA nach DIN EN 61400-1:2011-08 [7] als nicht topografisch komplexe Standorte zu bezeichnen sind. Im Dezember 2019 wurde die Norm DIN EN IEC 61400-1:2019 [6] veröffentlicht, welche die Norm DIN EN 61400-1:2011-08 [7] ersetzt. Entsprechend der Richtlinie DIBt 2012 [1.1] ist die jeweils angewendete Ausgabe der Norm DIN EN (IEC) 61400-1, entsprechend [6] oder [7], in Ihrer Gesamtheit anzuwenden, weshalb auch die Ermittlung der topografischen Komplexität im vorliegenden Gutachten nach [6] erfolgt. Sind vereinzelte Standorte neu geplanter WEA als topografisch komplex zu bezeichnen, wird der vereinfachte Nachweis der Standorteignung nach [1.1] um die Kriterien nach DIN EN IEC 61400-1:2019 [6], Abschnitt 11.9, erweitert. Die Vergleiche der Auslegungswerte für die zu untersuchenden Größen mit den im Rahmen dieses Gutachtens ermittelten Werten sind nach der DIBt Richtlinie Fassung Oktober 2012 nur für neu geplante Anlagen zu führen [1.1]. Für bestehende Anlagen, die nach der DIBt 1993 [3] oder DIBt 2004 [2] typengeprüft wurden, darf im Falle einer Parkänderung / -erweiterung der Nachweis der Standorteignung auch weiterhin nach dem Verfahren der DIBt 2004 erbracht werden [1.1].

Die Richtlinie DIBt 2012 [1.1] lässt folgende Möglichkeiten, bzw. mögliche auftretende Konfigurationen, in Bezug auf die Typenprüfung und die dieser zu Grunde gelegten Richtlinie, unberücksichtigt:

i. Der geplanten Anlage liegt eine Typenprüfung nach der Richtlinie DIBt 2004 [2] zu Grunde.

ii. Einer oder mehrerer zu berücksichtigender Bestandsanlagen liegt eine Typenprüfung nach der DIBt 2012 [1.1] Richtlinie zu Grunde.

Für diese zwei beschriebenen Fälle, die nicht durch die DIBt 2012 [1.1] abgedeckt sind, werden folgende Verfahrensweisen gemäß [1.2] als Quasistandard angewandt:

i. Liegt einer neu geplanten Anlage eine Typenprüfung gemäß DIBt 2004 [2] zu Grunde, wird der Nachweis der Standorteignung basierend auf dem vereinfachten Verfahren nach DIBt 2012 [1.1], beschrieben in Abschnitt 1.2.1, geführt. Dieser Nachweis entspricht den Mindestanforderungen der zum Nachweis der Standorteignung der Typenprüfung nach DIBt 2004 [2] zu Grunde gelegten Richtlinie DIN EN 61400-1:2004 [8], bzw. IEC 61400-1 ed.2 [4].

ii. Da davon auszugehen ist, dass für bereits genehmigte, bzw. bestehende Anlagen mit einer Typenprüfung nach DIBt 2012 [1.1] die Standorteignung in deren Genehmigungsverfahren

nachgewiesen wurde, werden nur durch hinzukommende Anlagen beeinflusste Parameter geprüft und mit den Auslegungswerten verglichen. Dies entspricht lediglich der effektiven Turbulenzintensität I_{eff}, welche durch einen Zubau erhöht werden kann.

Nach DIN EN 1991-1-4/NA:2010-12 [9] ist bei zylindrischen Bauwerken die Untersuchung von Interferenzeffekten oder wirbelerregten Schwingungen zu führen, wenn deren Abstand untereinander den in [9] definierten Mindestabstand unterschreitet. Diese Untersuchung ist nicht Bestandteil der Richtlinie DIBt 2012 [1.1] und wird daher im vorliegenden Gutachten nicht durchgeführt, sondern hat durch einen dritten unabhängigen Gutachter oder Prüfstatiker zu erfolgen.

1.2.1 Vergleich der Windbedingungen an topografisch nicht komplexen Standorten

Der nach der DIBt Richtlinie Fassung 2012 [1.1] vereinfachte Nachweis zur Standorteignung verlangt folgende Nachweise der Windbedingungen auf Nabenhöhe der geplanten WEA:

i. Vergleich der mittleren Windgeschwindigkeit.

   (1) Die mittlere Windgeschwindigkeit am Standort ist um mindestens 5 % kleiner als gemäß Typen-/Einzelprüfung, oder

   (2) die mittlere Windgeschwindigkeit ist kleiner als gemäß Typen-/Einzelprüfung und für den Formparameter k der Weibull-Funktion gilt: $k \geq 2$.

ii. Vergleich der effektiven Turbulenzintensität nach DIN EN 61400-1:2011-08 [7] zwischen 0.2 v_{m50} (h) und 0.4 v_{m50} (h) mit der Auslegungsturbulenz nach NTM.

iii. Vergleich der 50-Jahreswindgeschwindigkeit.

   (1) Die Windzone gemäß Typen-/Einzelprüfung deckt die Windzone des betrachteten Standortes entsprechend der Windzonenkarte ab (die detaillierten Regelungen gemäß DIN EN 1991-1-4, Absatz 4.3.3 einschließlich NA [9] für nicht ebene Geländelagen sind ggf. zu beachten), oder

   (2) die 50-Jahreswindgeschwindigkeit v_{m50} (h) gemäß Typen-/Einzelprüfung deckt die 50-Jahreswindgeschwindigkeit am Standort ab (z.B. Nachweis durch eine Extremwindabschätzung).

1.2.2 Vergleich der Windbedingungen an topografisch komplexen Standorten

Handelt es sich nach Abschnitt 11.2 der DIN EN IEC 61400-1:2019 [6] um einen als topografisch komplex zu bezeichnenden Standort der Kategorie L, M oder H und liegt der zu untersuchenden WEA eine Typenprüfung nach DIBt 2012 [1.1] zu Grunde, wird der vereinfachte Nachweis zur Standorteignung nach Abschnitt 1.2.1 um folgende Nachweise der Windbedingungen auf Nabenhöhe der geplanten WEA, basierend auf DIN EN IEC 61400-1:2019 [6] erweitert.

i. Der windenergiegewichtete Mittelwert aller Richtungen der Schräganströmung δ darf den vorgegebenen Wert von +/- 8°, bzw. den in der Typenprüfung angegebenen Wert, nicht überschreiten bzw. unterschreiten.

ii. Der über alle Richtungen und Windgeschwindigkeiten energiegewichtete Standortmittelwert des Höhenexponenten α darf den Wert von $0.05 \leq \alpha \leq 0.25$, bzw. den in der Typenprüfung angegebenen Wert nicht überschreiten bzw. unterschreiten.

iii. Der Standortmittelwert der Luftdichte ρ darf bei allen Windgeschwindigkeiten größer gleich der Nennwindgeschwindigkeit v_r den Wert 1.225 kg/m³ oder den in der Typenprüfung angegebenen Wert nicht überschreiten. Alternativ kann eine Luftdichte über dem Wert von 1.225 kg/m³ oder dem in der Typenprüfung angegeben Wert durch Einhaltung der folgenden Ungleichung nachgewiesen werden:

$$\rho_{\text{Auslegung}} * v^2_{\text{ave,Auslegung}} \geq \rho_{\text{Standort}} * v^2_{\text{ave,Standort}}$$

iv. Es ist der Nachweis zu erbringen, dass die Auslegungswerte des ETM auch unter Berücksichtigung der Nachlaufsituation mit der höchsten Nachlaufturbulenz im Zentrum des Nachlaufs, nicht überschritten werden.

1.2.3 Verfahren bei Überschreitungen – Nachweis durch Vergleich der Lasten

Kann der vereinfachte Nachweis der Windbedingungen nach DIBt 2012 [1.1] aus Abschnitt 1.2.1 nicht geführt werden, da die zu prüfenden Parameter mittlere Windgeschwindigkeit v_{ave} oder effektive Turbulenzintensität I_{eff} nicht eingehalten werden, kann die Standorteignung durch einen Lastvergleich (Vergleich der standortspezifischen Lasten mit den Lastannahmen der Typenprüfung) der Betriebsfestigkeitslasten nachgewiesen werden. In diesem Fall ist der Nachweis der Standorteignung der jeweiligen WEA auf Basis eines Lastvergleiches der Betriebsfestigkeitslasten (DLC 1.2) zu führen. Wird der Auslegungswert v_{m50} nicht eingehalten, kann die Standorteignung auf Basis eines Lastvergleichs der Extremlasten nachgewiesen werden. In diesem Fall ist der Nachweis der Standorteignung der jeweiligen WEA auf Basis eines Lastvergleiches der Extremlasten (DLC 1.1, DLC 1.3, DLC 6.1, und DLC 6.2) zu führen.

Kann der Nachweis der Windbedingungen an einem als topografisch komplex zu bezeichnenden Standort nach Abschnitt 1.2.1 und Abschnitt 1.2.2 nicht geführt werden, da einer oder mehrere der zu prüfenden Werte nicht eingehalten werden, kann die Standorteignung entsprechend DIN EN IEC 61400-1:2019 [6] auf Basis eines Lastvergleiches unter Berücksichtigung der standortspezifischen Windbedingungen aus Abschnitt 1.2.1 und Abschnitt 1.2.2 durchgeführt werden. Demnach ist der Nachweis der Standorteignung der jeweiligen WEA auf Basis eines Lastvergleiches der Betriebsfestigkeitslasten (DLC 1.2) und/oder der Extremlasten (DLC 1.1, DLC 1.3, DLC 6.1, und DLC 6.2) zu führen.

In beiden Fällen werden die der Typenprüfung zu Grunde gelegten Auslegungslasten mit den standortspezifischen Lasten, die auf Basis der standortspezifischen Windbedingungen aus dem vorliegenden Gutachten ermittelt werden, verglichen. Wenn sich zeigt, dass die standortspezifischen Lasten die Auslegungslasten nicht überschreiten oder diese einhalten, ist eine Standorteignung durch den Vergleich der Lasten nachgewiesen. Werden die Auslegungslasten nicht eingehalten, muss die Anlage gegebenenfalls mit einer sektoriellen Betriebseinschränkung betrieben werden, um die Lasten soweit zu reduzieren, dass sie innerhalb der Auslegungslasten liegen, oder die Standorteignung kann nicht durch einen Vergleich der Lasten nachgewiesen werden.

Die Berechnung der standortspezifischen Lasten erfolgt in der Regel durch den Hersteller der betrachteten WEA. Der zugehörige Bericht zur durchgeführten Lastberechnung wird der I17-Wind GmbH & Co. KG im Rahmen einer Geheimhaltungsvereinbarung vorgelegt. Zudem ist es möglich die Betriebsfestigkeits- und Extremlasten einer WEA basierend auf einem generischen Anlagenmodell zu ermitteln und mit den Auslegungslasten, welche mittels des identischen generischen Anlagenmodells ermittelt werden, zu vergleichen. Diese Berechnungen erfolgen in der Regel nicht durch den Anlagenhersteller, sondern durch einen dritten unabhängigen Gutachter. Die Berichte werden von der I17-Wind GmbH & Co. KG dahingehend überprüft, dass die Eingangsdaten korrekt übernommen und angesetzt wurden. Das Ergebnis einer Lastberechnung wird als richtig vorausgesetzt. Eine Haftung für die Richtigkeit einer Lastrechnung, sowohl eines Anlagenherstellers als auch eines dritten, unabhängigen Gutachters, wird nicht übernommen.

1.3 Hinweise zu den zu Grunde gelegten Richtlinien

Folgende, von der DIBt 2012 Richtlinie [1.1] und der DIN EN IEC 61400-1:2019 [6] abweichende, jedoch konservativ abdeckende, Verfahren wurden für das vorliegende Gutachten zur Standorteignung von WEA gewählt:

I. Entsprechend der DIBt 2012 [1.1] ist es für eine Prüfung der Standorteignung Voraussetzung, dass für die WEA eine Typenprüfung bzw. eine Einzelprüfung vorliegt. Ist dies nicht der Fall, wird der Vergleich auf Basis von vorläufigen Auslegungswerten, für die die Typenprüfung voraussichtlich angestrebt wird, durchgeführt. Somit behält das vorliegende Gutachten im Falle einer Typenprüfung bzw. Einzelprüfung, welche die zu Grunde gelegten Auslegungsparameter abdeckt, seine Gültigkeit.

II. Es wird davon ausgegangen, dass jede im Gutachten betrachtete WEA die Ihrer Typenprüfung zu Grunde gelegte Auslegungslebensdauer τ_{TP} noch nicht überschritten hat.

III. Der Vergleich des Standortwertes der mittleren Windgeschwindigkeit auf Nabenhöhe v_{ave} mit dem Auslegungswert kann nur nach [1.1] erfolgen, wenn die Auslegungswerte der zu betrachtenden WEA einen Formparameter k der Weibullverteilung von k = 2.0 ausweisen. Wenn die Auslegungswerte der zu betrachtenden WEA einen Formparameter $k \neq 2.0$ ausweisen, kann der in [1.1] geforderte Vergleich nicht mehr erfolgen. In diesem Fall wird das Verfahren nach [6] gewählt, welches einen Vergleich der Wahrscheinlichkeitsdichtefunktion pdf_{NH} der standortspezifischen Windgeschwindigkeiten mit der Wahrscheinlichkeits-dichtefunktion pdf_{TP} der Typenprüfung in einem Bereich von v_{ave} - $2v_{ave}$ fordert. Zusätzlich wird der Bereich von $0.2v_{ref}$ - $0.4v_{ref}$ nach [7] herangezogen und stets der konservativ abdeckende Bereich dem Vergleich zu Grunde gelegt. In dem zu untersuchenden Bereich muss die Bedingung $pdf_{NH} \leq pdf_{TP}$ erfüllt sein. Die Berechnung der Wahrscheinlichkeitsdichte-funktionen pdf_{NH} und pdf_{TP} erfolgt entsprechend [6] auf Basis der Standortmittelwerte A_{NH} und k_{NH} bzw. der Auslegungswerte A_{TP} und k_{TP} der zu untersuchenden WEA.

Kann der Vergleich des Standortwertes der mittleren Windgeschwindigkeit auf Nabenhöhe v_{ave} mit dem Auslegungswert nach DIBt Richtlinie Fassung 2012 [1.1] nicht erbracht werden, wird sich zur Definition von sektoriellen Betriebsbeschränkungen vorbehalten den Vergleich der Wahrscheinlichkeitsdichtefunktion der standortspezifischen Windgeschwindigkeiten pdf_{NH} nach [6] durchzuführen, da dieses Verfahren das in [1.1] geforderte Verfahren konservativ mit abdeckt.

IV. Erfolgt der Nachweis der Standorteignung durch den Vergleich der Windbedingungen nach Abschnitt 1.2.1 und 1.2.2, hat der Vergleich der standortspezifischen effektiven Turbulenzintensität und der Auslegungsturbulenz nach NTM in dem Bereich zwischen $0.2v_{m50}$(h) und $0.4v_{m50}$(h) zu erfolgen [1.1]. Liegt einer zu betrachtenden WEA keine Auslegungsturbulenz nach NTM vor, erfolgt der Vergleich mit der in der Typenprüfung aufgeführten Auslegungsturbulenz. Entsprechend [6] hat der Vergleich in dem Bereich zwischen v_{ave} und $2v_{ave}$ zu erfolgen. Erfolgt der Nachweis der Standorteignung durch den Vergleich der Lasten nach Abschnitt 1.2.3, sind der Lastberechnung nach [1.1] mindestens die standortspezifischen effektiven Turbulenzintensitäten von v_{in} bis $0.4v_{m50}$(h) bzw. von v_{in} bis v_{out} entsprechend DLC 1.2 nach [6] zu Grunde zu legen. Im vorliegenden Gutachten werden die standortspezifischen effektiven Turbulenzintensitäten mindestens im Windgeschwindigkeits-bereich von 5 m/s bis 25 m/s (bzw. v_{out} wenn v_{out} < 25 m/s) ausgewiesen, was die oben beschriebenen Anforderungen für den Nachweis der Standorteignung durch den Vergleich der Windbedingungen nach [1.1], [6] und auch [7] abdeckt. Erfolgt der Nachweis der Standorteignung durch den Vergleich der Lasten, werden dem Anlagenhersteller grundsätzlich die standortspezifischen effektiven Turbulenzintensitäten in dem Bereich von v_{in} bis v_{out} zur Verfügung gestellt. Liegt einer zu prüfenden WEA eine Typenprüfung nach [2] zu Grunde,

erfolgt der Vergleich mit der Turbulenzkurve für Turbulenzkategorie A nach [1.1], da dieser Verlauf den nach [2] anzusetzenden mit abdeckt.

V. Bezüglich der effektiven Turbulenzintensität I_{eff} werden grundsätzlich alle Anlagen im Umkreis des 10fachen Rotordurchmessers D der geplanten Anlage(n) in die Betrachtung einbezogen und nachgewiesen. Dieses Kriterium deckt alle Kriterien nach [1.1], [6] und [7] ab.

VI. Der standortspezifische Mittelwert der Luftdichte ρ wird abdeckend für alle Windgeschwindigkeiten angegeben.

VII. Hinsichtlich der Auslegungswindbedingungen des ETM werden die Werte der höchsten Turbulenz im Zentrum des Nachlaufs ausgewiesen. Da eine Überschreitung der Auslegungswindbedingungen bezüglich des ETM in der Regel mit einer Überschreitung der effektiven Turbulenzintensität einhergeht, kann davon ausgegangen werden, dass eine Überschreitung der extremen Turbulenzintensität nur in solchen Fällen eintritt, in denen die Standorteignung durch eine Lastrechnung des Herstellers nachgewiesen werden muss, was dann auf Basis der ausgewiesenen Werte für die Extremturbulenz erfolgt. Aus diesem Grund wird der Vergleich der Auslegungswindbedingungen des ETM mit den Standortbedingungen nicht geführt.

VIII. Auf Grund der verwendeten Berechnungsprogramme und deren Zahlenausgabeformat, werden die im vorliegenden Gutachten ausgewiesenen Ergebnisse in der Regel mit dem Dezimaltrennzeichen „Punkt“ versehen.

IX. Auf Grund der unterschiedlichen Begrifflichkeiten und Bezeichnungen identischer Größen in den zu Grunde gelegten Richtlinien und Normen, werden im vorliegenden Gutachten teilweise Begriffe und Bezeichnungen gewählt bzw. eingeführt, die, soweit möglich, eine Ähnlichkeit zu den jeweiligen Begriffen und Bezeichnungen in den Richtlinien und Normen aufweisen, um sie diesen zuordnen zu können. Die korrekte Umsetzung der in den Richtlinien und Normen geforderten Vergleiche bleibt davon unberührt.

1.4 Qualität der zu Grunde gelegten Daten und Modelle

Alle im Rahmen des vorliegenden Gutachtens ermittelten Ergebnisse und Zwischenergebnisse basieren einerseits auf Angaben, die vom Auftraggeber übermittelt wurden und andererseits auf Berechnungsergebnissen, die durch die I17-Wind GmbH & Co. KG ermittelt wurden. Zu den Unsicherheiten der den Eingangsdaten vom Auftraggeber zu Grunde gelegten Berechnungsmodellen kann seitens der I17-Wind GmbH & Co. KG keine Aussage getroffen werden. Diese Eingangsdaten werden im Weiteren als richtig und repräsentativ für den betrachteten Standort vorausgesetzt.

Die in den Berechnungen herangezogenen Anlagenparameter, Schubbeiwert c_t und Schnelllaufzahl λ, werden in der Regel vom Anlagenhersteller bereitgestellt. Diese Werte werden als richtig vorausgesetzt. Die berücksichtigten Werte entsprechen dem Stand zum Zeitpunkt der Gutachtenerstellung. Änderungen sind dem Anlagenhersteller vorbehalten und bedürfen einer neuen Berechnung und Bewertung. Bei Anlagen, für die keine Informationen vorliegen, werden konservativ abdeckende, generische Anlagenparameter angesetzt, wobei keine Haftung für die Richtigkeit der ermittelten Werte übernommen wird.

Die im vorliegenden Gutachten angegebenen Nabenhöhen der geplanten WEA entsprechen stets der aktuell vorliegenden Dokumentation. In der Entwicklungsphase einer WEA sind geringfügige Änderungen der Nabenhöhe ohne eine Änderung der zu Grunde gelegten Auslegungswindbedingungen möglich, sodass die im vorliegenden Gutachten betrachtete Nabenhöhe von der in den Antragsunterlagen ausgewiesenen Nabenhöhe geringfügig abweichen kann. Das Gleiche gilt für die in den Genehmigungen dokumentierten Nabenhöhen bestehender WEA, die ebenfalls geringfügig von aktuellen Werten abweichen können. Bei einer Abweichung der Nabenhöhe von maximal ± 1 m behält das vorliegende Gutachten seine vollumfängliche Gültigkeit, wenn die im Gutachten berücksichtigten Auslegungswindbedingungen, durch die im Rahmen des Genehmigungsverfahrens eingereichten Auslegungswindbedingungen, abgedeckt sind.

Den von der I17-Wind GmbH & Co. KG ermittelten Ergebnissen liegen unterschiedliche, vereinfachte physikalische Modelle zu Grunde, die nur annähernd die Realität abbilden, jedoch als konservativ zu bewerten sind. Des Weiteren werden bei den Berechnungen teilweise vereinfachende Annahmen getroffen, die jedoch allesamt ebenfalls als konservativ zu bewerten sind.

2 Aufgabenstellung und Standort

2.1 Umfang des Gutachtens

Da im geplanten Windpark kein Anlagenstandort einer nach DIBt 2012 typengeprüften neu geplanten Anlage nach DIN EN IEC 61400-1:2019 [6] als topografisch komplexer Standort zu bezeichnen ist, findet für alle WEA das vereinfachte Verfahren nach Abschnitt 1.2.1 Anwendung.

2.2 Standortbeschreibung

Der Auftraggeber plant die Errichtung von zwei WEA des Typs Vestas V162-7.2 MW auf 169.0 m Nabenhöhe am Standort Gebstedt in Thüringen.

Die I17-Wind GmbH & Co. KG wurde damit beauftragt, ein Gutachten zur Standorteignung von WEA nach der DIBt 2012 Richtlinie [1.1] unter Berücksichtigung der in Tabelle 2.1 aufgeführten [21] und in Abbildung 2.1 dargestellten WEA zu erstellen. Tabelle 2.1 führt neben den Spezifikationen der WEA am Standort auch die der Typenprüfung zu Grunde gelegten, bzw. bei fehlender Information unterstellten, Richtlinien auf. Des Weiteren wird aufgeführt, welcher Wöhlerlinienkoeffizient *m* und welcher Betriebsmodus für die Berechnung der effektiven Turbulenzintensität I_{eff} herangezogen wurde. Die Ergebnisse in 3.3.3 berücksichtigen den jeweiligen Wöhlerlinienkoeffizienten aus Tabelle 2.1. Wenn über den Betriebsmodus keine Informationen in den Eingangsdaten vorliegen, wird stets mit dem Betriebsmodus gerechnet, der die konservativsten Ergebnisse liefert, was dem offenen, nicht leistungsreduzierten Betriebsmodus entspricht.

Die Spalte „Innerhalb 10 *D*“ weist aus, welche WEA sich innerhalb eines Umkreises von 10 *D* um die geplanten WEA befinden. Für diese WEA hat nach [6] und [7] eine Bewertung der topografischen Komplexität und der effektiven Turbulenzintensität I_{eff} zu erfolgen.

Im vorliegenden Gutachten beziehen sich alle Bezeichnungen auf die interne, laufende W-Nummer. Wird eine Größe mit dem Index $_{TP}$ bezeichnet, handelt es sich um den Auslegungswert der zu betrachtenden WEA. Eine Bezeichnung mit dem Index $_{NH}$ weist auf den standortspezifischen Wert der betrachteten Anlage hin.

Im vorgegebenen Windparklayout ergibt sich der geringste relative Abstand *s* einer neu geplanten WEA zu einer anderen WEA von 2.36, bezogen auf den größeren Rotordurchmesser *D*. Dies betrifft die WEA W2 und W12.

2.3 Auslegungswindbedingungen der geplanten WEA

Die Auslegungswindbedingungen werden entweder der Typenprüfung entnommen oder vom Hersteller übermittelt. Da der Vergleich der Auslegungswindbedingungen, abgesehen von I_{eff}, mit den standortspezifischen Bedingungen nur für neu geplante WEA zu führen ist, werden in Tabelle 2.2 nur die Auslegungswindbedingungen der neu geplanten WEA aufgeführt.

Tabelle 2.1: Zu untersuchende Windparkkonfiguration

Interne W-Nr.	Bezeichnung Auftraggeber	Neu / Bestand	Innerhalb 10 *D*	Topografische Komplexität		UTM ETRS89 Zone 32		Hersteller	WEA Typ	*NH*[1] [m]	*D* [m]	Betriebsmodus	*FEH* [m]	P_N [kW]	Prüfgrundlage DIBt	TK	Auslegungs-lebensdauer τ_{TP} [a]	$m_{max,TP}$ [-]
				Komplex	Kategorie	*X* [m]	*Y* [m]											
W1	WTG06	Neu	Ja	Nein	-	673607	5660479	Vestas	V162-7.2 MW	169.0	162.0	SO7200	0.0	7200	2012	S	25	10
W2	WTG07	Neu	Ja	Nein	-	674222	5660340	Vestas	V162-7.2 MW	169.0	162.0	SO7200	0.0	7200	2012	S	25	10
W3	PF01.1	Bestand	Ja	Nein	-	673624	5661472	Vestas	V162-5.6 MW	166.0	162.0	Modus 0	0.0	5600	2012	S	25	10
W4	PF03	Bestand	Ja	Nein	-	673611	5661779	Vestas	V172-7.2 MW	199.0	172.0	PO7200	0.0	7200	2012	S	25	10
W5	WEA1	Bestand	Ja	Nein	-	673406	5661434	Vestas	V150-6.0 MW	166.0	150.0	PO6000	0.0	6000	2012	S	25	10
W6	WTG01	Bestand	Ja	Nein	-	673892	5661497	Vestas	V150-4.2 MW	166.0	150.0	PO1/PO1-0S	0.0	4200	2012	B	20	10
W7	WTG02	Bestand	Ja	Nein	-	674341	5661448	Vestas	V150-4.2 MW	166.0	150.0	PO1/PO1-0S	0.0	4200	2012	B	20	10
W8	WTG03	Bestand	Ja	Nein	-	673576	5661178	Vestas	V150-4.2 MW	166.0	150.0	PO1/PO1-0S	0.0	4200	2012	B	20	10
W9	WTG04	Bestand	Ja	Nein	-	674044	5661047	Enercon	E-82 E2 / 2.300 kW	138.0	82.0	BM 0 s	0.0	2300	2012	A	20	10
W10	WTG05	Bestand	Ja	Nein	-	674573	5661103	Vestas	V150-4.2 MW	166.0	150.0	PO1/PO1-0S	0.0	4200	2012	B	20	10
W11	WEA03	Bestand	Ja	Nein	-	675085	5660989	Nordex	N175/6.X	179.0	175.0	Mode 0	0.0	6800	2012	S	25	14
W12	WEA04	Bestand	Ja	Nein	-	674607	5660350	Nordex	N163/6.X	164.0	163.0	Mode 1	0.0	6800	2012	S	25	14
W13	WEA05	Bestand	Ja	Nein	-	675070	5660516	Nordex	N175/6.X	179.0	175.0	Mode 0	0.0	6800	2012	S	25	14

Tabelle 2.2: Auslegungswindbedingungen der neu geplanten WEA

Interne W-Nr.	Prüfgrundlage	WZ	GK	$v_{ave,TP}$ [m/s]	k_{TP} [-]	$v_{m50,TP}$ [m/s]	TK	δ_{TP} [°]	α_{TP} [-]	ρ_{TP} [kg/m³]	Auslegungs-lebensdauer τ_{TP} [a]	Quelle
W1 und W2	DIBt 2012	S	S	7.0	2.0	37.6	S	8.0	0.27	1.225	25	[24.1, 24.2]

[1] *Siehe Kapitel 1.4 Absatz 3*

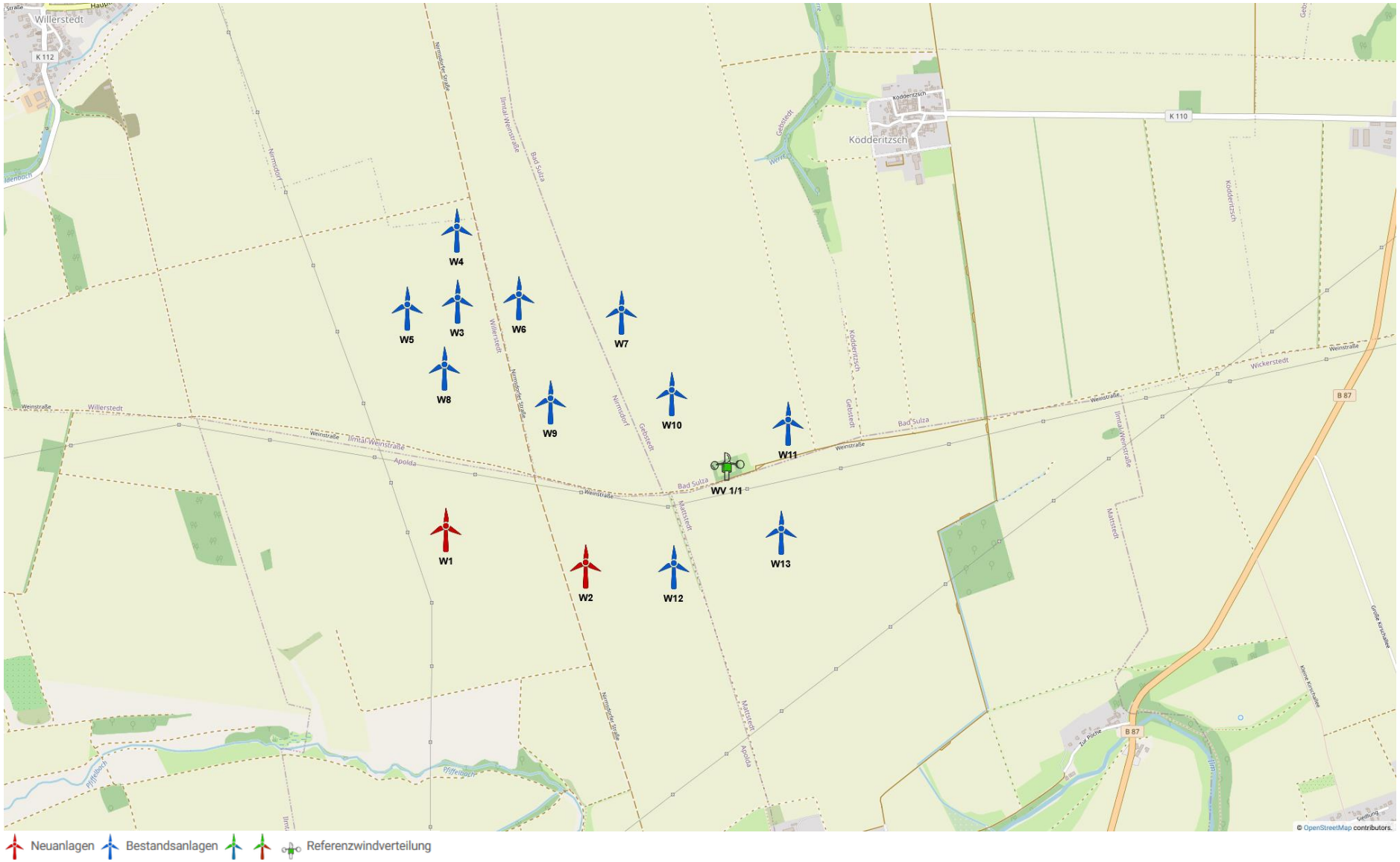


Abbildung 2.1: Zu untersuchende Windparkkonfiguration; Kartenmaterial: [19.1, 19.2]

3 Vergleich der Windbedingungen

3.1 Grundlagen

Vom Auftraggeber wurden standortbezogene Windverhältnisse, unterteilt in mindestens 12 Sektoren, übermittelt [22.1]. Diese werden als richtig und für den Standort repräsentativ vorausgesetzt.

Um die Windverhältnisse auf Nabenhöhe an jedem Anlagenstandort zu ermitteln, werden die Daten der Windverhältnisse [22.1] auf alle notwendigen Höhen umgerechnet, sofern diese nicht vorliegen. Die Umrechnung erfolgt auf Basis eines logarithmischen Windprofils und des am Standort der Windverteilung ermittelten Höhenexponenten α. Bei der vertikalen Umrechnung wird der Formparameter k als invariant mit der Höhe angenommen und lediglich der Skalenparameter A umgerechnet. Eine horizontale Umrechnung vom Standort der Winddaten zu den jeweiligen WEA Standorten erfolgt nicht. Liegen in [22.1] mehrere Windverteilungen vor, werden diese den jeweiligen WEA zugeordnet. Tabelle 3.1 führt eine der in [22.1] übermittelten Windbedingungen am Standort auf.

Tabelle 3.1: Windverhältnisse am Standort WV 1/1 [22.1]

UTM ETRS89 Zone 32			A [m/s]	k [-]	p [%]	v_{ave} [m/s]
X [m]	Y [m]	h_{WV} [m]				
674824	5660827	166.0				
Sektor | Windrichtung [°]						
N | 0			5.4	2.09	3.8	---
NNO | 30			6.0	2.21	6.1	---
ONO | 60			6.9	2.24	9.7	---
O | 90			6.0	2.30	6.6	---
OSO | 120			4.9	2.06	3.5	---
SSO | 150			5.8	2.24	4.0	---
S | 180			7.6	2.14	7.7	---
SSW | 210			9.5	2.65	12.8	---
WSW | 240			10.6	2.59	17.9	---
W | 270			9.0	2.17	16.8	---
WNW | 300			7.4	1.94	7.6	---
NNW | 330			5.2	1.87	3.4	---
Gesamt			**8.0**	**2.00**	**99.9**	**7.1**

3.2 Vergleich v_{ave} und v_{m50}

3.2.1 Vergleich der mittleren Windgeschwindigkeit v_{ave}

Liegt der Typenprüfung einer entsprechend Abschnitt 1.2.1 zu untersuchenden WEA ein Formparameter k mit $k = 2.0$ zu Grunde, ist der Vergleich der Windverhältnisse in Bezug auf die mittlere Windgeschwindigkeit v_{ave} auf Nabenhöhe jeder geplanten WEA so zu führen, dass gilt:

i. $v_{ave, NH} / v_{ave, TP} \leq 0.95$

oder

ii. $v_{ave, NH} / v_{ave, TP} \leq 1.00$ und $k_{NH} \geq 2.00$

Liegt der Typenprüfung einer entsprechend Abschnitt 1.2.1 zu untersuchenden WEA ein Formparameter k mit $k \neq 2.0$ zu Grunde, ist der Vergleich der Windverhältnisse in Bezug auf die mittlere Windgeschwindigkeit v_{ave} jeder geplanten WEA wie folgt zu führen:

i. Vergleich der Wahrscheinlichkeitsdichtefunktion der standortspezifischen Windgeschwindigkeiten pdf_{NH} mit der Wahrscheinlichkeitsdichtefunktion der Typenprüfung pdf_{TP} in einem Bereich von v_{ave} - $2v_{ave}$ nach [6] bzw. $0.2v_{ref}$ - $0.4v_{ref}$ nach [7]. In dem zu untersuchenden Bereich muss die Bedingung $pdf_{NH} \leq pdf_{TP}$ erfüllt sein.

Das Ergebnis der Berechnung der mittleren Windgeschwindigkeit v_{ave} und der Formparameter k der Weibullverteilung auf Nabenhöhe jeder neu geplanten WEA sind in Tabelle 3.2 dargestellt und werden mit den Auslegungswindbedingungen der jeweiligen WEA verglichen.

Tabelle 3.2: Vergleich der mittleren Windgeschwindigkeit v_{ave} auf Nabenhöhe der geplanten WEA

Interne W-Nr.	$v_{ave, NH}$ [m/s]	$v_{ave, TP}$ [m/s]	k_{NH} [-]	k_{TP} [-]	Wenn $k_{TP} = 2$: $v_{ave, NH} / v_{ave, TP}$ [-]	Wenn $k_{TP} \neq 2$: $pdf_{NH} \leq pdf_{TP}$	Nachweis möglich (gemäß 1.2.1)	Lastvergleich erforderlich (gemäß 1.2.3)
W1 & W2	7.1	7.0	2.00	2.00	1.01	-	Nein	Ja

3.2.2 Vergleich der 50-Jahres-Windgeschwindigkeit v_{m50}

Der Vergleich der 50-Jahreswindgeschwindigkeit $v_{m50, NH}$ auf Nabenhöhe der geplanten WEA mit dem Auslegungswert kann auf zwei Wegen erfolgen. Wenn die WEA in einer Windzone errichtet werden soll, die niedriger oder gleich der Windzone ist, die der Typenprüfung zu Grunde liegt, reicht der Nachweis, dass die Windzone gemäß Typenprüfung die Windzone des betrachteten Standortes abdeckt [1.1]. Ist dies nicht der Fall, muss nachgewiesen werden, dass die 50-Jahreswindgeschwindigkeit $v_{m50, TP}$ gemäß Typenprüfung die 50-Jahreswindgeschwindigkeit auf Nabenhöhe der geplanten WEA am Standort abdeckt [1.1, 4, 5]. Hierzu muss die 50-Jahreswindgeschwindigkeit $v_{m50, NH}$ mittels einer geeigneten Methode (z.B. der Gumbel-Methode [10]) am Standort ermittelt werden.

Den nachzuweisenden Standorten wird nach DIBt 2012 [1.1], bzw. nach DIN EN 1991-1-4/NA:2010-12 mit DIN EN 1991-1-4:2010-12 [9] die in Tabelle 3.3 aufgeführte Windzone entsprechend [11] und die Geländekategorie, basierend auf den durch den Standortbesuch gewonnenen Erkenntnissen und den verwendeten Satellitendaten [13.1], zu Grunde gelegt. Da, nach [1.1], in Übergangsgebieten der Geländekategorien stets die Gleichungen der niedrigeren Kategorie anzusetzen sind, wird der Vergleich in solchen Fällen auf Basis der Gleichungen für die niedrigere Geländekategorie durchgeführt.

In der folgenden Tabelle 3.3 werden die Auslegungswindbedingungen hinsichtlich v_{m50} mit den standortspezifischen Windbedingungen verglichen. Wenn die geplanten WEA in einer Windzone errichtet werden sollen, die durch die Auslegungswindbedingungen abgedeckt ist, ist die Standorteignung hinsichtlich v_{m50} nachgewiesen. Ist der Standort nicht durch die Auslegungswindbedingungen $v_{m50, TP}$ der geplanten WEA abgedeckt, erfolgt der Nachweis über eine standortspezifische Extremwindabschätzung [22.2]. Die Ergebnisse der standortspezifischen Extremwindabschätzung werden als richtig und repräsentativ für den Standort vorausgesetzt. Kann

der Nachweis durch keine der beiden Verfahrensweisen erbracht werden, kann der Nachweis ggf. durch einen Lastvergleich der Extremlasten nach Abschnitt 1.2.3 erbracht werden.

Tabelle 3.3: Vergleich der 50-Jahres-Windgeschwindigkeit v_{m50} auf Nabenhöhe der geplanten WEA

Interne W-Nr.	WZ_{TP}	GK_{TP}	$v_{m50, TP}$ [m/s]	WZ_{NH}	GK_{NH}	$v_{m50, NH}$ [1.1] [m/s]	$v_{m50, NH}$ [22.2] [m/s]	Nachweis möglich (gemäß 1.2.1)	Lastvergleich erforderlich (gemäß 1.2.3)
W1 & W2	S	S	37.60	2	II	39.30	37.50	Ja	Nein

3.3 Vergleich der effektiven Turbulenzintensität I_{eff}

3.3.1 Auslegungswindbedingungen hinsichtlich der Turbulenzintensität

Für die Turbulenzintensität auf Nabenhöhe einer nach der DIBt 2012 [1.1] typengeprüften WEA gibt es windgeschwindigkeitsabhängige Auslegungswerte in fünf Kategorien, welche in der DIN EN IEC 61400-1:2019 [6] aufgeführt sind und der Typenprüfung zu Grunde gelegt werden müssen. Bei den Turbulenzkategorien wird zwischen den vorgegebenen Kategorien A+, A, B, C und der durch den WEA-Hersteller definierbaren Kategorie S unterschieden.

Für WEA die nach der DIBt 2004 [2] typengeprüft sind, muss die windgeschwindigkeitsabhängige Turbulenzkategorie A, welche in der DIN EN 61400-1:2004 [8] definiert ist, als Auslegungswindbedingung hinsichtlich der Turbulenzintensität zu Grunde gelegt sein.

Für WEA die nach der DIBt 1993 [3] typengeprüft sind, wird nicht die in [3] definierte mittlere Turbulenzintensität von 0.20, sondern ebenfalls die in der DIN EN 61400-1:2004 [8] definierte windgeschwindigkeitsabhängige Turbulenzkategorie A, als Auslegungswindbedingung hinsichtlich der Turbulenzintensität zu Grunde gelegt.

In Tabelle 3.4 sind die unterschiedlichen Turbulenzkategorien und deren Verläufe dargestellt.

Tabelle 3.4: Richtlinienabhängige Auslegungswindbedingungen hinsichtlich der Turbulenzintensität

v_{hub} [m/s]	DIBt 2004 [2]	DIBt 2012 [1.1] DIN EN IEC 61400-1:2019 [6]				
	NTM A [8] [-]	NTM A+ [6] [-]	NTM A [5, 6, 7] [-]	NTM B [5, 6, 7] [-]	NTM C [5, 6, 7] [-]	S [-]
2	0.570	0.639	0.568	0.497	0.426	durch den WEA-Hersteller definiert
3	0.420	0.471	0.419	0.366	0.314	
4	0.345	0.387	0.344	0.301	0.258	
5	0.300	0.337	0.299	0.262	0.224	
6	0.270	0.303	0.269	0.236	0.202	
7	0.249	0.279	0.248	0.217	0.186	
8	0.233	0.261	0.232	0.203	0.174	
9	0.220	0.247	0.220	0.192	0.165	
10	0.210	0.236	0.210	0.183	0.157	
11	0.202	0.227	0.201	0.176	0.151	
12	0.195	0.219	0.195	0.170	0.146	
13	0.189	0.213	0.189	0.165	0.142	
14	0.184	0.207	0.184	0.161	0.138	
15	0.180	0.202	0.180	0.157	0.135	
16	0.176	0.198	0.176	0.154	0.132	
17	0.173	0.194	0.173	0.151	0.130	
18	0.170	0.191	0.170	0.149	0.127	
19	0.167	0.188	0.167	0.146	0.125	
20	0.165	0.185	0.165	0.144	0.124	
21	0.163	0.183	0.163	0.142	0.122	
22	0.161	0.181	0.161	0.141	0.121	
23	0.159	0.179	0.159	0.139	0.119	
24	0.158	0.177	0.157	0.138	0.118	
25	0.156	0.175	0.156	0.136	0.117	
26	0.155	0.174	0.154	0.135	0.116	
27	0.153	0.172	0.153	0.134	0.115	
28	0.152	0.171	0.152	0.133	0.114	
29	0.151	0.170	0.151	0.132	0.113	
30	0.150	0.169	0.150	0.131	0.112	

Der Vergleich des standortspezifischen Turbulenzverlaufes mit den windgeschwindigkeitsabhängigen Auslegungswerten erfolgt bei WEA die nach der DIBt 2004 [2] typengeprüft sind, auf Basis der Werte für die Turbulenzkategorie A nach [1.1, 5, 6, 7], da diese die Werte nach [8] mit abdecken.

3.3.2 Ermittlung der Umgebungsturbulenzintensität

3.3.2.1 Datengrundlage

Im Wesentlichen hängt die Umgebungsturbulenz I_{amb} von den Windverhältnissen, der Orographie und der Geländerauigkeit ab. Die Windverhältnisse aus [22.1] enthalten keinerlei Informationen zur Umgebungsturbulenzintensität vor Ort, somit wurde diese auf Basis der vorliegenden Informationen zur Bodenbedeckung [13.1] und der Topografie [13.2] am Standort auf Nabenhöhe ermittelt.

3.3.2.2 Vorgehensweise

Die Umgebungsturbulenzintensität I_{amb} beschreibt im Allgemeinen die Schwankung der Windgeschwindigkeit in einem Zeitintervall von 600 s um ihren Mittelwert. Sie ist als der Quotient aus der Standardabweichung σ der Windgeschwindigkeit und der zugehörigen mittleren Windgeschwindigkeit v_{ave} in einem 600 s Intervall zu bilden [6, 7, 8]. Liegen Daten einer Windmessung am Standort vor, kann I_{amb} direkt, bzw. I_{char} durch Addition der 1fachen Standardabweichung der Umgebungsturbulenzintensität σ_σ [4, 8] und I_{rep} durch Addition der 1.28fachen Standardabweichung der Umgebungsturbulenzintensität σ_σ [6, 7] zu I_{amb} ermittelt werden. Durch Ermittlung der Windscherung, kann die auf Messhöhe ermittelte charakteristische, bzw. repräsentative Turbulenzintensität auf Nabenhöhe extrapoliert werden. Liegt keine Messung vor, muss die Umgebungsturbulenzintensität rechnerisch ermittelt werden.

Zur Berechnung von I_{amb} werden an jedem zu untersuchenden WEA Standort die flächenmäßigen Informationen zur Bodenbedeckung aus dem CORINE Datensatz [13.1] mit 20 km Radius um den Standort zu Grunde gelegt. Die in [13.1] enthaltenen Flächen verschiedener Bodenbedeckung werden nach den Empfehlungen des Europäischen Wind Atlas [12] in Flächen mit einer Rauigkeitslänge z_0 konvertiert. Alle innerhalb eines Sektors liegenden Rauigkeitselemente werden abschließend nach Abstand und Größe gewichtet und in einen, für diesen Sektor, repräsentativen Rauigkeitswert umgerechnet. Aus den sektoriell vorliegenden Rauigkeitslängen wird mittels eines von der Rauigkeitslänge z_0 abhängigen Profils die Umgebungsturbulenzintensität auf Nabenhöhe der jeweiligen WEA berechnet.

Da in der Richtlinie des Deutschen Instituts für Bautechnik DIBt 2012 [1.1] für die Ermittlung der Standorteignung bezüglich der effektiven Turbulenzintensitäten Turbulenzwerte für verschiedene Windgeschwindigkeiten gefordert sind, wird den ermittelten Werten für die Umgebungsturbulenzintensität das NTM nach [6, 7] zu Grunde gelegt. Der ermittelten Turbulenzkurve wird in Anlehnung an das vom Risø DTU National Laboratory entwickelte Verfahren im Windfarm Assessment Tool eine windgeschwindigkeitsabhängige Standardabweichung σ_σ unterstellt, die ebenfalls dem NTM Verlauf folgt [15]. Die Werte für die Standardabweichung der Umgebungsturbulenzintensität σ_σ sind so gewählt, dass die Summe aus der Referenzturbulenzintensität nach NTM und dem 1fachen σ_σ die Referenzkurve nach [6, 7] ergibt.

Die repräsentative Turbulenzintensität I_{rep} wird nach dem beschriebenen Verfahren für jede zu betrachtende, nach DIBt 2012 [1.1] typen-/einzelgeprüfte, WEA auf Nabenhöhe ermittelt und den weiteren Berechnungen zu Grunde gelegt. Für Anlagen, deren Typen-/Einzelprüfung auf der Richtlinie DIBt 2004 [2] oder DIBt 1993 [3] basiert, findet die charakteristische Turbulenzintensität I_{char} Anwendung.

3.3.2.3 Untersuchung der topografischen Komplexität der Anlagenstandorte

Das verwendete Höhenmodell aus dem SRTM Datensatz [13.2] liegt in einer Auflösung von ca. 30 m vor und wird für die Ermittlung der topografischen Komplexität der Standorte herangezogen.

Die Standorte aller zu betrachtenden Anlagen werden basierend auf den Vorgaben der geltenden Norm DIN EN IEC 61400-1:2019 [6] auf topografische Komplexität untersucht und bewertet, da die topografische Komplexität eine Verzerrung und damit eine Abweichung der Turbulenzstruktur von den Auslegungswindbedingungen verursachen kann.

Die Komplexität eines Standortes wird durch die Neigung des Geländes und die Abweichungen der Topografie des Geländes von einer angenäherten Ebene dargestellt. Dazu werden mindestens 37 Ausgleichsebenen entsprechend der Kriterien aus [6] mittels der Methode der kleinsten Fehlerquadrate gebildet. Die DIN EN IEC 61400-1:2019 [6] lässt die Möglichkeit offen, die angenäherte Ebene für die Kreissektoren mit dem Radius 5 z_{hub} leewärts zur Position der zu untersuchenden WEA um 2 z_{hub} zu erweitern. Diese Erweiterung wird bei der Komplexitätsbewertung im vorliegenden Gutachten angewendet. In Abhängigkeit der Neigung der angenäherten Ebenen, der Abweichung des digitalen Geländemodells [13.2] von dieser und des Anteils der Windenergie aus dem betrachteten Sektor, lassen sich die Indizes *TSI* für die Geländeneigung und *TVI* für die Geländeabweichung berechnen. Überschreitet einer der berechneten Indizes die in Tabelle 3.5 aufgeführten Schwellenwerte, ist der untersuchte Standort als topografisch komplex zu bewerten, wobei der jeweils überschrittene Schwellenwert die Geländekomplexitätskategorie L, M oder H bestimmt.

Nach [6] hat an topografisch komplexen Standorten eine Erhöhung der longitudinalen Komponente der Umgebungsturbulenzintensität durch Multiplikation mit einem Turbulenzstrukturparameter C_{CT} gemäß Tabelle 3.5 zu erfolgen.

Tabelle 3.5: Komplexitätskriterien und C_{CT} nach DIN EN IEC 61400-1:2019 [6]

Radius der Kreisfläche um die WEA [m]	**Sektoramplitude der angenäherten Ausgleichsebene [°]**	**Schwellenwerte (untere Grenze)**					
		Index der Geländeneigung *TSI* [°]			**Index der Geländeabweichung *TVI* [%]**		
		L	**M**	**H**	**L**	**M**	**H**
5 z_{hub}	360	10	15	20	2	4	6
5 z_{hub}	30						
10 z_{hub}							
20 z_{hub}							
	Kategorie						
	L	**M**			**H**		
C_{CT}	1.05	1.10			1.15		

Die Ergebnisse der Bewertung der topografischen Komplexität der zu untersuchenden WEA können Tabelle 2.1 entnommen werden.

3.3.2.4 Repräsentative Turbulenzintensität

In Tabelle 3.6 werden die sektoriell nach dem in Abschnitt 3.3.2.2 beschriebenen Verfahren ermittelten, repräsentativen Turbulenzintensitäten, bezogen auf eine Windgeschwindigkeit von 15 m/s, für eine Anlagenposition aufgeführt.

Tabelle 3.6: Repräsentative Turbulenzintensität für einen Standort

Standort: W1	*NH*: 169.0 m	I_{rep} [-]
Sektor	Windrichtung [°]	
N	0	0.119
NNO	30	0.120
ONO	60	0.114
O	90	0.110
OSO	120	0.120
SSO	150	0.126
S	180	0.116
SSW	210	0.112
WSW	240	0.121
W	270	0.107
WNW	300	0.105
NNW	330	0.116

3.3.3 Ermittlung der effektiven Turbulenzintensität I_{eff}

3.3.3.1 Grundlagen

Die effektive Turbulenzintensität I_{eff} ist definiert als die mittlere Turbulenzintensität, die über die Lebensdauer einer WEA dieselbe Materialermüdung verursacht, wie die am Standort herrschenden, verschiedenen Turbulenzen. Die Materialkennzahl, die maßgeblich in die Berechnung der effektiven Turbulenzintensität einfließt, ist der Wöhlerlinienkoeffizient *m.* Im vorliegenden Gutachten liegt jeder zu betrachtenden WEA der anlagenspezifische Wöhlerlinienkoeffizient zu Grunde, der die strukturschwächste Komponente repräsentiert. Hierbei handelt es sich im Regelfall um die Rotorblätter einer WEA, welche durch Wöhlerlinienkoeffizienten zwischen m = 10 für glasfaser-verstärkte Verbundwerkstoffe und m = 15 für kohlefaserverstärkte Verbundwerkstoffe abgedeckt werden. Dadurch werden alle Komponenten einer WEA in die Betrachtung mit einbezogen.

Grundsätzlich setzt sich die effektive Turbulenzintensität I_{eff} an einer WEA aus der Umgebungsturbulenzintensität und der durch den Nachlauf anderer WEA induzierten Turbulenzintensität, dem sogenannten „Wake-Effekt“, zusammen. Hierbei sind je nach zu Grunde gelegter Richtlinie unterschiedliche Berücksichtigungen der Standardabweichung der Umgebungs-turbulenzintensität σ_o zu berücksichtigen.

Die Berechnung der induzierten Turbulenzintensität erfolgt nach den Ausarbeitungen in [10], Kapitel 2.4.4, wenn alle hierfür erforderlichen Anlagenparameter vorliegen oder konservativ abdeckend ermittelt werden konnten. Andernfalls erfolgt die Berechnung der induzierten Turbulenzintensität nach den Ausarbeitungen in [16], sowie den informativen Anhängen in [6] und [7]. Die generelle Vorgehensweise zur Ermittlung der effektiven Turbulenzintensität I_{eff} erfolgt in beiden Fällen entsprechend den Anforderungen aus [6] und [7].

Die induzierte Turbulenzintensität wird in [10] als eine Funktion beschrieben, die von den Abständen der WEA untereinander, der Umgebungsturbulenzintensität und von anlagenspezifischen Kenngrößen abhängig ist. Diese Kenngrößen sind einerseits der windgeschwindigkeitsabhängige Schubbeiwert c_t, als auch die windgeschwindigkeitsabhängige Schnelllaufzahl λ der turbulenzinduzierenden WEA. Das Modell bildet sowohl den voll ausgebildeten Nachlauf als auch den nicht voll ausgebildeten Nachlauf

hinter einer WEA ab. Die anlagenspezifischen Werte c_t und λ sind vom Anlagenhersteller übermittelt. Wenn für eine zu betrachtende WEA diese Werte nicht vorliegen, werden Sie, wenn möglich, auf Basis der Anlagenparameter wie Drehzahl und Rotordurchmesser ermittelt, oder durch eine konservativ abdeckende Standardkurve ersetzt. Der Ermittlung von I_{eff} werden die am Standort herrschenden geometrischen Verhältnisse, sowie die am Standort herrschenden Windbedingungen zu Grunde gelegt. Da in [10] keine Aussage zum berücksichtigenden Einflussbereich der WEA untereinander getroffen wird, werden sowohl die Bereiche im Volleinfluss (Rotor der WEA steht voll im Nachlauf einer anderen WEA), als auch die Bereiche im Teileinfluss (Rotor der WEA steht nur teilweise im Nachlauf einer anderen WEA) bei der Berechnung von I_{eff} berücksichtigt, was somit den konservativsten Ansatz darstellt.

Die induzierte Turbulenzintensität wird in [16] als eine Funktion beschrieben, die von den Abständen s der WEA untereinander und vom windgeschwindigkeitsabhängigen Schubbeiwert c_t abhängig ist. Die anlagenspezifischen c_t Werte sind vom Anlagenhersteller übermittelt. Wenn für eine zu betrachtende WEA diese Werte nicht vorliegen, werden Sie durch eine konservativ abdeckende Standardkurve ersetzt. Der Ermittlung von I_{eff} werden die am Standort herrschenden geometrischen Verhältnisse, sowie die am Standort herrschenden Windbedingungen zu Grunde gelegt. Da in [16] eine eindeutige Aussage zum berücksichtigenden Einflussbereich der WEA untereinander getroffen wird, wird genau dieser Bereich bei der Berechnung von I_{eff} berücksichtigt.

Die Ermittlung der induzierten Turbulenzintensität muss durchgeführt werden, solange sich eine WEA in einem Abstand s kleiner 10 D von der zu betrachtenden Anlage befindet [6, 7, 8]. Ist der Abstand s aller WEA im Umfeld grösser 10 D, bezogen auf die jeweils turbulenzinduzierende WEA, muss deren Einfluss nicht mehr berücksichtigt werden.

In keiner der zu Grunde gelegten Richtlinien und Normen [1.1 - 8] werden hinsichtlich des Abstandes s von WEA Grenzen definiert, bis zu welchen die Ergebnisse der effektiven Turbulenzintensitäten I_{eff} anwendbar oder belastbar sind. Dasselbe gilt für die in [10] und [16] beschriebenen Turbulenzmodelle. Verschiedene Untersuchungen und Ausarbeitungen haben gezeigt, dass die Turbulenzmodelle auch bei geringen relativen Abständen s im Bereich $3\ D \geq s \geq 2\ D$ konservative Ergebnisse liefern und belastbar sind. Diese Ergebnisse können sowohl für einen Vergleich der Windbedingungen entsprechend Abschnitt 1.2.1 als auch für einen Nachweis gemäß 1.2.3 herangezogen werden. Die Ergebnisse der ermittelten, effektiven Turbulenzintensitäten bei Anlagenabständen s von unter 2.0 D sollten nicht mehr für eine standortspezifische Lastrechnung (siehe Abschnitt 1.2.3) herangezogen werden. In diesen Nachlaufsituationen ist eine Abschaltung erforderlich. Eine Ausnahme bilden Abstände s von unter 2.0 D in Verbindung mit einem großen Nabenhöhenunterschied der betrachteten WEA. In solch einer Situation kann es durch die geometrischen Verhältnisse dazu kommen, dass der Nachlauf der turbulenzinduzierenden WEA über bzw. unter der Rotorkreisfläche der beeinflussten WEA strömt. In diesem Fall sind keine Betriebsbeschränkungen bzw. Abschaltungen erforderlich.

Die ermittelten Werte für I_{eff} werden den Auslegungswerten, die der Typen-/Einzelprüfung der betrachteten Anlage zu Grunde liegen, gegenübergestellt. Liegen die ermittelten Werte nicht oberhalb der Auslegungswerte, gilt eine Standorteignung hinsichtlich der effektiven Turbulenzintensität als nachgewiesen. Liegen die Werte über den Auslegungswerten, kann eine Standorteignung hinsichtlich der effektiven Turbulenzintensität nicht durch den Vergleich mit den Auslegungswerten nachgewiesen werden. Der Nachweis der Standorteignung kann in diesem Fall jedoch durch eine standortspezifische Lastrechnung seitens des Anlagenherstellers oder eines unabhängigen Dritten erfolgen.

3.3.3.2 Berücksichtigte sektorielle Betriebsbeschränkungen (WSM)

Bei der Berechnung der effektiven Turbulenzintensität I_{eff} können sektorielle Betriebsbeschränkungen (WSM) an WEA berücksichtigt werden. Die Betriebsbeschränkungen können sich aus beispielsweise zu geringen Abständen *s* ergeben, oder Bestandteil der Genehmigung bereits bestehender WEA sein. Des Weiteren kann ein WSM dafür genutzt werden, den Einfluss einer neu geplanten WEA auf den zu berücksichtigenden Bestand derart zu reduzieren, dass die geplante WEA keinen signifikanten Einfluss mehr auf die effektive Turbulenzintensität I_{eff} einer Bestandsanlage hat oder um Überschreitungen der effektiven Turbulenzintensität I_{eff} an dieser zu verhindern. Die im Folgenden aufgeführten Betriebsbeschränkungen stellen immer eine Mindestanforderung dar, deren technische Umsetzbarkeit nicht geprüft wurde. Wenn möglich, wird für jedes WSM an einer beeinflussenden WEA ein alternatives WSM an der beeinflussten WEA ausgewiesen. Hierbei handelt es sich in der Regel um eine Abschaltung an der beeinflussten WEA, da die Lasten an einer abgeschalteten WEA geringer sind als die Lasten im frei angeströmten Betrieb.

Bei der Berechnung der effektiven Turbulenzintensität I_{eff} wurden keine sektoriellen Betriebsbeschränkungen berücksichtigt.

3.3.3.3 Ergebnis

Die folgende Tabelle 3.7 stellt die ermittelten effektiven Turbulenzintensitäten vor Zubau der geplanten WEA in Abhängigkeit der Windgeschwindigkeit dar. Aufgeführt werden nur Bestands-WEA, für die ein Vergleich der Situation vor mit der Situation nach dem geplanten Zubau durchgeführt wird. Tabelle 3.8 stellt die ermittelten effektiven Turbulenzintensitäten nach Zubau der geplanten WEA in Abhängigkeit von der Windgeschwindigkeit dar. Die nach der jeweils zu Grunde gelegten Richtlinie ermittelten effektiven Turbulenzintensitäten werden der Referenzkurve nach DIBt 2012 [1.1] oder der Referenzkurve der jeweiligen Typenprüfung gegenübergestellt. Überschreitungen sind ***fett kursiv*** dargestellt.

Tabelle 3.7: Ermittelte effektive Turbulenzintensitäten I_{eff} (vor Zubau)

v_{hub}	W3[S1]	W4[S2]	W5[S3]	W6[B]	W8[B]	Referenz Klasse S1	Referenz Klasse S2	Referenz Klasse S3	Referenz Klasse B
3	***0.438***	0.350	***0.442***	***0.377***	***0.371***	0.370	0.370	0.370	0.366
4	***0.425***	0.320	***0.411***	***0.348***	***0.339***	0.340	0.340	0.340	0.301
5	***0.400***	***0.308***	***0.403***	***0.345***	***0.322***	0.306	0.306	0.306	0.262
6	***0.378***	***0.287***	***0.374***	***0.327***	***0.296***	0.281	0.281	0.281	0.236
7	***0.360***	***0.270***	***0.348***	***0.311***	***0.273***	0.260	0.260	0.260	0.217
8	***0.347***	***0.258***	***0.329***	***0.302***	***0.255***	0.243	0.243	0.243	0.203
9	***0.337***	***0.250***	***0.314***	***0.298***	***0.242***	0.230	0.230	0.230	0.192
10	***0.311***	***0.219***	***0.265***	***0.262***	***0.207***	0.216	0.216	0.216	0.183
11	***0.279***	0.189	***0.213***	***0.222***	0.175	0.192	0.192	0.192	0.176
12	***0.243***	0.167	***0.177***	***0.194***	0.151	0.168	0.168	0.168	0.170
13	***0.214***	0.151	0.153	***0.176***	0.135	0.158	0.158	0.158	0.165
14	***0.193***	0.140	0.137	***0.163***	0.125	0.147	0.147	0.147	0.161
15	***0.177***	0.132	0.125	0.152	0.119	0.142	0.142	0.142	0.157
16	***0.165***	0.125	0.118	0.144	0.116	0.136	0.136	0.136	0.154
17	***0.153***	0.120	0.113	0.137	0.113	0.133	0.133	0.133	0.151
18	***0.142***	0.115	0.111	0.132	0.111	0.129	0.129	0.129	0.149
19	***0.134***	0.111	0.108	0.126	0.109	0.127	0.127	0.127	0.146
20	***0.127***	0.108	0.107	0.121	0.107	0.124	0.124	0.124	0.144
21	0.121	0.105	0.105	0.116	0.106	0.123	0.123	0.123	0.142
22	0.115	0.103	0.104	0.112	0.104	0.122	0.122	0.122	0.141
23	0.111	0.101	0.102	0.108	0.103	0.120	0.120	0.120	0.139
24	0.107	0.100	0.101	0.105	0.101	0.118	0.118	0.118	0.138
25	-	0.098	0.100	-	-	-	0.116	0.117	0.136

Tabelle 3.8: Ermittelte effektive Turbulenzintensitäten I_{eff} (nach Zubau)

v_{hub}	W1[S2]	W2[S2]	W3[S1]	W4[S2]	W5[S3]	W6[B]	W7[B]	W8[B]	W9[A]	W10[B]	W11[S5]	W12[S4]	W13[S5]	Referenz Klasse S1	Referenz Klasse S2	Referenz Klasse S3	Referenz Klasse S4	Referenz Klasse S5	Referenz Klasse B	Referenz Klasse A
3	0.287	0.298	***0.438***	0.350	***0.442***	***0.377***	0.318	***0.372***	0.322	0.308	0.294	0.329	0.293	0.370	0.370	0.370	0.332	0.326	0.366	0.419
4	0.241	0.265	***0.425***	0.320	***0.411***	***0.348***	0.285	***0.339***	0.284	0.272	0.266	***0.290***	0.265	0.340	0.340	0.340	0.282	0.304	0.301	0.344
5	0.215	0.258	***0.400***	***0.308***	***0.403***	***0.345***	0.256	***0.322***	0.254	0.247	0.259	***0.287***	0.258	0.306	0.306	0.306	0.253	0.285	0.262	0.299
6	0.195	0.238	***0.378***	***0.287***	***0.374***	***0.327***	0.233	***0.296***	0.231	0.225	0.243	***0.276***	0.240	0.281	0.281	0.281	0.233	0.266	0.236	0.269
7	0.179	0.220	***0.360***	***0.270***	***0.348***	***0.311***	0.216	***0.273***	0.214	0.207	0.227	***0.262***	0.224	0.260	0.260	0.260	0.219	0.249	0.217	0.248
8	0.165	0.202	***0.347***	***0.258***	***0.329***	***0.302***	0.201	***0.256***	0.199	0.190	0.207	***0.250***	0.206	0.243	0.243	0.243	0.208	0.233	0.203	0.232
9	0.152	0.184	***0.337***	***0.250***	***0.314***	***0.298***	0.183	***0.242***	0.182	0.174	0.188	***0.239***	0.190	0.230	0.230	0.230	0.200	0.218	0.192	0.220
10	0.140	0.170	***0.311***	***0.219***	***0.265***	***0.262***	0.167	***0.208***	0.165	0.161	0.176	***0.214***	0.182	0.216	0.216	0.216	0.193	0.204	0.183	0.210
11	0.132	0.156	***0.279***	0.189	***0.213***	***0.222***	0.156	0.176	0.152	0.152	0.163	***0.199***	0.171	0.192	0.192	0.192	0.188	0.192	0.176	0.201
12	0.126	0.143	***0.243***	0.167	***0.177***	***0.194***	0.143	0.152	0.142	0.141	0.151	0.180	0.161	0.168	0.168	0.168	0.183	0.182	0.170	0.195
13	0.122	0.132	***0.214***	0.151	0.153	***0.176***	0.134	0.136	0.134	0.132	0.141	0.162	0.151	0.158	0.158	0.158	0.179	0.173	0.165	0.189
14	0.119	0.124	***0.193***	0.140	0.137	***0.163***	0.128	0.126	0.128	0.126	0.133	0.150	0.143	0.147	0.147	0.147	0.176	0.165	0.161	0.184
15	0.116	0.119	***0.177***	0.132	0.125	0.152	0.123	0.120	0.123	0.122	0.126	0.141	0.136	0.142	0.142	0.142	0.173	0.158	0.157	0.180
16	0.114	0.116	***0.165***	0.125	0.118	0.144	0.119	0.116	0.120	0.118	0.121	0.134	0.130	0.136	0.136	0.136	0.171	0.151	0.154	0.176
17	0.112	0.113	***0.153***	0.120	0.114	0.137	0.116	0.113	0.117	0.115	0.117	0.128	0.125	0.133	0.133	0.133	0.169	0.145	0.151	0.173
18	0.110	0.111	***0.142***	0.115	0.111	0.132	0.114	0.111	0.115	0.113	0.114	0.123	0.121	0.129	0.129	0.129	0.167	0.139	0.149	0.170
19	0.108	0.109	***0.134***	0.111	0.108	0.126	0.111	0.109	0.112	0.111	0.111	0.119	0.118	0.127	0.127	0.127	0.165	0.134	0.146	0.167
20	0.107	0.107	***0.127***	0.108	0.107	0.121	0.109	0.107	0.110	0.109	0.109	0.116	0.116	0.124	0.124	0.124	0.163	0.128	0.144	0.165
21	0.106	0.106	0.121	0.105	0.105	0.116	0.107	0.106	0.108	0.107	0.107	0.112	0.112	0.123	0.123	0.123	0.162	0.124	0.142	0.163
22	0.104	0.104	0.115	0.103	0.104	0.112	0.105	0.104	0.107	0.105	0.105	0.109	0.110	0.122	0.122	0.122	0.161	0.120	0.141	0.161
23	0.103	0.103	0.111	0.101	0.102	0.108	0.104	0.103	0.105	0.103	0.103	0.106	0.107	0.120	0.120	0.120	0.159	0.117	0.139	0.159
24	0.102	0.102	0.107	0.100	0.101	0.105	0.102	0.101	0.103	0.102	0.102	0.104	0.105	0.118	0.118	0.118	0.158	0.114	0.138	0.157
25	0.100	0.100	-	0.098	0.100	-	-	-	0.102	-	0.100	0.102	0.103	-	0.116	0.117	0.157	0.112	0.136	0.156

3.3.3.4 Geforderte sektorielle Betriebsbeschränkungen (WSM)

Auf Grund des relativen Abstands von unter 2.0 *D* zwischen den Bestands-WEA W3 und verschiedenen Bestandsanlagen müssen für die betroffene Bestands-WEA W3 die effektiven Turbulenzintensitäten I_{eff} vor und nach dem geplanten Zubau jeweils ohne die Bestands-WEA, welche sich näher als 2.0 *D* zu der zu betrachtenden Bestands-WEA befindet, bewertet werden. Nach dieser Bewertung sind die folgenden sektoriellen Betriebsbeschränkungen notwendig, um den Einfluss der neu geplanten WEA zu verhindern.

Tabelle 3.9: Geforderte Betriebsbeschränkungen zum Schutz von W3

WEA	Start WSM [°]	Ende WSM [°]	Startwind-geschwindigkeit [m/s]	Endwind-geschwindigkeit [m/s]	Betriebsmodus
W1	166	196	v_{in}	11.5	Abschaltung
Alternativ: W3	166	196	v_{in}	11.5	Abschaltung

Um die Überschreitungen hinsichtlich der effektiven Turbulenzintensität an betroffenen Bestands-WEA zu verhindern bzw. nicht weiter zu erhöhen, sind die folgenden sektoriellen Betriebsbeschränkungen notwendig.

Tabelle 3.10: Geforderte Betriebsbeschränkungen zum Schutz von W12

WEA	Start WSM [°]	Ende WSM [°]	Startwind-geschwindigkeit [m/s]	Endwind-geschwindigkeit [m/s]	Betriebsmodus
W2	241	297	3.5	11.5	Abschaltung
Alternativ: W12	241	297	3.5	11.5	Abschaltung

3.4 Schräganströmung δ

Da es sich bei keinem Anlagenstandort einer nach DIBt 2012 typengeprüften neu geplanten Anlage um einen nach DIN EN IEC 61400-1:2019 [6] topografisch komplexen Standort handelt, sind die Nachweise nach Abschnitt 1.2.2 nicht zu führen. Die Ausweisung der Werte erfolgt rein informativ und ein Vergleich mit den Auslegungswindbedingungen erfolgt im vorliegenden Gutachten nicht. Die Werte können jedoch einer eventuell erforderlichen Lastrechnung durch den Anlagenhersteller zu Grunde gelegt werden.

Die Ermittlung der Schräganströmung δ_{NH} erfolgt gemäß [6] und entspricht der Neigung der angenäherten Ebene mit einem Radius 5 z_{hub} vor der WEA und 2 z_{hub} hinter der WEA gegenüber der horizontalen Mittelgeraden des betrachteten Sektors.

Die folgende Tabelle 3.11 stellt die Ergebnisse der ermittelten Schräganströmung δ_{NH} dar.

Tabelle 3.11 Standortmittelwert der Schräganströmung δ_{NH} der neu geplanten WEA

Interne W-Nr.	δ_{NH} [°]
W1	0.8
W2	0.8

3.5 Höhenexponent α

Da es sich bei keinem Anlagenstandort einer nach DIBt 2012 typengeprüften neu geplanten Anlage um einen nach DIN EN IEC 61400-1:2019 [6] topografisch komplexen Standort handelt, sind die Nachweise nach Abschnitt 1.2.2 nicht zu führen. Die Ausweisung der Werte erfolgt rein informativ und ein Vergleich mit den Auslegungswindbedingungen erfolgt im vorliegenden Gutachten nicht. Bei einer eventuell erforderlichen Lastrechnung durch den Anlagenhersteller kann ein alternativer, konservativ abdeckender Höhenexponenten zu Grunde gelegt werden.

Die Ermittlung des Höhenexponenten erfolgt entsprechend der DIN EN IEC 61400-1:2019 [6] auf Basis der ermittelten Rauigkeiten am Standort. Einflüsse der Stabilität der Atmosphäre werden dabei nicht berücksichtigt. Die Ermittlung berücksichtigt keinen Einfluss der Topografie, der bei den hier untersuchten Nabenhöhen vernachlässigt werden kann, solange sich keine schroffen Geländekanten oder Steilhänge in unmittelbarer Umgebung der betrachteten WEA befinden. Der über alle Windrichtungen energiegewichtete Standortmittelwert des Höhenexponenten α_{NH} ist für alle zu betrachtenden Anlagen in einem Bereich von der unteren Blattspitze bis zur oberen Blattspitze zu ermitteln.

Die folgende Tabelle 3.12 stellt die Ergebnisse der Standortmittelwerte des Höhenexponenten α_{NH} dar.

Tabelle 3.12 Standortmittelwert des Höhenexponenten α_{NH} der neu geplanten WEA

Interne W-Nr.	α_{NH} [-]
W1	0.14
W2	0.14

3.6 Luftdichte ρ

Da es sich bei keinem Anlagenstandort einer nach DIBt 2012 typengeprüften neu geplanten Anlage um einen nach DIN EN IEC 61400-1:2019 [6] topografisch komplexen Standort handelt, sind die Nachweise nach Abschnitt 1.2.2 nicht zu führen. Die Ausweisung der Werte erfolgt rein informativ und ein Vergleich mit den Auslegungswindbedingungen erfolgt im vorliegenden Gutachten nicht. Die Werte können jedoch einer eventuell erforderlichen Lastrechnung durch den Anlagenhersteller zu Grunde gelegt werden.

Die Berechnung der mittleren Luftdichte ρ_{NH} auf Nabenhöhe der jeweiligen WEA erfolgt entsprechend der Norm DIN ISO 2553 [17]. Als Datengrundlage dient die mittlere Temperatur in 2 m über Grund, die in einem 1 km Raster über den Zeitraum von 1981 – 2010 vorliegt [18] und entsprechend [17] auf die zu untersuchende Nabenhöhe umgerechnet wird.

Die folgende Tabelle 3.13 stellt die Ergebnisse des Standortmittelwertes der Luftdichte ρ_{NH} für jede zu untersuchende WEA dar.

Tabelle 3.13: Standortmittelwert der Luftdichte ρ_{NH} der neu geplanten WEA

Interne W-Nr.	ρ_{NH} [kg/m³]
W1	1.197
W2	1.198

3.7 Extreme Turbulenzintensität I_{ext}

Da es sich bei keinem Anlagenstandort einer nach DIBt 2012 typengeprüften neu geplanten Anlage um einen nach DIN EN IEC 61400-1:2019 [6] topografisch komplexen Standort handelt, sind die Nachweise nach Abschnitt 1.2.2 nicht zu führen. Die Ausweisung der Werte erfolgt rein informativ und ein Vergleich mit den Auslegungswindbedingungen erfolgt im vorliegenden Gutachten nicht. Die Werte können jedoch einer eventuell erforderlichen Lastrechnung durch den Anlagenhersteller zu Grunde gelegt werden.

Die Ermittlung der Extremturbulenzintensität erfolgt durch die Betrachtung aller auftretenden Nachlaufsituationen und stellt das Ergebnis mit dem höchsten Wert, im Zentrum aller betrachteten Nachlaufsituationen dar. Wenn keine Nachlaufsituationen zu berücksichtigen sind, wird der Wert der höchsten repräsentativen Turbulenzintensität ausgewiesen. Entsprechend [6] berücksichtigen alle ausgewiesenen Werte den jeweiligen anzusetzenden Turbulenzstrukturparameter C_{CT}.

Die folgende Tabelle 3.14 stellt die ermittelten extremen Turbulenzintensitäten $I_{ext, NH}$ in Abhängigkeit der Windgeschwindigkeit dar.

Tabelle 3.14: Ermittelte extreme Turbulenzintensitäten $I_{ext, NH}$

v_{hub}	W1	W2
3	0.326	0.344
4	0.277	0.319
5	0.260	0.319
6	0.244	0.297
7	0.227	0.279
8	0.214	0.258
9	0.203	0.238
10	0.185	0.226
11	0.173	0.210
12	0.160	0.195
13	0.148	0.180
14	0.140	0.168
15	0.133	0.157
16	0.128	0.147
17	0.124	0.140
18	0.121	0.135
19	0.118	0.130
20	0.115	0.127
21	0.112	0.122
22	0.110	0.119
23	0.108	0.115
24	0.106	0.112
25	0.105	0.109

4 Zusammenfassung

4.1 Neu geplante WEA

Es wurden die Standortbedingungen nach Abschnitt 1.2.1 für die neu geplanten WEA ermittelt und mit den Auslegungswerten verglichen. Dieser Vergleich hat gezeigt, dass

i. W1 und W2 eine Überschreitung der mittleren Windgeschwindigkeit $v_{hub,\,NH}$ im Vergleich zur Auslegungswindgeschwindigkeit $v_{hub,\,TP}$ aufweisen (siehe Abschnitt 3.2.1),

ii. W1 und W2 an einem Standort errichtet werden sollen, der den Auslegungswert der 50-Jahreswindgeschwindigkeit $v_{m50,\,TP}$ nicht überschreitet (siehe Abschnitt 3.2.2) und

iii. W1 und W2 keine Überschreitungen der effektiven Turbulenzintensität I_{eff} gegenüber den Auslegungswerten aufweisen (siehe Abschnitt 3.3.3.3).

Für die WEA W1 und W2 hat eine seitens des Herstellers Vestas durchgeführte Überprüfung der standortspezifischen Lasten der WEA, in der geplanten Konfiguration nach Tabelle 2.1, anhand der dem Hersteller zur Verfügung gestellten Ergebnisse aus Kapitel 3 ergeben, dass die Auslegungslasten der WEA nicht überschritten werden [25]. Die Ergebnisse in [25] wurden von der I17-Wind GmbH & Co. KG hinsichtlich der berücksichtigten Eingangsdaten geprüft und werden als richtig vorausgesetzt.

Die Standorteignung gemäß DIBt 2012 [1.1] ist für die WEA W1 und W2 unter Berücksichtigung der standortspezifischen Lastrechnung [25] durch das vorliegende Gutachten nachgewiesen.

Die folgende Tabelle stellt die Ergebnisse zum Nachweis der Standorteignung der geplanten WEA zusammenfassend dar.

Tabelle 4.1: Zusammenfassung der Ergebnisse geplante WEA

Interne W-Nr.	Hersteller	WEA Typ	*NH* [m]	*FEH* [m]	Standorteignung gemäß DIBt 2012 nachgewiesen
W1	Vestas	V162-7.2 MW	169.0	0.0	Ja
W2	Vestas	V162-7.2 MW	169.0	0.0	Ja

4.2 Bestehende WEA

Für die Bestands-WEA W7, W9 – W11 und W13 konnte die nach DIBt 2012 [1.1] nachzuweisende Standorteignung hinsichtlich der effektiven Turbulenzintensität durch den Vergleich mit den Auslegungswerten nachgewiesen werden.

Die Bestands-WEA W4, W5, W6 und W8 weisen Überschreitungen der effektiven Turbulenzintensität nach der Richtlinie DIBt 2012 [1.1] auf. Durch einen Vergleich der Situation vor, mit der Situation nach dem geplanten Zubau konnte gezeigt werden, dass der geplante Zubau keinen signifikanten Einfluss auf die Standorteignung hinsichtlich der effektiven Turbulenzintensitäten der WEA W4, W5 und W7 hat. Bei diesem Vergleich wurde die Erhöhung der effektiven Turbulenzintensität durch den Zubau und ggf. deren Einfluss auf die PEL nach [20] untersucht. Somit ist die Standorteignung hinsichtlich der effektiven Turbulenzintensität für diese WEA unter Maßgabe einer in deren Genehmigungsverfahren nachgewiesenen Standorteignung weiterhin nachgewiesen.

Die Bestands-WEA W12weist Überschreitungen hinsichtlich der effektiven Turbulenzintensität auf, die durch den Zubau verursacht werden. Um die Standorteignung der WEA W12 auch nach Zubau nachweisen zu können, sind die in Abschnitt 3.3.3.4 aufgeführten sektoriellen Betriebsbeschränkungen notwendig.

Die Bestands-WEA W3weist sowohl vor Zubau als auch nach Zubau Überschreitungen hinsichtlich der effektiven Turbulenzintensität auf, die durch den Zubau erhöht werden. Um die Standorteignung der WEA W3 auch nach Zubau nachweisen zu können bzw. die Überschreitungen der effektiven Turbulenzintensität nicht signifikant zu erhöhen, sind die in Abschnitt 3.3.3.4 aufgeführten sektoriellen Betriebsbeschränkungen notwendig. Bei der Festlegung der Betriebseinschränkungen wurde aufgrund des Abstandes von unter 2.0 RD zwischen den WEA W3 und verschiedenen Bestands-WEA die Erhöhung der effektiven Turbulenzintensität durch den Zubau und ggf. deren Einfluss auf die PEL nach [20] für diese WEA ohne Berücksichtigung der kritischen WEA untersucht. Somit ist die Standorteignung hinsichtlich der effektiven Turbulenzintensität für diese WEA unter Maßgabe einer in deren Genehmigungsverfahren nachgewiesenen Standorteignung weiterhin nachgewiesen.

Die folgende Tabelle stellt die Ergebnisse zum Nachweis der Standorteignung der Bestands-WEA zusammenfassend dar.

Tabelle 4.2: Zusammenfassung der Ergebnisse Bestands-WEA

Interne W-Nr.	Hersteller	WEA Typ	*NH* [m]	*FEH* [m]	Standorteignung gemäß DIBt 2012 nachgewiesen
W3	Vestas	V162-5.6 MW	166.0	0.0	Ja, siehe Abschnitt 3.3.3.4
W4	Vestas	V172-7.2 MW	199.0	0.0	Ja
W5	Vestas	V150-6.0 MW	166.0	0.0	Ja
W6	Vestas	V150-4.2 MW	166.0	0.0	Ja
W7	Vestas	V150-4.2 MW	166.0	0.0	Ja
W8	Vestas	V150-4.2 MW	166.0	0.0	Ja
W9	Enercon	E-82 E2 / 2.300 kW	138.0	0.0	Ja
W10	Vestas	V150-4.2 MW	166.0	0.0	Ja
W11	Nordex	N175/6.X	179.0	0.0	Ja
W12	Nordex	N163/6.X	164.0	0.0	Ja, siehe Abschnitt 3.3.3.4
W13	Nordex	N175/6.X	179.0	0.0	Ja

5 Standortbesichtigung

Die Notwendigkeit einer Standortbesichtigung ergibt sich sowohl aus der Richtlinie DIBt Fassung Oktober 2012 [1.1], als auch dem Mindeststandard des BWE-Windgutachterbeirats [14]. Entsprechend wurde diese am 04.02.2022 und 02.07.2024 durch den Auftraggeber durchgeführt [23].

Die Standortbesichtigung dient zur Ermittlung, bzw. zum Abgleich von Geländebeschaffenheit mit vorhandenen Satellitendaten zur Rauigkeit [13.1] und ggf. zu den Höhenlinien [13.2]. Mögliche turbulenzrelevante Einzelstrukturen wurden untersucht und dokumentiert. Die Standort-dokumentation bestätigt die zu Grunde gelegten Rauigkeiten und die Ergebnisse zur Komplexität.

Abkürzungs- und Symbolverzeichnis

Abkürzung	Bedeutung
BImSchG	Bundes-Immissionsschutzgesetz
DIBt	Deutsches Institut für Bautechnik
DIN	Deutsches Institut für Normung
EN	Europäische Norm
ETM	Extremes Turbulenzmodell
ETRS89	Europäisches Terrestrisches Referenzsystem von 1989
GK	Gauß-Krüger, Geländekategorie
H	Komplexitätskategorie Stark
IEC	International Electrotechnical Commission
L	Komplexitätskategorie Gering
M	Komplexitätskategorie Mittel
NA	Nationaler Anhang
NTM	Normales Turbulenzmodell
PEL	Pseudo-Äquivalente-Last
pdf	Wahrscheinlichkeitsdichtefunktion
TK	Turbulenzkategorie, Auslegungsturbulenz
TP	Typenprüfung
UTM	Universal Transverse Mercator Projection
WEA	Windenergieanlage(n)
WGS84	World Geodetic System (letzte Revision in 2004)
WSM	Wind Sector Management, Sektorielle Betriebsbeschränkung
WV	Windverteilung
WZ	Windzone

Symbol	Bedeutung	Einheit
A	Skalenparameter der Weibullverteilung	[m/s]
C_{CT}	Turbulenzstrukturparameter	[-]
c_t	Schubbeiwert	[-]
D	Rotordurchmesser	[m]
FEH	Fundamenterhöhung	[m]
h_{WV}	Höhe der Windbedingungen / Windverteilung über Grund	[m]
I_{amb}	Umgebungsturbulenzintensität	[-]
i_C	Komplexitätsindex	[-]
I_{char}	Charakteristische Turbulenzintensität	[-]
I_{ext}	Extreme Turbulenzintensität	[-]
I_{eff}	Effektive Turbulenzintensität auf Nabenhöhe	[-]
I_{rep}	Repräsentative Turbulenzintensität	[-]
k	Formparameter der Weibullverteilung	[-]
λ	Schnelllaufzahl	[-]
m	Wöhlerlinienkoeffizient	[-]
NH	Nabenhöhe	[m]
p	Sektorielle Häufigkeit	[%]
P_N	Nennleistung	[kW]
s	Dimensionsloser Abstand zwischen WEA, bezogen auf den jeweils größeren Rotordurchmesser	[-]

Symbol	Bedeutung	Einheit
τ	Lebensdauer	[a]
TSI	Index der Geländeneigung	[°]
TVI	Index der Geländeabweichung	[%]
v_{ave}	Jahresmittel der Windgeschwindigkeit auf Nabenhöhe	[m/s]
v_{hub}	Windgeschwindigkeit auf Nabenhöhe	[m/s]
v_{in}	Einschaltwindgeschwindigkeit der WEA	[m/s]
v_{m50}	10-Minuten Mittelwert der 50-Jahres-Windgeschwindigkeit auf Nabenhöhe	[m/s]
v_{out}	Abschaltwindgeschwindigkeit der WEA	[m/s]
v_r	Nennwindgeschwindigkeit der WEA	[m/s]
v_{ref}	Auslegungswert des 10-Minuten Mittelwerts der 50-Jahres-Windgeschwindigkeit	[m/s]
X	Rechtswert	[m]
Y	Hochwert	[m]
z_0	Rauigkeitslänge	[m]
z_{hub}	Nabenhöhe der betrachteten WEA	[m]
α	Höhenexponent	[-]
δ	Schräganströmung	[°]
ρ	Luftdichte	[kg/m³]
σ	Standardabweichung der Windgeschwindigkeit	[m/s]
σ_σ	Standardabweichung der Turbulenzintensität	[-]

Literaturverzeichnis

[1.1] *Deutsches Institut für Bautechnik – DIBt -, Berlin; Referat I 8 Bautechnisches Prüfamt Grundlagen der Standsicherheit; Richtlinie für Windenergieanlagen – Einwirkungen und Standsicherheitsnachweise für Turm und Gründung; Fassung Oktober 2012 und korrigierte Fassung März 2015;*

[1.2] *DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik; DKE/AK 383.0.01/Untergruppe DIBt2012 an die PG „Windenergieanlagen" des DIBt; Anwendung der DIBt 2012 zur Prüfung der Standorteignung, 30.01.2015;*

[2] *Deutsches Institut für Bautechnik – DIBt -, Berlin; Richtlinie für Windenergieanlagen – Einwirkungen und Standsicherheitsnachweise für Turm und Gründung; Fassung März 2004; Schriften des Deutschen Instituts für Bautechnik Reihe B, Heft 8;*

[3] *Deutsches Institut für Bautechnik – DIBt -, Berlin; Richtlinie für Windkraftanlagen – Einwirkungen und Standsicherheitsnachweise für Turm und Gründung; Fassung Juni 1993; 2. Überarbeitete Auflage 1995; Schriften des Deutschen Instituts für Bautechnik Reihe B, Heft 8;*

[4] *International Electrotechnical Comission (IEC); IEC 61400-1 Edition 2.0 International Standard Wind turbine generator systems – Part 1: Safety requirements;*

[5] *International Electrotechnical Comission (IEC); IEC 61400-1 Edition 3.0 International Standard Windturbines – Part 1: Design requirement; Mit Implementierung von 61400-1/A1, Amendment 1, 2009;*

[6] *Deutsches Institut für Normung e.V.; DIN EN IEC 61400-1:2019; Windenergieanlagen – Teil 1: Auslegungsanforderungen (IEC61400-1:2019; Deutsche Fassung EN IEC 61400-1:2019; Dezember 2019;*

[7] *Deutsches Institut für Normung e.V.; DIN EN 61400-1:2011-08 Windenergieanlagen – Teil 1: Auslegungsanforderungen (IEC 61400-1:2005 + A1:2012); Deutsche Fassung EN 61400-1:2005 + A1:2010;*

[8] *Deutsches Institut für Normung e.V.; DIN EN 61400-1:2004 Windenergieanlagen – Teil 1: Sicherheitsanforderungen (IEC 61400-1:1999); Deutsche Fassung EN 61400-1:2004;*

[9] *Deutsches Institut für Normung e.V.; DIN EN 1991-1-4/NA:2010-12 mit DIN EN 1991-1-4:2010-12; Nationaler Anhang – Eurocode 1: Einwirkungen auf Tragwerke – Teil 1-4: Allgemeine Einwirkungen: Windlasten;*

[10] *ECN Solar & Wind Energy, J.W.M. Dekker und J.T.G. Pierik [Hrsg.]: European Wind Turbine Standards II, Petten, (NLD), 1998;*

[11] *Deutsches Institut für Bautechnik; Windzonen nach Verwaltungsgrenzen; Windzonen_nach_Verwaltungsgrenzen.xlsx; Stand 02.06.2022;*

[12] *European Wind Atlas, Risø National Laboratory, Roskilde (DK), 1989 Troen, Ib; Petersen, Erik L.;*

[13.1] *European Environment Agency; Corine Land Cover (CLC) 2018, Version 20 (final version); Veröffentlicht im Juni 2019;*

[13.2] *U.S. Geological Survey Earth Resources Observation & Science Center (EROS); SRTM 1 Arc-Sec Global; Download am 02.12.2016;*

[14] *BWE Bundesverband WindEnergie; BWE-Windgutachterbeirat - Mindeststandards zur Dokumentation von gutachterlichen Stellungnahmen zur Ermittlung der Umgebungsturbulenzintensität; 15.11.2016;*

[15] *Risø DTU National Laboratory for Sustainable Energy, Windfarm Assessment Tool Version 3.3.0.128;*

[16] *Frandsen, Sten T. (2007): Turbulence and turbulence-generated structural loading in wind turbine clusters. Roskilde (DK);*

[17] *Deutsches Institut für Normung e.V.; DIN ISO 2533; Normatmosphäre; Dezember 1979;*

[18] *Deutscher Wetterdienst; DWD Climate Data Center (CDC), Vieljährige mittlere Raster der Lufttemperatur (2m) für Deutschland 1981-2010, Version v1.0.;*

[19.1] *OpenStreetMap und Mitwirkende; SRTM | Kartendarstellung: OpenTopoMap (CC-BY-SA); Siehe auch: https://creativecommons.org;*

[19.2] *Microsoft Corporation; © 2019 Digital Globe © CNES (2019) Distribution Airbus DS; Siehe auch: https://www.microsoft.com/en-us/maps/product;*

[20] *Rodenhausen M., Moser W., Hülsmann C., Bergemann C., Könker M., McKenna R.; Prüfung der Standorteignung für Windenergieanlagen: Ein pragmatischer Ansatz; Ernst & Sohn Verlag für Architektur und technische Wissenschaften GmbH & Co. KG, Berlin. Bautechnik 93 (2016) Heft 10;*

[21] *Pavana GmbH; E-Mail mit dem Betreff: " AW: WP Gebstedt/Willerstedt - Update" vom 22.01.2025; Daten zur Verfügung gestellt in WakeGuard® Layout-ID: 3719954; 21-01-2025_I17-SE-IND_29856_V2.pdf;*

[22.1] *Pavana GmbH; E-Mail mit dem Betreff: " AW: WP Gebstedt/Willerstedt - Update" vom 22.01.2025; Daten zur Verfügung gestellt in WakeGuard® Layout-ID: 3719954 – Referenzwindverteilung auf 166.0 m Höhe ü. Grund; 21-01-2025_I17-SE-IND_29856_V2.pdf;*

[22.2] *Pavana GmbH; Abschätzung der Extremwindgeschwindigkeit $v_{m50}(h)$; Bericht 2024PAV01334; Version 0; 15.08.2024;*

[23] *Pavana GmbH; Standortbesichtigung Standort: Gebstedt, Thüringen (Deutschland); Bericht 2024PAV01144; Version 0; 15.08.2024;*

[24.1] *DNV Energy Systems Renewables Certification GmbH; Gutachtliche Stellungnahme für Lastannahmen zur Turmberechnung der Vestas Turbinen; Vestas EnVentus EV162-6.8 / 7.2 MW mit 169 m Nabenhöhe, Windzone S, 25 Jahre Entwurfslebensdauer; Bericht - Nr.: L-08867-A052-0B; 11.12.2023;*

[24.2] *Vestas Wind Systems A/S; Gutachterinformation Auslegungswerte Turbulenz EnVentus™ V162-7.2 MW 50/60 Hz 25 Jahre; Documentnr.: 0114-3579 V02; 19.05.2022;*

[25] *Vestas Wind Systems A/S; Lastrechnung Planung;*

RESTRICTED

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

VESTAS ENVENTUS EV162-6.8 / 7.2 MW MIT 169 M NABENHÖHE, WINDZONE S, 25 JAHRE ENTWURFSLEBENSDAUER

Gutachtliche Stellungnahme für Lastannahmen zur Turmberechnung der Vestas Turbinen

Vestas Wind Systems A/S

Report No.: L-08867-A052-0B
Date: 2023-12-11



T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

Unrestricted © 2023 DNV. This document is the property of Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Projektname:	Vestas EnVentus EV162-6.8 / 7.2 MW mit 169 m Nabenhöhe, Windzone S, 25 jahre Entwurfslebensdauer	DNV Energy Systems Renewables Certification Renewables Certification GmbH
Titel:	Gutachtliche Stellungnahme für Lastannahmen zur Turmberechnung der Vestas Turbinen	Brooktorkai 18 20457 Hamburg
Kunde:	Vestas Wind Systems A/S, Hedeager 42, 8200 Aarhus N	Germany
Kontaktperson:	Shereef Kather	Tel.: +49 40 36149-0
Erstellungsdatum:	2023-12-11	
Projekt - Nr.:	10367766	
Bericht - Nr.:	L-08867-A052-0B	

Geltender Vertrag für diesen Bericht: 233187-SFA-20220613

Objective:

Gutachterliche Stellungnahme für Lastannahmen zur Turmberechnung der Vestas EnVentus EV162-6.8 / 7.2 MW mit 169 m Nabenhöhe (Entwurfslebensdauer 25 Jahre) für Windzone S.

Der gegebene Turmname ist HA2A90A.

Erstellt von:	Geprüft von:
Andreas Reimann Gutachter	Pedersen, Trine Bjerre 2023.12.11 11:55:26 +01'00' Trine Bjerre Pedersen Projektleiterin

Copyright © DNV 2022. All rights reserved. Unless otherwise agreed in writing: (i) This publication or parts thereof may not be copied, reproduced or transmitted in any form, or by any means, whether digitally or otherwise; (ii) The content of this publication shall be kept confidential by the customer; (iii) No third party may rely on its contents; and (iv) DNV undertakes no duty of care toward any third party. Reference to part of this publication which may lead to misinterpretation is prohibited.

DNV Distribution:

☐ Uneingeschränkter Verteiler (intern und extern)

☐ Uneingeschränkter Verteiler innerhalb DNV GL

☒ VERTRAULICH. Vertrieb innerhalb von DNV gemäß geltendem Vertrag.*

☐ Geheim. Nur autorisierter Zugriff.

* Verteilung angeben: DNV Renewables Certification

Schlüsselwörter:

Vestas EnVentus EV162-6.8 / 7.2 MW, DIBt-Richtlinie: 2012-10, Lastannahmen

Rev. No.	Datum	Grund für Herausgabe	Erstellt von	Geprüft von
0	2022-06-24	Erste Ausgabe	GREU	MARWOL
1	2023-09-05	RNA Lastdokument 0122-3112 aktualisiert auf V02, jetzt mit Vergleich zu design Lasten 0104-6018.V04	GREU	MARWOL
2	2023-12-11	Anlagendaten aktualisiert	ANDREIM	TRINEP

T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Inhaltsverzeichnis

1 ZUSAMMENFASSUNG 1

2 ZERTIFIZIERUNGSSCHEMA (NORMEN UND RICHTLINIEN) 1

3 PRÜFUNTERLAGEN 1

4 BEWERTUNGSGRUNDLAGEN 1

5 PRÜFBEMERKUNGEN FÜR DIE LASTANNAHMEN 2

6 SCHLUSSBEMERKUNG 3

Anlage A PRÜFUNTERLAGEN

T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

1 ZUSAMMENFASSUNG

Die aufgeführten Lastannahmen werden für die Windenergieanlagen EnVentus EV162-6.8 / 7.2 MW der Firma Vestas mit einer Nabenhöhe von 169 m, für DIBt S angenommen.

Die Richtigkeit der vorgelegten Lasten, sowie die Übereinstimmung der Lasten mit den Anforderungen der DIBt "Richtlinie für Windenergieanlagen, Einwirkungen und Standsicherheitsnachweise für Turm und Gründung", Fassung Oktober 2012 wurden anhand von Plausibilitätsprüfungen unter Berücksichtigung der dimensionierenden Eingangsdaten geprüft und soweit vorliegend bestätigt.

2 ZERTIFIZIERUNGSSCHEMA (NORMEN UND RICHTLINIEN)

Document No.	Title
DIBt-Richtlinie: 2012-10	Richtlinie für Windenergieanlagen Einwirkungen und Standsicherheitsnachweise für Turm und Gründung

3 PRÜFUNTERLAGEN

Die Unterlagen für die Windenergieanlage EnVentus EV162-6.8 / 7.2 MW mit 169 m Nabenhöhe der Firma Vestas sind in Anlage 1 aufgeführt.

4 BEWERTUNGSGRUNDLAGEN

4.1 Umweltbedingungen für die Lastannahmen

Die Windbedingungen der Vestas EnVentus EV162-6.8 / 7.2 MW Turbinen mit 169 m Nabenhöhe sind entsprechend der Windklasse S gemäß DIBt 2012 angesetzt.

	EnVentus EV162-6.8 / 7.2 MW mit 169 m Nabenhöhe HA2A90A DIBt S
Jahresmittel der Windgeschwindigkeit in Nabenhöhe	7,5 m/s für 6,8MW 7,0 m/s für 7,2MW
Weibull k-Parameter	2
50-Jahres-Wind, Vm50 (10 min) in Nabenhöhe	37,60 m/s
1-Jahres-Wind, Vm1 (10 min) in Nabenhöhe	30,10 m/s
Luftdichte	1,225kg/m^3
Geländeneigung	8°
Geländerauigkeitsexponent (normale Bedingungen)	0,27
Geländerauigkeitsexponent (extreme Bedingungen)	0,11
Umgebungsturbulenzintensität nach IEC 61400-1 für NTM	Siehe Tabelle 1
Umgebungsturbulenzintensität I_{ref} nach IEC 61400-1 für ETM	0,16
Lastsicherheitsbeiwert für DLC8.1 (Sicherheitsklasse S)	γ_F = 1,35
Erdbebenzone	Erdbebenzone 3; Bedeutungskategorie II, Baugrundklassen A, B, C mit den geologischen Untergrundklassen R, T, S nach DIN EN 1998-1/NA:2011-01 Tabelle NA.4

Wind Geschwindigkeit [m/s]	NTM Fatigue [-]	NTM Extreme [-]
2	0,560	0,462
4	0,340	0,280
6	0,281	0,219
8	0,243	0,189
10	0,216	0,170

T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

12	0,168	0,158
14	0,147	0,150
16	0,136	0,143
18	0,129	0,138
20	0,124	0,134
22	0,122	0,131
24	0,118	0,128
26	0,116	0,126
28	0,114	0,124
30	0,112	0,122
32	0,110	0,120
34	0,109	0,119
36	0,108	0,118
41	0,105	0,114

Tabelle 1 Turbulenzintensität für NTM.

Der Einfluss der Turbulenzintensität aufgrund der Nachlaufströmung benachbarter Anlagen ist in den o.g. Angaben nicht berücksichtigt.

4.2 Anlagedaten für die Lastannahmen

	EnVentus EV162-6.8 / 7.2 MW mit 169 m Nabenhöhe HA2A90A DIBt S
Nennleistung	6,8 MW / 7,2 MW
Rotordurchmesser	162 m
Einschaltgeschwindigkeit	3,0 m/s
Nennwindgeschwindigkeit	11,0 m/s / 11,4 m/s
Abschaltgeschwindigkeit	25,0 m/s
Nennrotordrehzahl	9,18 rpm / 9,57 rpm
Nabenhöhe	169 m
Stahl-Beton Hybrid Turm mit nominaler 1. Biegeeigenfrequenz mit	
Steifer Einspannung	0,197 Hz
Weicher Einspannung	0,186 Hz
Rechnerische Lebensdauer	25 Jahre
Version des Reglers	1

4.3 Gültigkeit für die Lastannahmen

Eigenfrequenzbereich des Turmes	von 0,177 Hz bis 0,207 Hz
Dynamischen Drehfedersteifigkeit des Gesamtsystems aus Boden und Fundament	≥ 99 GNm/rad (weich); ≥ 174 GNm/rad (steif), siehe Tabelle 5-1 und Tabelle 5-2 in Dokument [5]
Mindestabständen von Windturbinen zu einander, solange die folgenden Bedingungen laut Kapitel 7.3.3 der DIBt-Richtlinie erfüllt sind.	Der Abstand der Turmachsen benachbarter Windenergieanlagen darf den 8-facher Rotor-durchmesser für Vm50 ≤ 40 m/s auf Nabenhöhe nicht unterschreiten Der Abstand der Turmachsen benachbarter Windenergieanlagen darf den 5-facher Rotor-durchmesser für Vm50 ≥ 45 m/s auf Nabenhöhe nicht unterschreiten. Zwischenwerte von Vm50 ist der Abstand linear zu interpolieren.

5 PRÜFBEMERKUNGEN FÜR DIE LASTANNAHMEN

Extremlastfälle:

Die Übereinstimmung der Extremlastfälle wurde mit der DIBt-Richtlinie „Richtlinie für Windenergieanlagen: Einwirkungen und Standsicherheitsnachweise für Turm und Gründung“; Oktober 2012 bei Anwendung standortspezifischer Windbedingungen geprüft. Die Extremlasten sind in den Vestas Wind System A/S Berichten gemäß DIBt-Richtlinie einschließlich Lastsicherheitsbeiwerten aufgeführt.

T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Erdbebenlasten wurden nach DIN EN 1998-1/2010-10 und NA/2011-01 für die Untergrundverhältnisse nach Tabelle NA.4 im nationalen Anhang zur DIN EN 1998-1 berechnet und geprüft.

Betriebfestigkeit:

Die Lastannahmen für den Betriebsfestigkeitsnachweis basieren auf die DIBt-Richtlinie: „Richtlinie für Windenergieanlagen; Einwirkungen und Standsicherheitsnachweise für Turm und Gründung“; Fassung Oktober 2012. Die Lastkollektive wurden mit dem Vestas Turbinen Simulator (VTS), Version VTS002, des aeroelastischen PC-Programmes Flex5 berechnet und für den Turmkopf, den Turmfuß sowie für unterschiedliche Turmschnitte angegeben. Die Fundamentlasten sind gesondert im Dokument [5] aufgeführt.

Die Berechnung der Betriebfestigkeitslasten wurde unter Berücksichtigung eines dreidimensionalen Turbulenzfeldes durchgeführt.

5.1 OFFENE PUNKTE

Die Turmzeichnung wurde weder bei DNV eingereicht noch bewertet. Aus diesem Grund muss die statische Abbildung des Turms im Lastmodell zusammen mit der Turmbewertung verifiziert werden.

6 SCHLUSSBEMERKUNG

Die aufgeführten Lastannahmen werden für die Windenergieanlagen EnVentus EV162-6.8 / 7.2 MW der Firma Vestas mit einer Nabenhöhe von 169 m, für DIBt S angenommen.

Wirbelerregte Querschwingungen auf die Turmlasten wurden nicht berücksichtigt. Einwirkungen daraus sollten bei der Turmauslegung betrachtet werden. Das Inbetriebnahmehandbuch muss die Verhinderung unzulässiger Turmschwingungen, wie von Vestas definiert, beschreiben. Die Transportlasten wurden nicht berücksichtigt.

Erdbebenlasten wurden nach DIN EN 1998-1/2010-10 und NA/2011-01 berechnet und geprüft, siehe Abschnitt 4.1 (Umweltbedingungen).

Es wurden keine Ride-Through Lastfälle (Stützung der Netzspannung durch Windenergieanlagen bei Netzstörung) bei Spannungsabfall definiert oder berechnet. Ride-Through Lastfälle bei Spannungsabfall sind nicht Bestandteil dieses Gutachtens.

Turmzeichnungen lagen für die Prüfung nicht vor. Die Überprüfung des Turm-Simulationsmodells zur Berechnung der Betriebsfestigkeits- und Extremlasten wurde mittels Vergleich zu den Turmmodelldaten im Turmdokument [4] vollzogen.

Die Lasten sind gültig für die in Abschnitt 4 sowie im folgenden gelisteten Bedingungen:

- Beiträge aus Eigengewichtsmomenten aufgrund von Schiefstellung der Turmachse sind nicht in den ausgewiesenen Lasten enthalten. Diese Lasten müssen später den extremalen Auslegungslasten für Turm- und Gründung gemäß Anforderungen in DIBt [1], Abschnitt 7.4.1 hinzugefügt werden.
- die aufgeführten Windgeschwindigkeiten in Abschnitt 4.1 müssen die Windgeschindigkeiten gemäß DIN EN1991-1-4/NA abdecken.
- Dass sich das Lastnivieau bei gleichen externen Bedingungen nach dem Typenzertifizierungsprozess (Validierung der Lastannahmen durch Lastmessungen) nicht erhöht.

Die Richtigkeit der vorgelegten Lasten, sowie die Übereinstimmung der Lasten mit den Anforderungen der DIBt "Richtlinie für Windenergieanlagen, Einwirkungen und Standsicherheitsnachweise für Turm und Gründung", Fassung

T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Oktober 2012 wurden anhand von Plausibilitätsprüfungen unter Berücksichtigung der dimensionierenden Eingangsdaten geprüft und soweit vorliegend bestätigt.

T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

ANLAGE A
PRÜFUNTERLAGEN

Prüfung der Vestas EnVentus EV162-6.8 / 7.2 MW mit 169 m Nabenhöhe, Windzone S

Beschreibung der geprüften EnVentus EV162-6.8 / 7.2 MW Windenergieanlage

Die EnVentus EV162-6.8 / 7.2 MW ist eine mit Getriebe und Dauermagent Synchrongenerator ausgestattete, pitch geregelte, luv seitig angeströmte Windenergieanlage, mit variabler Rotorgeschwindigkeit. Die EnVentus EV162-6.8 / 7.2 MW unterstützt 2 Leistungslevel, 6,8 MW und 7,2 MW. Die hier geprüfte Variante hat einen Stahl-Beton Hybrid Turm mit einer Nabenhöhe von 169m. Die Lasten wurden nach DIBt Klasse S geprüft.

Schnittstelle zu anderen Gewerken:

Beiträge aus Eigengewichtsmomenten aufgrund von Schiefstellung der Turmachse sind nicht in den ausgewiesenen Lasten enthalten. Diese Lasten müssen später den extremalen Auslegungslasten für Turm- und Gründung gemäß Anforderungen in DIBt [1], Abschnitt 7.4.1 hinzugefügt werden.

Turmzeichnungen lagen für die Prüfung nicht vor. Die Überprüfung des Turm-Simulationsmodells zur Berechnung der Betriebsfestigkeits- und Extremlasten wie Turmdokument [4] angegeben muss später bei Vorlage der Zeichnung überprüft werden.

Basis der Prüfung

Angewandte Normen und Richtlinien:

Document No.	Version	Title
[1] DIBt	2012	Richtlinie für Windenergieanlagen

Die Prüfung der Lasten basiert auf:

Document No.	Version	Title
[2] 0086-8845	11	IEC 61400-1 and DIBt 2012 Vestas design load case interpretations - Generic document

Prüfunterlagen

Liste der Dokumente:

Dokumenten Nr.	Version	Titel
[3] 0133-2031	02	Combine Load Spectrum (28 Seiten) EV162-6.8/7.2MW, Mk1B, WZ2GK2(S), 169m, 50/60Hz, GS
[4] 0121-5839	05	Combine Tower Loads (61 Seiten) – HA2A90A, EV162-6.8/7.2MW, Mk1B, WZ2GK2(S), 169m, 50/60Hz, GS
[5] 0122-8671	03	Combine Foundation Loads (223 Seiten) – HA2A90A, EV162-6.8/7.2MW, Mk1B, WZ2GK2(S), 169m, 50/60Hz, GS

T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE



Zeichnungen (informativ):

Dokumenten Nr.	Version	Titel
Nicht verfügbar	-	Hybrid Turm HA2A90A EV162-6.8/7.2MW, EnVentus, DIBt (S), 169m

Referenzdokumente (informativ):

Dokumenten Nr.	Version	Titel
[6] 0110-2938	02	Controller Specification EnVentus Mk1B/C
[7] 0104-6018	04	EV162 Design Loads
[8] 0132-1883	03	EnVentus Mk1B_C Main Maintenance Loads ((EV162 Mk1B loads only))
[9] 0121-5084	01	EnVentus – Mk1B Mechanical Brake Evaluation
[10] 0120-9349	01	Mk1BC_Rotor_lock_loads
[11] 0124-0036	06	Load Extrapolation EV162-6.8/7.2MW, Mk1B, HH169m
[12] 0112-2952	05	Turbine Configurations & Operational Properties – EnVentus MK1B/C (only examined in reference to onhand investigated EV162, HH169 CHT)
[13] 216354-LTR-20220110	2022-01-10	DNV Letter. Concept approval: Edge Whirling Controller (EWC)

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

About DNV

DNV is the independent expert in risk management and assurance, operating in more than 100 countries. Through its broad experience and deep expertise DNV advances safety and sustainable performance, sets industry benchmarks, and inspires and invents solutions.

Whether assessing a new ship design, optimizing the performance of a wind farm, analyzing sensor data from a gas pipeline or certifying a food company's supply chain, DNV enables its customers and their stakeholders to make critical decisions with confidence.

Driven by its purpose, to safeguard life, property, and the environment, DNV helps tackle the challenges and global transformations facing its customers and the world today and is a trusted voice for many of the world's most successful and forward-thinking companies.

T05 0136-0316 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

CONFIDENTIAL

CLASS T05

Vestas

Document:
0122-8671 VER 03

Description:
Foundation loads – EV162-6.8/7.2MW HH169m HA2A90A

Combine Foundation loads – HA2A90A

EV162-6.8/7.2 MW, Mk1B, WZ2GK2(S), 169 m

50/60 Hz, GS



T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

QMS 00091 VER 00

COPYRIGHT © - VESTAS WIND SYSTEMS A/S, HEDEAGER 44, DK-8200 AARHUS N, DENMARK, WWW.VESTAS.COM
This document is the property of Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed to others for any purpose nor may the rights be exercised by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: ELiA 2.8.b5 Classification: Confidential

DNV
DNV Business Assurance A/S
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

91576

Version History

VERSION:	DATE:	CHANGE:
00	2022.05.01	New document.
01	2022.05.03	Fix typo in Table 1-2 and valid frequency range.
02	2022.09.14	TR4 Model Update
03	2023.11.24	FND stiffness clarification (no change in loads)

Table of Contents

CHAPTER:	DESCRIPTION:	PAGE:
1.	**Introduction**	**3**
2.	**Extreme loads**	**4**
3.	**Production loads**	**6**
4.	**Fatigue loads**	**6**
5.	**Stiffness of foundation**	**7**
Appendix A.	**Co-ordinate systems**	**8**
Appendix B.	**Rain flow count**	**9**
B.1	6.8MW, 20yrs lifetime, soft tower	9
B.2	6.8MW, 20yrs lifetime, stiff tower	10
B.3	6.8MW, 25yrs lifetime, soft tower	11
B.4	6.8MW, 25yrs lifetime, stiff tower	12
B.5	7.2MW, 20yrs lifetime, soft tower	13
B.6	7.2MW, 20yrs lifetime, stiff tower	14
B.7	7.2MW, 25yrs lifetime, soft tower	15
B.8	7.2MW, 25yrs lifetime, stiff tower	16
Appendix C.	**Markov matrices – issued from [1]**	**17**
Appendix D.	**Markov matrices – issued from [2]**	**43**
Appendix E.	**Markov matrices – issued from [3]**	**69**
Appendix F.	**Markov matrices – issued from [4]**	**95**
Appendix G.	**Markov matrices – issued from [5]**	**120**
Appendix H.	**Markov matrices – issued from [6]**	**145**
Appendix I.	**Markov matrices – issued from [7]**	**171**
Appendix J.	**Markov matrices – issued from [8]**	**197**

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-11-27 by KASOHE

DNV
DNV Business Assurance A/S
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

1. Introduction

This document presents the foundation loads from the EV162-6.8/7.2 MW, GS, HH 169, WZ2GK2(S) HA2A90A load spectrum. The loads are simulated in accordance with DIBt - Richtlinie für Windenergianlagen Ed. October 2012, ref. [A]. Tower used for calculating the loads can be found in ref. [B].

Reference	Description	Doc No.
[A]	DIBt - Richtlinie für Windenergianlagen Ed. October 2012	
[B]	Tower drawing	N/A

Table 1-1 Reference to documents.

Ref.	Simulation Path
[1]	**EV162 6.8MW DIBt HH169 20yrs HA2A90A soft**
	H:\ENVENTUS\Mk1a\Variants\F3\ExportModel\073_Week35_LoadIteration\Prep_Files\MK1B_EV162_6800kW_HH169_dibt_STD_20y_HA2A90A_soft\Loads\Postloads_MB\
[2]	**EV162 6.8MW DIBt HH169 20yrs HA2A90A stiff**
	H:\ENVENTUS\Mk1a\Variants\F3\ExportModel\073_Week35_LoadIteration\Prep_Files\MK1B_EV162_6800kW_HH169_dibt_STD_20y_HA2A90A_stiff\Loads\Postloads_MB \
[3]	**EV162 6.8MW DIBt HH169 25yrs HA2A90A soft**
	H:\ENVENTUS\Mk1a\Variants\F3\ExportModel\073_Week35_LoadIteration\Prep_Files\MK1B_EV162_6800kW_HH169_dibt_STD_25y_HA2A90A_soft\Loads\Postloads_MB \
[4]	**EV162 6.8MW DIBt HH169 25yrs HA2A90A stiff**
	H:\ENVENTUS\Mk1a\Variants\F3\ExportModel\073_Week35_LoadIteration\Prep_Files\MK1B_EV162_6800kW_HH169_dibt_STD_25y_HA2A90A_stiff\Loads\Postloads_MB \
[5]	**EV162 7.2MW DIBt HH169 20yrs HA2A90A soft**
	H:\ENVENTUS\Mk1a\Variants\F3\ExportModel\073_Week35_LoadIteration\Prep_Files\MK1B_EV162_7200kW_HH169_dibt_STD_20y_HA2A90A_soft\Loads\Postloads_MB \
[6]	**EV162 7.2MW DIBt HH169 20yrs HA2A90A stiff**
	H:\ENVENTUS\Mk1a\Variants\F3\ExportModel\073_Week35_LoadIteration\Prep_Files\MK1B_EV162_7200kW_HH169_dibt_STD_20y_HA2A90A_stiff\Loads\Postloads_MB \
[7]	**EV162 7.2MW DIBt HH169 25yrs HA2A90A soft**
	H:\ENVENTUS\Mk1a\Variants\F3\ExportModel\073_Week35_LoadIteration\Prep_Files\MK1B_EV162_7200kW_HH169_dibt_STD_25y_HA2A90A_soft\Loads\Postloads_MB \
[8]	**EV162 7.2MW DIBt HH169 25yrs HA2A90A stiff**
	H:\ENVENTUS\Mk1a\Variants\F3\ExportModel\073_Week35_LoadIteration\Prep_Files\MK1B_EV162_7200kW_HH169_dibt_STD_25y_HA2A90A_stiff\Loads\Postloads_MB \

Table 1-2 Reference to simulations.

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV
DNV Business Assurance A/S
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

2. Extreme loads

Foundation loads components at the instant of extreme resulting bending moment are given in beneath table. Own weight moment contribution due to tower out of vertical is not included.

Loads are given at height: 2.62m

Mbt1: Resulting bending moment. SQRT(Mxt1^2 + Myt1^2) (also M_{res})
Lead LC/Family

Characteristic Extreme								
Lead	LC/Family	PLF	Type	Mbt	Mzt	FndFr	Fzt	Ref
Sensor	[-]	[-]	[-]	[kNm]	[kNm]	[kN]	[kN]	[-]
Mbt	1314etm00(fam88)	1.35	Abs	**215600**	-1782.97	2062.51	-19736.11	[6]
Mzt	43ETMRSHWO100(fam293)	1.35	Abs	50702.60	**-11881.42**	407.58	-19585.24	[1]
FndFr	1316etm00(fam89)	1.35	Abs	201200	-2023.96	**2224.11**	-19719.86	[6]
Fzt	61E50a00000(fam308)	1.50	Abs	40415.25	1204.49	423.22	**-19543.46**	[1]

Table 2-1 Characteristic Extreme (excl. PLF). Load cases sorted with PLF.

Characteristic Extreme								
Lead	LC/Family	PLF	Type	Mbt	Mzt	FndFr	Fzt	Ref
Sensor	[-]	[-]	[-]	[kNm]	[kNm]	[kN]	[kN]	[-]
Mbt	23CoEogvra30(fam182)	1.1	Abs	**263000**	-2124.70	1766.50	-19763.64	[1]
Mzt	43ETMRSHWO100(fam293)	1.35	Abs	50702.6	**-11881.42**	407.58	-19585.24	[1]
FndFr	1316etm00(fam89)	1.35	Abs	201200	-2023.96	**2224.11**	-19719.86	[6]
Fzt	12IceUHWO100(fam76)	1.35	Abs	96622.66	2348.35	542.25	**-19940.83**	[5]

Table 2-2 Characteristic Extreme (excl. PLF). Load cases sorted without PLF.

Characteristic Extreme								
Lead	LC/Family	PLF	Type	Mbt	Mzt	FndFr	Fzt	Ref
Sensor	[-]	[-]	[-]	[kNm]	[kNm]	[kN]	[kN]	[-]
Mbt	23CoEogvra30(fam182)	1.1	Abs	**263000**	-2124.70	1766.50	-19763.64	[1]
Mzt	22REYHWO1b00(fam169)	1.1	Abs	71264.49	**-11599.93**	627.86	-19571.00	[1]
FndFr	23CoEogVrp40(fam191)	1.1	Abs	243400	-876.47	**1945.71**	-19760.75	[6]
Fzt	23CoEogvra30(fam182)	1.1	Abs	204600	522.78	1316.31	**-19855.84**	[1]

Table 2-3 Characteristic Extreme (excl. PLF). Only load cases with PLF = 1.10.

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems A/S
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Characteristic Extreme								
Lead	LC/Family	PLF	Type	Mbt	Mzt	FndFr	Fzt	Ref
Sensor	[-]	[-]	[-]	[kNm]	[kNm]	[kN]	[kN]	[-]
Mbt	1314etm00(fam88)	1.35	Abs	**215600**	-1782.97	2062.51	-19736.11	[6]
Mzt	43ETMRSHWO100(fam293)	1.35	Abs	50702.6	**-11881.42**	407.58	-19585.24	[1]
FndFr	1316etm00(fam89)	1.35	Abs	201200	-2023.96	**2224.11**	-19719.86	[6]
Fzt	12IceUHWO100(fam76)	1.35	Abs	96622.66	2348.35	542.25	**-19940.83**	[5]

Table 2-4 Characteristic Extreme (excl. PLF). Only load cases with PLF = 1.35.

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems A/S
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

3. Production loads

The production loads are calculated for the main sensors of the foundation. The following loads are calculated.

Char. load Characteristic Extreme (excl. PLF, Load cases sorted without PLF). Only load cases with PLF = 1.35 and 1.50 are included in the evaluation.

Prob.: 1e-2 Load level with an exceedance probability of 1e-2

Prob.: 1e-4 Load level with an exceedance probability of 1e-4

Production loads							
		Char. load	Prob.:1e-2	Prob.:1e-4	Ref		
M_{res}	[kNm]	215600.00	161384.75	184120.89	[6]	[4]	[2]
M_z	[kNm]	-11881.42	-4585.96	-6825.16	[1]	[5]	[5]
F_{res}	[kN]	2224.11	1160.35	1555.38	[6]	[2]	[2]
F_z	[kN]	-19940.83	-19806.14	-19853.24	[5]	[5]	[1]

Table 3-1 Production loads.

4. Fatigue loads

For the foundation, the mean loads have to be considered. The mean loads must be combined with either the equivalent loads or the fatigue load spectrum.

Loads are given at height: 2.62m

The equivalent loads given may be used only if the material property can be characterized by an S/N-curve with the same slope as given for the equivalent loads.

Equivalent and Mean Fatigue Foundation Loads							
		Mean load	Range m = 4	Range m = 7	Ref		
Fy	[kN]	465.96	1682.88	1482.05	[5]	[2]	[2]
Mx	[kNm]	-76969.26	107142.02	99612.13	[5]	[2]	[2]
Mz	[kNm]	-237.41	9924.92	9393.99	[5]	[5]	[5]

Table 4-1 Fatigue loads for N=1E7 cycles.

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems A/S
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

5. Stiffness of foundation

The tower loads have been calculated for a foundation stiffness of $C_{\varphi,dyn}$ = 999 GNm/rad, corresponding to a nominal tower frequency of 0.197 Hz for the stiff tower (refs. [2], [4], [6] and [8]) and $C_{\varphi,dyn}$ = 200 GNm/rad corresponding to a nominal frequency of 0.186 Hz for the soft tower (refs. [1], [3], [5] and [7]) – these are gravity corrected values.
The spring stiffness of the foundation must be at least $C_{\varphi,dyn}$ ≥ 99 GNm/rad for soft towers (refs. [1], [3], [5] and [7]) and $C_{\varphi,dyn}$ ≥ 174 GNm/rad for stiff towers (refs. [2], [4], [6] and [8]) to loads to be valid.
Concurrent values for rotational and lateral stiffness of the foundation are given in Table 5-1 and Table 5-2.

Concurrent values for rotational and lateral stiffness										
Rotational stiffness	[GNm/rad]	174	235	318	430	500	552	673	820	1000
Lateral stiffness	[MN/m]	235.0	31.8	19.8	16.0	14.1	13.5	12.4	12.0	11.0

Table 5-1 Minimum lateral stiffness (stiff tower – refs. [2], [4], [6] and [8]).

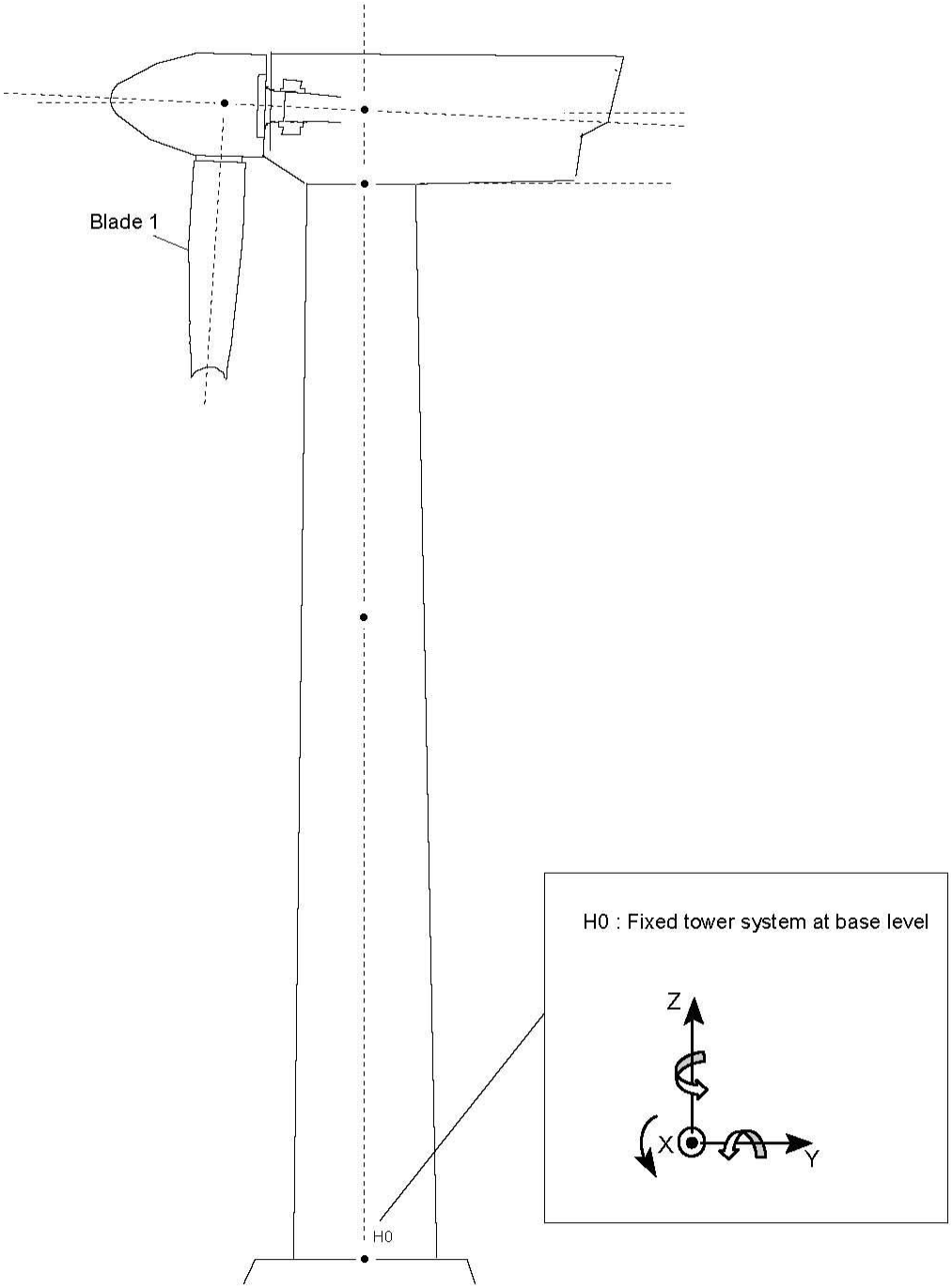
Concurrent values for rotational- and lateral stiffness										
Rotational stiffness	[GNm/rad]	99	151	244	394	500	552	673	820	1000
Lateral stiffness	[MN/m]	235.0	15.0	9.6	7.3	7.3	7.0	6.8	6.5	6.0

Table 5-2 Minimum lateral stiffness (soft tower – refs. [1], [3], [5] and [7]).

Due to the foundation stiffness, the tower frequency varies between 0.187 Hz and 0.199 Hz for the stiff tower and between 0.177 Hz and 0.195 Hz for the soft tower. Overall, the natural frequency of the tower must be within the frequency interval [0.177; 0.207] Hz (±5%) for the loads in this document to be valid.

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Appendix A. Co-ordinate systems



T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Classification: Confidential

VESTAS PROPRIETARY NOTICE

DNV
DNV Energy Systems A/S
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Appendix B. Rain flow count

This appendix contains the rain flow spectrum for the shear force, the bending moment and the torsional moment in the bottom of the tower.

B.1 6.8MW, 20yrs lifetime, soft tower

Foundation Fatigue Load Spectrum					
Tower shear, bottom F_y [kN]		Tower bending, bottom M_x [kNm]		Tower torsion, bottom M_z [kNm]	
Range	Frequency	Range	Frequency	Range	Frequency
2.6734E+03	4.8920E-01	3.0774E+05	9.4104E+00	2.2759E+04	6.2500E-01
2.5665E+03	6.9323E+00	2.9543E+05	6.7218E+00	2.1849E+04	0.0000E+00
2.4595E+03	3.9228E+01	2.8312E+05	3.9528E+01	2.0938E+04	0.0000E+00
2.3526E+03	4.9985E+02	2.7081E+05	4.7955E+01	2.0028E+04	3.6631E+00
2.2457E+03	6.8068E+02	2.5850E+05	5.6889E+01	1.9118E+04	2.6835E+00
2.1387E+03	2.0955E+03	2.4619E+05	6.0878E+01	1.8207E+04	1.6251E+02
2.0318E+03	9.2959E+03	2.3388E+05	4.0641E+01	1.7297E+04	2.8745E+02
1.9249E+03	9.2933E+03	2.2157E+05	5.1068E+01	1.6387E+04	1.1659E+03
1.8179E+03	2.7346E+04	2.0926E+05	8.7705E+01	1.5476E+04	4.7429E+03
1.7110E+03	5.3366E+04	1.9695E+05	8.9549E+01	1.4566E+04	1.5555E+04
1.6041E+03	1.0487E+05	1.8464E+05	1.9843E+02	1.3655E+04	6.7279E+04
1.4971E+03	1.4663E+05	1.7233E+05	1.4541E+02	1.2745E+04	1.8646E+05
1.3902E+03	3.2824E+05	1.6002E+05	1.2156E+03	1.1835E+04	4.1775E+05
1.2832E+03	6.1187E+05	1.4771E+05	4.9465E+03	1.0924E+04	5.8321E+05
1.1763E+03	1.1619E+06	1.3540E+05	2.6588E+04	1.0014E+04	7.3606E+05
1.0694E+03	2.2627E+06	1.2309E+05	8.0849E+04	9.1036E+03	1.0733E+06
9.6243E+02	4.0986E+06	1.1078E+05	2.0814E+05	8.1933E+03	1.7928E+06
8.5549E+02	8.0080E+06	9.8475E+04	4.6180E+05	7.2829E+03	3.9094E+06
7.4856E+02	1.4516E+07	8.6166E+04	8.9753E+05	6.3725E+03	8.4064E+06
6.4162E+02	2.5980E+07	7.3856E+04	1.9254E+06	5.4622E+03	1.5571E+07
5.3468E+02	4.4520E+07	6.1547E+04	4.8805E+06	4.5518E+03	2.8012E+07
4.2775E+02	6.9076E+07	4.9238E+04	1.5109E+07	3.6415E+03	4.3621E+07
3.2081E+02	9.7764E+07	3.6928E+04	4.7480E+07	2.7311E+03	6.1167E+07
2.1387E+02	1.4524E+08	2.4619E+04	1.2485E+08	1.8207E+03	7.4175E+07
1.0694E+02	3.5804E+08	1.2309E+04	2.1384E+08	9.1036E+02	1.7045E+08

Table 5-3 Rainflow counting spectra, issued from [1].

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

B.2 6.8MW, 20yrs lifetime, stiff tower

Foundation Fatigue Load Spectrum					
Tower shear, bottom F_y [kN]		**Tower bending, bottom M_x [kNm]**		**Tower torsion, bottom M_z [kNm]**	
Range	Frequency	Range	Frequency	Range	Frequency
2.9735E+03	8.2085E+00	3.2811E+05	9.2415E+00	2.1336E+04	6.2500E-01
2.8546E+03	7.1625E+01	3.1499E+05	4.0330E+00	2.0482E+04	1.4335E+00
2.7357E+03	1.3599E+03	3.0186E+05	2.3327E+01	1.9629E+04	1.9858E+00
2.6167E+03	3.1873E+03	2.8874E+05	4.2130E+01	1.8775E+04	9.8869E+01
2.4978E+03	2.7600E+03	2.7561E+05	6.3708E+01	1.7922E+04	5.4030E+01
2.3788E+03	1.0827E+04	2.6249E+05	5.4361E+01	1.7068E+04	2.5139E+02
2.2599E+03	1.6916E+04	2.4936E+05	7.5274E+01	1.6215E+04	1.4399E+03
2.1409E+03	4.0674E+04	2.3624E+05	5.2224E+01	1.5362E+04	3.6583E+03
2.0220E+03	6.7956E+04	2.2312E+05	8.5178E+01	1.4508E+04	1.8362E+04
1.9031E+03	1.4345E+05	2.0999E+05	9.9048E+01	1.3655E+04	5.8640E+04
1.7841E+03	2.5574E+05	1.9687E+05	1.7580E+03	1.2801E+04	1.5007E+05
1.6652E+03	5.1754E+05	1.8374E+05	3.8965E+03	1.1948E+04	3.4654E+05
1.5462E+03	8.5619E+05	1.7062E+05	1.2712E+04	1.1094E+04	5.5572E+05
1.4273E+03	1.5769E+06	1.5749E+05	2.9622E+04	1.0241E+04	5.8946E+05
1.3084E+03	2.7508E+06	1.4437E+05	8.5435E+04	9.3877E+03	9.0492E+05
1.1894E+03	4.9243E+06	1.3124E+05	2.1958E+05	8.5342E+03	1.2585E+06
1.0705E+03	8.0230E+06	1.1812E+05	5.2485E+05	7.6808E+03	2.6012E+06
9.5153E+02	1.3838E+07	1.0500E+05	1.2670E+06	6.8274E+03	5.1365E+06
8.3259E+02	2.1291E+07	9.1871E+04	2.7987E+06	5.9740E+03	1.0233E+07
7.1365E+02	3.2457E+07	7.8747E+04	6.6355E+06	5.1205E+03	1.8421E+07
5.9471E+02	4.4151E+07	6.5622E+04	1.5570E+07	4.2671E+03	2.9734E+07
4.7577E+02	5.6691E+07	5.2498E+04	3.5461E+07	3.4137E+03	4.4631E+07
3.5682E+02	7.6527E+07	3.9373E+04	7.0774E+07	2.5603E+03	5.9868E+07
2.3788E+02	1.1533E+08	2.6249E+04	1.2374E+08	1.7068E+03	7.1034E+07
1.1894E+02	3.1910E+08	1.3124E+04	1.8413E+08	8.5342E+02	1.7185E+08

Table 5-4 Rainflow counting spectra, issued from [2].

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborgparkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

B.3 6.8MW, 25yrs lifetime, soft tower

Foundation Fatigue Load Spectrum					
Tower shear, bottom F_y [kN]		Tower bending, bottom M_x [kNm]		Tower torsion, bottom M_z [kNm]	
Range	Frequency	Range	Frequency	Range	Frequency
2.5407E+03	5.1804E+00	3.1261E+05	5.0412E+00	1.8078E+04	1.0710E+02
2.4390E+03	3.3608E+00	3.0011E+05	6.7216E+00	1.7355E+04	1.1125E-01
2.3374E+03	2.1596E+01	2.8760E+05	1.6662E+01	1.6632E+04	5.5238E+00
2.2358E+03	6.2853E+02	2.7510E+05	4.1727E+01	1.5909E+04	1.2948E+03
2.1342E+03	7.5276E+02	2.6259E+05	8.2047E+01	1.5185E+04	2.1600E+03
2.0325E+03	2.0290E+03	2.5009E+05	7.9443E+01	1.4462E+04	1.1225E+04
1.9309E+03	5.2589E+03	2.3758E+05	6.5002E+01	1.3739E+04	3.0695E+04
1.8293E+03	9.7852E+03	2.2508E+05	3.8711E+01	1.3016E+04	1.0243E+05
1.7277E+03	1.3369E+04	2.1257E+05	9.7744E+01	1.2293E+04	1.7063E+05
1.6260E+03	4.8800E+04	2.0007E+05	7.3111E+01	1.1570E+04	3.3822E+05
1.5244E+03	8.2831E+04	1.8757E+05	1.9366E+02	1.0847E+04	5.5178E+05
1.4228E+03	1.4291E+05	1.7506E+05	2.5456E+02	1.0124E+04	5.1938E+05
1.3211E+03	3.1612E+05	1.6256E+05	5.7740E+02	9.4005E+03	6.8205E+05
1.2195E+03	6.3547E+05	1.5005E+05	2.3239E+03	8.6774E+03	1.0446E+06
1.1179E+03	1.0896E+06	1.3755E+05	1.0981E+04	7.9543E+03	1.5077E+06
1.0163E+03	2.3194E+06	1.2504E+05	4.0667E+04	7.2311E+03	2.7405E+06
9.1464E+02	4.4611E+06	1.1254E+05	1.2794E+05	6.5080E+03	5.0012E+06
8.1302E+02	8.3731E+06	1.0004E+05	3.5577E+05	5.7849E+03	9.7385E+06
7.1139E+02	1.6060E+07	8.7531E+04	8.0006E+05	5.0618E+03	1.6272E+07
6.0976E+02	3.0607E+07	7.5026E+04	1.6968E+06	4.3387E+03	2.6516E+07
5.0813E+02	5.2758E+07	6.2522E+04	4.0751E+06	3.6156E+03	4.0287E+07
4.0651E+02	8.4844E+07	5.0018E+04	1.3157E+07	2.8925E+03	5.7222E+07
3.0488E+02	1.2162E+08	3.7513E+04	4.8154E+07	2.1693E+03	7.1445E+07
2.0325E+02	1.8327E+08	2.5009E+04	1.4836E+08	1.4462E+03	8.3527E+07
1.0163E+02	4.4666E+08	1.2504E+04	2.8366E+08	7.2311E+02	2.1237E+08

Table 5-5 Rainflow counting spectra, issued from [3].

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

B.4 6.8MW, 25yrs lifetime, stiff tower

Foundation Fatigue Load Spectrum					
Tower shear, bottom F_y [kN]		Tower bending, bottom M_x [kNm]		Tower torsion, bottom M_z [kNm]	
Range	Frequency	Range	Frequency	Range	Frequency
2.8564E+03	2.3750E+00	3.2533E+05	5.0412E+00	1.9559E+04	2.3054E+00
2.7422E+03	1.7076E+01	3.1231E+05	1.1552E+01	1.8777E+04	0.0000E+00
2.6279E+03	1.0277E+02	2.9930E+05	2.1493E+01	1.7994E+04	1.0485E+02
2.5137E+03	2.2113E+03	2.8629E+05	4.0255E+01	1.7212E+04	3.8853E+01
2.3994E+03	3.8800E+03	2.7328E+05	7.0776E+01	1.6430E+04	7.1091E+02
2.2852E+03	2.9548E+03	2.6026E+05	7.7707E+01	1.5647E+04	5.8544E+02
2.1709E+03	1.3928E+04	2.4725E+05	7.2839E+01	1.4865E+04	4.9442E+03
2.0566E+03	2.4342E+04	2.3424E+05	7.0373E+01	1.4083E+04	2.2952E+04
1.9424E+03	5.3413E+04	2.2122E+05	8.0376E+01	1.3300E+04	7.4467E+04
1.8281E+03	1.1317E+05	2.0821E+05	1.0389E+02	1.2518E+04	1.6294E+05
1.7139E+03	2.1392E+05	1.9520E+05	2.6888E+02	1.1735E+04	3.1019E+05
1.5996E+03	4.2483E+05	1.8218E+05	2.5460E+03	1.0953E+04	5.3622E+05
1.4853E+03	7.6808E+05	1.6917E+05	8.0686E+03	1.0171E+04	5.7168E+05
1.3711E+03	1.4782E+06	1.5616E+05	1.6035E+04	9.3884E+03	7.5598E+05
1.2568E+03	2.6903E+06	1.4314E+05	5.3434E+04	8.6060E+03	1.1487E+06
1.1426E+03	4.8108E+06	1.3013E+05	1.5283E+05	7.8236E+03	1.8679E+06
1.0283E+03	8.4849E+06	1.1712E+05	3.8216E+05	7.0413E+03	3.5240E+06
9.1406E+02	1.4565E+07	1.0410E+05	1.0045E+06	6.2589E+03	6.9332E+06
7.9980E+02	2.3851E+07	9.1092E+04	2.4504E+06	5.4766E+03	1.2952E+07
6.8555E+02	3.7489E+07	7.8079E+04	5.9401E+06	4.6942E+03	2.2989E+07
5.7129E+02	5.4535E+07	6.5066E+04	1.5049E+07	3.9118E+03	3.6995E+07
4.5703E+02	7.1233E+07	5.2052E+04	3.7330E+07	3.1295E+03	5.5232E+07
3.4277E+02	9.6667E+07	3.9039E+04	8.2316E+07	2.3471E+03	7.5343E+07
2.2852E+02	1.4851E+08	2.6026E+04	1.5583E+08	1.5647E+03	8.7092E+07
1.1426E+02	3.9566E+08	1.3013E+04	2.4302E+08	7.8236E+02	2.1393E+08

Table 5-6 Rainflow counting spectra, issued from [4].

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborgvænget 6-12
DK-2900 Hellerup
VAT No. DK89832314

B.5 7.2MW, 20yrs lifetime, soft tower

Foundation Fatigue Load Spectrum					
Tower shear, bottom F_y [kN]		Tower bending, bottom M_x [kNm]		Tower torsion, bottom M_z [kNm]	
Range	Frequency	Range	Frequency	Range	Frequency
2.6481E+03	5.4436E+00	3.2642E+05	1.3359E+00	2.0209E+04	2.1509E-01
2.5422E+03	4.2967E+00	3.1337E+05	4.0076E+00	1.9400E+04	1.2680E+00
2.4362E+03	4.4126E+02	3.0031E+05	6.7324E+00	1.8592E+04	9.3118E+01
2.3303E+03	1.3527E+02	2.8725E+05	9.7651E+00	1.7783E+04	2.0463E+01
2.2244E+03	1.0263E+03	2.7420E+05	3.2755E+01	1.6975E+04	1.6957E+02
2.1185E+03	3.5983E+03	2.6114E+05	6.5271E+01	1.6167E+04	9.4285E+02
2.0125E+03	6.3449E+03	2.4808E+05	8.6118E+01	1.5358E+04	4.4405E+03
1.9066E+03	9.0093E+03	2.3503E+05	5.7026E+01	1.4550E+04	1.7721E+04
1.8007E+03	2.8101E+04	2.2197E+05	5.3459E+01	1.3742E+04	5.6556E+04
1.6948E+03	4.8316E+04	2.0891E+05	6.0777E+01	1.2933E+04	1.4404E+05
1.5888E+03	7.8827E+04	1.9585E+05	1.3426E+02	1.2125E+04	3.2475E+05
1.4829E+03	1.3361E+05	1.8280E+05	1.5840E+02	1.1317E+04	5.2037E+05
1.3770E+03	2.6177E+05	1.6974E+05	1.6611E+02	1.0508E+04	4.6998E+05
1.2711E+03	5.1824E+05	1.5668E+05	2.1789E+03	9.7001E+03	7.1290E+05
1.1652E+03	9.9039E+05	1.4363E+05	6.4062E+03	8.8917E+03	1.0799E+06
1.0592E+03	1.7540E+06	1.3057E+05	3.4614E+04	8.0834E+03	1.8329E+06
9.5331E+02	3.4425E+06	1.1751E+05	7.0948E+04	7.2751E+03	3.4966E+06
8.4739E+02	6.5271E+06	1.0446E+05	2.7601E+05	6.4667E+03	6.5722E+06
7.4146E+02	1.2952E+07	9.1399E+04	6.2241E+05	5.6584E+03	1.2244E+07
6.3554E+02	2.4414E+07	7.8342E+04	1.2911E+06	4.8500E+03	2.0839E+07
5.2962E+02	4.4332E+07	6.5285E+04	3.2468E+06	4.0417E+03	3.2388E+07
4.2369E+02	7.1035E+07	5.2228E+04	1.0604E+07	3.2334E+03	4.6423E+07
3.1777E+02	1.0245E+08	3.9171E+04	3.7660E+07	2.4250E+03	5.8530E+07
2.1185E+02	1.6103E+08	2.6114E+04	1.2147E+08	1.6167E+03	6.9560E+07
1.0592E+02	3.7542E+08	1.3057E+04	2.2891E+08	8.0834E+02	1.7406E+08

Table 5-7 Rainflow counting spectra, issued from [5].

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborgvejen 6, 2.
DK-2900 Hellerup
VAT No. DK89832314

B.6 7.2MW, 20yrs lifetime, stiff tower

Foundation Fatigue Load Spectrum					
Tower shear, bottom F_y [kN]		**Tower bending, bottom M_x [kNm]**		**Tower torsion, bottom M_z [kNm]**	
Range	Frequency	Range	Frequency	Range	Frequency
2.8435E+03	1.1135E+01	3.2268E+05	4.0076E+00	1.9182E+04	9.5829E+01
2.7298E+03	5.7449E+01	3.0978E+05	4.0607E+00	1.8415E+04	7.4383E+00
2.6160E+03	1.3236E+03	2.9687E+05	1.2554E+01	1.7648E+04	8.4995E+01
2.5023E+03	7.8893E+02	2.8396E+05	2.5071E+01	1.6880E+04	1.2927E+02
2.3886E+03	2.7445E+03	2.7105E+05	6.3969E+01	1.6113E+04	1.2189E+03
2.2748E+03	5.4280E+03	2.5815E+05	9.4824E+01	1.5346E+04	2.5844E+03
2.1611E+03	1.2547E+04	2.4524E+05	5.8116E+01	1.4579E+04	1.3528E+04
2.0473E+03	2.6795E+04	2.3233E+05	7.2682E+01	1.3811E+04	3.9295E+04
1.9336E+03	5.3866E+04	2.1943E+05	8.0647E+01	1.3044E+04	1.1976E+05
1.8199E+03	1.1307E+05	2.0652E+05	1.4247E+02	1.2277E+04	2.7733E+05
1.7061E+03	2.3049E+05	1.9361E+05	6.6001E+02	1.1509E+04	4.4924E+05
1.5924E+03	4.2386E+05	1.8070E+05	2.6744E+03	1.0742E+04	4.2588E+05
1.4786E+03	7.8952E+05	1.6780E+05	3.6054E+03	9.9748E+03	5.7774E+05
1.3649E+03	1.4009E+06	1.5489E+05	1.5926E+04	9.2075E+03	8.6346E+05
1.2511E+03	2.7394E+06	1.4198E+05	6.2275E+04	8.4402E+03	1.2255E+06
1.1374E+03	4.7992E+06	1.2907E+05	1.5626E+05	7.6729E+03	2.3556E+06
1.0237E+03	7.8814E+06	1.1617E+05	3.9740E+05	6.9056E+03	4.4352E+06
9.0993E+02	1.3822E+07	1.0326E+05	9.1152E+05	6.1383E+03	8.0509E+06
7.9619E+02	2.2325E+07	9.0352E+04	2.2646E+06	5.3710E+03	1.4149E+07
6.8244E+02	3.3512E+07	7.7444E+04	5.5460E+06	4.6038E+03	2.2785E+07
5.6870E+02	4.6094E+07	6.4537E+04	1.3708E+07	3.8365E+03	3.3681E+07
4.5496E+02	5.9961E+07	5.1629E+04	3.3731E+07	3.0692E+03	4.6560E+07
3.4122E+02	7.9920E+07	3.8722E+04	7.2017E+07	2.3019E+03	5.6987E+07
2.2748E+02	1.2037E+08	2.5815E+04	1.2791E+08	1.5346E+03	6.6823E+07
1.1374E+02	3.3772E+08	1.2907E+04	1.8958E+08	7.6729E+02	1.7489E+08

Table 5-8 Rainflow counting spectra, issued from [6].

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

B.7 7.2MW, 25yrs lifetime, soft tower

Foundation Fatigue Load Spectrum					
Tower shear, bottom F_y [kN]		**Tower bending, bottom M_x [kNm]**		**Tower torsion, bottom M_z [kNm]**	
Range	Frequency	Range	Frequency	Range	Frequency
2.4374E+03	3.6143E+00	3.1218E+05	8.3480E+00	1.8358E+04	6.6460E-02
2.3399E+03	1.1229E+01	2.9969E+05	8.3480E+00	1.7624E+04	1.0653E+02
2.2424E+03	5.8716E+01	2.8720E+05	1.3357E+01	1.6890E+04	8.0643E+00
2.1449E+03	1.1636E+03	2.7472E+05	3.0500E+01	1.6155E+04	2.0161E+01
2.0474E+03	1.3014E+03	2.6223E+05	8.8984E+01	1.5421E+04	6.9429E+02
1.9499E+03	3.2193E+03	2.4974E+05	8.3829E+01	1.4687E+04	3.7834E+03
1.8524E+03	9.3448E+03	2.3726E+05	6.7195E+01	1.3952E+04	2.2276E+04
1.7549E+03	1.7403E+04	2.2477E+05	4.9208E+01	1.3218E+04	5.8028E+04
1.6575E+03	1.8491E+04	2.1228E+05	8.0614E+01	1.2484E+04	1.7905E+05
1.5600E+03	3.3945E+04	1.9979E+05	7.3116E+01	1.1749E+04	2.6157E+05
1.4625E+03	7.9193E+04	1.8731E+05	1.2672E+02	1.1015E+04	4.7508E+05
1.3650E+03	1.3404E+05	1.7482E+05	2.0874E+02	1.0281E+04	4.3248E+05
1.2675E+03	2.8806E+05	1.6233E+05	1.7848E+02	9.5464E+03	5.7596E+05
1.1700E+03	5.4862E+05	1.4985E+05	1.5070E+03	8.8120E+03	8.6120E+05
1.0725E+03	1.0291E+06	1.3736E+05	9.3438E+03	8.0777E+03	1.3159E+06
9.7497E+02	1.8855E+06	1.2487E+05	2.2076E+04	7.3433E+03	2.3234E+06
8.7747E+02	3.8703E+06	1.1238E+05	8.4904E+04	6.6090E+03	4.3444E+06
7.7998E+02	7.1492E+06	9.9897E+04	2.6791E+05	5.8747E+03	8.1509E+06
6.8248E+02	1.4434E+07	8.7410E+04	5.3386E+05	5.1403E+03	1.4360E+07
5.8498E+02	2.8362E+07	7.4923E+04	1.2677E+06	4.4060E+03	2.4487E+07
4.8749E+02	5.0796E+07	6.2436E+04	3.1020E+06	3.6717E+03	3.7798E+07
3.8999E+02	8.4449E+07	4.9949E+04	1.0433E+07	2.9373E+03	5.4945E+07
2.9249E+02	1.2378E+08	3.7461E+04	4.1474E+07	2.2030E+03	7.3459E+07
1.9499E+02	1.9938E+08	2.4974E+04	1.4253E+08	1.4687E+03	8.3710E+07
9.7497E+01	4.5531E+08	1.2487E+04	2.9013E+08	7.3433E+02	2.1399E+08

Table 5-9 Rainflow counting spectra, issued from [7].

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

B.8 7.2MW, 25yrs lifetime, stiff tower

Foundation Fatigue Load Spectrum					
Tower shear, bottom F_y [kN]		**Tower bending, bottom M_x [kNm]**		**Tower torsion, bottom M_z [kNm]**	
Range	Frequency	Range	Frequency	Range	Frequency
2.5725E+03	4.2164E+02	3.2416E+05	3.3392E+00	1.8078E+04	1.0423E+02
2.4696E+03	4.1651E+02	3.1119E+05	5.0088E+00	1.7355E+04	2.4803E+00
2.3667E+03	5.8673E+02	2.9822E+05	1.0164E+01	1.6631E+04	3.1987E+00
2.2638E+03	1.0190E+03	2.8526E+05	2.5205E+01	1.5908E+04	1.2833E+02
2.1609E+03	2.6911E+03	2.7229E+05	5.1657E+01	1.5185E+04	2.2662E+03
2.0580E+03	4.6062E+03	2.5932E+05	1.1275E+02	1.4462E+04	7.0320E+03
1.9551E+03	1.3442E+04	2.4636E+05	8.7363E+01	1.3739E+04	2.7846E+04
1.8522E+03	3.1288E+04	2.3339E+05	5.0440E+01	1.3016E+04	8.0380E+04
1.7493E+03	5.2623E+04	2.2043E+05	1.0692E+02	1.2293E+04	1.8963E+05
1.6464E+03	1.1468E+05	2.0746E+05	9.6588E+01	1.1570E+04	2.8432E+05
1.5435E+03	2.7259E+05	1.9449E+05	1.6461E+02	1.0847E+04	4.7915E+05
1.4406E+03	4.5407E+05	1.8153E+05	1.0986E+03	1.0124E+04	4.4199E+05
1.3377E+03	8.1022E+05	1.6856E+05	6.8759E+02	9.4004E+03	5.9250E+05
1.2348E+03	1.5450E+06	1.5559E+05	7.5722E+03	8.6773E+03	8.6475E+05
1.1319E+03	3.0022E+06	1.4263E+05	1.6964E+04	7.9542E+03	1.3674E+06
1.0290E+03	5.2974E+06	1.2966E+05	8.0048E+04	7.2311E+03	2.4809E+06
9.2610E+02	9.3805E+06	1.1670E+05	1.9514E+05	6.5080E+03	4.5826E+06
8.2320E+02	1.5257E+07	1.0373E+05	6.0910E+05	5.7849E+03	8.5293E+06
7.2030E+02	2.5370E+07	9.0764E+04	1.4252E+06	5.0618E+03	1.4693E+07
6.1740E+02	3.8107E+07	7.7797E+04	3.8454E+06	4.3386E+03	2.5487E+07
5.1450E+02	5.3156E+07	6.4831E+04	1.1067E+07	3.6155E+03	3.8452E+07
4.1160E+02	6.9905E+07	5.1865E+04	2.9941E+07	2.8924E+03	5.5348E+07
3.0870E+02	9.7269E+07	3.8899E+04	7.6075E+07	2.1693E+03	7.2609E+07
2.0580E+02	1.5498E+08	2.5932E+04	1.5533E+08	1.4462E+03	8.2464E+07
1.0290E+02	4.1955E+08	1.2966E+04	2.5430E+08	7.2311E+02	2.1398E+08

Table 5-10 Rainflow counting spectra, issued from [8].

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Appendix C. Markov matrices – issued from [1]

This appendix contains the Markov Matrices for the shear force, the bending moment and the torsional moment in the bottom of the tower, from ref. [1]. Foundation design must be verified for the most critical Markov matrices.

Markov Matrices								
Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.4714E+03	5.3468E+01	5.7330E+00	1.4672E+05	1.2309E+04	2.6887E+00	1.2024E+04	0.0000E+00	2.6887E+00
1.4714E+03	0.0000E+00	2.4976E+02	1.4672E+05	0.0000E+00	2.6887E+00	8.1977E+03	0.0000E+00	2.6887E+00
1.4079E+03	0.0000E+00	3.2831E+02	1.3268E+05	6.1547E+03	5.3774E+00	7.6511E+03	9.1036E+02	2.6887E+00
1.3444E+03	5.3468E+01	2.1392E+01	1.3268E+05	0.0000E+00	2.6887E+00	7.6511E+03	4.5518E+02	1.0128E+02
1.3444E+03	0.0000E+00	7.8325E+03	1.2565E+05	6.1547E+03	2.6887E+00	7.6511E+03	0.0000E+00	1.2377E+01
1.2809E+03	1.6041E+02	4.9144E+02	1.2565E+05	0.0000E+00	2.6887E+00	7.1045E+03	3.1863E+03	3.5000E+00
1.2809E+03	1.0694E+02	2.4707E+02	1.1161E+05	0.0000E+00	8.0661E+00	7.1045E+03	2.2759E+03	3.5000E+00
1.2809E+03	5.3468E+01	5.8409E+02	1.0458E+05	1.2309E+04	2.6887E+00	7.1045E+03	1.3655E+03	3.5000E+00
1.2809E+03	0.0000E+00	3.4698E+04	1.0458E+05	6.1547E+03	2.6887E+00	7.1045E+03	4.5518E+02	6.1887E+00
1.2173E+03	1.6041E+02	2.1298E+03	1.0458E+05	0.0000E+00	4.0804E+01	7.1045E+03	0.0000E+00	1.0339E+03
1.2173E+03	1.0694E+02	3.7028E+03	9.7562E+04	2.4619E+04	2.6887E+00	6.5579E+03	2.7311E+03	3.5000E+00
1.2173E+03	5.3468E+01	3.1541E+04	9.7562E+04	1.8464E+04	2.6887E+00	6.5579E+03	1.8207E+03	3.5000E+00
1.2173E+03	0.0000E+00	8.1437E+04	9.7562E+04	1.2309E+04	2.6887E+00	6.5579E+03	9.1036E+02	3.5000E+00
1.1538E+03	2.6734E+02	2.6887E+00	9.7562E+04	6.1547E+03	5.3774E+00	6.5579E+03	4.5518E+02	3.1150E+02
1.1538E+03	2.1387E+02	6.8171E+02	9.7562E+04	0.0000E+00	2.3943E+01	6.5579E+03	0.0000E+00	1.1530E+03
1.1538E+03	1.6041E+02	9.7615E+03	9.0539E+04	2.4619E+04	3.5000E+00	6.0114E+03	4.5518E+03	3.5000E+00
1.1538E+03	1.0694E+02	2.7108E+04	9.0539E+04	1.8464E+04	7.0000E+00	6.0114E+03	4.0966E+03	3.5000E+00
1.1538E+03	5.3468E+01	1.2339E+05	9.0539E+04	1.2309E+04	6.1887E+00	6.0114E+03	3.6415E+03	2.6887E+00
1.1538E+03	0.0000E+00	3.7908E+05	9.0539E+04	6.1547E+03	8.0661E+00	6.0114E+03	3.1863E+03	6.1887E+00
1.0903E+03	6.4162E+02	1.4129E+01	9.0539E+04	0.0000E+00	2.8510E+01	6.0114E+03	2.2759E+03	2.6887E+00
1.0903E+03	4.8122E+02	4.7167E+02	8.3516E+04	2.4619E+04	3.5000E+00	6.0114E+03	9.1036E+02	3.5000E+00
1.0903E+03	4.2775E+02	5.8083E+03	8.3516E+04	1.8464E+04	1.4000E+01	6.0114E+03	4.5518E+02	6.5566E+02
1.0903E+03	3.2081E+02	2.3783E+02	8.3516E+04	1.2309E+04	1.0217E+01	6.0114E+03	0.0000E+00	3.4667E+03
1.0903E+03	2.6734E+02	5.3774E+00	8.3516E+04	6.1547E+03	2.8255E+01	5.4648E+03	5.4622E+03	3.5000E+00
1.0903E+03	2.1387E+02	8.7704E+03	8.3516E+04	0.0000E+00	6.4410E+01	5.4648E+03	3.6415E+03	3.5000E+00
1.0903E+03	1.6041E+02	1.6748E+04	7.6493E+04	2.4619E+04	8.0661E+00	5.4648E+03	3.1863E+03	1.2646E+01
1.0903E+03	1.0694E+02	1.1178E+05	7.6493E+04	1.2309E+04	1.7033E+01	5.4648E+03	2.7311E+03	3.5000E+00
1.0903E+03	5.3468E+01	5.6928E+05	7.6493E+04	6.1547E+03	3.6794E+01	5.4648E+03	2.2759E+03	7.0000E+00
1.0903E+03	0.0000E+00	1.0942E+06	7.6493E+04	0.0000E+00	7.2482E+01	5.4648E+03	1.8207E+03	8.9167E-02
1.0268E+03	1.0159E+03	1.3443E+00	6.9470E+04	1.7233E+05	1.3443E+00	5.4648E+03	1.3655E+03	1.0737E+01
1.0268E+03	8.5549E+02	2.4707E+02	6.9470E+04	1.6002E+05	1.3443E+00	5.4648E+03	9.1036E+02	1.2317E+02
1.0268E+03	5.8815E+02	5.3774E+00	6.9470E+04	3.6928E+04	1.0500E+01	5.4648E+03	4.5518E+02	3.6438E+03
1.0268E+03	5.3468E+02	9.4335E+02	6.9470E+04	3.0774E+04	3.9387E+00	5.4648E+03	0.0000E+00	1.8820E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Certificate No. TUDOR
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0268E+03	4.8122E+02	1.5862E+04	6.9470E+04	2.4619E+04	1.0500E+01	4.9182E+03	6.3725E+03	3.5000E+00
1.0268E+03	4.2775E+02	6.9310E+03	6.9470E+04	1.8464E+04	9.6887E+00	4.9182E+03	5.9174E+03	2.6887E+00
1.0268E+03	3.7428E+02	6.3989E+03	6.9470E+04	1.2309E+04	1.7500E+01	4.9182E+03	4.0966E+03	2.6887E+00
1.0268E+03	3.2081E+02	9.7063E+03	6.9470E+04	6.1547E+03	2.4755E+01	4.9182E+03	3.6415E+03	3.8239E+00
1.0268E+03	2.6734E+02	2.1702E+04	6.9470E+04	0.0000E+00	8.7898E+01	4.9182E+03	3.1863E+03	5.6269E+02
1.0268E+03	2.1387E+02	2.2619E+04	6.2447E+04	9.2321E+04	2.6887E+00	4.9182E+03	2.2759E+03	1.5180E+02
1.0268E+03	1.6041E+02	1.9316E+05	6.2447E+04	3.6928E+04	2.6887E+00	4.9182E+03	1.8207E+03	1.8486E+03
1.0268E+03	1.0694E+02	7.2885E+05	6.2447E+04	3.0774E+04	1.2377E+01	4.9182E+03	1.3655E+03	3.2109E+03
1.0268E+03	5.3468E+01	2.0020E+06	6.2447E+04	2.4619E+04	1.5877E+01	4.9182E+03	9.1036E+02	8.9929E+02
1.0268E+03	0.0000E+00	3.2187E+06	6.2447E+04	1.8464E+04	1.0500E+01	4.9182E+03	4.5518E+02	3.5820E+04
9.6329E+02	1.0694E+03	1.3443E+00	6.2447E+04	1.2309E+04	2.2794E+01	4.9182E+03	0.0000E+00	1.7868E+05
9.6329E+02	1.0159E+03	1.7500E+00	6.2447E+04	6.1547E+03	3.0565E+01	4.3716E+03	1.5931E+04	1.3443E+00
9.6329E+02	9.6243E+02	1.2451E+02	6.2447E+04	0.0000E+00	6.3116E+01	4.3716E+03	6.8277E+03	3.5000E+00
9.6329E+02	9.0896E+02	9.4335E+02	5.5424E+04	1.7849E+05	1.3443E+00	4.3716E+03	5.9174E+03	8.0661E+00
9.6329E+02	8.5549E+02	4.9683E+02	5.5424E+04	1.6618E+05	2.6887E+00	4.3716E+03	5.4622E+03	7.2371E+00
9.6329E+02	8.0203E+02	4.3464E+02	5.5424E+04	1.6002E+05	1.3443E+00	4.3716E+03	5.0070E+03	8.6449E+01
9.6329E+02	7.4856E+02	1.3382E+04	5.5424E+04	1.4771E+05	1.3443E+00	4.3716E+03	4.5518E+03	5.3774E+00
9.6329E+02	6.9509E+02	2.7596E+04	5.5424E+04	1.3540E+05	1.3443E+00	4.3716E+03	4.0966E+03	2.1771E+01
9.6329E+02	6.4162E+02	4.5794E+04	5.5424E+04	7.3856E+04	2.6887E+00	4.3716E+03	3.6415E+03	7.2371E+00
9.6329E+02	5.8815E+02	5.6082E+04	5.5424E+04	6.7702E+04	1.2500E+00	4.3716E+03	3.1863E+03	4.2233E+03
9.6329E+02	5.3468E+02	5.8860E+04	5.5424E+04	5.5392E+04	2.6887E+00	4.3716E+03	2.7311E+03	1.1200E+03
9.6329E+02	4.8122E+02	1.3810E+05	5.5424E+04	4.9238E+04	6.1887E+00	4.3716E+03	2.2759E+03	1.8642E+03
9.6329E+02	4.2775E+02	1.8379E+05	5.5424E+04	4.3083E+04	7.0000E+00	4.3716E+03	1.8207E+03	4.9166E+03
9.6329E+02	3.7428E+02	2.1094E+05	5.5424E+04	3.6928E+04	6.1887E+00	4.3716E+03	1.3655E+03	6.8795E+03
9.6329E+02	3.2081E+02	2.7228E+05	5.5424E+04	3.0774E+04	6.1887E+00	4.3716E+03	9.1036E+02	5.8845E+04
9.6329E+02	2.6734E+02	3.3698E+05	5.5424E+04	2.4619E+04	8.8774E+00	4.3716E+03	4.5518E+02	1.6246E+05
9.6329E+02	2.1387E+02	3.5032E+05	5.5424E+04	1.8464E+04	2.9066E+01	4.3716E+03	0.0000E+00	5.9672E+05
9.6329E+02	1.6041E+02	8.4876E+05	5.5424E+04	1.2309E+04	2.8255E+01	3.8250E+03	1.7297E+04	1.3443E+00
9.6329E+02	1.0694E+02	2.6541E+06	5.5424E+04	6.1547E+03	2.8693E+01	3.8250E+03	9.5588E+03	2.6887E+00
9.6329E+02	5.3468E+01	6.0279E+06	5.5424E+04	0.0000E+00	1.1308E+02	3.8250E+03	6.8277E+03	3.3137E+00
9.6329E+02	0.0000E+00	8.4174E+06	4.8402E+04	1.6002E+05	1.7500E+00	3.8250E+03	6.3725E+03	2.7333E+00
8.9977E+02	1.7645E+03	2.1732E+02	4.8402E+04	1.5387E+05	1.3443E+00	3.8250E+03	5.9174E+03	7.8201E+02
8.9977E+02	1.6575E+03	2.1732E+02	4.8402E+04	1.4771E+05	6.1887E+00	3.8250E+03	5.4622E+03	6.0357E+02
8.9977E+02	1.4971E+03	8.9134E+02	4.8402E+04	1.4156E+05	1.3443E+00	3.8250E+03	5.0070E+03	3.5058E+01
8.9977E+02	1.4436E+03	1.6528E+03	4.8402E+04	1.3540E+05	1.3443E+00	3.8250E+03	4.5518E+03	1.5932E+03
8.9977E+02	1.3367E+03	1.2317E+02	4.8402E+04	1.2925E+05	1.7500E+00	3.8250E+03	4.0966E+03	1.8504E+04
8.9977E+02	1.2832E+03	2.4768E+02	4.8402E+04	1.2309E+05	1.3443E+00	3.8250E+03	3.6415E+03	1.3923E+04
8.9977E+02	1.2298E+03	7.2147E+02	4.8402E+04	1.1078E+05	1.7500E+00	3.8250E+03	3.1863E+03	2.8030E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.9977E+02	1.1763E+03	1.2451E+02	4.8402E+04	7.3856E+04	2.6887E+00	3.8250E+03	2.7311E+03	9.8137E+04
8.9977E+02	1.1228E+03	1.6548E+03	4.8402E+04	6.7702E+04	3.5000E+00	3.8250E+03	2.2759E+03	9.9333E+04
8.9977E+02	1.0694E+03	4.3773E+02	4.8402E+04	5.5392E+04	1.2500E+00	3.8250E+03	1.8207E+03	1.5119E+05
8.9977E+02	1.0159E+03	4.9793E+03	4.8402E+04	4.9238E+04	3.5000E+00	3.8250E+03	1.3655E+03	1.1326E+05
8.9977E+02	9.6243E+02	1.4315E+04	4.8402E+04	4.3083E+04	6.1887E+00	3.8250E+03	9.1036E+02	2.4038E+05
8.9977E+02	9.0896E+02	2.5390E+04	4.8402E+04	3.6928E+04	1.8566E+01	3.8250E+03	4.5518E+02	5.8159E+05
8.9977E+02	8.5549E+02	3.4864E+04	4.8402E+04	3.0774E+04	1.9377E+01	3.8250E+03	0.0000E+00	1.5109E+06
8.9977E+02	8.0203E+02	5.1169E+04	4.8402E+04	2.4619E+04	2.0189E+01	3.2784E+03	1.2745E+04	1.7500E+00
8.9977E+02	7.4856E+02	8.7025E+04	4.8402E+04	1.8464E+04	1.4344E+01	3.2784E+03	1.0924E+04	1.7500E+00
8.9977E+02	6.9509E+02	1.5958E+05	4.8402E+04	1.2309E+04	3.2922E+01	3.2784E+03	1.0469E+04	1.3443E+00
8.9977E+02	6.4162E+02	2.8177E+05	4.8402E+04	6.1547E+03	4.2783E+01	3.2784E+03	8.1933E+03	3.6186E+00
8.9977E+02	5.8815E+02	5.2130E+05	4.8402E+04	0.0000E+00	9.6819E+01	3.2784E+03	7.2829E+03	9.6588E-02
8.9977E+02	5.3468E+02	7.9818E+05	4.1379E+04	1.7233E+05	1.3443E+00	3.2784E+03	6.8277E+03	4.5781E+01
8.9977E+02	4.8122E+02	1.0374E+06	4.1379E+04	1.6002E+05	1.3443E+00	3.2784E+03	6.3725E+03	1.3374E+03
8.9977E+02	4.2775E+02	1.3774E+06	4.1379E+04	1.5387E+05	1.3443E+00	3.2784E+03	5.9174E+03	4.1490E+03
8.9977E+02	3.7428E+02	1.6942E+06	4.1379E+04	1.4771E+05	1.3443E+00	3.2784E+03	5.4622E+03	1.9967E+03
8.9977E+02	3.2081E+02	1.8128E+06	4.1379E+04	1.4156E+05	3.0943E+00	3.2784E+03	5.0070E+03	2.2039E+04
8.9977E+02	2.6734E+02	2.1371E+06	4.1379E+04	1.3540E+05	2.6887E+00	3.2784E+03	4.5518E+03	4.4970E+04
8.9977E+02	2.1387E+02	2.0687E+06	4.1379E+04	1.2925E+05	2.6887E+00	3.2784E+03	4.0966E+03	7.1036E+04
8.9977E+02	1.6041E+02	3.3372E+06	4.1379E+04	1.2309E+05	7.9387E+00	3.2784E+03	3.6415E+03	1.6850E+05
8.9977E+02	1.0694E+02	7.0210E+06	4.1379E+04	1.1694E+05	3.5000E+00	3.2784E+03	3.1863E+03	1.8323E+05
8.9977E+02	5.3468E+01	1.3915E+07	4.1379E+04	1.1078E+05	4.8443E+00	3.2784E+03	2.7311E+03	2.5459E+05
8.9977E+02	0.0000E+00	1.6154E+07	4.1379E+04	9.8475E+04	3.5000E+00	3.2784E+03	2.2759E+03	3.5641E+05
8.3626E+02	1.7645E+03	1.2354E+02	4.1379E+04	9.2321E+04	3.5000E+00	3.2784E+03	1.8207E+03	3.2476E+05
8.3626E+02	1.6575E+03	2.1732E+02	4.1379E+04	8.6166E+04	3.5000E+00	3.2784E+03	1.3655E+03	2.6466E+05
8.3626E+02	1.5506E+03	7.7732E+02	4.1379E+04	7.3856E+04	1.5877E+01	3.2784E+03	9.1036E+02	5.0063E+05
8.3626E+02	1.4971E+03	1.1200E+03	4.1379E+04	6.7702E+04	2.6887E+00	3.2784E+03	4.5518E+02	1.4678E+06
8.3626E+02	1.4436E+03	7.2416E+02	4.1379E+04	6.1547E+04	6.1887E+00	3.2784E+03	0.0000E+00	3.1715E+06
8.3626E+02	1.3902E+03	8.1216E+02	4.1379E+04	5.5392E+04	2.6887E+00	2.7318E+03	1.3655E+04	1.7500E+00
8.3626E+02	1.3367E+03	1.2168E+03	4.1379E+04	4.9238E+04	3.5000E+00	2.7318E+03	1.1835E+04	1.7500E+00
8.3626E+02	1.2832E+03	6.5985E+03	4.1379E+04	4.3083E+04	1.4000E+01	2.7318E+03	1.1380E+04	1.3443E+00
8.3626E+02	1.2298E+03	6.2299E+03	4.1379E+04	3.6928E+04	3.3377E+01	2.7318E+03	1.0014E+04	4.8443E+00
8.3626E+02	1.1763E+03	1.2703E+04	4.1379E+04	3.0774E+04	1.9377E+01	2.7318E+03	9.5588E+03	3.0943E+00
8.3626E+02	1.1228E+03	2.3277E+04	4.1379E+04	2.4619E+04	3.4634E+01	2.7318E+03	9.1036E+03	1.0331E+01
8.3626E+02	1.0694E+03	3.4685E+04	4.1379E+04	1.8464E+04	3.7667E+01	2.7318E+03	8.6484E+03	8.0260E+01
8.3626E+02	1.0159E+03	7.4623E+04	4.1379E+04	1.2309E+04	1.4859E+02	2.7318E+03	8.1933E+03	2.6887E+00
8.3626E+02	9.6243E+02	1.0183E+05	4.1379E+04	6.1547E+03	1.3918E+02	2.7318E+03	7.7381E+03	1.3381E+03
8.3626E+02	9.0896E+02	1.5213E+05	4.1379E+04	0.0000E+00	6.4651E+03	2.7318E+03	7.2829E+03	7.8028E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Denmark A/S Tuborgvænget 6, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.3626E+02	8.5549E+02	2.3773E+05	3.4356E+04	1.8464E+05	1.3443E+00	2.7318E+03	6.8277E+03	9.5008E+03
8.3626E+02	8.0203E+02	3.7063E+05	3.4356E+04	1.6618E+05	1.7500E+00	2.7318E+03	6.3725E+03	2.0394E+04
8.3626E+02	7.4856E+02	5.1102E+05	3.4356E+04	1.6002E+05	1.3443E+00	2.7318E+03	5.9174E+03	2.6273E+04
8.3626E+02	6.9509E+02	8.3381E+05	3.4356E+04	1.5387E+05	4.4387E+00	2.7318E+03	5.4622E+03	1.0420E+05
8.3626E+02	6.4162E+02	1.1969E+06	3.4356E+04	1.4771E+05	3.0943E+00	2.7318E+03	5.0070E+03	1.2395E+05
8.3626E+02	5.8815E+02	1.6324E+06	3.4356E+04	1.4156E+05	3.5000E+00	2.7318E+03	4.5518E+03	2.3079E+05
8.3626E+02	5.3468E+02	2.3009E+06	3.4356E+04	1.3540E+05	3.5000E+00	2.7318E+03	4.0966E+03	3.5200E+05
8.3626E+02	4.8122E+02	3.1275E+06	3.4356E+04	1.2925E+05	8.3443E+00	2.7318E+03	3.6415E+03	4.3980E+05
8.3626E+02	4.2775E+02	4.0206E+06	3.4356E+04	1.2309E+05	4.8443E+00	2.7318E+03	3.1863E+03	5.9468E+05
8.3626E+02	3.7428E+02	4.7503E+06	3.4356E+04	1.1694E+05	7.9387E+00	2.7318E+03	2.7311E+03	6.1197E+05
8.3626E+02	3.2081E+02	5.2575E+06	3.4356E+04	1.1078E+05	3.0943E+00	2.7318E+03	2.2759E+03	6.6162E+05
8.3626E+02	2.6734E+02	5.2947E+06	3.4356E+04	1.0463E+05	7.0000E+00	2.7318E+03	1.8207E+03	5.0624E+05
8.3626E+02	2.1387E+02	5.4791E+06	3.4356E+04	9.8475E+04	2.6887E+00	2.7318E+03	1.3655E+03	7.2709E+05
8.3626E+02	1.6041E+02	6.9559E+06	3.4356E+04	9.2321E+04	1.3443E+00	2.7318E+03	9.1036E+02	1.1070E+06
8.3626E+02	1.0694E+02	1.1967E+07	3.4356E+04	8.6166E+04	2.6887E+00	2.7318E+03	4.5518E+02	2.6058E+06
8.3626E+02	5.3468E+01	2.2172E+07	3.4356E+04	7.3856E+04	9.6887E+00	2.7318E+03	0.0000E+00	5.8937E+06
8.3626E+02	0.0000E+00	2.4911E+07	3.4356E+04	6.7702E+04	3.5000E+00	2.1852E+03	1.6842E+04	6.2500E-01
7.7275E+02	1.8714E+03	1.2354E+02	3.4356E+04	6.1547E+04	1.2377E+01	2.1852E+03	1.5931E+04	6.2500E-01
7.7275E+02	1.8179E+03	1.4046E+02	3.4356E+04	5.5392E+04	9.6887E+00	2.1852E+03	1.3655E+04	1.3443E+00
7.7275E+02	1.7110E+03	2.8683E+02	3.4356E+04	4.9238E+04	2.1439E+01	2.1852E+03	1.2745E+04	6.2333E+00
7.7275E+02	1.6575E+03	1.1098E+03	3.4356E+04	4.3083E+04	2.3689E+01	2.1852E+03	1.1380E+04	6.4274E+01
7.7275E+02	1.6041E+03	1.4050E+03	3.4356E+04	3.6928E+04	6.4277E+01	2.1852E+03	1.0924E+04	3.0943E+00
7.7275E+02	1.5506E+03	1.8785E+03	3.4356E+04	3.0774E+04	5.1306E+01	2.1852E+03	1.0469E+04	8.2973E+02
7.7275E+02	1.4971E+03	1.9480E+03	3.4356E+04	2.4619E+04	6.1278E+01	2.1852E+03	1.0014E+04	1.3443E+00
7.7275E+02	1.4436E+03	3.4147E+03	3.4356E+04	1.8464E+04	1.5318E+02	2.1852E+03	9.5588E+03	8.2991E+02
7.7275E+02	1.3902E+03	2.9003E+03	3.4356E+04	1.2309E+04	3.4351E+03	2.1852E+03	9.1036E+03	1.6766E+03
7.7275E+02	1.3367E+03	8.8829E+03	3.4356E+04	6.1547E+03	5.0411E+03	2.1852E+03	8.6484E+03	1.2509E+03
7.7275E+02	1.2832E+03	2.1750E+04	3.4356E+04	0.0000E+00	8.4225E+03	2.1852E+03	8.1933E+03	6.5683E+01
7.7275E+02	1.2298E+03	3.1616E+04	2.7333E+04	1.7233E+05	6.2500E-01	2.1852E+03	7.7381E+03	1.9149E+04
7.7275E+02	1.1763E+03	3.9125E+04	2.7333E+04	1.4771E+05	1.7500E+00	2.1852E+03	7.2829E+03	2.9140E+04
7.7275E+02	1.1228E+03	6.8425E+04	2.7333E+04	1.4156E+05	3.5000E+00	2.1852E+03	6.8277E+03	4.2889E+04
7.7275E+02	1.0694E+03	8.4191E+04	2.7333E+04	1.3540E+05	3.0943E+00	2.1852E+03	6.3725E+03	1.1773E+05
7.7275E+02	1.0159E+03	1.6851E+05	2.7333E+04	1.2925E+05	4.8443E+00	2.1852E+03	5.9174E+03	1.2944E+05
7.7275E+02	9.6243E+02	1.8709E+05	2.7333E+04	1.2309E+05	1.7500E+00	2.1852E+03	5.4622E+03	2.5171E+05
7.7275E+02	9.0896E+02	2.9887E+05	2.7333E+04	1.1694E+05	4.1250E+00	2.1852E+03	5.0070E+03	2.6935E+05
7.7275E+02	8.5549E+02	4.0486E+05	2.7333E+04	1.1078E+05	1.1439E+01	2.1852E+03	4.5518E+03	4.5753E+05
7.7275E+02	8.0203E+02	5.8078E+05	2.7333E+04	1.0463E+05	6.1887E+00	2.1852E+03	4.0966E+03	5.8820E+05
7.7275E+02	7.4856E+02	7.9168E+05	2.7333E+04	9.2321E+04	9.2830E+00	2.1852E+03	3.6415E+03	7.5209E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.7275E+02	6.9509E+02	1.1823E+06	2.7333E+04	8.6166E+04	3.5000E+00	2.1852E+03	3.1863E+03	9.9083E+05
7.7275E+02	6.4162E+02	1.7168E+06	2.7333E+04	8.0011E+04	3.5000E+00	2.1852E+03	2.7311E+03	9.6434E+05
7.7275E+02	5.8815E+02	2.0820E+06	2.7333E+04	7.3856E+04	1.5877E+01	2.1852E+03	2.2759E+03	1.1104E+06
7.7275E+02	5.3468E+02	3.0742E+06	2.7333E+04	6.7702E+04	3.5105E+01	2.1852E+03	1.8207E+03	1.2180E+06
7.7275E+02	4.8122E+02	3.9285E+06	2.7333E+04	6.1547E+04	1.3189E+01	2.1852E+03	1.3655E+03	1.3656E+06
7.7275E+02	4.2775E+02	4.8230E+06	2.7333E+04	5.5392E+04	2.6377E+01	2.1852E+03	9.1036E+02	1.9881E+06
7.7275E+02	3.7428E+02	5.4306E+06	2.7333E+04	4.9238E+04	7.1200E+01	2.1852E+03	4.5518E+02	4.5345E+06
7.7275E+02	3.2081E+02	6.2147E+06	2.7333E+04	4.3083E+04	4.4819E+01	2.1852E+03	0.0000E+00	9.5432E+06
7.7275E+02	2.6734E+02	5.9761E+06	2.7333E+04	3.6928E+04	9.7122E+01	1.6386E+03	1.3200E+04	1.1854E+01
7.7275E+02	2.1387E+02	6.2211E+06	2.7333E+04	3.0774E+04	1.8402E+02	1.6386E+03	1.2745E+04	6.7313E+01
7.7275E+02	1.6041E+02	8.4578E+06	2.7333E+04	2.4619E+04	3.4459E+03	1.6386E+03	1.2290E+04	1.7500E+00
7.7275E+02	1.0694E+02	1.4181E+07	2.7333E+04	1.8464E+04	2.9677E+02	1.6386E+03	1.1835E+04	4.9785E+00
7.7275E+02	5.3468E+01	2.7455E+07	2.7333E+04	1.2309E+04	1.3892E+04	1.6386E+03	1.1380E+04	1.7946E+00
7.7275E+02	0.0000E+00	3.0167E+07	2.7333E+04	6.1547E+03	1.5762E+04	1.6386E+03	1.0924E+04	1.8881E+02
7.0923E+02	2.0853E+03	1.0510E+01	2.7333E+04	0.0000E+00	3.0643E+04	1.6386E+03	1.0469E+04	8.8991E+02
7.0923E+02	1.9783E+03	1.0510E+01	2.0310E+04	2.0311E+05	1.3443E+00	1.6386E+03	1.0014E+04	3.2630E+03
7.0923E+02	1.9249E+03	3.5831E+02	2.0310E+04	1.7849E+05	4.4583E-02	1.6386E+03	9.5588E+03	1.7710E+03
7.0923E+02	1.8714E+03	1.2317E+02	2.0310E+04	1.5387E+05	1.9693E+00	1.6386E+03	9.1036E+03	5.4923E+03
7.0923E+02	1.8179E+03	1.8880E+03	2.0310E+04	1.4771E+05	1.3443E+00	1.6386E+03	8.6484E+03	4.8427E+03
7.0923E+02	1.7645E+03	3.5831E+02	2.0310E+04	1.3540E+05	3.0943E+00	1.6386E+03	8.1933E+03	1.6783E+04
7.0923E+02	1.7110E+03	1.2425E+03	2.0310E+04	1.2925E+05	3.0943E+00	1.6386E+03	7.7381E+03	3.3645E+04
7.0923E+02	1.6575E+03	1.5169E+03	2.0310E+04	1.2309E+05	1.9693E+00	1.6386E+03	7.2829E+03	7.8591E+04
7.0923E+02	1.6041E+03	2.1872E+03	2.0310E+04	1.1694E+05	5.4693E+00	1.6386E+03	6.8277E+03	9.2993E+04
7.0923E+02	1.5506E+03	3.4722E+03	2.0310E+04	1.1078E+05	1.7500E+00	1.6386E+03	6.3725E+03	1.6975E+05
7.0923E+02	1.4971E+03	5.3674E+03	2.0310E+04	1.0463E+05	5.2500E+00	1.6386E+03	5.9174E+03	3.1291E+05
7.0923E+02	1.4436E+03	1.3960E+04	2.0310E+04	9.8475E+04	1.1125E+01	1.6386E+03	5.4622E+03	4.1117E+05
7.0923E+02	1.3902E+03	1.2971E+04	2.0310E+04	9.2321E+04	7.0000E+00	1.6386E+03	5.0070E+03	5.0146E+05
7.0923E+02	1.3367E+03	3.0650E+04	2.0310E+04	8.6166E+04	1.2250E+01	1.6386E+03	4.5518E+03	8.3220E+05
7.0923E+02	1.2832E+03	3.3531E+04	2.0310E+04	8.0011E+04	1.9721E+01	1.6386E+03	4.0966E+03	1.1350E+06
7.0923E+02	1.2298E+03	3.8860E+04	2.0310E+04	7.3856E+04	1.8123E+01	1.6386E+03	3.6415E+03	1.3331E+06
7.0923E+02	1.1763E+03	4.8666E+04	2.0310E+04	6.7702E+04	9.6887E+00	1.6386E+03	3.1863E+03	1.5439E+06
7.0923E+02	1.1228E+03	7.9071E+04	2.0310E+04	6.1547E+04	1.2580E+02	1.6386E+03	2.7311E+03	1.8310E+06
7.0923E+02	1.0694E+03	1.3818E+05	2.0310E+04	5.5392E+04	9.4557E+01	1.6386E+03	2.2759E+03	2.0922E+06
7.0923E+02	1.0159E+03	1.6856E+05	2.0310E+04	4.9238E+04	9.8451E+01	1.6386E+03	1.8207E+03	2.0224E+06
7.0923E+02	9.6243E+02	2.3312E+05	2.0310E+04	4.3083E+04	3.5526E+03	1.6386E+03	1.3655E+03	2.3661E+06
7.0923E+02	9.0896E+02	2.9415E+05	2.0310E+04	3.6928E+04	1.3762E+02	1.6386E+03	9.1036E+02	3.3265E+06
7.0923E+02	8.5549E+02	5.3121E+05	2.0310E+04	3.0774E+04	3.1751E+02	1.6386E+03	4.5518E+02	7.2080E+06
7.0923E+02	8.0203E+02	6.7640E+05	2.0310E+04	2.4619E+04	3.8718E+03	1.6386E+03	0.0000E+00	1.5402E+07

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.0923E+02	7.4856E+02	9.7224E+05	2.0310E+04	1.8464E+04	4.1447E+03	1.0920E+03	1.6842E+04	2.7056E+01
7.0923E+02	6.9509E+02	1.3063E+06	2.0310E+04	1.2309E+04	1.4590E+04	1.0920E+03	1.5931E+04	1.3443E+00
7.0923E+02	6.4162E+02	1.6947E+06	2.0310E+04	6.1547E+03	2.9664E+04	1.0920E+03	1.4566E+04	4.0748E+01
7.0923E+02	5.8815E+02	2.2790E+06	2.0310E+04	0.0000E+00	1.0325E+05	1.0920E+03	1.4111E+04	1.7500E+00
7.0923E+02	5.3468E+02	3.2682E+06	1.3287E+04	1.8464E+05	4.4583E-02	1.0920E+03	1.3655E+04	3.0784E+02
7.0923E+02	4.8122E+02	4.0534E+06	1.3287E+04	1.6618E+05	6.2500E-01	1.0920E+03	1.3200E+04	2.4533E+02
7.0923E+02	4.2775E+02	4.7355E+06	1.3287E+04	1.4771E+05	1.3443E+00	1.0920E+03	1.2745E+04	5.7616E+01
7.0923E+02	3.7428E+02	5.6846E+06	1.3287E+04	1.4156E+05	1.3443E+00	1.0920E+03	1.2290E+04	5.8404E+02
7.0923E+02	3.2081E+02	5.6920E+06	1.3287E+04	1.3540E+05	6.2500E-01	1.0920E+03	1.1835E+04	1.3747E+02
7.0923E+02	2.6734E+02	6.1055E+06	1.3287E+04	1.2925E+05	6.2500E-01	1.0920E+03	1.1380E+04	3.3278E+02
7.0923E+02	2.1387E+02	6.4817E+06	1.3287E+04	1.1694E+05	2.3750E+00	1.0920E+03	1.0924E+04	2.5599E+03
7.0923E+02	1.6041E+02	7.5665E+06	1.3287E+04	1.1078E+05	3.5000E+00	1.0920E+03	1.0469E+04	1.9480E+03
7.0923E+02	1.0694E+02	1.2846E+07	1.3287E+04	9.8475E+04	6.5943E+00	1.0920E+03	1.0014E+04	6.7348E+03
7.0923E+02	5.3468E+01	2.6799E+07	1.3287E+04	9.2321E+04	3.5011E+01	1.0920E+03	9.5588E+03	7.2610E+03
7.0923E+02	0.0000E+00	3.0054E+07	1.3287E+04	8.6166E+04	1.4488E+01	1.0920E+03	9.1036E+03	1.5254E+04
6.4572E+02	2.4595E+03	3.6186E+00	1.3287E+04	8.0011E+04	3.7937E+01	1.0920E+03	8.6484E+03	4.5243E+04
6.4572E+02	2.2457E+03	3.6186E+00	1.3287E+04	7.3856E+04	4.0424E+01	1.0920E+03	8.1933E+03	6.2190E+04
6.4572E+02	2.1922E+03	4.5893E+02	1.3287E+04	6.7702E+04	6.8180E+01	1.0920E+03	7.7381E+03	7.0602E+04
6.4572E+02	2.1387E+03	7.1660E+01	1.3287E+04	6.1547E+04	7.4657E+01	1.0920E+03	7.2829E+03	1.1548E+05
6.4572E+02	2.0853E+03	2.1020E+01	1.3287E+04	5.5392E+04	1.9273E+02	1.0920E+03	6.8277E+03	1.8601E+05
6.4572E+02	2.0318E+03	2.6998E+02	1.3287E+04	4.9238E+04	2.0073E+03	1.0920E+03	6.3725E+03	2.7649E+05
6.4572E+02	1.9783E+03	3.2570E+02	1.3287E+04	4.3083E+04	3.1008E+02	1.0920E+03	5.9174E+03	4.9903E+05
6.4572E+02	1.9249E+03	1.2341E+03	1.3287E+04	3.6928E+04	2.2868E+03	1.0920E+03	5.4622E+03	5.9893E+05
6.4572E+02	1.8714E+03	2.2514E+02	1.3287E+04	3.0774E+04	2.3193E+03	1.0920E+03	5.0070E+03	7.3281E+05
6.4572E+02	1.8179E+03	3.5449E+03	1.3287E+04	2.4619E+04	1.5077E+04	1.0920E+03	4.5518E+03	1.1486E+06
6.4572E+02	1.7645E+03	8.6378E+02	1.3287E+04	1.8464E+04	1.3188E+04	1.0920E+03	4.0966E+03	1.4246E+06
6.4572E+02	1.7110E+03	3.4998E+03	1.3287E+04	1.2309E+04	3.3082E+04	1.0920E+03	3.6415E+03	1.8344E+06
6.4572E+02	1.6575E+03	5.6061E+03	1.3287E+04	6.1547E+03	7.6460E+04	1.0920E+03	3.1863E+03	2.2563E+06
6.4572E+02	1.6041E+03	9.2973E+03	1.3287E+04	0.0000E+00	5.1113E+05	1.0920E+03	2.7311E+03	2.8758E+06
6.4572E+02	1.5506E+03	1.9655E+04	6.2644E+03	2.8927E+05	1.3443E+00	1.0920E+03	2.2759E+03	3.4018E+06
6.4572E+02	1.4971E+03	6.4595E+03	6.2644E+03	1.7233E+05	4.4583E-02	1.0920E+03	1.8207E+03	3.3371E+06
6.4572E+02	1.4436E+03	1.9699E+04	6.2644E+03	1.3540E+05	1.9693E+00	1.0920E+03	1.3655E+03	3.8721E+06
6.4572E+02	1.3902E+03	3.1851E+04	6.2644E+03	1.2925E+05	2.0585E+00	1.0920E+03	9.1036E+02	4.7649E+06
6.4572E+02	1.3367E+03	4.1339E+04	6.2644E+03	1.2309E+05	3.2639E+00	1.0920E+03	4.5518E+02	1.0759E+07
6.4572E+02	1.2832E+03	6.0705E+04	6.2644E+03	1.1694E+05	3.2995E-01	1.0920E+03	0.0000E+00	2.3920E+07
6.4572E+02	1.2298E+03	8.5527E+04	6.2644E+03	1.1078E+05	1.9361E+00	5.4535E+02	1.8207E+04	1.0510E+01
6.4572E+02	1.1763E+03	7.1698E+04	6.2644E+03	1.0463E+05	3.1344E+03	5.4535E+02	1.7752E+04	3.7566E+01
6.4572E+02	1.1228E+03	1.4672E+05	6.2644E+03	9.8475E+04	1.5741E+03	5.4535E+02	1.5931E+04	2.0665E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.4572E+02	1.0694E+03	2.0048E+05	6.2644E+03	9.2321E+04	3.1483E+03	5.4535E+02	1.5476E+04	1.0417E+00
6.4572E+02	1.0159E+03	2.7152E+05	6.2644E+03	8.6166E+04	1.6280E+03	5.4535E+02	1.5021E+04	5.6000E+02
6.4572E+02	9.6243E+02	4.1267E+05	6.2644E+03	8.0011E+04	9.4988E+03	5.4535E+02	1.4566E+04	6.6548E+01
6.4572E+02	9.0896E+02	4.8173E+05	6.2644E+03	7.3856E+04	1.1151E+04	5.4535E+02	1.4111E+04	5.8006E+02
6.4572E+02	8.5549E+02	6.1844E+05	6.2644E+03	6.7702E+04	1.1832E+04	5.4535E+02	1.3655E+04	3.0023E+03
6.4572E+02	8.0203E+02	8.5363E+05	6.2644E+03	6.1547E+04	1.6604E+04	5.4535E+02	1.3200E+04	2.6119E+03
6.4572E+02	7.4856E+02	1.1256E+06	6.2644E+03	5.5392E+04	2.1459E+04	5.4535E+02	1.2745E+04	1.3855E+03
6.4572E+02	6.9509E+02	1.6517E+06	6.2644E+03	4.9238E+04	2.1668E+04	5.4535E+02	1.2290E+04	6.3972E+03
6.4572E+02	6.4162E+02	2.1081E+06	6.2644E+03	4.3083E+04	3.8041E+04	5.4535E+02	1.1835E+04	8.7041E+03
6.4572E+02	5.8815E+02	2.7295E+06	6.2644E+03	3.6928E+04	5.3569E+04	5.4535E+02	1.1380E+04	9.2838E+03
6.4572E+02	5.3468E+02	3.4106E+06	6.2644E+03	3.0774E+04	1.0642E+05	5.4535E+02	1.0924E+04	3.0781E+04
6.4572E+02	4.8122E+02	4.0743E+06	6.2644E+03	2.4619E+04	2.3060E+05	5.4535E+02	1.0469E+04	2.6799E+04
6.4572E+02	4.2775E+02	4.3768E+06	6.2644E+03	1.8464E+04	7.2247E+05	5.4535E+02	1.0014E+04	4.2814E+04
6.4572E+02	3.7428E+02	5.2080E+06	6.2644E+03	1.2309E+04	1.4677E+06	5.4535E+02	9.5588E+03	4.8501E+04
6.4572E+02	3.2081E+02	4.7803E+06	6.2644E+03	6.1547E+03	3.6003E+06	5.4535E+02	9.1036E+03	5.0070E+04
6.4572E+02	2.6734E+02	4.9687E+06	6.2644E+03	0.0000E+00	7.8857E+06	5.4535E+02	8.6484E+03	5.3976E+04
6.4572E+02	2.1387E+02	4.9003E+06	-7.5841E+02	3.0774E+05	1.3443E+00	5.4535E+02	8.1933E+03	8.9734E+04
6.4572E+02	1.6041E+02	6.0249E+06	-7.5841E+02	1.7233E+05	4.4583E-02	5.4535E+02	7.7381E+03	1.2165E+05
6.4572E+02	1.0694E+02	1.0148E+07	-7.5841E+02	1.5387E+05	1.9693E+00	5.4535E+02	7.2829E+03	2.0221E+05
6.4572E+02	5.3468E+01	2.2682E+07	-7.5841E+02	1.4771E+05	4.4583E-02	5.4535E+02	6.8277E+03	2.8149E+05
6.4572E+02	0.0000E+00	2.7559E+07	-7.5841E+02	1.4156E+05	7.1417E-01	5.4535E+02	6.3725E+03	4.0558E+05
5.8220E+02	2.5665E+03	3.6186E+00	-7.5841E+02	1.3540E+05	6.6211E-02	5.4535E+02	5.9174E+03	6.1188E+05
5.8220E+02	2.2991E+03	8.9167E-02	-7.5841E+02	1.2925E+05	1.3443E+00	5.4535E+02	5.4622E+03	7.5808E+05
5.8220E+02	2.2457E+03	4.3749E+01	-7.5841E+02	1.2309E+05	1.3838E+00	5.4535E+02	5.0070E+03	1.0941E+06
5.8220E+02	2.1922E+03	1.0510E+01	-7.5841E+02	1.1694E+05	2.0356E+00	5.4535E+02	4.5518E+03	1.4346E+06
5.8220E+02	2.1387E+03	3.2474E+01	-7.5841E+02	1.1078E+05	3.4691E+00	5.4535E+02	4.0966E+03	1.7880E+06
5.8220E+02	2.0853E+03	1.7663E+01	-7.5841E+02	1.0463E+05	7.3416E+00	5.4535E+02	3.6415E+03	2.1074E+06
5.8220E+02	2.0318E+03	6.8487E+02	-7.5841E+02	9.8475E+04	2.3873E+03	5.4535E+02	3.1863E+03	2.7200E+06
5.8220E+02	1.9783E+03	5.3406E+02	-7.5841E+02	9.2321E+04	3.9402E+03	5.4535E+02	2.7311E+03	3.5663E+06
5.8220E+02	1.9249E+03	9.4502E+02	-7.5841E+02	8.6166E+04	1.5938E+03	5.4535E+02	2.2759E+03	4.3196E+06
5.8220E+02	1.8714E+03	6.9202E+02	-7.5841E+02	8.0011E+04	2.5464E+03	5.4535E+02	1.8207E+03	5.2257E+06
5.8220E+02	1.8179E+03	4.4936E+03	-7.5841E+02	7.3856E+04	6.3311E+03	5.4535E+02	1.3655E+03	5.5443E+06
5.8220E+02	1.7645E+03	2.8569E+03	-7.5841E+02	6.7702E+04	1.3446E+04	5.4535E+02	9.1036E+02	6.9984E+06
5.8220E+02	1.7110E+03	2.2988E+03	-7.5841E+02	6.1547E+04	3.1107E+04	5.4535E+02	4.5518E+02	1.5450E+07
5.8220E+02	1.6575E+03	9.9454E+03	-7.5841E+02	5.5392E+04	5.4306E+04	5.4535E+02	0.0000E+00	3.4017E+07
5.8220E+02	1.6041E+03	1.0483E+04	-7.5841E+02	4.9238E+04	5.9320E+04	-1.2490E+00	1.6387E+04	8.9167E-02
5.8220E+02	1.5506E+03	8.8108E+03	-7.5841E+02	4.3083E+04	7.9046E+04	-1.2490E+00	1.5931E+04	6.5809E+01
5.8220E+02	1.4971E+03	2.1722E+04	-7.5841E+02	3.6928E+04	1.2375E+05	-1.2490E+00	1.5476E+04	4.7297E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.8220E+02	1.4436E+03	1.8673E+04	-7.5841E+02	3.0774E+04	2.0047E+05	-1.2490E+00	1.5021E+04	1.2713E+03
5.8220E+02	1.3902E+03	2.9984E+04	-7.5841E+02	2.4619E+04	2.5911E+05	-1.2490E+00	1.4566E+04	1.0463E+03
5.8220E+02	1.3367E+03	3.6077E+04	-7.5841E+02	1.8464E+04	5.5378E+05	-1.2490E+00	1.4111E+04	3.0119E+03
5.8220E+02	1.2832E+03	6.2951E+04	-7.5841E+02	1.2309E+04	8.2751E+05	-1.2490E+00	1.3655E+04	8.0941E+03
5.8220E+02	1.2298E+03	6.8503E+04	-7.5841E+02	6.1547E+03	1.5349E+06	-1.2490E+00	1.3200E+04	6.2209E+03
5.8220E+02	1.1763E+03	1.4272E+05	-7.5841E+02	0.0000E+00	6.1787E+06	-1.2490E+00	1.2745E+04	1.2565E+04
5.8220E+02	1.1228E+03	1.6100E+05	-7.7813E+03	3.0158E+05	1.3443E+00	-1.2490E+00	1.2290E+04	4.7486E+04
5.8220E+02	1.0694E+03	2.5254E+05	-7.7813E+03	2.8927E+05	1.3443E+00	-1.2490E+00	1.1835E+04	4.3161E+04
5.8220E+02	1.0159E+03	2.6942E+05	-7.7813E+03	2.7081E+05	1.3443E+00	-1.2490E+00	1.1380E+04	9.7460E+04
5.8220E+02	9.6243E+02	4.1591E+05	-7.7813E+03	2.5234E+05	1.3443E+00	-1.2490E+00	1.0924E+04	7.9994E+04
5.8220E+02	9.0896E+02	5.4717E+05	-7.7813E+03	2.4003E+05	6.2500E-01	-1.2490E+00	1.0469E+04	5.2417E+04
5.8220E+02	8.5549E+02	7.7216E+05	-7.7813E+03	1.6002E+05	4.4583E-02	-1.2490E+00	1.0014E+04	6.9310E+04
5.8220E+02	8.0203E+02	1.0881E+06	-7.7813E+03	1.5387E+05	3.7105E-03	-1.2490E+00	9.5588E+03	9.9422E+04
5.8220E+02	7.4856E+02	1.2837E+06	-7.7813E+03	1.4771E+05	2.6872E+00	-1.2490E+00	9.1036E+03	1.0590E+05
5.8220E+02	6.9509E+02	1.5085E+06	-7.7813E+03	1.4156E+05	7.1417E-01	-1.2490E+00	8.6484E+03	1.1414E+05
5.8220E+02	6.4162E+02	1.8672E+06	-7.7813E+03	1.3540E+05	1.9996E-01	-1.2490E+00	8.1933E+03	1.2433E+05
5.8220E+02	5.8815E+02	2.4207E+06	-7.7813E+03	1.2925E+05	8.9167E-02	-1.2490E+00	7.7381E+03	2.1298E+05
5.8220E+02	5.3468E+02	2.8151E+06	-7.7813E+03	1.2309E+05	1.3443E+00	-1.2490E+00	7.2829E+03	2.6773E+05
5.8220E+02	4.8122E+02	2.9235E+06	-7.7813E+03	1.1694E+05	1.8078E+01	-1.2490E+00	6.8277E+03	4.0782E+05
5.8220E+02	4.2775E+02	3.6846E+06	-7.7813E+03	1.1078E+05	1.6289E+01	-1.2490E+00	6.3725E+03	4.8406E+05
5.8220E+02	3.7428E+02	3.5291E+06	-7.7813E+03	1.0463E+05	1.4823E+01	-1.2490E+00	5.9174E+03	6.9065E+05
5.8220E+02	3.2081E+02	3.4934E+06	-7.7813E+03	9.8475E+04	6.6111E+01	-1.2490E+00	5.4622E+03	1.0202E+06
5.8220E+02	2.6734E+02	3.2767E+06	-7.7813E+03	9.2321E+04	1.7168E+03	-1.2490E+00	5.0070E+03	1.2318E+06
5.8220E+02	2.1387E+02	3.3191E+06	-7.7813E+03	8.6166E+04	6.8831E+01	-1.2490E+00	4.5518E+03	1.6527E+06
5.8220E+02	1.6041E+02	3.7379E+06	-7.7813E+03	8.0011E+04	3.7011E+03	-1.2490E+00	4.0966E+03	2.0426E+06
5.8220E+02	1.0694E+02	6.8686E+06	-7.7813E+03	7.3856E+04	1.4442E+02	-1.2490E+00	3.6415E+03	2.8387E+06
5.8220E+02	5.3468E+01	1.6747E+07	-7.7813E+03	6.7702E+04	2.2587E+03	-1.2490E+00	3.1863E+03	3.2442E+06
5.8220E+02	0.0000E+00	2.3031E+07	-7.7813E+03	6.1547E+04	9.9986E+02	-1.2490E+00	2.7311E+03	4.1505E+06
5.1869E+02	2.4595E+03	4.1077E+00	-7.7813E+03	5.5392E+04	1.0200E+04	-1.2490E+00	2.2759E+03	5.4026E+06
5.1869E+02	2.4061E+03	1.0856E+01	-7.7813E+03	4.9238E+04	6.3484E+04	-1.2490E+00	1.8207E+03	6.8073E+06
5.1869E+02	2.3526E+03	4.3791E+02	-7.7813E+03	4.3083E+04	6.5271E+04	-1.2490E+00	1.3655E+03	6.9903E+06
5.1869E+02	2.2991E+03	1.3816E+01	-7.7813E+03	3.6928E+04	2.4808E+05	-1.2490E+00	9.1036E+02	8.6813E+06
5.1869E+02	2.2457E+03	1.0510E+01	-7.7813E+03	3.0774E+04	4.2310E+05	-1.2490E+00	4.5518E+02	1.9987E+07
5.1869E+02	2.1922E+03	5.6522E+01	-7.7813E+03	2.4619E+04	6.9071E+05	-1.2490E+00	0.0000E+00	4.6253E+07
5.1869E+02	2.1387E+03	1.4311E+03	-7.7813E+03	1.8464E+04	9.4634E+05	-5.4785E+02	1.7752E+04	2.1020E+01
5.1869E+02	2.0853E+03	1.6232E+02	-7.7813E+03	1.2309E+04	1.2473E+06	-5.4785E+02	1.7297E+04	4.5311E+01
5.1869E+02	2.0318E+03	1.4846E+03	-7.7813E+03	6.1547E+03	1.5626E+06	-5.4785E+02	1.6387E+04	5.6000E+02
5.1869E+02	1.9783E+03	2.3655E+03	-7.7813E+03	0.0000E+00	2.2577E+06	-5.4785E+02	1.5931E+04	9.3877E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Denmark A/S Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.1869E+02	1.9249E+03	1.6440E+03	-1.4804E+04	3.0774E+05	2.6887E+00	-5.4785E+02	1.5476E+04	2.1098E+01
5.1869E+02	1.8714E+03	2.1635E+03	-1.4804E+04	2.7696E+05	1.7500E+00	-5.4785E+02	1.5021E+04	1.8287E+02
5.1869E+02	1.8179E+03	3.8189E+03	-1.4804E+04	2.7081E+05	3.5000E+00	-5.4785E+02	1.4566E+04	4.8587E+02
5.1869E+02	1.7645E+03	1.5945E+03	-1.4804E+04	2.6465E+05	2.6887E+00	-5.4785E+02	1.4111E+04	4.8603E+03
5.1869E+02	1.7110E+03	3.1197E+03	-1.4804E+04	2.5234E+05	1.7946E+00	-5.4785E+02	1.3655E+04	1.0121E+04
5.1869E+02	1.6575E+03	9.4650E+03	-1.4804E+04	2.4003E+05	5.2500E+00	-5.4785E+02	1.3200E+04	1.7651E+04
5.1869E+02	1.6041E+03	1.1728E+04	-1.4804E+04	2.2157E+05	1.7500E+00	-5.4785E+02	1.2745E+04	3.0523E+04
5.1869E+02	1.5506E+03	1.8738E+04	-1.4804E+04	2.0926E+05	6.2500E-01	-5.4785E+02	1.2290E+04	4.4968E+04
5.1869E+02	1.4971E+03	1.3328E+04	-1.4804E+04	1.9695E+05	6.2500E-01	-5.4785E+02	1.1835E+04	8.0880E+04
5.1869E+02	1.4436E+03	1.7121E+04	-1.4804E+04	1.8464E+05	6.2500E-01	-5.4785E+02	1.1380E+04	1.0153E+05
5.1869E+02	1.3902E+03	3.7307E+04	-1.4804E+04	1.6618E+05	1.3375E-01	-5.4785E+02	1.0924E+04	1.4660E+05
5.1869E+02	1.3367E+03	5.8769E+04	-1.4804E+04	1.6002E+05	1.7500E+00	-5.4785E+02	1.0469E+04	8.5626E+04
5.1869E+02	1.2832E+03	5.2616E+04	-1.4804E+04	1.5387E+05	2.6617E-01	-5.4785E+02	1.0014E+04	1.1456E+05
5.1869E+02	1.2298E+03	6.1673E+04	-1.4804E+04	1.4771E+05	1.4335E+00	-5.4785E+02	9.5588E+03	8.0844E+04
5.1869E+02	1.1763E+03	1.1154E+05	-1.4804E+04	1.4156E+05	2.8670E+00	-5.4785E+02	9.1036E+03	1.6251E+05
5.1869E+02	1.1228E+03	1.2087E+05	-1.4804E+04	1.3540E+05	1.5673E+00	-5.4785E+02	8.6484E+03	1.2686E+05
5.1869E+02	1.0694E+03	1.4391E+05	-1.4804E+04	1.2925E+05	1.5146E+00	-5.4785E+02	8.1933E+03	1.4069E+05
5.1869E+02	1.0159E+03	1.8241E+05	-1.4804E+04	1.2309E+05	1.8188E+01	-5.4785E+02	7.7381E+03	1.9226E+05
5.1869E+02	9.6243E+02	2.5845E+05	-1.4804E+04	1.1694E+05	9.3708E-01	-5.4785E+02	7.2829E+03	2.4926E+05
5.1869E+02	9.0896E+02	2.8169E+05	-1.4804E+04	1.1078E+05	3.2598E+01	-5.4785E+02	6.8277E+03	4.0458E+05
5.1869E+02	8.5549E+02	4.5812E+05	-1.4804E+04	1.0463E+05	1.7173E+01	-5.4785E+02	6.3725E+03	5.5760E+05
5.1869E+02	8.0203E+02	5.4486E+05	-1.4804E+04	9.8475E+04	6.7110E+01	-5.4785E+02	5.9174E+03	7.5451E+05
5.1869E+02	7.4856E+02	7.6775E+05	-1.4804E+04	9.2321E+04	3.5138E+03	-5.4785E+02	5.4622E+03	9.3396E+05
5.1869E+02	6.9509E+02	9.3226E+05	-1.4804E+04	8.6166E+04	1.4649E+03	-5.4785E+02	5.0070E+03	1.3688E+06
5.1869E+02	6.4162E+02	1.1797E+06	-1.4804E+04	8.0011E+04	1.2435E+02	-5.4785E+02	4.5518E+03	1.8251E+06
5.1869E+02	5.8815E+02	1.4438E+06	-1.4804E+04	7.3856E+04	1.3260E+03	-5.4785E+02	4.0966E+03	2.1315E+06
5.1869E+02	5.3468E+02	1.4856E+06	-1.4804E+04	6.7702E+04	2.5139E+03	-5.4785E+02	3.6415E+03	2.8612E+06
5.1869E+02	4.8122E+02	2.1080E+06	-1.4804E+04	6.1547E+04	7.3402E+03	-5.4785E+02	3.1863E+03	3.4190E+06
5.1869E+02	4.2775E+02	2.3900E+06	-1.4804E+04	5.5392E+04	2.4283E+04	-5.4785E+02	2.7311E+03	4.3059E+06
5.1869E+02	3.7428E+02	2.3886E+06	-1.4804E+04	4.9238E+04	3.7300E+04	-5.4785E+02	2.2759E+03	4.8431E+06
5.1869E+02	3.2081E+02	2.9549E+06	-1.4804E+04	4.3083E+04	1.3802E+05	-5.4785E+02	1.8207E+03	5.4316E+06
5.1869E+02	2.6734E+02	2.8166E+06	-1.4804E+04	3.6928E+04	2.9812E+05	-5.4785E+02	1.3655E+03	6.2855E+06
5.1869E+02	2.1387E+02	2.9256E+06	-1.4804E+04	3.0774E+04	5.7005E+05	-5.4785E+02	9.1036E+02	7.1312E+06
5.1869E+02	1.6041E+02	3.7051E+06	-1.4804E+04	2.4619E+04	1.1371E+06	-5.4785E+02	4.5518E+02	1.6609E+07
5.1869E+02	1.0694E+02	5.2674E+06	-1.4804E+04	1.8464E+04	1.6472E+06	-5.4785E+02	0.0000E+00	3.5130E+07
5.1869E+02	5.3468E+01	1.4275E+07	-1.4804E+04	1.2309E+04	2.6086E+06	-1.0944E+03	1.8207E+04	4.6602E+00
5.1869E+02	0.0000E+00	2.2647E+07	-1.4804E+04	6.1547E+03	3.6942E+06	-1.0944E+03	1.6842E+04	1.1150E+02
4.5518E+02	2.4061E+03	1.3443E+00	-1.4804E+04	0.0000E+00	3.3406E+06	-1.0944E+03	1.6387E+04	8.1554E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE
DNV Business Assurance Tuborgvænkej 8.2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.5518E+02	2.2991E+03	3.6186E+00	-2.1827E+04	3.0158E+05	2.6887E+00	-1.0944E+03	1.5931E+04	1.1616E+01
4.5518E+02	2.2457E+03	1.3443E+00	-2.1827E+04	2.9543E+05	1.3443E+00	-1.0944E+03	1.5476E+04	2.1842E+02
4.5518E+02	2.1922E+03	3.6186E+00	-2.1827E+04	2.8927E+05	1.3443E+00	-1.0944E+03	1.5021E+04	1.2205E+03
4.5518E+02	2.1387E+03	7.1846E+01	-2.1827E+04	2.8312E+05	9.6472E+00	-1.0944E+03	1.4566E+04	7.6036E+02
4.5518E+02	2.0853E+03	8.7456E+01	-2.1827E+04	2.7696E+05	1.3443E+00	-1.0944E+03	1.4111E+04	2.6057E+03
4.5518E+02	2.0318E+03	5.3922E+02	-2.1827E+04	2.7081E+05	4.8443E+00	-1.0944E+03	1.3655E+04	5.4982E+03
4.5518E+02	1.9783E+03	2.3657E+03	-2.1827E+04	2.5850E+05	2.6887E+00	-1.0944E+03	1.3200E+04	8.4003E+03
4.5518E+02	1.9249E+03	3.5350E+02	-2.1827E+04	2.5234E+05	1.7946E+00	-1.0944E+03	1.2745E+04	8.0689E+03
4.5518E+02	1.8714E+03	1.0941E+03	-2.1827E+04	2.4619E+05	7.0000E+00	-1.0944E+03	1.2290E+04	2.7589E+04
4.5518E+02	1.8179E+03	4.8425E+03	-2.1827E+04	2.4003E+05	3.0943E+00	-1.0944E+03	1.1835E+04	2.4525E+04
4.5518E+02	1.7645E+03	1.7764E+03	-2.1827E+04	2.3388E+05	3.0943E+00	-1.0944E+03	1.1380E+04	4.1552E+04
4.5518E+02	1.7110E+03	8.9151E+03	-2.1827E+04	2.2157E+05	4.8443E+00	-1.0944E+03	1.0924E+04	4.9684E+04
4.5518E+02	1.6575E+03	2.7603E+03	-2.1827E+04	2.1541E+05	6.2500E-01	-1.0944E+03	1.0469E+04	6.0754E+04
4.5518E+02	1.6041E+03	5.3042E+03	-2.1827E+04	2.0926E+05	2.3750E+00	-1.0944E+03	1.0014E+04	5.8890E+04
4.5518E+02	1.5506E+03	6.1744E+03	-2.1827E+04	2.0311E+05	1.3443E+00	-1.0944E+03	9.5588E+03	1.1108E+05
4.5518E+02	1.4971E+03	2.2540E+03	-2.1827E+04	1.9695E+05	6.2500E-01	-1.0944E+03	9.1036E+03	8.0763E+04
4.5518E+02	1.4436E+03	1.0009E+04	-2.1827E+04	1.9080E+05	6.6958E-01	-1.0944E+03	8.6484E+03	1.0998E+05
4.5518E+02	1.3902E+03	1.3035E+04	-2.1827E+04	1.7849E+05	4.4583E-02	-1.0944E+03	8.1933E+03	1.3829E+05
4.5518E+02	1.3367E+03	1.3821E+04	-2.1827E+04	1.7233E+05	8.9167E-02	-1.0944E+03	7.7381E+03	2.0485E+05
4.5518E+02	1.2832E+03	2.0240E+04	-2.1827E+04	1.6618E+05	1.3375E-01	-1.0944E+03	7.2829E+03	2.5162E+05
4.5518E+02	1.2298E+03	3.7868E+04	-2.1827E+04	1.6002E+05	4.4583E-02	-1.0944E+03	6.8277E+03	3.4025E+05
4.5518E+02	1.1763E+03	3.3238E+04	-2.1827E+04	1.5387E+05	1.4667E+00	-1.0944E+03	6.3725E+03	5.0627E+05
4.5518E+02	1.1228E+03	5.7732E+04	-2.1827E+04	1.4771E+05	6.9121E-01	-1.0944E+03	5.9174E+03	6.8675E+05
4.5518E+02	1.0694E+03	6.8893E+04	-2.1827E+04	1.4156E+05	3.7105E-03	-1.0944E+03	5.4622E+03	8.4978E+05
4.5518E+02	1.0159E+03	1.0704E+05	-2.1827E+04	1.3540E+05	5.4229E+00	-1.0944E+03	5.0070E+03	1.0968E+06
4.5518E+02	9.6243E+02	1.1913E+05	-2.1827E+04	1.2925E+05	3.0582E-01	-1.0944E+03	4.5518E+03	1.5737E+06
4.5518E+02	9.0896E+02	1.3882E+05	-2.1827E+04	1.2309E+05	1.2763E+01	-1.0944E+03	4.0966E+03	1.7961E+06
4.5518E+02	8.5549E+02	2.0119E+05	-2.1827E+04	1.1694E+05	2.4930E+01	-1.0944E+03	3.6415E+03	2.1129E+06
4.5518E+02	8.0203E+02	3.0222E+05	-2.1827E+04	1.1078E+05	5.6182E+00	-1.0944E+03	3.1863E+03	2.8366E+06
4.5518E+02	7.4856E+02	3.0023E+05	-2.1827E+04	1.0463E+05	1.6902E+03	-1.0944E+03	2.7311E+03	3.4080E+06
4.5518E+02	6.9509E+02	5.0527E+05	-2.1827E+04	9.8475E+04	1.0708E+02	-1.0944E+03	2.2759E+03	3.7324E+06
4.5518E+02	6.4162E+02	6.5241E+05	-2.1827E+04	9.2321E+04	5.7231E+01	-1.0944E+03	1.8207E+03	3.9239E+06
4.5518E+02	5.8815E+02	6.9497E+05	-2.1827E+04	8.6166E+04	1.3828E+03	-1.0944E+03	1.3655E+03	3.6415E+06
4.5518E+02	5.3468E+02	9.8876E+05	-2.1827E+04	8.0011E+04	4.6063E+03	-1.0944E+03	9.1036E+02	5.6111E+06
4.5518E+02	4.8122E+02	1.1378E+06	-2.1827E+04	7.3856E+04	3.4500E+03	-1.0944E+03	4.5518E+02	1.2080E+07
4.5518E+02	4.2775E+02	1.3920E+06	-2.1827E+04	6.7702E+04	7.4002E+03	-1.0944E+03	0.0000E+00	2.5491E+07
4.5518E+02	3.7428E+02	1.9844E+06	-2.1827E+04	6.1547E+04	3.5453E+03	-1.6410E+03	1.9573E+04	3.6186E+00
4.5518E+02	3.2081E+02	2.3472E+06	-2.1827E+04	5.5392E+04	2.2559E+04	-1.6410E+03	1.7297E+04	8.3335E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.5518E+02	2.6734E+02	3.2361E+06	-2.1827E+04	4.9238E+04	4.7004E+04	-1.6410E+03	1.6842E+04	3.9715E+00
4.5518E+02	2.1387E+02	3.6655E+06	-2.1827E+04	4.3083E+04	1.3533E+05	-1.6410E+03	1.6387E+04	4.5934E+00
4.5518E+02	1.6041E+02	3.5807E+06	-2.1827E+04	3.6928E+04	2.9565E+05	-1.6410E+03	1.5931E+04	9.0720E+01
4.5518E+02	1.0694E+02	4.9943E+06	-2.1827E+04	3.0774E+04	8.2173E+05	-1.6410E+03	1.5476E+04	1.5959E+02
4.5518E+02	5.3468E+01	1.4417E+07	-2.1827E+04	2.4619E+04	1.7278E+06	-1.6410E+03	1.5021E+04	2.4251E+02
4.5518E+02	0.0000E+00	2.6035E+07	-2.1827E+04	1.8464E+04	3.9560E+06	-1.6410E+03	1.4566E+04	1.3940E+02
3.9166E+02	2.6734E+03	4.8920E-01	-2.1827E+04	1.2309E+04	6.4314E+06	-1.6410E+03	1.4111E+04	1.4245E+03
3.9166E+02	2.3526E+03	1.3816E+01	-2.1827E+04	6.1547E+03	9.9503E+06	-1.6410E+03	1.3655E+04	2.3251E+03
3.9166E+02	2.2457E+03	1.7480E+01	-2.1827E+04	0.0000E+00	1.0293E+07	-1.6410E+03	1.3200E+04	1.4861E+03
3.9166E+02	2.1922E+03	1.4518E+00	-2.8850E+04	3.0774E+05	1.3443E+00	-1.6410E+03	1.2745E+04	1.3123E+03
3.9166E+02	2.1387E+03	2.8977E+01	-2.8850E+04	2.8312E+05	5.2085E+00	-1.6410E+03	1.2290E+04	4.6241E+03
3.9166E+02	2.0853E+03	8.4862E+01	-2.8850E+04	2.7696E+05	6.7217E+00	-1.6410E+03	1.1835E+04	4.6203E+03
3.9166E+02	2.0318E+03	4.6971E+02	-2.8850E+04	2.7081E+05	7.8972E+00	-1.6410E+03	1.1380E+04	4.2183E+03
3.9166E+02	1.9783E+03	1.8166E+02	-2.8850E+04	2.6465E+05	1.7053E+01	-1.6410E+03	1.0924E+04	1.0971E+04
3.9166E+02	1.9249E+03	7.3318E+01	-2.8850E+04	2.5850E+05	1.0458E+01	-1.6410E+03	1.0469E+04	2.0453E+04
3.9166E+02	1.8714E+03	9.7047E+01	-2.8850E+04	2.5234E+05	5.8335E+00	-1.6410E+03	1.0014E+04	3.4310E+04
3.9166E+02	1.8179E+03	2.4152E+02	-2.8850E+04	2.4619E+05	6.1887E+00	-1.6410E+03	9.5588E+03	4.4370E+04
3.9166E+02	1.7645E+03	3.6194E+02	-2.8850E+04	2.4003E+05	3.5446E+00	-1.6410E+03	9.1036E+03	7.1715E+04
3.9166E+02	1.7110E+03	5.5647E+02	-2.8850E+04	2.3388E+05	1.7500E+00	-1.6410E+03	8.6484E+03	8.2251E+04
3.9166E+02	1.6575E+03	2.2701E+03	-2.8850E+04	2.2772E+05	4.8443E+00	-1.6410E+03	8.1933E+03	7.8076E+04
3.9166E+02	1.6041E+03	1.1057E+03	-2.8850E+04	2.2157E+05	3.5000E+00	-1.6410E+03	7.7381E+03	1.4885E+05
3.9166E+02	1.5506E+03	3.2511E+03	-2.8850E+04	2.0926E+05	6.2500E-01	-1.6410E+03	7.2829E+03	1.6414E+05
3.9166E+02	1.4971E+03	2.5985E+03	-2.8850E+04	1.9695E+05	4.4583E-02	-1.6410E+03	6.8277E+03	2.8445E+05
3.9166E+02	1.4436E+03	4.1717E+03	-2.8850E+04	1.9080E+05	4.4583E-02	-1.6410E+03	6.3725E+03	3.6116E+05
3.9166E+02	1.3902E+03	2.0117E+03	-2.8850E+04	1.8464E+05	1.8750E+00	-1.6410E+03	5.9174E+03	6.0661E+05
3.9166E+02	1.3367E+03	3.6260E+03	-2.8850E+04	1.7849E+05	9.0521E-01	-1.6410E+03	5.4622E+03	7.4825E+05
3.9166E+02	1.2832E+03	5.5079E+03	-2.8850E+04	1.7233E+05	8.4792E-01	-1.6410E+03	5.0070E+03	9.7391E+05
3.9166E+02	1.2298E+03	9.9501E+03	-2.8850E+04	1.6618E+05	4.4583E-02	-1.6410E+03	4.5518E+03	1.2523E+06
3.9166E+02	1.1763E+03	1.1618E+04	-2.8850E+04	1.6002E+05	1.2500E+00	-1.6410E+03	4.0966E+03	1.5125E+06
3.9166E+02	1.1228E+03	1.5551E+04	-2.8850E+04	1.5387E+05	1.1215E+01	-1.6410E+03	3.6415E+03	1.8480E+06
3.9166E+02	1.0694E+03	3.8008E+04	-2.8850E+04	1.4771E+05	1.3375E-01	-1.6410E+03	3.1863E+03	2.3324E+06
3.9166E+02	1.0159E+03	3.3753E+04	-2.8850E+04	1.4156E+05	3.1881E+01	-1.6410E+03	2.7311E+03	2.4083E+06
3.9166E+02	9.6243E+02	4.7321E+04	-2.8850E+04	1.3540E+05	4.7090E+00	-1.6410E+03	2.2759E+03	2.3542E+06
3.9166E+02	9.0896E+02	4.4963E+04	-2.8850E+04	1.2925E+05	8.8191E+00	-1.6410E+03	1.8207E+03	2.6260E+06
3.9166E+02	8.5549E+02	6.8563E+04	-2.8850E+04	1.2309E+05	9.1762E+00	-1.6410E+03	1.3655E+03	2.5149E+06
3.9166E+02	8.0203E+02	9.4274E+04	-2.8850E+04	1.1694E+05	1.7037E+01	-1.6410E+03	9.1036E+02	4.3628E+06
3.9166E+02	7.4856E+02	1.0731E+05	-2.8850E+04	1.1078E+05	1.8052E+02	-1.6410E+03	4.5518E+02	9.4690E+06
3.9166E+02	6.9509E+02	1.3571E+05	-2.8850E+04	1.0463E+05	1.9542E+01	-1.6410E+03	0.0000E+00	1.9362E+07

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.9166E+02	6.4162E+02	1.6216E+05	-2.8850E+04	9.8475E+04	9.9322E+02	-2.1876E+03	1.8662E+04	6.2500E-01
3.9166E+02	5.8815E+02	2.3341E+05	-2.8850E+04	9.2321E+04	7.0319E+02	-2.1876E+03	1.7752E+04	1.5625E+00
3.9166E+02	5.3468E+02	3.5656E+05	-2.8850E+04	8.6166E+04	1.8810E+03	-2.1876E+03	1.6842E+04	2.5113E-01
3.9166E+02	4.8122E+02	4.0095E+05	-2.8850E+04	8.0011E+04	3.3792E+03	-2.1876E+03	1.6387E+04	4.3989E+00
3.9166E+02	4.2775E+02	6.7412E+05	-2.8850E+04	7.3856E+04	6.0753E+03	-2.1876E+03	1.5931E+04	6.4370E+00
3.9166E+02	3.7428E+02	1.0239E+06	-2.8850E+04	6.7702E+04	1.5038E+04	-2.1876E+03	1.5476E+04	1.1348E+02
3.9166E+02	3.2081E+02	1.7238E+06	-2.8850E+04	6.1547E+04	1.2240E+04	-2.1876E+03	1.5021E+04	6.0810E+01
3.9166E+02	2.6734E+02	2.6252E+06	-2.8850E+04	5.5392E+04	1.9884E+04	-2.1876E+03	1.4566E+04	2.2997E+02
3.9166E+02	2.1387E+02	3.7578E+06	-2.8850E+04	4.9238E+04	6.8915E+04	-2.1876E+03	1.4111E+04	2.4454E+02
3.9166E+02	1.6041E+02	4.8382E+06	-2.8850E+04	4.3083E+04	7.4546E+04	-2.1876E+03	1.3655E+04	4.2910E+02
3.9166E+02	1.0694E+02	5.6321E+06	-2.8850E+04	3.6928E+04	2.8091E+05	-2.1876E+03	1.3200E+04	8.1222E+02
3.9166E+02	5.3468E+01	1.4622E+07	-2.8850E+04	3.0774E+04	6.1131E+05	-2.1876E+03	1.2745E+04	3.6120E+02
3.9166E+02	0.0000E+00	3.1473E+07	-2.8850E+04	2.4619E+04	1.6232E+06	-2.1876E+03	1.2290E+04	3.2073E+02
3.2815E+02	2.4061E+03	4.5970E+00	-2.8850E+04	1.8464E+04	3.6970E+06	-2.1876E+03	1.1835E+04	2.9425E+02
3.2815E+02	2.3526E+03	9.7840E-01	-2.8850E+04	1.2309E+04	6.6040E+06	-2.1876E+03	1.1380E+04	2.6514E+02
3.2815E+02	2.2991E+03	1.3889E+00	-2.8850E+04	6.1547E+03	1.0731E+07	-2.1876E+03	1.0924E+04	1.0113E+03
3.2815E+02	2.2457E+03	1.3816E+01	-2.8850E+04	0.0000E+00	1.1491E+07	-2.1876E+03	1.0469E+04	1.0983E+04
3.2815E+02	2.1922E+03	1.5976E+01	-3.5873E+04	2.9543E+05	1.3443E+00	-2.1876E+03	1.0014E+04	2.4442E+03
3.2815E+02	2.1387E+03	1.3296E+01	-3.5873E+04	2.8312E+05	3.0943E+00	-2.1876E+03	9.5588E+03	8.1188E+03
3.2815E+02	2.0853E+03	1.3493E+01	-3.5873E+04	2.7696E+05	1.0417E+01	-2.1876E+03	9.1036E+03	7.3651E+03
3.2815E+02	2.0318E+03	7.5369E+00	-3.5873E+04	2.6465E+05	4.8443E+00	-2.1876E+03	8.6484E+03	2.3478E+04
3.2815E+02	1.9783E+03	4.1276E+00	-3.5873E+04	2.5850E+05	1.0053E+01	-2.1876E+03	8.1933E+03	3.7072E+04
3.2815E+02	1.9249E+03	1.5210E+01	-3.5873E+04	2.5234E+05	3.0943E+00	-2.1876E+03	7.7381E+03	5.3027E+04
3.2815E+02	1.8714E+03	9.2196E+01	-3.5873E+04	2.4619E+05	3.5446E+00	-2.1876E+03	7.2829E+03	1.6801E+05
3.2815E+02	1.8179E+03	4.6875E+01	-3.5873E+04	2.4003E+05	1.0053E+01	-2.1876E+03	6.8277E+03	2.2043E+05
3.2815E+02	1.7645E+03	1.2950E+02	-3.5873E+04	2.3388E+05	5.2500E+00	-2.1876E+03	6.3725E+03	2.7147E+05
3.2815E+02	1.7110E+03	8.4866E+01	-3.5873E+04	2.2772E+05	2.3750E+00	-2.1876E+03	5.9174E+03	4.0839E+05
3.2815E+02	1.6575E+03	1.6654E+02	-3.5873E+04	2.2157E+05	3.5446E+00	-2.1876E+03	5.4622E+03	5.4660E+05
3.2815E+02	1.6041E+03	1.5268E+02	-3.5873E+04	2.1541E+05	8.7977E+00	-2.1876E+03	5.0070E+03	7.6441E+05
3.2815E+02	1.5506E+03	3.0461E+02	-3.5873E+04	2.0926E+05	2.4196E+00	-2.1876E+03	4.5518E+03	1.0543E+06
3.2815E+02	1.4971E+03	4.2334E+02	-3.5873E+04	2.0311E+05	1.2946E+00	-2.1876E+03	4.0966E+03	1.2699E+06
3.2815E+02	1.4436E+03	6.9505E+02	-3.5873E+04	1.9695E+05	5.2531E+00	-2.1876E+03	3.6415E+03	1.5043E+06
3.2815E+02	1.3902E+03	8.7410E+02	-3.5873E+04	1.9080E+05	7.1417E-01	-2.1876E+03	3.1863E+03	1.6847E+06
3.2815E+02	1.3367E+03	1.2967E+03	-3.5873E+04	1.8464E+05	1.7946E+00	-2.1876E+03	2.7311E+03	1.7870E+06
3.2815E+02	1.2832E+03	1.8927E+03	-3.5873E+04	1.7849E+05	1.1170E+01	-2.1876E+03	2.2759E+03	1.6812E+06
3.2815E+02	1.2298E+03	3.0129E+03	-3.5873E+04	1.7233E+05	3.0446E+00	-2.1876E+03	1.8207E+03	1.7771E+06
3.2815E+02	1.1763E+03	5.5998E+03	-3.5873E+04	1.6002E+05	7.8638E+00	-2.1876E+03	1.3655E+03	2.0587E+06
3.2815E+02	1.1228E+03	7.7245E+03	-3.5873E+04	1.5387E+05	8.4480E+00	-2.1876E+03	9.1036E+02	3.0838E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.2815E+02	1.0694E+03	7.2690E+03	-3.5873E+04	1.4771E+05	2.9200E+00	-2.1876E+03	4.5518E+02	6.6009E+06
3.2815E+02	1.0159E+03	6.5130E+03	-3.5873E+04	1.4156E+05	3.8739E+00	-2.1876E+03	0.0000E+00	1.2906E+07
3.2815E+02	9.6243E+02	1.1907E+04	-3.5873E+04	1.3540E+05	4.1434E+00	-2.7342E+03	1.8207E+04	9.4410E-01
3.2815E+02	9.0896E+02	1.1337E+04	-3.5873E+04	1.2925E+05	1.9169E+02	-2.7342E+03	1.7752E+04	6.2500E-01
3.2815E+02	8.5549E+02	2.9801E+04	-3.5873E+04	1.2309E+05	2.9747E+01	-2.7342E+03	1.7297E+04	9.4410E-01
3.2815E+02	8.0203E+02	2.4487E+04	-3.5873E+04	1.1694E+05	1.5118E+02	-2.7342E+03	1.6842E+04	3.6047E+00
3.2815E+02	7.4856E+02	3.6958E+04	-3.5873E+04	1.1078E+05	2.7933E+02	-2.7342E+03	1.6387E+04	9.4893E-01
3.2815E+02	6.9509E+02	4.9696E+04	-3.5873E+04	1.0463E+05	2.1278E+02	-2.7342E+03	1.5931E+04	1.7094E+01
3.2815E+02	6.4162E+02	9.3595E+04	-3.5873E+04	9.8475E+04	4.4464E+02	-2.7342E+03	1.5476E+04	2.3874E+00
3.2815E+02	5.8815E+02	8.4976E+04	-3.5873E+04	9.2321E+04	4.6188E+02	-2.7342E+03	1.5021E+04	1.9387E+02
3.2815E+02	5.3468E+02	1.4875E+05	-3.5873E+04	8.6166E+04	3.1839E+03	-2.7342E+03	1.4566E+04	5.1421E+00
3.2815E+02	4.8122E+02	1.9382E+05	-3.5873E+04	8.0011E+04	4.7159E+03	-2.7342E+03	1.4111E+04	3.4652E+01
3.2815E+02	4.2775E+02	4.0129E+05	-3.5873E+04	7.3856E+04	2.0067E+03	-2.7342E+03	1.3655E+04	9.5085E+00
3.2815E+02	3.7428E+02	7.5549E+05	-3.5873E+04	6.7702E+04	8.1323E+03	-2.7342E+03	1.3200E+04	3.0134E+01
3.2815E+02	3.2081E+02	1.6288E+06	-3.5873E+04	6.1547E+04	1.3126E+04	-2.7342E+03	1.2745E+04	1.2902E+01
3.2815E+02	2.6734E+02	2.7206E+06	-3.5873E+04	5.5392E+04	2.2217E+04	-2.7342E+03	1.2290E+04	2.3957E+01
3.2815E+02	2.1387E+02	3.9489E+06	-3.5873E+04	4.9238E+04	6.1944E+04	-2.7342E+03	1.1835E+04	4.3918E+01
3.2815E+02	1.6041E+02	5.3219E+06	-3.5873E+04	4.3083E+04	8.7282E+04	-2.7342E+03	1.1380E+04	5.1708E+02
3.2815E+02	1.0694E+02	6.2207E+06	-3.5873E+04	3.6928E+04	2.1695E+05	-2.7342E+03	1.0924E+04	4.9183E+01
3.2815E+02	5.3468E+01	1.3386E+07	-3.5873E+04	3.0774E+04	4.8098E+05	-2.7342E+03	1.0469E+04	1.6606E+02
3.2815E+02	0.0000E+00	3.1082E+07	-3.5873E+04	2.4619E+04	1.2554E+06	-2.7342E+03	1.0014E+04	5.2309E+02
2.6463E+02	2.5130E+03	1.3443E+00	-3.5873E+04	1.8464E+04	2.7499E+06	-2.7342E+03	9.5588E+03	8.5818E+02
2.6463E+02	2.4061E+03	1.7500E+00	-3.5873E+04	1.2309E+04	4.3643E+06	-2.7342E+03	9.1036E+03	1.7901E+03
2.6463E+02	2.3526E+03	1.3443E+00	-3.5873E+04	6.1547E+03	8.2748E+06	-2.7342E+03	8.6484E+03	7.5244E+03
2.6463E+02	2.2991E+03	3.6631E+00	-3.5873E+04	0.0000E+00	8.3549E+06	-2.7342E+03	8.1933E+03	1.0976E+04
2.6463E+02	2.2457E+03	7.0031E+00	-4.2896E+04	2.7696E+05	1.3443E+00	-2.7342E+03	7.7381E+03	2.1391E+04
2.6463E+02	2.1922E+03	5.3774E+00	-4.2896E+04	2.7081E+05	2.6887E+00	-2.7342E+03	7.2829E+03	3.9039E+04
2.6463E+02	2.1387E+03	1.5566E+01	-4.2896E+04	2.6465E+05	1.7500E+00	-2.7342E+03	6.8277E+03	4.6756E+04
2.6463E+02	2.0853E+03	9.6918E+00	-4.2896E+04	2.5850E+05	9.2416E+00	-2.7342E+03	6.3725E+03	1.3063E+05
2.6463E+02	2.0318E+03	1.4125E+01	-4.2896E+04	2.5234E+05	7.8972E+00	-2.7342E+03	5.9174E+03	2.5095E+05
2.6463E+02	1.9783E+03	8.7977E+00	-4.2896E+04	2.4619E+05	1.3443E+00	-2.7342E+03	5.4622E+03	3.0824E+05
2.6463E+02	1.9249E+03	1.4555E+01	-4.2896E+04	2.4003E+05	1.7500E+00	-2.7342E+03	5.0070E+03	4.7846E+05
2.6463E+02	1.8714E+03	2.4113E+01	-4.2896E+04	2.3388E+05	3.0943E+00	-2.7342E+03	4.5518E+03	6.4968E+05
2.6463E+02	1.8179E+03	1.2753E+01	-4.2896E+04	2.2772E+05	1.7500E+00	-2.7342E+03	4.0966E+03	7.6626E+05
2.6463E+02	1.7645E+03	1.2132E+01	-4.2896E+04	2.1541E+05	1.7946E+00	-2.7342E+03	3.6415E+03	1.0111E+06
2.6463E+02	1.7110E+03	2.2811E+01	-4.2896E+04	2.0926E+05	1.5996E+01	-2.7342E+03	3.1863E+03	1.0344E+06
2.6463E+02	1.6575E+03	2.1800E+01	-4.2896E+04	2.0311E+05	6.6958E-01	-2.7342E+03	2.7311E+03	1.2314E+06
2.6463E+02	1.6041E+03	5.5745E+01	-4.2896E+04	1.9695E+05	1.7946E+00	-2.7342E+03	2.2759E+03	1.1711E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.6463E+02	1.5506E+03	3.4291E+01	-4.2896E+04	1.9080E+05	2.3750E+00	-2.7342E+03	1.8207E+03	1.2106E+06
2.6463E+02	1.4971E+03	9.0283E+01	-4.2896E+04	1.8464E+05	1.0982E+01	-2.7342E+03	1.3655E+03	1.2422E+06
2.6463E+02	1.4436E+03	1.1299E+02	-4.2896E+04	1.7849E+05	5.3592E+00	-2.7342E+03	9.1036E+02	2.2830E+06
2.6463E+02	1.3902E+03	2.8117E+02	-4.2896E+04	1.7233E+05	1.3372E+01	-2.7342E+03	4.5518E+02	4.5384E+06
2.6463E+02	1.3367E+03	1.7604E+02	-4.2896E+04	1.6618E+05	2.0359E+00	-2.7342E+03	0.0000E+00	8.8961E+06
2.6463E+02	1.2832E+03	4.7637E+02	-4.2896E+04	1.5387E+05	1.0942E+01	-3.2808E+03	2.2759E+04	6.2500E-01
2.6463E+02	1.2298E+03	7.2307E+02	-4.2896E+04	1.4771E+05	7.0075E+00	-3.2808E+03	1.8662E+04	4.4583E-02
2.6463E+02	1.1763E+03	9.6076E+02	-4.2896E+04	1.4156E+05	9.6845E+00	-3.2808E+03	1.7752E+04	2.2885E+00
2.6463E+02	1.1228E+03	9.8467E+02	-4.2896E+04	1.3540E+05	1.1270E+02	-3.2808E+03	1.7297E+04	9.8868E-01
2.6463E+02	1.0694E+03	9.5681E+02	-4.2896E+04	1.2925E+05	8.2240E+01	-3.2808E+03	1.6842E+04	7.2094E+00
2.6463E+02	1.0159E+03	2.0560E+03	-4.2896E+04	1.2309E+05	1.6486E+02	-3.2808E+03	1.6387E+04	1.2778E+01
2.6463E+02	9.6243E+02	3.9449E+03	-4.2896E+04	1.1694E+05	7.8715E+01	-3.2808E+03	1.5931E+04	4.2231E+00
2.6463E+02	9.0896E+02	2.7913E+03	-4.2896E+04	1.1078E+05	1.6897E+02	-3.2808E+03	1.5476E+04	1.5691E+00
2.6463E+02	8.5549E+02	6.7403E+03	-4.2896E+04	1.0463E+05	2.7974E+02	-3.2808E+03	1.5021E+04	6.5770E+00
2.6463E+02	8.0203E+02	6.0039E+03	-4.2896E+04	9.8475E+04	6.6627E+02	-3.2808E+03	1.4566E+04	5.3578E+00
2.6463E+02	7.4856E+02	7.2456E+03	-4.2896E+04	9.2321E+04	8.7102E+02	-3.2808E+03	1.4111E+04	9.6019E+00
2.6463E+02	6.9509E+02	3.1378E+04	-4.2896E+04	8.6166E+04	1.6151E+03	-3.2808E+03	1.3655E+04	1.5625E+00
2.6463E+02	6.4162E+02	3.5962E+04	-4.2896E+04	8.0011E+04	3.2053E+03	-3.2808E+03	1.3200E+04	1.2240E+01
2.6463E+02	5.8815E+02	8.0723E+04	-4.2896E+04	7.3856E+04	3.7952E+03	-3.2808E+03	1.2745E+04	2.7894E+00
2.6463E+02	5.3468E+02	2.2402E+05	-4.2896E+04	6.7702E+04	6.9363E+03	-3.2808E+03	1.2290E+04	9.4769E+01
2.6463E+02	4.8122E+02	3.4089E+05	-4.2896E+04	6.1547E+04	1.3752E+04	-3.2808E+03	1.1835E+04	9.4291E+01
2.6463E+02	4.2775E+02	6.4056E+05	-4.2896E+04	5.5392E+04	1.4458E+04	-3.2808E+03	1.1380E+04	1.9948E+01
2.6463E+02	3.7428E+02	1.1323E+06	-4.2896E+04	4.9238E+04	5.7703E+04	-3.2808E+03	1.0924E+04	4.0116E+02
2.6463E+02	3.2081E+02	1.9253E+06	-4.2896E+04	4.3083E+04	1.1425E+05	-3.2808E+03	1.0469E+04	1.0461E+01
2.6463E+02	2.6734E+02	3.0188E+06	-4.2896E+04	3.6928E+04	2.5057E+05	-3.2808E+03	1.0014E+04	4.0799E+01
2.6463E+02	2.1387E+02	4.7662E+06	-4.2896E+04	3.0774E+04	7.6964E+05	-3.2808E+03	9.5588E+03	9.3840E+01
2.6463E+02	1.6041E+02	5.6460E+06	-4.2896E+04	2.4619E+04	1.3323E+06	-3.2808E+03	9.1036E+03	1.0571E+02
2.6463E+02	1.0694E+02	6.7508E+06	-4.2896E+04	1.8464E+04	2.2267E+06	-3.2808E+03	8.6484E+03	6.2594E+02
2.6463E+02	5.3468E+01	1.0249E+07	-4.2896E+04	1.2309E+04	3.3626E+06	-3.2808E+03	8.1933E+03	9.8942E+03
2.6463E+02	0.0000E+00	2.8492E+07	-4.2896E+04	6.1547E+03	5.3524E+06	-3.2808E+03	7.7381E+03	2.8742E+03
2.0112E+02	2.4595E+03	3.5446E+00	-4.2896E+04	0.0000E+00	7.9671E+06	-3.2808E+03	7.2829E+03	1.4769E+04
2.0112E+02	2.3526E+03	4.4387E+00	-4.9918E+04	2.7081E+05	1.3443E+00	-3.2808E+03	6.8277E+03	8.2496E+03
2.0112E+02	2.2991E+03	3.5000E+00	-4.9918E+04	2.5234E+05	1.3443E+00	-3.2808E+03	6.3725E+03	3.7586E+04
2.0112E+02	2.2457E+03	3.5000E+00	-4.9918E+04	2.4619E+05	5.2085E+00	-3.2808E+03	5.9174E+03	6.4850E+04
2.0112E+02	2.1922E+03	1.7056E+01	-4.9918E+04	2.4003E+05	2.6887E+00	-3.2808E+03	5.4622E+03	1.0240E+05
2.0112E+02	2.1387E+03	7.0031E+00	-4.9918E+04	2.2772E+05	2.6887E+00	-3.2808E+03	5.0070E+03	1.9164E+05
2.0112E+02	2.0853E+03	4.8443E+00	-4.9918E+04	2.1541E+05	1.0417E+01	-3.2808E+03	4.5518E+03	2.9815E+05
2.0112E+02	2.0318E+03	6.1887E+00	-4.9918E+04	2.0926E+05	2.0455E+01	-3.2808E+03	4.0966E+03	4.6711E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.0112E+02	1.9783E+03	1.1617E+01	-4.9918E+04	2.0311E+05	2.5744E+01	-3.2808E+03	3.6415E+03	6.1902E+05
2.0112E+02	1.9249E+03	4.4387E+00	-4.9918E+04	1.9695E+05	1.4554E+00	-3.2808E+03	3.1863E+03	6.4591E+05
2.0112E+02	1.8714E+03	7.2588E+00	-4.9918E+04	1.9080E+05	1.7283E+01	-3.2808E+03	2.7311E+03	8.3042E+05
2.0112E+02	1.8179E+03	6.5196E+00	-4.9918E+04	1.8464E+05	2.1110E+01	-3.2808E+03	2.2759E+03	6.5773E+05
2.0112E+02	1.7645E+03	5.6405E+00	-4.9918E+04	1.7849E+05	1.2481E+01	-3.2808E+03	1.8207E+03	7.5660E+05
2.0112E+02	1.7110E+03	1.2256E+01	-4.9918E+04	1.7233E+05	2.1141E+01	-3.2808E+03	1.3655E+03	6.9276E+05
2.0112E+02	1.6575E+03	5.1480E+00	-4.9918E+04	1.6618E+05	2.4950E+01	-3.2808E+03	9.1036E+02	1.2309E+06
2.0112E+02	1.6041E+03	2.3966E+00	-4.9918E+04	1.6002E+05	1.8501E+01	-3.2808E+03	4.5518E+02	3.0080E+06
2.0112E+02	1.5506E+03	1.6403E+01	-4.9918E+04	1.5387E+05	2.8956E+01	-3.2808E+03	0.0000E+00	5.8712E+06
2.0112E+02	1.4971E+03	1.9988E+01	-4.9918E+04	1.4771E+05	8.6005E+01	-3.8274E+03	1.9118E+04	4.4583E-02
2.0112E+02	1.4436E+03	2.7578E+01	-4.9918E+04	1.4156E+05	1.7394E+02	-3.8274E+03	1.8662E+04	1.3443E+00
2.0112E+02	1.3902E+03	1.0471E+01	-4.9918E+04	1.3540E+05	3.1346E+01	-3.8274E+03	1.8207E+04	8.3335E+01
2.0112E+02	1.3367E+03	4.2812E+01	-4.9918E+04	1.2925E+05	1.3151E+02	-3.8274E+03	1.7297E+04	3.2393E-01
2.0112E+02	1.2832E+03	1.4085E+02	-4.9918E+04	1.2309E+05	1.2889E+02	-3.8274E+03	1.6842E+04	9.4233E-01
2.0112E+02	1.2298E+03	2.0756E+02	-4.9918E+04	1.1694E+05	2.1328E+02	-3.8274E+03	1.6387E+04	1.6071E+00
2.0112E+02	1.1763E+03	1.4676E+02	-4.9918E+04	1.1078E+05	2.4400E+02	-3.8274E+03	1.5476E+04	1.2616E+01
2.0112E+02	1.1228E+03	1.8127E+02	-4.9918E+04	1.0463E+05	2.9541E+03	-3.8274E+03	1.5021E+04	7.8181E-01
2.0112E+02	1.0694E+03	1.1387E+03	-4.9918E+04	9.8475E+04	7.3050E+02	-3.8274E+03	1.4566E+04	1.2500E+00
2.0112E+02	1.0159E+03	1.0162E+03	-4.9918E+04	9.2321E+04	1.5243E+03	-3.8274E+03	1.3655E+04	1.7500E+00
2.0112E+02	9.6243E+02	1.9070E+03	-4.9918E+04	8.6166E+04	3.9242E+03	-3.8274E+03	1.3200E+04	1.6196E-01
2.0112E+02	9.0896E+02	4.3835E+03	-4.9918E+04	8.0011E+04	3.4218E+03	-3.8274E+03	1.2745E+04	1.7149E+00
2.0112E+02	8.5549E+02	2.2119E+03	-4.9918E+04	7.3856E+04	4.2492E+03	-3.8274E+03	1.2290E+04	2.6145E+00
2.0112E+02	8.0203E+02	5.2306E+03	-4.9918E+04	6.7702E+04	6.2660E+03	-3.8274E+03	1.1835E+04	2.2090E+00
2.0112E+02	7.4856E+02	1.3739E+04	-4.9918E+04	6.1547E+04	1.2748E+04	-3.8274E+03	1.1380E+04	2.6483E+01
2.0112E+02	6.9509E+02	2.1146E+04	-4.9918E+04	5.5392E+04	2.1987E+04	-3.8274E+03	1.0924E+04	8.5498E+01
2.0112E+02	6.4162E+02	6.0981E+04	-4.9918E+04	4.9238E+04	3.1165E+04	-3.8274E+03	1.0469E+04	3.1430E+00
2.0112E+02	5.8815E+02	1.0706E+05	-4.9918E+04	4.3083E+04	5.4311E+04	-3.8274E+03	1.0014E+04	5.4693E+00
2.0112E+02	5.3468E+02	2.1503E+05	-4.9918E+04	3.6928E+04	1.3072E+05	-3.8274E+03	9.5588E+03	5.4149E+00
2.0112E+02	4.8122E+02	3.7691E+05	-4.9918E+04	3.0774E+04	3.6597E+05	-3.8274E+03	9.1036E+03	9.8218E+01
2.0112E+02	4.2775E+02	6.7953E+05	-4.9918E+04	2.4619E+04	9.7054E+05	-3.8274E+03	8.6484E+03	1.9692E+02
2.0112E+02	3.7428E+02	1.4304E+06	-4.9918E+04	1.8464E+04	1.9920E+06	-3.8274E+03	8.1933E+03	3.3401E+02
2.0112E+02	3.2081E+02	2.4835E+06	-4.9918E+04	1.2309E+04	2.9795E+06	-3.8274E+03	7.7381E+03	1.6900E+03
2.0112E+02	2.6734E+02	4.2347E+06	-4.9918E+04	6.1547E+03	4.8135E+06	-3.8274E+03	7.2829E+03	6.1036E+02
2.0112E+02	2.1387E+02	6.9737E+06	-4.9918E+04	0.0000E+00	8.8230E+06	-3.8274E+03	6.8277E+03	2.2967E+03
2.0112E+02	1.6041E+02	9.2526E+06	-5.6941E+04	2.5234E+05	1.3443E+00	-3.8274E+03	6.3725E+03	9.3683E+03
2.0112E+02	1.0694E+02	1.0081E+07	-5.6941E+04	2.4619E+05	1.3443E+00	-3.8274E+03	5.9174E+03	6.9519E+03
2.0112E+02	5.3468E+01	1.1235E+07	-5.6941E+04	2.4003E+05	7.8972E+00	-3.8274E+03	5.4622E+03	1.7844E+04
2.0112E+02	0.0000E+00	3.1593E+07	-5.6941E+04	2.3388E+05	1.1761E+01	-3.8274E+03	5.0070E+03	5.7116E+04

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.3761E+02	2.4595E+03	1.3443E+00	-5.6941E+04	2.2772E+05	2.6887E+00	-3.8274E+03	4.5518E+03	5.6090E+04
1.3761E+02	2.3526E+03	2.6887E+00	-5.6941E+04	2.2157E+05	1.3443E+00	-3.8274E+03	4.0966E+03	8.8002E+04
1.3761E+02	2.2991E+03	2.3750E+00	-5.6941E+04	2.1541E+05	5.2085E+00	-3.8274E+03	3.6415E+03	2.4607E+05
1.3761E+02	2.2457E+03	4.4387E+00	-5.6941E+04	2.0926E+05	1.3443E+00	-3.8274E+03	3.1863E+03	2.7470E+05
1.3761E+02	2.1922E+03	1.3443E+00	-5.6941E+04	2.0311E+05	7.8086E+00	-3.8274E+03	2.7311E+03	3.7296E+05
1.3761E+02	2.1387E+03	3.5835E+00	-5.6941E+04	1.9695E+05	8.0831E+00	-3.8274E+03	2.2759E+03	3.1349E+05
1.3761E+02	2.0853E+03	4.4387E+00	-5.6941E+04	1.9080E+05	2.5587E+01	-3.8274E+03	1.8207E+03	3.6346E+05
1.3761E+02	2.0318E+03	1.7500E+00	-5.6941E+04	1.8464E+05	5.2193E+00	-3.8274E+03	1.3655E+03	3.9286E+05
1.3761E+02	1.9783E+03	2.0354E+00	-5.6941E+04	1.7849E+05	3.1668E+01	-3.8274E+03	9.1036E+02	6.0015E+05
1.3761E+02	1.9249E+03	3.0943E+00	-5.6941E+04	1.7233E+05	7.0093E+00	-3.8274E+03	4.5518E+02	1.6190E+06
1.3761E+02	1.8179E+03	2.4642E+00	-5.6941E+04	1.6618E+05	9.3151E+00	-3.8274E+03	0.0000E+00	3.6457E+06
1.3761E+02	1.7645E+03	1.8838E+00	-5.6941E+04	1.6002E+05	2.2054E+01	-4.3740E+03	2.0028E+04	4.4583E-02
1.3761E+02	1.7110E+03	8.9167E-02	-5.6941E+04	1.5387E+05	3.4580E+01	-4.3740E+03	1.6387E+04	6.2500E-01
1.3761E+02	1.6575E+03	2.9572E-01	-5.6941E+04	1.4771E+05	6.3855E+01	-4.3740E+03	1.5931E+04	8.9167E-02
1.3761E+02	1.6041E+03	1.0551E+01	-5.6941E+04	1.4156E+05	1.8904E+02	-4.3740E+03	1.3200E+04	1.2814E+00
1.3761E+02	1.5506E+03	8.3155E-01	-5.6941E+04	1.3540E+05	6.4498E+02	-4.3740E+03	1.2745E+04	2.8536E-01
1.3761E+02	1.4971E+03	3.3171E+01	-5.6941E+04	1.2925E+05	9.5845E+01	-4.3740E+03	1.2290E+04	7.5875E-01
1.3761E+02	1.4436E+03	5.4696E+01	-5.6941E+04	1.2309E+05	2.4766E+02	-4.3740E+03	1.1835E+04	7.3580E-01
1.3761E+02	1.3902E+03	1.2539E+01	-5.6941E+04	1.1694E+05	1.6071E+03	-4.3740E+03	1.1380E+04	4.4583E-02
1.3761E+02	1.3367E+03	5.8191E+01	-5.6941E+04	1.1078E+05	5.9902E+02	-4.3740E+03	1.0924E+04	1.2500E+00
1.3761E+02	1.2832E+03	5.6511E+01	-5.6941E+04	1.0463E+05	5.1560E+03	-4.3740E+03	1.0469E+04	3.0943E+00
1.3761E+02	1.2298E+03	9.8452E+01	-5.6941E+04	9.8475E+04	1.9354E+03	-4.3740E+03	1.0014E+04	1.4120E+00
1.3761E+02	1.1763E+03	2.1339E+02	-5.6941E+04	9.2321E+04	2.9505E+03	-4.3740E+03	9.5588E+03	3.5000E+00
1.3761E+02	1.1228E+03	1.0818E+02	-5.6941E+04	8.6166E+04	9.7699E+03	-4.3740E+03	9.1036E+03	6.4013E+01
1.3761E+02	1.0694E+03	1.1273E+02	-5.6941E+04	8.0011E+04	1.8286E+04	-4.3740E+03	8.6484E+03	9.1628E+00
1.3761E+02	1.0159E+03	1.0524E+03	-5.6941E+04	7.3856E+04	1.2676E+04	-4.3740E+03	8.1933E+03	4.8148E+00
1.3761E+02	9.6243E+02	1.2037E+03	-5.6941E+04	6.7702E+04	1.6909E+04	-4.3740E+03	7.7381E+03	5.5657E+00
1.3761E+02	9.0896E+02	1.4316E+03	-5.6941E+04	6.1547E+04	1.6937E+04	-4.3740E+03	7.2829E+03	7.1953E+01
1.3761E+02	8.5549E+02	9.1969E+03	-5.6941E+04	5.5392E+04	2.4509E+04	-4.3740E+03	6.8277E+03	1.0684E+02
1.3761E+02	8.0203E+02	1.2385E+04	-5.6941E+04	4.9238E+04	4.2491E+04	-4.3740E+03	6.3725E+03	3.3126E+02
1.3761E+02	7.4856E+02	2.1184E+04	-5.6941E+04	4.3083E+04	1.0018E+05	-4.3740E+03	5.9174E+03	1.8396E+03
1.3761E+02	6.9509E+02	4.4301E+04	-5.6941E+04	3.6928E+04	1.6055E+05	-4.3740E+03	5.4622E+03	3.7278E+03
1.3761E+02	6.4162E+02	9.2561E+04	-5.6941E+04	3.0774E+04	3.6029E+05	-4.3740E+03	5.0070E+03	3.9274E+03
1.3761E+02	5.8815E+02	1.5786E+05	-5.6941E+04	2.4619E+04	9.3263E+05	-4.3740E+03	4.5518E+03	4.2481E+03
1.3761E+02	5.3468E+02	2.7177E+05	-5.6941E+04	1.8464E+04	2.0850E+06	-4.3740E+03	4.0966E+03	3.6890E+04
1.3761E+02	4.8122E+02	5.3545E+05	-5.6941E+04	1.2309E+04	3.2137E+06	-4.3740E+03	3.6415E+03	6.7569E+04
1.3761E+02	4.2775E+02	8.8702E+05	-5.6941E+04	6.1547E+03	4.6671E+06	-4.3740E+03	3.1863E+03	6.1751E+04
1.3761E+02	3.7428E+02	1.5756E+06	-5.6941E+04	0.0000E+00	1.0690E+07	-4.3740E+03	2.7311E+03	1.1093E+05

Classification: Confidential
VESTAS PROPRIETARY NOTICE
DNV
DNV Energy Systems
Tuborgvænkvej 8.2.
DK-2900 Hellerup
VAT No. DK89832314
T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.3761E+02	3.2081E+02	2.4369E+06	-6.3964E+04	2.4003E+05	1.3443E+00	-4.3740E+03	2.2759E+03	1.3636E+05
1.3761E+02	2.6734E+02	4.2955E+06	-6.3964E+04	2.3388E+05	1.3443E+00	-4.3740E+03	1.8207E+03	1.4167E+05
1.3761E+02	2.1387E+02	6.5632E+06	-6.3964E+04	2.2157E+05	1.3443E+00	-4.3740E+03	1.3655E+03	1.9222E+05
1.3761E+02	1.6041E+02	8.0158E+06	-6.3964E+04	2.1541E+05	6.5528E+00	-4.3740E+03	9.1036E+02	3.8326E+05
1.3761E+02	1.0694E+02	8.7462E+06	-6.3964E+04	2.0311E+05	5.6601E+00	-4.3740E+03	4.5518E+02	8.9941E+05
1.3761E+02	5.3468E+01	9.0677E+06	-6.3964E+04	1.9695E+05	6.3894E+00	-4.3740E+03	0.0000E+00	1.9713E+06
1.3761E+02	0.0000E+00	2.5624E+07	-6.3964E+04	1.9080E+05	1.5775E+01	-4.9206E+03	1.8662E+04	6.2500E-01
7.4091E+01	2.5665E+03	6.2500E-01	-6.3964E+04	1.8464E+05	1.6479E+01	-4.9206E+03	1.5931E+04	8.3335E+01
7.4091E+01	2.4595E+03	2.6887E+00	-6.3964E+04	1.7849E+05	5.9431E+01	-4.9206E+03	1.3655E+04	4.4583E-02
7.4091E+01	2.4061E+03	4.0331E+00	-6.3964E+04	1.7233E+05	3.0987E+01	-4.9206E+03	1.3200E+04	6.2500E-01
7.4091E+01	2.3526E+03	2.6887E+00	-6.3964E+04	1.6002E+05	5.7500E+00	-4.9206E+03	1.2745E+04	1.2500E+00
7.4091E+01	2.2991E+03	3.0943E+00	-6.3964E+04	1.5387E+05	1.4474E+01	-4.9206E+03	1.1835E+04	8.6578E-01
7.4091E+01	2.2457E+03	1.7500E+00	-6.3964E+04	1.4771E+05	3.0283E+01	-4.9206E+03	1.1380E+04	4.8443E+00
7.4091E+01	2.1387E+03	3.7193E+00	-6.3964E+04	1.4156E+05	5.6692E+02	-4.9206E+03	1.0924E+04	3.6186E+00
7.4091E+01	2.0318E+03	4.4583E-02	-6.3964E+04	1.3540E+05	1.8389E+02	-4.9206E+03	9.1036E+03	3.5000E+00
7.4091E+01	1.9783E+03	7.6250E+00	-6.3964E+04	1.2925E+05	3.2392E+03	-4.9206E+03	8.6484E+03	1.3260E+00
7.4091E+01	1.9249E+03	3.5000E+00	-6.3964E+04	1.2309E+05	2.7318E+03	-4.9206E+03	8.1933E+03	3.5000E+00
7.4091E+01	1.8714E+03	6.6958E-01	-6.3964E+04	1.1694E+05	4.9700E+03	-4.9206E+03	7.7381E+03	6.0814E+00
7.4091E+01	1.8179E+03	4.4583E-02	-6.3964E+04	1.1078E+05	2.8973E+03	-4.9206E+03	7.2829E+03	4.1310E-01
7.4091E+01	1.7645E+03	4.4583E-02	-6.3964E+04	1.0463E+05	7.1944E+03	-4.9206E+03	6.8277E+03	7.4908E+00
7.4091E+01	1.7110E+03	1.0462E+01	-6.3964E+04	9.8475E+04	3.4807E+03	-4.9206E+03	6.3725E+03	3.4305E+02
7.4091E+01	1.6575E+03	2.1628E-02	-6.3964E+04	9.2321E+04	1.0427E+04	-4.9206E+03	5.9174E+03	5.6213E+01
7.4091E+01	1.4971E+03	1.1895E+01	-6.3964E+04	8.6166E+04	1.9252E+04	-4.9206E+03	5.4622E+03	2.2542E+02
7.4091E+01	1.4436E+03	6.9121E-01	-6.3964E+04	8.0011E+04	1.9591E+04	-4.9206E+03	5.0070E+03	1.7399E+03
7.4091E+01	1.3902E+03	2.1012E+01	-6.3964E+04	7.3856E+04	1.0886E+04	-4.9206E+03	4.5518E+03	6.8697E+03
7.4091E+01	1.3367E+03	2.5442E+01	-6.3964E+04	6.7702E+04	1.9546E+04	-4.9206E+03	4.0966E+03	2.0574E+02
7.4091E+01	1.2832E+03	2.4816E+01	-6.3964E+04	6.1547E+04	5.0814E+04	-4.9206E+03	3.6415E+03	2.3720E+03
7.4091E+01	1.2298E+03	3.9940E+01	-6.3964E+04	5.5392E+04	5.7329E+04	-4.9206E+03	3.1863E+03	4.7854E+03
7.4091E+01	1.1763E+03	4.5889E+01	-6.3964E+04	4.9238E+04	8.2480E+04	-4.9206E+03	2.7311E+03	1.2680E+03
7.4091E+01	1.1228E+03	7.5988E+01	-6.3964E+04	4.3083E+04	1.3059E+05	-4.9206E+03	2.2759E+03	1.4716E+04
7.4091E+01	1.0694E+03	1.0486E+02	-6.3964E+04	3.6928E+04	1.8993E+05	-4.9206E+03	1.8207E+03	8.1080E+03
7.4091E+01	1.0159E+03	1.4724E+02	-6.3964E+04	3.0774E+04	4.1677E+05	-4.9206E+03	1.3655E+03	5.2810E+04
7.4091E+01	9.6243E+02	1.9467E+02	-6.3964E+04	2.4619E+04	1.0046E+06	-4.9206E+03	9.1036E+02	9.8292E+04
7.4091E+01	9.0896E+02	1.7042E+03	-6.3964E+04	1.8464E+04	2.0971E+06	-4.9206E+03	4.5518E+02	2.8167E+05
7.4091E+01	8.5549E+02	3.6282E+03	-6.3964E+04	1.2309E+04	3.2752E+06	-4.9206E+03	0.0000E+00	9.4447E+05
7.4091E+01	8.0203E+02	1.1867E+04	-6.3964E+04	6.1547E+03	4.0702E+06	-5.4672E+03	1.4111E+04	6.6958E-01
7.4091E+01	7.4856E+02	3.4365E+04	-6.3964E+04	0.0000E+00	9.5335E+06	-5.4672E+03	1.3200E+04	7.1417E-01
7.4091E+01	6.9509E+02	3.1731E+04	-7.0987E+04	1.9695E+05	2.8300E+00	-5.4672E+03	1.2745E+04	1.9642E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborgvænkvej 8.2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.4091E+01	6.4162E+02	8.3108E+04	-7.0987E+04	1.8464E+05	6.3894E+00	-5.4672E+03	8.6484E+03	7.7187E+00
7.4091E+01	5.8815E+02	1.3453E+05	-7.0987E+04	1.7849E+05	1.0115E+01	-5.4672E+03	7.7381E+03	5.4774E+00
7.4091E+01	5.3468E+02	2.2651E+05	-7.0987E+04	1.7233E+05	3.6186E+00	-5.4672E+03	7.2829E+03	1.1122E+01
7.4091E+01	4.8122E+02	3.4011E+05	-7.0987E+04	1.6002E+05	1.7435E+01	-5.4672E+03	6.8277E+03	2.2121E+00
7.4091E+01	4.2775E+02	6.5819E+05	-7.0987E+04	1.5387E+05	5.8789E+02	-5.4672E+03	6.3725E+03	1.2368E+00
7.4091E+01	3.7428E+02	9.1198E+05	-7.0987E+04	1.4771E+05	5.0770E+02	-5.4672E+03	5.9174E+03	5.5135E+01
7.4091E+01	3.2081E+02	1.2689E+06	-7.0987E+04	1.4156E+05	5.2954E+02	-5.4672E+03	5.4622E+03	4.0271E+01
7.4091E+01	2.6734E+02	1.6507E+06	-7.0987E+04	1.3540E+05	8.3193E+01	-5.4672E+03	5.0070E+03	7.9033E+01
7.4091E+01	2.1387E+02	1.8773E+06	-7.0987E+04	1.2925E+05	1.0765E+03	-5.4672E+03	4.5518E+03	5.7769E+01
7.4091E+01	1.6041E+02	2.0466E+06	-7.0987E+04	1.2309E+05	4.1563E+03	-5.4672E+03	4.0966E+03	5.1445E+01
7.4091E+01	1.0694E+02	1.8286E+06	-7.0987E+04	1.1694E+05	2.4199E+03	-5.4672E+03	3.6415E+03	6.3806E+01
7.4091E+01	5.3468E+01	2.7416E+06	-7.0987E+04	1.1078E+05	4.0624E+03	-5.4672E+03	3.1863E+03	6.8591E+02
7.4091E+01	0.0000E+00	1.2467E+07	-7.0987E+04	1.0463E+05	1.8872E+03	-5.4672E+03	2.7311E+03	1.1778E+03
1.0577E+01	2.4061E+03	1.3443E+00	-7.0987E+04	9.8475E+04	2.4905E+03	-5.4672E+03	2.2759E+03	5.1999E+03
1.0577E+01	2.2991E+03	3.0943E+00	-7.0987E+04	9.2321E+04	4.9446E+03	-5.4672E+03	1.8207E+03	8.9602E+02
1.0577E+01	2.2457E+03	1.3443E+00	-7.0987E+04	8.6166E+04	1.8123E+04	-5.4672E+03	1.3655E+03	7.7584E+03
1.0577E+01	1.7645E+03	8.9167E-02	-7.0987E+04	8.0011E+04	2.4316E+04	-5.4672E+03	9.1036E+02	1.7300E+04
1.0577E+01	1.6041E+03	4.4583E-02	-7.0987E+04	7.3856E+04	2.5360E+04	-5.4672E+03	4.5518E+02	5.9835E+04
1.0577E+01	1.5506E+03	1.9693E+00	-7.0987E+04	6.7702E+04	3.3494E+04	-5.4672E+03	0.0000E+00	2.2147E+05
1.0577E+01	1.4971E+03	4.4583E-02	-7.0987E+04	6.1547E+04	3.7305E+04	-6.0138E+03	1.6842E+04	4.4583E-02
1.0577E+01	1.4436E+03	3.4142E+00	-7.0987E+04	5.5392E+04	9.0281E+04	-6.0138E+03	1.4566E+04	4.4583E-02
1.0577E+01	1.3902E+03	3.5375E+00	-7.0987E+04	4.9238E+04	1.7808E+05	-6.0138E+03	1.4111E+04	4.4583E-02
1.0577E+01	1.3367E+03	3.8531E+00	-7.0987E+04	4.3083E+04	2.3785E+05	-6.0138E+03	7.7381E+03	8.9167E-02
1.0577E+01	1.2832E+03	1.5712E+01	-7.0987E+04	3.6928E+04	4.1324E+05	-6.0138E+03	7.2829E+03	3.2393E-01
1.0577E+01	1.2298E+03	3.1389E+00	-7.0987E+04	3.0774E+04	6.5812E+05	-6.0138E+03	6.8277E+03	1.2500E+00
1.0577E+01	1.1763E+03	6.3699E+00	-7.0987E+04	2.4619E+04	1.4333E+06	-6.0138E+03	6.3725E+03	1.4283E+00
1.0577E+01	1.1228E+03	3.1371E+01	-7.0987E+04	1.8464E+04	2.0909E+06	-6.0138E+03	5.9174E+03	1.5739E+00
1.0577E+01	1.0694E+03	1.7174E+01	-7.0987E+04	1.2309E+04	3.1997E+06	-6.0138E+03	5.4622E+03	1.8589E+02
1.0577E+01	1.0159E+03	4.8890E+01	-7.0987E+04	6.1547E+03	3.6066E+06	-6.0138E+03	5.0070E+03	1.1637E+01
1.0577E+01	9.6243E+02	5.7149E+01	-7.0987E+04	0.0000E+00	8.3503E+06	-6.0138E+03	4.5518E+03	3.2142E+01
1.0577E+01	9.0896E+02	8.5058E+02	-7.8010E+04	2.2157E+05	1.3443E+00	-6.0138E+03	4.0966E+03	2.0637E+02
1.0577E+01	8.5549E+02	8.7156E+02	-7.8010E+04	1.7233E+05	2.0219E+01	-6.0138E+03	3.6415E+03	3.3536E+01
1.0577E+01	8.0203E+02	3.1301E+03	-7.8010E+04	1.6002E+05	1.5488E+01	-6.0138E+03	3.1863E+03	6.2532E+01
1.0577E+01	7.4856E+02	4.0887E+03	-7.8010E+04	1.5387E+05	4.4583E-02	-6.0138E+03	2.7311E+03	7.2659E+00
1.0577E+01	6.9509E+02	1.4350E+04	-7.8010E+04	1.4771E+05	8.5477E+01	-6.0138E+03	2.2759E+03	2.1926E+01
1.0577E+01	6.4162E+02	1.8242E+04	-7.8010E+04	1.4156E+05	8.0305E+01	-6.0138E+03	1.8207E+03	5.0005E+01
1.0577E+01	5.8815E+02	2.9499E+04	-7.8010E+04	1.3540E+05	5.3629E+02	-6.0138E+03	1.3655E+03	1.0153E+02
1.0577E+01	5.3468E+02	5.3781E+04	-7.8010E+04	1.2925E+05	3.4356E+02	-6.0138E+03	9.1036E+02	3.7909E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0577E+01	4.8122E+02	7.6387E+04	-7.8010E+04	1.2309E+05	6.9241E+02	-6.0138E+03	4.5518E+02	6.1149E+03
1.0577E+01	4.2775E+02	1.4600E+05	-7.8010E+04	1.1694E+05	3.1033E+03	-6.0138E+03	0.0000E+00	6.2784E+04
1.0577E+01	3.7428E+02	2.3389E+05	-7.8010E+04	1.1078E+05	1.2482E+03	-6.5604E+03	1.5931E+04	6.2500E-01
1.0577E+01	3.2081E+02	2.3418E+05	-7.8010E+04	1.0463E+05	1.6708E+04	-6.5604E+03	1.5476E+04	6.2500E-01
1.0577E+01	2.6734E+02	4.2412E+05	-7.8010E+04	9.8475E+04	7.5734E+03	-6.5604E+03	1.3655E+04	1.3443E+00
1.0577E+01	2.1387E+02	6.6220E+05	-7.8010E+04	9.2321E+04	1.9076E+04	-6.5604E+03	7.7381E+03	1.5066E+01
1.0577E+01	1.6041E+02	1.5156E+06	-7.8010E+04	8.6166E+04	9.5926E+03	-6.5604E+03	6.3725E+03	8.9167E-02
1.0577E+01	1.0694E+02	3.1487E+06	-7.8010E+04	8.0011E+04	1.3572E+04	-6.5604E+03	5.9174E+03	6.2171E+00
1.0577E+01	5.3468E+01	8.6337E+06	-7.8010E+04	7.3856E+04	3.8095E+04	-6.5604E+03	5.4622E+03	1.0986E+01
1.0577E+01	0.0000E+00	2.6609E+07	-7.8010E+04	6.7702E+04	5.4209E+04	-6.5604E+03	5.0070E+03	6.9049E+00
-5.2937E+01	2.5665E+03	1.3443E+00	-7.8010E+04	6.1547E+04	6.0950E+04	-6.5604E+03	4.5518E+03	9.6792E+00
-5.2937E+01	2.3526E+03	1.3443E+00	-7.8010E+04	5.5392E+04	1.9685E+05	-6.5604E+03	4.0966E+03	1.3392E+00
-5.2937E+01	2.2457E+03	1.3443E+00	-7.8010E+04	4.9238E+04	2.4477E+05	-6.5604E+03	3.6415E+03	2.8994E+01
-5.2937E+01	1.7645E+03	4.4583E-02	-7.8010E+04	4.3083E+04	5.3251E+05	-6.5604E+03	3.1863E+03	9.7881E+00
-5.2937E+01	1.7110E+03	4.4583E-02	-7.8010E+04	3.6928E+04	8.0756E+05	-6.5604E+03	2.7311E+03	9.1868E+00
-5.2937E+01	1.6575E+03	2.4078E-01	-7.8010E+04	3.0774E+04	1.4041E+06	-6.5604E+03	2.2759E+03	3.6398E+01
-5.2937E+01	1.5506E+03	1.3443E+00	-7.8010E+04	2.4619E+04	2.0887E+06	-6.5604E+03	1.8207E+03	2.1060E+02
-5.2937E+01	1.4971E+03	6.2500E-01	-7.8010E+04	1.8464E+04	3.3042E+06	-6.5604E+03	1.3655E+03	4.7304E+01
-5.2937E+01	1.4436E+03	1.3519E+01	-7.8010E+04	1.2309E+04	3.2881E+06	-6.5604E+03	9.1036E+02	4.2780E+01
-5.2937E+01	1.3902E+03	8.4335E+00	-7.8010E+04	6.1547E+03	3.5969E+06	-6.5604E+03	4.5518E+02	3.3536E+03
-5.2937E+01	1.3367E+03	1.3889E+00	-7.8010E+04	0.0000E+00	7.1331E+06	-6.5604E+03	0.0000E+00	7.3570E+03
-5.2937E+01	1.2832E+03	1.3681E+01	-8.5033E+04	1.5387E+05	4.0130E+01	-7.1070E+03	7.2829E+03	1.2500E+00
-5.2937E+01	1.2298E+03	1.6120E+01	-8.5033E+04	1.4771E+05	4.4842E+02	-7.1070E+03	6.8277E+03	4.8392E+00
-5.2937E+01	1.1763E+03	1.3684E+01	-8.5033E+04	1.4156E+05	5.4259E+01	-7.1070E+03	6.3725E+03	1.6715E+02
-5.2937E+01	1.1228E+03	1.7063E+01	-8.5033E+04	1.3540E+05	9.2680E+01	-7.1070E+03	5.9174E+03	2.8860E+01
-5.2937E+01	1.0694E+03	2.2742E+01	-8.5033E+04	1.2925E+05	1.1172E+03	-7.1070E+03	5.0070E+03	1.9774E+00
-5.2937E+01	1.0159E+03	3.5051E+01	-8.5033E+04	1.2309E+05	8.4208E+02	-7.1070E+03	4.5518E+03	4.7420E+00
-5.2937E+01	9.6243E+02	5.7213E+01	-8.5033E+04	1.1694E+05	2.4145E+03	-7.1070E+03	4.0966E+03	1.0799E+01
-5.2937E+01	9.0896E+02	8.4104E+02	-8.5033E+04	1.1078E+05	5.4583E+03	-7.1070E+03	3.6415E+03	3.1250E+00
-5.2937E+01	8.5549E+02	1.6868E+03	-8.5033E+04	1.0463E+05	5.5474E+03	-7.1070E+03	3.1863E+03	1.5669E+01
-5.2937E+01	8.0203E+02	1.6664E+02	-8.5033E+04	9.8475E+04	1.0533E+04	-7.1070E+03	2.7311E+03	3.3230E+00
-5.2937E+01	7.4856E+02	9.3743E+02	-8.5033E+04	9.2321E+04	2.8206E+04	-7.1070E+03	2.2759E+03	6.3896E+00
-5.2937E+01	6.9509E+02	1.7325E+03	-8.5033E+04	8.6166E+04	2.8179E+04	-7.1070E+03	1.8207E+03	6.3954E+00
-5.2937E+01	6.4162E+02	1.9807E+02	-8.5033E+04	8.0011E+04	3.8898E+04	-7.1070E+03	1.3655E+03	3.1924E+01
-5.2937E+01	5.8815E+02	1.8617E+03	-8.5033E+04	7.3856E+04	8.6370E+04	-7.1070E+03	9.1036E+02	3.6580E+01
-5.2937E+01	5.3468E+02	1.1798E+03	-8.5033E+04	6.7702E+04	9.4963E+04	-7.1070E+03	4.5518E+02	1.3943E+03
-5.2937E+01	4.8122E+02	9.7578E+03	-8.5033E+04	6.1547E+04	1.7921E+05	-7.1070E+03	0.0000E+00	2.9266E+03
-5.2937E+01	4.2775E+02	1.8133E+04	-8.5033E+04	5.5392E+04	2.3655E+05	-7.6536E+03	7.7381E+03	6.3073E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-5.2937E+01	3.7428E+02	1.6419E+04	-8.5033E+04	4.9238E+04	4.5171E+05	-7.6536E+03	5.9174E+03	8.4594E+00
-5.2937E+01	3.2081E+02	2.7930E+04	-8.5033E+04	4.3083E+04	7.0707E+05	-7.6536E+03	5.4622E+03	4.3289E+00
-5.2937E+01	2.6734E+02	4.0523E+04	-8.5033E+04	3.6928E+04	1.1434E+06	-7.6536E+03	5.0070E+03	4.2494E+00
-5.2937E+01	2.1387E+02	4.7803E+04	-8.5033E+04	3.0774E+04	1.7786E+06	-7.6536E+03	4.0966E+03	1.2368E+00
-5.2937E+01	1.6041E+02	7.4483E+04	-8.5033E+04	2.4619E+04	2.6345E+06	-7.6536E+03	3.6415E+03	9.0976E+00
-5.2937E+01	1.0694E+02	2.9205E+05	-8.5033E+04	1.8464E+04	3.1210E+06	-7.6536E+03	3.1863E+03	1.7295E+02
-5.2937E+01	5.3468E+01	1.1571E+06	-8.5033E+04	1.2309E+04	3.1598E+06	-7.6536E+03	2.7311E+03	4.3289E+00
-5.2937E+01	0.0000E+00	4.8287E+06	-8.5033E+04	6.1547E+03	3.2753E+06	-7.6536E+03	2.2759E+03	4.7517E+00
-1.1645E+02	1.8714E+03	1.3443E+00	-8.5033E+04	0.0000E+00	7.0874E+06	-7.6536E+03	1.8207E+03	1.2397E+00
-1.1645E+02	1.7645E+03	6.2500E-01	-9.2056E+04	1.5387E+05	1.0510E+01	-7.6536E+03	1.3655E+03	1.7104E+01
-1.1645E+02	1.6575E+03	3.0943E+00	-9.2056E+04	1.4771E+05	1.0510E+01	-7.6536E+03	9.1036E+02	1.6843E+02
-1.1645E+02	1.6041E+03	2.3750E+00	-9.2056E+04	1.4156E+05	2.5616E+02	-7.6536E+03	4.5518E+02	2.7350E+02
-1.1645E+02	1.5506E+03	2.6887E+00	-9.2056E+04	1.3540E+05	3.1778E+03	-7.6536E+03	0.0000E+00	7.2227E+02
-1.1645E+02	1.4971E+03	1.3443E+00	-9.2056E+04	1.2925E+05	3.5331E+03	-8.2002E+03	9.1036E+03	8.9167E-02
-1.1645E+02	1.4436E+03	5.2500E+00	-9.2056E+04	1.2309E+05	3.5516E+03	-8.2002E+03	6.3725E+03	9.8981E+00
-1.1645E+02	1.3902E+03	1.7500E+00	-9.2056E+04	1.1694E+05	5.6462E+03	-8.2002E+03	5.9174E+03	1.2368E+00
-1.1645E+02	1.3367E+03	8.3443E+00	-9.2056E+04	1.1078E+05	5.5677E+03	-8.2002E+03	5.4622E+03	1.3392E+00
-1.1645E+02	1.2832E+03	8.3443E+00	-9.2056E+04	1.0463E+05	1.1317E+04	-8.2002E+03	4.5518E+03	2.7779E+00
-1.1645E+02	1.2298E+03	1.0809E+01	-9.2056E+04	9.8475E+04	1.3019E+04	-8.2002E+03	4.0966E+03	3.1910E+00
-1.1645E+02	1.1763E+03	1.4000E+01	-9.2056E+04	9.2321E+04	2.4920E+04	-8.2002E+03	3.6415E+03	3.2393E-01
-1.1645E+02	1.1228E+03	1.6778E+01	-9.2056E+04	8.6166E+04	2.7167E+04	-8.2002E+03	3.1863E+03	1.8882E+00
-1.1645E+02	1.0694E+03	7.9387E+00	-9.2056E+04	8.0011E+04	5.0381E+04	-8.2002E+03	2.7311E+03	7.2094E+00
-1.1645E+02	1.0159E+03	3.4722E+01	-9.2056E+04	7.3856E+04	9.1196E+04	-8.2002E+03	2.2759E+03	5.2647E+00
-1.1645E+02	9.6243E+02	3.6438E+01	-9.2056E+04	6.7702E+04	1.5627E+05	-8.2002E+03	1.8207E+03	1.8882E+00
-1.1645E+02	9.0896E+02	5.6150E+01	-9.2056E+04	6.1547E+04	2.2833E+05	-8.2002E+03	9.1036E+02	2.3905E+00
-1.1645E+02	8.5549E+02	4.3915E+01	-9.2056E+04	5.5392E+04	3.1071E+05	-8.2002E+03	4.5518E+02	2.7653E+01
-1.1645E+02	8.0203E+02	7.3037E+01	-9.2056E+04	4.9238E+04	6.1277E+05	-8.2002E+03	0.0000E+00	2.5979E+01
-1.1645E+02	7.4856E+02	5.9491E+01	-9.2056E+04	4.3083E+04	1.0820E+06	-8.7468E+03	6.8277E+03	1.5739E+00
-1.1645E+02	6.9509E+02	8.8411E+01	-9.2056E+04	3.6928E+04	1.4745E+06	-8.7468E+03	4.5518E+03	3.2393E-01
-1.1645E+02	6.4162E+02	1.9272E+02	-9.2056E+04	3.0774E+04	2.1895E+06	-8.7468E+03	4.0966E+03	3.2393E-01
-1.1645E+02	5.8815E+02	1.4552E+02	-9.2056E+04	2.4619E+04	2.7119E+06	-8.7468E+03	2.2759E+03	2.6887E+00
-1.1645E+02	5.3468E+02	2.1412E+02	-9.2056E+04	1.8464E+04	3.2893E+06	-8.7468E+03	1.3655E+03	3.4489E+00
-1.1645E+02	4.8122E+02	1.9571E+03	-9.2056E+04	1.2309E+04	3.3209E+06	-8.7468E+03	9.1036E+02	2.4868E+00
-1.1645E+02	4.2775E+02	2.1075E+03	-9.2056E+04	6.1547E+03	3.2404E+06	-8.7468E+03	4.5518E+02	4.0018E+01
-1.1645E+02	3.7428E+02	5.5508E+03	-9.2056E+04	0.0000E+00	7.4906E+06	-8.7468E+03	0.0000E+00	2.0923E+02
-1.1645E+02	3.2081E+02	4.1582E+03	-9.9078E+04	1.5387E+05	2.3514E+02	-9.2934E+03	4.5518E+03	1.2500E+00
-1.1645E+02	2.6734E+02	1.1199E+04	-9.9078E+04	1.4771E+05	2.7056E+01	-9.2934E+03	3.6415E+03	1.8882E+00
-1.1645E+02	2.1387E+02	1.4393E+04	-9.9078E+04	1.4156E+05	5.2646E+02	-9.2934E+03	9.1036E+02	7.6225E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.1645E+02	1.6041E+02	1.9474E+04	-9.9078E+04	1.3540E+05	1.6912E+03	-9.2934E+03	4.5518E+02	3.7538E+01
-1.1645E+02	1.0694E+02	4.2765E+04	-9.9078E+04	1.2925E+05	2.7912E+03	-9.2934E+03	0.0000E+00	6.3932E+01
-1.1645E+02	5.3468E+01	1.1021E+05	-9.9078E+04	1.2309E+05	3.3512E+03	-9.8400E+03	4.5518E+02	1.2500E+00
-1.1645E+02	0.0000E+00	4.3546E+05	-9.9078E+04	1.1694E+05	1.7224E+04	-9.8400E+03	0.0000E+00	1.4871E+01
-1.7996E+02	2.0318E+03	6.2500E-01	-9.9078E+04	1.1078E+05	1.4532E+04	-1.0387E+04	1.3655E+03	8.9167E-02
-1.7996E+02	1.8179E+03	1.3443E+00	-9.9078E+04	1.0463E+05	1.6571E+04	-1.0387E+04	4.5518E+02	1.0642E+01
-1.7996E+02	1.7110E+03	4.1250E+00	-9.9078E+04	9.8475E+04	1.6363E+04	-1.0387E+04	0.0000E+00	2.4736E+00
-1.7996E+02	1.6041E+03	1.7946E+00	-9.9078E+04	9.2321E+04	2.7179E+04	-1.0933E+04	3.6415E+03	8.9167E-02
-1.7996E+02	1.5506E+03	3.5000E+00	-9.9078E+04	8.6166E+04	5.4341E+04	-1.0933E+04	9.1036E+02	8.9167E-02
-1.7996E+02	1.4436E+03	6.5943E+00	-9.9078E+04	8.0011E+04	6.3702E+04	-1.0933E+04	0.0000E+00	1.2788E+01
-1.7996E+02	1.3902E+03	5.8750E+00	-9.9078E+04	7.3856E+04	8.7932E+04	-1.1480E+04	0.0000E+00	2.4868E+00
-1.7996E+02	1.3367E+03	8.3443E+00	-9.9078E+04	6.7702E+04	1.2533E+05			
-1.7996E+02	1.2832E+03	9.2830E+00	-9.9078E+04	6.1547E+04	2.5854E+05			
-1.7996E+02	1.2298E+03	4.8443E+00	-9.9078E+04	5.5392E+04	4.6929E+05			
-1.7996E+02	1.1763E+03	1.0627E+01	-9.9078E+04	4.9238E+04	7.7528E+05			
-1.7996E+02	1.1228E+03	1.0314E+01	-9.9078E+04	4.3083E+04	1.3431E+06			
-1.7996E+02	1.0694E+03	2.9409E+01	-9.9078E+04	3.6928E+04	1.9909E+06			
-1.7996E+02	1.0159E+03	8.8730E+00	-9.9078E+04	3.0774E+04	2.9586E+06			
-1.7996E+02	9.6243E+02	1.4127E+01	-9.9078E+04	2.4619E+04	3.8912E+06			
-1.7996E+02	9.0896E+02	3.4849E+01	-9.9078E+04	1.8464E+04	4.2711E+06			
-1.7996E+02	8.5549E+02	2.3278E+01	-9.9078E+04	1.2309E+04	4.1195E+06			
-1.7996E+02	8.0203E+02	6.0785E+01	-9.9078E+04	6.1547E+03	3.6998E+06			
-1.7996E+02	7.4856E+02	3.4895E+01	-9.9078E+04	0.0000E+00	9.5699E+06			
-1.7996E+02	6.9509E+02	2.9594E+01	-1.0610E+05	1.6002E+05	6.1585E+01			
-1.7996E+02	6.4162E+02	1.0436E+02	-1.0610E+05	1.5387E+05	6.1585E+01			
-1.7996E+02	5.8815E+02	2.4217E+01	-1.0610E+05	1.4771E+05	6.1585E+01			
-1.7996E+02	5.3468E+02	7.5313E+01	-1.0610E+05	1.4156E+05	8.4683E+02			
-1.7996E+02	4.8122E+02	5.8229E+01	-1.0610E+05	1.3540E+05	1.6542E+03			
-1.7996E+02	4.2775E+02	1.3913E+02	-1.0610E+05	1.2925E+05	1.2320E+03			
-1.7996E+02	3.7428E+02	1.3849E+02	-1.0610E+05	1.2309E+05	1.9311E+03			
-1.7996E+02	3.2081E+02	7.5248E+01	-1.0610E+05	1.1694E+05	4.7187E+03			
-1.7996E+02	2.6734E+02	3.5081E+03	-1.0610E+05	1.1078E+05	9.4541E+03			
-1.7996E+02	2.1387E+02	8.5336E+03	-1.0610E+05	1.0463E+05	1.6995E+04			
-1.7996E+02	1.6041E+02	1.9651E+03	-1.0610E+05	9.8475E+04	3.8350E+04			
-1.7996E+02	1.0694E+02	1.7778E+04	-1.0610E+05	9.2321E+04	4.8013E+04			
-1.7996E+02	5.3468E+01	2.7944E+04	-1.0610E+05	8.6166E+04	3.4092E+04			
-1.7996E+02	0.0000E+00	1.2881E+05	-1.0610E+05	8.0011E+04	7.8774E+04			
-2.4348E+02	1.8179E+03	1.7500E+00	-1.0610E+05	7.3856E+04	7.7791E+04			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.4348E+02	1.6575E+03	1.3443E+00	-1.0610E+05	6.7702E+04	1.3206E+05			
-2.4348E+02	1.4436E+03	3.0943E+00	-1.0610E+05	6.1547E+04	2.2729E+05			
-2.4348E+02	1.3902E+03	4.8443E+00	-1.0610E+05	5.5392E+04	4.4469E+05			
-2.4348E+02	1.3367E+03	7.9387E+00	-1.0610E+05	4.9238E+04	5.7618E+05			
-2.4348E+02	1.2832E+03	3.0000E+00	-1.0610E+05	4.3083E+04	1.0817E+06			
-2.4348E+02	1.2298E+03	4.8443E+00	-1.0610E+05	3.6928E+04	1.6853E+06			
-2.4348E+02	1.1763E+03	1.0094E+01	-1.0610E+05	3.0774E+04	2.8649E+06			
-2.4348E+02	1.1228E+03	4.8443E+00	-1.0610E+05	2.4619E+04	4.2115E+06			
-2.4348E+02	1.0694E+03	1.1972E+01	-1.0610E+05	1.8464E+04	5.1801E+06			
-2.4348E+02	1.0159E+03	1.1033E+01	-1.0610E+05	1.2309E+04	5.1446E+06			
-2.4348E+02	9.6243E+02	3.5000E+00	-1.0610E+05	6.1547E+03	5.5339E+06			
-2.4348E+02	9.0896E+02	1.9467E+01	-1.0610E+05	0.0000E+00	1.3293E+07			
-2.4348E+02	8.5549E+02	1.5877E+01	-1.1312E+05	1.4156E+05	1.2317E+02			
-2.4348E+02	8.0203E+02	1.5877E+01	-1.1312E+05	1.3540E+05	5.6000E+02			
-2.4348E+02	7.4856E+02	1.8566E+01	-1.1312E+05	1.2925E+05	1.2273E+03			
-2.4348E+02	6.9509E+02	2.9967E+01	-1.1312E+05	1.2309E+05	3.6420E+03			
-2.4348E+02	6.4162E+02	2.0443E+01	-1.1312E+05	1.1694E+05	6.4271E+03			
-2.4348E+02	5.8815E+02	1.7217E+01	-1.1312E+05	1.1078E+05	7.8058E+03			
-2.4348E+02	5.3468E+02	2.6094E+01	-1.1312E+05	1.0463E+05	1.6815E+04			
-2.4348E+02	4.8122E+02	2.8693E+01	-1.1312E+05	9.8475E+04	1.6902E+04			
-2.4348E+02	4.2775E+02	3.6511E+01	-1.1312E+05	9.2321E+04	1.7802E+04			
-2.4348E+02	3.7428E+02	9.6588E+01	-1.1312E+05	8.6166E+04	1.8193E+04			
-2.4348E+02	3.2081E+02	7.1629E+01	-1.1312E+05	8.0011E+04	6.1899E+04			
-2.4348E+02	2.6734E+02	6.7112E+01	-1.1312E+05	7.3856E+04	6.1455E+04			
-2.4348E+02	2.1387E+02	1.6851E+03	-1.1312E+05	6.7702E+04	1.2488E+05			
-2.4348E+02	1.6041E+02	7.8738E+01	-1.1312E+05	6.1547E+04	1.5894E+05			
-2.4348E+02	1.0694E+02	3.2534E+03	-1.1312E+05	5.5392E+04	3.0556E+05			
-2.4348E+02	5.3468E+01	1.0084E+04	-1.1312E+05	4.9238E+04	5.0750E+05			
-2.4348E+02	0.0000E+00	8.0851E+03	-1.1312E+05	4.3083E+04	9.3664E+05			
-3.0699E+02	1.7645E+03	1.3443E+00	-1.1312E+05	3.6928E+04	1.6895E+06			
-3.0699E+02	1.7110E+03	1.3443E+00	-1.1312E+05	3.0774E+04	2.8364E+06			
-3.0699E+02	1.6575E+03	2.6887E+00	-1.1312E+05	2.4619E+04	4.5386E+06			
-3.0699E+02	1.6041E+03	4.0331E+00	-1.1312E+05	1.8464E+04	5.1988E+06			
-3.0699E+02	1.4971E+03	3.5000E+00	-1.1312E+05	1.2309E+04	5.8076E+06			
-3.0699E+02	1.4436E+03	5.2830E+00	-1.1312E+05	6.1547E+03	6.4088E+06			
-3.0699E+02	1.3902E+03	4.4387E+00	-1.1312E+05	0.0000E+00	1.5921E+07			
-3.0699E+02	1.2832E+03	1.3443E+00	-1.2015E+05	1.4156E+05	1.8512E+02			
-3.0699E+02	1.2298E+03	5.3774E+00	-1.2015E+05	1.3540E+05	9.4654E+02			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.0699E+02	1.1763E+03	3.5000E+00	-1.2015E+05	1.2925E+05	9.3060E+02			
-3.0699E+02	1.1228E+03	1.7500E+00	-1.2015E+05	1.2309E+05	1.6621E+03			
-3.0699E+02	1.0694E+03	1.2500E+00	-1.2015E+05	1.1694E+05	5.2934E+03			
-3.0699E+02	1.0159E+03	4.0331E+00	-1.2015E+05	1.1078E+05	9.0974E+03			
-3.0699E+02	9.6243E+02	4.4387E+00	-1.2015E+05	1.0463E+05	1.0292E+04			
-3.0699E+02	9.0896E+02	1.2377E+01	-1.2015E+05	9.8475E+04	1.7527E+04			
-3.0699E+02	8.5549E+02	7.0000E+00	-1.2015E+05	9.2321E+04	3.8623E+04			
-3.0699E+02	7.4856E+02	6.1887E+00	-1.2015E+05	8.6166E+04	2.8985E+04			
-3.0699E+02	6.9509E+02	8.8774E+00	-1.2015E+05	8.0011E+04	6.4335E+04			
-3.0699E+02	6.4162E+02	3.5000E+00	-1.2015E+05	7.3856E+04	8.9832E+04			
-3.0699E+02	5.8815E+02	1.7755E+01	-1.2015E+05	6.7702E+04	1.1678E+05			
-3.0699E+02	5.3468E+02	2.4939E+01	-1.2015E+05	6.1547E+04	1.3852E+05			
-3.0699E+02	4.8122E+02	2.4755E+01	-1.2015E+05	5.5392E+04	2.0875E+05			
-3.0699E+02	4.2775E+02	1.6943E+01	-1.2015E+05	4.9238E+04	3.8871E+05			
-3.0699E+02	3.7428E+02	3.4071E+01	-1.2015E+05	4.3083E+04	6.6645E+05			
-3.0699E+02	3.2081E+02	2.9600E+01	-1.2015E+05	3.6928E+04	1.3131E+06			
-3.0699E+02	2.6734E+02	4.9216E+01	-1.2015E+05	3.0774E+04	2.5254E+06			
-3.0699E+02	2.1387E+02	3.5643E+01	-1.2015E+05	2.4619E+04	4.1182E+06			
-3.0699E+02	1.6041E+02	5.6899E+01	-1.2015E+05	1.8464E+04	5.6573E+06			
-3.0699E+02	1.0694E+02	1.0719E+02	-1.2015E+05	1.2309E+04	5.9975E+06			
-3.0699E+02	5.3468E+01	1.8920E+03	-1.2015E+05	6.1547E+03	6.7510E+06			
-3.0699E+02	0.0000E+00	2.6506E+03	-1.2015E+05	0.0000E+00	1.6988E+07			
-3.7051E+02	1.6575E+03	1.3443E+00	-1.2717E+05	1.2925E+05	5.9521E+02			
-3.7051E+02	1.5506E+03	2.6887E+00	-1.2717E+05	1.2309E+05	2.0134E+03			
-3.7051E+02	1.4436E+03	1.7500E+00	-1.2717E+05	1.1694E+05	1.2855E+03			
-3.7051E+02	1.3902E+03	5.3774E+00	-1.2717E+05	1.1078E+05	1.0579E+04			
-3.7051E+02	1.2832E+03	1.7500E+00	-1.2717E+05	1.0463E+05	1.3664E+04			
-3.7051E+02	8.5549E+02	6.1887E+00	-1.2717E+05	9.8475E+04	1.4159E+04			
-3.7051E+02	8.0203E+02	6.1887E+00	-1.2717E+05	9.2321E+04	4.1255E+04			
-3.7051E+02	7.4856E+02	2.6887E+00	-1.2717E+05	8.6166E+04	4.1283E+04			
-3.7051E+02	6.9509E+02	3.5000E+00	-1.2717E+05	8.0011E+04	5.7109E+04			
-3.7051E+02	6.4162E+02	9.7779E+00	-1.2717E+05	7.3856E+04	5.6773E+04			
-3.7051E+02	5.8815E+02	9.6887E+00	-1.2717E+05	6.7702E+04	9.3689E+04			
-3.7051E+02	5.3468E+02	1.6689E+01	-1.2717E+05	6.1547E+04	1.7106E+05			
-3.7051E+02	4.8122E+02	6.1887E+00	-1.2717E+05	5.5392E+04	2.0921E+05			
-3.7051E+02	4.2775E+02	3.5261E+01	-1.2717E+05	4.9238E+04	4.0354E+05			
-3.7051E+02	3.7428E+02	1.9632E+01	-1.2717E+05	4.3083E+04	6.6106E+05			
-3.7051E+02	3.2081E+02	2.2155E+01	-1.2717E+05	3.6928E+04	1.2657E+06			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.7051E+02	2.6734E+02	1.2994E+01	-1.2717E+05	3.0774E+04	2.2901E+06			
-3.7051E+02	2.1387E+02	3.0221E+01	-1.2717E+05	2.4619E+04	3.8998E+06			
-3.7051E+02	1.6041E+02	4.2849E+01	-1.2717E+05	1.8464E+04	5.2409E+06			
-3.7051E+02	1.0694E+02	8.6598E+01	-1.2717E+05	1.2309E+04	6.3307E+06			
-3.7051E+02	5.3468E+01	1.8935E+02	-1.2717E+05	6.1547E+03	7.2486E+06			
-3.7051E+02	0.0000E+00	4.4264E+02	-1.2717E+05	0.0000E+00	1.9883E+07			
-4.3402E+02	8.0203E+02	2.6887E+00	-1.3419E+05	1.3540E+05	2.1732E+02			
-4.3402E+02	7.4856E+02	1.0939E+01	-1.3419E+05	1.1078E+05	1.2354E+02			
-4.3402E+02	6.9509E+02	7.0000E+00	-1.3419E+05	1.0463E+05	2.1352E+03			
-4.3402E+02	6.4162E+02	9.6887E+00	-1.3419E+05	9.8475E+04	5.6088E+03			
-4.3402E+02	5.8815E+02	3.5000E+00	-1.3419E+05	9.2321E+04	2.0765E+04			
-4.3402E+02	5.3468E+02	9.6887E+00	-1.3419E+05	8.6166E+04	2.0188E+04			
-4.3402E+02	4.8122E+02	2.3132E+01	-1.3419E+05	8.0011E+04	2.6985E+04			
-4.3402E+02	4.2775E+02	1.3917E+01	-1.3419E+05	7.3856E+04	7.3818E+04			
-4.3402E+02	3.7428E+02	1.6943E+01	-1.3419E+05	6.7702E+04	7.4079E+04			
-4.3402E+02	3.2081E+02	1.8655E+01	-1.3419E+05	6.1547E+04	9.8987E+04			
-4.3402E+02	2.6734E+02	2.5655E+01	-1.3419E+05	5.5392E+04	1.9052E+05			
-4.3402E+02	2.1387E+02	2.3695E+01	-1.3419E+05	4.9238E+04	4.1482E+05			
-4.3402E+02	1.6041E+02	5.2039E+01	-1.3419E+05	4.3083E+04	7.2743E+05			
-4.3402E+02	1.0694E+02	7.4629E+01	-1.3419E+05	3.6928E+04	1.3106E+06			
-4.3402E+02	5.3468E+01	6.3972E+01	-1.3419E+05	3.0774E+04	2.8324E+06			
-4.3402E+02	0.0000E+00	1.8684E+02	-1.3419E+05	2.4619E+04	4.7864E+06			
-4.9754E+02	1.6041E+03	1.3443E+00	-1.3419E+05	1.8464E+04	6.1265E+06			
-4.9754E+02	1.5506E+03	1.3443E+00	-1.3419E+05	1.2309E+04	6.7517E+06			
-4.9754E+02	1.0694E+03	2.6887E+00	-1.3419E+05	6.1547E+03	7.7774E+06			
-4.9754E+02	8.5549E+02	2.6887E+00	-1.3419E+05	0.0000E+00	2.0846E+07			
-4.9754E+02	7.4856E+02	3.5000E+00	-1.4122E+05	1.1078E+05	2.1732E+02			
-4.9754E+02	6.9509E+02	3.5000E+00	-1.4122E+05	1.0463E+05	2.9041E+03			
-4.9754E+02	6.4162E+02	1.7833E-01	-1.4122E+05	9.8475E+04	1.3443E+00			
-4.9754E+02	5.3468E+02	1.2377E+01	-1.4122E+05	9.2321E+04	6.6380E+03			
-4.9754E+02	4.8122E+02	8.9167E-02	-1.4122E+05	8.6166E+04	8.2975E+02			
-4.9754E+02	4.2775E+02	8.8774E+00	-1.4122E+05	8.0011E+04	1.4742E+04			
-4.9754E+02	3.7428E+02	1.1566E+01	-1.4122E+05	7.3856E+04	1.4365E+04			
-4.9754E+02	3.2081E+02	3.8672E+01	-1.4122E+05	6.7702E+04	4.2594E+04			
-4.9754E+02	2.6734E+02	1.6943E+01	-1.4122E+05	6.1547E+04	4.9669E+04			
-4.9754E+02	2.1387E+02	2.5910E+01	-1.4122E+05	5.5392E+04	1.1592E+05			
-4.9754E+02	1.6041E+02	4.2172E+01	-1.4122E+05	4.9238E+04	1.7683E+05			
-4.9754E+02	1.0694E+02	4.0349E+01	-1.4122E+05	4.3083E+04	5.0758E+05			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-4.9754E+02	5.3468E+01	6.5098E+01	-1.4122E+05	3.6928E+04	9.6168E+05			
-4.9754E+02	0.0000E+00	1.5537E+02	-1.4122E+05	3.0774E+04	2.0416E+06			
-5.6105E+02	1.0159E+03	2.6887E+00	-1.4122E+05	2.4619E+04	3.1316E+06			
-5.6105E+02	9.0896E+02	2.6887E+00	-1.4122E+05	1.8464E+04	4.5780E+06			
-5.6105E+02	8.0203E+02	2.6887E+00	-1.4122E+05	1.2309E+04	5.3357E+06			
-5.6105E+02	6.9509E+02	6.1887E+00	-1.4122E+05	6.1547E+03	6.5984E+06			
-5.6105E+02	6.4162E+02	3.5000E+00	-1.4122E+05	0.0000E+00	1.7631E+07			
-5.6105E+02	4.8122E+02	6.6274E+00	-1.4824E+05	8.0011E+04	2.9041E+03			
-5.6105E+02	4.2775E+02	3.5000E+00	-1.4824E+05	7.3856E+04	1.5115E+03			
-5.6105E+02	3.7428E+02	5.3774E+00	-1.4824E+05	6.7702E+04	2.6887E+00			
-5.6105E+02	3.2081E+02	1.3533E+01	-1.4824E+05	6.1547E+04	8.9702E+03			
-5.6105E+02	2.6734E+02	2.6887E+00	-1.4824E+05	5.5392E+04	8.2609E+03			
-5.6105E+02	2.1387E+02	1.9721E+01	-1.4824E+05	4.9238E+04	7.7528E+04			
-5.6105E+02	1.6041E+02	2.2066E+01	-1.4824E+05	4.3083E+04	1.8464E+05			
-5.6105E+02	1.0694E+02	3.2010E+01	-1.4824E+05	3.6928E+04	4.2727E+05			
-5.6105E+02	5.3468E+01	5.0339E+01	-1.4824E+05	3.0774E+04	8.6795E+05			
-5.6105E+02	0.0000E+00	7.6608E+01	-1.4824E+05	2.4619E+04	1.6473E+06			
-6.2456E+02	1.0694E+03	2.6887E+00	-1.4824E+05	1.8464E+04	2.4419E+06			
-6.2456E+02	5.3468E+02	2.6887E+00	-1.4824E+05	1.2309E+04	3.0083E+06			
-6.2456E+02	3.7428E+02	2.6887E+00	-1.4824E+05	6.1547E+03	3.5290E+06			
-6.2456E+02	3.2081E+02	2.6887E+00	-1.4824E+05	0.0000E+00	1.0296E+07			
-6.2456E+02	2.6734E+02	5.3774E+00	-1.5526E+05	5.5392E+04	3.1526E+03			
-6.2456E+02	2.1387E+02	1.0755E+01	-1.5526E+05	4.9238E+04	1.2317E+02			
-6.2456E+02	1.6041E+02	8.8774E+00	-1.5526E+05	4.3083E+04	3.5692E+04			
-6.2456E+02	1.0694E+02	1.1566E+01	-1.5526E+05	3.6928E+04	7.3048E+04			
-6.2456E+02	5.3468E+01	5.6961E+01	-1.5526E+05	3.0774E+04	2.4724E+05			
-6.2456E+02	0.0000E+00	5.7966E+01	-1.5526E+05	2.4619E+04	4.1664E+05			
-6.8808E+02	5.3468E+02	2.6887E+00	-1.5526E+05	1.8464E+04	8.2434E+05			
-6.8808E+02	2.6734E+02	5.3774E+00	-1.5526E+05	1.2309E+04	8.2902E+05			
-6.8808E+02	2.1387E+02	8.0661E+00	-1.5526E+05	6.1547E+03	1.1890E+06			
-6.8808E+02	1.6041E+02	5.3774E+00	-1.5526E+05	0.0000E+00	4.0484E+06			
-6.8808E+02	1.0694E+02	2.4755E+01	-1.6228E+05	4.9238E+04	1.3443E+00			
-6.8808E+02	5.3468E+01	3.2483E+01	-1.6228E+05	4.3083E+04	8.0757E+02			
-6.8808E+02	0.0000E+00	3.5255E+01	-1.6228E+05	3.6928E+04	1.0770E+04			
-7.5159E+02	3.7428E+02	2.6887E+00	-1.6228E+05	3.0774E+04	3.7804E+04			
-7.5159E+02	3.2081E+02	2.6887E+00	-1.6228E+05	2.4619E+04	2.0949E+04			
-7.5159E+02	2.1387E+02	2.6887E+00	-1.6228E+05	1.8464E+04	9.1964E+04			
-7.5159E+02	1.6041E+02	3.5000E+00	-1.6228E+05	1.2309E+04	1.0523E+05			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-7.5159E+02	1.0694E+02	2.6887E+00	-1.6228E+05	6.1547E+03	1.4434E+05			
-7.5159E+02	5.3468E+01	5.3774E+00	-1.6228E+05	0.0000E+00	8.3284E+05			
-7.5159E+02	0.0000E+00	1.0500E+01	-1.6931E+05	2.4619E+04	6.7516E+03			
-8.1511E+02	4.2775E+02	2.6887E+00	-1.6931E+05	1.8464E+04	1.1617E+04			
-8.1511E+02	2.1387E+02	8.0661E+00	-1.6931E+05	1.2309E+04	5.8083E+03			
-8.1511E+02	1.6041E+02	5.3774E+00	-1.6931E+05	6.1547E+03	9.1100E+03			
-8.1511E+02	1.0694E+02	2.6887E+00	-1.6931E+05	0.0000E+00	7.9207E+04			
-8.1511E+02	5.3468E+01	7.0000E+00	-1.7633E+05	1.8464E+04	5.8083E+03			
-8.1511E+02	0.0000E+00	6.1887E+00	-1.7633E+05	6.1547E+03	5.3774E+00			
-8.7862E+02	4.2775E+02	2.6887E+00	-1.7633E+05	0.0000E+00	1.0778E+04			
-8.7862E+02	2.6734E+02	2.6887E+00	-1.8335E+05	0.0000E+00	2.6887E+00			
-8.7862E+02	2.1387E+02	5.3774E+00						
-8.7862E+02	1.0694E+02	2.6887E+00						
-8.7862E+02	0.0000E+00	2.5922E+01						
-9.4213E+02	1.0694E+02	2.6887E+00						
-9.4213E+02	5.3468E+01	3.5000E+00						
-9.4213E+02	0.0000E+00	5.3774E+00						
-1.0056E+03	1.6041E+02	2.6887E+00						
-1.0056E+03	1.0694E+02	6.1887E+00						
-1.0056E+03	5.3468E+01	2.6887E+00						

Table 5-11 [1] Markov Matrix

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborgvejkaj 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Appendix D. Markov matrices – issued from [2]

This appendix contains the Markov Matrices for the shear force, the bending moment and the torsional moment in the bottom of the tower, from ref. [2]. Foundation design must be verified for the most critical Markov matrices.

Markov Matrices								
Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.6369E+03	0.0000E+00	1.1200E+03	1.5215E+05	0.0000E+00	2.6887E+00	7.8056E+03	4.2671E+02	2.6887E+00
1.5673E+03	0.0000E+00	2.2400E+03	1.4474E+05	1.3124E+04	2.6887E+00	7.8056E+03	0.0000E+00	8.8774E+00
1.4978E+03	5.9471E+01	2.2673E+03	1.3734E+05	0.0000E+00	2.6887E+00	7.2382E+03	1.2801E+03	2.6887E+00
1.4978E+03	0.0000E+00	4.9829E+03	1.2993E+05	0.0000E+00	2.6887E+00	7.2382E+03	8.5342E+02	7.0000E+00
1.4283E+03	5.9471E+01	3.5000E+00	1.2252E+05	1.3124E+04	2.6887E+00	7.2382E+03	4.2671E+02	2.6887E+00
1.4283E+03	0.0000E+00	2.0474E+04	1.2252E+05	6.5622E+03	2.6887E+00	7.2382E+03	0.0000E+00	9.4344E+02
1.3588E+03	5.9471E+01	8.4099E+03	1.2252E+05	0.0000E+00	2.6887E+00	6.6709E+03	1.7068E+03	7.0000E+00
1.3588E+03	0.0000E+00	5.2129E+04	1.1511E+05	6.5622E+03	2.6887E+00	6.6709E+03	1.2801E+03	3.5000E+00
1.2893E+03	2.3788E+02	8.2975E+02	1.0771E+05	6.5622E+03	5.3774E+00	6.6709E+03	4.2671E+02	3.9854E+01
1.2893E+03	1.1894E+02	2.0164E+03	1.0771E+05	0.0000E+00	6.1887E+00	6.6709E+03	0.0000E+00	4.2866E+02
1.2893E+03	5.9471E+01	2.5422E+04	1.0030E+05	2.6249E+04	2.6887E+00	6.1036E+03	4.2671E+03	3.5000E+00
1.2893E+03	0.0000E+00	2.4144E+05	1.0030E+05	1.9687E+04	3.5000E+00	6.1036E+03	3.8404E+03	3.5000E+00
1.2198E+03	4.7577E+02	8.2975E+02	1.0030E+05	1.3124E+04	8.9167E-02	6.1036E+03	3.4137E+03	6.1887E+00
1.2198E+03	2.9735E+02	2.8858E+02	1.0030E+05	6.5622E+03	1.3443E+01	6.1036E+03	2.9870E+03	1.0500E+01
1.2198E+03	2.3788E+02	1.0774E+02	1.0030E+05	0.0000E+00	8.0661E+00	6.1036E+03	1.2801E+03	7.2371E+00
1.2198E+03	1.7841E+02	2.2152E+03	9.2892E+04	1.9687E+04	5.3774E+00	6.1036E+03	8.5342E+02	7.2371E+00
1.2198E+03	1.1894E+02	5.9130E+03	9.2892E+04	1.3124E+04	8.0661E+00	6.1036E+03	4.2671E+02	5.7556E+02
1.2198E+03	5.9471E+01	8.6873E+04	9.2892E+04	6.5622E+03	1.3443E+01	6.1036E+03	0.0000E+00	4.7962E+03
1.2198E+03	0.0000E+00	5.1790E+05	9.2892E+04	0.0000E+00	3.0387E+01	5.5362E+03	6.4007E+03	3.5000E+00
1.1503E+03	3.5682E+02	2.1732E+02	8.5485E+04	4.5936E+04	7.0000E+00	5.5362E+03	3.8404E+03	3.5000E+00
1.1503E+03	2.9735E+02	1.7500E+00	8.5485E+04	2.6249E+04	1.2500E+00	5.5362E+03	3.4137E+03	5.3774E+00
1.1503E+03	2.3788E+02	5.7367E+02	8.5485E+04	1.9687E+04	1.3443E+01	5.5362E+03	2.1336E+03	8.1661E+00
1.1503E+03	1.7841E+02	9.8496E+03	8.5485E+04	1.3124E+04	5.3774E+00	5.5362E+03	1.7068E+03	3.5000E+00
1.1503E+03	1.1894E+02	2.1821E+04	8.5485E+04	6.5622E+03	1.1566E+01	5.5362E+03	1.2801E+03	2.3514E+02
1.1503E+03	5.9471E+01	3.2850E+05	8.5485E+04	0.0000E+00	2.6811E+01	5.5362E+03	8.5342E+02	5.1827E+01
1.1503E+03	0.0000E+00	1.3637E+06	7.8077E+04	9.1871E+04	3.5000E+00	5.5362E+03	4.2671E+02	3.5184E+03
1.0808E+03	5.9471E+02	5.6000E+02	7.8077E+04	4.5936E+04	3.5000E+00	5.5362E+03	0.0000E+00	1.7649E+04
1.0808E+03	2.9735E+02	8.3378E+02	7.8077E+04	3.2811E+04	1.3917E+01	4.9689E+03	1.7068E+04	1.3443E+00
1.0808E+03	2.3788E+02	4.2989E+03	7.8077E+04	2.6249E+04	1.3189E+01	4.9689E+03	7.2541E+03	3.5000E+00
1.0808E+03	1.7841E+02	2.6599E+04	7.8077E+04	1.9687E+04	3.5000E+00	4.9689E+03	6.8274E+03	3.5000E+00
1.0808E+03	1.1894E+02	8.2495E+04	7.8077E+04	1.3124E+04	1.1566E+01	4.9689E+03	4.6938E+03	2.6887E+00
1.0808E+03	5.9471E+01	9.7622E+05	7.8077E+04	6.5622E+03	1.8566E+01	4.9689E+03	2.9870E+03	9.9571E+00
1.0808E+03	0.0000E+00	3.4308E+06	7.8077E+04	0.0000E+00	5.3264E+01	4.9689E+03	2.5603E+03	9.9571E+00
1.0112E+03	1.1894E+03	2.8683E+02	7.0670E+04	1.8374E+05	1.3443E+00	4.9689E+03	2.1336E+03	7.2094E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0112E+03	1.0110E+03	2.4707E+02	7.0670E+04	9.8433E+04	3.5000E+00	4.9689E+03	1.7068E+03	1.8707E+02
1.0112E+03	8.3259E+02	2.0959E+03	7.0670E+04	5.2498E+04	3.5000E+00	4.9689E+03	1.2801E+03	1.0063E+03
1.0112E+03	7.7312E+02	7.4121E+02	7.0670E+04	4.5936E+04	6.1887E+00	4.9689E+03	8.5342E+02	1.0990E+04
1.0112E+03	7.1365E+02	5.6000E+02	7.0670E+04	3.2811E+04	1.0500E+01	4.9689E+03	4.2671E+02	2.6929E+04
1.0112E+03	6.5418E+02	7.9488E+03	7.0670E+04	2.6249E+04	1.2377E+01	4.9689E+03	0.0000E+00	1.6695E+05
1.0112E+03	5.9471E+02	2.7174E+03	7.0670E+04	1.9687E+04	1.3189E+01	4.4016E+03	6.8274E+03	2.6887E+00
1.0112E+03	5.3524E+02	1.1834E+04	7.0670E+04	1.3124E+04	8.8774E+00	4.4016E+03	5.5472E+03	5.3774E+00
1.0112E+03	4.7577E+02	1.7679E+04	7.0670E+04	6.5622E+03	3.8927E+01	4.4016E+03	5.1205E+03	7.0000E+00
1.0112E+03	4.1630E+02	9.1196E+03	7.0670E+04	0.0000E+00	1.0543E+02	4.4016E+03	4.6938E+03	9.9258E+00
1.0112E+03	3.5682E+02	1.7621E+03	6.3263E+04	8.5309E+04	6.1887E+00	4.4016E+03	4.2671E+03	1.5334E+01
1.0112E+03	2.9735E+02	1.0605E+04	6.3263E+04	7.2184E+04	3.5000E+00	4.4016E+03	3.8404E+03	5.6041E+02
1.0112E+03	2.3788E+02	1.3280E+04	6.3263E+04	6.5622E+04	3.5000E+00	4.4016E+03	3.4137E+03	1.0717E+01
1.0112E+03	1.7841E+02	1.1323E+05	6.3263E+04	5.9060E+04	7.0000E+00	4.4016E+03	2.9870E+03	4.2343E+03
1.0112E+03	1.1894E+02	4.7791E+05	6.3263E+04	5.2498E+04	1.0500E+01	4.4016E+03	2.5603E+03	1.7391E+02
1.0112E+03	5.9471E+01	2.8417E+06	6.3263E+04	4.5936E+04	6.1887E+00	4.4016E+03	2.1336E+03	1.6238E+03
1.0112E+03	0.0000E+00	6.8475E+06	6.3263E+04	3.9373E+04	2.0443E+01	4.4016E+03	1.7068E+03	6.5462E+03
9.4173E+02	1.9625E+03	2.1732E+02	6.3263E+04	3.2811E+04	1.2377E+01	4.4016E+03	1.2801E+03	1.3709E+04
9.4173E+02	1.6652E+03	1.3443E+00	6.3263E+04	2.6249E+04	1.0500E+01	4.4016E+03	8.5342E+02	4.8942E+04
9.4173E+02	1.5462E+03	1.9249E+03	6.3263E+04	1.9687E+04	8.1553E+00	4.4016E+03	4.2671E+02	1.9239E+05
9.4173E+02	1.4868E+03	1.2451E+02	6.3263E+04	1.3124E+04	1.2377E+01	4.4016E+03	0.0000E+00	5.3938E+05
9.4173E+02	1.3084E+03	3.1232E+03	6.3263E+04	6.5622E+03	5.1571E+01	3.8342E+03	1.5362E+04	1.3443E+00
9.4173E+02	1.2489E+03	1.0586E+01	6.3263E+04	0.0000E+00	6.8082E+01	3.8342E+03	1.1521E+04	1.7500E+00
9.4173E+02	1.1894E+03	9.5419E+03	5.5856E+04	1.7062E+05	1.7500E+00	3.8342E+03	8.9609E+03	2.6887E+00
9.4173E+02	1.1299E+03	4.3908E+02	5.5856E+04	1.5749E+05	4.0331E+00	3.8342E+03	7.6808E+03	2.6887E+00
9.4173E+02	1.0705E+03	1.5160E+04	5.5856E+04	1.5093E+05	1.7500E+00	3.8342E+03	6.4007E+03	7.2371E+00
9.4173E+02	1.0110E+03	2.2001E+04	5.5856E+04	1.0500E+05	6.1887E+00	3.8342E+03	5.9740E+03	6.0999E+02
9.4173E+02	9.5153E+02	1.8260E+04	5.5856E+04	9.1871E+04	7.0000E+00	3.8342E+03	5.5472E+03	8.1333E+02
9.4173E+02	8.9206E+02	2.2558E+04	5.5856E+04	8.5309E+04	2.6887E+00	3.8342E+03	5.1205E+03	4.4607E+02
9.4173E+02	8.3259E+02	5.8151E+04	5.5856E+04	7.8747E+04	3.5000E+00	3.8342E+03	4.6938E+03	3.5892E+00
9.4173E+02	7.7312E+02	1.1283E+05	5.5856E+04	7.2184E+04	8.2500E+00	3.8342E+03	4.2671E+03	9.1833E+03
9.4173E+02	7.1365E+02	8.8834E+04	5.5856E+04	5.9060E+04	3.5000E+00	3.8342E+03	3.8404E+03	1.2526E+04
9.4173E+02	6.5418E+02	1.6760E+05	5.5856E+04	5.2498E+04	2.0627E+01	3.8342E+03	3.4137E+03	1.9309E+04
9.4173E+02	5.9471E+02	2.4132E+05	5.5856E+04	4.5936E+04	1.4000E+01	3.8342E+03	2.9870E+03	7.5673E+04
9.4173E+02	5.3524E+02	2.6282E+05	5.5856E+04	3.9373E+04	6.1887E+00	3.8342E+03	2.5603E+03	7.6963E+04
9.4173E+02	4.7577E+02	3.2220E+05	5.5856E+04	3.2811E+04	1.9377E+01	3.8342E+03	2.1336E+03	1.5370E+05
9.4173E+02	4.1630E+02	3.4300E+05	5.5856E+04	2.6249E+04	1.3278E+01	3.8342E+03	1.7068E+03	1.2364E+05
9.4173E+02	3.5682E+02	4.2818E+05	5.5856E+04	1.9687E+04	4.2130E+01	3.8342E+03	1.2801E+03	1.0336E+05
9.4173E+02	2.9735E+02	3.5212E+05	5.5856E+04	1.3124E+04	2.0443E+01	3.8342E+03	8.5342E+02	2.8025E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
9.4173E+02	2.3788E+02	3.4330E+05	5.5856E+04	6.5622E+03	5.0582E+01	3.8342E+03	4.2671E+02	5.7275E+05
9.4173E+02	1.7841E+02	4.5811E+05	5.5856E+04	0.0000E+00	8.6435E+01	3.8342E+03	0.0000E+00	1.6176E+06
9.4173E+02	1.1894E+02	1.4458E+06	4.8448E+04	1.5749E+05	1.7500E+00	3.2669E+03	2.0482E+04	1.3443E+00
9.4173E+02	5.9471E+01	6.4832E+06	4.8448E+04	1.5093E+05	3.0943E+00	3.2669E+03	1.6642E+04	1.3443E+00
9.4173E+02	0.0000E+00	1.2256E+07	4.8448E+04	1.4437E+05	1.3443E+00	3.2669E+03	1.1094E+04	1.3443E+00
8.7222E+02	2.2004E+03	5.7367E+02	4.8448E+04	1.3124E+05	3.5000E+00	3.2669E+03	9.8144E+03	1.3443E+00
8.7222E+02	2.0815E+03	2.1732E+02	4.8448E+04	1.2468E+05	3.5000E+00	3.2669E+03	9.3877E+03	1.7500E+00
8.7222E+02	2.0220E+03	1.1200E+03	4.8448E+04	1.1812E+05	4.4387E+00	3.2669E+03	6.8274E+03	2.2926E+01
8.7222E+02	1.9031E+03	1.3443E+00	4.8448E+04	9.8433E+04	3.5000E+00	3.2669E+03	6.4007E+03	8.0661E+00
8.7222E+02	1.8436E+03	5.0415E+02	4.8448E+04	9.1871E+04	2.6887E+00	3.2669E+03	5.9740E+03	3.2247E+03
8.7222E+02	1.7841E+03	1.5917E+03	4.8448E+04	8.5309E+04	3.5000E+00	3.2669E+03	5.5472E+03	5.9374E+03
8.7222E+02	1.7247E+03	5.8897E+03	4.8448E+04	7.8747E+04	5.3774E+00	3.2669E+03	5.1205E+03	2.3416E+04
8.7222E+02	1.6652E+03	2.6883E+03	4.8448E+04	7.2184E+04	2.6887E+00	3.2669E+03	4.6938E+03	1.7452E+04
8.7222E+02	1.6057E+03	2.6847E+03	4.8448E+04	6.5622E+04	1.3189E+01	3.2669E+03	4.2671E+03	6.4884E+04
8.7222E+02	1.5462E+03	4.8858E+03	4.8448E+04	5.9060E+04	1.3189E+01	3.2669E+03	3.8404E+03	1.2563E+05
8.7222E+02	1.4868E+03	8.7861E+03	4.8448E+04	5.2498E+04	3.7606E+01	3.2669E+03	3.4137E+03	1.8196E+05
8.7222E+02	1.4273E+03	1.3506E+04	4.8448E+04	4.5936E+04	1.2377E+01	3.2669E+03	2.9870E+03	1.6809E+05
8.7222E+02	1.3678E+03	3.2126E+04	4.8448E+04	3.9373E+04	3.1417E+01	3.2669E+03	2.5603E+03	3.1545E+05
8.7222E+02	1.3084E+03	5.2402E+04	4.8448E+04	3.2811E+04	1.9377E+01	3.2669E+03	2.1336E+03	3.0437E+05
8.7222E+02	1.2489E+03	4.0584E+04	4.8448E+04	2.6249E+04	3.7221E+01	3.2669E+03	1.7068E+03	3.1752E+05
8.7222E+02	1.1894E+03	6.2941E+04	4.8448E+04	1.9687E+04	2.2973E+01	3.2669E+03	1.2801E+03	3.1774E+05
8.7222E+02	1.1299E+03	9.3646E+04	4.8448E+04	1.3124E+04	2.2066E+01	3.2669E+03	8.5342E+02	5.0789E+05
8.7222E+02	1.0705E+03	1.7436E+05	4.8448E+04	6.5622E+03	5.0594E+01	3.2669E+03	4.2671E+02	1.6533E+06
8.7222E+02	1.0110E+03	2.0433E+05	4.8448E+04	0.0000E+00	1.2965E+02	3.2669E+03	0.0000E+00	3.1362E+06
8.7222E+02	9.5153E+02	3.2734E+05	4.1041E+04	1.7062E+05	1.7500E+00	2.6996E+03	1.3655E+04	3.0943E+00
8.7222E+02	8.9206E+02	5.6347E+05	4.1041E+04	1.6406E+05	1.7500E+00	2.6996E+03	1.1521E+04	1.7500E+00
8.7222E+02	8.3259E+02	5.8608E+05	4.1041E+04	1.5749E+05	1.3443E+00	2.6996E+03	1.1094E+04	1.7500E+00
8.7222E+02	7.7312E+02	8.4822E+05	4.1041E+04	1.5093E+05	4.0331E+00	2.6996E+03	1.0668E+04	1.3443E+00
8.7222E+02	7.1365E+02	1.0899E+06	4.1041E+04	1.4437E+05	1.7500E+00	2.6996E+03	1.0241E+04	1.7500E+00
8.7222E+02	6.5418E+02	1.4379E+06	4.1041E+04	1.3781E+05	6.1887E+00	2.6996E+03	9.8144E+03	1.3443E+00
8.7222E+02	5.9471E+02	1.8222E+06	4.1041E+04	1.3124E+05	6.1887E+00	2.6996E+03	9.3877E+03	3.0943E+00
8.7222E+02	5.3524E+02	2.3574E+06	4.1041E+04	1.2468E+05	6.1887E+00	2.6996E+03	8.5342E+03	1.3917E+01
8.7222E+02	4.7577E+02	2.3224E+06	4.1041E+04	1.1812E+05	5.7830E+00	2.6996E+03	8.1075E+03	3.6186E+00
8.7222E+02	4.1630E+02	2.6190E+06	4.1041E+04	1.1156E+05	5.2500E+00	2.6996E+03	7.6808E+03	4.1289E+03
8.7222E+02	3.5682E+02	2.6717E+06	4.1041E+04	1.0500E+05	1.3443E+00	2.6996E+03	7.2541E+03	1.2333E+03
8.7222E+02	2.9735E+02	2.4486E+06	4.1041E+04	9.8433E+04	4.4387E+00	2.6996E+03	6.8274E+03	3.0062E+03
8.7222E+02	2.3788E+02	2.4154E+06	4.1041E+04	8.5309E+04	3.5000E+00	2.6996E+03	6.4007E+03	1.7466E+04
8.7222E+02	1.7841E+02	2.0916E+06	4.1041E+04	7.8747E+04	2.6887E+00	2.6996E+03	5.9740E+03	3.2023E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.7222E+02	1.1894E+02	3.7346E+06	4.1041E+04	7.2184E+04	7.0000E+00	2.6996E+03	5.5472E+03	8.1563E+04
8.7222E+02	5.9471E+01	1.1771E+07	4.1041E+04	6.5622E+04	1.9377E+01	2.6996E+03	5.1205E+03	1.0582E+05
8.7222E+02	0.0000E+00	1.8657E+07	4.1041E+04	5.9060E+04	1.6689E+01	2.6996E+03	4.6938E+03	2.4995E+05
8.0271E+02	2.3788E+03	2.8683E+02	4.1041E+04	5.2498E+04	1.3189E+01	2.6996E+03	4.2671E+03	2.6935E+05
8.0271E+02	2.2599E+03	5.2085E+00	4.1041E+04	4.5936E+04	2.1000E+01	2.6996E+03	3.8404E+03	4.9399E+05
8.0271E+02	2.2004E+03	2.8683E+02	4.1041E+04	3.9373E+04	2.2877E+01	2.6996E+03	3.4137E+03	3.9625E+05
8.0271E+02	2.1409E+03	1.0952E+03	4.1041E+04	3.2811E+04	6.4594E+01	2.6996E+03	2.9870E+03	6.4445E+05
8.0271E+02	2.0815E+03	1.4083E+03	4.1041E+04	2.6249E+04	3.3189E+01	2.6996E+03	2.5603E+03	5.7525E+05
8.0271E+02	2.0220E+03	3.6530E+03	4.1041E+04	1.9687E+04	7.3419E+01	2.6996E+03	2.1336E+03	5.6049E+05
8.0271E+02	1.9625E+03	2.1010E+03	4.1041E+04	1.3124E+04	4.6811E+01	2.6996E+03	1.7068E+03	6.6107E+05
8.0271E+02	1.9031E+03	4.5281E+03	4.1041E+04	6.5622E+03	2.1092E+02	2.6996E+03	1.2801E+03	7.9555E+05
8.0271E+02	1.8436E+03	3.8781E+03	4.1041E+04	0.0000E+00	6.5972E+03	2.6996E+03	8.5342E+02	1.1223E+06
8.0271E+02	1.7841E+03	1.0165E+04	3.3634E+04	1.7062E+05	1.3443E+00	2.6996E+03	4.2671E+02	2.9288E+06
8.0271E+02	1.7247E+03	2.3518E+04	3.3634E+04	1.6406E+05	4.4387E+00	2.6996E+03	0.0000E+00	6.0230E+06
8.0271E+02	1.6652E+03	2.4612E+04	3.3634E+04	1.5749E+05	1.7500E+00	2.1323E+03	1.5362E+04	6.2500E-01
8.0271E+02	1.6057E+03	4.4440E+04	3.3634E+04	1.5093E+05	4.8443E+00	2.1323E+03	1.2801E+04	3.0943E+00
8.0271E+02	1.5462E+03	3.3145E+04	3.3634E+04	1.4437E+05	7.0000E+00	2.1323E+03	1.2375E+04	1.7500E+00
8.0271E+02	1.4868E+03	6.1295E+04	3.3634E+04	1.3781E+05	4.8443E+00	2.1323E+03	1.1521E+04	1.7500E+00
8.0271E+02	1.4273E+03	9.8561E+04	3.3634E+04	1.3124E+05	7.5330E+00	2.1323E+03	1.1094E+04	1.7500E+00
8.0271E+02	1.3678E+03	1.2095E+05	3.3634E+04	1.2468E+05	9.6887E+00	2.1323E+03	1.0668E+04	8.2300E+02
8.0271E+02	1.3084E+03	1.8732E+05	3.3634E+04	1.1812E+05	4.8443E+00	2.1323E+03	1.0241E+04	2.3648E+02
8.0271E+02	1.2489E+03	2.8590E+05	3.3634E+04	1.1156E+05	3.0943E+00	2.1323E+03	9.8144E+03	1.2108E+03
8.0271E+02	1.1894E+03	3.6213E+05	3.3634E+04	1.0500E+05	8.7500E+00	2.1323E+03	9.3877E+03	1.6755E+03
8.0271E+02	1.1299E+03	5.5343E+05	3.3634E+04	9.8433E+04	1.1844E+01	2.1323E+03	8.9609E+03	8.6706E+00
8.0271E+02	1.0705E+03	6.0745E+05	3.3634E+04	9.1871E+04	1.1033E+01	2.1323E+03	8.5342E+03	2.6548E+03
8.0271E+02	1.0110E+03	9.0327E+05	3.3634E+04	8.5309E+04	2.0627E+01	2.1323E+03	8.1075E+03	4.0268E+03
8.0271E+02	9.5153E+02	1.3105E+06	3.3634E+04	7.8747E+04	1.2377E+01	2.1323E+03	7.6808E+03	1.6486E+04
8.0271E+02	8.9206E+02	1.4830E+06	3.3634E+04	7.2184E+04	1.5967E+01	2.1323E+03	7.2541E+03	3.4743E+04
8.0271E+02	8.3259E+02	2.0101E+06	3.3634E+04	6.5622E+04	4.7001E+01	2.1323E+03	6.8274E+03	4.3687E+04
8.0271E+02	7.7312E+02	2.3839E+06	3.3634E+04	5.9060E+04	2.1439E+01	2.1323E+03	6.4007E+03	1.5517E+05
8.0271E+02	7.1365E+02	3.1277E+06	3.3634E+04	5.2498E+04	1.6689E+01	2.1323E+03	5.9740E+03	1.1151E+05
8.0271E+02	6.5418E+02	3.9609E+06	3.3634E+04	4.5936E+04	3.4544E+01	2.1323E+03	5.5472E+03	2.2208E+05
8.0271E+02	5.9471E+02	3.9719E+06	3.3634E+04	3.9373E+04	3.2566E+01	2.1323E+03	5.1205E+03	3.3034E+05
8.0271E+02	5.3524E+02	4.6720E+06	3.3634E+04	3.2811E+04	6.3238E+01	2.1323E+03	4.6938E+03	3.8600E+05
8.0271E+02	4.7577E+02	4.9954E+06	3.3634E+04	2.6249E+04	9.0832E+01	2.1323E+03	4.2671E+03	5.1334E+05
8.0271E+02	4.1630E+02	5.2195E+06	3.3634E+04	1.9687E+04	1.0143E+02	2.1323E+03	3.8404E+03	6.8780E+05
8.0271E+02	3.5682E+02	5.5508E+06	3.3634E+04	1.3124E+04	6.8704E+03	2.1323E+03	3.4137E+03	9.4058E+05
8.0271E+02	2.9735E+02	4.6512E+06	3.3634E+04	6.5622E+03	5.0771E+03	2.1323E+03	2.9870E+03	1.0726E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Energy Systems Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.0271E+02	2.3788E+02	3.8129E+06	3.3634E+04	0.0000E+00	7.2688E+03	2.1323E+03	2.5603E+03	1.1937E+06
8.0271E+02	1.7841E+02	3.4637E+06	2.6226E+04	1.7718E+05	6.2500E-01	2.1323E+03	2.1336E+03	1.1283E+06
8.0271E+02	1.1894E+02	5.9296E+06	2.6226E+04	1.6406E+05	1.9693E+00	2.1323E+03	1.7068E+03	1.2181E+06
8.0271E+02	5.9471E+01	1.6482E+07	2.6226E+04	1.5749E+05	3.5000E+00	2.1323E+03	1.2801E+03	1.5234E+06
8.0271E+02	0.0000E+00	2.4514E+07	2.6226E+04	1.5093E+05	4.8443E+00	2.1323E+03	8.5342E+02	2.4545E+06
7.3320E+02	2.5572E+03	8.6051E+02	2.6226E+04	1.3781E+05	4.8443E+00	2.1323E+03	4.2671E+02	4.9482E+06
7.3320E+02	2.3788E+03	5.7367E+02	2.6226E+04	1.3124E+05	7.9387E+00	2.1323E+03	0.0000E+00	1.0292E+07
7.3320E+02	2.3194E+03	1.7168E+03	2.6226E+04	1.2468E+05	8.9693E+00	1.5649E+03	1.6215E+04	1.9693E+00
7.3320E+02	2.2599E+03	6.9208E+01	2.6226E+04	1.1812E+05	4.1250E+00	1.5649E+03	1.3655E+04	3.6047E+00
7.3320E+02	2.2004E+03	9.9791E+02	2.6226E+04	1.1156E+05	1.3189E+01	1.5649E+03	1.3228E+04	1.7500E+00
7.3320E+02	2.1409E+03	2.2042E+03	2.6226E+04	1.0500E+05	1.3189E+01	1.5649E+03	1.2801E+04	1.3443E+00
7.3320E+02	2.0815E+03	2.7344E+03	2.6226E+04	9.8433E+04	1.7500E+00	1.5649E+03	1.2375E+04	4.9335E+00
7.3320E+02	2.0220E+03	5.0833E+03	2.6226E+04	9.1871E+04	2.6910E+01	1.5649E+03	1.1948E+04	2.1858E+02
7.3320E+02	1.9625E+03	5.2999E+03	2.6226E+04	8.5309E+04	4.3732E+01	1.5649E+03	1.1521E+04	2.4520E+01
7.3320E+02	1.9031E+03	1.2516E+04	2.6226E+04	7.8747E+04	2.3689E+01	1.5649E+03	1.1094E+04	9.0593E+02
7.3320E+02	1.8436E+03	2.0463E+04	2.6226E+04	7.2184E+04	2.7189E+01	1.5649E+03	1.0668E+04	3.2449E+02
7.3320E+02	1.7841E+03	1.2614E+04	2.6226E+04	6.5622E+04	5.7171E+01	1.5649E+03	1.0241E+04	1.3214E+03
7.3320E+02	1.7247E+03	2.8389E+04	2.6226E+04	5.9060E+04	4.1623E+01	1.5649E+03	9.8144E+03	2.0577E+03
7.3320E+02	1.6652E+03	4.6837E+04	2.6226E+04	5.2498E+04	3.5255E+01	1.5649E+03	9.3877E+03	3.6914E+03
7.3320E+02	1.6057E+03	7.1324E+04	2.6226E+04	4.5936E+04	6.6122E+01	1.5649E+03	8.9609E+03	7.0083E+03
7.3320E+02	1.5462E+03	9.4568E+04	2.6226E+04	3.9373E+04	1.5988E+02	1.5649E+03	8.5342E+03	1.7492E+04
7.3320E+02	1.4868E+03	1.1933E+05	2.6226E+04	3.2811E+04	1.4239E+02	1.5649E+03	8.1075E+03	3.5487E+04
7.3320E+02	1.4273E+03	1.6683E+05	2.6226E+04	2.6249E+04	2.1190E+02	1.5649E+03	7.6808E+03	3.7351E+04
7.3320E+02	1.3678E+03	2.2127E+05	2.6226E+04	1.9687E+04	2.5580E+02	1.5649E+03	7.2541E+03	8.6591E+04
7.3320E+02	1.3084E+03	2.6895E+05	2.6226E+04	1.3124E+04	1.0874E+04	1.5649E+03	6.8274E+03	1.3686E+05
7.3320E+02	1.2489E+03	3.7781E+05	2.6226E+04	6.5622E+03	2.2965E+04	1.5649E+03	6.4007E+03	1.5898E+05
7.3320E+02	1.1894E+03	5.1484E+05	2.6226E+04	0.0000E+00	4.3319E+04	1.5649E+03	5.9740E+03	2.8801E+05
7.3320E+02	1.1299E+03	7.0170E+05	1.8819E+04	1.6406E+05	1.3443E+00	1.5649E+03	5.5472E+03	4.1790E+05
7.3320E+02	1.0705E+03	8.3617E+05	1.8819E+04	1.5093E+05	1.9693E+00	1.5649E+03	5.1205E+03	4.6354E+05
7.3320E+02	1.0110E+03	9.5346E+05	1.8819E+04	1.4437E+05	1.3443E+00	1.5649E+03	4.6938E+03	7.8185E+05
7.3320E+02	9.5153E+02	1.5506E+06	1.8819E+04	1.3781E+05	6.2500E-01	1.5649E+03	4.2671E+03	1.0274E+06
7.3320E+02	8.9206E+02	1.8340E+06	1.8819E+04	1.3124E+05	6.5943E+00	1.5649E+03	3.8404E+03	1.1924E+06
7.3320E+02	8.3259E+02	2.1436E+06	1.8819E+04	1.2468E+05	6.5000E+00	1.5649E+03	3.4137E+03	1.4073E+06
7.3320E+02	7.7312E+02	2.7070E+06	1.8819E+04	1.1156E+05	1.3443E+00	1.5649E+03	2.9870E+03	1.8112E+06
7.3320E+02	7.1365E+02	3.3946E+06	1.8819E+04	1.0500E+05	3.0943E+00	1.5649E+03	2.5603E+03	2.0206E+06
7.3320E+02	6.5418E+02	3.8848E+06	1.8819E+04	9.8433E+04	1.2873E+01	1.5649E+03	2.1336E+03	2.2103E+06
7.3320E+02	5.9471E+02	4.5562E+06	1.8819E+04	9.1871E+04	1.8972E+01	1.5649E+03	1.7068E+03	2.0476E+06
7.3320E+02	5.3524E+02	4.5923E+06	1.8819E+04	8.5309E+04	4.8917E+01	1.5649E+03	1.2801E+03	2.4093E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.3320E+02	4.7577E+02	5.5708E+06	1.8819E+04	7.8747E+04	2.6500E+01	1.5649E+03	8.5342E+02	3.5633E+06
7.3320E+02	4.1630E+02	5.2686E+06	1.8819E+04	7.2184E+04	3.7162E+01	1.5649E+03	4.2671E+02	7.9109E+06
7.3320E+02	3.5682E+02	5.4136E+06	1.8819E+04	6.5622E+04	6.7442E+01	1.5649E+03	0.0000E+00	1.6769E+07
7.3320E+02	2.9735E+02	4.9226E+06	1.8819E+04	5.9060E+04	1.7961E+02	9.9760E+02	1.7922E+04	1.0510E+01
7.3320E+02	2.3788E+02	4.1129E+06	1.8819E+04	5.2498E+04	2.6028E+02	9.9760E+02	1.7495E+04	2.7056E+01
7.3320E+02	1.7841E+02	3.6410E+06	1.8819E+04	4.5936E+04	3.5663E+03	9.9760E+02	1.6642E+04	2.7056E+01
7.3320E+02	1.1894E+02	6.1996E+06	1.8819E+04	3.9373E+04	2.5677E+02	9.9760E+02	1.6215E+04	1.0331E+02
7.3320E+02	5.9471E+01	1.8578E+07	1.8819E+04	3.2811E+04	4.0353E+02	9.9760E+02	1.4508E+04	4.2431E+01
7.3320E+02	0.0000E+00	2.7789E+07	1.8819E+04	2.6249E+04	7.6260E+03	9.9760E+02	1.4081E+04	1.7316E+01
6.6368E+02	2.7357E+03	5.6000E+02	1.8819E+04	1.9687E+04	7.7550E+03	9.9760E+02	1.3655E+04	2.9395E+02
6.6368E+02	2.4978E+03	6.1585E+01	1.8819E+04	1.3124E+04	4.6417E+03	9.9760E+02	1.3228E+04	2.3876E+02
6.6368E+02	2.4383E+03	1.1200E+03	1.8819E+04	6.5622E+03	4.9037E+04	9.9760E+02	1.2801E+04	5.8915E+02
6.6368E+02	2.3788E+03	6.2159E+02	1.8819E+04	0.0000E+00	2.9918E+05	9.9760E+02	1.2375E+04	1.7228E+02
6.6368E+02	2.3194E+03	2.0824E+03	1.1412E+04	2.2312E+05	4.4583E-02	9.9760E+02	1.1948E+04	6.7725E+02
6.6368E+02	2.2599E+03	3.7372E+03	1.1412E+04	1.7062E+05	6.2500E-01	9.9760E+02	1.1521E+04	2.9647E+01
6.6368E+02	2.2004E+03	2.2032E+03	1.1412E+04	1.6406E+05	4.4583E-02	9.9760E+02	1.1094E+04	3.1732E+03
6.6368E+02	2.1409E+03	9.9926E+03	1.1412E+04	1.5749E+05	4.4583E-02	9.9760E+02	1.0668E+04	1.5384E+02
6.6368E+02	2.0815E+03	2.7769E+03	1.1412E+04	1.4437E+05	6.6958E-01	9.9760E+02	1.0241E+04	5.2143E+03
6.6368E+02	2.0220E+03	7.0706E+03	1.1412E+04	1.3781E+05	6.2500E-01	9.9760E+02	9.8144E+03	7.0772E+03
6.6368E+02	1.9625E+03	9.3200E+03	1.1412E+04	1.3124E+05	1.9693E+00	9.9760E+02	9.3877E+03	2.2942E+04
6.6368E+02	1.9031E+03	1.5293E+04	1.1412E+04	1.2468E+05	4.4583E-02	9.9760E+02	8.9609E+03	2.6894E+04
6.6368E+02	1.8436E+03	2.1804E+04	1.1412E+04	1.1812E+05	6.2500E-01	9.9760E+02	8.5342E+03	4.6935E+04
6.6368E+02	1.7841E+03	2.0575E+04	1.1412E+04	1.1156E+05	1.9693E+00	9.9760E+02	8.1075E+03	5.4222E+04
6.6368E+02	1.7247E+03	4.2244E+04	1.1412E+04	1.0500E+05	1.1844E+01	9.9760E+02	7.6808E+03	6.1623E+04
6.6368E+02	1.6652E+03	5.1909E+04	1.1412E+04	9.8433E+04	1.4623E+01	9.9760E+02	7.2541E+03	1.2132E+05
6.6368E+02	1.6057E+03	7.7517E+04	1.1412E+04	9.1871E+04	3.0090E+01	9.9760E+02	6.8274E+03	1.9169E+05
6.6368E+02	1.5462E+03	7.3802E+04	1.1412E+04	8.5309E+04	8.4591E+02	9.9760E+02	6.4007E+03	2.7072E+05
6.6368E+02	1.4868E+03	1.0740E+05	1.1412E+04	7.8747E+04	2.4179E+03	9.9760E+02	5.9740E+03	4.7103E+05
6.6368E+02	1.4273E+03	1.6989E+05	1.1412E+04	7.2184E+04	4.0396E+03	9.9760E+02	5.5472E+03	5.8309E+05
6.6368E+02	1.3678E+03	1.9389E+05	1.1412E+04	6.5622E+04	1.1315E+02	9.9760E+02	5.1205E+03	7.6181E+05
6.6368E+02	1.3084E+03	2.5907E+05	1.1412E+04	5.9060E+04	1.0228E+03	9.9760E+02	4.6938E+03	1.0816E+06
6.6368E+02	1.2489E+03	3.5615E+05	1.1412E+04	5.2498E+04	2.8984E+03	9.9760E+02	4.2671E+03	1.2536E+06
6.6368E+02	1.1894E+03	4.4949E+05	1.1412E+04	4.5936E+04	6.8483E+03	9.9760E+02	3.8404E+03	1.6821E+06
6.6368E+02	1.1299E+03	6.0304E+05	1.1412E+04	3.9373E+04	6.3873E+03	9.9760E+02	3.4137E+03	1.8948E+06
6.6368E+02	1.0705E+03	8.1509E+05	1.1412E+04	3.2811E+04	1.1522E+04	9.9760E+02	2.9870E+03	2.5987E+06
6.6368E+02	1.0110E+03	1.0631E+06	1.1412E+04	2.6249E+04	8.1434E+03	9.9760E+02	2.5603E+03	3.0285E+06
6.6368E+02	9.5153E+02	1.3261E+06	1.1412E+04	1.9687E+04	2.9902E+04	9.9760E+02	2.1336E+03	3.6286E+06
6.6368E+02	8.9206E+02	1.6427E+06	1.1412E+04	1.3124E+04	3.6034E+04	9.9760E+02	1.7068E+03	3.6357E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.6368E+02	8.3259E+02	2.0102E+06	1.1412E+04	6.5622E+03	2.8085E+05	9.9760E+02	1.2801E+03	4.0907E+06
6.6368E+02	7.7312E+02	2.5321E+06	1.1412E+04	0.0000E+00	1.8275E+06	9.9760E+02	8.5342E+02	5.1334E+06
6.6368E+02	7.1365E+02	3.0796E+06	4.0047E+03	1.6406E+05	4.4583E-02	9.9760E+02	4.2671E+02	1.1847E+07
6.6368E+02	6.5418E+02	3.8106E+06	4.0047E+03	1.5093E+05	6.7329E-01	9.9760E+02	0.0000E+00	2.6573E+07
6.6368E+02	5.9471E+02	4.1643E+06	4.0047E+03	1.4437E+05	2.6887E+00	4.3027E+02	1.7922E+04	1.0510E+01
6.6368E+02	5.3524E+02	4.7955E+06	4.0047E+03	1.3781E+05	2.6887E+00	4.3027E+02	1.7068E+04	1.1382E+02
6.6368E+02	4.7577E+02	5.3075E+06	4.0047E+03	1.3124E+05	4.4583E-02	4.3027E+02	1.6642E+04	1.0417E+00
6.6368E+02	4.1630E+02	5.4451E+06	4.0047E+03	1.2468E+05	4.4583E-02	4.3027E+02	1.6215E+04	4.0130E+01
6.6368E+02	3.5682E+02	5.2793E+06	4.0047E+03	1.1156E+05	1.5682E+03	4.3027E+02	1.5788E+04	3.9714E+01
6.6368E+02	2.9735E+02	5.1304E+06	4.0047E+03	1.0500E+05	3.9193E+03	4.3027E+02	1.5362E+04	6.4334E+02
6.6368E+02	2.3788E+02	4.1096E+06	4.0047E+03	9.8433E+04	2.3648E+03	4.3027E+02	1.4935E+04	2.4130E+00
6.6368E+02	1.7841E+02	4.2044E+06	4.0047E+03	9.1871E+04	7.0788E+03	4.3027E+02	1.4508E+04	3.0253E+02
6.6368E+02	1.1894E+02	6.4421E+06	4.0047E+03	8.5309E+04	7.1312E+03	4.3027E+02	1.4081E+04	5.6260E+02
6.6368E+02	5.9471E+01	1.8652E+07	4.0047E+03	7.8747E+04	1.1088E+04	4.3027E+02	1.3655E+04	4.6032E+03
6.6368E+02	0.0000E+00	2.8367E+07	4.0047E+03	7.2184E+04	1.4636E+04	4.3027E+02	1.3228E+04	4.2324E+03
5.9417E+02	2.9735E+03	1.2500E+00	4.0047E+03	6.5622E+04	1.3680E+04	4.3027E+02	1.2801E+04	2.6769E+03
5.9417E+02	2.7357E+03	5.6000E+02	4.0047E+03	5.9060E+04	2.2520E+04	4.3027E+02	1.2375E+04	6.0664E+03
5.9417E+02	2.6167E+03	6.1630E+01	4.0047E+03	5.2498E+04	2.1530E+04	4.3027E+02	1.1948E+04	7.7385E+03
5.9417E+02	2.5572E+03	1.1200E+03	4.0047E+03	4.5936E+04	4.2090E+04	4.3027E+02	1.1521E+04	1.3770E+04
5.9417E+02	2.4978E+03	2.2270E+01	4.0047E+03	3.9373E+04	5.3673E+04	4.3027E+02	1.1094E+04	3.0585E+04
5.9417E+02	2.4383E+03	7.1975E+02	4.0047E+03	3.2811E+04	1.3915E+05	4.3027E+02	1.0668E+04	5.1946E+04
5.9417E+02	2.3788E+03	5.6993E+02	4.0047E+03	2.6249E+04	3.5747E+05	4.3027E+02	1.0241E+04	4.7505E+04
5.9417E+02	2.3194E+03	1.6681E+03	4.0047E+03	1.9687E+04	8.2140E+05	4.3027E+02	9.8144E+03	4.9105E+04
5.9417E+02	2.2599E+03	2.7591E+02	4.0047E+03	1.3124E+04	1.8396E+06	4.3027E+02	9.3877E+03	3.5392E+04
5.9417E+02	2.2004E+03	3.4473E+03	4.0047E+03	6.5622E+03	4.6801E+06	4.3027E+02	8.9609E+03	7.2570E+04
5.9417E+02	2.1409E+03	2.5990E+03	4.0047E+03	0.0000E+00	1.6437E+07	4.3027E+02	8.5342E+03	7.5349E+04
5.9417E+02	2.0815E+03	5.5215E+03	-3.4026E+03	3.2811E+05	1.3443E+00	4.3027E+02	8.1075E+03	8.1791E+04
5.9417E+02	2.0220E+03	5.5642E+03	-3.4026E+03	3.0186E+05	1.7500E+00	4.3027E+02	7.6808E+03	1.2705E+05
5.9417E+02	1.9625E+03	1.3244E+04	-3.4026E+03	1.6406E+05	4.8294E-02	4.3027E+02	7.2541E+03	2.4302E+05
5.9417E+02	1.9031E+03	1.4536E+04	-3.4026E+03	1.5093E+05	8.9167E-02	4.3027E+02	6.8274E+03	2.7412E+05
5.9417E+02	1.8436E+03	1.7171E+04	-3.4026E+03	1.3781E+05	1.4439E+01	4.3027E+02	6.4007E+03	4.0765E+05
5.9417E+02	1.7841E+03	3.3609E+04	-3.4026E+03	1.3124E+05	8.9167E-02	4.3027E+02	5.9740E+03	5.7798E+05
5.9417E+02	1.7247E+03	3.7463E+04	-3.4026E+03	1.2468E+05	1.3838E+00	4.3027E+02	5.5472E+03	7.4970E+05
5.9417E+02	1.6652E+03	3.8113E+04	-3.4026E+03	1.1812E+05	1.5761E+03	4.3027E+02	5.1205E+03	9.8085E+05
5.9417E+02	1.6057E+03	5.9173E+04	-3.4026E+03	1.1156E+05	6.6680E+00	4.3027E+02	4.6938E+03	1.2966E+06
5.9417E+02	1.5462E+03	7.8019E+04	-3.4026E+03	1.0500E+05	4.8863E+00	4.3027E+02	4.2671E+03	1.5645E+06
5.9417E+02	1.4868E+03	1.3152E+05	-3.4026E+03	9.8433E+04	8.3719E+02	4.3027E+02	3.8404E+03	2.1510E+06
5.9417E+02	1.4273E+03	1.1680E+05	-3.4026E+03	9.1871E+04	3.3105E+03	4.3027E+02	3.4137E+03	2.5051E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.9417E+02	1.3678E+03	1.8850E+05	-3.4026E+03	8.5309E+04	5.9404E+03	4.3027E+02	2.9870E+03	2.9825E+06
5.9417E+02	1.3084E+03	1.9019E+05	-3.4026E+03	7.8747E+04	4.2436E+03	4.3027E+02	2.5603E+03	3.9842E+06
5.9417E+02	1.2489E+03	3.0024E+05	-3.4026E+03	7.2184E+04	9.0362E+02	4.3027E+02	2.1336E+03	4.6626E+06
5.9417E+02	1.1894E+03	3.9144E+05	-3.4026E+03	6.5622E+04	2.4898E+04	4.3027E+02	1.7068E+03	5.9321E+06
5.9417E+02	1.1299E+03	4.5446E+05	-3.4026E+03	5.9060E+04	3.1283E+04	4.3027E+02	1.2801E+03	5.8599E+06
5.9417E+02	1.0705E+03	6.2781E+05	-3.4026E+03	5.2498E+04	5.8940E+04	4.3027E+02	8.5342E+02	7.7878E+06
5.9417E+02	1.0110E+03	7.4265E+05	-3.4026E+03	4.5936E+04	9.2683E+04	4.3027E+02	4.2671E+02	1.7499E+07
5.9417E+02	9.5153E+02	9.5742E+05	-3.4026E+03	3.9373E+04	1.7991E+05	4.3027E+02	0.0000E+00	3.6158E+07
5.9417E+02	8.9206E+02	1.2267E+06	-3.4026E+03	3.2811E+04	2.6362E+05	-1.3706E+02	1.6642E+04	3.6186E+00
5.9417E+02	8.3259E+02	1.5891E+06	-3.4026E+03	2.6249E+04	3.5926E+05	-1.3706E+02	1.6215E+04	6.4757E+02
5.9417E+02	7.7312E+02	2.0029E+06	-3.4026E+03	1.9687E+04	3.9239E+05	-1.3706E+02	1.5788E+04	1.0510E+01
5.9417E+02	7.1365E+02	2.2600E+06	-3.4026E+03	1.3124E+04	5.4105E+05	-1.3706E+02	1.5362E+04	2.9628E+02
5.9417E+02	6.5418E+02	2.6262E+06	-3.4026E+03	6.5622E+03	1.1566E+06	-1.3706E+02	1.4935E+04	1.1949E+03
5.9417E+02	5.9471E+02	3.0372E+06	-3.4026E+03	0.0000E+00	4.8754E+06	-1.3706E+02	1.4508E+04	1.2307E+03
5.9417E+02	5.3524E+02	3.8683E+06	-1.0810E+04	2.8218E+05	3.5000E+00	-1.3706E+02	1.4081E+04	4.3546E+03
5.9417E+02	4.7577E+02	4.0002E+06	-1.0810E+04	2.7561E+05	4.4583E-02	-1.3706E+02	1.3655E+04	4.2741E+03
5.9417E+02	4.1630E+02	4.0179E+06	-1.0810E+04	2.6905E+05	1.7500E+00	-1.3706E+02	1.3228E+04	1.0509E+04
5.9417E+02	3.5682E+02	4.3526E+06	-1.0810E+04	2.3624E+05	1.3443E+00	-1.3706E+02	1.2801E+04	1.8716E+04
5.9417E+02	2.9735E+02	4.5884E+06	-1.0810E+04	1.9687E+05	4.4583E-02	-1.3706E+02	1.2375E+04	4.0913E+04
5.9417E+02	2.3788E+02	4.0762E+06	-1.0810E+04	1.8374E+05	6.6958E-01	-1.3706E+02	1.1948E+04	7.0712E+04
5.9417E+02	1.7841E+02	3.7997E+06	-1.0810E+04	1.7718E+05	4.4583E-02	-1.3706E+02	1.1521E+04	1.1305E+05
5.9417E+02	1.1894E+02	6.0045E+06	-1.0810E+04	1.6406E+05	8.9167E-02	-1.3706E+02	1.1094E+04	7.9022E+04
5.9417E+02	5.9471E+01	1.7950E+07	-1.0810E+04	1.5093E+05	8.9167E-02	-1.3706E+02	1.0668E+04	8.3834E+04
5.9417E+02	0.0000E+00	3.0123E+07	-1.0810E+04	1.4437E+05	1.3375E-01	-1.3706E+02	1.0241E+04	4.9862E+04
5.2466E+02	2.9141E+03	5.2085E+00	-1.0810E+04	1.3781E+05	1.3746E-01	-1.3706E+02	9.8144E+03	6.9470E+04
5.2466E+02	2.7951E+03	5.4112E+01	-1.0810E+04	1.3124E+05	2.3034E-01	-1.3706E+02	9.3877E+03	1.1293E+05
5.2466E+02	2.6762E+03	1.1227E+02	-1.0810E+04	1.2468E+05	1.1988E+01	-1.3706E+02	8.9609E+03	1.5046E+05
5.2466E+02	2.6167E+03	2.7056E+01	-1.0810E+04	1.1812E+05	1.5673E+00	-1.3706E+02	8.5342E+03	9.9660E+04
5.2466E+02	2.5572E+03	9.3160E+01	-1.0810E+04	1.1156E+05	9.2776E+01	-1.3706E+02	8.1075E+03	1.7319E+05
5.2466E+02	2.4978E+03	1.1760E+01	-1.0810E+04	1.0500E+05	7.0287E+01	-1.3706E+02	7.6808E+03	1.9119E+05
5.2466E+02	2.4383E+03	3.1530E+01	-1.0810E+04	9.8433E+04	1.3784E+02	-1.3706E+02	7.2541E+03	2.7239E+05
5.2466E+02	2.3788E+03	2.9521E+02	-1.0810E+04	9.1871E+04	3.2022E+02	-1.3706E+02	6.8274E+03	3.6577E+05
5.2466E+02	2.3194E+03	1.2951E+03	-1.0810E+04	8.5309E+04	1.4166E+03	-1.3706E+02	6.4007E+03	5.1312E+05
5.2466E+02	2.2599E+03	1.7990E+03	-1.0810E+04	7.8747E+04	2.0560E+03	-1.3706E+02	5.9740E+03	6.1596E+05
5.2466E+02	2.2004E+03	2.2516E+03	-1.0810E+04	7.2184E+04	3.7708E+03	-1.3706E+02	5.5472E+03	8.7385E+05
5.2466E+02	2.1409E+03	1.6166E+03	-1.0810E+04	6.5622E+04	1.1031E+04	-1.3706E+02	5.1205E+03	1.2879E+06
5.2466E+02	2.0815E+03	5.8643E+03	-1.0810E+04	5.9060E+04	1.0697E+04	-1.3706E+02	4.6938E+03	1.4537E+06
5.2466E+02	2.0220E+03	2.3929E+03	-1.0810E+04	5.2498E+04	2.1947E+04	-1.3706E+02	4.2671E+03	1.9098E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Denmark A/S Tuborgvænget 6-12 DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.2466E+02	1.9625E+03	6.1967E+03	-1.0810E+04	4.5936E+04	9.2552E+04	-1.3706E+02	3.8404E+03	2.4219E+06
5.2466E+02	1.9031E+03	9.7762E+03	-1.0810E+04	3.9373E+04	1.6960E+05	-1.3706E+02	3.4137E+03	3.1078E+06
5.2466E+02	1.8436E+03	1.0982E+04	-1.0810E+04	3.2811E+04	3.4481E+05	-1.3706E+02	2.9870E+03	3.8842E+06
5.2466E+02	1.7841E+03	1.2815E+04	-1.0810E+04	2.6249E+04	5.6938E+05	-1.3706E+02	2.5603E+03	4.8012E+06
5.2466E+02	1.7247E+03	1.1087E+04	-1.0810E+04	1.9687E+04	8.7379E+05	-1.3706E+02	2.1336E+03	5.6173E+06
5.2466E+02	1.6652E+03	2.6112E+04	-1.0810E+04	1.3124E+04	1.0345E+06	-1.3706E+02	1.7068E+03	6.3921E+06
5.2466E+02	1.6057E+03	3.6231E+04	-1.0810E+04	6.5622E+03	2.3204E+06	-1.3706E+02	1.2801E+03	7.2941E+06
5.2466E+02	1.5462E+03	3.5182E+04	-1.0810E+04	0.0000E+00	5.7875E+06	-1.3706E+02	8.5342E+02	8.7001E+06
5.2466E+02	1.4868E+03	6.4897E+04	-1.8217E+04	3.0186E+05	6.5528E+00	-1.3706E+02	4.2671E+02	2.1183E+07
5.2466E+02	1.4273E+03	6.9528E+04	-1.8217E+04	2.9530E+05	1.7500E+00	-1.3706E+02	0.0000E+00	4.6579E+07
5.2466E+02	1.3678E+03	9.6824E+04	-1.8217E+04	2.8218E+05	1.7500E+00	-7.0439E+02	1.9202E+04	1.0417E+00
5.2466E+02	1.3084E+03	1.2202E+05	-1.8217E+04	2.7561E+05	3.0943E+00	-7.0439E+02	1.8775E+04	1.0510E+01
5.2466E+02	1.2489E+03	1.8691E+05	-1.8217E+04	2.6249E+05	4.1250E+00	-7.0439E+02	1.7922E+04	6.1840E-01
5.2466E+02	1.1894E+03	2.4356E+05	-1.8217E+04	2.5593E+05	6.2500E-01	-7.0439E+02	1.7068E+04	8.2649E+00
5.2466E+02	1.1299E+03	3.0311E+05	-1.8217E+04	2.4936E+05	1.3443E+00	-7.0439E+02	1.6642E+04	4.1074E+01
5.2466E+02	1.0705E+03	3.0374E+05	-1.8217E+04	2.2968E+05	1.7500E+00	-7.0439E+02	1.6215E+04	3.1825E+01
5.2466E+02	1.0110E+03	4.5429E+05	-1.8217E+04	2.2312E+05	2.3750E+00	-7.0439E+02	1.5788E+04	3.7890E+01
5.2466E+02	9.5153E+02	4.4796E+05	-1.8217E+04	2.1655E+05	6.2500E-01	-7.0439E+02	1.5362E+04	5.5208E+01
5.2466E+02	8.9206E+02	6.6880E+05	-1.8217E+04	1.9030E+05	4.4583E-02	-7.0439E+02	1.4935E+04	4.0755E+02
5.2466E+02	8.3259E+02	6.9090E+05	-1.8217E+04	1.7718E+05	4.4583E-02	-7.0439E+02	1.4508E+04	2.0574E+03
5.2466E+02	7.7312E+02	9.1001E+05	-1.8217E+04	1.7062E+05	4.4583E-02	-7.0439E+02	1.4081E+04	5.6857E+03
5.2466E+02	7.1365E+02	1.1226E+06	-1.8217E+04	1.6406E+05	1.3375E-01	-7.0439E+02	1.3655E+04	9.0485E+03
5.2466E+02	6.5418E+02	1.1808E+06	-1.8217E+04	1.5749E+05	1.7207E-01	-7.0439E+02	1.3228E+04	1.5505E+04
5.2466E+02	5.9471E+02	1.5326E+06	-1.8217E+04	1.5093E+05	1.0510E+01	-7.0439E+02	1.2801E+04	2.2621E+04
5.2466E+02	5.3524E+02	1.8803E+06	-1.8217E+04	1.4437E+05	1.3375E-01	-7.0439E+02	1.2375E+04	3.2349E+04
5.2466E+02	4.7577E+02	1.8860E+06	-1.8217E+04	1.3781E+05	1.0517E+01	-7.0439E+02	1.1948E+04	5.5358E+04
5.2466E+02	4.1630E+02	2.1622E+06	-1.8217E+04	1.3124E+05	3.7326E+01	-7.0439E+02	1.1521E+04	5.0664E+04
5.2466E+02	3.5682E+02	2.7953E+06	-1.8217E+04	1.2468E+05	8.5579E+01	-7.0439E+02	1.1094E+04	1.0433E+05
5.2466E+02	2.9735E+02	3.2081E+06	-1.8217E+04	1.1812E+05	1.1400E+02	-7.0439E+02	1.0668E+04	1.0464E+05
5.2466E+02	2.3788E+02	3.7935E+06	-1.8217E+04	1.1156E+05	9.4064E+01	-7.0439E+02	1.0241E+04	1.1924E+05
5.2466E+02	1.7841E+02	4.3908E+06	-1.8217E+04	1.0500E+05	1.7547E+03	-7.0439E+02	9.8144E+03	8.5099E+04
5.2466E+02	1.1894E+02	6.7932E+06	-1.8217E+04	9.8433E+04	1.8654E+03	-7.0439E+02	9.3877E+03	1.0366E+05
5.2466E+02	5.9471E+01	2.0021E+07	-1.8217E+04	9.1871E+04	1.8464E+03	-7.0439E+02	8.9609E+03	1.1735E+05
5.2466E+02	0.0000E+00	3.6124E+07	-1.8217E+04	8.5309E+04	5.2190E+03	-7.0439E+02	8.5342E+03	1.1552E+05
4.5515E+02	2.8546E+03	4.4583E-02	-1.8217E+04	7.8747E+04	1.8324E+03	-7.0439E+02	8.1075E+03	1.4322E+05
4.5515E+02	2.7951E+03	1.0510E+01	-1.8217E+04	7.2184E+04	4.7361E+03	-7.0439E+02	7.6808E+03	2.0438E+05
4.5515E+02	2.7357E+03	2.6943E+01	-1.8217E+04	6.5622E+04	9.5681E+03	-7.0439E+02	7.2541E+03	2.6092E+05
4.5515E+02	2.6762E+03	4.0130E+01	-1.8217E+04	5.9060E+04	2.1621E+04	-7.0439E+02	6.8274E+03	3.7460E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.5515E+02	2.6167E+03	2.7101E+01	-1.8217E+04	5.2498E+04	2.9590E+04	-7.0439E+02	6.4007E+03	4.8072E+05
4.5515E+02	2.5572E+03	9.5283E+02	-1.8217E+04	4.5936E+04	7.5682E+04	-7.0439E+02	5.9740E+03	7.6229E+05
4.5515E+02	2.4978E+03	9.2996E+01	-1.8217E+04	3.9373E+04	1.8327E+05	-7.0439E+02	5.5472E+03	8.4832E+05
4.5515E+02	2.4383E+03	6.1735E+01	-1.8217E+04	3.2811E+04	5.3934E+05	-7.0439E+02	5.1205E+03	1.1200E+06
4.5515E+02	2.3788E+03	1.1687E+03	-1.8217E+04	2.6249E+04	1.1889E+06	-7.0439E+02	4.6938E+03	1.4490E+06
4.5515E+02	2.3194E+03	4.3972E+01	-1.8217E+04	1.9687E+04	2.3662E+06	-7.0439E+02	4.2671E+03	1.7543E+06
4.5515E+02	2.2599E+03	1.7094E+02	-1.8217E+04	1.3124E+04	3.1118E+06	-7.0439E+02	3.8404E+03	2.2984E+06
4.5515E+02	2.2004E+03	7.2847E+02	-1.8217E+04	6.5622E+03	6.3103E+06	-7.0439E+02	3.4137E+03	2.7075E+06
4.5515E+02	2.1409E+03	5.9763E+02	-1.8217E+04	0.0000E+00	1.3838E+07	-7.0439E+02	2.9870E+03	3.4515E+06
4.5515E+02	2.0815E+03	3.2037E+03	-2.5624E+04	3.2155E+05	7.8972E+00	-7.0439E+02	2.5603E+03	4.1246E+06
4.5515E+02	2.0220E+03	1.1920E+03	-2.5624E+04	2.8874E+05	1.3443E+00	-7.0439E+02	2.1336E+03	4.5127E+06
4.5515E+02	1.9625E+03	2.0493E+03	-2.5624E+04	2.8218E+05	4.4387E+00	-7.0439E+02	1.7068E+03	4.6934E+06
4.5515E+02	1.9031E+03	2.2804E+03	-2.5624E+04	2.7561E+05	4.8443E+00	-7.0439E+02	1.2801E+03	5.1781E+06
4.5515E+02	1.8436E+03	6.2208E+03	-2.5624E+04	2.6905E+05	8.3443E+00	-7.0439E+02	8.5342E+02	6.9547E+06
4.5515E+02	1.7841E+03	6.3836E+03	-2.5624E+04	2.6249E+05	5.2500E+00	-7.0439E+02	4.2671E+02	1.5923E+07
4.5515E+02	1.7247E+03	5.5076E+03	-2.5624E+04	2.4936E+05	2.3750E+00	-7.0439E+02	0.0000E+00	3.2115E+07
4.5515E+02	1.6652E+03	1.7468E+04	-2.5624E+04	2.4280E+05	1.7500E+00	-1.2717E+03	1.8349E+04	6.1840E-01
4.5515E+02	1.6057E+03	1.2436E+04	-2.5624E+04	2.3624E+05	1.9693E+00	-1.2717E+03	1.7068E+04	4.5488E+00
4.5515E+02	1.5462E+03	1.8915E+04	-2.5624E+04	2.2312E+05	6.2500E-01	-1.2717E+03	1.6642E+04	5.7133E+00
4.5515E+02	1.4868E+03	1.4961E+04	-2.5624E+04	2.1655E+05	1.3443E+00	-1.2717E+03	1.6215E+04	1.1061E+00
4.5515E+02	1.4273E+03	3.0109E+04	-2.5624E+04	2.0999E+05	8.9167E-02	-1.2717E+03	1.5788E+04	1.0666E+02
4.5515E+02	1.3678E+03	4.0416E+04	-2.5624E+04	1.9030E+05	1.7946E+00	-1.2717E+03	1.5362E+04	1.1176E+02
4.5515E+02	1.3084E+03	4.4166E+04	-2.5624E+04	1.8374E+05	4.4583E-02	-1.2717E+03	1.4935E+04	5.8668E+02
4.5515E+02	1.2489E+03	4.9852E+04	-2.5624E+04	1.7718E+05	1.9221E+00	-1.2717E+03	1.4508E+04	2.7088E+02
4.5515E+02	1.1894E+03	7.4882E+04	-2.5624E+04	1.7062E+05	4.4583E-02	-1.2717E+03	1.4081E+04	2.0165E+03
4.5515E+02	1.1299E+03	6.6323E+04	-2.5624E+04	1.6406E+05	8.9167E-02	-1.2717E+03	1.3655E+04	5.2365E+03
4.5515E+02	1.0705E+03	1.1942E+05	-2.5624E+04	1.5749E+05	1.1170E+01	-1.2717E+03	1.3228E+04	2.9349E+03
4.5515E+02	1.0110E+03	1.1116E+05	-2.5624E+04	1.5093E+05	4.4583E-02	-1.2717E+03	1.2801E+04	1.0057E+04
4.5515E+02	9.5153E+02	1.5698E+05	-2.5624E+04	1.4437E+05	1.2203E+01	-1.2717E+03	1.2375E+04	1.4450E+04
4.5515E+02	8.9206E+02	1.8167E+05	-2.5624E+04	1.3781E+05	1.0915E+01	-1.2717E+03	1.1948E+04	1.5330E+04
4.5515E+02	8.3259E+02	2.3402E+05	-2.5624E+04	1.3124E+05	2.2917E+00	-1.2717E+03	1.1521E+04	1.3444E+04
4.5515E+02	7.7312E+02	2.5648E+05	-2.5624E+04	1.2468E+05	2.3236E+01	-1.2717E+03	1.1094E+04	3.7335E+04
4.5515E+02	7.1365E+02	3.1702E+05	-2.5624E+04	1.1812E+05	5.0140E+01	-1.2717E+03	1.0668E+04	3.5289E+04
4.5515E+02	6.5418E+02	3.5124E+05	-2.5624E+04	1.1156E+05	2.6354E+02	-1.2717E+03	1.0241E+04	5.6006E+04
4.5515E+02	5.9471E+02	4.7369E+05	-2.5624E+04	1.0500E+05	8.8471E+02	-1.2717E+03	9.8144E+03	5.8999E+04
4.5515E+02	5.3524E+02	4.6052E+05	-2.5624E+04	9.8433E+04	2.3600E+02	-1.2717E+03	9.3877E+03	9.7682E+04
4.5515E+02	4.7577E+02	7.6917E+05	-2.5624E+04	9.1871E+04	8.6472E+02	-1.2717E+03	8.9609E+03	7.9885E+04
4.5515E+02	4.1630E+02	1.2208E+06	-2.5624E+04	8.5309E+04	2.5091E+03	-1.2717E+03	8.5342E+03	9.0963E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborgvænget 6-8, DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.5515E+02	3.5682E+02	1.8343E+06	-2.5624E+04	7.8747E+04	5.9793E+03	-1.2717E+03	8.1075E+03	1.1242E+05
4.5515E+02	2.9735E+02	3.3360E+06	-2.5624E+04	7.2184E+04	5.4374E+03	-1.2717E+03	7.6808E+03	2.0388E+05
4.5515E+02	2.3788E+02	4.8653E+06	-2.5624E+04	6.5622E+04	1.1438E+04	-1.2717E+03	7.2541E+03	2.3413E+05
4.5515E+02	1.7841E+02	6.2427E+06	-2.5624E+04	5.9060E+04	3.3203E+04	-1.2717E+03	6.8274E+03	2.7053E+05
4.5515E+02	1.1894E+02	8.1049E+06	-2.5624E+04	5.2498E+04	7.2788E+04	-1.2717E+03	6.4007E+03	4.4223E+05
4.5515E+02	5.9471E+01	1.9839E+07	-2.5624E+04	4.5936E+04	1.2774E+05	-1.2717E+03	5.9740E+03	5.6499E+05
4.5515E+02	0.0000E+00	3.9102E+07	-2.5624E+04	3.9373E+04	3.0162E+05	-1.2717E+03	5.5472E+03	7.5433E+05
3.8563E+02	2.7357E+03	1.0510E+01	-2.5624E+04	3.2811E+04	6.8806E+05	-1.2717E+03	5.1205E+03	9.7599E+05
3.8563E+02	2.6762E+03	4.0130E+01	-2.5624E+04	2.6249E+04	1.5253E+06	-1.2717E+03	4.6938E+03	1.3035E+06
3.8563E+02	2.6167E+03	2.6887E+00	-2.5624E+04	1.9687E+04	4.1913E+06	-1.2717E+03	4.2671E+03	1.5709E+06
3.8563E+02	2.5572E+03	1.5625E+01	-2.5624E+04	1.3124E+04	6.0235E+06	-1.2717E+03	3.8404E+03	1.9128E+06
3.8563E+02	2.4978E+03	3.0150E+01	-2.5624E+04	6.5622E+03	1.0623E+07	-1.2717E+03	3.4137E+03	2.4304E+06
3.8563E+02	2.4383E+03	5.6175E+02	-2.5624E+04	0.0000E+00	2.1969E+07	-1.2717E+03	2.9870E+03	2.6146E+06
3.8563E+02	2.3788E+03	4.6593E+02	-3.3032E+04	3.1499E+05	1.3443E+00	-1.2717E+03	2.5603E+03	3.0156E+06
3.8563E+02	2.3194E+03	1.1761E+01	-3.3032E+04	3.0842E+05	1.3443E+00	-1.2717E+03	2.1336E+03	3.1749E+06
3.8563E+02	2.2599E+03	2.2334E+01	-3.3032E+04	2.9530E+05	2.6887E+00	-1.2717E+03	1.7068E+03	3.2157E+06
3.8563E+02	2.2004E+03	2.4424E+01	-3.3032E+04	2.8874E+05	3.0943E+00	-1.2717E+03	1.2801E+03	3.4222E+06
3.8563E+02	2.1409E+03	8.0799E+01	-3.3032E+04	2.7561E+05	7.5330E+00	-1.2717E+03	8.5342E+02	5.2236E+06
3.8563E+02	2.0815E+03	2.0030E+02	-3.3032E+04	2.6905E+05	1.2208E+01	-1.2717E+03	4.2671E+02	1.1842E+07
3.8563E+02	2.0220E+03	6.4448E+02	-3.3032E+04	2.6249E+05	7.9833E+00	-1.2717E+03	0.0000E+00	2.4049E+07
3.8563E+02	1.9625E+03	2.6453E+03	-3.3032E+04	2.5593E+05	5.2085E+00	-1.8391E+03	1.8349E+04	3.6186E+00
3.8563E+02	1.9031E+03	1.1380E+03	-3.3032E+04	2.4936E+05	1.7500E+00	-1.8391E+03	1.7922E+04	4.4583E-02
3.8563E+02	1.8436E+03	4.2847E+02	-3.3032E+04	2.4280E+05	8.3443E+00	-1.8391E+03	1.7068E+04	4.6602E+00
3.8563E+02	1.7841E+03	2.3135E+02	-3.3032E+04	2.3624E+05	3.5000E+00	-1.8391E+03	1.6642E+04	1.0555E+01
3.8563E+02	1.7247E+03	2.8524E+03	-3.3032E+04	2.2968E+05	1.7500E+00	-1.8391E+03	1.6215E+04	8.9446E+01
3.8563E+02	1.6652E+03	2.3502E+03	-3.3032E+04	2.2312E+05	6.2500E-01	-1.8391E+03	1.5788E+04	9.3845E+01
3.8563E+02	1.6057E+03	3.0376E+03	-3.3032E+04	2.1655E+05	1.9642E+00	-1.8391E+03	1.5362E+04	6.9081E+01
3.8563E+02	1.5462E+03	3.8346E+03	-3.3032E+04	1.9687E+05	6.2500E-01	-1.8391E+03	1.4935E+04	7.4004E+01
3.8563E+02	1.4868E+03	2.5432E+03	-3.3032E+04	1.9030E+05	6.6958E-01	-1.8391E+03	1.4508E+04	1.4390E+03
3.8563E+02	1.4273E+03	3.4454E+03	-3.3032E+04	1.8374E+05	2.4196E+00	-1.8391E+03	1.4081E+04	2.4756E+02
3.8563E+02	1.3678E+03	9.7890E+03	-3.3032E+04	1.7718E+05	4.4583E-02	-1.8391E+03	1.3655E+04	5.3448E+02
3.8563E+02	1.3084E+03	1.0994E+04	-3.3032E+04	1.7062E+05	1.4908E+00	-1.8391E+03	1.3228E+04	1.0321E+03
3.8563E+02	1.2489E+03	1.1368E+04	-3.3032E+04	1.6406E+05	1.2538E+01	-1.8391E+03	1.2801E+04	3.8580E+02
3.8563E+02	1.1894E+03	1.2430E+04	-3.3032E+04	1.5749E+05	7.5248E-01	-1.8391E+03	1.2375E+04	8.4000E+02
3.8563E+02	1.1299E+03	1.8392E+04	-3.3032E+04	1.5093E+05	9.0118E+01	-1.8391E+03	1.1948E+04	1.1016E+03
3.8563E+02	1.0705E+03	2.3223E+04	-3.3032E+04	1.4437E+05	1.0556E+01	-1.8391E+03	1.1521E+04	3.5721E+03
3.8563E+02	1.0110E+03	3.2344E+04	-3.3032E+04	1.3781E+05	3.1832E+01	-1.8391E+03	1.1094E+04	8.9686E+03
3.8563E+02	9.5153E+02	3.1179E+04	-3.3032E+04	1.3124E+05	1.1528E+02	-1.8391E+03	1.0668E+04	5.4100E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.8563E+02	8.9206E+02	4.8550E+04	-3.3032E+04	1.2468E+05	3.8895E+02	-1.8391E+03	1.0241E+04	1.5217E+04
3.8563E+02	8.3259E+02	4.7038E+04	-3.3032E+04	1.1812E+05	6.9380E+01	-1.8391E+03	9.8144E+03	1.8768E+04
3.8563E+02	7.7312E+02	8.0824E+04	-3.3032E+04	1.1156E+05	1.9523E+02	-1.8391E+03	9.3877E+03	3.0293E+04
3.8563E+02	7.1365E+02	1.1740E+05	-3.3032E+04	1.0500E+05	3.0594E+02	-1.8391E+03	8.9609E+03	3.4416E+04
3.8563E+02	6.5418E+02	1.3608E+05	-3.3032E+04	9.8433E+04	1.5695E+03	-1.8391E+03	8.5342E+03	6.8099E+04
3.8563E+02	5.9471E+02	1.8067E+05	-3.3032E+04	9.1871E+04	1.9296E+03	-1.8391E+03	8.1075E+03	6.4271E+04
3.8563E+02	5.3524E+02	2.8937E+05	-3.3032E+04	8.5309E+04	4.1135E+03	-1.8391E+03	7.6808E+03	1.3758E+05
3.8563E+02	4.7577E+02	4.8696E+05	-3.3032E+04	7.8747E+04	6.0393E+03	-1.8391E+03	7.2541E+03	1.5598E+05
3.8563E+02	4.1630E+02	7.7086E+05	-3.3032E+04	7.2184E+04	2.1181E+04	-1.8391E+03	6.8274E+03	2.4381E+05
3.8563E+02	3.5682E+02	1.8803E+06	-3.3032E+04	6.5622E+04	1.0908E+04	-1.8391E+03	6.4007E+03	3.5065E+05
3.8563E+02	2.9735E+02	2.9026E+06	-3.3032E+04	5.9060E+04	2.1842E+04	-1.8391E+03	5.9740E+03	5.6609E+05
3.8563E+02	2.3788E+02	5.4033E+06	-3.3032E+04	5.2498E+04	6.1427E+04	-1.8391E+03	5.5472E+03	5.8667E+05
3.8563E+02	1.7841E+02	6.6515E+06	-3.3032E+04	4.5936E+04	1.1949E+05	-1.8391E+03	5.1205E+03	8.4521E+05
3.8563E+02	1.1894E+02	8.0312E+06	-3.3032E+04	3.9373E+04	2.2512E+05	-1.8391E+03	4.6938E+03	1.1098E+06
3.8563E+02	5.9471E+01	1.4721E+07	-3.3032E+04	3.2811E+04	4.6677E+05	-1.8391E+03	4.2671E+03	1.1049E+06
3.8563E+02	0.0000E+00	3.5621E+07	-3.3032E+04	2.6249E+04	1.3802E+06	-1.8391E+03	3.8404E+03	1.5730E+06
3.1612E+02	2.7357E+03	1.3443E+00	-3.3032E+04	1.9687E+04	2.7607E+06	-1.8391E+03	3.4137E+03	1.8893E+06
3.1612E+02	2.6762E+03	1.3443E+00	-3.3032E+04	1.3124E+04	4.4286E+06	-1.8391E+03	2.9870E+03	2.0465E+06
3.1612E+02	2.6167E+03	3.0943E+00	-3.3032E+04	6.5622E+03	8.1740E+06	-1.8391E+03	2.5603E+03	2.1682E+06
3.1612E+02	2.5572E+03	6.9585E+00	-3.3032E+04	0.0000E+00	1.7471E+07	-1.8391E+03	2.1336E+03	2.0819E+06
3.1612E+02	2.4978E+03	1.3106E+01	-4.0439E+04	3.1499E+05	1.3443E+00	-1.8391E+03	1.7068E+03	2.3621E+06
3.1612E+02	2.4383E+03	1.7544E+01	-4.0439E+04	2.8874E+05	5.2500E+00	-1.8391E+03	1.2801E+03	2.3890E+06
3.1612E+02	2.3788E+03	1.7500E+00	-4.0439E+04	2.8218E+05	9.2416E+00	-1.8391E+03	8.5342E+02	3.9402E+06
3.1612E+02	2.3194E+03	5.0637E+00	-4.0439E+04	2.7561E+05	2.6887E+00	-1.8391E+03	4.2671E+02	8.7126E+06
3.1612E+02	2.2599E+03	2.9127E+02	-4.0439E+04	2.6905E+05	7.9387E+00	-1.8391E+03	0.0000E+00	1.7247E+07
3.1612E+02	2.2004E+03	1.1803E+01	-4.0439E+04	2.6249E+05	3.1835E+00	-2.4064E+03	1.8349E+04	8.4122E+01
3.1612E+02	2.1409E+03	4.4643E+02	-4.0439E+04	2.4936E+05	1.3147E+01	-2.4064E+03	1.7495E+04	9.8868E-01
3.1612E+02	2.0815E+03	3.8326E+01	-4.0439E+04	2.4280E+05	7.2193E+00	-2.4064E+03	1.7068E+04	9.4233E-01
3.1612E+02	2.0220E+03	2.3916E+01	-4.0439E+04	2.3624E+05	1.0503E+01	-2.4064E+03	1.6642E+04	2.0655E-01
3.1612E+02	1.9625E+03	4.0668E+01	-4.0439E+04	2.2968E+05	4.8443E+00	-2.4064E+03	1.6215E+04	4.0275E-01
3.1612E+02	1.9031E+03	6.7207E+01	-4.0439E+04	2.1655E+05	5.2085E+00	-2.4064E+03	1.5788E+04	2.1272E+02
3.1612E+02	1.8436E+03	1.7460E+03	-4.0439E+04	2.0999E+05	6.5031E+00	-2.4064E+03	1.5362E+04	2.6835E+00
3.1612E+02	1.7841E+03	5.1987E+02	-4.0439E+04	1.9030E+05	1.2500E+00	-2.4064E+03	1.4935E+04	1.0193E+02
3.1612E+02	1.7247E+03	3.4908E+01	-4.0439E+04	1.8374E+05	4.4583E-02	-2.4064E+03	1.4508E+04	9.0289E+01
3.1612E+02	1.6652E+03	1.2551E+02	-4.0439E+04	1.7718E+05	1.1817E+01	-2.4064E+03	1.4081E+04	2.2504E+01
3.1612E+02	1.6057E+03	1.2328E+02	-4.0439E+04	1.7062E+05	1.0898E+01	-2.4064E+03	1.3655E+04	8.3967E+01
3.1612E+02	1.5462E+03	1.6476E+02	-4.0439E+04	1.6406E+05	1.9376E+00	-2.4064E+03	1.3228E+04	4.1225E+01
3.1612E+02	1.4868E+03	2.1416E+02	-4.0439E+04	1.5749E+05	3.5318E+00	-2.4064E+03	1.2801E+04	7.3606E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.1612E+02	1.4273E+03	1.9576E+03	-4.0439E+04	1.5093E+05	9.5832E+01	-2.4064E+03	1.2375E+04	9.0618E+01
3.1612E+02	1.3678E+03	1.5769E+03	-4.0439E+04	1.4437E+05	1.0715E+02	-2.4064E+03	1.1948E+04	4.1908E+02
3.1612E+02	1.3084E+03	6.8510E+02	-4.0439E+04	1.3781E+05	6.8189E+01	-2.4064E+03	1.1521E+04	1.0193E+02
3.1612E+02	1.2489E+03	1.5548E+03	-4.0439E+04	1.3124E+05	1.5535E+02	-2.4064E+03	1.1094E+04	6.4584E+02
3.1612E+02	1.1894E+03	1.5962E+03	-4.0439E+04	1.2468E+05	2.4327E+02	-2.4064E+03	1.0668E+04	7.8101E+03
3.1612E+02	1.1299E+03	4.1454E+03	-4.0439E+04	1.1812E+05	3.8196E+02	-2.4064E+03	1.0241E+04	5.5694E+02
3.1612E+02	1.0705E+03	3.4326E+03	-4.0439E+04	1.1156E+05	5.7125E+02	-2.4064E+03	9.8144E+03	1.5397E+03
3.1612E+02	1.0110E+03	6.0701E+03	-4.0439E+04	1.0500E+05	6.3204E+02	-2.4064E+03	9.3877E+03	3.3391E+03
3.1612E+02	9.5153E+02	1.3178E+04	-4.0439E+04	9.8433E+04	7.1851E+02	-2.4064E+03	8.9609E+03	2.6761E+03
3.1612E+02	8.9206E+02	1.4008E+04	-4.0439E+04	9.1871E+04	4.0708E+03	-2.4064E+03	8.5342E+03	2.4646E+04
3.1612E+02	8.3259E+02	2.0113E+04	-4.0439E+04	8.5309E+04	1.4226E+03	-2.4064E+03	8.1075E+03	3.1293E+04
3.1612E+02	7.7312E+02	2.9320E+04	-4.0439E+04	7.8747E+04	5.2658E+03	-2.4064E+03	7.6808E+03	6.0912E+04
3.1612E+02	7.1365E+02	4.9150E+04	-4.0439E+04	7.2184E+04	7.0271E+03	-2.4064E+03	7.2541E+03	1.1719E+05
3.1612E+02	6.5418E+02	9.8209E+04	-4.0439E+04	6.5622E+04	1.1477E+04	-2.4064E+03	6.8274E+03	1.7012E+05
3.1612E+02	5.9471E+02	1.5991E+05	-4.0439E+04	5.9060E+04	3.0307E+04	-2.4064E+03	6.4007E+03	1.5411E+05
3.1612E+02	5.3524E+02	2.8178E+05	-4.0439E+04	5.2498E+04	6.9972E+04	-2.4064E+03	5.9740E+03	3.4730E+05
3.1612E+02	4.7577E+02	5.5605E+05	-4.0439E+04	4.5936E+04	1.4392E+05	-2.4064E+03	5.5472E+03	3.7515E+05
3.1612E+02	4.1630E+02	9.7009E+05	-4.0439E+04	3.9373E+04	3.5003E+05	-2.4064E+03	5.1205E+03	5.4782E+05
3.1612E+02	3.5682E+02	1.9179E+06	-4.0439E+04	3.2811E+04	8.2275E+05	-2.4064E+03	4.6938E+03	9.0866E+05
3.1612E+02	2.9735E+02	3.0285E+06	-4.0439E+04	2.6249E+04	1.3682E+06	-2.4064E+03	4.2671E+03	9.4782E+05
3.1612E+02	2.3788E+02	4.9346E+06	-4.0439E+04	1.9687E+04	2.3321E+06	-2.4064E+03	3.8404E+03	1.1393E+06
3.1612E+02	1.7841E+02	6.0419E+06	-4.0439E+04	1.3124E+04	3.4050E+06	-2.4064E+03	3.4137E+03	1.3627E+06
3.1612E+02	1.1894E+02	7.9651E+06	-4.0439E+04	6.5622E+03	6.6363E+06	-2.4064E+03	2.9870E+03	1.4427E+06
3.1612E+02	5.9471E+01	1.1776E+07	-4.0439E+04	0.0000E+00	1.1858E+07	-2.4064E+03	2.5603E+03	1.5505E+06
3.1612E+02	0.0000E+00	3.3078E+07	-4.7846E+04	2.9530E+05	4.0331E+00	-2.4064E+03	2.1336E+03	1.5894E+06
2.4661E+02	2.7357E+03	3.7193E+00	-4.7846E+04	2.8874E+05	1.0417E+01	-2.4064E+03	1.7068E+03	1.4959E+06
2.4661E+02	2.6762E+03	1.7500E+00	-4.7846E+04	2.8218E+05	3.0943E+00	-2.4064E+03	1.2801E+03	1.7514E+06
2.4661E+02	2.6167E+03	1.3443E+00	-4.7846E+04	2.7561E+05	1.3443E+00	-2.4064E+03	8.5342E+02	2.6819E+06
2.4661E+02	2.4978E+03	1.3443E+00	-4.7846E+04	2.6905E+05	1.7500E+00	-2.4064E+03	4.2671E+02	5.9800E+06
2.4661E+02	2.4383E+03	2.6887E+00	-4.7846E+04	2.6249E+05	4.0331E+00	-2.4064E+03	0.0000E+00	1.1474E+07
2.4661E+02	2.3788E+03	3.1389E+00	-4.7846E+04	2.5593E+05	1.4136E+01	-2.9737E+03	1.7922E+04	2.0139E+00
2.4661E+02	2.3194E+03	7.8972E+00	-4.7846E+04	2.4936E+05	3.0943E+00	-2.9737E+03	1.7495E+04	1.3443E+00
2.4661E+02	2.2599E+03	3.5000E+00	-4.7846E+04	2.4280E+05	4.0331E+00	-2.9737E+03	1.7068E+04	1.4435E+01
2.4661E+02	2.2004E+03	1.3443E+00	-4.7846E+04	2.3624E+05	1.3443E+00	-2.9737E+03	1.6642E+04	7.2986E+00
2.4661E+02	2.1409E+03	1.1303E+01	-4.7846E+04	2.2968E+05	4.4583E-02	-2.9737E+03	1.6215E+04	1.3235E+01
2.4661E+02	2.0815E+03	3.5958E+01	-4.7846E+04	2.2312E+05	2.2544E+01	-2.9737E+03	1.5788E+04	7.8036E-01
2.4661E+02	2.0220E+03	1.9072E+01	-4.7846E+04	2.1655E+05	7.6230E+00	-2.9737E+03	1.5362E+04	9.2992E+00
2.4661E+02	1.9625E+03	2.4484E+01	-4.7846E+04	2.0999E+05	1.5000E+00	-2.9737E+03	1.4935E+04	2.8089E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.4661E+02	1.9031E+03	1.5611E+01	-4.7846E+04	2.0343E+05	2.6750E-01	-2.9737E+03	1.4508E+04	7.0056E+00
2.4661E+02	1.8436E+03	1.2349E+01	-4.7846E+04	1.9687E+05	1.1282E+01	-2.9737E+03	1.4081E+04	2.0996E+00
2.4661E+02	1.7841E+03	4.4583E-02	-4.7846E+04	1.9030E+05	1.5001E+00	-2.9737E+03	1.3655E+04	2.3609E+01
2.4661E+02	1.7247E+03	3.3510E+01	-4.7846E+04	1.8374E+05	1.1198E+01	-2.9737E+03	1.3228E+04	3.0574E+01
2.4661E+02	1.6652E+03	7.6616E+01	-4.7846E+04	1.7718E+05	4.8659E+00	-2.9737E+03	1.2801E+04	2.0546E+01
2.4661E+02	1.6057E+03	4.3091E+01	-4.7846E+04	1.6406E+05	1.0184E+01	-2.9737E+03	1.2375E+04	3.1938E+01
2.4661E+02	1.5462E+03	8.7968E+01	-4.7846E+04	1.5749E+05	2.4792E+01	-2.9737E+03	1.1948E+04	1.6250E+01
2.4661E+02	1.4868E+03	2.0239E+02	-4.7846E+04	1.5093E+05	1.2219E+01	-2.9737E+03	1.1521E+04	1.9729E+02
2.4661E+02	1.4273E+03	1.6387E+02	-4.7846E+04	1.4437E+05	3.2089E+01	-2.9737E+03	1.1094E+04	2.7375E+02
2.4661E+02	1.3678E+03	2.2790E+02	-4.7846E+04	1.3781E+05	1.2214E+02	-2.9737E+03	1.0668E+04	4.7442E+01
2.4661E+02	1.3084E+03	2.4750E+02	-4.7846E+04	1.3124E+05	3.0675E+01	-2.9737E+03	1.0241E+04	8.1154E+02
2.4661E+02	1.2489E+03	3.9163E+02	-4.7846E+04	1.2468E+05	3.4013E+02	-2.9737E+03	9.8144E+03	1.1553E+02
2.4661E+02	1.1894E+03	4.5067E+02	-4.7846E+04	1.1812E+05	3.8692E+02	-2.9737E+03	9.3877E+03	9.5685E+02
2.4661E+02	1.1299E+03	7.0498E+02	-4.7846E+04	1.1156E+05	2.4160E+03	-2.9737E+03	8.9609E+03	8.0307E+02
2.4661E+02	1.0705E+03	1.4404E+03	-4.7846E+04	1.0500E+05	7.1346E+02	-2.9737E+03	8.5342E+03	3.2500E+03
2.4661E+02	1.0110E+03	1.1356E+03	-4.7846E+04	9.8433E+04	4.8090E+03	-2.9737E+03	8.1075E+03	1.2745E+04
2.4661E+02	9.5153E+02	1.8264E+03	-4.7846E+04	9.1871E+04	1.1342E+03	-2.9737E+03	7.6808E+03	6.1537E+03
2.4661E+02	8.9206E+02	4.5077E+03	-4.7846E+04	8.5309E+04	3.1659E+03	-2.9737E+03	7.2541E+03	1.1435E+04
2.4661E+02	8.3259E+02	4.3360E+03	-4.7846E+04	7.8747E+04	4.3666E+03	-2.9737E+03	6.8274E+03	2.3656E+04
2.4661E+02	7.7312E+02	8.4829E+03	-4.7846E+04	7.2184E+04	5.0927E+03	-2.9737E+03	6.4007E+03	6.8458E+04
2.4661E+02	7.1365E+02	2.3110E+04	-4.7846E+04	6.5622E+04	1.6245E+04	-2.9737E+03	5.9740E+03	1.4597E+05
2.4661E+02	6.5418E+02	2.4363E+04	-4.7846E+04	5.9060E+04	2.6364E+04	-2.9737E+03	5.5472E+03	1.6965E+05
2.4661E+02	5.9471E+02	7.7172E+04	-4.7846E+04	5.2498E+04	6.7859E+04	-2.9737E+03	5.1205E+03	3.1178E+05
2.4661E+02	5.3524E+02	1.7564E+05	-4.7846E+04	4.5936E+04	1.1890E+05	-2.9737E+03	4.6938E+03	3.4734E+05
2.4661E+02	4.7577E+02	2.9613E+05	-4.7846E+04	3.9373E+04	2.9500E+05	-2.9737E+03	4.2671E+03	4.6649E+05
2.4661E+02	4.1630E+02	7.0475E+05	-4.7846E+04	3.2811E+04	6.3798E+05	-2.9737E+03	3.8404E+03	8.0127E+05
2.4661E+02	3.5682E+02	1.3262E+06	-4.7846E+04	2.6249E+04	1.3884E+06	-2.9737E+03	3.4137E+03	8.0071E+05
2.4661E+02	2.9735E+02	2.1752E+06	-4.7846E+04	1.9687E+04	2.5304E+06	-2.9737E+03	2.9870E+03	8.3349E+05
2.4661E+02	2.3788E+02	4.5148E+06	-4.7846E+04	1.3124E+04	3.4292E+06	-2.9737E+03	2.5603E+03	9.2851E+05
2.4661E+02	1.7841E+02	6.5925E+06	-4.7846E+04	6.5622E+03	5.8980E+06	-2.9737E+03	2.1336E+03	9.2439E+05
2.4661E+02	1.1894E+02	9.0929E+06	-4.7846E+04	0.0000E+00	9.6088E+06	-2.9737E+03	1.7068E+03	9.2075E+05
2.4661E+02	5.9471E+01	1.4473E+07	-5.5253E+04	3.0186E+05	6.5528E+00	-2.9737E+03	1.2801E+03	9.8400E+05
2.4661E+02	0.0000E+00	3.9914E+07	-5.5253E+04	2.7561E+05	6.9585E+00	-2.9737E+03	8.5342E+02	1.8621E+06
1.7709E+02	2.9735E+03	1.7500E+00	-5.5253E+04	2.6905E+05	5.2085E+00	-2.9737E+03	4.2671E+02	4.0559E+06
1.7709E+02	2.8546E+03	5.2085E+00	-5.5253E+04	2.5593E+05	7.1274E+00	-2.9737E+03	0.0000E+00	7.8834E+06
1.7709E+02	2.5572E+03	3.0943E+00	-5.5253E+04	2.4936E+05	1.2832E+01	-3.5410E+03	2.1336E+04	6.2500E-01
1.7709E+02	2.4978E+03	1.7500E+00	-5.5253E+04	2.3624E+05	1.7500E+00	-3.5410E+03	1.7068E+04	7.8697E-01
1.7709E+02	2.4383E+03	5.2500E+00	-5.5253E+04	2.2312E+05	1.1042E+01	-3.5410E+03	1.6642E+04	3.9286E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.7709E+02	2.3788E+03	4.8889E+00	-5.5253E+04	2.1655E+05	1.9642E+00	-3.5410E+03	1.6215E+04	3.6047E+00
1.7709E+02	2.3194E+03	1.7500E+00	-5.5253E+04	2.0999E+05	3.3329E+01	-3.5410E+03	1.5788E+04	4.5139E+00
1.7709E+02	2.2599E+03	5.2085E+00	-5.5253E+04	2.0343E+05	1.5318E+01	-3.5410E+03	1.5362E+04	1.3235E+01
1.7709E+02	2.2004E+03	6.5528E+00	-5.5253E+04	1.9687E+05	1.2484E+01	-3.5410E+03	1.4935E+04	7.8697E-01
1.7709E+02	2.1409E+03	5.2500E+00	-5.5253E+04	1.9030E+05	1.5729E+01	-3.5410E+03	1.4508E+04	6.2171E+00
1.7709E+02	2.0815E+03	1.7011E+01	-5.5253E+04	1.8374E+05	6.0642E+00	-3.5410E+03	1.4081E+04	5.6103E+00
1.7709E+02	2.0220E+03	2.4196E+00	-5.5253E+04	1.7718E+05	1.3375E-01	-3.5410E+03	1.3655E+04	4.0196E+00
1.7709E+02	1.9625E+03	1.5625E+01	-5.5253E+04	1.7062E+05	3.0097E+00	-3.5410E+03	1.3228E+04	2.3684E+00
1.7709E+02	1.9031E+03	1.3511E+01	-5.5253E+04	1.6406E+05	1.3039E+00	-3.5410E+03	1.2801E+04	5.5167E+00
1.7709E+02	1.8436E+03	1.1761E+01	-5.5253E+04	1.5749E+05	1.7816E+00	-3.5410E+03	1.2375E+04	7.4210E-03
1.7709E+02	1.7841E+03	4.1394E+01	-5.5253E+04	1.5093E+05	9.8096E+01	-3.5410E+03	1.1948E+04	1.1059E+01
1.7709E+02	1.7247E+03	1.1740E+02	-5.5253E+04	1.4437E+05	2.2362E+02	-3.5410E+03	1.1521E+04	8.5793E+01
1.7709E+02	1.6652E+03	1.3502E+01	-5.5253E+04	1.3781E+05	2.6876E+01	-3.5410E+03	1.1094E+04	1.7842E+02
1.7709E+02	1.6057E+03	5.6552E+01	-5.5253E+04	1.3124E+05	5.8609E+02	-3.5410E+03	1.0668E+04	2.7333E+00
1.7709E+02	1.5462E+03	1.0459E+02	-5.5253E+04	1.2468E+05	2.2785E+02	-3.5410E+03	1.0241E+04	1.4715E+01
1.7709E+02	1.4868E+03	9.9962E+01	-5.5253E+04	1.1812E+05	4.6177E+02	-3.5410E+03	9.8144E+03	1.1288E+01
1.7709E+02	1.4273E+03	9.0317E+01	-5.5253E+04	1.1156E+05	3.0115E+03	-3.5410E+03	9.3877E+03	3.3678E+01
1.7709E+02	1.3678E+03	1.2321E+02	-5.5253E+04	1.0500E+05	1.7128E+03	-3.5410E+03	8.9609E+03	2.2221E+02
1.7709E+02	1.3084E+03	1.1083E+02	-5.5253E+04	9.8433E+04	5.2207E+03	-3.5410E+03	8.5342E+03	2.5731E+02
1.7709E+02	1.2489E+03	1.7673E+02	-5.5253E+04	9.1871E+04	3.0607E+03	-3.5410E+03	8.1075E+03	8.3568E+02
1.7709E+02	1.1894E+03	3.6384E+02	-5.5253E+04	8.5309E+04	2.5207E+04	-3.5410E+03	7.6808E+03	1.4229E+03
1.7709E+02	1.1299E+03	2.5471E+02	-5.5253E+04	7.8747E+04	2.2297E+04	-3.5410E+03	7.2541E+03	8.7398E+03
1.7709E+02	1.0705E+03	2.9445E+02	-5.5253E+04	7.2184E+04	1.9739E+04	-3.5410E+03	6.8274E+03	9.8728E+03
1.7709E+02	1.0110E+03	2.7091E+02	-5.5253E+04	6.5622E+04	1.6027E+04	-3.5410E+03	6.4007E+03	7.6541E+03
1.7709E+02	9.5153E+02	1.6231E+03	-5.5253E+04	5.9060E+04	3.8869E+04	-3.5410E+03	5.9740E+03	2.4646E+04
1.7709E+02	8.9206E+02	3.1909E+03	-5.5253E+04	5.2498E+04	6.6199E+04	-3.5410E+03	5.5472E+03	4.1348E+04
1.7709E+02	8.3259E+02	1.8317E+03	-5.5253E+04	4.5936E+04	1.3870E+05	-3.5410E+03	5.1205E+03	8.5263E+04
1.7709E+02	7.7312E+02	6.9613E+03	-5.5253E+04	3.9373E+04	3.7515E+05	-3.5410E+03	4.6938E+03	1.6964E+05
1.7709E+02	7.1365E+02	1.6353E+04	-5.5253E+04	3.2811E+04	9.1781E+05	-3.5410E+03	4.2671E+03	2.8159E+05
1.7709E+02	6.5418E+02	3.6665E+04	-5.5253E+04	2.6249E+04	1.2278E+06	-3.5410E+03	3.8404E+03	3.4487E+05
1.7709E+02	5.9471E+02	5.2452E+04	-5.5253E+04	1.9687E+04	2.7596E+06	-3.5410E+03	3.4137E+03	4.5805E+05
1.7709E+02	5.3524E+02	1.0515E+05	-5.5253E+04	1.3124E+04	3.8546E+06	-3.5410E+03	2.9870E+03	6.0360E+05
1.7709E+02	4.7577E+02	1.8083E+05	-5.5253E+04	6.5622E+03	6.8886E+06	-3.5410E+03	2.5603E+03	5.7171E+05
1.7709E+02	4.1630E+02	4.7710E+05	-5.5253E+04	0.0000E+00	9.6382E+06	-3.5410E+03	2.1336E+03	5.2022E+05
1.7709E+02	3.5682E+02	1.0163E+06	-6.2661E+04	2.6249E+05	1.3443E+00	-3.5410E+03	1.7068E+03	5.3603E+05
1.7709E+02	2.9735E+02	2.2944E+06	-6.2661E+04	2.5593E+05	1.3443E+00	-3.5410E+03	1.2801E+03	6.2243E+05
1.7709E+02	2.3788E+02	5.1744E+06	-6.2661E+04	2.4936E+05	1.8040E+01	-3.5410E+03	8.5342E+02	1.0223E+06
1.7709E+02	1.7841E+02	9.9187E+06	-6.2661E+04	2.3624E+05	9.2416E+00	-3.5410E+03	4.2671E+02	2.5154E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV A/S
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.7709E+02	1.1894E+02	1.4630E+07	-6.2661E+04	2.2312E+05	7.6230E+00	-3.5410E+03	0.0000E+00	4.5958E+06
1.7709E+02	5.9471E+01	2.2742E+07	-6.2661E+04	2.1655E+05	5.5984E+00	-4.1084E+03	2.0055E+04	4.4583E-02
1.7709E+02	0.0000E+00	5.3656E+07	-6.2661E+04	2.0999E+05	9.7645E+00	-4.1084E+03	1.9202E+04	9.4410E-01
1.0758E+02	2.7951E+03	1.7500E+00	-6.2661E+04	2.0343E+05	1.0187E+01	-4.1084E+03	1.7068E+04	4.4583E-02
1.0758E+02	2.5572E+03	1.7500E+00	-6.2661E+04	1.9687E+05	2.1328E+01	-4.1084E+03	1.6215E+04	4.4583E-02
1.0758E+02	2.4978E+03	1.3443E+00	-6.2661E+04	1.9030E+05	2.9896E+01	-4.1084E+03	1.5362E+04	4.4583E-02
1.0758E+02	2.4383E+03	1.7500E+00	-6.2661E+04	1.8374E+05	1.6349E+01	-4.1084E+03	1.4935E+04	8.4279E+01
1.0758E+02	2.3194E+03	1.7500E+00	-6.2661E+04	1.7718E+05	2.4749E+01	-4.1084E+03	1.4081E+04	6.1985E-01
1.0758E+02	2.2599E+03	1.7500E+00	-6.2661E+04	1.7062E+05	7.6292E+00	-4.1084E+03	1.3655E+04	2.5113E-01
1.0758E+02	2.2004E+03	1.8392E+00	-6.2661E+04	1.6406E+05	1.8432E+01	-4.1084E+03	1.3228E+04	1.0862E+00
1.0758E+02	2.1409E+03	5.2085E+00	-6.2661E+04	1.5749E+05	4.4877E+02	-4.1084E+03	1.2801E+04	4.4583E-02
1.0758E+02	2.0815E+03	8.9167E-02	-6.2661E+04	1.5093E+05	9.4081E+01	-4.1084E+03	1.2375E+04	6.6958E-01
1.0758E+02	2.0220E+03	1.2167E+01	-6.2661E+04	1.4437E+05	5.9121E+02	-4.1084E+03	1.1948E+04	2.2547E+00
1.0758E+02	1.9031E+03	1.2386E+01	-6.2661E+04	1.3781E+05	8.8726E+02	-4.1084E+03	1.1521E+04	3.5036E+00
1.0758E+02	1.8436E+03	3.1251E+01	-6.2661E+04	1.3124E+05	1.2016E+03	-4.1084E+03	1.1094E+04	2.5446E+00
1.0758E+02	1.7841E+03	2.6084E+01	-6.2661E+04	1.2468E+05	6.8817E+03	-4.1084E+03	1.0668E+04	5.1185E+00
1.0758E+02	1.7247E+03	4.4583E-02	-6.2661E+04	1.1812E+05	4.6870E+03	-4.1084E+03	1.0241E+04	2.9497E+00
1.0758E+02	1.6652E+03	4.6784E+01	-6.2661E+04	1.1156E+05	2.3407E+03	-4.1084E+03	9.8144E+03	6.5000E+00
1.0758E+02	1.6057E+03	4.1802E+01	-6.2661E+04	1.0500E+05	3.4816E+03	-4.1084E+03	9.3877E+03	1.8173E+01
1.0758E+02	1.5462E+03	1.0506E+01	-6.2661E+04	9.8433E+04	1.5454E+04	-4.1084E+03	8.9609E+03	4.7368E+00
1.0758E+02	1.4868E+03	4.6248E+01	-6.2661E+04	9.1871E+04	1.4850E+04	-4.1084E+03	8.5342E+03	1.2368E+00
1.0758E+02	1.4273E+03	1.1517E+02	-6.2661E+04	8.5309E+04	1.9609E+04	-4.1084E+03	8.1075E+03	6.7914E+01
1.0758E+02	1.3678E+03	8.6845E+01	-6.2661E+04	7.8747E+04	2.1848E+04	-4.1084E+03	7.6808E+03	6.5739E+02
1.0758E+02	1.3084E+03	1.3456E+02	-6.2661E+04	7.2184E+04	3.6042E+04	-4.1084E+03	7.2541E+03	3.9703E+02
1.0758E+02	1.2489E+03	1.7070E+02	-6.2661E+04	6.5622E+04	4.5337E+04	-4.1084E+03	6.8274E+03	2.2497E+01
1.0758E+02	1.1894E+03	1.9488E+02	-6.2661E+04	5.9060E+04	4.5175E+04	-4.1084E+03	6.4007E+03	1.5094E+03
1.0758E+02	1.1299E+03	2.1064E+02	-6.2661E+04	5.2498E+04	6.8517E+04	-4.1084E+03	5.9740E+03	7.3983E+03
1.0758E+02	1.0705E+03	1.9326E+02	-6.2661E+04	4.5936E+04	1.2380E+05	-4.1084E+03	5.5472E+03	1.8428E+03
1.0758E+02	1.0110E+03	4.7248E+02	-6.2661E+04	3.9373E+04	2.3609E+05	-4.1084E+03	5.1205E+03	1.5001E+04
1.0758E+02	9.5153E+02	3.8131E+02	-6.2661E+04	3.2811E+04	5.8924E+05	-4.1084E+03	4.6938E+03	7.1812E+03
1.0758E+02	8.9206E+02	4.5166E+02	-6.2661E+04	2.6249E+04	1.4278E+06	-4.1084E+03	4.2671E+03	4.4344E+04
1.0758E+02	8.3259E+02	1.3114E+03	-6.2661E+04	1.9687E+04	2.5540E+06	-4.1084E+03	3.8404E+03	9.3330E+04
1.0758E+02	7.7312E+02	4.4286E+03	-6.2661E+04	1.3124E+04	4.4165E+06	-4.1084E+03	3.4137E+03	9.7568E+04
1.0758E+02	7.1365E+02	8.2490E+03	-6.2661E+04	6.5622E+03	6.0107E+06	-4.1084E+03	2.9870E+03	1.7057E+05
1.0758E+02	6.5418E+02	1.1608E+04	-6.2661E+04	0.0000E+00	1.0953E+07	-4.1084E+03	2.5603E+03	1.3570E+05
1.0758E+02	5.9471E+02	2.0828E+04	-7.0068E+04	2.4280E+05	1.3443E+00	-4.1084E+03	2.1336E+03	2.0167E+05
1.0758E+02	5.3524E+02	4.8903E+04	-7.0068E+04	2.3624E+05	3.4550E+00	-4.1084E+03	1.7068E+03	2.2685E+05
1.0758E+02	4.7577E+02	1.5725E+05	-7.0068E+04	2.2968E+05	5.5188E+00	-4.1084E+03	1.2801E+03	2.8827E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0758E+02	4.1630E+02	3.2360E+05	-7.0068E+04	2.2312E+05	4.1744E+00	-4.1084E+03	8.5342E+02	4.9804E+05
1.0758E+02	3.5682E+02	6.6732E+05	-7.0068E+04	2.1655E+05	7.6230E+00	-4.1084E+03	4.2671E+02	1.3129E+06
1.0758E+02	2.9735E+02	1.4381E+06	-7.0068E+04	2.0999E+05	1.4289E+01	-4.1084E+03	0.0000E+00	2.8616E+06
1.0758E+02	2.3788E+02	2.5477E+06	-7.0068E+04	2.0343E+05	2.8217E+00	-4.6757E+03	1.7922E+04	9.4410E-01
1.0758E+02	1.7841E+02	4.3549E+06	-7.0068E+04	1.9687E+05	2.1724E+01	-4.6757E+03	1.7068E+04	6.2500E-01
1.0758E+02	1.1894E+02	6.8243E+06	-7.0068E+04	1.9030E+05	2.0604E+01	-4.6757E+03	1.4508E+04	4.4583E-02
1.0758E+02	5.9471E+01	1.1867E+07	-7.0068E+04	1.8374E+05	2.0117E+01	-4.6757E+03	1.3655E+04	6.2500E-01
1.0758E+02	0.0000E+00	3.3920E+07	-7.0068E+04	1.7718E+05	3.7262E+01	-4.6757E+03	1.3228E+04	4.4583E-02
3.8070E+01	2.6167E+03	6.9585E+00	-7.0068E+04	1.7062E+05	3.6643E+01	-4.6757E+03	1.2375E+04	6.6958E-01
3.8070E+01	2.3788E+03	6.2500E-01	-7.0068E+04	1.6406E+05	3.8156E+01	-4.6757E+03	1.1948E+04	2.8536E-01
3.8070E+01	1.9625E+03	3.5000E+00	-7.0068E+04	1.5749E+05	5.2839E+02	-4.6757E+03	1.1521E+04	4.8156E-01
3.8070E+01	1.9031E+03	4.4583E-02	-7.0068E+04	1.5093E+05	5.5565E+01	-4.6757E+03	1.0668E+04	1.7500E+00
3.8070E+01	1.7841E+03	6.2500E-01	-7.0068E+04	1.4437E+05	1.1419E+03	-4.6757E+03	1.0241E+04	3.6186E+00
3.8070E+01	1.7247E+03	1.0417E+01	-7.0068E+04	1.3781E+05	2.0194E+03	-4.6757E+03	9.3877E+03	9.7179E-01
3.8070E+01	1.6057E+03	2.0834E+01	-7.0068E+04	1.3124E+05	8.5646E+02	-4.6757E+03	8.9609E+03	3.1250E+00
3.8070E+01	1.5462E+03	1.1851E+01	-7.0068E+04	1.2468E+05	3.4762E+03	-4.6757E+03	8.5342E+03	4.1479E+00
3.8070E+01	1.4868E+03	1.8754E+01	-7.0068E+04	1.1812E+05	1.8991E+03	-4.6757E+03	8.1075E+03	5.3882E+00
3.8070E+01	1.4273E+03	1.1756E+01	-7.0068E+04	1.1156E+05	7.1798E+03	-4.6757E+03	7.6808E+03	2.6583E+01
3.8070E+01	1.3678E+03	7.3480E+00	-7.0068E+04	1.0500E+05	1.9854E+04	-4.6757E+03	7.2541E+03	2.0763E+01
3.8070E+01	1.3084E+03	3.4340E+01	-7.0068E+04	9.8433E+04	1.1929E+04	-4.6757E+03	6.8274E+03	9.5153E+01
3.8070E+01	1.2489E+03	5.5630E+01	-7.0068E+04	9.1871E+04	2.2090E+04	-4.6757E+03	6.4007E+03	1.0517E+02
3.8070E+01	1.1894E+03	6.1383E+01	-7.0068E+04	8.5309E+04	3.1653E+04	-4.6757E+03	5.9740E+03	1.7263E+03
3.8070E+01	1.1299E+03	1.7086E+01	-7.0068E+04	7.8747E+04	4.7714E+04	-4.6757E+03	5.5472E+03	3.5709E+01
3.8070E+01	1.0705E+03	2.8867E+01	-7.0068E+04	7.2184E+04	4.1150E+04	-4.6757E+03	5.1205E+03	1.2348E+03
3.8070E+01	1.0110E+03	6.0362E+01	-7.0068E+04	6.5622E+04	6.5222E+04	-4.6757E+03	4.6938E+03	1.7498E+03
3.8070E+01	9.5153E+02	1.2105E+02	-7.0068E+04	5.9060E+04	7.8241E+04	-4.6757E+03	4.2671E+03	1.8164E+03
3.8070E+01	8.9206E+02	9.3696E+02	-7.0068E+04	5.2498E+04	1.0721E+05	-4.6757E+03	3.8404E+03	1.8541E+04
3.8070E+01	8.3259E+02	9.7913E+02	-7.0068E+04	4.5936E+04	1.4991E+05	-4.6757E+03	3.4137E+03	8.7482E+03
3.8070E+01	7.7312E+02	2.3852E+02	-7.0068E+04	3.9373E+04	2.8557E+05	-4.6757E+03	2.9870E+03	1.4349E+04
3.8070E+01	7.1365E+02	6.7138E+03	-7.0068E+04	3.2811E+04	4.5972E+05	-4.6757E+03	2.5603E+03	4.6610E+04
3.8070E+01	6.5418E+02	9.6601E+03	-7.0068E+04	2.6249E+04	1.3249E+06	-4.6757E+03	2.1336E+03	4.9578E+04
3.8070E+01	5.9471E+02	1.9793E+04	-7.0068E+04	1.9687E+04	2.5070E+06	-4.6757E+03	1.7068E+03	8.8659E+04
3.8070E+01	5.3524E+02	1.4832E+04	-7.0068E+04	1.3124E+04	3.4962E+06	-4.6757E+03	1.2801E+03	9.0858E+04
3.8070E+01	4.7577E+02	7.7336E+04	-7.0068E+04	6.5622E+03	5.5209E+06	-4.6757E+03	8.5342E+02	2.1330E+05
3.8070E+01	4.1630E+02	1.5363E+05	-7.0068E+04	0.0000E+00	1.2980E+07	-4.6757E+03	4.2671E+02	5.3424E+05
3.8070E+01	3.5682E+02	2.8385E+05	-7.7475E+04	2.2968E+05	5.2085E+00	-4.6757E+03	0.0000E+00	1.3518E+06
3.8070E+01	2.9735E+02	5.0361E+05	-7.7475E+04	2.2312E+05	1.3443E+00	-5.2430E+03	2.0055E+04	4.4583E-02
3.8070E+01	2.3788E+02	9.8653E+05	-7.7475E+04	2.0343E+05	4.9785E+00	-5.2430E+03	1.4508E+04	4.4583E-02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.8070E+01	1.7841E+02	1.3346E+06	-7.7475E+04	1.9687E+05	1.6833E+01	-5.2430E+03	1.3228E+04	7.1417E-01
3.8070E+01	1.1894E+02	2.1483E+06	-7.7475E+04	1.9030E+05	4.5300E+02	-5.2430E+03	1.2801E+04	2.0139E+00
3.8070E+01	5.9471E+01	6.6814E+06	-7.7475E+04	1.8374E+05	2.7056E+01	-5.2430E+03	1.1948E+04	1.9642E+00
3.8070E+01	0.0000E+00	2.7162E+07	-7.7475E+04	1.7718E+05	7.1107E+01	-5.2430E+03	9.3877E+03	8.9167E-02
-3.1443E+01	2.7357E+03	1.7500E+00	-7.7475E+04	1.7062E+05	2.9757E+02	-5.2430E+03	8.9609E+03	1.7833E-01
-3.1443E+01	2.5572E+03	3.5000E+00	-7.7475E+04	1.6406E+05	4.7017E+02	-5.2430E+03	8.1075E+03	3.9816E+00
-3.1443E+01	2.4383E+03	1.7500E+00	-7.7475E+04	1.5749E+05	2.7368E+02	-5.2430E+03	7.6808E+03	4.0707E+00
-3.1443E+01	1.7841E+03	4.4583E-02	-7.7475E+04	1.5093E+05	1.6004E+02	-5.2430E+03	7.2541E+03	2.3013E+00
-3.1443E+01	1.7247E+03	8.9167E-02	-7.7475E+04	1.4437E+05	7.5657E+02	-5.2430E+03	6.8274E+03	3.5870E+01
-3.1443E+01	1.6652E+03	3.5446E+00	-7.7475E+04	1.3781E+05	1.3008E+03	-5.2430E+03	6.4007E+03	1.0428E+01
-3.1443E+01	1.6057E+03	1.4109E+00	-7.7475E+04	1.3124E+05	2.5504E+03	-5.2430E+03	5.9740E+03	3.6444E+01
-3.1443E+01	1.5462E+03	2.3335E+01	-7.7475E+04	1.2468E+05	4.3317E+03	-5.2430E+03	5.5472E+03	5.5984E+01
-3.1443E+01	1.4868E+03	9.2831E+00	-7.7475E+04	1.1812E+05	3.9718E+03	-5.2430E+03	5.1205E+03	4.2765E+01
-3.1443E+01	1.4273E+03	2.3090E+01	-7.7475E+04	1.1156E+05	8.3005E+03	-5.2430E+03	4.6938E+03	2.3758E+01
-3.1443E+01	1.3678E+03	7.0892E+00	-7.7475E+04	1.0500E+05	1.2206E+04	-5.2430E+03	4.2671E+03	7.6636E+01
-3.1443E+01	1.3084E+03	1.1250E+01	-7.7475E+04	9.8433E+04	2.4350E+04	-5.2430E+03	3.8404E+03	1.1997E+02
-3.1443E+01	1.2489E+03	2.1262E+01	-7.7475E+04	9.1871E+04	2.8825E+04	-5.2430E+03	3.4137E+03	5.4484E+02
-3.1443E+01	1.1894E+03	1.6103E+01	-7.7475E+04	8.5309E+04	6.3334E+04	-5.2430E+03	2.9870E+03	2.2758E+03
-3.1443E+01	1.1299E+03	4.4271E+01	-7.7475E+04	7.8747E+04	6.9058E+04	-5.2430E+03	2.5603E+03	1.3882E+03
-3.1443E+01	1.0705E+03	3.2911E+01	-7.7475E+04	7.2184E+04	1.0309E+05	-5.2430E+03	2.1336E+03	5.5432E+03
-3.1443E+01	1.0110E+03	7.3393E+01	-7.7475E+04	6.5622E+04	1.6670E+05	-5.2430E+03	1.7068E+03	3.1182E+02
-3.1443E+01	9.5153E+02	6.8042E+01	-7.7475E+04	5.9060E+04	2.0303E+05	-5.2430E+03	1.2801E+03	1.7738E+04
-3.1443E+01	8.9206E+02	1.0114E+02	-7.7475E+04	5.2498E+04	3.0159E+05	-5.2430E+03	8.5342E+02	4.5646E+04
-3.1443E+01	8.3259E+02	1.7154E+03	-7.7475E+04	4.5936E+04	3.5278E+05	-5.2430E+03	4.2671E+02	1.2180E+05
-3.1443E+01	7.7312E+02	4.8737E+03	-7.7475E+04	3.9373E+04	5.1095E+05	-5.2430E+03	0.0000E+00	4.2868E+05
-3.1443E+01	7.1365E+02	4.9460E+03	-7.7475E+04	3.2811E+04	6.7365E+05	-5.8104E+03	1.6642E+04	4.4583E-02
-3.1443E+01	6.5418E+02	5.0470E+03	-7.7475E+04	2.6249E+04	1.4142E+06	-5.8104E+03	1.4508E+04	6.2500E-01
-3.1443E+01	5.9471E+02	6.6905E+03	-7.7475E+04	1.9687E+04	3.3832E+06	-5.8104E+03	1.2801E+04	1.3443E+00
-3.1443E+01	5.3524E+02	1.3616E+04	-7.7475E+04	1.3124E+04	4.0631E+06	-5.8104E+03	8.1075E+03	1.5607E+00
-3.1443E+01	4.7577E+02	1.7162E+04	-7.7475E+04	6.5622E+03	5.3493E+06	-5.8104E+03	7.6808E+03	1.7833E-01
-3.1443E+01	4.1630E+02	1.5553E+04	-7.7475E+04	0.0000E+00	1.5756E+07	-5.8104E+03	7.2541E+03	5.5594E+01
-3.1443E+01	3.5682E+02	3.0784E+04	-8.4883E+04	2.1655E+05	2.8300E+00	-5.8104E+03	6.8274E+03	7.3703E-01
-3.1443E+01	2.9735E+02	7.2639E+04	-8.4883E+04	1.8374E+05	3.2503E+02	-5.8104E+03	6.4007E+03	1.3392E+00
-3.1443E+01	2.3788E+02	1.7022E+05	-8.4883E+04	1.7718E+05	6.9181E+02	-5.8104E+03	5.9740E+03	3.2532E+01
-3.1443E+01	1.7841E+02	6.6549E+05	-8.4883E+04	1.7062E+05	1.5394E+02	-5.8104E+03	5.5472E+03	1.7031E+02
-3.1443E+01	1.1894E+02	2.0035E+06	-8.4883E+04	1.6406E+05	1.8798E+02	-5.8104E+03	5.1205E+03	1.0903E+01
-3.1443E+01	5.9471E+01	6.4545E+06	-8.4883E+04	1.5749E+05	5.0205E+02	-5.8104E+03	4.6938E+03	2.4646E+02
-3.1443E+01	0.0000E+00	2.5610E+07	-8.4883E+04	1.5093E+05	4.1464E+02	-5.8104E+03	4.2671E+03	1.0156E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Denmark A/S Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.0096E+02	1.8436E+03	3.5000E+00	-8.4883E+04	1.4437E+05	1.6568E+03	-5.8104E+03	3.8404E+03	1.0672E+01
-1.0096E+02	1.7841E+03	1.3443E+00	-8.4883E+04	1.3781E+05	3.6911E+03	-5.8104E+03	3.4137E+03	3.8087E+02
-1.0096E+02	1.7247E+03	1.7500E+00	-8.4883E+04	1.3124E+05	3.1739E+03	-5.8104E+03	2.9870E+03	1.3846E+02
-1.0096E+02	1.6652E+03	7.0000E+00	-8.4883E+04	1.2468E+05	8.4964E+03	-5.8104E+03	2.5603E+03	1.6960E+03
-1.0096E+02	1.6057E+03	4.4583E-02	-8.4883E+04	1.1812E+05	1.6404E+04	-5.8104E+03	2.1336E+03	9.5322E+01
-1.0096E+02	1.5462E+03	1.0500E+01	-8.4883E+04	1.1156E+05	2.2107E+04	-5.8104E+03	1.7068E+03	7.9164E+01
-1.0096E+02	1.4868E+03	1.8087E+01	-8.4883E+04	1.0500E+05	3.5528E+04	-5.8104E+03	1.2801E+03	6.0284E+03
-1.0096E+02	1.4273E+03	2.2158E+01	-8.4883E+04	9.8433E+04	4.1730E+04	-5.8104E+03	8.5342E+02	4.1453E+03
-1.0096E+02	1.3678E+03	3.1835E+00	-8.4883E+04	9.1871E+04	7.6864E+04	-5.8104E+03	4.2671E+02	2.7619E+04
-1.0096E+02	1.3084E+03	1.7847E+01	-8.4883E+04	8.5309E+04	9.8763E+04	-5.8104E+03	0.0000E+00	8.7018E+04
-1.0096E+02	1.2489E+03	1.9417E+01	-8.4883E+04	7.8747E+04	1.6492E+05	-6.3777E+03	1.6642E+04	4.4583E-02
-1.0096E+02	1.1894E+03	2.7858E+01	-8.4883E+04	7.2184E+04	2.1192E+05	-6.3777E+03	1.5788E+04	6.2500E-01
-1.0096E+02	1.1299E+03	4.7500E+01	-8.4883E+04	6.5622E+04	2.9868E+05	-6.3777E+03	7.6808E+03	1.2500E+00
-1.0096E+02	1.0705E+03	3.8565E+01	-8.4883E+04	5.9060E+04	4.5438E+05	-6.3777E+03	6.8274E+03	4.1310E-01
-1.0096E+02	1.0110E+03	5.5791E+01	-8.4883E+04	5.2498E+04	5.9720E+05	-6.3777E+03	6.4007E+03	1.8992E+01
-1.0096E+02	9.5153E+02	5.1293E+01	-8.4883E+04	4.5936E+04	7.7809E+05	-6.3777E+03	5.9740E+03	9.7455E+00
-1.0096E+02	8.9206E+02	5.9960E+01	-8.4883E+04	3.9373E+04	1.0128E+06	-6.3777E+03	5.5472E+03	7.3703E-01
-1.0096E+02	8.3259E+02	9.2481E+01	-8.4883E+04	3.2811E+04	1.5125E+06	-6.3777E+03	5.1205E+03	3.1382E+00
-1.0096E+02	7.7312E+02	7.5823E+01	-8.4883E+04	2.6249E+04	2.0768E+06	-6.3777E+03	4.6938E+03	1.2622E+01
-1.0096E+02	7.1365E+02	1.2625E+02	-8.4883E+04	1.9687E+04	2.8508E+06	-6.3777E+03	4.2671E+03	8.5354E+00
-1.0096E+02	6.5418E+02	1.8742E+02	-8.4883E+04	1.3124E+04	3.7628E+06	-6.3777E+03	3.8404E+03	3.6260E+01
-1.0096E+02	5.9471E+02	2.2914E+02	-8.4883E+04	6.5622E+03	4.9003E+06	-6.3777E+03	3.4137E+03	1.2064E+01
-1.0096E+02	5.3524E+02	2.4315E+02	-8.4883E+04	0.0000E+00	1.4133E+07	-6.3777E+03	2.9870E+03	4.2390E+00
-1.0096E+02	4.7577E+02	3.7834E+02	-9.2290E+04	1.9687E+05	1.5488E+01	-6.3777E+03	2.5603E+03	1.1352E+01
-1.0096E+02	4.1630E+02	5.8372E+03	-9.2290E+04	1.9030E+05	8.4683E+02	-6.3777E+03	2.1336E+03	9.8777E+01
-1.0096E+02	3.5682E+02	2.4158E+03	-9.2290E+04	1.8374E+05	1.0510E+01	-6.3777E+03	1.7068E+03	6.3434E+01
-1.0096E+02	2.9735E+02	5.8294E+03	-9.2290E+04	1.7718E+05	5.8135E+02	-6.3777E+03	1.2801E+03	9.0066E+01
-1.0096E+02	2.3788E+02	1.0608E+04	-9.2290E+04	1.7062E+05	1.6720E+03	-6.3777E+03	8.5342E+02	1.7472E+02
-1.0096E+02	1.7841E+02	2.3191E+04	-9.2290E+04	1.6406E+05	6.0457E+02	-6.3777E+03	4.2671E+02	9.7722E+02
-1.0096E+02	1.1894E+02	6.3509E+04	-9.2290E+04	1.5749E+05	3.0270E+03	-6.3777E+03	0.0000E+00	1.1155E+04
-1.0096E+02	5.9471E+01	2.9545E+05	-9.2290E+04	1.5093E+05	3.8957E+02	-6.9450E+03	8.5342E+03	1.3816E+01
-1.0096E+02	0.0000E+00	1.2567E+06	-9.2290E+04	1.4437E+05	4.6336E+03	-6.9450E+03	6.8274E+03	2.4736E+00
-1.7047E+02	2.0220E+03	3.5000E+00	-9.2290E+04	1.3781E+05	4.1431E+03	-6.9450E+03	6.4007E+03	2.5361E+00
-1.7047E+02	1.9625E+03	7.6250E+00	-9.2290E+04	1.3124E+05	5.1526E+03	-6.9450E+03	5.9740E+03	1.9774E+00
-1.7047E+02	1.9031E+03	6.2500E-01	-9.2290E+04	1.2468E+05	8.3758E+03	-6.9450E+03	5.5472E+03	1.2500E+00
-1.7047E+02	1.8436E+03	7.0000E+00	-9.2290E+04	1.1812E+05	1.2114E+04	-6.9450E+03	5.1205E+03	3.5759E+01
-1.7047E+02	1.7247E+03	3.5000E+00	-9.2290E+04	1.1156E+05	2.1919E+04	-6.9450E+03	4.6938E+03	3.2393E-01
-1.7047E+02	1.6652E+03	6.0943E+00	-9.2290E+04	1.0500E+05	5.4003E+04	-6.9450E+03	4.2671E+03	1.0546E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.7047E+02	1.6057E+03	1.4939E+01	-9.2290E+04	9.8433E+04	7.3194E+04	-6.9450E+03	3.8404E+03	1.2500E+00
-1.7047E+02	1.5462E+03	3.5000E+00	-9.2290E+04	9.1871E+04	9.1806E+04	-6.9450E+03	3.4137E+03	1.9156E+01
-1.7047E+02	1.4868E+03	1.4000E+01	-9.2290E+04	8.5309E+04	1.5046E+05	-6.9450E+03	2.9870E+03	1.8158E+02
-1.7047E+02	1.4273E+03	9.9080E+00	-9.2290E+04	7.8747E+04	2.5859E+05	-6.9450E+03	2.5603E+03	3.2393E-01
-1.7047E+02	1.3678E+03	1.3722E+01	-9.2290E+04	7.2184E+04	3.4510E+05	-6.9450E+03	2.1336E+03	2.5322E+01
-1.7047E+02	1.3084E+03	1.4625E+01	-9.2290E+04	6.5622E+04	4.9222E+05	-6.9450E+03	1.7068E+03	3.7143E+01
-1.7047E+02	1.2489E+03	1.8656E+01	-9.2290E+04	5.9060E+04	6.9872E+05	-6.9450E+03	1.2801E+03	7.5610E+00
-1.7047E+02	1.1894E+03	2.8654E+01	-9.2290E+04	5.2498E+04	9.0633E+05	-6.9450E+03	8.5342E+02	1.8502E+02
-1.7047E+02	1.1299E+03	3.4128E+01	-9.2290E+04	4.5936E+04	1.3358E+06	-6.9450E+03	4.2671E+02	1.8846E+03
-1.7047E+02	1.0705E+03	3.1222E+01	-9.2290E+04	3.9373E+04	1.9384E+06	-6.9450E+03	0.0000E+00	8.3345E+03
-1.7047E+02	1.0110E+03	4.4538E+01	-9.2290E+04	3.2811E+04	2.4029E+06	-7.5124E+03	8.1075E+03	1.2500E+00
-1.7047E+02	9.5153E+02	2.3594E+01	-9.2290E+04	2.6249E+04	2.9236E+06	-7.5124E+03	7.6808E+03	8.9167E-02
-1.7047E+02	8.9206E+02	2.4222E+01	-9.2290E+04	1.9687E+04	3.3225E+06	-7.5124E+03	7.2541E+03	1.7397E+02
-1.7047E+02	8.3259E+02	5.4164E+01	-9.2290E+04	1.3124E+04	3.2037E+06	-7.5124E+03	5.9740E+03	1.8882E+00
-1.7047E+02	7.7312E+02	5.9528E+01	-9.2290E+04	6.5622E+03	3.5564E+06	-7.5124E+03	5.5472E+03	3.2393E-01
-1.7047E+02	7.1365E+02	3.4571E+01	-9.2290E+04	0.0000E+00	1.1440E+07	-7.5124E+03	4.6938E+03	6.2779E+00
-1.7047E+02	6.5418E+02	4.3766E+01	-9.9697E+04	1.8374E+05	1.1200E+03	-7.5124E+03	4.2671E+03	2.6887E+00
-1.7047E+02	5.9471E+02	9.2997E+01	-9.9697E+04	1.7718E+05	6.1585E+01	-7.5124E+03	3.8404E+03	8.9278E+00
-1.7047E+02	5.3524E+02	7.9901E+01	-9.9697E+04	1.7062E+05	1.9563E+02	-7.5124E+03	3.4137E+03	3.0294E+01
-1.7047E+02	4.7577E+02	1.4116E+02	-9.9697E+04	1.6406E+05	2.7548E+03	-7.5124E+03	2.9870E+03	2.2121E+00
-1.7047E+02	4.1630E+02	1.3227E+02	-9.9697E+04	1.5749E+05	2.3634E+03	-7.5124E+03	2.5603E+03	8.6578E+00
-1.7047E+02	3.5682E+02	2.0807E+02	-9.9697E+04	1.5093E+05	4.7382E+03	-7.5124E+03	2.1336E+03	1.5000E+01
-1.7047E+02	2.9735E+02	3.5009E+03	-9.9697E+04	1.4437E+05	4.3041E+03	-7.5124E+03	1.2801E+03	5.1716E+01
-1.7047E+02	2.3788E+02	2.8020E+02	-9.9697E+04	1.3781E+05	4.5900E+03	-7.5124E+03	8.5342E+02	4.9991E+01
-1.7047E+02	1.7841E+02	1.3857E+04	-9.9697E+04	1.3124E+05	1.1385E+04	-7.5124E+03	4.2671E+02	6.8995E+01
-1.7047E+02	1.1894E+02	1.0493E+04	-9.9697E+04	1.2468E+05	2.1559E+04	-7.5124E+03	0.0000E+00	5.5810E+02
-1.7047E+02	5.9471E+01	2.6435E+04	-9.9697E+04	1.1812E+05	2.2232E+04	-8.0797E+03	6.8274E+03	3.6186E+00
-1.7047E+02	0.0000E+00	1.2637E+05	-9.9697E+04	1.1156E+05	3.9193E+04	-8.0797E+03	6.4007E+03	2.6887E+00
-2.3998E+02	1.9625E+03	1.7500E+00	-9.9697E+04	1.0500E+05	5.7019E+04	-8.0797E+03	5.9740E+03	8.9167E-02
-2.3998E+02	1.7841E+03	3.5000E+00	-9.9697E+04	9.8433E+04	7.6997E+04	-8.0797E+03	5.5472E+03	1.2500E+00
-2.3998E+02	1.7247E+03	1.7500E+00	-9.9697E+04	9.1871E+04	1.1011E+05	-8.0797E+03	5.1205E+03	2.6887E+00
-2.3998E+02	1.6652E+03	3.0943E+00	-9.9697E+04	8.5309E+04	1.8015E+05	-8.0797E+03	4.2671E+03	2.6887E+00
-2.3998E+02	1.6057E+03	6.5943E+00	-9.9697E+04	7.8747E+04	2.6430E+05	-8.0797E+03	3.8404E+03	3.0126E+00
-2.3998E+02	1.5462E+03	4.8443E+00	-9.9697E+04	7.2184E+04	3.6922E+05	-8.0797E+03	3.4137E+03	6.6274E+00
-2.3998E+02	1.4868E+03	2.6887E+00	-9.9697E+04	6.5622E+04	5.9997E+05	-8.0797E+03	2.9870E+03	7.5333E+00
-2.3998E+02	1.4273E+03	4.4387E+00	-9.9697E+04	5.9060E+04	9.2101E+05	-8.0797E+03	2.5603E+03	8.9167E-02
-2.3998E+02	1.3678E+03	5.7830E+00	-9.9697E+04	5.2498E+04	1.3905E+06	-8.0797E+03	2.1336E+03	1.2368E+00
-2.3998E+02	1.3084E+03	1.0936E+01	-9.9697E+04	4.5936E+04	2.0242E+06	-8.0797E+03	1.7068E+03	8.6936E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.3998E+02	1.2489E+03	2.1939E+01	-9.9697E+04	3.9373E+04	2.6065E+06	-8.0797E+03	1.2801E+03	1.8882E+00
-2.3998E+02	1.1894E+03	5.3774E+00	-9.9697E+04	3.2811E+04	3.7056E+06	-8.0797E+03	8.5342E+02	9.7179E-01
-2.3998E+02	1.1299E+03	2.0722E+01	-9.9697E+04	2.6249E+04	4.3709E+06	-8.0797E+03	4.2671E+02	3.7816E+01
-2.3998E+02	1.0705E+03	1.5750E+01	-9.9697E+04	1.9687E+04	4.2814E+06	-8.0797E+03	0.0000E+00	2.4479E+02
-2.3998E+02	1.0110E+03	2.1533E+01	-9.9697E+04	1.3124E+04	4.0702E+06	-8.6470E+03	6.4007E+03	1.2500E+00
-2.3998E+02	9.5153E+02	1.7627E+01	-9.9697E+04	6.5622E+03	4.2833E+06	-8.6470E+03	3.4137E+03	8.9167E-02
-2.3998E+02	8.9206E+02	5.3774E+00	-9.9697E+04	0.0000E+00	1.1441E+07	-8.6470E+03	2.9870E+03	3.0126E+00
-2.3998E+02	8.3259E+02	6.8695E+01	-1.0710E+05	1.9030E+05	2.8683E+02	-8.6470E+03	2.5603E+03	1.8882E+00
-2.3998E+02	7.7312E+02	2.1000E+01	-1.0710E+05	1.8374E+05	5.6000E+02	-8.6470E+03	2.1336E+03	1.2368E+00
-2.3998E+02	7.1365E+02	2.9967E+01	-1.0710E+05	1.7718E+05	1.2354E+02	-8.6470E+03	1.7068E+03	8.9167E-02
-2.3998E+02	6.5418E+02	3.3816E+01	-1.0710E+05	1.7062E+05	1.1200E+03	-8.6470E+03	1.2801E+03	8.9167E-02
-2.3998E+02	5.9471E+02	4.1261E+01	-1.0710E+05	1.6406E+05	1.4852E+03	-8.6470E+03	8.5342E+02	3.2706E+00
-2.3998E+02	5.3524E+02	3.0132E+01	-1.0710E+05	1.5749E+05	1.9288E+03	-8.6470E+03	4.2671E+02	1.7361E+02
-2.3998E+02	4.7577E+02	4.6428E+01	-1.0710E+05	1.5093E+05	2.1002E+03	-8.6470E+03	0.0000E+00	2.3777E+01
-2.3998E+02	4.1630E+02	5.6227E+01	-1.0710E+05	1.4437E+05	3.2680E+03	-9.2143E+03	3.4137E+03	1.2500E+00
-2.3998E+02	3.5682E+02	4.7988E+01	-1.0710E+05	1.3781E+05	1.2465E+04	-9.2143E+03	2.1336E+03	1.2368E+00
-2.3998E+02	2.9735E+02	4.7356E+01	-1.0710E+05	1.3124E+05	2.3967E+04	-9.2143E+03	1.7068E+03	8.9167E-02
-2.3998E+02	2.3788E+02	4.4944E+01	-1.0710E+05	1.2468E+05	1.6588E+04	-9.2143E+03	1.2801E+03	3.2393E-01
-2.3998E+02	1.7841E+02	1.8361E+02	-1.0710E+05	1.1812E+05	2.7452E+04	-9.2143E+03	4.2671E+02	2.7210E+01
-2.3998E+02	1.1894E+02	6.8362E+02	-1.0710E+05	1.1156E+05	4.4440E+04	-9.2143E+03	0.0000E+00	3.9882E+01
-2.3998E+02	5.9471E+01	5.2034E+03	-1.0710E+05	1.0500E+05	4.7444E+04	-9.7817E+03	5.5472E+03	8.9167E-02
-2.3998E+02	0.0000E+00	2.9644E+04	-1.0710E+05	9.8433E+04	9.4503E+04	-9.7817E+03	2.9870E+03	8.9167E-02
-3.0949E+02	2.1409E+03	1.7500E+00	-1.0710E+05	9.1871E+04	1.5228E+05	-9.7817E+03	8.5342E+02	1.2368E+00
-3.0949E+02	2.0220E+03	1.7500E+00	-1.0710E+05	8.5309E+04	1.8315E+05	-9.7817E+03	4.2671E+02	1.8882E+00
-3.0949E+02	1.9625E+03	3.5000E+00	-1.0710E+05	7.8747E+04	3.6658E+05	-9.7817E+03	0.0000E+00	1.2015E+01
-3.0949E+02	1.9031E+03	3.5000E+00	-1.0710E+05	7.2184E+04	5.1332E+05	-1.0349E+04	8.5342E+02	2.6887E+00
-3.0949E+02	1.7247E+03	3.5000E+00	-1.0710E+05	6.5622E+04	7.4531E+05	-1.0349E+04	4.2671E+02	1.2587E+01
-3.0949E+02	1.6057E+03	8.7500E+00	-1.0710E+05	5.9060E+04	1.1755E+06	-1.0349E+04	0.0000E+00	6.8939E+00
-3.0949E+02	1.4868E+03	3.0943E+00	-1.0710E+05	5.2498E+04	1.6977E+06	-1.0916E+04	3.8404E+03	8.9167E-02
-3.0949E+02	1.4273E+03	4.8443E+00	-1.0710E+05	4.5936E+04	2.5076E+06	-1.0916E+04	0.0000E+00	5.1755E+00
-3.0949E+02	1.3678E+03	8.8774E+00	-1.0710E+05	3.9373E+04	3.2085E+06	-1.1484E+04	4.2671E+02	1.2500E+00
-3.0949E+02	1.3084E+03	7.0330E+00	-1.0710E+05	3.2811E+04	4.3688E+06	-1.2051E+04	4.2671E+02	8.9167E-02
-3.0949E+02	1.2489E+03	1.4439E+01	-1.0710E+05	2.6249E+04	4.9391E+06			
-3.0949E+02	1.1894E+03	3.0943E+00	-1.0710E+05	1.9687E+04	5.1496E+06			
-3.0949E+02	1.1299E+03	1.1439E+01	-1.0710E+05	1.3124E+04	4.4963E+06			
-3.0949E+02	1.0705E+03	1.6689E+01	-1.0710E+05	6.5622E+03	3.8745E+06			
-3.0949E+02	1.0110E+03	1.3189E+01	-1.0710E+05	0.0000E+00	1.1432E+07			
-3.0949E+02	9.5153E+02	7.0000E+00	-1.1451E+05	1.7718E+05	6.1585E+01			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.0949E+02	8.9206E+02	1.0500E+01	-1.1451E+05	1.7062E+05	2.0898E+03			
-3.0949E+02	8.3259E+02	3.5000E+00	-1.1451E+05	1.6406E+05	1.5224E+03			
-3.0949E+02	7.7312E+02	7.0000E+00	-1.1451E+05	1.5749E+05	1.2513E+03			
-3.0949E+02	7.1365E+02	5.4666E+00	-1.1451E+05	1.5093E+05	3.5350E+03			
-3.0949E+02	6.5418E+02	8.8774E+00	-1.1451E+05	1.4437E+05	1.2859E+04			
-3.0949E+02	5.9471E+02	2.0367E+01	-1.1451E+05	1.3781E+05	1.1162E+04			
-3.0949E+02	5.3524E+02	3.5510E+01	-1.1451E+05	1.3124E+05	2.6461E+04			
-3.0949E+02	4.7577E+02	3.8630E+01	-1.1451E+05	1.2468E+05	1.5295E+04			
-3.0949E+02	4.1630E+02	3.3005E+01	-1.1451E+05	1.1812E+05	4.1961E+04			
-3.0949E+02	3.5682E+02	3.0950E+01	-1.1451E+05	1.1156E+05	3.9827E+04			
-3.0949E+02	2.9735E+02	2.3316E+01	-1.1451E+05	1.0500E+05	7.1564E+04			
-3.0949E+02	2.3788E+02	2.0533E+01	-1.1451E+05	9.8433E+04	9.8510E+04			
-3.0949E+02	1.7841E+02	7.7005E+01	-1.1451E+05	9.1871E+04	1.4828E+05			
-3.0949E+02	1.1894E+02	6.1877E+01	-1.1451E+05	8.5309E+04	2.4812E+05			
-3.0949E+02	5.9471E+01	2.3831E+02	-1.1451E+05	7.8747E+04	3.1517E+05			
-3.0949E+02	0.0000E+00	1.0152E+04	-1.1451E+05	7.2184E+04	5.0847E+05			
-3.7901E+02	1.9031E+03	1.7500E+00	-1.1451E+05	6.5622E+04	7.3593E+05			
-3.7901E+02	1.6057E+03	3.5000E+00	-1.1451E+05	5.9060E+04	1.1200E+06			
-3.7901E+02	1.5462E+03	1.3443E+00	-1.1451E+05	5.2498E+04	1.8185E+06			
-3.7901E+02	1.4868E+03	1.7500E+00	-1.1451E+05	4.5936E+04	2.6929E+06			
-3.7901E+02	1.4273E+03	3.5000E+00	-1.1451E+05	3.9373E+04	3.4706E+06			
-3.7901E+02	1.3678E+03	1.7500E+00	-1.1451E+05	3.2811E+04	4.8160E+06			
-3.7901E+02	1.2489E+03	5.2500E+00	-1.1451E+05	2.6249E+04	5.3516E+06			
-3.7901E+02	1.1894E+03	6.1887E+00	-1.1451E+05	1.9687E+04	5.2927E+06			
-3.7901E+02	1.1299E+03	2.6887E+00	-1.1451E+05	1.3124E+04	4.6952E+06			
-3.7901E+02	1.0705E+03	1.7417E+01	-1.1451E+05	6.5622E+03	3.9988E+06			
-3.7901E+02	9.5153E+02	7.0000E+00	-1.1451E+05	0.0000E+00	1.1966E+07			
-3.7901E+02	8.9206E+02	5.3774E+00	-1.2192E+05	1.8374E+05	6.1585E+01			
-3.7901E+02	8.3259E+02	7.0000E+00	-1.2192E+05	1.7718E+05	6.1585E+01			
-3.7901E+02	7.7312E+02	1.7755E+01	-1.2192E+05	1.5749E+05	3.1142E+03			
-3.7901E+02	7.1365E+02	9.6887E+00	-1.2192E+05	1.5093E+05	2.6898E+03			
-3.7901E+02	6.5418E+02	1.3189E+01	-1.2192E+05	1.4437E+05	1.2120E+03			
-3.7901E+02	5.9471E+02	2.2066E+01	-1.2192E+05	1.3781E+05	7.1286E+03			
-3.7901E+02	5.3524E+02	6.1887E+00	-1.2192E+05	1.3124E+05	1.9507E+04			
-3.7901E+02	4.7577E+02	5.3774E+00	-1.2192E+05	1.2468E+05	1.9533E+04			
-3.7901E+02	4.1630E+02	1.9294E+01	-1.2192E+05	1.1812E+05	5.0802E+04			
-3.7901E+02	3.5682E+02	1.1566E+01	-1.2192E+05	1.1156E+05	4.6586E+04			
-3.7901E+02	2.9735E+02	3.0138E+01	-1.2192E+05	1.0500E+05	8.1258E+04			

Classification: Confidential
VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.7901E+02	2.3788E+02	2.6632E+01	-1.2192E+05	9.8433E+04	9.7804E+04			
-3.7901E+02	1.7841E+02	5.4893E+01	-1.2192E+05	9.1871E+04	1.7527E+05			
-3.7901E+02	1.1894E+02	6.3149E+01	-1.2192E+05	8.5309E+04	2.4718E+05			
-3.7901E+02	5.9471E+01	1.1256E+02	-1.2192E+05	7.8747E+04	3.6409E+05			
-3.7901E+02	0.0000E+00	3.9371E+03	-1.2192E+05	7.2184E+04	5.6110E+05			
-4.4852E+02	1.9625E+03	1.7500E+00	-1.2192E+05	6.5622E+04	7.8133E+05			
-4.4852E+02	1.7841E+03	3.5000E+00	-1.2192E+05	5.9060E+04	1.2557E+06			
-4.4852E+02	1.4868E+03	1.3443E+00	-1.2192E+05	5.2498E+04	1.8026E+06			
-4.4852E+02	1.0705E+03	1.0417E+01	-1.2192E+05	4.5936E+04	2.5002E+06			
-4.4852E+02	8.9206E+02	2.6887E+00	-1.2192E+05	3.9373E+04	3.4827E+06			
-4.4852E+02	8.3259E+02	1.3189E+01	-1.2192E+05	3.2811E+04	4.3418E+06			
-4.4852E+02	6.5418E+02	6.1887E+00	-1.2192E+05	2.6249E+04	4.8572E+06			
-4.4852E+02	5.9471E+02	9.6887E+00	-1.2192E+05	1.9687E+04	4.9774E+06			
-4.4852E+02	4.7577E+02	1.2377E+01	-1.2192E+05	1.3124E+04	4.2630E+06			
-4.4852E+02	4.1630E+02	8.8774E+00	-1.2192E+05	6.5622E+03	3.5119E+06			
-4.4852E+02	3.5682E+02	1.5066E+01	-1.2192E+05	0.0000E+00	1.1924E+07			
-4.4852E+02	2.9735E+02	1.3443E+01	-1.2933E+05	1.5749E+05	5.6000E+02			
-4.4852E+02	2.3788E+02	3.8453E+01	-1.2933E+05	1.5093E+05	8.4683E+02			
-4.4852E+02	1.7841E+02	1.7933E+01	-1.2933E+05	1.4437E+05	4.3725E+03			
-4.4852E+02	1.1894E+02	2.2066E+01	-1.2933E+05	1.3781E+05	2.5459E+03			
-4.4852E+02	5.9471E+01	1.1552E+02	-1.2933E+05	1.3124E+05	3.5457E+03			
-4.4852E+02	0.0000E+00	1.7149E+03	-1.2933E+05	1.2468E+05	1.4120E+04			
-5.1803E+02	8.9206E+02	3.5000E+00	-1.2933E+05	1.1812E+05	3.4832E+04			
-5.1803E+02	6.5418E+02	2.6887E+00	-1.2933E+05	1.1156E+05	4.0415E+04			
-5.1803E+02	5.9471E+02	1.2500E+00	-1.2933E+05	1.0500E+05	6.9554E+04			
-5.1803E+02	5.3524E+02	8.0661E+00	-1.2933E+05	9.8433E+04	1.4676E+05			
-5.1803E+02	4.7577E+02	8.0661E+00	-1.2933E+05	9.1871E+04	1.4468E+05			
-5.1803E+02	4.1630E+02	5.3774E+00	-1.2933E+05	8.5309E+04	2.4727E+05			
-5.1803E+02	3.5682E+02	8.0661E+00	-1.2933E+05	7.8747E+04	3.5762E+05			
-5.1803E+02	2.9735E+02	6.1887E+00	-1.2933E+05	7.2184E+04	5.7255E+05			
-5.1803E+02	2.3788E+02	1.7755E+01	-1.2933E+05	6.5622E+04	8.9758E+05			
-5.1803E+02	1.7841E+02	1.1566E+01	-1.2933E+05	5.9060E+04	1.4182E+06			
-5.1803E+02	1.1894E+02	1.4344E+01	-1.2933E+05	5.2498E+04	1.9956E+06			
-5.1803E+02	5.9471E+01	5.6771E+01	-1.2933E+05	4.5936E+04	3.0714E+06			
-5.1803E+02	0.0000E+00	1.4347E+02	-1.2933E+05	3.9373E+04	4.0031E+06			
-5.8754E+02	7.1365E+02	2.6887E+00	-1.2933E+05	3.2811E+04	4.6817E+06			
-5.8754E+02	5.3524E+02	2.6887E+00	-1.2933E+05	2.6249E+04	5.3027E+06			
-5.8754E+02	4.7577E+02	8.9666E+00	-1.2933E+05	1.9687E+04	5.5738E+06			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-5.8754E+02	3.5682E+02	5.3774E+00	-1.2933E+05	1.3124E+04	4.4264E+06			
-5.8754E+02	2.9735E+02	1.0755E+01	-1.2933E+05	6.5622E+03	3.6362E+06			
-5.8754E+02	2.3788E+02	8.8774E+00	-1.2933E+05	0.0000E+00	1.2018E+07			
-5.8754E+02	1.7841E+02	2.1510E+01	-1.3673E+05	1.5093E+05	2.1732E+02			
-5.8754E+02	1.1894E+02	1.0755E+01	-1.3673E+05	1.3124E+05	5.7888E+02			
-5.8754E+02	5.9471E+01	3.9264E+01	-1.3673E+05	1.2468E+05	1.0417E+01			
-5.8754E+02	0.0000E+00	1.2301E+02	-1.3673E+05	1.1812E+05	8.1730E+03			
-6.5706E+02	2.9735E+02	8.9167E-02	-1.3673E+05	1.1156E+05	1.4764E+04			
-6.5706E+02	1.7841E+02	5.3774E+00	-1.3673E+05	1.0500E+05	3.5253E+04			
-6.5706E+02	1.1894E+02	1.1655E+01	-1.3673E+05	9.8433E+04	6.4044E+04			
-6.5706E+02	5.9471E+01	1.7127E+01	-1.3673E+05	9.1871E+04	1.0632E+05			
-6.5706E+02	0.0000E+00	4.4039E+01	-1.3673E+05	8.5309E+04	1.3247E+05			
-7.2657E+02	4.1630E+02	2.6887E+00	-1.3673E+05	7.8747E+04	3.3344E+05			
-7.2657E+02	2.9735E+02	2.6887E+00	-1.3673E+05	7.2184E+04	4.7173E+05			
-7.2657E+02	1.7841E+02	8.8774E+00	-1.3673E+05	6.5622E+04	7.7504E+05			
-7.2657E+02	1.1894E+02	2.6887E+00	-1.3673E+05	5.9060E+04	1.2797E+06			
-7.2657E+02	5.9471E+01	1.5877E+01	-1.3673E+05	5.2498E+04	2.0108E+06			
-7.2657E+02	0.0000E+00	2.1255E+01	-1.3673E+05	4.5936E+04	2.8147E+06			
-7.9608E+02	3.5682E+02	2.6887E+00	-1.3673E+05	3.9373E+04	3.8627E+06			
-7.9608E+02	2.9735E+02	2.6887E+00	-1.3673E+05	3.2811E+04	4.8513E+06			
-7.9608E+02	1.7841E+02	2.6887E+00	-1.3673E+05	2.6249E+04	5.4144E+06			
-7.9608E+02	1.1894E+02	5.3774E+00	-1.3673E+05	1.9687E+04	5.6017E+06			
-7.9608E+02	5.9471E+01	6.1887E+00	-1.3673E+05	1.3124E+04	4.4290E+06			
-7.9608E+02	0.0000E+00	2.3695E+01	-1.3673E+05	6.5622E+03	3.9608E+06			
-8.6560E+02	4.1630E+02	2.6887E+00	-1.3673E+05	0.0000E+00	1.1457E+07			
-8.6560E+02	1.7841E+02	2.6887E+00	-1.4414E+05	1.3124E+05	2.1732E+02			
-8.6560E+02	5.9471E+01	6.1887E+00	-1.4414E+05	1.1156E+05	1.9498E+03			
-8.6560E+02	0.0000E+00	2.0106E+01	-1.4414E+05	1.0500E+05	1.2951E+03			
-9.3511E+02	5.9471E+01	2.6887E+00	-1.4414E+05	9.8433E+04	5.4395E+03			
			-1.4414E+05	9.1871E+04	1.3823E+04			
			-1.4414E+05	8.5309E+04	2.9969E+04			
			-1.4414E+05	7.8747E+04	5.7585E+04			
			-1.4414E+05	7.2184E+04	1.1994E+05			
			-1.4414E+05	6.5622E+04	2.2988E+05			
			-1.4414E+05	5.9060E+04	5.0679E+05			
			-1.4414E+05	5.2498E+04	9.7681E+05			
			-1.4414E+05	4.5936E+04	1.3764E+06			
			-1.4414E+05	3.9373E+04	2.1004E+06			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
			-1.4414E+05	3.2811E+04	2.6267E+06			
			-1.4414E+05	2.6249E+04	3.6142E+06			
			-1.4414E+05	1.9687E+04	3.4844E+06			
			-1.4414E+05	1.3124E+04	3.1307E+06			
			-1.4414E+05	6.5622E+03	2.9391E+06			
			-1.4414E+05	0.0000E+00	8.9359E+06			
			-1.5155E+05	8.5309E+04	4.4388E+02			
			-1.5155E+05	7.8747E+04	4.9548E+02			
			-1.5155E+05	7.2184E+04	8.0829E+03			
			-1.5155E+05	6.5622E+04	8.3436E+04			
			-1.5155E+05	5.9060E+04	1.2651E+05			
			-1.5155E+05	5.2498E+04	1.6505E+05			
			-1.5155E+05	4.5936E+04	3.8883E+05			
			-1.5155E+05	3.9373E+04	7.8515E+05			
			-1.5155E+05	3.2811E+04	1.0200E+06			
			-1.5155E+05	2.6249E+04	1.4196E+06			
			-1.5155E+05	1.9687E+04	1.4258E+06			
			-1.5155E+05	1.3124E+04	1.5575E+06			
			-1.5155E+05	6.5622E+03	1.2708E+06			
			-1.5155E+05	0.0000E+00	4.4351E+06			
			-1.5896E+05	9.8433E+04	1.3443E+00			
			-1.5896E+05	8.5309E+04	1.2317E+02			
			-1.5896E+05	6.5622E+04	2.6887E+00			
			-1.5896E+05	5.9060E+04	6.8789E+03			
			-1.5896E+05	5.2498E+04	2.1691E+04			
			-1.5896E+05	4.5936E+04	4.8180E+04			
			-1.5896E+05	3.9373E+04	9.0605E+04			
			-1.5896E+05	3.2811E+04	1.4506E+05			
			-1.5896E+05	2.6249E+04	2.0348E+05			
			-1.5896E+05	1.9687E+04	2.0905E+05			
			-1.5896E+05	1.3124E+04	2.2381E+05			
			-1.5896E+05	6.5622E+03	2.9209E+05			
			-1.5896E+05	0.0000E+00	1.4413E+06			
			-1.6636E+05	3.9373E+04	6.4900E+03			
			-1.6636E+05	3.2811E+04	5.8110E+03			
			-1.6636E+05	2.6249E+04	2.4177E+04			
			-1.6636E+05	1.9687E+04	1.4921E+04			
			-1.6636E+05	1.3124E+04	3.3061E+03			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices								
Tower shear, bottom F_y [kN]			**Tower bending, bottom M_x [kNm]**			**Tower torsion, bottom M_z [kNm]**		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
			-1.6636E+05	6.5622E+03	1.4924E+04			
			-1.6636E+05	0.0000E+00	2.8750E+05			
			-1.7377E+05	2.6249E+04	2.6887E+00			
			-1.7377E+05	1.3124E+04	2.6887E+00			
			-1.7377E+05	6.5622E+03	2.6887E+00			
			-1.7377E+05	0.0000E+00	3.6915E+04			

Table 5-12 [2] Markov Matrix

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Appendix E. Markov matrices – issued from [3]

This appendix contains the Markov Matrices for the shear force, the bending moment and the torsional moment in the bottom of the tower, from ref. [3]. Foundation design must be verified for the most critical Markov matrices.

Markov Matrices								
Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.3806E+03	5.0813E+01	1.3121E+03	1.4965E+05	1.2504E+04	3.3608E+00	8.3937E+03	0.0000E+00	3.3608E+00
1.3806E+03	0.0000E+00	3.1789E+02	1.4257E+05	0.0000E+00	3.3608E+00	7.9479E+03	3.6156E+02	3.5000E+00
1.3200E+03	1.0163E+02	3.0884E+02	1.2840E+05	0.0000E+00	3.3608E+00	7.9479E+03	0.0000E+00	3.3608E+00
1.3200E+03	5.0813E+01	3.3608E+00	1.2132E+05	0.0000E+00	1.0082E+01	7.5021E+03	0.0000E+00	6.8608E+00
1.3200E+03	0.0000E+00	2.5522E+03	1.1424E+05	6.2522E+03	3.3608E+00	7.0564E+03	1.0847E+03	3.5000E+00
1.2594E+03	1.0163E+02	2.8034E+03	1.1424E+05	0.0000E+00	1.0082E+01	7.0564E+03	0.0000E+00	2.9636E+01
1.2594E+03	5.0813E+01	6.1491E+02	1.0716E+05	0.0000E+00	6.7216E+00	6.6106E+03	2.1693E+03	3.5000E+00
1.2594E+03	0.0000E+00	1.6658E+04	1.0007E+05	1.8757E+04	3.3608E+00	6.6106E+03	3.6156E+02	1.0032E+02
1.1988E+03	1.5244E+02	3.3576E+03	1.0007E+05	1.2504E+04	3.3608E+00	6.6106E+03	0.0000E+00	1.3722E+01
1.1988E+03	1.0163E+02	8.9134E+03	1.0007E+05	6.2522E+03	1.0082E+01	6.1649E+03	2.8925E+03	3.3608E+00
1.1988E+03	5.0813E+01	2.4482E+04	1.0007E+05	0.0000E+00	1.3582E+01	6.1649E+03	2.5309E+03	7.0000E+00
1.1988E+03	0.0000E+00	1.1506E+05	9.2992E+04	1.2504E+04	1.3582E+01	6.1649E+03	1.8078E+03	1.1125E-01
1.1382E+03	2.0325E+02	1.4770E+03	9.2992E+04	6.2522E+03	6.8608E+00	6.1649E+03	1.4462E+03	3.5000E+00
1.1382E+03	1.5244E+02	2.6733E+03	9.2992E+04	0.0000E+00	4.0603E+01	6.1649E+03	1.0847E+03	3.5000E+00
1.1382E+03	1.0163E+02	4.5094E+04	8.5909E+04	2.5009E+04	3.5000E+00	6.1649E+03	7.2311E+02	7.0350E+02
1.1382E+03	5.0813E+01	1.9060E+05	8.5909E+04	1.8757E+04	1.3722E+01	6.1649E+03	3.6156E+02	1.7082E+01
1.1382E+03	0.0000E+00	5.7840E+05	8.5909E+04	1.2504E+04	1.7222E+01	6.1649E+03	0.0000E+00	5.5412E+02
1.0777E+03	3.5569E+02	5.4330E+02	8.5909E+04	6.2522E+03	2.0443E+01	5.7191E+03	4.7002E+03	3.5000E+00
1.0777E+03	3.0488E+02	8.3702E+01	8.5909E+04	0.0000E+00	4.0443E+01	5.7191E+03	3.9771E+03	3.5000E+00
1.0777E+03	2.5407E+02	9.3382E+03	7.8827E+04	1.8757E+04	7.0000E+00	5.7191E+03	3.2540E+03	3.5000E+00
1.0777E+03	2.0325E+02	5.8095E+03	7.8827E+04	1.2504E+04	3.5000E+00	5.7191E+03	2.5309E+03	3.3608E+00
1.0777E+03	1.5244E+02	4.7996E+04	7.8827E+04	6.2522E+03	5.1219E+01	5.7191E+03	7.2311E+02	1.7500E+00
1.0777E+03	1.0163E+02	2.6608E+05	7.8827E+04	0.0000E+00	5.8804E+01	5.7191E+03	3.6156E+02	4.1925E+03
1.0777E+03	5.0813E+01	8.4088E+05	7.1744E+04	1.6881E+05	1.6804E+00	5.7191E+03	0.0000E+00	6.4222E+03
1.0777E+03	0.0000E+00	1.8514E+06	7.1744E+04	3.1261E+04	3.5000E+00	5.2733E+03	3.6156E+03	3.3608E+00
1.0171E+03	8.1302E+02	1.1792E+03	7.1744E+04	1.8757E+04	1.7361E+01	5.2733E+03	2.5309E+03	3.5000E+00
1.0171E+03	7.6220E+02	1.6804E+00	7.1744E+04	1.2504E+04	1.7222E+01	5.2733E+03	2.1693E+03	7.0000E+00
1.0171E+03	6.0976E+02	4.8094E+03	7.1744E+04	6.2522E+03	5.7908E+01	5.2733E+03	1.8078E+03	3.5000E+00
1.0171E+03	5.5895E+02	1.4000E+03	7.1744E+04	0.0000E+00	9.9655E+01	5.2733E+03	1.0847E+03	3.5000E+00
1.0171E+03	5.0813E+02	2.1781E+04	6.4661E+04	1.6881E+05	1.6804E+00	5.2733E+03	3.6156E+02	4.5310E+03
1.0171E+03	4.5732E+02	3.8933E+04	6.4661E+04	6.2522E+04	3.3608E+00	5.2733E+03	0.0000E+00	2.0953E+04
1.0171E+03	4.0651E+02	3.3172E+04	6.4661E+04	5.0018E+04	3.3608E+00	4.8276E+03	6.5080E+03	3.5000E+00
1.0171E+03	3.5569E+02	2.0452E+04	6.4661E+04	4.3765E+04	3.5000E+00	4.8276E+03	6.1465E+03	3.5000E+00
1.0171E+03	3.0488E+02	4.2974E+04	6.4661E+04	3.7513E+04	3.5000E+00	4.8276E+03	5.7849E+03	3.5000E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Energy Systems Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0171E+03	2.5407E+02	3.4215E+04	6.4661E+04	3.1261E+04	3.5000E+00	4.8276E+03	3.9771E+03	3.3608E+00
1.0171E+03	2.0325E+02	1.2016E+05	6.4661E+04	2.5009E+04	6.8608E+00	4.8276E+03	2.5309E+03	1.2446E+01
1.0171E+03	1.5244E+02	2.3576E+05	6.4661E+04	1.8757E+04	1.1611E+01	4.8276E+03	2.1693E+03	3.3608E+00
1.0171E+03	1.0163E+02	1.0049E+06	6.4661E+04	1.2504E+04	2.0722E+01	4.8276E+03	1.4462E+03	3.4551E+03
1.0171E+03	5.0813E+01	3.1010E+06	6.4661E+04	6.2522E+03	2.3804E+01	4.8276E+03	1.0847E+03	1.5180E+04
1.0171E+03	0.0000E+00	5.1130E+06	6.4661E+04	0.0000E+00	6.1775E+01	4.8276E+03	7.2311E+02	1.4943E+04
9.5651E+02	1.0163E+03	7.0000E+02	5.7579E+04	1.6881E+05	1.6804E+00	4.8276E+03	3.6156E+02	3.8974E+04
9.5651E+02	9.1464E+02	1.1757E+03	5.7579E+04	1.5630E+05	1.6804E+00	4.8276E+03	0.0000E+00	1.6944E+05
9.5651E+02	8.6383E+02	1.7500E+00	5.7579E+04	1.3755E+05	1.7500E+00	4.3818E+03	5.7849E+03	2.3602E+00
9.5651E+02	8.1302E+02	2.3584E+03	5.7579E+04	5.0018E+04	3.3608E+00	4.3818E+03	5.4234E+03	3.3608E+00
9.5651E+02	7.6220E+02	4.7327E+03	5.7579E+04	3.7513E+04	6.8608E+00	4.3818E+03	5.0618E+03	6.7216E+00
9.5651E+02	7.1139E+02	1.5216E+04	5.7579E+04	3.1261E+04	1.7222E+01	4.3818E+03	4.7002E+03	3.3608E+00
9.5651E+02	6.6057E+02	2.1295E+04	5.7579E+04	2.5009E+04	1.7222E+01	4.3818E+03	3.9771E+03	3.5000E+00
9.5651E+02	6.0976E+02	4.0550E+04	5.7579E+04	1.8757E+04	1.0361E+01	4.3818E+03	3.6156E+03	6.8608E+00
9.5651E+02	5.5895E+02	1.3055E+05	5.7579E+04	1.2504E+04	2.4082E+01	4.3818E+03	3.2540E+03	2.6275E+01
9.5651E+02	5.0813E+02	2.2215E+05	5.7579E+04	6.2522E+03	5.2214E+01	4.3818E+03	2.8925E+03	1.1050E+03
9.5651E+02	4.5732E+02	3.6698E+05	5.7579E+04	0.0000E+00	6.7490E+01	4.3818E+03	2.5309E+03	4.2966E+03
9.5651E+02	4.0651E+02	4.2490E+05	5.0496E+04	1.6256E+05	1.6804E+00	4.3818E+03	2.1693E+03	3.1816E+03
9.5651E+02	3.5569E+02	5.9431E+05	5.0496E+04	1.5005E+05	3.3608E+00	4.3818E+03	1.8078E+03	1.4686E+04
9.5651E+02	3.0488E+02	6.3911E+05	5.0496E+04	1.4380E+05	1.6804E+00	4.3818E+03	1.4462E+03	2.2591E+04
9.5651E+02	2.5407E+02	7.4520E+05	5.0496E+04	1.3755E+05	3.3608E+00	4.3818E+03	1.0847E+03	2.3256E+04
9.5651E+02	2.0325E+02	1.0165E+06	5.0496E+04	1.3130E+05	6.7216E+00	4.3818E+03	7.2311E+02	3.3930E+04
9.5651E+02	1.5244E+02	1.8231E+06	5.0496E+04	1.2504E+05	1.6804E+00	4.3818E+03	3.6156E+02	2.0049E+05
9.5651E+02	1.0163E+02	4.2390E+06	5.0496E+04	1.1254E+05	1.7500E+00	4.3818E+03	0.0000E+00	3.6822E+05
9.5651E+02	5.0813E+01	9.5548E+06	5.0496E+04	9.3783E+04	3.3608E+00	3.9361E+03	6.8696E+03	3.3608E+00
9.5651E+02	0.0000E+00	1.2250E+07	5.0496E+04	8.1279E+04	3.3608E+00	3.9361E+03	6.5080E+03	9.0118E+00
8.9593E+02	1.5752E+03	2.9393E+02	5.0496E+04	6.2522E+04	4.6108E+00	3.9361E+03	6.1465E+03	6.7216E+00
8.9593E+02	1.5244E+03	4.2607E+02	5.0496E+04	5.0018E+04	3.5000E+00	3.9361E+03	5.7849E+03	2.5826E+02
8.9593E+02	1.4736E+03	2.7165E+02	5.0496E+04	4.3765E+04	3.3608E+00	3.9361E+03	5.0618E+03	9.0728E+02
8.9593E+02	1.2195E+03	2.7165E+02	5.0496E+04	3.7513E+04	4.7500E+00	3.9361E+03	4.7002E+03	1.0718E+02
8.9593E+02	1.1687E+03	1.0389E+03	5.0496E+04	3.1261E+04	1.0361E+01	3.9361E+03	4.3387E+03	6.7216E+00
8.9593E+02	1.1179E+03	8.5382E+02	5.0496E+04	2.5009E+04	2.0972E+01	3.9361E+03	3.9771E+03	1.4034E+03
8.9593E+02	1.0671E+03	3.1220E+02	5.0496E+04	1.8757E+04	2.4222E+01	3.9361E+03	3.6156E+03	6.7151E+03
8.9593E+02	1.0163E+03	3.5161E+03	5.0496E+04	1.2504E+04	2.7694E+01	3.9361E+03	3.2540E+03	1.2498E+04
8.9593E+02	9.6546E+02	1.7811E+04	5.0496E+04	6.2522E+03	5.3596E+01	3.9361E+03	2.8925E+03	1.4131E+04
8.9593E+02	9.1464E+02	1.4008E+04	5.0496E+04	0.0000E+00	8.6852E+01	3.9361E+03	2.5309E+03	1.8092E+04
8.9593E+02	8.6383E+02	1.5573E+04	4.3414E+04	1.6881E+05	1.6804E+00	3.9361E+03	2.1693E+03	5.1201E+04
8.9593E+02	8.1302E+02	5.4323E+04	4.3414E+04	1.6256E+05	1.6804E+00	3.9361E+03	1.8078E+03	8.1447E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.9593E+02	7.6220E+02	8.8227E+04	4.3414E+04	1.5005E+05	1.6804E+00	3.9361E+03	1.4462E+03	5.5275E+04
8.9593E+02	7.1139E+02	1.3022E+05	4.3414E+04	1.4380E+05	1.6804E+00	3.9361E+03	1.0847E+03	1.0664E+05
8.9593E+02	6.6057E+02	2.8214E+05	4.3414E+04	1.3755E+05	1.6804E+00	3.9361E+03	7.2311E+02	1.1448E+05
8.9593E+02	6.0976E+02	4.6940E+05	4.3414E+04	1.3130E+05	3.5000E+00	3.9361E+03	3.6156E+02	3.9405E+05
8.9593E+02	5.5895E+02	7.4057E+05	4.3414E+04	1.2504E+05	3.3608E+00	3.9361E+03	0.0000E+00	8.5858E+05
8.9593E+02	5.0813E+02	1.2131E+06	4.3414E+04	1.1879E+05	7.0000E+00	3.4903E+03	6.8696E+03	3.3608E+00
8.9593E+02	4.5732E+02	1.9557E+06	4.3414E+04	1.1254E+05	3.5000E+00	3.4903E+03	5.7849E+03	1.1125E-01
8.9593E+02	4.0651E+02	2.3031E+06	4.3414E+04	1.0629E+05	1.6804E+00	3.4903E+03	5.4234E+03	1.4678E+03
8.9593E+02	3.5569E+02	3.0495E+06	4.3414E+04	6.8774E+04	3.3608E+00	3.4903E+03	5.0618E+03	1.8859E+04
8.9593E+02	3.0488E+02	3.3598E+06	4.3414E+04	6.2522E+04	1.3582E+01	3.4903E+03	4.7002E+03	1.9743E+01
8.9593E+02	2.5407E+02	4.0521E+06	4.3414E+04	5.6270E+04	3.5000E+00	3.4903E+03	4.3387E+03	8.7216E+03
8.9593E+02	2.0325E+02	3.7255E+06	4.3414E+04	5.0018E+04	3.5000E+00	3.4903E+03	3.9771E+03	1.7793E+04
8.9593E+02	1.5244E+02	5.3307E+06	4.3414E+04	4.3765E+04	3.3608E+00	3.4903E+03	3.6156E+03	2.5910E+04
8.9593E+02	1.0163E+02	9.5058E+06	4.3414E+04	3.7513E+04	1.7361E+01	3.4903E+03	3.2540E+03	7.2728E+04
8.9593E+02	5.0813E+01	1.8681E+07	4.3414E+04	3.1261E+04	3.5000E+00	3.4903E+03	2.8925E+03	9.7309E+04
8.9593E+02	0.0000E+00	2.1839E+07	4.3414E+04	2.5009E+04	2.7443E+01	3.4903E+03	2.5309E+03	1.9782E+05
8.3535E+02	1.6768E+03	1.5442E+02	4.3414E+04	1.8757E+04	2.4194E+01	3.4903E+03	2.1693E+03	1.9647E+05
8.3535E+02	1.4736E+03	7.0000E+02	4.3414E+04	1.2504E+04	8.5137E+01	3.4903E+03	1.8078E+03	2.2603E+05
8.3535E+02	1.4228E+03	3.5855E+02	4.3414E+04	6.2522E+03	5.4798E+01	3.4903E+03	1.4462E+03	1.8430E+05
8.3535E+02	1.3720E+03	1.0585E+03	4.3414E+04	0.0000E+00	4.0834E+03	3.4903E+03	1.0847E+03	1.8095E+05
8.3535E+02	1.3211E+03	2.2141E+03	3.6331E+04	1.8757E+05	1.6804E+00	3.4903E+03	7.2311E+02	3.2963E+05
8.3535E+02	1.2703E+03	1.5149E+03	3.6331E+04	1.6256E+05	1.7500E+00	3.4903E+03	3.6156E+02	1.0101E+06
8.3535E+02	1.2195E+03	2.2021E+03	3.6331E+04	1.5630E+05	1.7500E+00	3.4903E+03	0.0000E+00	1.9480E+06
8.3535E+02	1.1687E+03	3.8907E+03	3.6331E+04	1.5005E+05	1.7500E+00	3.0445E+03	1.3016E+04	1.6804E+00
8.3535E+02	1.1179E+03	8.1828E+03	3.6331E+04	1.4380E+05	3.5000E+00	3.0445E+03	1.1931E+04	1.6804E+00
8.3535E+02	1.0671E+03	1.7737E+04	3.6331E+04	1.3755E+05	8.4716E+00	3.0445E+03	1.0847E+04	1.7500E+00
8.3535E+02	1.0163E+03	3.6863E+04	3.6331E+04	1.3130E+05	6.8608E+00	3.0445E+03	9.7620E+03	1.6804E+00
8.3535E+02	9.6546E+02	5.4165E+04	3.6331E+04	1.2504E+05	1.2111E+01	3.0445E+03	6.5080E+03	1.0211E+03
8.3535E+02	9.1464E+02	1.3974E+05	3.6331E+04	1.1879E+05	1.0361E+01	3.0445E+03	6.1465E+03	3.0878E+03
8.3535E+02	8.6383E+02	1.2550E+05	3.6331E+04	1.1254E+05	5.1108E+00	3.0445E+03	5.7849E+03	4.8332E+03
8.3535E+02	8.1302E+02	2.3861E+05	3.6331E+04	1.0629E+05	3.5000E+00	3.0445E+03	5.4234E+03	2.4330E+04
8.3535E+02	7.6220E+02	3.6867E+05	3.6331E+04	1.0004E+05	3.5000E+00	3.0445E+03	5.0618E+03	2.3773E+04
8.3535E+02	7.1139E+02	5.4133E+05	3.6331E+04	9.3783E+04	5.2500E+00	3.0445E+03	4.7002E+03	5.5160E+04
8.3535E+02	6.6057E+02	8.6561E+05	3.6331E+04	7.5026E+04	3.5000E+00	3.0445E+03	4.3387E+03	6.8786E+04
8.3535E+02	6.0976E+02	1.3678E+06	3.6331E+04	6.8774E+04	7.0000E+00	3.0445E+03	3.9771E+03	1.3060E+05
8.3535E+02	5.5895E+02	1.9644E+06	3.6331E+04	6.2522E+04	1.0500E+01	3.0445E+03	3.6156E+03	1.6984E+05
8.3535E+02	5.0813E+02	2.5610E+06	3.6331E+04	5.6270E+04	3.3608E+00	3.0445E+03	3.2540E+03	2.6996E+05
8.3535E+02	4.5732E+02	3.6094E+06	3.6331E+04	5.0018E+04	2.0722E+01	3.0445E+03	2.8925E+03	2.5296E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.3535E+02	4.0651E+02	4.5996E+06	3.6331E+04	4.3765E+04	1.7222E+01	3.0445E+03	2.5309E+03	3.3340E+05
8.3535E+02	3.5569E+02	5.7318E+06	3.6331E+04	3.7513E+04	2.4361E+01	3.0445E+03	2.1693E+03	2.1330E+05
8.3535E+02	3.0488E+02	5.9725E+06	3.6331E+04	3.1261E+04	5.9941E+01	3.0445E+03	1.8078E+03	3.5127E+05
8.3535E+02	2.5407E+02	6.8024E+06	3.6331E+04	2.5009E+04	6.4547E+01	3.0445E+03	1.4462E+03	2.5905E+05
8.3535E+02	2.0325E+02	7.1662E+06	3.6331E+04	1.8757E+04	1.0677E+02	3.0445E+03	1.0847E+03	3.1674E+05
8.3535E+02	1.5244E+02	8.4461E+06	3.6331E+04	1.2504E+04	1.3274E+02	3.0445E+03	7.2311E+02	7.4603E+05
8.3535E+02	1.0163E+02	1.5381E+07	3.6331E+04	6.2522E+03	3.3439E+02	3.0445E+03	3.6156E+02	1.7801E+06
8.3535E+02	5.0813E+01	2.8423E+07	3.6331E+04	0.0000E+00	4.3700E+03	3.0445E+03	0.0000E+00	3.2411E+06
8.3535E+02	0.0000E+00	3.1891E+07	2.9248E+04	1.5630E+05	6.2500E-01	2.5988E+03	1.2293E+04	1.6804E+00
7.7478E+02	1.8801E+03	1.7557E+02	2.9248E+04	1.4380E+05	3.4304E+00	2.5988E+03	1.1931E+04	3.4304E+00
7.7478E+02	1.8293E+03	1.7557E+02	2.9248E+04	1.3755E+05	1.7500E+00	2.5988E+03	1.1208E+04	1.6804E+00
7.7478E+02	1.6260E+03	7.1715E+02	2.9248E+04	1.3130E+05	3.4304E+00	2.5988E+03	1.0847E+04	1.7500E+00
7.7478E+02	1.5752E+03	4.8768E+02	2.9248E+04	1.2504E+05	1.6804E+00	2.5988E+03	1.0124E+04	1.7500E+00
7.7478E+02	1.4736E+03	7.8660E+01	2.9248E+04	1.1879E+05	7.0000E+00	2.5988E+03	9.7620E+03	3.4304E+00
7.7478E+02	1.4228E+03	2.1349E+03	2.9248E+04	1.1254E+05	1.7500E+00	2.5988E+03	9.4005E+03	3.5000E+00
7.7478E+02	1.3720E+03	2.5701E+03	2.9248E+04	1.0629E+05	1.2111E+01	2.5988E+03	8.6774E+03	1.6804E+00
7.7478E+02	1.3211E+03	1.1958E+04	2.9248E+04	9.3783E+04	1.7500E+00	2.5988E+03	7.9543E+03	3.5000E+00
7.7478E+02	1.2703E+03	5.8261E+03	2.9248E+04	8.7531E+04	1.2250E+01	2.5988E+03	7.5927E+03	3.5000E+00
7.7478E+02	1.2195E+03	1.4017E+04	2.9248E+04	8.1279E+04	6.8608E+00	2.5988E+03	7.2311E+03	1.7320E+03
7.7478E+02	1.1687E+03	2.8258E+04	2.9248E+04	7.5026E+04	3.5000E+00	2.5988E+03	6.8696E+03	6.5435E+03
7.7478E+02	1.1179E+03	4.0503E+04	2.9248E+04	6.8774E+04	3.9277E+01	2.5988E+03	6.5080E+03	4.2567E+03
7.7478E+02	1.0671E+03	5.9193E+04	2.9248E+04	6.2522E+04	3.5000E+00	2.5988E+03	6.1465E+03	1.1948E+04
7.7478E+02	1.0163E+03	9.6862E+04	2.9248E+04	5.6270E+04	2.4082E+01	2.5988E+03	5.7849E+03	3.9142E+04
7.7478E+02	9.6546E+02	1.4888E+05	2.9248E+04	5.0018E+04	2.4361E+01	2.5988E+03	5.4234E+03	4.1744E+04
7.7478E+02	9.1464E+02	1.9978E+05	2.9248E+04	4.3765E+04	4.7052E+01	2.5988E+03	5.0618E+03	9.8433E+04
7.7478E+02	8.6383E+02	3.1639E+05	2.9248E+04	3.7513E+04	6.2832E+01	2.5988E+03	4.7002E+03	1.6667E+05
7.7478E+02	8.1302E+02	4.8107E+05	2.9248E+04	3.1261E+04	3.8222E+01	2.5988E+03	4.3387E+03	2.1441E+05
7.7478E+02	7.6220E+02	5.7255E+05	2.9248E+04	2.5009E+04	4.2878E+03	2.5988E+03	3.9771E+03	3.0756E+05
7.7478E+02	7.1139E+02	8.4412E+05	2.9248E+04	1.8757E+04	9.4032E+01	2.5988E+03	3.6156E+03	4.1955E+05
7.7478E+02	6.6057E+02	1.0929E+06	2.9248E+04	1.2504E+04	1.7203E+04	2.5988E+03	3.2540E+03	3.8118E+05
7.7478E+02	6.0976E+02	1.7640E+06	2.9248E+04	6.2522E+03	7.3602E+03	2.5988E+03	2.8925E+03	4.7571E+05
7.7478E+02	5.5895E+02	2.4693E+06	2.9248E+04	0.0000E+00	3.1755E+04	2.5988E+03	2.5309E+03	6.9838E+05
7.7478E+02	5.0813E+02	3.2638E+06	2.2166E+04	1.5005E+05	1.7500E+00	2.5988E+03	2.1693E+03	5.4698E+05
7.7478E+02	4.5732E+02	4.0634E+06	2.2166E+04	1.4380E+05	1.6804E+00	2.5988E+03	1.8078E+03	5.6169E+05
7.7478E+02	4.0651E+02	5.3929E+06	2.2166E+04	1.3755E+05	2.3750E+00	2.5988E+03	1.4462E+03	5.4356E+05
7.7478E+02	3.5569E+02	6.1527E+06	2.2166E+04	1.3130E+05	1.7500E+00	2.5988E+03	1.0847E+03	5.9995E+05
7.7478E+02	3.0488E+02	6.8726E+06	2.2166E+04	1.2504E+05	7.4858E+00	2.5988E+03	7.2311E+02	1.1493E+06
7.7478E+02	2.5407E+02	6.9311E+06	2.2166E+04	1.1879E+05	1.7500E+00	2.5988E+03	3.6156E+02	2.9070E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.7478E+02	2.0325E+02	7.3333E+06	2.2166E+04	1.1254E+05	1.0500E+01	2.5988E+03	0.0000E+00	5.7970E+06
7.7478E+02	1.5244E+02	9.2989E+06	2.2166E+04	1.0629E+05	4.1250E+00	2.1530E+03	1.3378E+04	1.6804E+00
7.7478E+02	1.0163E+02	1.6869E+07	2.2166E+04	1.0004E+05	1.6804E+00	2.1530E+03	1.2293E+04	5.2500E+00
7.7478E+02	5.0813E+01	3.2659E+07	2.2166E+04	9.3783E+04	3.4304E+00	2.1530E+03	1.1931E+04	1.6804E+00
7.7478E+02	0.0000E+00	3.6210E+07	2.2166E+04	8.7531E+04	5.2500E+00	2.1530E+03	1.1570E+04	1.6804E+00
7.1420E+02	1.9309E+03	7.6980E+01	2.2166E+04	8.1279E+04	1.3930E+01	2.1530E+03	1.0124E+04	1.6804E+00
7.1420E+02	1.8293E+03	2.9393E+02	2.2166E+04	7.5026E+04	1.3861E+01	2.1530E+03	9.4005E+03	7.9730E+00
7.1420E+02	1.7785E+03	7.6980E+01	2.2166E+04	6.8774E+04	3.2080E+01	2.1530E+03	9.0389E+03	1.3570E+01
7.1420E+02	1.6768E+03	1.1355E+03	2.2166E+04	6.2522E+04	2.6890E+01	2.1530E+03	8.6774E+03	4.1102E+00
7.1420E+02	1.6260E+03	1.1987E+03	2.2166E+04	5.6270E+04	8.5276E+01	2.1530E+03	8.3158E+03	1.4300E+03
7.1420E+02	1.5752E+03	9.6313E+02	2.2166E+04	5.0018E+04	1.4061E+02	2.1530E+03	7.9543E+03	3.6612E+03
7.1420E+02	1.5244E+03	1.4263E+03	2.2166E+04	4.3765E+04	1.6011E+02	2.1530E+03	7.5927E+03	5.0668E+03
7.1420E+02	1.4736E+03	3.7917E+03	2.2166E+04	3.7513E+04	1.6275E+02	2.1530E+03	7.2311E+03	8.2920E+03
7.1420E+02	1.4228E+03	5.3316E+03	2.2166E+04	3.1261E+04	1.8746E+02	2.1530E+03	6.8696E+03	3.7734E+04
7.1420E+02	1.3720E+03	1.3599E+04	2.2166E+04	2.5009E+04	4.6933E+03	2.1530E+03	6.5080E+03	4.0772E+04
7.1420E+02	1.3211E+03	1.2806E+04	2.2166E+04	1.8757E+04	4.8421E+03	2.1530E+03	6.1465E+03	3.9849E+04
7.1420E+02	1.2703E+03	2.1450E+04	2.2166E+04	1.2504E+04	9.4761E+03	2.1530E+03	5.7849E+03	1.0963E+05
7.1420E+02	1.2195E+03	3.0682E+04	2.2166E+04	6.2522E+03	3.4817E+04	2.1530E+03	5.4234E+03	1.8664E+05
7.1420E+02	1.1687E+03	4.3882E+04	2.2166E+04	0.0000E+00	6.4301E+04	2.1530E+03	5.0618E+03	1.6448E+05
7.1420E+02	1.1179E+03	5.5725E+04	1.5083E+04	1.7506E+05	1.6804E+00	2.1530E+03	4.7002E+03	2.1103E+05
7.1420E+02	1.0671E+03	9.1482E+04	1.5083E+04	1.5630E+05	6.2500E-01	2.1530E+03	4.3387E+03	3.4120E+05
7.1420E+02	1.0163E+03	1.5752E+05	1.5083E+04	1.3755E+05	2.3054E+00	2.1530E+03	3.9771E+03	3.9713E+05
7.1420E+02	9.6546E+02	1.5428E+05	1.5083E+04	1.3130E+05	2.9304E+00	2.1530E+03	3.6156E+03	5.5070E+05
7.1420E+02	9.1464E+02	2.1091E+05	1.5083E+04	1.2504E+05	6.8063E-01	2.1530E+03	3.2540E+03	6.7497E+05
7.1420E+02	8.6383E+02	3.3218E+05	1.5083E+04	1.1879E+05	4.0554E+00	2.1530E+03	2.8925E+03	8.2999E+05
7.1420E+02	8.1302E+02	5.3720E+05	1.5083E+04	1.1254E+05	6.2500E-01	2.1530E+03	2.5309E+03	9.0174E+05
7.1420E+02	7.6220E+02	6.8002E+05	1.5083E+04	1.0004E+05	6.2500E-01	2.1530E+03	2.1693E+03	9.3528E+05
7.1420E+02	7.1139E+02	1.0829E+06	1.5083E+04	9.3783E+04	3.1917E+01	2.1530E+03	1.8078E+03	1.1027E+06
7.1420E+02	6.6057E+02	1.3843E+06	1.5083E+04	8.7531E+04	2.3054E+00	2.1530E+03	1.4462E+03	1.1261E+06
7.1420E+02	6.0976E+02	1.8555E+06	1.5083E+04	8.1279E+04	5.2875E+00	2.1530E+03	1.0847E+03	1.3138E+06
7.1420E+02	5.5895E+02	2.6800E+06	1.5083E+04	7.5026E+04	4.1846E+01	2.1530E+03	7.2311E+02	2.1001E+06
7.1420E+02	5.0813E+02	3.4268E+06	1.5083E+04	6.8774E+04	2.2332E+01	2.1530E+03	3.6156E+02	4.6843E+06
7.1420E+02	4.5732E+02	4.4588E+06	1.5083E+04	6.2522E+04	3.6472E+01	2.1530E+03	0.0000E+00	8.8041E+06
7.1420E+02	4.0651E+02	5.8328E+06	1.5083E+04	5.6270E+04	1.1291E+02	1.7073E+03	1.6270E+04	1.6804E+00
7.1420E+02	3.5569E+02	6.8094E+06	1.5083E+04	5.0018E+04	2.3040E+03	1.7073E+03	1.1570E+04	1.6804E+00
7.1420E+02	3.0488E+02	7.2269E+06	1.5083E+04	4.3765E+04	4.5219E+03	1.7073E+03	1.0847E+04	7.9730E+00
7.1420E+02	2.5407E+02	7.2461E+06	1.5083E+04	3.7513E+04	2.5848E+03	1.7073E+03	1.0124E+04	5.4740E+02
7.1420E+02	2.0325E+02	7.7061E+06	1.5083E+04	3.1261E+04	1.1877E+04	1.7073E+03	9.7620E+03	2.7340E+02

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.1420E+02	1.5244E+02	9.1646E+06	1.5083E+04	2.5009E+04	5.2519E+03	1.7073E+03	9.4005E+03	2.6374E+03
7.1420E+02	1.0163E+02	1.5371E+07	1.5083E+04	1.8757E+04	5.0442E+03	1.7073E+03	9.0389E+03	2.4010E+03
7.1420E+02	5.0813E+01	3.1529E+07	1.5083E+04	1.2504E+04	4.1191E+04	1.7073E+03	8.6774E+03	8.5917E+03
7.1420E+02	0.0000E+00	3.8815E+07	1.5083E+04	6.2522E+03	4.6268E+04	1.7073E+03	8.3158E+03	5.7248E+03
6.5362E+02	2.1342E+03	2.6275E+01	1.5083E+04	0.0000E+00	4.1014E+05	1.7073E+03	7.9543E+03	1.7393E+04
6.5362E+02	2.0325E+03	7.6980E+01	8.0005E+03	1.6881E+05	5.5625E-02	1.7073E+03	7.5927E+03	2.4104E+04
6.5362E+02	1.9309E+03	5.4740E+02	8.0005E+03	1.5630E+05	5.5625E-02	1.7073E+03	7.2311E+03	3.1352E+04
6.5362E+02	1.8801E+03	9.0118E+01	8.0005E+03	1.5005E+05	5.5625E-02	1.7073E+03	6.8696E+03	4.2377E+04
6.5362E+02	1.7785E+03	1.0948E+03	8.0005E+03	1.3755E+05	3.9858E+00	1.7073E+03	6.5080E+03	1.0084E+05
6.5362E+02	1.7277E+03	1.0474E+03	8.0005E+03	1.3130E+05	6.2500E-01	1.7073E+03	6.1465E+03	1.4952E+05
6.5362E+02	1.6768E+03	1.0849E+03	8.0005E+03	1.1879E+05	3.3608E+00	1.7073E+03	5.7849E+03	2.2822E+05
6.5362E+02	1.6260E+03	7.9962E+03	8.0005E+03	1.1254E+05	1.6804E+00	1.7073E+03	5.4234E+03	2.9167E+05
6.5362E+02	1.5752E+03	2.0989E+03	8.0005E+03	1.0629E+05	6.2500E-01	1.7073E+03	5.0618E+03	3.0388E+05
6.5362E+02	1.5244E+03	1.8604E+03	8.0005E+03	1.0004E+05	9.8206E+02	1.7073E+03	4.7002E+03	4.6237E+05
6.5362E+02	1.4736E+03	1.8429E+04	8.0005E+03	9.3783E+04	2.9467E+03	1.7073E+03	4.3387E+03	5.1684E+05
6.5362E+02	1.4228E+03	9.5402E+03	8.0005E+03	8.7531E+04	1.9699E+03	1.7073E+03	3.9771E+03	6.5358E+05
6.5362E+02	1.3720E+03	1.4016E+04	8.0005E+03	8.1279E+04	2.9946E+03	1.7073E+03	3.6156E+03	8.2081E+05
6.5362E+02	1.3211E+03	2.3709E+04	8.0005E+03	7.5026E+04	5.9497E+03	1.7073E+03	3.2540E+03	1.1762E+06
6.5362E+02	1.2703E+03	3.8813E+04	8.0005E+03	6.8774E+04	8.9269E+03	1.7073E+03	2.8925E+03	1.2816E+06
6.5362E+02	1.2195E+03	6.2189E+04	8.0005E+03	6.2522E+04	1.2004E+04	1.7073E+03	2.5309E+03	1.2559E+06
6.5362E+02	1.1687E+03	5.9408E+04	8.0005E+03	5.6270E+04	8.0779E+03	1.7073E+03	2.1693E+03	1.6072E+06
6.5362E+02	1.1179E+03	9.9308E+04	8.0005E+03	5.0018E+04	1.8073E+04	1.7073E+03	1.8078E+03	1.3857E+06
6.5362E+02	1.0671E+03	1.2759E+05	8.0005E+03	4.3765E+04	1.0554E+04	1.7073E+03	1.4462E+03	1.7383E+06
6.5362E+02	1.0163E+03	1.9333E+05	8.0005E+03	3.7513E+04	2.5297E+04	1.7073E+03	1.0847E+03	2.0955E+06
6.5362E+02	9.6546E+02	2.3428E+05	8.0005E+03	3.1261E+04	6.1337E+04	1.7073E+03	7.2311E+02	2.9045E+06
6.5362E+02	9.1464E+02	4.3673E+05	8.0005E+03	2.5009E+04	1.0319E+05	1.7073E+03	3.6156E+02	6.7181E+06
6.5362E+02	8.6383E+02	5.1121E+05	8.0005E+03	1.8757E+04	2.6273E+05	1.7073E+03	0.0000E+00	1.3246E+07
6.5362E+02	8.1302E+02	6.4709E+05	8.0005E+03	1.2504E+04	6.6696E+05	1.2615E+03	1.4462E+04	1.6804E+00
6.5362E+02	7.6220E+02	7.7334E+05	8.0005E+03	6.2522E+03	1.0317E+06	1.2615E+03	1.3016E+04	5.0160E+01
6.5362E+02	7.1139E+02	1.3181E+06	8.0005E+03	0.0000E+00	4.9718E+06	1.2615E+03	1.2293E+04	1.7025E+02
6.5362E+02	6.6057E+02	1.7092E+06	9.1795E+02	3.1261E+05	1.6804E+00	1.2615E+03	1.1931E+04	3.7876E+01
6.5362E+02	6.0976E+02	2.4153E+06	9.1795E+02	2.8135E+05	1.6804E+00	1.2615E+03	1.1570E+04	2.1111E+01
6.5362E+02	5.5895E+02	2.9775E+06	9.1795E+02	2.6259E+05	1.6804E+00	1.2615E+03	1.1208E+04	1.0852E+01
6.5362E+02	5.0813E+02	3.8732E+06	9.1795E+02	1.6881E+05	1.7360E+00	1.2615E+03	1.0847E+04	2.1598E+02
6.5362E+02	4.5732E+02	4.8743E+06	9.1795E+02	1.6256E+05	1.1125E-01	1.2615E+03	1.0485E+04	3.1009E+03
6.5362E+02	4.0651E+02	5.5171E+06	9.1795E+02	1.5630E+05	6.2500E-01	1.2615E+03	1.0124E+04	1.2644E+01
6.5362E+02	3.5569E+02	6.1485E+06	9.1795E+02	1.5005E+05	5.5625E-02	1.2615E+03	9.7620E+03	1.1608E+04
6.5362E+02	3.0488E+02	6.0427E+06	9.1795E+02	1.4380E+05	5.5625E-02	1.2615E+03	9.4005E+03	3.9978E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.5362E+02	2.5407E+02	6.2556E+06	9.1795E+02	1.3130E+05	1.7916E+00	1.2615E+03	9.0389E+03	4.0781E+03
6.5362E+02	2.0325E+02	5.8133E+06	9.1795E+02	1.1879E+05	8.2660E-02	1.2615E+03	8.6774E+03	1.2384E+04
6.5362E+02	1.5244E+02	6.9579E+06	9.1795E+02	1.1254E+05	3.1806E+00	1.2615E+03	8.3158E+03	1.5264E+04
6.5362E+02	1.0163E+02	1.1999E+07	9.1795E+02	1.0629E+05	9.7861E+02	1.2615E+03	7.9543E+03	1.9094E+04
6.5362E+02	5.0813E+01	2.7226E+07	9.1795E+02	1.0004E+05	9.8304E+02	1.2615E+03	7.5927E+03	3.8459E+04
6.5362E+02	0.0000E+00	3.3234E+07	9.1795E+02	9.3783E+04	2.9753E+03	1.2615E+03	7.2311E+03	3.6245E+04
5.9304E+02	2.1850E+03	5.4740E+02	9.1795E+02	8.7531E+04	5.9460E+03	1.2615E+03	6.8696E+03	8.2501E+04
5.9304E+02	2.0834E+03	5.4740E+02	9.1795E+02	8.1279E+04	5.1108E+03	1.2615E+03	6.5080E+03	1.2829E+05
5.9304E+02	1.9817E+03	5.4740E+02	9.1795E+02	7.5026E+04	1.5855E+04	1.2615E+03	6.1465E+03	1.8598E+05
5.9304E+02	1.9309E+03	1.3193E+01	9.1795E+02	6.8774E+04	1.0895E+04	1.2615E+03	5.7849E+03	1.8720E+05
5.9304E+02	1.8801E+03	7.7728E+02	9.1795E+02	6.2522E+04	8.0150E+03	1.2615E+03	5.4234E+03	3.4697E+05
5.9304E+02	1.8293E+03	2.1238E+03	9.1795E+02	5.6270E+04	6.7519E+04	1.2615E+03	5.0618E+03	4.6332E+05
5.9304E+02	1.7785E+03	1.3070E+03	9.1795E+02	5.0018E+04	5.6542E+04	1.2615E+03	4.7002E+03	6.8284E+05
5.9304E+02	1.7277E+03	8.4610E+02	9.1795E+02	4.3765E+04	6.4537E+04	1.2615E+03	4.3387E+03	9.1216E+05
5.9304E+02	1.6768E+03	2.0097E+02	9.1795E+02	3.7513E+04	9.4184E+04	1.2615E+03	3.9771E+03	9.4645E+05
5.9304E+02	1.6260E+03	7.1416E+03	9.1795E+02	3.1261E+04	1.7161E+05	1.2615E+03	3.6156E+03	1.1482E+06
5.9304E+02	1.5752E+03	1.0298E+04	9.1795E+02	2.5009E+04	3.7994E+05	1.2615E+03	3.2540E+03	1.6402E+06
5.9304E+02	1.5244E+03	1.2828E+04	9.1795E+02	1.8757E+04	7.9562E+05	1.2615E+03	2.8925E+03	1.5868E+06
5.9304E+02	1.4736E+03	6.5167E+03	9.1795E+02	1.2504E+04	2.0607E+06	1.2615E+03	2.5309E+03	2.4446E+06
5.9304E+02	1.4228E+03	8.2083E+03	9.1795E+02	6.2522E+03	5.0035E+06	1.2615E+03	2.1693E+03	2.2496E+06
5.9304E+02	1.3720E+03	2.3411E+04	9.1795E+02	0.0000E+00	1.2084E+07	1.2615E+03	1.8078E+03	2.4619E+06
5.9304E+02	1.3211E+03	4.1361E+04	-6.1647E+03	3.1261E+05	1.6804E+00	1.2615E+03	1.4462E+03	2.7480E+06
5.9304E+02	1.2703E+03	3.7239E+04	-6.1647E+03	2.5009E+05	1.6804E+00	1.2615E+03	1.0847E+03	2.6945E+06
5.9304E+02	1.2195E+03	6.3113E+04	-6.1647E+03	1.7506E+05	6.2500E-01	1.2615E+03	7.2311E+02	4.1988E+06
5.9304E+02	1.1687E+03	7.8007E+04	-6.1647E+03	1.6256E+05	5.5625E-02	1.2615E+03	3.6156E+02	9.4301E+06
5.9304E+02	1.1179E+03	1.0198E+05	-6.1647E+03	1.5630E+05	5.5625E-02	1.2615E+03	0.0000E+00	1.9387E+07
5.9304E+02	1.0671E+03	1.4029E+05	-6.1647E+03	1.4380E+05	2.3054E+00	8.1575E+02	1.5909E+04	3.3820E+01
5.9304E+02	1.0163E+03	2.4853E+05	-6.1647E+03	1.3755E+05	7.3625E-01	8.1575E+02	1.4824E+04	3.5855E+02
5.9304E+02	9.6546E+02	3.3795E+05	-6.1647E+03	1.3130E+05	1.7916E+00	8.1575E+02	1.4462E+04	1.6804E+00
5.9304E+02	9.1464E+02	4.2074E+05	-6.1647E+03	1.2504E+05	1.7360E+00	8.1575E+02	1.3739E+04	4.5059E+00
5.9304E+02	8.6383E+02	5.9506E+05	-6.1647E+03	1.1879E+05	5.8198E+00	8.1575E+02	1.3378E+04	1.9411E+01
5.9304E+02	8.1302E+02	8.0149E+05	-6.1647E+03	1.1254E+05	2.9450E+00	8.1575E+02	1.3016E+04	3.9237E+02
5.9304E+02	7.6220E+02	1.0192E+06	-6.1647E+03	1.0629E+05	3.5222E+01	8.1575E+02	1.2655E+04	2.2573E+02
5.9304E+02	7.1139E+02	1.3216E+06	-6.1647E+03	1.0004E+05	1.0099E+03	8.1575E+02	1.2293E+04	1.3817E+03
5.9304E+02	6.6057E+02	1.8308E+06	-6.1647E+03	9.3783E+04	1.0339E+03	8.1575E+02	1.1931E+04	6.4038E+02
5.9304E+02	6.0976E+02	2.3536E+06	-6.1647E+03	8.7531E+04	2.1480E+03	8.1575E+02	1.1570E+04	1.2744E+02
5.9304E+02	5.5895E+02	2.7657E+06	-6.1647E+03	8.1279E+04	3.9215E+01	8.1575E+02	1.1208E+04	2.3898E+03
5.9304E+02	5.0813E+02	3.2351E+06	-6.1647E+03	7.5026E+04	4.6334E+03	8.1575E+02	1.0847E+04	8.1196E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.9304E+02	4.5732E+02	3.8953E+06	-6.1647E+03	6.8774E+04	6.9866E+03	8.1575E+02	1.0485E+04	9.2514E+03
5.9304E+02	4.0651E+02	4.2974E+06	-6.1647E+03	6.2522E+04	1.2182E+03	8.1575E+02	1.0124E+04	6.9585E+03
5.9304E+02	3.5569E+02	4.6973E+06	-6.1647E+03	5.6270E+04	2.1298E+03	8.1575E+02	9.7620E+03	4.9672E+03
5.9304E+02	3.0488E+02	4.4487E+06	-6.1647E+03	5.0018E+04	3.1828E+04	8.1575E+02	9.4005E+03	6.1536E+03
5.9304E+02	2.5407E+02	4.1445E+06	-6.1647E+03	4.3765E+04	1.0829E+05	8.1575E+02	9.0389E+03	1.4311E+04
5.9304E+02	2.0325E+02	3.9239E+06	-6.1647E+03	3.7513E+04	2.2180E+05	8.1575E+02	8.6774E+03	2.1339E+04
5.9304E+02	1.5244E+02	5.0412E+06	-6.1647E+03	3.1261E+04	4.2742E+05	8.1575E+02	8.3158E+03	5.2276E+04
5.9304E+02	1.0163E+02	8.7951E+06	-6.1647E+03	2.5009E+04	7.4510E+05	8.1575E+02	7.9543E+03	5.5489E+04
5.9304E+02	5.0813E+01	2.0281E+07	-6.1647E+03	1.8757E+04	1.0809E+06	8.1575E+02	7.5927E+03	7.0735E+04
5.9304E+02	0.0000E+00	2.8328E+07	-6.1647E+03	1.2504E+04	1.4270E+06	8.1575E+02	7.2311E+03	9.2953E+04
5.3246E+02	2.1342E+03	4.5788E+00	-6.1647E+03	6.2522E+03	1.7976E+06	8.1575E+02	6.8696E+03	9.2151E+04
5.3246E+02	2.0834E+03	3.8955E+01	-6.1647E+03	0.0000E+00	2.8708E+06	8.1575E+02	6.5080E+03	1.4031E+05
5.3246E+02	2.0325E+03	6.3953E+02	-1.3247E+04	2.9385E+05	3.3608E+00	8.1575E+02	6.1465E+03	2.0928E+05
5.3246E+02	1.9309E+03	1.1758E+03	-1.3247E+04	2.7510E+05	1.6804E+00	8.1575E+02	5.7849E+03	3.7938E+05
5.3246E+02	1.8801E+03	2.2774E+02	-1.3247E+04	2.6884E+05	5.1108E+00	8.1575E+02	5.4234E+03	4.0201E+05
5.3246E+02	1.8293E+03	3.6601E+02	-1.3247E+04	2.6259E+05	1.6804E+00	8.1575E+02	5.0618E+03	5.5375E+05
5.3246E+02	1.7785E+03	2.1483E+03	-1.3247E+04	2.4384E+05	3.5000E+00	8.1575E+02	4.7002E+03	7.8604E+05
5.3246E+02	1.7277E+03	3.2295E+03	-1.3247E+04	2.3133E+05	6.2500E-01	8.1575E+02	4.3387E+03	1.0435E+06
5.3246E+02	1.6768E+03	8.9327E+02	-1.3247E+04	2.0632E+05	1.2500E+00	8.1575E+02	3.9771E+03	1.2196E+06
5.3246E+02	1.6260E+03	5.8822E+03	-1.3247E+04	1.7506E+05	5.5625E-02	8.1575E+02	3.6156E+03	1.6316E+06
5.3246E+02	1.5752E+03	4.4138E+03	-1.3247E+04	1.6881E+05	1.1125E-01	8.1575E+02	3.2540E+03	1.7440E+06
5.3246E+02	1.5244E+03	1.2090E+04	-1.3247E+04	1.5630E+05	5.5625E-02	8.1575E+02	2.8925E+03	2.2799E+06
5.3246E+02	1.4736E+03	1.3179E+04	-1.3247E+04	1.5005E+05	1.6688E-01	8.1575E+02	2.5309E+03	3.0486E+06
5.3246E+02	1.4228E+03	1.2398E+04	-1.3247E+04	1.4380E+05	1.6804E+00	8.1575E+02	2.1693E+03	3.4887E+06
5.3246E+02	1.3720E+03	1.7116E+04	-1.3247E+04	1.3755E+05	2.4954E-01	8.1575E+02	1.8078E+03	3.7873E+06
5.3246E+02	1.3211E+03	3.4204E+04	-1.3247E+04	1.3130E+05	2.7225E+00	8.1575E+02	1.4462E+03	3.7819E+06
5.3246E+02	1.2703E+03	5.0337E+04	-1.3247E+04	1.2504E+05	2.7225E+00	8.1575E+02	1.0847E+03	4.3718E+06
5.3246E+02	1.2195E+03	6.3784E+04	-1.3247E+04	1.1879E+05	5.0063E-01	8.1575E+02	7.2311E+02	6.1952E+06
5.3246E+02	1.1687E+03	9.6691E+04	-1.3247E+04	1.1254E+05	1.9888E+01	8.1575E+02	3.6156E+02	1.3920E+07
5.3246E+02	1.1179E+03	8.9853E+04	-1.3247E+04	1.0629E+05	3.4334E+01	8.1575E+02	0.0000E+00	2.8251E+07
5.3246E+02	1.0671E+03	1.2025E+05	-1.3247E+04	1.0004E+05	4.8260E+01	3.6999E+02	1.5909E+04	3.9237E+02
5.3246E+02	1.0163E+03	1.6095E+05	-1.3247E+04	9.3783E+04	2.2017E+03	3.6999E+02	1.5185E+04	1.1801E+00
5.3246E+02	9.6546E+02	2.2017E+05	-1.3247E+04	8.7531E+04	5.9663E+01	3.6999E+02	1.4462E+04	1.6295E+02
5.3246E+02	9.1464E+02	3.2919E+05	-1.3247E+04	8.1279E+04	6.1703E+01	3.6999E+02	1.4101E+04	7.1851E+02
5.3246E+02	8.6383E+02	3.3896E+05	-1.3247E+04	7.5026E+04	2.1588E+02	3.6999E+02	1.3739E+04	1.2199E+03
5.3246E+02	8.1302E+02	5.7492E+05	-1.3247E+04	6.8774E+04	4.4986E+03	3.6999E+02	1.3378E+04	5.5396E+01
5.3246E+02	7.6220E+02	7.1184E+05	-1.3247E+04	6.2522E+04	4.2687E+03	3.6999E+02	1.3016E+04	2.7633E+03
5.3246E+02	7.1139E+02	9.5197E+05	-1.3247E+04	5.6270E+04	7.9741E+03	3.6999E+02	1.2655E+04	7.9501E+02

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.3246E+02	6.6057E+02	1.0954E+06	-1.3247E+04	5.0018E+04	4.0405E+04	3.6999E+02	1.2293E+04	1.9179E+03
5.3246E+02	6.0976E+02	1.3239E+06	-1.3247E+04	4.3765E+04	8.7703E+04	3.6999E+02	1.1931E+04	6.4120E+03
5.3246E+02	5.5895E+02	1.8467E+06	-1.3247E+04	3.7513E+04	3.0528E+05	3.6999E+02	1.1570E+04	1.2031E+04
5.3246E+02	5.0813E+02	2.0087E+06	-1.3247E+04	3.1261E+04	5.9714E+05	3.6999E+02	1.1208E+04	1.8954E+04
5.3246E+02	4.5732E+02	2.4132E+06	-1.3247E+04	2.5009E+04	1.1486E+06	3.6999E+02	1.0847E+04	4.5040E+04
5.3246E+02	4.0651E+02	2.6781E+06	-1.3247E+04	1.8757E+04	1.6813E+06	3.6999E+02	1.0485E+04	3.2675E+04
5.3246E+02	3.5569E+02	2.6444E+06	-1.3247E+04	1.2504E+04	2.4358E+06	3.6999E+02	1.0124E+04	4.0812E+04
5.3246E+02	3.0488E+02	3.1062E+06	-1.3247E+04	6.2522E+03	3.7252E+06	3.6999E+02	9.7620E+03	2.3348E+04
5.3246E+02	2.5407E+02	3.1279E+06	-1.3247E+04	0.0000E+00	3.1754E+06	3.6999E+02	9.4005E+03	4.7815E+04
5.3246E+02	2.0325E+02	3.4521E+06	-2.0330E+04	3.0636E+05	1.6804E+00	3.6999E+02	9.0389E+03	2.9799E+04
5.3246E+02	1.5244E+02	3.5762E+06	-2.0330E+04	2.9385E+05	1.6804E+00	3.6999E+02	8.6774E+03	3.9478E+04
5.3246E+02	1.0163E+02	5.6202E+06	-2.0330E+04	2.8760E+05	1.6804E+00	3.6999E+02	8.3158E+03	6.4996E+04
5.3246E+02	5.0813E+01	1.5766E+07	-2.0330E+04	2.8135E+05	1.1621E+01	3.6999E+02	7.9543E+03	6.9476E+04
5.3246E+02	0.0000E+00	2.7284E+07	-2.0330E+04	2.7510E+05	1.1552E+01	3.6999E+02	7.5927E+03	1.0121E+05
4.7189E+02	2.1850E+03	1.7271E+01	-2.0330E+04	2.6884E+05	3.4304E+00	3.6999E+02	7.2311E+03	1.4613E+05
4.7189E+02	2.1342E+03	1.7326E+01	-2.0330E+04	2.5009E+05	7.0000E+00	3.6999E+02	6.8696E+03	1.7267E+05
4.7189E+02	2.0834E+03	2.7955E+01	-2.0330E+04	2.4384E+05	5.2500E+00	3.6999E+02	6.5080E+03	2.7871E+05
4.7189E+02	2.0325E+03	5.6919E+02	-2.0330E+04	2.3758E+05	3.4304E+00	3.6999E+02	6.1465E+03	2.9507E+05
4.7189E+02	1.9817E+03	3.2521E+01	-2.0330E+04	2.3133E+05	1.7500E+00	3.6999E+02	5.7849E+03	4.3556E+05
4.7189E+02	1.9309E+03	1.2441E+03	-2.0330E+04	2.1883E+05	1.7500E+00	3.6999E+02	5.4234E+03	6.0001E+05
4.7189E+02	1.8801E+03	1.2635E+02	-2.0330E+04	2.1257E+05	3.0000E+00	3.6999E+02	5.0618E+03	8.2131E+05
4.7189E+02	1.8293E+03	9.2403E+02	-2.0330E+04	2.0007E+05	6.2500E-01	3.6999E+02	4.7002E+03	9.7506E+05
4.7189E+02	1.7785E+03	3.5393E+02	-2.0330E+04	1.9382E+05	5.5625E-02	3.6999E+02	4.3387E+03	1.2662E+06
4.7189E+02	1.7277E+03	3.1580E+03	-2.0330E+04	1.8757E+05	1.3056E+00	3.6999E+02	3.9771E+03	1.4976E+06
4.7189E+02	1.6768E+03	3.9779E+02	-2.0330E+04	1.8131E+05	5.5625E-02	3.6999E+02	3.6156E+03	1.8810E+06
4.7189E+02	1.6260E+03	1.0476E+03	-2.0330E+04	1.7506E+05	5.5625E-02	3.6999E+02	3.2540E+03	2.2271E+06
4.7189E+02	1.5752E+03	3.7814E+03	-2.0330E+04	1.6881E+05	5.5625E-02	3.6999E+02	2.8925E+03	2.6908E+06
4.7189E+02	1.5244E+03	2.4134E+03	-2.0330E+04	1.6256E+05	2.0281E+00	3.6999E+02	2.5309E+03	3.3116E+06
4.7189E+02	1.4736E+03	4.5817E+03	-2.0330E+04	1.5005E+05	7.9188E-01	3.6999E+02	2.1693E+03	4.3771E+06
4.7189E+02	1.4228E+03	5.2866E+03	-2.0330E+04	1.4380E+05	1.6688E-01	3.6999E+02	1.8078E+03	4.9740E+06
4.7189E+02	1.3720E+03	2.0075E+04	-2.0330E+04	1.3755E+05	1.9391E-01	3.6999E+02	1.4462E+03	5.9805E+06
4.7189E+02	1.3211E+03	7.8814E+03	-2.0330E+04	1.3130E+05	2.0698E+00	3.6999E+02	1.0847E+03	5.8904E+06
4.7189E+02	1.2703E+03	1.4191E+04	-2.0330E+04	1.2504E+05	1.1125E-01	3.6999E+02	7.2311E+02	8.0155E+06
4.7189E+02	1.2195E+03	2.1595E+04	-2.0330E+04	1.1879E+05	1.5771E+01	3.6999E+02	3.6156E+02	1.8361E+07
4.7189E+02	1.1687E+03	3.5515E+04	-2.0330E+04	1.1254E+05	3.5149E+01	3.6999E+02	0.0000E+00	3.7149E+07
4.7189E+02	1.1179E+03	3.6665E+04	-2.0330E+04	1.0629E+05	3.1166E+01	-7.5773E+01	1.6270E+04	1.1801E+00
4.7189E+02	1.0671E+03	5.2555E+04	-2.0330E+04	1.0004E+05	2.1130E+03	-7.5773E+01	1.5185E+04	5.5987E+01
4.7189E+02	1.0163E+03	7.9485E+04	-2.0330E+04	9.3783E+04	2.1436E+03	-7.5773E+01	1.4824E+04	1.8824E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Denmark A/S Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.7189E+02	9.6546E+02	8.4484E+04	-2.0330E+04	8.7531E+04	2.6605E+01	-7.5773E+01	1.4462E+04	7.0439E+02
4.7189E+02	9.1464E+02	1.7957E+05	-2.0330E+04	8.1279E+04	4.5782E+03	-7.5773E+01	1.4101E+04	1.7846E+03
4.7189E+02	8.6383E+02	1.3049E+05	-2.0330E+04	7.5026E+04	4.9454E+03	-7.5773E+01	1.3739E+04	3.3445E+03
4.7189E+02	8.1302E+02	2.2047E+05	-2.0330E+04	6.8774E+04	3.9782E+03	-7.5773E+01	1.3378E+04	1.5185E+03
4.7189E+02	7.6220E+02	2.7721E+05	-2.0330E+04	6.2522E+04	7.2158E+03	-7.5773E+01	1.3016E+04	1.0625E+04
4.7189E+02	7.1139E+02	3.8366E+05	-2.0330E+04	5.6270E+04	1.4445E+04	-7.5773E+01	1.2655E+04	9.9343E+03
4.7189E+02	6.6057E+02	4.7498E+05	-2.0330E+04	5.0018E+04	3.1439E+04	-7.5773E+01	1.2293E+04	1.7772E+04
4.7189E+02	6.0976E+02	6.4252E+05	-2.0330E+04	4.3765E+04	8.7698E+04	-7.5773E+01	1.1931E+04	4.1875E+04
4.7189E+02	5.5895E+02	1.0455E+06	-2.0330E+04	3.7513E+04	2.3998E+05	-7.5773E+01	1.1570E+04	2.3781E+04
4.7189E+02	5.0813E+02	1.1900E+06	-2.0330E+04	3.1261E+04	7.0325E+05	-7.5773E+01	1.1208E+04	4.0609E+04
4.7189E+02	4.5732E+02	1.3522E+06	-2.0330E+04	2.5009E+04	1.6998E+06	-7.5773E+01	1.0847E+04	7.9837E+04
4.7189E+02	4.0651E+02	1.7968E+06	-2.0330E+04	1.8757E+04	3.8106E+06	-7.5773E+01	1.0485E+04	5.7391E+04
4.7189E+02	3.5569E+02	2.3041E+06	-2.0330E+04	1.2504E+04	6.9534E+06	-7.5773E+01	1.0124E+04	5.0077E+04
4.7189E+02	3.0488E+02	2.8728E+06	-2.0330E+04	6.2522E+03	1.1467E+07	-7.5773E+01	9.7620E+03	4.2621E+04
4.7189E+02	2.5407E+02	3.5737E+06	-2.0330E+04	0.0000E+00	1.1389E+07	-7.5773E+01	9.4005E+03	5.7589E+04
4.7189E+02	2.0325E+02	4.2950E+06	-2.7412E+04	2.8135E+05	1.6804E+00	-7.5773E+01	9.0389E+03	7.7297E+04
4.7189E+02	1.5244E+02	4.6285E+06	-2.7412E+04	2.7510E+05	1.6804E+00	-7.5773E+01	8.6774E+03	5.5970E+04
4.7189E+02	1.0163E+02	5.7682E+06	-2.7412E+04	2.6884E+05	1.6804E+00	-7.5773E+01	8.3158E+03	1.2152E+05
4.7189E+02	5.0813E+01	1.6358E+07	-2.7412E+04	2.6259E+05	2.0371E+01	-7.5773E+01	7.9543E+03	7.6463E+04
4.7189E+02	0.0000E+00	2.9938E+07	-2.7412E+04	2.5634E+05	8.6108E+00	-7.5773E+01	7.5927E+03	1.4868E+05
4.1131E+02	2.2866E+03	6.1150E-01	-2.7412E+04	2.5009E+05	1.0010E+01	-7.5773E+01	7.2311E+03	1.9194E+05
4.1131E+02	2.2358E+03	4.5232E+00	-2.7412E+04	2.4384E+05	5.5625E-02	-7.5773E+01	6.8696E+03	2.4809E+05
4.1131E+02	2.1850E+03	4.5232E+00	-2.7412E+04	2.3758E+05	5.1804E+00	-7.5773E+01	6.5080E+03	3.0948E+05
4.1131E+02	2.1342E+03	1.8951E+01	-2.7412E+04	2.3133E+05	1.8612E+00	-7.5773E+01	6.1465E+03	3.1888E+05
4.1131E+02	2.0325E+03	4.5232E+00	-2.7412E+04	2.2508E+05	4.1250E+00	-7.5773E+01	5.7849E+03	4.8870E+05
4.1131E+02	1.9817E+03	2.7997E+01	-2.7412E+04	2.1883E+05	1.8056E+00	-7.5773E+01	5.4234E+03	6.0576E+05
4.1131E+02	1.9309E+03	6.1776E+02	-2.7412E+04	2.1257E+05	2.3054E+00	-7.5773E+01	5.0618E+03	8.3954E+05
4.1131E+02	1.8801E+03	6.4790E+01	-2.7412E+04	2.0632E+05	1.2500E+00	-7.5773E+01	4.7002E+03	9.6290E+05
4.1131E+02	1.8293E+03	5.9819E+02	-2.7412E+04	2.0007E+05	5.5625E-02	-7.5773E+01	4.3387E+03	1.2967E+06
4.1131E+02	1.7785E+03	1.5624E+02	-2.7412E+04	1.8131E+05	6.2500E-01	-7.5773E+01	3.9771E+03	1.5472E+06
4.1131E+02	1.7277E+03	7.5024E+02	-2.7412E+04	1.7506E+05	6.2500E-01	-7.5773E+01	3.6156E+03	2.1235E+06
4.1131E+02	1.6768E+03	1.2904E+02	-2.7412E+04	1.6881E+05	2.2250E-01	-7.5773E+01	3.2540E+03	2.5327E+06
4.1131E+02	1.6260E+03	6.1176E+02	-2.7412E+04	1.6256E+05	6.8063E-01	-7.5773E+01	2.8925E+03	3.1054E+06
4.1131E+02	1.5752E+03	1.4241E+03	-2.7412E+04	1.5630E+05	7.9188E-01	-7.5773E+01	2.5309E+03	4.1160E+06
4.1131E+02	1.5244E+03	1.7440E+03	-2.7412E+04	1.5005E+05	5.5625E-02	-7.5773E+01	2.1693E+03	5.0524E+06
4.1131E+02	1.4736E+03	1.7107E+03	-2.7412E+04	1.4380E+05	1.6407E+01	-7.5773E+01	1.8078E+03	5.7903E+06
4.1131E+02	1.4228E+03	1.3124E+03	-2.7412E+04	1.3755E+05	8.9550E-01	-7.5773E+01	1.4462E+03	6.2098E+06
4.1131E+02	1.3720E+03	4.1610E+03	-2.7412E+04	1.3130E+05	2.0550E+01	-7.5773E+01	1.0847E+03	6.6436E+06

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.1131E+02	1.3211E+03	3.9447E+03	-2.7412E+04	1.2504E+05	7.9188E-01	-7.5773E+01	7.2311E+02	8.7071E+06
4.1131E+02	1.2703E+03	3.9075E+03	-2.7412E+04	1.1879E+05	7.7941E+00	-7.5773E+01	3.6156E+02	2.1696E+07
4.1131E+02	1.2195E+03	6.5819E+03	-2.7412E+04	1.1254E+05	1.0814E+01	-7.5773E+01	0.0000E+00	4.7894E+07
4.1131E+02	1.1687E+03	1.6182E+04	-2.7412E+04	1.0629E+05	2.4048E+01	-5.2153E+02	1.5909E+04	7.5036E+02
4.1131E+02	1.1179E+03	1.2987E+04	-2.7412E+04	1.0004E+05	1.1988E+02	-5.2153E+02	1.5547E+04	4.5232E+00
4.1131E+02	1.0671E+03	1.6884E+04	-2.7412E+04	9.3783E+04	8.4649E+00	-5.2153E+02	1.5185E+04	5.0160E+01
4.1131E+02	1.0163E+03	2.5626E+04	-2.7412E+04	8.7531E+04	2.8855E+02	-5.2153E+02	1.4824E+04	7.1452E+02
4.1131E+02	9.6546E+02	3.6645E+04	-2.7412E+04	8.1279E+04	4.5754E+03	-5.2153E+02	1.4462E+04	1.9354E+03
4.1131E+02	9.1464E+02	5.4859E+04	-2.7412E+04	7.5026E+04	5.7577E+03	-5.2153E+02	1.4101E+04	1.9491E+03
4.1131E+02	8.6383E+02	5.2036E+04	-2.7412E+04	6.8774E+04	1.0653E+04	-5.2153E+02	1.3739E+04	5.2991E+03
4.1131E+02	8.1302E+02	6.8899E+04	-2.7412E+04	6.2522E+04	9.8772E+03	-5.2153E+02	1.3378E+04	5.4287E+03
4.1131E+02	7.6220E+02	1.1084E+05	-2.7412E+04	5.6270E+04	1.6111E+04	-5.2153E+02	1.3016E+04	1.6045E+04
4.1131E+02	7.1139E+02	1.7241E+05	-2.7412E+04	5.0018E+04	3.6445E+04	-5.2153E+02	1.2655E+04	2.9336E+04
4.1131E+02	6.6057E+02	1.4579E+05	-2.7412E+04	4.3765E+04	1.2273E+05	-5.2153E+02	1.2293E+04	1.6933E+04
4.1131E+02	6.0976E+02	2.2783E+05	-2.7412E+04	3.7513E+04	2.2196E+05	-5.2153E+02	1.1931E+04	3.5558E+04
4.1131E+02	5.5895E+02	3.2721E+05	-2.7412E+04	3.1261E+04	6.7636E+05	-5.2153E+02	1.1570E+04	6.1487E+04
4.1131E+02	5.0813E+02	3.5531E+05	-2.7412E+04	2.5009E+04	1.8892E+06	-5.2153E+02	1.1208E+04	7.6203E+04
4.1131E+02	4.5732E+02	6.5432E+05	-2.7412E+04	1.8757E+04	4.5923E+06	-5.2153E+02	1.0847E+04	8.0270E+04
4.1131E+02	4.0651E+02	9.0416E+05	-2.7412E+04	1.2504E+04	9.1052E+06	-5.2153E+02	1.0485E+04	9.1684E+04
4.1131E+02	3.5569E+02	1.2819E+06	-2.7412E+04	6.2522E+03	1.5398E+07	-5.2153E+02	1.0124E+04	7.9883E+04
4.1131E+02	3.0488E+02	1.9099E+06	-2.7412E+04	0.0000E+00	1.6074E+07	-5.2153E+02	9.7620E+03	5.4569E+04
4.1131E+02	2.5407E+02	3.0590E+06	-3.4495E+04	2.7510E+05	3.3608E+00	-5.2153E+02	9.4005E+03	7.7968E+04
4.1131E+02	2.0325E+02	4.4390E+06	-3.4495E+04	2.6884E+05	3.3608E+00	-5.2153E+02	9.0389E+03	1.0388E+05
4.1131E+02	1.5244E+02	5.0221E+06	-3.4495E+04	2.6259E+05	1.9812E+01	-5.2153E+02	8.6774E+03	1.1386E+05
4.1131E+02	1.0163E+02	6.7121E+06	-3.4495E+04	2.5634E+05	1.8271E+01	-5.2153E+02	8.3158E+03	1.3014E+05
4.1131E+02	5.0813E+01	1.7255E+07	-3.4495E+04	2.5009E+05	8.6108E+00	-5.2153E+02	7.9543E+03	1.1097E+05
4.1131E+02	0.0000E+00	3.7714E+07	-3.4495E+04	2.4384E+05	3.5000E+00	-5.2153E+02	7.5927E+03	1.2121E+05
3.5073E+02	2.2866E+03	5.5625E-02	-3.4495E+04	2.3758E+05	8.6804E+00	-5.2153E+02	7.2311E+03	1.6578E+05
3.5073E+02	2.2358E+03	4.5232E+00	-3.4495E+04	2.3133E+05	3.5000E+00	-5.2153E+02	6.8696E+03	2.3451E+05
3.5073E+02	2.1342E+03	1.6804E+00	-3.4495E+04	2.2508E+05	8.2605E+00	-5.2153E+02	6.5080E+03	3.3893E+05
3.5073E+02	2.0834E+03	1.4244E+01	-3.4495E+04	2.1883E+05	5.9306E+00	-5.2153E+02	6.1465E+03	3.7559E+05
3.5073E+02	2.0325E+03	9.9269E+00	-3.4495E+04	2.0632E+05	1.8612E+00	-5.2153E+02	5.7849E+03	4.7507E+05
3.5073E+02	1.9817E+03	4.7816E+01	-3.4495E+04	2.0007E+05	8.3161E+00	-5.2153E+02	5.4234E+03	7.3052E+05
3.5073E+02	1.9309E+03	5.0698E+00	-3.4495E+04	1.9382E+05	6.8063E-01	-5.2153E+02	5.0618E+03	8.5982E+05
3.5073E+02	1.8801E+03	1.4177E+01	-3.4495E+04	1.8131E+05	1.1125E-01	-5.2153E+02	4.7002E+03	1.1124E+06
3.5073E+02	1.8293E+03	1.5554E+01	-3.4495E+04	1.7506E+05	5.5625E-02	-5.2153E+02	4.3387E+03	1.5120E+06
3.5073E+02	1.7785E+03	7.3536E+01	-3.4495E+04	1.6881E+05	3.1669E+00	-5.2153E+02	3.9771E+03	1.9837E+06
3.5073E+02	1.7277E+03	5.3367E+01	-3.4495E+04	1.6256E+05	1.8120E+00	-5.2153E+02	3.6156E+03	2.1331E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.5073E+02	1.6768E+03	2.1285E+02	-3.4495E+04	1.5630E+05	1.1125E-01	-5.2153E+02	3.2540E+03	2.8513E+06
3.5073E+02	1.6260E+03	9.7224E+01	-3.4495E+04	1.5005E+05	3.6933E-01	-5.2153E+02	2.8925E+03	3.0676E+06
3.5073E+02	1.5752E+03	2.3608E+02	-3.4495E+04	1.4380E+05	2.5080E+01	-5.2153E+02	2.5309E+03	4.0814E+06
3.5073E+02	1.5244E+03	2.4317E+02	-3.4495E+04	1.3755E+05	1.0951E+00	-5.2153E+02	2.1693E+03	4.3854E+06
3.5073E+02	1.4736E+03	3.5270E+02	-3.4495E+04	1.3130E+05	2.8756E+00	-5.2153E+02	1.8078E+03	4.9363E+06
3.5073E+02	1.4228E+03	4.5975E+02	-3.4495E+04	1.2504E+05	4.5420E+00	-5.2153E+02	1.4462E+03	4.8951E+06
3.5073E+02	1.3720E+03	1.4049E+03	-3.4495E+04	1.1879E+05	1.3009E+02	-5.2153E+02	1.0847E+03	6.0973E+06
3.5073E+02	1.3211E+03	1.9941E+03	-3.4495E+04	1.1254E+05	1.3053E+02	-5.2153E+02	7.2311E+02	8.0582E+06
3.5073E+02	1.2703E+03	1.7564E+03	-3.4495E+04	1.0629E+05	4.4538E+01	-5.2153E+02	3.6156E+02	1.7357E+07
3.5073E+02	1.2195E+03	2.2061E+03	-3.4495E+04	1.0004E+05	1.2000E+03	-5.2153E+02	0.0000E+00	3.4316E+07
3.5073E+02	1.1687E+03	3.8462E+03	-3.4495E+04	9.3783E+04	8.4443E+02	-9.6729E+02	1.6270E+04	1.3021E+00
3.5073E+02	1.1179E+03	5.7172E+03	-3.4495E+04	8.7531E+04	4.9966E+02	-9.6729E+02	1.5547E+04	3.4023E+01
3.5073E+02	1.0671E+03	6.4040E+03	-3.4495E+04	8.1279E+04	3.5802E+03	-9.6729E+02	1.5185E+04	5.0362E+01
3.5073E+02	1.0163E+03	6.6869E+03	-3.4495E+04	7.5026E+04	3.7774E+03	-9.6729E+02	1.4824E+04	1.5396E+02
3.5073E+02	9.6546E+02	1.1080E+04	-3.4495E+04	6.8774E+04	6.3836E+03	-9.6729E+02	1.4462E+04	1.4680E+03
3.5073E+02	9.1464E+02	1.6483E+04	-3.4495E+04	6.2522E+04	2.0172E+04	-9.6729E+02	1.4101E+04	1.3214E+03
3.5073E+02	8.6383E+02	1.9045E+04	-3.4495E+04	5.6270E+04	1.3502E+04	-9.6729E+02	1.3739E+04	5.5965E+03
3.5073E+02	8.1302E+02	2.2673E+04	-3.4495E+04	5.0018E+04	3.3880E+04	-9.6729E+02	1.3378E+04	4.1081E+03
3.5073E+02	7.6220E+02	3.0132E+04	-3.4495E+04	4.3765E+04	1.0684E+05	-9.6729E+02	1.3016E+04	4.3355E+03
3.5073E+02	7.1139E+02	4.6708E+04	-3.4495E+04	3.7513E+04	1.7063E+05	-9.6729E+02	1.2655E+04	2.0815E+04
3.5073E+02	6.6057E+02	6.1926E+04	-3.4495E+04	3.1261E+04	4.3663E+05	-9.6729E+02	1.2293E+04	1.5060E+04
3.5073E+02	6.0976E+02	9.2126E+04	-3.4495E+04	2.5009E+04	1.2634E+06	-9.6729E+02	1.1931E+04	2.0998E+04
3.5073E+02	5.5895E+02	1.3375E+05	-3.4495E+04	1.8757E+04	3.4030E+06	-9.6729E+02	1.1570E+04	3.2669E+04
3.5073E+02	5.0813E+02	1.7677E+05	-3.4495E+04	1.2504E+04	5.9713E+06	-9.6729E+02	1.1208E+04	4.6091E+04
3.5073E+02	4.5732E+02	2.4120E+05	-3.4495E+04	6.2522E+03	1.0678E+07	-9.6729E+02	1.0847E+04	2.9549E+04
3.5073E+02	4.0651E+02	4.2763E+05	-3.4495E+04	0.0000E+00	1.1683E+07	-9.6729E+02	1.0485E+04	5.7601E+04
3.5073E+02	3.5569E+02	7.7471E+05	-4.1578E+04	2.7510E+05	1.6804E+00	-9.6729E+02	1.0124E+04	5.1450E+04
3.5073E+02	3.0488E+02	1.5604E+06	-4.1578E+04	2.6884E+05	8.1909E+00	-9.6729E+02	9.7620E+03	6.7364E+04
3.5073E+02	2.5407E+02	2.9776E+06	-4.1578E+04	2.6259E+05	1.7500E+00	-9.6729E+02	9.4005E+03	5.9253E+04
3.5073E+02	2.0325E+02	5.0279E+06	-4.1578E+04	2.5634E+05	8.1909E+00	-9.6729E+02	9.0389E+03	5.1820E+04
3.5073E+02	1.5244E+02	7.3168E+06	-4.1578E+04	2.5009E+05	6.8608E+00	-9.6729E+02	8.6774E+03	7.3688E+04
3.5073E+02	1.0163E+02	8.4193E+06	-4.1578E+04	2.4384E+05	3.3608E+00	-9.6729E+02	8.3158E+03	1.0549E+05
3.5073E+02	5.0813E+01	1.7569E+07	-4.1578E+04	2.3758E+05	1.3441E+01	-9.6729E+02	7.9543E+03	1.1718E+05
3.5073E+02	0.0000E+00	4.0216E+07	-4.1578E+04	2.3133E+05	1.7500E+00	-9.6729E+02	7.5927E+03	1.2348E+05
2.9015E+02	2.3374E+03	1.6804E+00	-4.1578E+04	2.2508E+05	1.7500E+00	-9.6729E+02	7.2311E+03	1.8642E+05
2.9015E+02	2.2358E+03	1.6804E+00	-4.1578E+04	2.1883E+05	1.6804E+00	-9.6729E+02	6.8696E+03	2.4072E+05
2.9015E+02	2.1850E+03	4.5232E+00	-4.1578E+04	2.1257E+05	1.7500E+00	-9.6729E+02	6.5080E+03	2.4841E+05
2.9015E+02	2.1342E+03	5.0412E+00	-4.1578E+04	2.0632E+05	1.8612E+00	-9.6729E+02	6.1465E+03	3.1319E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborgvænget 6-12
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.9015E+02	2.0834E+03	6.9860E+00	-4.1578E+04	2.0007E+05	1.8612E+00	-9.6729E+02	5.7849E+03	5.2420E+05
2.9015E+02	2.0325E+03	1.6521E+01	-4.1578E+04	1.9382E+05	1.3846E+01	-9.6729E+02	5.4234E+03	5.7618E+05
2.9015E+02	1.9817E+03	1.7674E+01	-4.1578E+04	1.8757E+05	7.9188E-01	-9.6729E+02	5.0618E+03	7.3168E+05
2.9015E+02	1.9309E+03	1.4464E+01	-4.1578E+04	1.8131E+05	5.5623E+00	-9.6729E+02	4.7002E+03	9.5682E+05
2.9015E+02	1.8801E+03	5.8759E+01	-4.1578E+04	1.7506E+05	1.2540E+01	-9.6729E+02	4.3387E+03	1.2209E+06
2.9015E+02	1.8293E+03	3.8416E+01	-4.1578E+04	1.6881E+05	2.3436E+01	-9.6729E+02	3.9771E+03	1.4919E+06
2.9015E+02	1.7785E+03	1.7236E+01	-4.1578E+04	1.6256E+05	1.2409E+01	-9.6729E+02	3.6156E+03	1.7478E+06
2.9015E+02	1.7277E+03	6.1161E+00	-4.1578E+04	1.5630E+05	1.3767E+01	-9.6729E+02	3.2540E+03	2.2583E+06
2.9015E+02	1.6768E+03	5.2620E+01	-4.1578E+04	1.5005E+05	1.0362E-01	-9.6729E+02	2.8925E+03	2.5777E+06
2.9015E+02	1.6260E+03	4.9758E+01	-4.1578E+04	1.4380E+05	1.5367E+00	-9.6729E+02	2.5309E+03	3.4308E+06
2.9015E+02	1.5752E+03	8.1966E+00	-4.1578E+04	1.3755E+05	1.6963E+00	-9.6729E+02	2.1693E+03	3.4989E+06
2.9015E+02	1.5244E+03	4.0996E+01	-4.1578E+04	1.3130E+05	1.6778E+01	-9.6729E+02	1.8078E+03	3.4566E+06
2.9015E+02	1.4736E+03	3.4414E+01	-4.1578E+04	1.2504E+05	1.9440E+02	-9.6729E+02	1.4462E+03	3.7512E+06
2.9015E+02	1.4228E+03	1.1711E+02	-4.1578E+04	1.1879E+05	3.8954E+01	-9.6729E+02	1.0847E+03	4.3056E+06
2.9015E+02	1.3720E+03	1.5635E+02	-4.1578E+04	1.1254E+05	1.8100E+02	-9.6729E+02	7.2311E+02	5.7090E+06
2.9015E+02	1.3211E+03	3.4453E+02	-4.1578E+04	1.0629E+05	2.1137E+02	-9.6729E+02	3.6156E+02	1.3825E+07
2.9015E+02	1.2703E+03	3.8185E+02	-4.1578E+04	1.0004E+05	2.6205E+02	-9.6729E+02	0.0000E+00	2.7272E+07
2.9015E+02	1.2195E+03	4.0774E+02	-4.1578E+04	9.3783E+04	7.4488E+02	-1.4131E+03	1.6270E+04	6.2500E-01
2.9015E+02	1.1687E+03	1.0259E+03	-4.1578E+04	8.7531E+04	9.8738E+02	-1.4131E+03	1.5547E+04	1.7661E+01
2.9015E+02	1.1179E+03	9.8396E+02	-4.1578E+04	8.1279E+04	1.5172E+03	-1.4131E+03	1.5185E+04	1.0226E+01
2.9015E+02	1.0671E+03	1.6150E+03	-4.1578E+04	7.5026E+04	3.9453E+03	-1.4131E+03	1.4824E+04	3.1644E+01
2.9015E+02	1.0163E+03	3.5588E+03	-4.1578E+04	6.8774E+04	4.2195E+03	-1.4131E+03	1.4462E+04	7.4436E+01
2.9015E+02	9.6546E+02	3.0869E+03	-4.1578E+04	6.2522E+04	1.1346E+04	-1.4131E+03	1.4101E+04	9.1755E+02
2.9015E+02	9.1464E+02	3.6811E+03	-4.1578E+04	5.6270E+04	1.8515E+04	-1.4131E+03	1.3739E+04	4.4930E+02
2.9015E+02	8.6383E+02	5.0699E+03	-4.1578E+04	5.0018E+04	4.0850E+04	-1.4131E+03	1.3378E+04	2.3284E+03
2.9015E+02	8.1302E+02	9.4578E+03	-4.1578E+04	4.3765E+04	8.4539E+04	-1.4131E+03	1.3016E+04	1.1835E+03
2.9015E+02	7.6220E+02	1.3462E+04	-4.1578E+04	3.7513E+04	2.2208E+05	-1.4131E+03	1.2655E+04	5.1161E+03
2.9015E+02	7.1139E+02	1.0181E+04	-4.1578E+04	3.1261E+04	6.4813E+05	-1.4131E+03	1.2293E+04	2.6360E+03
2.9015E+02	6.6057E+02	2.3770E+04	-4.1578E+04	2.5009E+04	1.4685E+06	-1.4131E+03	1.1931E+04	2.4930E+03
2.9015E+02	6.0976E+02	4.4068E+04	-4.1578E+04	1.8757E+04	2.6872E+06	-1.4131E+03	1.1570E+04	8.5011E+03
2.9015E+02	5.5895E+02	6.1599E+04	-4.1578E+04	1.2504E+04	4.2717E+06	-1.4131E+03	1.1208E+04	7.3889E+03
2.9015E+02	5.0813E+02	1.6474E+05	-4.1578E+04	6.2522E+03	7.3164E+06	-1.4131E+03	1.0847E+04	7.9230E+03
2.9015E+02	4.5732E+02	3.6945E+05	-4.1578E+04	0.0000E+00	8.9727E+06	-1.4131E+03	1.0485E+04	2.1814E+04
2.9015E+02	4.0651E+02	5.2903E+05	-4.8660E+04	2.9385E+05	1.6804E+00	-1.4131E+03	1.0124E+04	2.2543E+04
2.9015E+02	3.5569E+02	1.0752E+06	-4.8660E+04	2.5009E+05	1.4701E+01	-1.4131E+03	9.7620E+03	2.4301E+04
2.9015E+02	3.0488E+02	2.0765E+06	-4.8660E+04	2.4384E+05	1.6804E+00	-1.4131E+03	9.4005E+03	4.2911E+04
2.9015E+02	2.5407E+02	3.1137E+06	-4.8660E+04	2.3758E+05	1.6804E+00	-1.4131E+03	9.0389E+03	5.1410E+04
2.9015E+02	2.0325E+02	4.7872E+06	-4.8660E+04	2.3133E+05	8.1909E+00	-1.4131E+03	8.6774E+03	4.4288E+04

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.9015E+02	1.5244E+02	5.4356E+06	-4.8660E+04	2.1883E+05	6.5105E+00	-1.4131E+03	8.3158E+03	6.1321E+04
2.9015E+02	1.0163E+02	6.9846E+06	-4.8660E+04	2.1257E+05	6.5105E+00	-1.4131E+03	7.9543E+03	6.9260E+04
2.9015E+02	5.0813E+01	1.1449E+07	-4.8660E+04	2.0632E+05	4.4627E+01	-1.4131E+03	7.5927E+03	9.6326E+04
2.9015E+02	0.0000E+00	3.4095E+07	-4.8660E+04	2.0007E+05	1.1390E+01	-1.4131E+03	7.2311E+03	1.2303E+05
2.2958E+02	2.3374E+03	1.6804E+00	-4.8660E+04	1.8757E+05	2.0436E+01	-1.4131E+03	6.8696E+03	1.7313E+05
2.2958E+02	2.2866E+03	3.3608E+00	-4.8660E+04	1.8131E+05	3.8827E+01	-1.4131E+03	6.5080E+03	2.1704E+05
2.2958E+02	2.2358E+03	3.4304E+00	-4.8660E+04	1.7506E+05	5.1744E+00	-1.4131E+03	6.1465E+03	3.2952E+05
2.2958E+02	2.1850E+03	8.2465E+00	-4.8660E+04	1.6881E+05	1.6067E+01	-1.4131E+03	5.7849E+03	4.1092E+05
2.2958E+02	2.1342E+03	1.7360E+00	-4.8660E+04	1.6256E+05	2.0590E+01	-1.4131E+03	5.4234E+03	6.0109E+05
2.2958E+02	2.0834E+03	5.1804E+00	-4.8660E+04	1.5630E+05	2.7330E+01	-1.4131E+03	5.0618E+03	6.2457E+05
2.2958E+02	2.0325E+03	9.9409E+00	-4.8660E+04	1.5005E+05	3.5027E+00	-1.4131E+03	4.7002E+03	1.0102E+06
2.2958E+02	1.9817E+03	1.3427E+01	-4.8660E+04	1.4380E+05	3.5552E+00	-1.4131E+03	4.3387E+03	1.0477E+06
2.2958E+02	1.9309E+03	8.5968E+00	-4.8660E+04	1.3755E+05	1.3066E+02	-1.4131E+03	3.9771E+03	1.2393E+06
2.2958E+02	1.8801E+03	3.7362E+00	-4.8660E+04	1.3130E+05	1.3225E+02	-1.4131E+03	3.6156E+03	1.4404E+06
2.2958E+02	1.8293E+03	3.0977E+00	-4.8660E+04	1.2504E+05	2.8121E+01	-1.4131E+03	3.2540E+03	1.9783E+06
2.2958E+02	1.7785E+03	9.6603E+00	-4.8660E+04	1.1879E+05	2.5539E+02	-1.4131E+03	2.8925E+03	1.9011E+06
2.2958E+02	1.7277E+03	3.5556E+00	-4.8660E+04	1.1254E+05	3.2529E+02	-1.4131E+03	2.5309E+03	2.3051E+06
2.2958E+02	1.6768E+03	6.7430E+00	-4.8660E+04	1.0629E+05	4.5812E+02	-1.4131E+03	2.1693E+03	2.6488E+06
2.2958E+02	1.6260E+03	2.1436E+01	-4.8660E+04	1.0004E+05	4.6331E+02	-1.4131E+03	1.8078E+03	2.7085E+06
2.2958E+02	1.5752E+03	4.9026E+00	-4.8660E+04	9.3783E+04	6.2623E+02	-1.4131E+03	1.4462E+03	2.6213E+06
2.2958E+02	1.5244E+03	1.2207E+01	-4.8660E+04	8.7531E+04	7.5075E+02	-1.4131E+03	1.0847E+03	2.8382E+06
2.2958E+02	1.4736E+03	2.3870E+01	-4.8660E+04	8.1279E+04	1.9049E+03	-1.4131E+03	7.2311E+02	4.6392E+06
2.2958E+02	1.4228E+03	1.0120E+01	-4.8660E+04	7.5026E+04	2.8954E+03	-1.4131E+03	3.6156E+02	1.0591E+07
2.2958E+02	1.3720E+03	8.4408E+00	-4.8660E+04	6.8774E+04	3.9442E+03	-1.4131E+03	0.0000E+00	2.0777E+07
2.2958E+02	1.3211E+03	2.0789E+01	-4.8660E+04	6.2522E+04	8.2437E+03	-1.8588E+03	1.5909E+04	4.5788E+00
2.2958E+02	1.2703E+03	7.0781E+01	-4.8660E+04	5.6270E+04	9.1245E+03	-1.8588E+03	1.5547E+04	1.2357E+00
2.2958E+02	1.2195E+03	9.1982E+01	-4.8660E+04	5.0018E+04	1.7999E+04	-1.8588E+03	1.5185E+04	1.3624E+02
2.2958E+02	1.1687E+03	1.7008E+02	-4.8660E+04	4.3765E+04	7.2599E+04	-1.8588E+03	1.4824E+04	1.3074E+02
2.2958E+02	1.1179E+03	3.8524E+02	-4.8660E+04	3.7513E+04	1.1096E+05	-1.8588E+03	1.4462E+04	7.6418E+00
2.2958E+02	1.0671E+03	1.3035E+03	-4.8660E+04	3.1261E+04	3.9460E+05	-1.8588E+03	1.4101E+04	1.4075E+02
2.2958E+02	1.0163E+03	5.5689E+02	-4.8660E+04	2.5009E+04	9.7557E+05	-1.8588E+03	1.3739E+04	4.0551E+02
2.2958E+02	9.6546E+02	4.7555E+02	-4.8660E+04	1.8757E+04	2.2078E+06	-1.8588E+03	1.3378E+04	7.3117E+02
2.2958E+02	9.1464E+02	9.4177E+02	-4.8660E+04	1.2504E+04	3.6977E+06	-1.8588E+03	1.3016E+04	3.3715E+02
2.2958E+02	8.6383E+02	1.8596E+03	-4.8660E+04	6.2522E+03	6.0855E+06	-1.8588E+03	1.2655E+04	2.3646E+02
2.2958E+02	8.1302E+02	7.5431E+03	-4.8660E+04	0.0000E+00	1.0765E+07	-1.8588E+03	1.2293E+04	1.5360E+03
2.2958E+02	7.6220E+02	3.7932E+03	-5.5743E+04	2.6259E+05	1.6804E+00	-1.8588E+03	1.1931E+04	4.5613E+03
2.2958E+02	7.1139E+02	1.3186E+04	-5.5743E+04	2.5009E+05	3.3608E+00	-1.8588E+03	1.1570E+04	5.1029E+03
2.2958E+02	6.6057E+02	3.9353E+04	-5.5743E+04	2.4384E+05	9.8713E+00	-1.8588E+03	1.1208E+04	1.6101E+03

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.2958E+02	6.0976E+02	4.6027E+04	-5.5743E+04	2.3758E+05	1.6804E+00	-1.8588E+03	1.0847E+04	6.5008E+03
2.2958E+02	5.5895E+02	9.7467E+04	-5.5743E+04	2.3133E+05	8.1909E+00	-1.8588E+03	1.0485E+04	1.0959E+04
2.2958E+02	5.0813E+02	2.3158E+05	-5.5743E+04	2.1883E+05	5.2179E+00	-1.8588E+03	1.0124E+04	1.5093E+04
2.2958E+02	4.5732E+02	4.0964E+05	-5.5743E+04	2.1257E+05	5.2179E+00	-1.8588E+03	9.7620E+03	1.5944E+04
2.2958E+02	4.0651E+02	7.4408E+05	-5.5743E+04	2.0632E+05	6.5105E+00	-1.8588E+03	9.4005E+03	1.3629E+04
2.2958E+02	3.5569E+02	1.4957E+06	-5.5743E+04	2.0007E+05	5.5625E-02	-1.8588E+03	9.0389E+03	1.9162E+04
2.2958E+02	3.0488E+02	2.2506E+06	-5.5743E+04	1.9382E+05	2.1341E+01	-1.8588E+03	8.6774E+03	2.4541E+04
2.2958E+02	2.5407E+02	3.9420E+06	-5.5743E+04	1.8757E+05	1.4290E+01	-1.8588E+03	8.3158E+03	7.0898E+04
2.2958E+02	2.0325E+02	6.3027E+06	-5.5743E+04	1.8131E+05	5.5625E-02	-1.8588E+03	7.9543E+03	5.0497E+04
2.2958E+02	1.5244E+02	8.6285E+06	-5.5743E+04	1.7506E+05	3.0097E-01	-1.8588E+03	7.5927E+03	8.8428E+04
2.2958E+02	1.0163E+02	1.0209E+07	-5.5743E+04	1.6881E+05	3.8768E+01	-1.8588E+03	7.2311E+03	6.5513E+04
2.2958E+02	5.0813E+01	1.0864E+07	-5.5743E+04	1.6256E+05	3.5831E+00	-1.8588E+03	6.8696E+03	1.3348E+05
2.2958E+02	0.0000E+00	3.3888E+07	-5.5743E+04	1.5630E+05	3.8409E+01	-1.8588E+03	6.5080E+03	2.0959E+05
1.6900E+02	2.4899E+03	1.7500E+00	-5.5743E+04	1.5005E+05	4.1929E+01	-1.8588E+03	6.1465E+03	2.2952E+05
1.6900E+02	2.3374E+03	1.7500E+00	-5.5743E+04	1.4380E+05	8.7847E+01	-1.8588E+03	5.7849E+03	4.1620E+05
1.6900E+02	2.2866E+03	5.1108E+00	-5.5743E+04	1.3755E+05	5.5772E+00	-1.8588E+03	5.4234E+03	4.8580E+05
1.6900E+02	2.2358E+03	1.0635E+01	-5.5743E+04	1.3130E+05	2.6439E+01	-1.8588E+03	5.0618E+03	5.4365E+05
1.6900E+02	2.1850E+03	6.5105E+00	-5.5743E+04	1.2504E+05	2.7996E+02	-1.8588E+03	4.7002E+03	7.7038E+05
1.6900E+02	2.1342E+03	1.1747E+01	-5.5743E+04	1.1879E+05	6.7737E+01	-1.8588E+03	4.3387E+03	9.1573E+05
1.6900E+02	2.0834E+03	9.3054E+00	-5.5743E+04	1.1254E+05	1.4025E+03	-1.8588E+03	3.9771E+03	1.0558E+06
1.6900E+02	2.0325E+03	5.1108E+00	-5.5743E+04	1.0629E+05	5.5199E+02	-1.8588E+03	3.6156E+03	1.4421E+06
1.6900E+02	1.9817E+03	5.2220E+00	-5.5743E+04	1.0004E+05	3.4702E+03	-1.8588E+03	3.2540E+03	1.3267E+06
1.6900E+02	1.9309E+03	3.5416E+00	-5.5743E+04	9.3783E+04	4.0313E+03	-1.8588E+03	2.8925E+03	1.8996E+06
1.6900E+02	1.8801E+03	1.7500E+00	-5.5743E+04	8.7531E+04	4.7922E+03	-1.8588E+03	2.5309E+03	2.0172E+06
1.6900E+02	1.8293E+03	2.3750E+00	-5.5743E+04	8.1279E+04	6.0270E+03	-1.8588E+03	2.1693E+03	1.8197E+06
1.6900E+02	1.7785E+03	1.6804E+00	-5.5743E+04	7.5026E+04	1.4611E+04	-1.8588E+03	1.8078E+03	1.9272E+06
1.6900E+02	1.7277E+03	6.2500E-01	-5.5743E+04	6.8774E+04	7.0588E+03	-1.8588E+03	1.4462E+03	1.5884E+06
1.6900E+02	1.6768E+03	1.8612E+00	-5.5743E+04	6.2522E+04	2.0947E+04	-1.8588E+03	1.0847E+03	2.0813E+06
1.6900E+02	1.6260E+03	6.8063E-01	-5.5743E+04	5.6270E+04	2.7874E+04	-1.8588E+03	7.2311E+02	3.7810E+06
1.6900E+02	1.5752E+03	7.9188E-01	-5.5743E+04	5.0018E+04	3.8739E+04	-1.8588E+03	3.6156E+02	8.0814E+06
1.6900E+02	1.5244E+03	1.3132E+01	-5.5743E+04	4.3765E+04	7.0142E+04	-1.8588E+03	0.0000E+00	1.5044E+07
1.6900E+02	1.4736E+03	3.2640E+01	-5.5743E+04	3.7513E+04	1.3216E+05	-2.3046E+03	1.5909E+04	3.4023E+01
1.6900E+02	1.4228E+03	4.0055E+01	-5.5743E+04	3.1261E+04	3.1310E+05	-2.3046E+03	1.5547E+04	7.0311E+00
1.6900E+02	1.3720E+03	4.7538E+01	-5.5743E+04	2.5009E+04	8.0319E+05	-2.3046E+03	1.5185E+04	1.1801E+00
1.6900E+02	1.3211E+03	1.8327E+01	-5.5743E+04	1.8757E+04	2.3042E+06	-2.3046E+03	1.4824E+04	1.3053E+02
1.6900E+02	1.2703E+03	5.7709E+01	-5.5743E+04	1.2504E+04	4.3630E+06	-2.3046E+03	1.4462E+04	9.7546E-01
1.6900E+02	1.2195E+03	2.9239E+00	-5.5743E+04	6.2522E+03	6.4225E+06	-2.3046E+03	1.4101E+04	1.8044E+01
1.6900E+02	1.1687E+03	8.9162E+01	-5.5743E+04	0.0000E+00	1.4297E+07	-2.3046E+03	1.3739E+04	1.0623E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.6900E+02	1.1179E+03	1.1259E+02	-6.2825E+04	2.3758E+05	1.6804E+00	-2.3046E+03	1.3378E+04	2.3385E+01
1.6900E+02	1.0671E+03	2.6097E+02	-6.2825E+04	2.1883E+05	1.6804E+00	-2.3046E+03	1.3016E+04	1.9853E+02
1.6900E+02	1.0163E+03	2.3694E+02	-6.2825E+04	2.1257E+05	8.1909E+00	-2.3046E+03	1.2655E+04	1.5138E+01
1.6900E+02	9.6546E+02	9.2596E+02	-6.2825E+04	2.0007E+05	9.7605E+00	-2.3046E+03	1.2293E+04	1.4631E+02
1.6900E+02	9.1464E+02	7.9543E+02	-6.2825E+04	1.9382E+05	1.7636E+00	-2.3046E+03	1.1931E+04	2.6704E+02
1.6900E+02	8.6383E+02	3.7655E+03	-6.2825E+04	1.8757E+05	2.5513E+01	-2.3046E+03	1.1570E+04	2.9967E+01
1.6900E+02	8.1302E+02	4.6104E+03	-6.2825E+04	1.8131E+05	4.9554E+01	-2.3046E+03	1.1208E+04	1.1332E+03
1.6900E+02	7.6220E+02	1.2948E+04	-6.2825E+04	1.7506E+05	4.6920E+01	-2.3046E+03	1.0847E+04	4.7859E+03
1.6900E+02	7.1139E+02	2.2630E+04	-6.2825E+04	1.6881E+05	1.2644E+01	-2.3046E+03	1.0485E+04	4.0216E+03
1.6900E+02	6.6057E+02	4.2285E+04	-6.2825E+04	1.6256E+05	9.1247E-01	-2.3046E+03	1.0124E+04	2.5160E+03
1.6900E+02	6.0976E+02	1.0496E+05	-6.2825E+04	1.5630E+05	2.4592E+01	-2.3046E+03	9.7620E+03	3.8675E+03
1.6900E+02	5.5895E+02	1.5348E+05	-6.2825E+04	1.5005E+05	2.4458E+01	-2.3046E+03	9.4005E+03	5.9689E+03
1.6900E+02	5.0813E+02	2.7468E+05	-6.2825E+04	1.4380E+05	5.1347E+00	-2.3046E+03	9.0389E+03	7.7130E+03
1.6900E+02	4.5732E+02	5.4300E+05	-6.2825E+04	1.3755E+05	7.1229E+02	-2.3046E+03	8.6774E+03	4.6183E+03
1.6900E+02	4.0651E+02	9.7212E+05	-6.2825E+04	1.3130E+05	8.8749E+01	-2.3046E+03	8.3158E+03	7.0752E+03
1.6900E+02	3.5569E+02	1.8873E+06	-6.2825E+04	1.2504E+05	8.5000E+02	-2.3046E+03	7.9543E+03	3.4123E+04
1.6900E+02	3.0488E+02	3.2188E+06	-6.2825E+04	1.1879E+05	2.5866E+03	-2.3046E+03	7.5927E+03	3.5411E+04
1.6900E+02	2.5407E+02	6.1712E+06	-6.2825E+04	1.1254E+05	4.2522E+03	-2.3046E+03	7.2311E+03	4.8187E+04
1.6900E+02	2.0325E+02	9.8512E+06	-6.2825E+04	1.0629E+05	3.8501E+03	-2.3046E+03	6.8696E+03	9.9472E+04
1.6900E+02	1.5244E+02	1.2869E+07	-6.2825E+04	1.0004E+05	9.2598E+03	-2.3046E+03	6.5080E+03	1.5371E+05
1.6900E+02	1.0163E+02	1.3878E+07	-6.2825E+04	9.3783E+04	4.7742E+03	-2.3046E+03	6.1465E+03	1.5574E+05
1.6900E+02	5.0813E+01	1.4430E+07	-6.2825E+04	8.7531E+04	1.0404E+04	-2.3046E+03	5.7849E+03	2.8474E+05
1.6900E+02	0.0000E+00	3.7953E+07	-6.2825E+04	8.1279E+04	2.0226E+04	-2.3046E+03	5.4234E+03	2.9234E+05
1.0842E+02	2.4899E+03	1.7500E+00	-6.2825E+04	7.5026E+04	3.5137E+04	-2.3046E+03	5.0618E+03	4.1748E+05
1.0842E+02	2.4390E+03	1.6804E+00	-6.2825E+04	6.8774E+04	2.1333E+04	-2.3046E+03	4.7002E+03	4.3274E+05
1.0842E+02	2.3374E+03	1.6804E+00	-6.2825E+04	6.2522E+04	1.9810E+04	-2.3046E+03	4.3387E+03	7.5921E+05
1.0842E+02	2.2866E+03	3.9858E+00	-6.2825E+04	5.6270E+04	5.7291E+04	-2.3046E+03	3.9771E+03	8.5159E+05
1.0842E+02	2.2358E+03	5.1108E+00	-6.2825E+04	5.0018E+04	6.0919E+04	-2.3046E+03	3.6156E+03	1.0236E+06
1.0842E+02	2.1850E+03	5.1108E+00	-6.2825E+04	4.3765E+04	8.6046E+04	-2.3046E+03	3.2540E+03	1.2428E+06
1.0842E+02	2.1342E+03	1.6804E+00	-6.2825E+04	3.7513E+04	1.9108E+05	-2.3046E+03	2.8925E+03	1.3725E+06
1.0842E+02	2.0834E+03	6.8608E+00	-6.2825E+04	3.1261E+04	3.4337E+05	-2.3046E+03	2.5309E+03	1.4468E+06
1.0842E+02	2.0325E+03	1.7500E+00	-6.2825E+04	2.5009E+04	8.4719E+05	-2.3046E+03	2.1693E+03	1.1149E+06
1.0842E+02	1.9817E+03	3.3608E+00	-6.2825E+04	1.8757E+04	2.3143E+06	-2.3046E+03	1.8078E+03	1.3773E+06
1.0842E+02	1.8801E+03	7.0000E+00	-6.2825E+04	1.2504E+04	4.4622E+06	-2.3046E+03	1.4462E+03	1.4092E+06
1.0842E+02	1.8293E+03	3.5000E+00	-6.2825E+04	6.2522E+03	6.2854E+06	-2.3046E+03	1.0847E+03	1.6920E+06
1.0842E+02	1.7785E+03	6.8063E-01	-6.2825E+04	0.0000E+00	1.3422E+07	-2.3046E+03	7.2311E+02	2.9114E+06
1.0842E+02	1.7277E+03	5.5625E-02	-6.9908E+04	2.3758E+05	1.6804E+00	-2.3046E+03	3.6156E+02	5.7653E+06
1.0842E+02	1.6260E+03	1.3021E+01	-6.9908E+04	2.3133E+05	1.6804E+00	-2.3046E+03	0.0000E+00	1.1185E+07

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0842E+02	1.5752E+03	1.1125E-01	-6.9908E+04	2.1257E+05	6.5105E+00	-2.7503E+03	1.6632E+04	5.5625E-02
1.0842E+02	1.5244E+03	2.2250E-01	-6.9908E+04	2.0632E+05	5.2179E+00	-2.7503E+03	1.5909E+04	4.5788E+00
1.0842E+02	1.4736E+03	1.3327E+00	-6.9908E+04	1.9382E+05	1.6804E+00	-2.7503E+03	1.5547E+04	2.0246E-01
1.0842E+02	1.4228E+03	5.5625E-02	-6.9908E+04	1.8757E+05	1.5984E+01	-2.7503E+03	1.5185E+04	3.4593E+01
1.0842E+02	1.3720E+03	2.8653E+01	-6.9908E+04	1.8131E+05	1.8867E+01	-2.7503E+03	1.4824E+04	3.0232E+00
1.0842E+02	1.3211E+03	1.6202E+01	-6.9908E+04	1.7506E+05	3.2771E+01	-2.7503E+03	1.4462E+04	1.5850E+00
1.0842E+02	1.2703E+03	2.7834E+01	-6.9908E+04	1.6881E+05	3.8123E+01	-2.7503E+03	1.4101E+04	2.0643E+00
1.0842E+02	1.2195E+03	5.7704E+01	-6.9908E+04	1.5005E+05	4.5232E+00	-2.7503E+03	1.3739E+04	2.0429E+01
1.0842E+02	1.1687E+03	1.2634E+02	-6.9908E+04	1.4380E+05	1.2392E+03	-2.7503E+03	1.3378E+04	2.4673E+01
1.0842E+02	1.1179E+03	1.8855E+02	-6.9908E+04	1.3755E+05	4.8111E+01	-2.7503E+03	1.3016E+04	4.2884E+00
1.0842E+02	1.0671E+03	9.4634E+01	-6.9908E+04	1.3130E+05	2.9650E+03	-2.7503E+03	1.2655E+04	1.4029E+01
1.0842E+02	1.0163E+03	2.1710E+02	-6.9908E+04	1.2504E+05	1.4329E+03	-2.7503E+03	1.2293E+04	2.0094E+01
1.0842E+02	9.6546E+02	2.6232E+02	-6.9908E+04	1.1879E+05	1.8659E+03	-2.7503E+03	1.1931E+04	1.8902E+02
1.0842E+02	9.1464E+02	1.7985E+03	-6.9908E+04	1.1254E+05	5.0562E+03	-2.7503E+03	1.1570E+04	3.1817E+01
1.0842E+02	8.6383E+02	3.0455E+03	-6.9908E+04	1.0629E+05	7.4452E+03	-2.7503E+03	1.1208E+04	2.9041E+00
1.0842E+02	8.1302E+02	8.3917E+03	-6.9908E+04	1.0004E+05	1.1705E+04	-2.7503E+03	1.0847E+04	5.3854E+02
1.0842E+02	7.6220E+02	8.8717E+03	-6.9908E+04	9.3783E+04	2.4402E+03	-2.7503E+03	1.0485E+04	3.7482E+02
1.0842E+02	7.1139E+02	1.8868E+04	-6.9908E+04	8.7531E+04	2.7782E+03	-2.7503E+03	1.0124E+04	7.7182E+01
1.0842E+02	6.6057E+02	4.5677E+04	-6.9908E+04	8.1279E+04	1.0140E+04	-2.7503E+03	9.7620E+03	1.1927E+02
1.0842E+02	6.0976E+02	1.1914E+05	-6.9908E+04	7.5026E+04	2.7814E+04	-2.7503E+03	9.4005E+03	1.1718E+03
1.0842E+02	5.5895E+02	1.6850E+05	-6.9908E+04	6.8774E+04	3.5872E+04	-2.7503E+03	9.0389E+03	6.8504E+02
1.0842E+02	5.0813E+02	3.0466E+05	-6.9908E+04	6.2522E+04	3.5518E+04	-2.7503E+03	8.6774E+03	1.8923E+03
1.0842E+02	4.5732E+02	5.4838E+05	-6.9908E+04	5.6270E+04	6.7339E+04	-2.7503E+03	8.3158E+03	4.3153E+03
1.0842E+02	4.0651E+02	9.8764E+05	-6.9908E+04	5.0018E+04	1.1591E+05	-2.7503E+03	7.9543E+03	4.3641E+03
1.0842E+02	3.5569E+02	1.4544E+06	-6.9908E+04	4.3765E+04	1.4879E+05	-2.7503E+03	7.5927E+03	2.0049E+04
1.0842E+02	3.0488E+02	2.0385E+06	-6.9908E+04	3.7513E+04	3.0459E+05	-2.7503E+03	7.2311E+03	3.0705E+04
1.0842E+02	2.5407E+02	3.1167E+06	-6.9908E+04	3.1261E+04	4.1854E+05	-2.7503E+03	6.8696E+03	2.9122E+04
1.0842E+02	2.0325E+02	4.2781E+06	-6.9908E+04	2.5009E+04	1.1769E+06	-2.7503E+03	6.5080E+03	6.2829E+04
1.0842E+02	1.5244E+02	5.3855E+06	-6.9908E+04	1.8757E+04	2.3116E+06	-2.7503E+03	6.1465E+03	9.3800E+04
1.0842E+02	1.0163E+02	5.0048E+06	-6.9908E+04	1.2504E+04	4.6555E+06	-2.7503E+03	5.7849E+03	1.9516E+05
1.0842E+02	5.0813E+01	5.3182E+06	-6.9908E+04	6.2522E+03	4.9526E+06	-2.7503E+03	5.4234E+03	2.1750E+05
1.0842E+02	0.0000E+00	2.0855E+07	-6.9908E+04	0.0000E+00	1.1719E+07	-2.7503E+03	5.0618E+03	3.0043E+05
4.7843E+01	2.5407E+03	1.6804E+00	-7.6991E+04	2.1257E+05	1.6804E+00	-2.7503E+03	4.7002E+03	4.0635E+05
4.7843E+01	2.2866E+03	1.6804E+00	-7.6991E+04	2.0007E+05	1.6804E+00	-2.7503E+03	4.3387E+03	4.4111E+05
4.7843E+01	2.1342E+03	1.7500E+00	-7.6991E+04	1.7506E+05	1.2644E+01	-2.7503E+03	3.9771E+03	5.9480E+05
4.7843E+01	2.0834E+03	3.4304E+00	-7.6991E+04	1.6256E+05	2.2944E+01	-2.7503E+03	3.6156E+03	6.3902E+05
4.7843E+01	1.9817E+03	5.5625E-02	-7.6991E+04	1.5630E+05	1.2644E+01	-2.7503E+03	3.2540E+03	8.0729E+05
4.7843E+01	1.9309E+03	4.1250E+00	-7.6991E+04	1.4380E+05	1.7661E+01	-2.7503E+03	2.8925E+03	9.4990E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.7843E+01	1.7785E+03	6.2500E-01	-7.6991E+04	1.3755E+05	5.0160E+01	-2.7503E+03	2.5309E+03	9.2850E+05
4.7843E+01	1.7277E+03	1.6688E-01	-7.6991E+04	1.3130E+05	1.6601E+02	-2.7503E+03	2.1693E+03	8.4805E+05
4.7843E+01	1.6768E+03	2.2250E-01	-7.6991E+04	1.2504E+05	9.4207E+01	-2.7503E+03	1.8078E+03	7.3841E+05
4.7843E+01	1.5244E+03	5.5625E-02	-7.6991E+04	1.1879E+05	9.9468E+02	-2.7503E+03	1.4462E+03	9.9416E+05
4.7843E+01	1.4736E+03	6.2500E-01	-7.6991E+04	1.1254E+05	1.1204E+03	-2.7503E+03	1.0847E+03	1.2218E+06
4.7843E+01	1.4228E+03	1.3077E+01	-7.6991E+04	1.0629E+05	3.4499E+03	-2.7503E+03	7.2311E+02	2.1301E+06
4.7843E+01	1.3720E+03	2.3610E+00	-7.6991E+04	1.0004E+05	3.9192E+03	-2.7503E+03	3.6156E+02	4.1945E+06
4.7843E+01	1.3211E+03	1.7571E+01	-7.6991E+04	9.3783E+04	1.5674E+04	-2.7503E+03	0.0000E+00	8.0567E+06
4.7843E+01	1.2703E+03	7.9188E-01	-7.6991E+04	8.7531E+04	1.4166E+04	-3.1961E+03	1.8078E+04	1.0417E+02
4.7843E+01	1.2195E+03	1.8924E+01	-7.6991E+04	8.1279E+04	4.8709E+03	-3.1961E+03	1.7716E+04	6.2500E-01
4.7843E+01	1.1687E+03	1.2083E+01	-7.6991E+04	7.5026E+04	1.6050E+04	-3.1961E+03	1.7355E+04	5.5625E-02
4.7843E+01	1.1179E+03	3.3375E+01	-7.6991E+04	6.8774E+04	2.9606E+04	-3.1961E+03	1.5909E+04	2.0246E-01
4.7843E+01	1.0671E+03	3.6459E+01	-7.6991E+04	6.2522E+04	6.3508E+04	-3.1961E+03	1.5185E+04	2.3602E+00
4.7843E+01	1.0163E+03	2.9758E+01	-7.6991E+04	5.6270E+04	8.4480E+04	-3.1961E+03	1.4824E+04	8.2863E-01
4.7843E+01	9.6546E+02	3.7628E+01	-7.6991E+04	5.0018E+04	1.9302E+05	-3.1961E+03	1.4462E+04	1.1779E+00
4.7843E+01	9.1464E+02	5.3368E+01	-7.6991E+04	4.3765E+04	2.8040E+05	-3.1961E+03	1.3739E+04	3.8514E+00
4.7843E+01	8.6383E+02	1.1761E+02	-7.6991E+04	3.7513E+04	6.2649E+05	-3.1961E+03	1.3378E+04	3.4304E+00
4.7843E+01	8.1302E+02	3.5516E+03	-7.6991E+04	3.1261E+04	1.3178E+06	-3.1961E+03	1.3016E+04	6.2500E-01
4.7843E+01	7.6220E+02	3.9971E+03	-7.6991E+04	2.5009E+04	2.0185E+06	-3.1961E+03	1.2293E+04	7.7300E-01
4.7843E+01	7.1139E+02	2.8556E+04	-7.6991E+04	1.8757E+04	3.5185E+06	-3.1961E+03	1.1931E+04	4.3860E+00
4.7843E+01	6.6057E+02	2.9289E+04	-7.6991E+04	1.2504E+04	4.7468E+06	-3.1961E+03	1.1570E+04	1.3894E+01
4.7843E+01	6.0976E+02	4.9965E+04	-7.6991E+04	6.2522E+03	4.8478E+06	-3.1961E+03	1.1208E+04	2.4068E+01
4.7843E+01	5.5895E+02	9.3778E+04	-7.6991E+04	0.0000E+00	9.5549E+06	-3.1961E+03	1.0847E+04	8.6397E+01
4.7843E+01	5.0813E+02	1.5305E+05	-8.4073E+04	1.3130E+05	1.3420E+02	-3.1961E+03	1.0485E+04	1.5557E+01
4.7843E+01	4.5732E+02	2.3227E+05	-8.4073E+04	1.2504E+05	6.7029E+02	-3.1961E+03	1.0124E+04	1.2367E+02
4.7843E+01	4.0651E+02	4.2432E+05	-8.4073E+04	1.1879E+05	8.0662E+02	-3.1961E+03	9.7620E+03	2.8095E+02
4.7843E+01	3.5569E+02	6.6941E+05	-8.4073E+04	1.1254E+05	1.6582E+03	-3.1961E+03	9.4005E+03	4.7543E+01
4.7843E+01	3.0488E+02	1.0223E+06	-8.4073E+04	1.0629E+05	3.9592E+03	-3.1961E+03	9.0389E+03	1.9283E+02
4.7843E+01	2.5407E+02	1.3037E+06	-8.4073E+04	1.0004E+05	3.6204E+03	-3.1961E+03	8.6774E+03	2.7085E+03
4.7843E+01	2.0325E+02	1.4999E+06	-8.4073E+04	9.3783E+04	8.8527E+03	-3.1961E+03	8.3158E+03	2.2875E+02
4.7843E+01	1.5244E+02	1.5434E+06	-8.4073E+04	8.7531E+04	1.0316E+04	-3.1961E+03	7.9543E+03	2.3386E+03
4.7843E+01	1.0163E+02	1.5380E+06	-8.4073E+04	8.1279E+04	3.3786E+04	-3.1961E+03	7.5927E+03	3.1888E+03
4.7843E+01	5.0813E+01	3.5028E+06	-8.4073E+04	7.5026E+04	3.6472E+04	-3.1961E+03	7.2311E+03	1.8429E+03
4.7843E+01	0.0000E+00	1.4670E+07	-8.4073E+04	6.8774E+04	7.4491E+04	-3.1961E+03	6.8696E+03	5.9605E+03
-1.2735E+01	2.2358E+03	1.6804E+00	-8.4073E+04	6.2522E+04	1.1257E+05	-3.1961E+03	6.5080E+03	7.1831E+03
-1.2735E+01	2.1850E+03	3.3608E+00	-8.4073E+04	5.6270E+04	1.7313E+05	-3.1961E+03	6.1465E+03	3.0850E+04
-1.2735E+01	2.0834E+03	1.6804E+00	-8.4073E+04	5.0018E+04	3.0299E+05	-3.1961E+03	5.7849E+03	2.5041E+04
-1.2735E+01	1.6260E+03	5.5625E-02	-8.4073E+04	4.3765E+04	5.6257E+05	-3.1961E+03	5.4234E+03	9.8367E+04

DNV Denmark A/S Tuborgparkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.2735E+01	1.5244E+03	1.6804E+00	-8.4073E+04	3.7513E+04	1.0307E+06	-3.1961E+03	5.0618E+03	1.2186E+05
-1.2735E+01	1.4736E+03	4.1806E+00	-8.4073E+04	3.1261E+04	1.9766E+06	-3.1961E+03	4.7002E+03	2.4083E+05
-1.2735E+01	1.4228E+03	1.3056E+00	-8.4073E+04	2.5009E+04	2.9615E+06	-3.1961E+03	4.3387E+03	3.2896E+05
-1.2735E+01	1.3720E+03	6.4304E+00	-8.4073E+04	1.8757E+04	4.0547E+06	-3.1961E+03	3.9771E+03	3.7236E+05
-1.2735E+01	1.3211E+03	3.9858E+00	-8.4073E+04	1.2504E+04	4.2668E+06	-3.1961E+03	3.6156E+03	5.7129E+05
-1.2735E+01	1.2703E+03	1.8743E+00	-8.4073E+04	6.2522E+03	4.2647E+06	-3.1961E+03	3.2540E+03	5.1928E+05
-1.2735E+01	1.2195E+03	1.7233E+01	-8.4073E+04	0.0000E+00	8.6516E+06	-3.1961E+03	2.8925E+03	6.6017E+05
-1.2735E+01	1.1687E+03	1.5954E+01	-9.1156E+04	1.5630E+05	1.3137E+01	-3.1961E+03	2.5309E+03	6.0731E+05
-1.2735E+01	1.1179E+03	7.5831E+00	-9.1156E+04	1.4380E+05	6.5066E+02	-3.1961E+03	2.1693E+03	7.0045E+05
-1.2735E+01	1.0671E+03	5.1664E+00	-9.1156E+04	1.3755E+05	7.6435E+01	-3.1961E+03	1.8078E+03	6.1239E+05
-1.2735E+01	1.0163E+03	2.7149E+01	-9.1156E+04	1.3130E+05	2.6876E+03	-3.1961E+03	1.4462E+03	6.1670E+05
-1.2735E+01	9.6546E+02	3.3547E+01	-9.1156E+04	1.2504E+05	1.2257E+03	-3.1961E+03	1.0847E+03	8.7495E+05
-1.2735E+01	9.1464E+02	3.6283E+01	-9.1156E+04	1.1879E+05	3.3918E+03	-3.1961E+03	7.2311E+02	1.4273E+06
-1.2735E+01	8.6383E+02	6.4746E+01	-9.1156E+04	1.1254E+05	2.0815E+03	-3.1961E+03	3.6156E+02	2.7757E+06
-1.2735E+01	8.1302E+02	2.0252E+03	-9.1156E+04	1.0629E+05	3.4975E+03	-3.1961E+03	0.0000E+00	5.4855E+06
-1.2735E+01	7.6220E+02	6.9411E+03	-9.1156E+04	1.0004E+05	8.8862E+03	-3.6418E+03	1.8078E+04	2.3054E+00
-1.2735E+01	7.1139E+02	6.2063E+03	-9.1156E+04	9.3783E+04	1.8863E+04	-3.6418E+03	1.6993E+04	5.5625E-02
-1.2735E+01	6.6057E+02	6.3607E+03	-9.1156E+04	8.7531E+04	1.7876E+04	-3.6418E+03	1.6270E+04	6.2500E-01
-1.2735E+01	6.0976E+02	1.0121E+04	-9.1156E+04	8.1279E+04	4.6212E+04	-3.6418E+03	1.5909E+04	9.0674E+00
-1.2735E+01	5.5895E+02	1.6230E+04	-9.1156E+04	7.5026E+04	6.2320E+04	-3.6418E+03	1.5547E+04	2.0246E-01
-1.2735E+01	5.0813E+02	2.0957E+04	-9.1156E+04	6.8774E+04	1.1999E+05	-3.6418E+03	1.5185E+04	1.5460E+00
-1.2735E+01	4.5732E+02	3.1078E+04	-9.1156E+04	6.2522E+04	1.7441E+05	-3.6418E+03	1.4462E+04	3.4786E+00
-1.2735E+01	4.0651E+02	6.9456E+04	-9.1156E+04	5.6270E+04	2.8849E+05	-3.6418E+03	1.4101E+04	2.7612E+00
-1.2735E+01	3.5569E+02	9.2437E+04	-9.1156E+04	5.0018E+04	5.8640E+05	-3.6418E+03	1.3739E+04	2.5809E-01
-1.2735E+01	3.0488E+02	1.2026E+05	-9.1156E+04	4.3765E+04	8.6583E+05	-3.6418E+03	1.3016E+04	2.0246E-01
-1.2735E+01	2.5407E+02	1.8978E+05	-9.1156E+04	3.7513E+04	1.4680E+06	-3.6418E+03	1.2655E+04	1.5460E+00
-1.2735E+01	2.0325E+02	4.2888E+05	-9.1156E+04	3.1261E+04	2.2566E+06	-3.6418E+03	1.1931E+04	1.6889E+00
-1.2735E+01	1.5244E+02	1.2241E+06	-9.1156E+04	2.5009E+04	3.1042E+06	-3.6418E+03	1.1570E+04	2.5556E+00
-1.2735E+01	1.0163E+02	3.5300E+06	-9.1156E+04	1.8757E+04	3.5481E+06	-3.6418E+03	1.1208E+04	1.4960E+00
-1.2735E+01	5.0813E+01	9.6881E+06	-9.1156E+04	1.2504E+04	4.1039E+06	-3.6418E+03	1.0847E+04	2.6939E+00
-1.2735E+01	0.0000E+00	3.0406E+07	-9.1156E+04	6.2522E+03	3.5517E+06	-3.6418E+03	1.0485E+04	3.3010E+00
-7.3313E+01	2.4390E+03	1.6804E+00	-9.1156E+04	0.0000E+00	8.5254E+06	-3.6418E+03	1.0124E+04	6.8063E-01
-7.3313E+01	1.6260E+03	1.6804E+00	-9.8238E+04	1.5630E+05	7.6980E+01	-3.6418E+03	9.7620E+03	5.0853E+00
-7.3313E+01	1.5752E+03	1.7500E+00	-9.8238E+04	1.5005E+05	1.3137E+01	-3.6418E+03	9.4005E+03	4.1806E+00
-7.3313E+01	1.5244E+03	6.2500E-01	-9.8238E+04	1.4380E+05	1.6295E+02	-3.6418E+03	9.0389E+03	1.0530E+02
-7.3313E+01	1.4736E+03	1.1125E-01	-9.8238E+04	1.3755E+05	7.6980E+01	-3.6418E+03	8.6774E+03	8.7485E+00
-7.3313E+01	1.4228E+03	1.6804E+00	-9.8238E+04	1.3130E+05	1.3887E+03	-3.6418E+03	8.3158E+03	3.3421E+02
-7.3313E+01	1.3211E+03	1.6804E+00	-9.8238E+04	1.2504E+05	1.8052E+03	-3.6418E+03	7.9543E+03	4.1356E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-7.3313E+01	1.2703E+03	5.2500E+00	-9.8238E+04	1.1879E+05	5.8803E+03	-3.6418E+03	7.5927E+03	9.2683E+02
-7.3313E+01	1.2195E+03	9.2914E+00	-9.8238E+04	1.1254E+05	2.3971E+04	-3.6418E+03	7.2311E+03	3.6641E+03
-7.3313E+01	1.1687E+03	5.9306E+00	-9.8238E+04	1.0629E+05	8.0857E+03	-3.6418E+03	6.8696E+03	8.0176E+03
-7.3313E+01	1.1179E+03	7.0000E+00	-9.8238E+04	1.0004E+05	2.8718E+04	-3.6418E+03	6.5080E+03	1.0082E+04
-7.3313E+01	1.0671E+03	1.0593E+01	-9.8238E+04	9.3783E+04	2.3780E+04	-3.6418E+03	6.1465E+03	5.9074E+03
-7.3313E+01	1.0163E+03	1.1611E+01	-9.8238E+04	8.7531E+04	4.1269E+04	-3.6418E+03	5.7849E+03	1.3462E+04
-7.3313E+01	9.6546E+02	2.9305E+01	-9.8238E+04	8.1279E+04	5.6409E+04	-3.6418E+03	5.4234E+03	1.2173E+04
-7.3313E+01	9.1464E+02	4.3899E+01	-9.8238E+04	7.5026E+04	6.3270E+04	-3.6418E+03	5.0618E+03	4.2442E+04
-7.3313E+01	8.6383E+02	4.1463E+01	-9.8238E+04	6.8774E+04	1.2746E+05	-3.6418E+03	4.7002E+03	7.2584E+04
-7.3313E+01	8.1302E+02	1.1792E+02	-9.8238E+04	6.2522E+04	1.8081E+05	-3.6418E+03	4.3387E+03	6.9091E+04
-7.3313E+01	7.6220E+02	7.7391E+01	-9.8238E+04	5.6270E+04	4.1214E+05	-3.6418E+03	3.9771E+03	1.4386E+05
-7.3313E+01	7.1139E+02	1.4425E+02	-9.8238E+04	5.0018E+04	5.6516E+05	-3.6418E+03	3.6156E+03	2.2975E+05
-7.3313E+01	6.6057E+02	1.4903E+02	-9.8238E+04	4.3765E+04	1.2752E+06	-3.6418E+03	3.2540E+03	4.1920E+05
-7.3313E+01	6.0976E+02	1.2136E+03	-9.8238E+04	3.7513E+04	2.0383E+06	-3.6418E+03	2.8925E+03	3.3037E+05
-7.3313E+01	5.5895E+02	2.2160E+02	-9.8238E+04	3.1261E+04	3.3945E+06	-3.6418E+03	2.5309E+03	4.0498E+05
-7.3313E+01	5.0813E+02	4.4499E+02	-9.8238E+04	2.5009E+04	4.3132E+06	-3.6418E+03	2.1693E+03	4.0018E+05
-7.3313E+01	4.5732E+02	5.2541E+02	-9.8238E+04	1.8757E+04	5.5486E+06	-3.6418E+03	1.8078E+03	3.8343E+05
-7.3313E+01	4.0651E+02	5.1369E+03	-9.8238E+04	1.2504E+04	5.1675E+06	-3.6418E+03	1.4462E+03	4.1626E+05
-7.3313E+01	3.5569E+02	1.1468E+04	-9.8238E+04	6.2522E+03	5.1398E+06	-3.6418E+03	1.0847E+03	4.9941E+05
-7.3313E+01	3.0488E+02	1.0196E+04	-9.8238E+04	0.0000E+00	1.1141E+07	-3.6418E+03	7.2311E+02	8.0163E+05
-7.3313E+01	2.5407E+02	1.4281E+04	-1.0532E+05	1.3755E+05	7.5255E+02	-3.6418E+03	3.6156E+02	1.9079E+06
-7.3313E+01	2.0325E+02	2.7185E+04	-1.0532E+05	1.3130E+05	9.0939E+02	-3.6418E+03	0.0000E+00	3.6460E+06
-7.3313E+01	1.5244E+02	5.7716E+04	-1.0532E+05	1.2504E+05	1.8153E+03	-4.0876E+03	1.6270E+04	5.5625E-02
-7.3313E+01	1.0163E+02	1.0576E+05	-1.0532E+05	1.1879E+05	4.2710E+03	-4.0876E+03	1.5909E+04	6.2500E-01
-7.3313E+01	5.0813E+01	5.6493E+05	-1.0532E+05	1.1254E+05	3.2842E+03	-4.0876E+03	1.5547E+04	3.0097E-01
-7.3313E+01	0.0000E+00	2.0763E+06	-1.0532E+05	1.0629E+05	1.3712E+04	-4.0876E+03	1.4462E+04	5.5625E-02
-1.3389E+02	1.8801E+03	6.2500E-01	-1.0532E+05	1.0004E+05	8.6076E+03	-4.0876E+03	1.3739E+04	7.7480E-01
-1.3389E+02	1.5752E+03	3.5000E+00	-1.0532E+05	9.3783E+04	3.3280E+04	-4.0876E+03	1.1931E+04	6.2500E-01
-1.3389E+02	1.5244E+03	6.2500E-01	-1.0532E+05	8.7531E+04	4.4143E+04	-4.0876E+03	1.1570E+04	6.0263E-02
-1.3389E+02	1.4736E+03	6.2500E-01	-1.0532E+05	8.1279E+04	5.4749E+04	-4.0876E+03	1.1208E+04	6.5204E-01
-1.3389E+02	1.4228E+03	1.6804E+00	-1.0532E+05	7.5026E+04	6.5089E+04	-4.0876E+03	1.0847E+04	1.2500E+00
-1.3389E+02	1.3720E+03	3.3608E+00	-1.0532E+05	6.8774E+04	1.2890E+05	-4.0876E+03	1.0124E+04	1.6804E+00
-1.3389E+02	1.3211E+03	3.4304E+00	-1.0532E+05	6.2522E+04	1.7500E+05	-4.0876E+03	9.7620E+03	6.0195E-01
-1.3389E+02	1.2703E+03	1.0430E+01	-1.0532E+05	5.6270E+04	2.8977E+05	-4.0876E+03	9.4005E+03	1.7500E+00
-1.3389E+02	1.2195E+03	1.5750E+01	-1.0532E+05	5.0018E+04	6.5254E+05	-4.0876E+03	9.0389E+03	4.1074E+00
-1.3389E+02	1.1687E+03	1.9180E+01	-1.0532E+05	4.3765E+04	1.0537E+06	-4.0876E+03	8.6774E+03	2.1235E+02
-1.3389E+02	1.1179E+03	1.0430E+01	-1.0532E+05	3.7513E+04	1.9326E+06	-4.0876E+03	8.3158E+03	3.1275E+01
-1.3389E+02	1.0671E+03	1.0847E+01	-1.0532E+05	3.1261E+04	3.2096E+06	-4.0876E+03	7.9543E+03	1.5460E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Energy Systems Tuborgvænget 6-8 DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.3389E+02	1.0163E+03	2.0791E+01	-1.0532E+05	2.5009E+04	5.1584E+06	-4.0876E+03	7.5927E+03	5.8353E+01
-1.3389E+02	9.6546E+02	2.9530E+01	-1.0532E+05	1.8757E+04	6.7706E+06	-4.0876E+03	7.2311E+03	8.3173E+01
-1.3389E+02	9.1464E+02	2.5193E+01	-1.0532E+05	1.2504E+04	6.6360E+06	-4.0876E+03	6.8696E+03	1.5201E+02
-1.3389E+02	8.6383E+02	2.0936E+01	-1.0532E+05	6.2522E+03	6.6450E+06	-4.0876E+03	6.5080E+03	2.4499E+02
-1.3389E+02	8.1302E+02	4.8140E+01	-1.0532E+05	0.0000E+00	1.5599E+07	-4.0876E+03	6.1465E+03	1.6871E+03
-1.3389E+02	7.6220E+02	7.8879E+01	-1.1240E+05	1.6256E+05	2.9393E+02	-4.0876E+03	5.7849E+03	4.6877E+01
-1.3389E+02	7.1139E+02	8.4231E+01	-1.1240E+05	1.3130E+05	7.6980E+01	-4.0876E+03	5.4234E+03	3.8826E+03
-1.3389E+02	6.6057E+02	8.5553E+01	-1.1240E+05	1.2504E+05	3.8426E+03	-4.0876E+03	5.0618E+03	1.4030E+04
-1.3389E+02	6.0976E+02	8.6347E+01	-1.1240E+05	1.1879E+05	4.0589E+03	-4.0876E+03	4.7002E+03	1.5912E+04
-1.3389E+02	5.5895E+02	1.1375E+02	-1.1240E+05	1.1254E+05	8.3157E+03	-4.0876E+03	4.3387E+03	5.9945E+04
-1.3389E+02	5.0813E+02	1.4870E+02	-1.1240E+05	1.0629E+05	4.8400E+03	-4.0876E+03	3.9771E+03	3.3488E+04
-1.3389E+02	4.5732E+02	2.2359E+03	-1.1240E+05	1.0004E+05	1.4159E+04	-4.0876E+03	3.6156E+03	4.1645E+04
-1.3389E+02	4.0651E+02	4.3415E+03	-1.1240E+05	9.3783E+04	3.1951E+04	-4.0876E+03	3.2540E+03	7.5509E+04
-1.3389E+02	3.5569E+02	4.5687E+03	-1.1240E+05	8.7531E+04	2.7986E+04	-4.0876E+03	2.8925E+03	1.1606E+05
-1.3389E+02	3.0488E+02	4.3947E+03	-1.1240E+05	8.1279E+04	3.9337E+04	-4.0876E+03	2.5309E+03	1.2797E+05
-1.3389E+02	2.5407E+02	1.3524E+04	-1.1240E+05	7.5026E+04	8.7607E+04	-4.0876E+03	2.1693E+03	1.6644E+05
-1.3389E+02	2.0325E+02	9.4476E+03	-1.1240E+05	6.8774E+04	1.0255E+05	-4.0876E+03	1.8078E+03	1.5904E+05
-1.3389E+02	1.5244E+02	1.5233E+04	-1.1240E+05	6.2522E+04	1.7193E+05	-4.0876E+03	1.4462E+03	2.1441E+05
-1.3389E+02	1.0163E+02	2.8860E+04	-1.1240E+05	5.6270E+04	2.6393E+05	-4.0876E+03	1.0847E+03	2.5560E+05
-1.3389E+02	5.0813E+01	6.3175E+04	-1.1240E+05	5.0018E+04	5.5909E+05	-4.0876E+03	7.2311E+02	4.8491E+05
-1.3389E+02	0.0000E+00	2.8817E+05	-1.1240E+05	4.3765E+04	8.1638E+05	-4.0876E+03	3.6156E+02	1.2121E+06
-1.9447E+02	1.5752E+03	6.2500E-01	-1.1240E+05	3.7513E+04	1.6450E+06	-4.0876E+03	0.0000E+00	2.4628E+06
-1.9447E+02	1.4736E+03	1.7500E+00	-1.1240E+05	3.1261E+04	3.2987E+06	-4.5334E+03	1.4824E+04	1.0417E+02
-1.9447E+02	1.4228E+03	7.0556E+00	-1.1240E+05	2.5009E+04	5.4222E+06	-4.5334E+03	1.2655E+04	5.5625E-02
-1.9447E+02	1.3720E+03	5.2500E+00	-1.1240E+05	1.8757E+04	7.1169E+06	-4.5334E+03	1.2293E+04	5.5625E-02
-1.9447E+02	1.3211E+03	3.5000E+00	-1.1240E+05	1.2504E+04	7.9772E+06	-4.5334E+03	1.1570E+04	6.8063E-01
-1.9447E+02	1.2703E+03	1.3791E+01	-1.1240E+05	6.2522E+03	8.3374E+06	-4.5334E+03	1.0847E+04	1.6804E+00
-1.9447E+02	1.2195E+03	3.5000E+00	-1.1240E+05	0.0000E+00	1.9631E+07	-4.5334E+03	1.0485E+04	2.3750E+00
-1.9447E+02	1.1687E+03	6.9304E+00	-1.1949E+05	1.2504E+05	4.6326E+02	-4.5334E+03	1.0124E+04	1.7500E+00
-1.9447E+02	1.1179E+03	5.2500E+00	-1.1949E+05	1.1879E+05	1.1298E+03	-4.5334E+03	9.7620E+03	1.7500E+00
-1.9447E+02	1.0671E+03	1.1611E+01	-1.1949E+05	1.1254E+05	4.1665E+03	-4.5334E+03	9.0389E+03	2.1794E+01
-1.9447E+02	1.0163E+03	3.5000E+00	-1.1949E+05	1.0629E+05	1.1560E+04	-4.5334E+03	8.3158E+03	5.4071E-02
-1.9447E+02	9.6546E+02	2.2901E+01	-1.1949E+05	1.0004E+05	2.2165E+04	-4.5334E+03	7.5927E+03	6.3054E+00
-1.9447E+02	9.1464E+02	1.5611E+01	-1.1949E+05	9.3783E+04	2.7079E+04	-4.5334E+03	7.2311E+03	2.1558E+01
-1.9447E+02	8.6383E+02	1.4832E+01	-1.1949E+05	8.7531E+04	4.5027E+04	-4.5334E+03	6.8696E+03	2.5000E+00
-1.9447E+02	8.1302E+02	1.7361E+01	-1.1949E+05	8.1279E+04	3.7116E+04	-4.5334E+03	6.5080E+03	7.1579E+00
-1.9447E+02	7.6220E+02	2.2111E+01	-1.1949E+05	7.5026E+04	6.0261E+04	-4.5334E+03	6.1465E+03	1.4123E+01
-1.9447E+02	7.1139E+02	3.3540E+01	-1.1949E+05	6.8774E+04	1.0081E+05	-4.5334E+03	5.7849E+03	2.4780E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.9447E+02	6.6057E+02	1.1722E+01	-1.1949E+05	6.2522E+04	1.4891E+05	-4.5334E+03	5.4234E+03	1.5220E+03
-1.9447E+02	6.0976E+02	3.4965E+01	-1.1949E+05	5.6270E+04	2.1637E+05	-4.5334E+03	5.0618E+03	4.8040E+03
-1.9447E+02	5.5895E+02	9.5803E+01	-1.1949E+05	5.0018E+04	3.5701E+05	-4.5334E+03	4.7002E+03	2.0358E+03
-1.9447E+02	5.0813E+02	3.0943E+01	-1.1949E+05	4.3765E+04	6.6300E+05	-4.5334E+03	4.3387E+03	1.1968E+03
-1.9447E+02	4.5732E+02	5.3473E+01	-1.1949E+05	3.7513E+04	1.2589E+06	-4.5334E+03	3.9771E+03	5.3536E+03
-1.9447E+02	4.0651E+02	9.3794E+01	-1.1949E+05	3.1261E+04	2.6591E+06	-4.5334E+03	3.6156E+03	2.4397E+04
-1.9447E+02	3.5569E+02	6.0207E+01	-1.1949E+05	2.5009E+04	4.7497E+06	-4.5334E+03	3.2540E+03	4.8491E+03
-1.9447E+02	3.0488E+02	1.1443E+02	-1.1949E+05	1.8757E+04	7.2185E+06	-4.5334E+03	2.8925E+03	1.6529E+04
-1.9447E+02	2.5407E+02	4.4022E+03	-1.1949E+05	1.2504E+04	8.9342E+06	-4.5334E+03	2.5309E+03	3.1072E+04
-1.9447E+02	2.0325E+02	2.6191E+02	-1.1949E+05	6.2522E+03	9.0124E+06	-4.5334E+03	2.1693E+03	5.7353E+04
-1.9447E+02	1.5244E+02	4.1635E+03	-1.1949E+05	0.0000E+00	2.2037E+07	-4.5334E+03	1.8078E+03	1.4932E+04
-1.9447E+02	1.0163E+02	4.4705E+03	-1.2657E+05	1.3130E+05	1.5442E+02	-4.5334E+03	1.4462E+03	8.5012E+04
-1.9447E+02	5.0813E+01	1.8666E+04	-1.2657E+05	1.2504E+05	1.5442E+02	-4.5334E+03	1.0847E+03	1.1467E+05
-1.9447E+02	0.0000E+00	6.1927E+04	-1.2657E+05	1.1879E+05	8.9844E+02	-4.5334E+03	7.2311E+02	1.9255E+05
-2.5505E+02	1.7277E+03	1.6804E+00	-1.2657E+05	1.1254E+05	2.6441E+03	-4.5334E+03	3.6156E+02	4.9490E+05
-2.5505E+02	1.6260E+03	1.7500E+00	-1.2657E+05	1.0629E+05	4.9933E+03	-4.5334E+03	0.0000E+00	1.4461E+06
-2.5505E+02	1.5752E+03	1.6804E+00	-1.2657E+05	1.0004E+05	1.1032E+04	-4.9791E+03	1.4101E+04	5.7362E+00
-2.5505E+02	1.5244E+03	3.5000E+00	-1.2657E+05	9.3783E+04	2.6842E+04	-4.9791E+03	1.3739E+04	6.2500E-01
-2.5505E+02	1.4736E+03	3.4304E+00	-1.2657E+05	8.7531E+04	3.9149E+04	-4.9791E+03	1.3378E+04	5.5625E-02
-2.5505E+02	1.4228E+03	1.6804E+00	-1.2657E+05	8.1279E+04	4.7734E+04	-4.9791E+03	1.3016E+04	3.0097E-01
-2.5505E+02	1.3720E+03	5.1108E+00	-1.2657E+05	7.5026E+04	5.6112E+04	-4.9791E+03	1.2655E+04	1.1125E-01
-2.5505E+02	1.3211E+03	5.0412E+00	-1.2657E+05	6.8774E+04	9.3032E+04	-4.9791E+03	1.1931E+04	7.7480E-01
-2.5505E+02	1.2703E+03	5.1108E+00	-1.2657E+05	6.2522E+04	1.4072E+05	-4.9791E+03	7.5927E+03	1.1125E-01
-2.5505E+02	1.2195E+03	1.6804E+00	-1.2657E+05	5.6270E+04	1.6208E+05	-4.9791E+03	6.8696E+03	5.1617E-01
-2.5505E+02	1.1687E+03	1.2500E+00	-1.2657E+05	5.0018E+04	3.4846E+05	-4.9791E+03	6.5080E+03	2.0147E+01
-2.5505E+02	1.1179E+03	3.4304E+00	-1.2657E+05	4.3765E+04	6.6514E+05	-4.9791E+03	6.1465E+03	5.8144E+00
-2.5505E+02	1.0671E+03	5.1108E+00	-1.2657E+05	3.7513E+04	1.2136E+06	-4.9791E+03	5.7849E+03	1.7897E+01
-2.5505E+02	1.0163E+03	3.3608E+00	-1.2657E+05	3.1261E+04	2.2877E+06	-4.9791E+03	5.4234E+03	1.7803E+01
-2.5505E+02	9.6546E+02	1.6804E+00	-1.2657E+05	2.5009E+04	4.4138E+06	-4.9791E+03	5.0618E+03	2.8160E+01
-2.5505E+02	9.1464E+02	3.3608E+00	-1.2657E+05	1.8757E+04	6.9098E+06	-4.9791E+03	4.7002E+03	2.2526E+02
-2.5505E+02	8.6383E+02	2.0722E+01	-1.2657E+05	1.2504E+04	8.1932E+06	-4.9791E+03	4.3387E+03	2.6118E+02
-2.5505E+02	8.1302E+02	3.3608E+00	-1.2657E+05	6.2522E+03	9.3353E+06	-4.9791E+03	3.9771E+03	1.5843E+02
-2.5505E+02	7.6220E+02	1.7361E+01	-1.2657E+05	0.0000E+00	2.4192E+07	-4.9791E+03	3.6156E+03	4.1411E+02
-2.5505E+02	7.1139E+02	1.0361E+01	-1.3365E+05	1.3130E+05	2.9393E+02	-4.9791E+03	3.2540E+03	8.4118E+01
-2.5505E+02	6.6057E+02	1.3861E+01	-1.3365E+05	1.2504E+05	5.8960E+02	-4.9791E+03	2.8925E+03	8.4378E+02
-2.5505E+02	6.0976E+02	1.7583E+01	-1.3365E+05	1.1879E+05	5.8960E+02	-4.9791E+03	2.5309E+03	2.0543E+03
-2.5505E+02	5.5895E+02	4.5915E+01	-1.3365E+05	1.1254E+05	1.5610E+02	-4.9791E+03	2.1693E+03	1.1591E+04
-2.5505E+02	5.0813E+02	1.1472E+01	-1.3365E+05	1.0629E+05	2.7165E+02	-4.9791E+03	1.8078E+03	1.2680E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.5505E+02	4.5732E+02	2.0021E+01	-1.3365E+05	1.0004E+05	3.8448E+03	-4.9791E+03	1.4462E+03	9.6077E+03
-2.5505E+02	4.0651E+02	4.5548E+01	-1.3365E+05	9.3783E+04	8.0540E+03	-4.9791E+03	1.0847E+03	2.5334E+04
-2.5505E+02	3.5569E+02	9.6581E+01	-1.3365E+05	8.7531E+04	3.9819E+04	-4.9791E+03	7.2311E+02	8.2595E+04
-2.5505E+02	3.0488E+02	3.7470E+01	-1.3365E+05	8.1279E+04	7.0759E+04	-4.9791E+03	3.6156E+02	2.0709E+05
-2.5505E+02	2.5407E+02	5.1270E+01	-1.3365E+05	7.5026E+04	6.3612E+04	-4.9791E+03	0.0000E+00	5.3888E+05
-2.5505E+02	2.0325E+02	7.7153E+01	-1.3365E+05	6.8774E+04	9.1426E+04	-5.4249E+03	1.4101E+04	6.2500E-01
-2.5505E+02	1.5244E+02	4.1248E+01	-1.3365E+05	6.2522E+04	1.3576E+05	-5.4249E+03	1.3378E+04	6.2500E-01
-2.5505E+02	1.0163E+02	2.1080E+03	-1.3365E+05	5.6270E+04	1.8972E+05	-5.4249E+03	1.3016E+04	5.5625E-02
-2.5505E+02	5.0813E+01	4.4175E+03	-1.3365E+05	5.0018E+04	2.9656E+05	-5.4249E+03	6.5080E+03	6.0445E+01
-2.5505E+02	0.0000E+00	1.1327E+04	-1.3365E+05	4.3765E+04	5.4624E+05	-5.4249E+03	5.7849E+03	3.2791E+01
-3.1562E+02	1.6768E+03	1.6804E+00	-1.3365E+05	3.7513E+04	1.1834E+06	-5.4249E+03	5.4234E+03	3.7171E+00
-3.1562E+02	1.5244E+03	1.6804E+00	-1.3365E+05	3.1261E+04	2.5045E+06	-5.4249E+03	5.0618E+03	1.1125E-01
-3.1562E+02	1.4736E+03	1.6804E+00	-1.3365E+05	2.5009E+04	4.5057E+06	-5.4249E+03	4.7002E+03	1.8795E+01
-3.1562E+02	1.4228E+03	8.5412E+00	-1.3365E+05	1.8757E+04	7.0272E+06	-5.4249E+03	4.3387E+03	2.1213E+01
-3.1562E+02	1.3720E+03	3.3608E+00	-1.3365E+05	1.2504E+04	7.8868E+06	-5.4249E+03	3.9771E+03	5.0602E+01
-3.1562E+02	1.3211E+03	1.6804E+00	-1.3365E+05	6.2522E+03	9.2739E+06	-5.4249E+03	3.6156E+03	1.7926E+01
-3.1562E+02	1.2703E+03	1.6804E+00	-1.3365E+05	0.0000E+00	2.5285E+07	-5.4249E+03	3.2540E+03	5.7784E+01
-3.1562E+02	1.2195E+03	1.7500E+00	-1.4073E+05	1.1879E+05	1.5442E+02	-5.4249E+03	2.8925E+03	6.1417E+01
-3.1562E+02	1.1687E+03	3.5000E+00	-1.4073E+05	1.0629E+05	1.0389E+03	-5.4249E+03	2.5309E+03	9.2155E+01
-3.1562E+02	1.0163E+03	1.6804E+00	-1.4073E+05	9.3783E+04	1.6804E+00	-5.4249E+03	2.1693E+03	1.9943E+03
-3.1562E+02	9.1464E+02	1.0000E+01	-1.4073E+05	8.7531E+04	1.8694E+04	-5.4249E+03	1.8078E+03	6.3465E+03
-3.1562E+02	8.6383E+02	3.3608E+00	-1.4073E+05	8.1279E+04	1.8151E+04	-5.4249E+03	1.4462E+03	2.9121E+03
-3.1562E+02	8.1302E+02	6.8608E+00	-1.4073E+05	7.5026E+04	2.6959E+04	-5.4249E+03	1.0847E+03	9.9312E+03
-3.1562E+02	7.6220E+02	1.0082E+01	-1.4073E+05	6.8774E+04	2.9163E+04	-5.4249E+03	7.2311E+02	2.6741E+04
-3.1562E+02	7.1139E+02	7.1112E+00	-1.4073E+05	6.2522E+04	7.7846E+04	-5.4249E+03	3.6156E+02	4.6828E+04
-3.1562E+02	6.6057E+02	1.0361E+01	-1.4073E+05	5.6270E+04	1.0979E+05	-5.4249E+03	0.0000E+00	1.7455E+05
-3.1562E+02	6.0976E+02	8.1108E+00	-1.4073E+05	5.0018E+04	2.5443E+05	-5.8706E+03	1.3016E+04	1.6804E+00
-3.1562E+02	5.5895E+02	2.0722E+01	-1.4073E+05	4.3765E+04	4.3418E+05	-5.8706E+03	6.1465E+03	2.5000E+00
-3.1562E+02	5.0813E+02	1.0472E+01	-1.4073E+05	3.7513E+04	1.0179E+06	-5.8706E+03	5.7849E+03	3.1541E+01
-3.1562E+02	4.5732E+02	2.7582E+01	-1.4073E+05	3.1261E+04	2.0290E+06	-5.8706E+03	5.4234E+03	2.4714E+00
-3.1562E+02	4.0651E+02	3.8931E+01	-1.4073E+05	2.5009E+04	4.0762E+06	-5.8706E+03	5.0618E+03	1.3140E+01
-3.1562E+02	3.5569E+02	2.3804E+01	-1.4073E+05	1.8757E+04	6.3117E+06	-5.8706E+03	4.7002E+03	1.9679E+01
-3.1562E+02	3.0488E+02	3.7915E+01	-1.4073E+05	1.2504E+04	7.8112E+06	-5.8706E+03	4.3387E+03	3.3122E+00
-3.1562E+02	2.5407E+02	2.0666E+01	-1.4073E+05	6.2522E+03	8.9643E+06	-5.8706E+03	3.9771E+03	3.3714E+01
-3.1562E+02	2.0325E+02	5.7523E+01	-1.4073E+05	0.0000E+00	2.3569E+07	-5.8706E+03	3.6156E+03	2.2049E+01
-3.1562E+02	1.5244E+02	5.9019E+01	-1.4782E+05	8.7531E+04	1.0372E+03	-5.8706E+03	3.2540E+03	4.8875E+01
-3.1562E+02	1.0163E+02	7.9790E+01	-1.4782E+05	7.5026E+04	3.9035E+03	-5.8706E+03	2.8925E+03	1.1045E+01
-3.1562E+02	5.0813E+01	2.0302E+02	-1.4782E+05	6.8774E+04	7.2604E+03	-5.8706E+03	2.5309E+03	1.9509E+00

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.1562E+02	0.0000E+00	2.7596E+03	-1.4782E+05	6.2522E+04	4.0930E+03	-5.8706E+03	2.1693E+03	8.9439E+00
-3.7620E+02	1.5244E+03	3.3608E+00	-1.4782E+05	5.6270E+04	2.6079E+04	-5.8706E+03	1.8078E+03	3.7167E+01
-3.7620E+02	1.4736E+03	1.7500E+00	-1.4782E+05	5.0018E+04	6.3875E+04	-5.8706E+03	1.4462E+03	2.7049E+02
-3.7620E+02	1.3720E+03	3.3608E+00	-1.4782E+05	4.3765E+04	1.9758E+05	-5.8706E+03	1.0847E+03	5.7656E+02
-3.7620E+02	1.2703E+03	3.4304E+00	-1.4782E+05	3.7513E+04	4.4191E+05	-5.8706E+03	7.2311E+02	5.6950E+02
-3.7620E+02	1.2195E+03	1.6804E+00	-1.4782E+05	3.1261E+04	1.1900E+06	-5.8706E+03	3.6156E+02	4.3734E+03
-3.7620E+02	1.0671E+03	3.3608E+00	-1.4782E+05	2.5009E+04	2.2133E+06	-5.8706E+03	0.0000E+00	3.2082E+04
-3.7620E+02	8.1302E+02	1.0500E+01	-1.4782E+05	1.8757E+04	3.7490E+06	-6.3164E+03	8.3158E+03	4.5232E+00
-3.7620E+02	7.6220E+02	1.0222E+01	-1.4782E+05	1.2504E+04	5.2022E+06	-6.3164E+03	7.2311E+03	1.2500E+00
-3.7620E+02	7.1139E+02	3.3608E+00	-1.4782E+05	6.2522E+03	6.2757E+06	-6.3164E+03	5.7849E+03	4.1821E+02
-3.7620E+02	6.6057E+02	3.5000E+00	-1.4782E+05	0.0000E+00	1.6710E+07	-6.3164E+03	5.4234E+03	9.3161E+00
-3.7620E+02	6.0976E+02	1.0222E+01	-1.5490E+05	6.2522E+04	1.0372E+03	-6.3164E+03	5.0618E+03	2.2250E-01
-3.7620E+02	5.5895E+02	1.0082E+01	-1.5490E+05	5.0018E+04	5.9851E+03	-6.3164E+03	4.7002E+03	3.5000E+00
-3.7620E+02	5.0813E+02	1.3722E+01	-1.5490E+05	4.3765E+04	2.9190E+04	-6.3164E+03	4.3387E+03	6.7662E+00
-3.7620E+02	4.5732E+02	1.3722E+01	-1.5490E+05	3.7513E+04	2.0120E+05	-6.3164E+03	3.9771E+03	6.8098E+00
-3.7620E+02	4.0651E+02	1.7054E+01	-1.5490E+05	3.1261E+04	4.6558E+05	-6.3164E+03	3.6156E+03	1.0558E+01
-3.7620E+02	3.5569E+02	1.3861E+01	-1.5490E+05	2.5009E+04	1.2612E+06	-6.3164E+03	2.8925E+03	4.8464E+01
-3.7620E+02	3.0488E+02	1.3582E+01	-1.5490E+05	1.8757E+04	1.8990E+06	-6.3164E+03	2.5309E+03	3.5000E+00
-3.7620E+02	2.5407E+02	3.1548E+01	-1.5490E+05	1.2504E+04	2.5126E+06	-6.3164E+03	2.1693E+03	9.7651E+00
-3.7620E+02	2.0325E+02	4.1248E+01	-1.5490E+05	6.2522E+03	3.0144E+06	-6.3164E+03	1.8078E+03	3.6587E+01
-3.7620E+02	1.5244E+02	3.1166E+01	-1.5490E+05	0.0000E+00	8.5334E+06	-6.3164E+03	1.4462E+03	7.7817E+00
-3.7620E+02	1.0163E+02	4.0554E+01	-1.6198E+05	5.6270E+04	3.6302E+03	-6.3164E+03	1.0847E+03	2.4849E+01
-3.7620E+02	5.0813E+01	1.7374E+02	-1.6198E+05	4.3765E+04	1.1792E+03	-6.3164E+03	7.2311E+02	2.1157E+03
-3.7620E+02	0.0000E+00	1.7501E+02	-1.6198E+05	3.7513E+04	1.1842E+03	-6.3164E+03	3.6156E+02	1.9403E+03
-4.3678E+02	1.5244E+03	1.6804E+00	-1.6198E+05	3.1261E+04	5.8384E+04	-6.3164E+03	0.0000E+00	1.5963E+04
-4.3678E+02	7.6220E+02	3.5000E+00	-1.6198E+05	2.5009E+04	1.6890E+05	-6.7622E+03	5.7849E+03	5.1617E-01
-4.3678E+02	7.1139E+02	1.0361E+01	-1.6198E+05	1.8757E+04	3.1819E+05	-6.7622E+03	5.4234E+03	5.4112E+00
-4.3678E+02	6.6057E+02	3.3608E+00	-1.6198E+05	1.2504E+04	4.1622E+05	-6.7622E+03	4.7002E+03	1.5460E+00
-4.3678E+02	6.0976E+02	3.5000E+00	-1.6198E+05	6.2522E+03	6.9602E+05	-6.7622E+03	4.3387E+03	1.1125E-01
-4.3678E+02	5.5895E+02	1.0472E+01	-1.6198E+05	0.0000E+00	2.5950E+06	-6.7622E+03	3.9771E+03	1.6783E+01
-4.3678E+02	5.0813E+02	1.3861E+01	-1.6906E+05	2.5009E+04	1.6009E+04	-6.7622E+03	3.6156E+03	2.1183E+02
-4.3678E+02	4.5732E+02	1.0222E+01	-1.6906E+05	1.8757E+04	1.3462E+04	-6.7622E+03	3.2540E+03	4.0767E+00
-4.3678E+02	4.0651E+02	2.6715E+01	-1.6906E+05	1.2504E+04	2.8298E+04	-6.7622E+03	2.8925E+03	6.2742E-01
-4.3678E+02	3.5569E+02	1.7082E+01	-1.6906E+05	6.2522E+03	2.2974E+04	-6.7622E+03	2.5309E+03	3.6102E+00
-4.3678E+02	3.0488E+02	2.7443E+01	-1.6906E+05	0.0000E+00	3.0847E+05	-6.7622E+03	1.8078E+03	1.4061E+01
-4.3678E+02	2.5407E+02	1.3722E+01	-1.7615E+05	0.0000E+00	1.4524E+04	-6.7622E+03	1.4462E+03	1.1888E+01
-4.3678E+02	2.0325E+02	1.7082E+01				-6.7622E+03	1.0847E+03	4.1668E+01
-4.3678E+02	1.5244E+02	4.7596E+01				-6.7622E+03	7.2311E+02	8.4650E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Energy Systems Tuborgvænkvej 6.2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-4.3678E+02	1.0163E+02	6.1990E+01				-6.7622E+03	3.6156E+02	2.7342E+03
-4.3678E+02	5.0813E+01	1.1038E+02				-6.7622E+03	0.0000E+00	4.2839E+03
-4.3678E+02	0.0000E+00	1.3696E+02				-7.2079E+03	7.5927E+03	1.1125E-01
-4.9736E+02	1.5244E+03	1.6804E+00				-7.2079E+03	6.5080E+03	2.3602E+00
-4.9736E+02	7.1139E+02	3.3608E+00				-7.2079E+03	5.7849E+03	6.0195E-01
-4.9736E+02	6.6057E+02	3.3608E+00				-7.2079E+03	5.0618E+03	9.0118E+00
-4.9736E+02	6.0976E+02	1.0361E+01				-7.2079E+03	4.7002E+03	1.6573E+00
-4.9736E+02	5.0813E+02	3.5000E+00				-7.2079E+03	4.3387E+03	5.1617E-01
-4.9736E+02	4.5732E+02	6.8608E+00				-7.2079E+03	3.9771E+03	1.1125E-01
-4.9736E+02	4.0651E+02	1.3582E+01				-7.2079E+03	3.2540E+03	3.5000E+00
-4.9736E+02	3.5569E+02	1.3722E+01				-7.2079E+03	2.8925E+03	1.0558E+01
-4.9736E+02	3.0488E+02	2.8415E+01				-7.2079E+03	2.5309E+03	5.0181E+00
-4.9736E+02	2.5407E+02	1.0082E+01				-7.2079E+03	2.1693E+03	5.8161E+00
-4.9736E+02	2.0325E+02	5.7407E+01				-7.2079E+03	1.8078E+03	4.0492E-01
-4.9736E+02	1.5244E+02	1.3833E+01				-7.2079E+03	1.4462E+03	3.8907E+01
-4.9736E+02	1.0163E+02	4.8830E+01				-7.2079E+03	1.0847E+03	1.4733E+01
-4.9736E+02	5.0813E+01	8.0469E+01				-7.2079E+03	7.2311E+02	2.9049E+00
-4.9736E+02	0.0000E+00	7.8102E+01				-7.2079E+03	3.6156E+02	1.4915E+03
-5.5793E+02	9.1464E+02	3.3608E+00				-7.2079E+03	0.0000E+00	9.1249E+02
-5.5793E+02	6.6057E+02	3.3608E+00				-7.6537E+03	6.8696E+03	3.3608E+00
-5.5793E+02	6.0976E+02	3.3608E+00				-7.6537E+03	5.4234E+03	1.6573E+00
-5.5793E+02	5.5895E+02	6.7216E+00				-7.6537E+03	4.7002E+03	1.3613E+00
-5.5793E+02	5.0813E+02	3.5000E+00				-7.6537E+03	3.6156E+03	2.3602E+00
-5.5793E+02	4.5732E+02	1.0222E+01				-7.6537E+03	2.1693E+03	3.3608E+00
-5.5793E+02	4.0651E+02	1.0082E+01				-7.6537E+03	1.8078E+03	4.0492E-01
-5.5793E+02	3.5569E+02	1.0082E+01				-7.6537E+03	1.4462E+03	1.0558E+01
-5.5793E+02	2.5407E+02	1.0222E+01				-7.6537E+03	1.0847E+03	7.4062E+00
-5.5793E+02	2.0325E+02	6.8608E+00				-7.6537E+03	7.2311E+02	9.2614E+00
-5.5793E+02	1.5244E+02	1.7082E+01				-7.6537E+03	3.6156E+02	5.4382E+01
-5.5793E+02	1.0163E+02	3.3886E+01				-7.6537E+03	0.0000E+00	3.2363E+02
-5.5793E+02	5.0813E+01	9.9094E+01				-8.0994E+03	6.1465E+03	4.0492E-01
-5.5793E+02	0.0000E+00	9.2662E+01				-8.0994E+03	5.0618E+03	4.6108E+00
-6.1851E+02	3.5569E+02	3.3608E+00				-8.0994E+03	4.3387E+03	1.1125E-01
-6.1851E+02	3.0488E+02	1.0082E+01				-8.0994E+03	3.2540E+03	5.7210E+00
-6.1851E+02	2.5407E+02	3.3608E+00				-8.0994E+03	2.5309E+03	2.3602E+00
-6.1851E+02	2.0325E+02	1.0222E+01				-8.0994E+03	2.1693E+03	5.0000E+00
-6.1851E+02	1.5244E+02	2.0304E+01				-8.0994E+03	1.8078E+03	9.1230E+00
-6.1851E+02	1.0163E+02	3.8082E+01				-8.0994E+03	1.4462E+03	4.0492E-01

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Energy Systems Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-6.1851E+02	5.0813E+01	8.0888E+01				-8.0994E+03	7.2311E+02	9.1230E+00
-6.1851E+02	0.0000E+00	6.5493E+01				-8.0994E+03	3.6156E+02	1.2746E+01
-6.7909E+02	4.5732E+02	3.3608E+00				-8.0994E+03	0.0000E+00	6.6673E+01
-6.7909E+02	3.0488E+02	3.3608E+00				-8.5452E+03	4.7002E+03	1.2500E+00
-6.7909E+02	2.5407E+02	3.3608E+00				-8.5452E+03	2.8925E+03	1.1125E-01
-6.7909E+02	2.0325E+02	1.3443E+01				-8.5452E+03	1.0847E+03	2.5000E+00
-6.7909E+02	1.5244E+02	1.3443E+01				-8.5452E+03	7.2311E+02	5.8322E+00
-6.7909E+02	1.0163E+02	2.0582E+01				-8.5452E+03	3.6156E+02	2.4714E+00
-6.7909E+02	5.0813E+01	3.4575E+01				-8.5452E+03	0.0000E+00	4.8396E+00
-6.7909E+02	0.0000E+00	3.8054E+01				-8.9910E+03	1.8078E+03	1.1125E-01
-7.3967E+02	2.0325E+02	6.7216E+00				-8.9910E+03	0.0000E+00	4.3380E+01
-7.3967E+02	1.5244E+02	1.3443E+01				-9.4367E+03	7.2311E+02	1.2500E+00
-7.3967E+02	5.0813E+01	1.7222E+01				-9.4367E+03	3.6156E+02	5.4112E+00
-7.3967E+02	0.0000E+00	3.5000E+00				-9.4367E+03	0.0000E+00	1.5460E+00
-8.0025E+02	3.0488E+02	6.7216E+00				-9.8825E+03	1.0847E+03	1.1125E-01
-8.0025E+02	2.0325E+02	3.3608E+00				-9.8825E+03	0.0000E+00	9.0118E+00
-8.0025E+02	1.5244E+02	6.7216E+00				-1.0328E+04	0.0000E+00	2.7651E+00
-8.0025E+02	1.0163E+02	6.7216E+00				-1.0774E+04	0.0000E+00	1.5460E+00
-8.0025E+02	5.0813E+01	6.7216E+00				-1.1220E+04	0.0000E+00	4.0492E-01
-8.0025E+02	0.0000E+00	1.5083E+01				-1.2557E+04	0.0000E+00	1.2500E+00
-8.6082E+02	5.0813E+01	6.8608E+00						
-8.6082E+02	0.0000E+00	1.0222E+01						
-9.2140E+02	4.0651E+02	3.3608E+00						
-9.2140E+02	1.5244E+02	3.3608E+00						
-9.2140E+02	1.0163E+02	3.3608E+00						
-9.2140E+02	0.0000E+00	3.3608E+00						
-9.8198E+02	2.0325E+02	3.3608E+00						
-9.8198E+02	1.0163E+02	3.3608E+00						
-9.8198E+02	5.0813E+01	3.3608E+00						
-9.8198E+02	0.0000E+00	3.3608E+00						
-1.0426E+03	1.0163E+02	3.3608E+00						

Table 5-13 [3] Markov Matrix

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Appendix F. Markov matrices – issued from [4]

This appendix contains the Markov Matrices for the shear force, the bending moment and the torsional moment in the bottom of the tower, from ref. [4]. Foundation design must be verified for the most critical Markov matrices.

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.5851E+03	0.0000E+00	1.4000E+03	1.5969E+05	0.0000E+00	3.3608E+00	8.5783E+03	0.0000E+00	3.5000E+00
1.5196E+03	0.0000E+00	2.1171E+03	1.4510E+05	6.5066E+03	6.7216E+00	8.0663E+03	0.0000E+00	3.3608E+00
1.4542E+03	5.7129E+01	7.1709E+02	1.3051E+05	6.5066E+03	3.3608E+00	7.0424E+03	4.3030E+03	3.3608E+00
1.4542E+03	0.0000E+00	6.5392E+03	1.1592E+05	6.5066E+03	3.3608E+00	7.0424E+03	1.1735E+03	3.3608E+00
1.3887E+03	5.7129E+01	7.2059E+02	1.1592E+05	0.0000E+00	6.7216E+00	7.0424E+03	3.9118E+02	3.3608E+00
1.3887E+03	0.0000E+00	2.1339E+04	1.0862E+05	1.3013E+04	3.3608E+00	7.0424E+03	0.0000E+00	1.0222E+01
1.3232E+03	1.7139E+02	1.6804E+00	1.0862E+05	6.5066E+03	3.3608E+00	6.5304E+03	2.3471E+03	3.5000E+00
1.3232E+03	5.7129E+01	1.4199E+04	1.0862E+05	0.0000E+00	1.6943E+01	6.5304E+03	1.5647E+03	3.5000E+00
1.3232E+03	0.0000E+00	8.6442E+04	1.0133E+05	2.6026E+04	3.3608E+00	6.5304E+03	7.8236E+02	7.0000E+00
1.2578E+03	1.1426E+02	5.2372E+03	1.0133E+05	1.9520E+04	3.3608E+00	6.5304E+03	3.9118E+02	2.9775E+01
1.2578E+03	5.7129E+01	5.4324E+04	1.0133E+05	1.3013E+04	3.5000E+00	6.5304E+03	0.0000E+00	1.0361E+01
1.2578E+03	0.0000E+00	2.1793E+05	1.0133E+05	6.5066E+03	1.3443E+01	6.0184E+03	3.1295E+03	7.0000E+00
1.1923E+03	5.1416E+02	2.7165E+02	1.0133E+05	0.0000E+00	2.3526E+01	6.0184E+03	2.3471E+03	3.5000E+00
1.1923E+03	3.4277E+02	1.6804E+00	9.4031E+04	1.3013E+04	3.3608E+00	6.0184E+03	1.9559E+03	1.1125E-01
1.1923E+03	1.7139E+02	5.4330E+02	9.4031E+04	6.5066E+03	3.4720E+00	6.0184E+03	7.8236E+02	3.5000E+00
1.1923E+03	1.1426E+02	1.4075E+03	9.4031E+04	0.0000E+00	2.3943E+01	6.0184E+03	3.9118E+02	8.0032E+02
1.1923E+03	5.7129E+01	9.5168E+04	8.6736E+04	5.2052E+04	3.5000E+00	6.0184E+03	0.0000E+00	1.9308E+03
1.1923E+03	0.0000E+00	7.8069E+05	8.6736E+04	6.5066E+03	2.3665E+01	5.5065E+03	3.5206E+03	3.5000E+00
1.1268E+03	3.9990E+02	7.0000E+02	8.6736E+04	0.0000E+00	4.7747E+01	5.5065E+03	3.1295E+03	3.5000E+00
1.1268E+03	2.8564E+02	3.3876E+01	7.9440E+04	7.8079E+04	3.5000E+00	5.5065E+03	2.7383E+03	3.3608E+00
1.1268E+03	2.2852E+02	2.7165E+02	7.9440E+04	5.2052E+04	3.5000E+00	5.5065E+03	2.3471E+03	3.3608E+00
1.1268E+03	1.7139E+02	1.2638E+03	7.9440E+04	3.9039E+04	3.5000E+00	5.5065E+03	1.9559E+03	3.5000E+00
1.1268E+03	1.1426E+02	3.1499E+04	7.9440E+04	3.2533E+04	3.5000E+00	5.5065E+03	1.1735E+03	7.6980E+01
1.1268E+03	5.7129E+01	5.3642E+05	7.9440E+04	2.6026E+04	6.7216E+00	5.5065E+03	7.8236E+02	6.8608E+00
1.1268E+03	0.0000E+00	1.8800E+06	7.9440E+04	1.9520E+04	1.3582E+01	5.5065E+03	3.9118E+02	4.3225E+03
1.0613E+03	5.1416E+02	1.6804E+00	7.9440E+04	1.3013E+04	3.3608E+00	5.5065E+03	0.0000E+00	1.4431E+04
1.0613E+03	3.9990E+02	1.2492E+03	7.9440E+04	6.5066E+03	2.0304E+01	4.9945E+03	8.2148E+03	3.3608E+00
1.0613E+03	2.8564E+02	9.8713E+00	7.9440E+04	0.0000E+00	5.4469E+01	4.9945E+03	6.2589E+03	7.0000E+00
1.0613E+03	2.2852E+02	6.5003E+03	7.2144E+04	1.8218E+05	1.6804E+00	4.9945E+03	5.8677E+03	3.5000E+00
1.0613E+03	1.7139E+02	1.9316E+04	7.2144E+04	8.4585E+04	3.5000E+00	4.9945E+03	3.9118E+03	3.3608E+00
1.0613E+03	1.1426E+02	1.6844E+05	7.2144E+04	4.5546E+04	3.5000E+00	4.9945E+03	2.3471E+03	3.3608E+00
1.0613E+03	5.7129E+01	1.4390E+06	7.2144E+04	3.2533E+04	1.0500E+01	4.9945E+03	1.9559E+03	3.5000E+00
1.0613E+03	0.0000E+00	4.9422E+06	7.2144E+04	2.6026E+04	3.5000E+00	4.9945E+03	1.5647E+03	1.0417E+02
9.9588E+02	1.1426E+03	3.5855E+02	7.2144E+04	1.9520E+04	1.4000E+01	4.9945E+03	1.1735E+03	1.0610E+03

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV DENMARK A/S Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
9.9588E+02	1.0283E+03	1.3021E+01	7.2144E+04	1.3013E+04	1.5111E+01	4.9945E+03	7.8236E+02	6.9407E+03
9.9588E+02	8.5693E+02	5.4505E+02	7.2144E+04	6.5066E+03	3.7386E+01	4.9945E+03	3.9118E+02	1.9630E+04
9.9588E+02	7.9980E+02	7.2604E+03	7.2144E+04	0.0000E+00	8.8060E+01	4.9945E+03	0.0000E+00	1.0599E+05
9.9588E+02	7.4267E+02	1.1409E+04	6.4849E+04	9.7598E+04	3.3608E+00	4.4826E+03	1.6038E+04	1.6804E+00
9.9588E+02	6.8555E+02	9.3348E+03	6.4849E+04	5.8559E+04	7.0000E+00	4.4826E+03	5.8677E+03	3.3608E+00
9.9588E+02	6.2842E+02	8.9354E+03	6.4849E+04	4.5546E+04	1.0361E+01	4.4826E+03	5.4766E+03	3.3608E+00
9.9588E+02	5.7129E+02	3.1374E+04	6.4849E+04	3.9039E+04	6.8608E+00	4.4826E+03	5.0854E+03	5.7210E+00
9.9588E+02	5.1416E+02	3.5306E+04	6.4849E+04	3.2533E+04	1.3722E+01	4.4826E+03	4.6942E+03	3.3608E+00
9.9588E+02	4.5703E+02	5.4178E+04	6.4849E+04	1.9520E+04	3.4720E+00	4.4826E+03	3.5206E+03	1.0361E+01
9.9588E+02	3.9990E+02	5.2807E+04	6.4849E+04	1.3013E+04	4.1165E+01	4.4826E+03	3.1295E+03	3.5000E+00
9.9588E+02	3.4277E+02	7.8978E+04	6.4849E+04	6.5066E+03	5.0547E+01	4.4826E+03	2.3471E+03	1.1535E+03
9.9588E+02	2.8564E+02	7.5082E+04	6.4849E+04	0.0000E+00	9.5490E+01	4.4826E+03	1.9559E+03	3.9272E+03
9.9588E+02	2.2852E+02	6.2541E+04	5.7553E+04	1.6917E+05	1.6804E+00	4.4826E+03	1.5647E+03	1.0588E+04
9.9588E+02	1.7139E+02	9.9825E+04	5.7553E+04	1.6266E+05	1.6804E+00	4.4826E+03	1.1735E+03	1.6491E+04
9.9588E+02	1.1426E+02	7.0053E+05	5.7553E+04	1.4965E+05	1.6804E+00	4.4826E+03	7.8236E+02	5.1645E+04
9.9588E+02	5.7129E+01	4.1677E+06	5.7553E+04	1.2362E+05	1.6804E+00	4.4826E+03	3.9118E+02	1.3143E+05
9.9588E+02	0.0000E+00	9.6661E+06	5.7553E+04	9.7598E+04	3.3608E+00	4.4826E+03	0.0000E+00	4.5198E+05
9.3041E+02	1.5996E+03	2.7165E+02	5.7553E+04	9.1092E+04	7.0000E+00	3.9706E+03	1.4474E+04	1.6804E+00
9.3041E+02	1.5425E+03	7.0000E+02	5.7553E+04	7.8079E+04	6.8608E+00	3.9706E+03	1.2909E+04	1.6804E+00
9.3041E+02	1.4282E+03	1.4000E+03	5.7553E+04	7.1572E+04	3.5000E+00	3.9706E+03	6.2589E+03	6.7216E+00
9.3041E+02	1.3711E+03	1.6804E+00	5.7553E+04	5.8559E+04	6.8608E+00	3.9706E+03	5.8677E+03	3.3608E+00
9.3041E+02	1.2568E+03	1.6804E+00	5.7553E+04	5.2052E+04	1.7361E+01	3.9706E+03	5.4766E+03	2.5826E+02
9.3041E+02	1.1997E+03	1.1428E+03	5.7553E+04	4.5546E+04	1.7222E+01	3.9706E+03	5.0854E+03	3.5000E+00
9.3041E+02	1.1426E+03	9.8480E+03	5.7553E+04	3.9039E+04	1.0500E+01	3.9706E+03	4.6942E+03	9.1064E+02
9.3041E+02	1.0854E+03	9.9278E+03	5.7553E+04	3.2533E+04	2.0722E+01	3.9706E+03	4.3030E+03	5.6354E+02
9.3041E+02	1.0283E+03	1.4176E+04	5.7553E+04	2.6026E+04	2.9542E+01	3.9706E+03	3.9118E+03	9.3039E+01
9.3041E+02	9.7119E+02	3.0315E+04	5.7553E+04	1.9520E+04	8.1108E+00	3.9706E+03	3.5206E+03	1.2542E+04
9.3041E+02	9.1406E+02	7.9234E+04	5.7553E+04	1.3013E+04	3.4304E+01	3.9706E+03	3.1295E+03	5.7146E+03
9.3041E+02	8.5693E+02	5.4173E+04	5.7553E+04	6.5066E+03	4.9276E+01	3.9706E+03	2.7383E+03	3.1993E+04
9.3041E+02	7.9980E+02	1.6988E+05	5.7553E+04	0.0000E+00	7.8245E+01	3.9706E+03	2.3471E+03	4.9039E+04
9.3041E+02	7.4267E+02	2.4356E+05	5.0257E+04	1.6917E+05	1.7500E+00	3.9706E+03	1.9559E+03	7.0335E+04
9.3041E+02	6.8555E+02	3.7294E+05	5.0257E+04	1.4314E+05	3.4304E+00	3.9706E+03	1.5647E+03	8.1123E+04
9.3041E+02	6.2842E+02	4.4372E+05	5.0257E+04	1.3664E+05	1.7500E+00	3.9706E+03	1.1735E+03	1.2320E+05
9.3041E+02	5.7129E+02	6.1365E+05	5.0257E+04	1.3013E+05	3.5000E+00	3.9706E+03	7.8236E+02	1.1746E+05
9.3041E+02	5.1416E+02	8.5654E+05	5.0257E+04	1.1712E+05	3.5000E+00	3.9706E+03	3.9118E+02	4.0591E+05
9.3041E+02	4.5703E+02	1.1329E+06	5.0257E+04	8.4585E+04	3.3608E+00	3.9706E+03	0.0000E+00	1.1735E+06
9.3041E+02	3.9990E+02	1.3390E+06	5.0257E+04	6.5066E+04	3.5000E+00	3.4586E+03	1.5647E+04	1.6804E+00
9.3041E+02	3.4277E+02	1.3678E+06	5.0257E+04	5.8559E+04	6.8608E+00	3.4586E+03	8.6060E+03	3.3608E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
9.3041E+02	2.8564E+02	1.3547E+06	5.0257E+04	5.2052E+04	8.2500E+00	3.4586E+03	6.6501E+03	3.3608E+00
9.3041E+02	2.2852E+02	1.4205E+06	5.0257E+04	4.5546E+04	1.1750E+01	3.4586E+03	5.8677E+03	3.3608E+00
9.3041E+02	1.7139E+02	1.1454E+06	5.0257E+04	3.9039E+04	2.4082E+01	3.4586E+03	5.4766E+03	1.4124E+03
9.3041E+02	1.1426E+02	2.5130E+06	5.0257E+04	3.2533E+04	1.7472E+01	3.4586E+03	5.0854E+03	7.6253E+02
9.3041E+02	5.7129E+01	9.5480E+06	5.0257E+04	2.6026E+04	2.5583E+01	3.4586E+03	4.6942E+03	2.3274E+04
9.3041E+02	0.0000E+00	1.7252E+07	5.0257E+04	1.9520E+04	1.7082E+01	3.4586E+03	4.3030E+03	1.2213E+04
8.6494E+02	2.0566E+03	7.2360E+02	5.0257E+04	1.3013E+04	4.4776E+01	3.4586E+03	3.9118E+03	1.1819E+04
8.6494E+02	1.9424E+03	7.1709E+02	5.0257E+04	6.5066E+03	7.1379E+01	3.4586E+03	3.5206E+03	8.5135E+04
8.6494E+02	1.8852E+03	3.5855E+02	5.0257E+04	0.0000E+00	2.0506E+03	3.4586E+03	3.1295E+03	9.8370E+04
8.6494E+02	1.8281E+03	1.5442E+02	4.2961E+04	1.6917E+05	1.6804E+00	3.4586E+03	2.7383E+03	2.1511E+05
8.6494E+02	1.7139E+03	5.5076E+02	4.2961E+04	1.6266E+05	3.4304E+00	3.4586E+03	2.3471E+03	1.9876E+05
8.6494E+02	1.6567E+03	7.1709E+02	4.2961E+04	1.4965E+05	1.7500E+00	3.4586E+03	1.9559E+03	2.9764E+05
8.6494E+02	1.5996E+03	1.1248E+04	4.2961E+04	1.4314E+05	5.0412E+00	3.4586E+03	1.5647E+03	2.6736E+05
8.6494E+02	1.5425E+03	2.4900E+03	4.2961E+04	1.3664E+05	1.1902E+01	3.4586E+03	1.1735E+03	1.7940E+05
8.6494E+02	1.4853E+03	8.8317E+03	4.2961E+04	1.3013E+05	3.3608E+00	3.4586E+03	7.8236E+02	3.7320E+05
8.6494E+02	1.4282E+03	5.7910E+03	4.2961E+04	1.2362E+05	6.8608E+00	3.4586E+03	3.9118E+02	1.2078E+06
8.6494E+02	1.3711E+03	1.8050E+04	4.2961E+04	1.1061E+05	5.1804E+00	3.4586E+03	0.0000E+00	2.3902E+06
8.6494E+02	1.3140E+03	2.6459E+04	4.2961E+04	1.0410E+05	3.3608E+00	2.9467E+03	1.9559E+04	1.6804E+00
8.6494E+02	1.2568E+03	4.3753E+04	4.2961E+04	9.1092E+04	7.0000E+00	2.9467E+03	1.2127E+04	3.3608E+00
8.6494E+02	1.1997E+03	5.2739E+04	4.2961E+04	8.4585E+04	6.8608E+00	2.9467E+03	1.1735E+04	1.6804E+00
8.6494E+02	1.1426E+03	9.6919E+04	4.2961E+04	7.8079E+04	3.3608E+00	2.9467E+03	1.1344E+04	1.6804E+00
8.6494E+02	1.0854E+03	1.5786E+05	4.2961E+04	6.5066E+04	1.3861E+01	2.9467E+03	1.0953E+04	1.7500E+00
8.6494E+02	1.0283E+03	2.2308E+05	4.2961E+04	5.2052E+04	2.0722E+01	2.9467E+03	1.0562E+04	1.7500E+00
8.6494E+02	9.7119E+02	3.3174E+05	4.2961E+04	4.5546E+04	4.3964E+01	2.9467E+03	9.7796E+03	1.6804E+00
8.6494E+02	9.1406E+02	4.9219E+05	4.2961E+04	3.9039E+04	3.0382E+01	2.9467E+03	8.6060E+03	1.7500E+00
8.6494E+02	8.5693E+02	6.9111E+05	4.2961E+04	3.2533E+04	6.8047E+01	2.9467E+03	8.2148E+03	1.7500E+00
8.6494E+02	7.9980E+02	9.8776E+05	4.2961E+04	2.6026E+04	3.7915E+01	2.9467E+03	7.8236E+03	3.5000E+00
8.6494E+02	7.4267E+02	1.2145E+06	4.2961E+04	1.9520E+04	3.9054E+01	2.9467E+03	7.0413E+03	3.6302E+03
8.6494E+02	6.8555E+02	1.8042E+06	4.2961E+04	1.3013E+04	4.7603E+01	2.9467E+03	6.6501E+03	4.8716E+03
8.6494E+02	6.2842E+02	2.0935E+06	4.2961E+04	6.5066E+03	1.1349E+02	2.9467E+03	6.2589E+03	3.7759E+03
8.6494E+02	5.7129E+02	2.7575E+06	4.2961E+04	0.0000E+00	3.5794E+02	2.9467E+03	5.8677E+03	1.0498E+04
8.6494E+02	5.1416E+02	3.3173E+06	3.5666E+04	1.6266E+05	1.6804E+00	2.9467E+03	5.4766E+03	1.2673E+04
8.6494E+02	4.5703E+02	3.8413E+06	3.5666E+04	1.4314E+05	1.6804E+00	2.9467E+03	5.0854E+03	5.1676E+04
8.6494E+02	3.9990E+02	4.3233E+06	3.5666E+04	1.3664E+05	6.9304E+00	2.9467E+03	4.6942E+03	1.0229E+05
8.6494E+02	3.4277E+02	3.9839E+06	3.5666E+04	1.3013E+05	4.1250E+00	2.9467E+03	4.3030E+03	8.8614E+04
8.6494E+02	2.8564E+02	3.9829E+06	3.5666E+04	1.2362E+05	5.1804E+00	2.9467E+03	3.9118E+03	1.8978E+05
8.6494E+02	2.2852E+02	3.5144E+06	3.5666E+04	1.1712E+05	1.1972E+01	2.9467E+03	3.5206E+03	2.8954E+05
8.6494E+02	1.7139E+02	3.2716E+06	3.5666E+04	1.1061E+05	1.3930E+01	2.9467E+03	3.1295E+03	3.3129E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.6494E+02	1.1426E+02	5.5714E+06	3.5666E+04	9.7598E+04	3.4304E+00	2.9467E+03	2.7383E+03	3.8775E+05
8.6494E+02	5.7129E+01	1.5907E+07	3.5666E+04	9.1092E+04	1.0361E+01	2.9467E+03	2.3471E+03	4.4425E+05
8.6494E+02	0.0000E+00	2.4980E+07	3.5666E+04	8.4585E+04	6.8608E+00	2.9467E+03	1.9559E+03	4.2549E+05
7.9947E+02	2.3994E+03	3.5855E+02	3.5666E+04	7.8079E+04	7.0000E+00	2.9467E+03	1.5647E+03	4.6526E+05
7.9947E+02	2.2852E+03	7.1709E+02	3.5666E+04	6.5066E+04	2.0833E+01	2.9467E+03	1.1735E+03	4.4581E+05
7.9947E+02	2.1138E+03	3.5855E+02	3.5666E+04	5.8559E+04	1.3722E+01	2.9467E+03	7.8236E+02	8.1222E+05
7.9947E+02	2.0566E+03	1.5442E+02	3.5666E+04	5.2052E+04	2.4500E+01	2.9467E+03	3.9118E+02	2.4456E+06
7.9947E+02	1.9995E+03	3.5855E+02	3.5666E+04	4.5546E+04	2.5750E+01	2.9467E+03	0.0000E+00	4.8075E+06
7.9947E+02	1.9424E+03	1.4000E+03	3.5666E+04	3.9039E+04	3.7103E+01	2.4347E+03	1.2518E+04	1.7500E+00
7.9947E+02	1.8852E+03	3.5959E+03	3.5666E+04	3.2533E+04	7.0985E+01	2.4347E+03	1.2127E+04	1.7500E+00
7.9947E+02	1.8281E+03	2.5143E+03	3.5666E+04	2.6026E+04	1.2751E+02	2.4347E+03	1.1735E+04	1.7500E+00
7.9947E+02	1.7710E+03	1.3001E+04	3.5666E+04	1.9520E+04	1.4250E+02	2.4347E+03	1.0171E+04	7.8730E+01
7.9947E+02	1.7139E+03	8.9856E+03	3.5666E+04	1.3013E+04	4.3038E+03	2.4347E+03	9.7796E+03	3.3608E+00
7.9947E+02	1.6567E+03	1.0533E+04	3.5666E+04	6.5066E+03	1.9909E+02	2.4347E+03	9.3884E+03	3.5000E+00
7.9947E+02	1.5996E+03	1.3553E+04	3.5666E+04	0.0000E+00	2.7083E+03	2.4347E+03	8.6060E+03	1.0372E+03
7.9947E+02	1.5425E+03	4.1054E+04	2.8370E+04	1.5616E+05	1.7500E+00	2.4347E+03	8.2148E+03	1.7500E+00
7.9947E+02	1.4853E+03	4.2681E+04	2.8370E+04	1.4965E+05	5.2500E+00	2.4347E+03	7.8236E+03	2.3204E+03
7.9947E+02	1.4282E+03	6.7233E+04	2.8370E+04	1.4314E+05	3.5000E+00	2.4347E+03	7.4325E+03	9.2079E+03
7.9947E+02	1.3711E+03	1.0557E+05	2.8370E+04	1.3664E+05	5.1804E+00	2.4347E+03	7.0413E+03	3.4808E+03
7.9947E+02	1.3140E+03	1.7217E+05	2.8370E+04	1.3013E+05	4.1250E+00	2.4347E+03	6.6501E+03	1.1958E+04
7.9947E+02	1.2568E+03	2.2012E+05	2.8370E+04	1.2362E+05	1.7430E+01	2.4347E+03	6.2589E+03	1.3671E+04
7.9947E+02	1.1997E+03	2.5796E+05	2.8370E+04	1.1712E+05	1.0361E+01	2.4347E+03	5.8677E+03	5.3598E+04
7.9947E+02	1.1426E+03	4.2714E+05	2.8370E+04	1.1061E+05	4.1250E+00	2.4347E+03	5.4766E+03	1.0105E+05
7.9947E+02	1.0854E+03	5.0603E+05	2.8370E+04	1.0410E+05	5.1804E+00	2.4347E+03	5.0854E+03	1.5116E+05
7.9947E+02	1.0283E+03	7.7891E+05	2.8370E+04	9.7598E+04	1.2250E+01	2.4347E+03	4.6942E+03	2.5359E+05
7.9947E+02	9.7119E+02	9.7908E+05	2.8370E+04	9.1092E+04	1.7430E+01	2.4347E+03	4.3030E+03	3.0608E+05
7.9947E+02	9.1406E+02	1.3028E+06	2.8370E+04	8.4585E+04	2.4222E+01	2.4347E+03	3.9118E+03	5.1026E+05
7.9947E+02	8.5693E+02	1.6334E+06	2.8370E+04	7.8079E+04	2.2250E+01	2.4347E+03	3.5206E+03	6.8047E+05
7.9947E+02	7.9980E+02	2.1240E+06	2.8370E+04	7.1572E+04	2.3943E+01	2.4347E+03	3.1295E+03	6.7271E+05
7.9947E+02	7.4267E+02	2.6419E+06	2.8370E+04	6.5066E+04	7.5696E+01	2.4347E+03	2.7383E+03	7.4566E+05
7.9947E+02	6.8555E+02	3.3042E+06	2.8370E+04	5.8559E+04	7.0862E+01	2.4347E+03	2.3471E+03	9.2423E+05
7.9947E+02	6.2842E+02	4.2501E+06	2.8370E+04	5.2052E+04	4.2832E+01	2.4347E+03	1.9559E+03	9.3753E+05
7.9947E+02	5.7129E+02	4.9695E+06	2.8370E+04	4.5546E+04	3.8082E+01	2.4347E+03	1.5647E+03	8.8435E+05
7.9947E+02	5.1416E+02	5.4779E+06	2.8370E+04	3.9039E+04	1.0025E+02	2.4347E+03	1.1735E+03	1.0039E+06
7.9947E+02	4.5703E+02	5.6049E+06	2.8370E+04	3.2533E+04	1.0875E+02	2.4347E+03	7.8236E+02	1.6094E+06
7.9947E+02	3.9990E+02	5.9214E+06	2.8370E+04	2.6026E+04	1.4141E+02	2.4347E+03	3.9118E+02	4.0761E+06
7.9947E+02	3.4277E+02	6.4123E+06	2.8370E+04	1.9520E+04	1.7575E+02	2.4347E+03	0.0000E+00	8.3169E+06
7.9947E+02	2.8564E+02	5.6094E+06	2.8370E+04	1.3013E+04	1.3159E+04	1.9227E+03	1.6821E+04	1.6804E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.9947E+02	2.2852E+02	4.9592E+06	2.8370E+04	6.5066E+03	1.9861E+04	1.9227E+03	1.2127E+04	3.4304E+00
7.9947E+02	1.7139E+02	4.2145E+06	2.8370E+04	0.0000E+00	3.4645E+04	1.9227E+03	1.1344E+04	1.7500E+00
7.9947E+02	1.1426E+02	6.7097E+06	2.1074E+04	1.6266E+05	6.2500E-01	1.9227E+03	1.0953E+04	3.4304E+00
7.9947E+02	5.7129E+01	1.9792E+07	2.1074E+04	1.5616E+05	1.6804E+00	1.9227E+03	1.0171E+04	5.4740E+02
7.9947E+02	0.0000E+00	3.1308E+07	2.1074E+04	1.4965E+05	6.2500E-01	1.9227E+03	9.7796E+03	2.8479E+02
7.3400E+02	2.5137E+03	3.5855E+02	2.1074E+04	1.4314E+05	2.3054E+00	1.9227E+03	9.3884E+03	3.1865E+03
7.3400E+02	2.3994E+03	3.5855E+02	2.1074E+04	1.3664E+05	2.3054E+00	1.9227E+03	8.9972E+03	8.2738E+02
7.3400E+02	2.2280E+03	1.2913E+02	2.1074E+04	1.3013E+05	3.3608E+00	1.9227E+03	8.6060E+03	2.1391E+03
7.3400E+02	2.1709E+03	4.6326E+02	2.1074E+04	1.2362E+05	1.6804E+00	1.9227E+03	8.2148E+03	1.4114E+03
7.3400E+02	2.1138E+03	2.2978E+03	2.1074E+04	1.1712E+05	3.5000E+00	1.9227E+03	7.8236E+03	6.8883E+03
7.3400E+02	2.0566E+03	2.1338E+03	2.1074E+04	1.1061E+05	2.3750E+00	1.9227E+03	7.4325E+03	2.5389E+04
7.3400E+02	1.9995E+03	1.4191E+03	2.1074E+04	1.0410E+05	1.0291E+01	1.9227E+03	7.0413E+03	3.5690E+04
7.3400E+02	1.9424E+03	3.9487E+03	2.1074E+04	9.7598E+04	1.4709E+01	1.9227E+03	6.6501E+03	7.9050E+04
7.3400E+02	1.8852E+03	5.9605E+03	2.1074E+04	9.1092E+04	2.2472E+01	1.9227E+03	6.2589E+03	8.3374E+04
7.3400E+02	1.8281E+03	9.7688E+03	2.1074E+04	8.4585E+04	1.8832E+01	1.9227E+03	5.8677E+03	2.3534E+05
7.3400E+02	1.7710E+03	1.1534E+04	2.1074E+04	7.8079E+04	3.6840E+01	1.9227E+03	5.4766E+03	2.9573E+05
7.3400E+02	1.7139E+03	2.0464E+04	2.1074E+04	7.1572E+04	3.7251E+01	1.9227E+03	5.0854E+03	2.6789E+05
7.3400E+02	1.6567E+03	2.5074E+04	2.1074E+04	6.5066E+04	3.9972E+01	1.9227E+03	4.6942E+03	4.0382E+05
7.3400E+02	1.5996E+03	4.6896E+04	2.1074E+04	5.8559E+04	7.2332E+01	1.9227E+03	4.3030E+03	5.8308E+05
7.3400E+02	1.5425E+03	5.6626E+04	2.1074E+04	5.2052E+04	1.9908E+02	1.9227E+03	3.9118E+03	6.4758E+05
7.3400E+02	1.4853E+03	8.7891E+04	2.1074E+04	4.5546E+04	4.3106E+03	1.9227E+03	3.5206E+03	8.9007E+05
7.3400E+02	1.4282E+03	1.0488E+05	2.1074E+04	3.9039E+04	1.5011E+02	1.9227E+03	3.1295E+03	1.1729E+06
7.3400E+02	1.3711E+03	1.2387E+05	2.1074E+04	3.2533E+04	4.4601E+02	1.9227E+03	2.7383E+03	1.3249E+06
7.3400E+02	1.3140E+03	2.1082E+05	2.1074E+04	2.6026E+04	4.7662E+03	1.9227E+03	2.3471E+03	1.4817E+06
7.3400E+02	1.2568E+03	2.9901E+05	2.1074E+04	1.9520E+04	6.7450E+02	1.9227E+03	1.9559E+03	1.5219E+06
7.3400E+02	1.1997E+03	3.6227E+05	2.1074E+04	1.3013E+04	7.3055E+03	1.9227E+03	1.5647E+03	1.5767E+06
7.3400E+02	1.1426E+03	5.0952E+05	2.1074E+04	6.5066E+03	3.1352E+04	1.9227E+03	1.1735E+03	2.1623E+06
7.3400E+02	1.0854E+03	6.5791E+05	2.1074E+04	0.0000E+00	1.9696E+05	1.9227E+03	7.8236E+02	2.8232E+06
7.3400E+02	1.0283E+03	7.7855E+05	1.3779E+04	1.6917E+05	1.6804E+00	1.9227E+03	3.9118E+02	6.7916E+06
7.3400E+02	9.7119E+02	1.0446E+06	1.3779E+04	1.3013E+05	2.3054E+00	1.9227E+03	0.0000E+00	1.2984E+07
7.3400E+02	9.1406E+02	1.3248E+06	1.3779E+04	1.2362E+05	1.7500E+00	1.4108E+03	1.2127E+04	1.7019E+02
7.3400E+02	8.5693E+02	1.8371E+06	1.3779E+04	1.1712E+05	6.8063E-01	1.4108E+03	1.1735E+04	6.7546E+00
7.3400E+02	7.9980E+02	2.4170E+06	1.3779E+04	1.1061E+05	3.0000E+00	1.4108E+03	1.1344E+04	1.9826E+01
7.3400E+02	7.4267E+02	2.8782E+06	1.3779E+04	1.0410E+05	1.7500E+00	1.4108E+03	1.0953E+04	9.9399E+02
7.3400E+02	6.8555E+02	3.3965E+06	1.3779E+04	9.7598E+04	3.4304E+00	1.4108E+03	1.0562E+04	3.6291E+01
7.3400E+02	6.2842E+02	4.3818E+06	1.3779E+04	9.1092E+04	3.3337E+01	1.4108E+03	1.0171E+04	2.9025E+03
7.3400E+02	5.7129E+02	4.9081E+06	1.3779E+04	8.4585E+04	5.7009E+01	1.4108E+03	9.7796E+03	1.4081E+03
7.3400E+02	5.1416E+02	5.7849E+06	1.3779E+04	7.8079E+04	9.5502E+01	1.4108E+03	9.3884E+03	3.1507E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.3400E+02	4.5703E+02	6.0828E+06	1.3779E+04	7.1572E+04	4.2484E+01	1.4108E+03	8.9972E+03	5.3341E+03
7.3400E+02	3.9990E+02	6.4711E+06	1.3779E+04	6.5066E+04	9.9847E+01	1.4108E+03	8.6060E+03	1.6584E+04
7.3400E+02	3.4277E+02	6.5431E+06	1.3779E+04	5.8559E+04	2.0092E+02	1.4108E+03	8.2148E+03	1.6082E+04
7.3400E+02	2.8564E+02	5.8117E+06	1.3779E+04	5.2052E+04	2.2320E+02	1.4108E+03	7.8236E+03	4.2630E+04
7.3400E+02	2.2852E+02	4.9543E+06	1.3779E+04	4.5546E+04	4.4757E+03	1.4108E+03	7.4325E+03	4.6832E+04
7.3400E+02	1.7139E+02	4.5636E+06	1.3779E+04	3.9039E+04	2.9023E+03	1.4108E+03	7.0413E+03	8.5206E+04
7.3400E+02	1.1426E+02	6.6252E+06	1.3779E+04	3.2533E+04	4.9337E+03	1.4108E+03	6.6501E+03	1.3939E+05
7.3400E+02	5.7129E+01	2.3022E+07	1.3779E+04	2.6026E+04	2.5322E+04	1.4108E+03	6.2589E+03	1.5513E+05
7.3400E+02	0.0000E+00	3.4231E+07	1.3779E+04	1.9520E+04	2.3652E+04	1.4108E+03	5.8677E+03	2.6669E+05
6.6853E+02	2.4565E+03	1.7585E+03	1.3779E+04	1.3013E+04	2.4389E+04	1.4108E+03	5.4766E+03	2.8484E+05
6.6853E+02	2.2852E+03	7.6980E+01	1.3779E+04	6.5066E+03	1.0845E+05	1.4108E+03	5.0854E+03	5.7130E+05
6.6853E+02	2.2280E+03	4.5458E+02	1.3779E+04	0.0000E+00	1.0333E+06	1.4108E+03	4.6942E+03	6.2667E+05
6.6853E+02	2.1709E+03	1.4000E+03	6.4829E+03	1.8218E+05	5.5625E-02	1.4108E+03	4.3030E+03	9.4775E+05
6.6853E+02	2.1138E+03	2.7244E+03	6.4829E+03	1.5616E+05	2.3054E+00	1.4108E+03	3.9118E+03	1.2453E+06
6.6853E+02	2.0566E+03	3.4380E+03	6.4829E+03	1.4965E+05	5.5625E-02	1.4108E+03	3.5206E+03	1.3471E+06
6.6853E+02	1.9995E+03	4.9777E+03	6.4829E+03	1.3664E+05	3.3608E+00	1.4108E+03	3.1295E+03	1.9095E+06
6.6853E+02	1.9424E+03	8.0406E+03	6.4829E+03	1.3013E+05	1.7360E+00	1.4108E+03	2.7383E+03	1.9482E+06
6.6853E+02	1.8852E+03	5.9904E+03	6.4829E+03	1.2362E+05	5.5625E-02	1.4108E+03	2.3471E+03	2.6209E+06
6.6853E+02	1.8281E+03	1.2486E+04	6.4829E+03	1.1712E+05	6.8063E-01	1.4108E+03	1.9559E+03	2.7982E+06
6.6853E+02	1.7710E+03	1.8654E+04	6.4829E+03	1.1061E+05	9.8263E+02	1.4108E+03	1.5647E+03	2.4924E+06
6.6853E+02	1.7139E+03	3.7956E+04	6.4829E+03	1.0410E+05	2.9361E+03	1.4108E+03	1.1735E+03	3.0488E+06
6.6853E+02	1.6567E+03	3.2511E+04	6.4829E+03	9.7598E+04	1.9740E+03	1.4108E+03	7.8236E+02	4.1925E+06
6.6853E+02	1.5996E+03	4.8125E+04	6.4829E+03	9.1092E+04	2.9636E+03	1.4108E+03	3.9118E+02	1.0034E+07
6.6853E+02	1.5425E+03	5.5007E+04	6.4829E+03	8.4585E+04	1.0400E+03	1.4108E+03	0.0000E+00	2.0847E+07
6.6853E+02	1.4853E+03	7.4540E+04	6.4829E+03	7.8079E+04	5.9823E+03	8.9882E+02	1.5647E+04	3.5501E+01
6.6853E+02	1.4282E+03	9.4458E+04	6.4829E+03	7.1572E+04	1.1900E+04	8.9882E+02	1.4474E+04	1.6804E+00
6.6853E+02	1.3711E+03	1.3044E+05	6.4829E+03	6.5066E+04	9.1043E+03	8.9882E+02	1.3691E+04	9.1692E+01
6.6853E+02	1.3140E+03	1.6814E+05	6.4829E+03	5.8559E+04	9.5974E+03	8.9882E+02	1.3300E+04	5.1426E+02
6.6853E+02	1.2568E+03	2.2199E+05	6.4829E+03	5.2052E+04	2.3099E+04	8.9882E+02	1.2909E+04	4.4258E+02
6.6853E+02	1.1997E+03	3.3653E+05	6.4829E+03	4.5546E+04	2.1974E+04	8.9882E+02	1.2518E+04	4.6950E+02
6.6853E+02	1.1426E+03	4.3493E+05	6.4829E+03	3.9039E+04	3.2633E+04	8.9882E+02	1.2127E+04	1.3756E+03
6.6853E+02	1.0854E+03	4.9898E+05	6.4829E+03	3.2533E+04	8.2216E+04	8.9882E+02	1.1735E+04	6.8642E+02
6.6853E+02	1.0283E+03	7.0164E+05	6.4829E+03	2.6026E+04	3.1349E+05	8.9882E+02	1.1344E+04	2.4394E+03
6.6853E+02	9.7119E+02	1.0120E+06	6.4829E+03	1.9520E+04	7.7384E+05	8.9882E+02	1.0953E+04	1.1560E+03
6.6853E+02	9.1406E+02	1.2777E+06	6.4829E+03	1.3013E+04	1.7033E+06	8.9882E+02	1.0562E+04	2.9853E+03
6.6853E+02	8.5693E+02	1.7293E+06	6.4829E+03	6.5066E+03	4.5637E+06	8.9882E+02	1.0171E+04	4.9206E+03
6.6853E+02	7.9980E+02	2.1593E+06	6.4829E+03	0.0000E+00	1.4023E+07	8.9882E+02	9.7796E+03	8.7191E+03
6.6853E+02	7.4267E+02	2.5686E+06	-8.1277E+02	3.2533E+05	1.6804E+00	8.9882E+02	9.3884E+03	1.7242E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborgvejkvej 6, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.6853E+02	6.8555E+02	3.4141E+06	-8.1277E+02	1.6266E+05	5.5625E-02	8.9882E+02	8.9972E+03	1.1946E+04
6.6853E+02	6.2842E+02	4.1143E+06	-8.1277E+02	1.5616E+05	1.1125E-01	8.9882E+02	8.6060E+03	2.5889E+04
6.6853E+02	5.7129E+02	4.8876E+06	-8.1277E+02	1.4965E+05	1.6804E+00	8.9882E+02	8.2148E+03	5.2490E+04
6.6853E+02	5.1416E+02	5.7868E+06	-8.1277E+02	1.4314E+05	1.2500E+00	8.9882E+02	7.8236E+03	6.8982E+04
6.6853E+02	4.5703E+02	6.4206E+06	-8.1277E+02	1.3664E+05	1.6804E+00	8.9882E+02	7.4325E+03	8.1386E+04
6.6853E+02	3.9990E+02	6.3689E+06	-8.1277E+02	1.3013E+05	1.7840E+00	8.9882E+02	7.0413E+03	1.2336E+05
6.6853E+02	3.4277E+02	7.3249E+06	-8.1277E+02	1.2362E+05	1.7360E+00	8.9882E+02	6.6501E+03	1.3771E+05
6.6853E+02	2.8564E+02	6.3744E+06	-8.1277E+02	1.1712E+05	2.0419E+00	8.9882E+02	6.2589E+03	2.1844E+05
6.6853E+02	2.2852E+02	5.7621E+06	-8.1277E+02	1.1061E+05	9.8024E+02	8.9882E+02	5.8677E+03	3.4600E+05
6.6853E+02	1.7139E+02	5.0072E+06	-8.1277E+02	1.0410E+05	9.8336E+02	8.9882E+02	5.4766E+03	5.6530E+05
6.6853E+02	1.1426E+02	7.4109E+06	-8.1277E+02	9.7598E+04	9.8185E+02	8.9882E+02	5.0854E+03	6.5869E+05
6.6853E+02	5.7129E+01	2.2519E+07	-8.1277E+02	9.1092E+04	7.0641E+03	8.9882E+02	4.6942E+03	1.0001E+06
6.6853E+02	0.0000E+00	3.4971E+07	-8.1277E+02	8.4585E+04	8.0780E+03	8.9882E+02	4.3030E+03	1.2467E+06
6.0307E+02	2.3994E+03	1.7671E+02	-8.1277E+02	7.8079E+04	2.0217E+03	8.9882E+02	3.9118E+03	1.4350E+06
6.0307E+02	2.3423E+03	1.4001E+03	-8.1277E+02	7.1572E+04	1.2027E+04	8.9882E+02	3.5206E+03	2.0166E+06
6.0307E+02	2.2280E+03	1.5679E+02	-8.1277E+02	6.5066E+04	6.7975E+03	8.9882E+02	3.1295E+03	2.4374E+06
6.0307E+02	2.1709E+03	9.8484E+02	-8.1277E+02	5.8559E+04	5.5049E+04	8.9882E+02	2.7383E+03	2.7702E+06
6.0307E+02	2.1138E+03	2.6275E+01	-8.1277E+02	5.2052E+04	5.2643E+04	8.9882E+02	2.3471E+03	3.8630E+06
6.0307E+02	2.0566E+03	1.0021E+03	-8.1277E+02	4.5546E+04	9.4323E+04	8.9882E+02	1.9559E+03	4.4272E+06
6.0307E+02	1.9995E+03	4.7301E+03	-8.1277E+02	3.9039E+04	1.3337E+05	8.9882E+02	1.5647E+03	4.3268E+06
6.0307E+02	1.9424E+03	2.5784E+03	-8.1277E+02	3.2533E+04	2.1409E+05	8.9882E+02	1.1735E+03	4.7727E+06
6.0307E+02	1.8852E+03	4.6104E+03	-8.1277E+02	2.6026E+04	2.8649E+05	8.9882E+02	7.8236E+02	6.4559E+06
6.0307E+02	1.8281E+03	1.2903E+04	-8.1277E+02	1.9520E+04	4.8129E+05	8.9882E+02	3.9118E+02	1.4684E+07
6.0307E+02	1.7710E+03	1.3123E+04	-8.1277E+02	1.3013E+04	8.8649E+05	8.9882E+02	0.0000E+00	3.2300E+07
6.0307E+02	1.7139E+03	1.3821E+04	-8.1277E+02	6.5066E+03	2.0129E+06	3.8685E+02	1.6821E+04	3.3820E+01
6.0307E+02	1.6567E+03	2.8590E+04	-8.1277E+02	0.0000E+00	1.2217E+07	3.8685E+02	1.5256E+04	3.6012E+02
6.0307E+02	1.5996E+03	2.4661E+04	-8.1085E+03	3.0581E+05	1.6804E+00	3.8685E+02	1.4865E+04	1.0511E+03
6.0307E+02	1.5425E+03	4.4620E+04	-8.1085E+03	2.9279E+05	1.7500E+00	3.8685E+02	1.4474E+04	6.6443E+02
6.0307E+02	1.4853E+03	6.3347E+04	-8.1085E+03	2.5376E+05	1.6804E+00	3.8685E+02	1.4083E+04	1.7653E+01
6.0307E+02	1.4282E+03	7.6603E+04	-8.1085E+03	2.2122E+05	6.2500E-01	3.8685E+02	1.3691E+04	4.5686E+02
6.0307E+02	1.3711E+03	1.0332E+05	-8.1085E+03	1.8218E+05	6.8063E-01	3.8685E+02	1.3300E+04	9.3761E+01
6.0307E+02	1.3140E+03	1.6210E+05	-8.1085E+03	1.7568E+05	5.5625E-02	3.8685E+02	1.2909E+04	1.8589E+03
6.0307E+02	1.2568E+03	2.0461E+05	-8.1085E+03	1.6266E+05	1.1125E-01	3.8685E+02	1.2518E+04	1.8529E+03
6.0307E+02	1.1997E+03	2.6685E+05	-8.1085E+03	1.5616E+05	1.1125E-01	3.8685E+02	1.2127E+04	8.6715E+03
6.0307E+02	1.1426E+03	3.3518E+05	-8.1085E+03	1.4965E+05	5.5625E-02	3.8685E+02	1.1735E+04	6.5418E+03
6.0307E+02	1.0854E+03	4.6150E+05	-8.1085E+03	1.4314E+05	8.2660E-02	3.8685E+02	1.1344E+04	1.0084E+04
6.0307E+02	1.0283E+03	6.3484E+05	-8.1085E+03	1.3664E+05	1.6532E-01	3.8685E+02	1.0953E+04	3.3368E+04
6.0307E+02	9.7119E+02	7.8076E+05	-8.1085E+03	1.3013E+05	1.6493E+01	3.8685E+02	1.0562E+04	3.7626E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.0307E+02	9.1406E+02	1.0662E+06	-8.1085E+03	1.2362E+05	2.1939E-01	3.8685E+02	1.0171E+04	3.9635E+04
6.0307E+02	8.5693E+02	1.3252E+06	-8.1085E+03	1.1712E+05	1.9029E+00	3.8685E+02	9.7796E+03	4.6047E+04
6.0307E+02	7.9980E+02	1.6755E+06	-8.1085E+03	1.1061E+05	7.7896E+01	3.8685E+02	9.3884E+03	6.2148E+04
6.0307E+02	7.4267E+02	2.0474E+06	-8.1085E+03	1.0410E+05	4.9751E+01	3.8685E+02	8.9972E+03	6.0222E+04
6.0307E+02	6.8555E+02	2.7234E+06	-8.1085E+03	9.7598E+04	5.2480E+01	3.8685E+02	8.6060E+03	4.6315E+04
6.0307E+02	6.2842E+02	3.0321E+06	-8.1085E+03	9.1092E+04	1.1707E+02	3.8685E+02	8.2148E+03	7.5279E+04
6.0307E+02	5.7129E+02	3.9868E+06	-8.1085E+03	8.4585E+04	3.9276E+03	3.8685E+02	7.8236E+03	1.1151E+05
6.0307E+02	5.1416E+02	4.4892E+06	-8.1085E+03	7.8079E+04	1.6707E+02	3.8685E+02	7.4325E+03	1.4557E+05
6.0307E+02	4.5703E+02	4.7410E+06	-8.1085E+03	7.1572E+04	6.9666E+03	3.8685E+02	7.0413E+03	1.4294E+05
6.0307E+02	3.9990E+02	5.2881E+06	-8.1085E+03	6.5066E+04	5.1827E+03	3.8685E+02	6.6501E+03	2.7781E+05
6.0307E+02	3.4277E+02	5.4670E+06	-8.1085E+03	5.8559E+04	1.8305E+03	3.8685E+02	6.2589E+03	3.7838E+05
6.0307E+02	2.8564E+02	5.7290E+06	-8.1085E+03	5.2052E+04	2.4580E+04	3.8685E+02	5.8677E+03	4.3464E+05
6.0307E+02	2.2852E+02	5.2077E+06	-8.1085E+03	4.5546E+04	8.4811E+04	3.8685E+02	5.4766E+03	7.1451E+05
6.0307E+02	1.7139E+02	5.1653E+06	-8.1085E+03	3.9039E+04	1.7539E+05	3.8685E+02	5.0854E+03	9.4970E+05
6.0307E+02	1.1426E+02	7.0834E+06	-8.1085E+03	3.2533E+04	3.6871E+05	3.8685E+02	4.6942E+03	1.1035E+06
6.0307E+02	5.7129E+01	2.0974E+07	-8.1085E+03	2.6026E+04	5.7235E+05	3.8685E+02	4.3030E+03	1.6735E+06
6.0307E+02	0.0000E+00	3.5413E+07	-8.1085E+03	1.9520E+04	9.0644E+05	3.8685E+02	3.9118E+03	1.8688E+06
5.3760E+02	2.6851E+03	6.2500E-01	-8.1085E+03	1.3013E+04	1.0691E+06	3.8685E+02	3.5206E+03	2.3995E+06
5.3760E+02	2.6279E+03	3.3820E+01	-8.1085E+03	6.5066E+03	2.0313E+06	3.8685E+02	3.1295E+03	2.8483E+06
5.3760E+02	2.5708E+03	9.5290E+00	-8.1085E+03	0.0000E+00	5.9864E+06	3.8685E+02	2.7383E+03	3.8283E+06
5.3760E+02	2.5137E+03	1.3137E+01	-1.5404E+04	2.9279E+05	6.5105E+00	3.8685E+02	2.3471E+03	4.6567E+06
5.3760E+02	2.3994E+03	3.3820E+01	-1.5404E+04	2.7978E+05	1.7500E+00	3.8685E+02	1.9559E+03	5.6119E+06
5.3760E+02	2.3423E+03	1.5443E+01	-1.5404E+04	2.7328E+05	1.7500E+00	3.8685E+02	1.5647E+03	6.9843E+06
5.3760E+02	2.2852E+03	1.6995E+02	-1.5404E+04	2.6026E+05	1.7500E+00	3.8685E+02	1.1735E+03	6.9185E+06
5.3760E+02	2.2280E+03	4.7874E+02	-1.5404E+04	2.5376E+05	1.7500E+00	3.8685E+02	7.8236E+02	9.4284E+06
5.3760E+02	2.1709E+03	2.1525E+03	-1.5404E+04	2.2773E+05	1.7500E+00	3.8685E+02	3.9118E+02	2.1003E+07
5.3760E+02	2.1138E+03	4.9482E+02	-1.5404E+04	2.1472E+05	6.2500E-01	3.8685E+02	0.0000E+00	4.2687E+07
5.3760E+02	2.0566E+03	1.8396E+03	-1.5404E+04	1.8869E+05	5.5625E-02	-1.2511E+02	1.6430E+04	7.0000E+02
5.3760E+02	1.9995E+03	1.2209E+03	-1.5404E+04	1.8218E+05	5.5625E-02	-1.2511E+02	1.5647E+04	7.6435E+01
5.3760E+02	1.9424E+03	3.2031E+03	-1.5404E+04	1.6917E+05	6.8063E-01	-1.2511E+02	1.5256E+04	1.4373E+01
5.3760E+02	1.8852E+03	2.5845E+03	-1.5404E+04	1.6266E+05	2.2250E-01	-1.2511E+02	1.4865E+04	5.2300E+02
5.3760E+02	1.8281E+03	1.9563E+03	-1.5404E+04	1.4965E+05	1.3829E-01	-1.2511E+02	1.4474E+04	1.4191E+03
5.3760E+02	1.7710E+03	7.9289E+03	-1.5404E+04	1.4314E+05	1.6688E-01	-1.2511E+02	1.4083E+04	3.3103E+03
5.3760E+02	1.7139E+03	1.1177E+04	-1.5404E+04	1.3664E+05	2.2250E-01	-1.2511E+02	1.3691E+04	5.2099E+03
5.3760E+02	1.6567E+03	9.2601E+03	-1.5404E+04	1.3013E+05	4.4500E-01	-1.2511E+02	1.3300E+04	5.6954E+03
5.3760E+02	1.5996E+03	1.9525E+04	-1.5404E+04	1.2362E+05	4.1393E+01	-1.2511E+02	1.2909E+04	1.8705E+04
5.3760E+02	1.5425E+03	3.4509E+04	-1.5404E+04	1.1712E+05	4.6149E+01	-1.2511E+02	1.2518E+04	1.7845E+04
5.3760E+02	1.4853E+03	3.4368E+04	-1.5404E+04	1.1061E+05	1.3519E+01	-1.2511E+02	1.2127E+04	4.1507E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborgvaenget 6.2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.3760E+02	1.4282E+03	4.9651E+04	-1.5404E+04	1.0410E+05	2.1488E+03	-1.2511E+02	1.1735E+04	4.2769E+04
5.3760E+02	1.3711E+03	7.8891E+04	-1.5404E+04	9.7598E+04	1.7065E+02	-1.2511E+02	1.1344E+04	6.5964E+04
5.3760E+02	1.3140E+03	1.1597E+05	-1.5404E+04	9.1092E+04	2.2871E+03	-1.2511E+02	1.0953E+04	8.6156E+04
5.3760E+02	1.2568E+03	1.1983E+05	-1.5404E+04	8.4585E+04	2.8274E+03	-1.2511E+02	1.0562E+04	8.4803E+04
5.3760E+02	1.1997E+03	1.5357E+05	-1.5404E+04	7.8079E+04	3.3192E+03	-1.2511E+02	1.0171E+04	8.4285E+04
5.3760E+02	1.1426E+03	2.0796E+05	-1.5404E+04	7.1572E+04	2.4132E+03	-1.2511E+02	9.7796E+03	4.7653E+04
5.3760E+02	1.0854E+03	2.8574E+05	-1.5404E+04	6.5066E+04	1.0765E+04	-1.2511E+02	9.3884E+03	6.4115E+04
5.3760E+02	1.0283E+03	3.6085E+05	-1.5404E+04	5.8559E+04	1.8951E+04	-1.2511E+02	8.9972E+03	9.2648E+04
5.3760E+02	9.7119E+02	4.7111E+05	-1.5404E+04	5.2052E+04	4.1417E+04	-1.2511E+02	8.6060E+03	9.7588E+04
5.3760E+02	9.1406E+02	5.2320E+05	-1.5404E+04	4.5546E+04	5.8908E+04	-1.2511E+02	8.2148E+03	1.6215E+05
5.3760E+02	8.5693E+02	7.2874E+05	-1.5404E+04	3.9039E+04	2.1025E+05	-1.2511E+02	7.8236E+03	1.2745E+05
5.3760E+02	7.9980E+02	8.6404E+05	-1.5404E+04	3.2533E+04	4.4680E+05	-1.2511E+02	7.4325E+03	1.8215E+05
5.3760E+02	7.4267E+02	9.8133E+05	-1.5404E+04	2.6026E+04	1.1309E+06	-1.2511E+02	7.0413E+03	2.4150E+05
5.3760E+02	6.8555E+02	1.2038E+06	-1.5404E+04	1.9520E+04	1.4369E+06	-1.2511E+02	6.6501E+03	3.2666E+05
5.3760E+02	6.2842E+02	1.5501E+06	-1.5404E+04	1.3013E+04	2.2652E+06	-1.2511E+02	6.2589E+03	4.0560E+05
5.3760E+02	5.7129E+02	1.8368E+06	-1.5404E+04	6.5066E+03	4.8398E+06	-1.2511E+02	5.8677E+03	5.1932E+05
5.3760E+02	5.1416E+02	2.0630E+06	-1.5404E+04	0.0000E+00	1.1649E+07	-1.2511E+02	5.4766E+03	7.3268E+05
5.3760E+02	4.5703E+02	2.4470E+06	-2.2700E+04	3.2533E+05	1.6804E+00	-1.2511E+02	5.0854E+03	1.0384E+06
5.3760E+02	3.9990E+02	3.0667E+06	-2.2700E+04	3.1882E+05	1.6804E+00	-1.2511E+02	4.6942E+03	1.3026E+06
5.3760E+02	3.4277E+02	3.2053E+06	-2.2700E+04	3.1231E+05	6.5105E+00	-1.2511E+02	4.3030E+03	1.7184E+06
5.3760E+02	2.8564E+02	3.7224E+06	-2.2700E+04	2.9279E+05	1.6804E+00	-1.2511E+02	3.9118E+03	2.4086E+06
5.3760E+02	2.2852E+02	4.4742E+06	-2.2700E+04	2.8629E+05	1.6804E+00	-1.2511E+02	3.5206E+03	2.5659E+06
5.3760E+02	1.7139E+02	4.7982E+06	-2.2700E+04	2.7978E+05	3.4304E+00	-1.2511E+02	3.1295E+03	3.4661E+06
5.3760E+02	1.1426E+02	6.4243E+06	-2.2700E+04	2.7328E+05	6.8608E+00	-1.2511E+02	2.7383E+03	4.4804E+06
5.3760E+02	5.7129E+01	2.1399E+07	-2.2700E+04	2.6677E+05	1.7500E+00	-1.2511E+02	2.3471E+03	5.9983E+06
5.3760E+02	0.0000E+00	4.0993E+07	-2.2700E+04	2.6026E+05	1.7500E+00	-1.2511E+02	1.9559E+03	6.8719E+06
4.7213E+02	2.7993E+03	6.2500E-01	-2.2700E+04	2.5376E+05	7.0000E+00	-1.2511E+02	1.5647E+03	7.5059E+06
4.7213E+02	2.7422E+03	6.5105E+00	-2.2700E+04	2.4725E+05	4.1250E+00	-1.2511E+02	1.1735E+03	8.0582E+06
4.7213E+02	2.6279E+03	6.2500E-01	-2.2700E+04	2.3424E+05	5.7358E+00	-1.2511E+02	7.8236E+02	1.0133E+07
4.7213E+02	2.5708E+03	3.3876E+01	-2.2700E+04	2.2773E+05	6.2500E-01	-1.2511E+02	3.9118E+02	2.5235E+07
4.7213E+02	2.5137E+03	1.1125E-01	-2.2700E+04	2.2122E+05	3.4304E+00	-1.2511E+02	0.0000E+00	5.5288E+07
4.7213E+02	2.4565E+03	5.0160E+01	-2.2700E+04	2.0821E+05	5.5625E-02	-6.3707E+02	1.5647E+04	1.3021E+00
4.7213E+02	2.3994E+03	7.7433E+02	-2.2700E+04	1.9520E+05	5.5625E-02	-6.3707E+02	1.5256E+04	1.2357E+00
4.7213E+02	2.3423E+03	6.5105E+00	-2.2700E+04	1.8869E+05	1.1125E-01	-6.3707E+02	1.4865E+04	6.0120E+01
4.7213E+02	2.2852E+03	6.9864E+01	-2.2700E+04	1.7568E+05	5.5625E-02	-6.3707E+02	1.4474E+04	1.9202E+02
4.7213E+02	2.2280E+03	6.5103E+01	-2.2700E+04	1.6917E+05	1.0362E-01	-6.3707E+02	1.4083E+04	3.1161E+03
4.7213E+02	2.1709E+03	2.3539E+03	-2.2700E+04	1.5616E+05	8.4750E-01	-6.3707E+02	1.3691E+04	4.5737E+03
4.7213E+02	2.1138E+03	3.3623E+02	-2.2700E+04	1.4965E+05	3.2612E-01	-6.3707E+02	1.3300E+04	9.5707E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.7213E+02	2.0566E+03	4.9265E+02	-2.2700E+04	1.4314E+05	1.6535E+01	-6.3707E+02	1.2909E+04	1.8745E+04
4.7213E+02	1.9995E+03	3.9443E+02	-2.2700E+04	1.3664E+05	2.6669E+00	-6.3707E+02	1.2518E+04	3.1172E+04
4.7213E+02	1.9424E+03	4.3101E+03	-2.2700E+04	1.3013E+05	1.3275E+01	-6.3707E+02	1.2127E+04	3.0700E+04
4.7213E+02	1.8852E+03	2.5711E+03	-2.2700E+04	1.2362E+05	5.4364E+00	-6.3707E+02	1.1735E+04	5.9958E+04
4.7213E+02	1.8281E+03	2.9264E+03	-2.2700E+04	1.1712E+05	3.1251E+01	-6.3707E+02	1.1344E+04	6.0390E+04
4.7213E+02	1.7710E+03	3.7234E+03	-2.2700E+04	1.1061E+05	5.8678E+01	-6.3707E+02	1.0953E+04	8.0405E+04
4.7213E+02	1.7139E+03	3.6108E+03	-2.2700E+04	1.0410E+05	1.2867E+03	-6.3707E+02	1.0562E+04	7.8403E+04
4.7213E+02	1.6567E+03	5.8586E+03	-2.2700E+04	9.7598E+04	1.8093E+02	-6.3707E+02	1.0171E+04	9.2407E+04
4.7213E+02	1.5996E+03	8.8860E+03	-2.2700E+04	9.1092E+04	2.2348E+03	-6.3707E+02	9.7796E+03	7.5549E+04
4.7213E+02	1.5425E+03	1.2023E+04	-2.2700E+04	8.4585E+04	2.5036E+02	-6.3707E+02	9.3884E+03	9.1297E+04
4.7213E+02	1.4853E+03	2.1812E+04	-2.2700E+04	7.8079E+04	4.8987E+03	-6.3707E+02	8.9972E+03	1.2300E+05
4.7213E+02	1.4282E+03	2.3096E+04	-2.2700E+04	7.1572E+04	5.2479E+03	-6.3707E+02	8.6060E+03	1.1875E+05
4.7213E+02	1.3711E+03	2.0454E+04	-2.2700E+04	6.5066E+04	7.2390E+03	-6.3707E+02	8.2148E+03	1.4837E+05
4.7213E+02	1.3140E+03	2.8830E+04	-2.2700E+04	5.8559E+04	2.7923E+04	-6.3707E+02	7.8236E+03	1.1290E+05
4.7213E+02	1.2568E+03	5.6699E+04	-2.2700E+04	5.2052E+04	4.7625E+04	-6.3707E+02	7.4325E+03	2.1434E+05
4.7213E+02	1.1997E+03	6.7866E+04	-2.2700E+04	4.5546E+04	8.1039E+04	-6.3707E+02	7.0413E+03	2.4211E+05
4.7213E+02	1.1426E+03	7.5525E+04	-2.2700E+04	3.9039E+04	2.4212E+05	-6.3707E+02	6.6501E+03	3.6301E+05
4.7213E+02	1.0854E+03	9.5151E+04	-2.2700E+04	3.2533E+04	7.2919E+05	-6.3707E+02	6.2589E+03	4.5295E+05
4.7213E+02	1.0283E+03	1.2477E+05	-2.2700E+04	2.6026E+04	1.7738E+06	-6.3707E+02	5.8677E+03	6.2895E+05
4.7213E+02	9.7119E+02	1.3888E+05	-2.2700E+04	1.9520E+04	4.6655E+06	-6.3707E+02	5.4766E+03	7.0845E+05
4.7213E+02	9.1406E+02	1.6879E+05	-2.2700E+04	1.3013E+04	7.4167E+06	-6.3707E+02	5.0854E+03	9.6027E+05
4.7213E+02	8.5693E+02	1.9903E+05	-2.2700E+04	6.5066E+03	1.2096E+07	-6.3707E+02	4.6942E+03	1.2204E+06
4.7213E+02	7.9980E+02	2.4921E+05	-2.2700E+04	0.0000E+00	2.6829E+07	-6.3707E+02	4.3030E+03	1.7542E+06
4.7213E+02	7.4267E+02	3.4929E+05	-2.9996E+04	3.0581E+05	3.3608E+00	-6.3707E+02	3.9118E+03	2.1930E+06
4.7213E+02	6.8555E+02	4.1557E+05	-2.9996E+04	2.8629E+05	1.6804E+00	-6.3707E+02	3.5206E+03	2.6855E+06
4.7213E+02	6.2842E+02	3.5382E+05	-2.9996E+04	2.7978E+05	6.7912E+00	-6.3707E+02	3.1295E+03	3.3176E+06
4.7213E+02	5.7129E+02	5.3041E+05	-2.9996E+04	2.7328E+05	6.8608E+00	-6.3707E+02	2.7383E+03	4.4194E+06
4.7213E+02	5.1416E+02	6.5258E+05	-2.9996E+04	2.6677E+05	5.2500E+00	-6.3707E+02	2.3471E+03	4.8099E+06
4.7213E+02	4.5703E+02	9.2987E+05	-2.9996E+04	2.6026E+05	1.1691E+01	-6.3707E+02	1.9559E+03	5.1937E+06
4.7213E+02	3.9990E+02	1.2759E+06	-2.9996E+04	2.5376E+05	1.7500E+00	-6.3707E+02	1.5647E+03	5.6831E+06
4.7213E+02	3.4277E+02	2.0554E+06	-2.9996E+04	2.4725E+05	5.5625E-02	-6.3707E+02	1.1735E+03	6.5409E+06
4.7213E+02	2.8564E+02	3.3189E+06	-2.9996E+04	2.4074E+05	7.0000E+00	-6.3707E+02	7.8236E+02	8.2544E+06
4.7213E+02	2.2852E+02	5.7234E+06	-2.9996E+04	2.3424E+05	2.3750E+00	-6.3707E+02	3.9118E+02	1.8809E+07
4.7213E+02	1.7139E+02	6.9695E+06	-2.9996E+04	2.2122E+05	5.5625E-02	-6.3707E+02	0.0000E+00	3.8576E+07
4.7213E+02	1.1426E+02	9.3100E+06	-2.9996E+04	2.1472E+05	6.2500E-01	-1.1490E+03	1.7212E+04	1.3021E+00
4.7213E+02	5.7129E+01	2.2669E+07	-2.9996E+04	2.0170E+05	6.2500E-01	-1.1490E+03	1.5647E+04	1.1801E+00
4.7213E+02	0.0000E+00	4.6937E+07	-2.9996E+04	1.9520E+05	1.7500E+00	-1.1490E+03	1.5256E+04	4.5232E+00
4.0666E+02	2.6279E+03	1.6804E+00	-2.9996E+04	1.8869E+05	2.4306E+00	-1.1490E+03	1.4865E+04	1.6252E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.0666E+02	2.5708E+03	6.5105E+00	-2.9996E+04	1.8218E+05	5.5625E-02	-1.1490E+03	1.4474E+04	4.5684E+02
4.0666E+02	2.5137E+03	1.6804E+00	-2.9996E+04	1.7568E+05	6.2500E-01	-1.1490E+03	1.4083E+04	3.1766E+03
4.0666E+02	2.4565E+03	1.6804E+00	-2.9996E+04	1.6917E+05	1.4018E+01	-1.1490E+03	1.3691E+04	1.5865E+03
4.0666E+02	2.3994E+03	1.4701E+01	-2.9996E+04	1.6266E+05	5.5625E-02	-1.1490E+03	1.3300E+04	6.9372E+03
4.0666E+02	2.3423E+03	7.0953E+02	-2.9996E+04	1.5616E+05	9.3871E-01	-1.1490E+03	1.2909E+04	9.7380E+03
4.0666E+02	2.2852E+03	5.6229E+02	-2.9996E+04	1.4965E+05	1.5092E+00	-1.1490E+03	1.2518E+04	5.4494E+03
4.0666E+02	2.2280E+03	3.5692E+00	-2.9996E+04	1.4314E+05	2.6417E+01	-1.1490E+03	1.2127E+04	2.1133E+04
4.0666E+02	2.1709E+03	6.3298E+01	-2.9996E+04	1.3664E+05	3.3596E+01	-1.1490E+03	1.1735E+04	1.9019E+04
4.0666E+02	2.1138E+03	1.9737E+02	-2.9996E+04	1.3013E+05	1.3412E+02	-1.1490E+03	1.1344E+04	2.5092E+04
4.0666E+02	2.0566E+03	2.5048E+02	-2.9996E+04	1.2362E+05	1.3626E+01	-1.1490E+03	1.0953E+04	3.0270E+04
4.0666E+02	1.9995E+03	1.1113E+03	-2.9996E+04	1.1712E+05	3.4123E+02	-1.1490E+03	1.0562E+04	6.0183E+04
4.0666E+02	1.9424E+03	1.0982E+03	-2.9996E+04	1.1061E+05	2.2905E+01	-1.1490E+03	1.0171E+04	5.2077E+04
4.0666E+02	1.8852E+03	6.6107E+01	-2.9996E+04	1.0410E+05	1.3872E+02	-1.1490E+03	9.7796E+03	5.6986E+04
4.0666E+02	1.8281E+03	5.9892E+02	-2.9996E+04	9.7598E+04	3.5658E+02	-1.1490E+03	9.3884E+03	5.6196E+04
4.0666E+02	1.7710E+03	1.5292E+03	-2.9996E+04	9.1092E+04	2.3495E+03	-1.1490E+03	8.9972E+03	6.1780E+04
4.0666E+02	1.7139E+03	9.6771E+02	-2.9996E+04	8.4585E+04	2.0657E+03	-1.1490E+03	8.6060E+03	1.0327E+05
4.0666E+02	1.6567E+03	4.8357E+02	-2.9996E+04	7.8079E+04	7.0089E+03	-1.1490E+03	8.2148E+03	1.0909E+05
4.0666E+02	1.5996E+03	1.3635E+03	-2.9996E+04	7.1572E+04	2.2362E+04	-1.1490E+03	7.8236E+03	1.1725E+05
4.0666E+02	1.5425E+03	2.6097E+03	-2.9996E+04	6.5066E+04	1.5110E+04	-1.1490E+03	7.4325E+03	1.7795E+05
4.0666E+02	1.4853E+03	4.2684E+03	-2.9996E+04	5.8559E+04	2.5495E+04	-1.1490E+03	7.0413E+03	2.1065E+05
4.0666E+02	1.4282E+03	5.8532E+03	-2.9996E+04	5.2052E+04	7.3517E+04	-1.1490E+03	6.6501E+03	2.7153E+05
4.0666E+02	1.3711E+03	3.6779E+03	-2.9996E+04	4.5546E+04	1.6881E+05	-1.1490E+03	6.2589E+03	4.0159E+05
4.0666E+02	1.3140E+03	6.2335E+03	-2.9996E+04	3.9039E+04	2.0577E+05	-1.1490E+03	5.8677E+03	5.8618E+05
4.0666E+02	1.2568E+03	6.6765E+03	-2.9996E+04	3.2533E+04	4.5273E+05	-1.1490E+03	5.4766E+03	7.2612E+05
4.0666E+02	1.1997E+03	1.2504E+04	-2.9996E+04	2.6026E+04	1.4548E+06	-1.1490E+03	5.0854E+03	9.3863E+05
4.0666E+02	1.1426E+03	1.5635E+04	-2.9996E+04	1.9520E+04	3.5848E+06	-1.1490E+03	4.6942E+03	1.1217E+06
4.0666E+02	1.0854E+03	1.4989E+04	-2.9996E+04	1.3013E+04	6.2310E+06	-1.1490E+03	4.3030E+03	1.5281E+06
4.0666E+02	1.0283E+03	2.3960E+04	-2.9996E+04	6.5066E+03	1.1941E+07	-1.1490E+03	3.9118E+03	1.7526E+06
4.0666E+02	9.7119E+02	3.2929E+04	-2.9996E+04	0.0000E+00	2.4935E+07	-1.1490E+03	3.5206E+03	2.3152E+06
4.0666E+02	9.1406E+02	3.8726E+04	-3.7291E+04	2.9930E+05	1.6804E+00	-1.1490E+03	3.1295E+03	2.6326E+06
4.0666E+02	8.5693E+02	5.1212E+04	-3.7291E+04	2.8629E+05	5.1804E+00	-1.1490E+03	2.7383E+03	3.2549E+06
4.0666E+02	7.9980E+02	6.3741E+04	-3.7291E+04	2.7978E+05	1.6804E+00	-1.1490E+03	2.3471E+03	3.8534E+06
4.0666E+02	7.4267E+02	8.9968E+04	-3.7291E+04	2.7328E+05	8.1909E+00	-1.1490E+03	1.9559E+03	3.8779E+06
4.0666E+02	6.8555E+02	8.7658E+04	-3.7291E+04	2.6677E+05	1.5191E+01	-1.1490E+03	1.5647E+03	4.0831E+06
4.0666E+02	6.2842E+02	1.3947E+05	-3.7291E+04	2.6026E+05	8.6804E+00	-1.1490E+03	1.1735E+03	4.1809E+06
4.0666E+02	5.7129E+02	2.0765E+05	-3.7291E+04	2.5376E+05	3.3608E+00	-1.1490E+03	7.8236E+02	5.8355E+06
4.0666E+02	5.1416E+02	2.4848E+05	-3.7291E+04	2.4725E+05	3.4304E+00	-1.1490E+03	3.9118E+02	1.4485E+07
4.0666E+02	4.5703E+02	4.3649E+05	-3.7291E+04	2.4074E+05	1.8056E+00	-1.1490E+03	0.0000E+00	2.9706E+07

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Energy Systems Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.0666E+02	3.9990E+02	7.2341E+05	-3.7291E+04	2.3424E+05	1.2316E+01	-1.6610E+03	1.5256E+04	2.9852E+00
4.0666E+02	3.4277E+02	1.7662E+06	-3.7291E+04	2.2773E+05	1.8056E+00	-1.6610E+03	1.4865E+04	2.4777E+02
4.0666E+02	2.8564E+02	3.3350E+06	-3.7291E+04	2.2122E+05	6.2500E-01	-1.6610E+03	1.4474E+04	1.4607E+02
4.0666E+02	2.2852E+02	5.4009E+06	-3.7291E+04	2.1472E+05	5.5625E-02	-1.6610E+03	1.4083E+04	2.2795E+02
4.0666E+02	1.7139E+02	8.2344E+06	-3.7291E+04	2.0821E+05	7.1911E+00	-1.6610E+03	1.3691E+04	9.3014E+02
4.0666E+02	1.1426E+02	9.3713E+06	-3.7291E+04	2.0170E+05	5.5625E-02	-1.6610E+03	1.3300E+04	1.8228E+03
4.0666E+02	5.7129E+01	1.9338E+07	-3.7291E+04	1.9520E+05	6.2500E-01	-1.6610E+03	1.2909E+04	1.7363E+02
4.0666E+02	0.0000E+00	4.6420E+07	-3.7291E+04	1.8869E+05	1.3221E+01	-1.6610E+03	1.2518E+04	1.3201E+03
3.4119E+02	2.5708E+03	1.6804E+00	-3.7291E+04	1.8218E+05	1.4971E+01	-1.6610E+03	1.2127E+04	4.3366E+02
3.4119E+02	2.5137E+03	1.7500E+00	-3.7291E+04	1.6917E+05	3.0097E-01	-1.6610E+03	1.1735E+04	8.8441E+03
3.4119E+02	2.4565E+03	1.4701E+01	-3.7291E+04	1.6266E+05	6.2500E-01	-1.6610E+03	1.1344E+04	6.6032E+03
3.4119E+02	2.3994E+03	1.6382E+01	-3.7291E+04	1.5616E+05	6.1302E+00	-1.6610E+03	1.0953E+04	1.1881E+04
3.4119E+02	2.2852E+03	1.1747E+01	-3.7291E+04	1.4965E+05	8.6514E-01	-1.6610E+03	1.0562E+04	1.7303E+04
3.4119E+02	2.2280E+03	1.6507E+01	-3.7291E+04	1.4314E+05	5.0701E+00	-1.6610E+03	1.0171E+04	1.8264E+04
3.4119E+02	2.1709E+03	8.1909E+00	-3.7291E+04	1.3664E+05	1.3590E+01	-1.6610E+03	9.7796E+03	3.3158E+04
3.4119E+02	2.1138E+03	3.1455E+01	-3.7291E+04	1.3013E+05	2.6666E+02	-1.6610E+03	9.3884E+03	3.2078E+04
3.4119E+02	2.0566E+03	3.0556E+00	-3.7291E+04	1.2362E+05	4.1989E+01	-1.6610E+03	8.9972E+03	4.1090E+04
3.4119E+02	1.9995E+03	6.8847E+00	-3.7291E+04	1.1712E+05	7.9662E+01	-1.6610E+03	8.6060E+03	3.9427E+04
3.4119E+02	1.9424E+03	3.9092E+02	-3.7291E+04	1.1061E+05	3.4488E+02	-1.6610E+03	8.2148E+03	7.0383E+04
3.4119E+02	1.8852E+03	1.3867E+03	-3.7291E+04	1.0410E+05	4.2950E+02	-1.6610E+03	7.8236E+03	9.0162E+04
3.4119E+02	1.8281E+03	8.6222E+01	-3.7291E+04	9.7598E+04	6.2769E+02	-1.6610E+03	7.4325E+03	1.3552E+05
3.4119E+02	1.7710E+03	1.1492E+02	-3.7291E+04	9.1092E+04	6.9068E+02	-1.6610E+03	7.0413E+03	1.4050E+05
3.4119E+02	1.7139E+03	2.6027E+02	-3.7291E+04	8.4585E+04	5.5194E+03	-1.6610E+03	6.6501E+03	1.9607E+05
3.4119E+02	1.6567E+03	2.7892E+03	-3.7291E+04	7.8079E+04	1.7160E+03	-1.6610E+03	6.2589E+03	2.7162E+05
3.4119E+02	1.5996E+03	1.6312E+02	-3.7291E+04	7.1572E+04	8.6464E+03	-1.6610E+03	5.8677E+03	4.3631E+05
3.4119E+02	1.5425E+03	1.3216E+02	-3.7291E+04	6.5066E+04	1.0358E+04	-1.6610E+03	5.4766E+03	5.9847E+05
3.4119E+02	1.4853E+03	1.2190E+02	-3.7291E+04	5.8559E+04	1.8871E+04	-1.6610E+03	5.0854E+03	6.8582E+05
3.4119E+02	1.4282E+03	4.6378E+02	-3.7291E+04	5.2052E+04	4.6054E+04	-1.6610E+03	4.6942E+03	1.1113E+06
3.4119E+02	1.3711E+03	7.0173E+02	-3.7291E+04	4.5546E+04	9.6610E+04	-1.6610E+03	4.3030E+03	1.0216E+06
3.4119E+02	1.3140E+03	1.1456E+03	-3.7291E+04	3.9039E+04	2.4758E+05	-1.6610E+03	3.9118E+03	1.5248E+06
3.4119E+02	1.2568E+03	1.9234E+03	-3.7291E+04	3.2533E+04	6.0076E+05	-1.6610E+03	3.5206E+03	1.8870E+06
3.4119E+02	1.1997E+03	2.0387E+03	-3.7291E+04	2.6026E+04	1.2142E+06	-1.6610E+03	3.1295E+03	2.2011E+06
3.4119E+02	1.1426E+03	2.1014E+03	-3.7291E+04	1.9520E+04	2.8352E+06	-1.6610E+03	2.7383E+03	2.4619E+06
3.4119E+02	1.0854E+03	4.2966E+03	-3.7291E+04	1.3013E+04	4.6451E+06	-1.6610E+03	2.3471E+03	2.7314E+06
3.4119E+02	1.0283E+03	6.6810E+03	-3.7291E+04	6.5066E+03	8.3263E+06	-1.6610E+03	1.9559E+03	2.7079E+06
3.4119E+02	9.7119E+02	1.0617E+04	-3.7291E+04	0.0000E+00	1.7521E+07	-1.6610E+03	1.5647E+03	2.5700E+06
3.4119E+02	9.1406E+02	1.2199E+04	-4.4587E+04	2.9930E+05	1.6804E+00	-1.6610E+03	1.1735E+03	2.9332E+06
3.4119E+02	8.5693E+02	1.4312E+04	-4.4587E+04	2.9279E+05	1.6804E+00	-1.6610E+03	7.8236E+02	4.5379E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.4119E+02	7.9980E+02	2.6970E+04	-4.4587E+04	2.8629E+05	9.8713E+00	-1.6610E+03	3.9118E+02	1.0642E+07
3.4119E+02	7.4267E+02	3.9660E+04	-4.4587E+04	2.7978E+05	8.1909E+00	-1.6610E+03	0.0000E+00	2.1127E+07
3.4119E+02	6.8555E+02	4.6879E+04	-4.4587E+04	2.7328E+05	1.7500E+00	-2.1730E+03	1.7603E+04	1.0417E+02
3.4119E+02	6.2842E+02	1.5656E+05	-4.4587E+04	2.6677E+05	3.3608E+00	-2.1730E+03	1.6821E+04	5.5625E-02
3.4119E+02	5.7129E+02	1.9506E+05	-4.4587E+04	2.6026E+05	5.1108E+00	-2.1730E+03	1.5647E+04	1.8829E+00
3.4119E+02	5.1416E+02	2.2282E+05	-4.4587E+04	2.5376E+05	9.8713E+00	-2.1730E+03	1.5256E+04	5.7033E+00
3.4119E+02	4.5703E+02	5.8245E+05	-4.4587E+04	2.4725E+05	7.6806E+00	-2.1730E+03	1.4865E+04	4.0077E+00
3.4119E+02	3.9990E+02	1.0577E+06	-4.4587E+04	2.4074E+05	1.1621E+01	-2.1730E+03	1.4474E+04	5.9595E+00
3.4119E+02	3.4277E+02	2.0512E+06	-4.4587E+04	2.3424E+05	8.6804E+00	-2.1730E+03	1.4083E+04	2.7806E+00
3.4119E+02	2.8564E+02	3.8944E+06	-4.4587E+04	2.2773E+05	1.8056E+00	-2.1730E+03	1.3691E+04	1.1376E+02
3.4119E+02	2.2852E+02	6.3783E+06	-4.4587E+04	2.2122E+05	6.5105E+00	-2.1730E+03	1.3300E+04	2.7663E+01
3.4119E+02	1.7139E+02	8.6404E+06	-4.4587E+04	2.1472E+05	3.5000E+00	-2.1730E+03	1.2909E+04	6.7909E+01
3.4119E+02	1.1426E+02	9.9827E+06	-4.4587E+04	2.0821E+05	5.5625E-02	-2.1730E+03	1.2518E+04	5.5833E+01
3.4119E+02	5.7129E+01	1.4249E+07	-4.4587E+04	2.0170E+05	1.3790E+01	-2.1730E+03	1.2127E+04	5.7787E+02
3.4119E+02	0.0000E+00	3.7791E+07	-4.4587E+04	1.9520E+05	1.0265E+01	-2.1730E+03	1.1735E+04	1.2243E+03
2.7572E+02	2.7422E+03	1.7500E+00	-4.4587E+04	1.8869E+05	1.8192E+00	-2.1730E+03	1.1344E+04	3.3685E+02
2.7572E+02	2.5708E+03	1.6804E+00	-4.4587E+04	1.7568E+05	1.7373E+01	-2.1730E+03	1.0953E+04	7.1220E+02
2.7572E+02	2.5137E+03	1.7500E+00	-4.4587E+04	1.6917E+05	1.0961E+01	-2.1730E+03	1.0562E+04	8.4458E+03
2.7572E+02	2.4565E+03	2.3054E+00	-4.4587E+04	1.6266E+05	3.5660E-01	-2.1730E+03	1.0171E+04	2.5428E+03
2.7572E+02	2.3423E+03	6.7912E+00	-4.4587E+04	1.5616E+05	1.8192E+00	-2.1730E+03	9.7796E+03	2.7845E+03
2.7572E+02	2.2852E+03	1.8132E+01	-4.4587E+04	1.4965E+05	4.2268E+01	-2.1730E+03	9.3884E+03	1.6886E+04
2.7572E+02	2.2280E+03	1.0635E+01	-4.4587E+04	1.4314E+05	2.3154E+01	-2.1730E+03	8.9972E+03	1.0594E+04
2.7572E+02	2.1709E+03	3.3608E+00	-4.4587E+04	1.3664E+05	1.1576E+02	-2.1730E+03	8.6060E+03	1.4978E+04
2.7572E+02	2.1138E+03	7.4858E+00	-4.4587E+04	1.3013E+05	3.5409E+01	-2.1730E+03	8.2148E+03	3.6248E+04
2.7572E+02	2.0566E+03	2.1701E+01	-4.4587E+04	1.2362E+05	2.0592E+02	-2.1730E+03	7.8236E+03	5.9059E+04
2.7572E+02	1.9995E+03	2.5337E+01	-4.4587E+04	1.1712E+05	3.5072E+02	-2.1730E+03	7.4325E+03	5.1749E+04
2.7572E+02	1.9424E+03	5.5500E+02	-4.4587E+04	1.1061E+05	8.0477E+02	-2.1730E+03	7.0413E+03	1.0469E+05
2.7572E+02	1.8852E+03	1.4915E+01	-4.4587E+04	1.0410E+05	1.0304E+03	-2.1730E+03	6.6501E+03	2.2208E+05
2.7572E+02	1.8281E+03	5.4454E+01	-4.4587E+04	9.7598E+04	1.1005E+03	-2.1730E+03	6.2589E+03	2.5442E+05
2.7572E+02	1.7710E+03	1.4719E+01	-4.4587E+04	9.1092E+04	1.9013E+03	-2.1730E+03	5.8677E+03	3.6802E+05
2.7572E+02	1.7139E+03	6.3035E+01	-4.4587E+04	8.4585E+04	1.4707E+03	-2.1730E+03	5.4766E+03	4.5733E+05
2.7572E+02	1.6567E+03	2.6411E+01	-4.4587E+04	7.8079E+04	2.5858E+03	-2.1730E+03	5.0854E+03	4.8674E+05
2.7572E+02	1.5996E+03	2.3743E+01	-4.4587E+04	7.1572E+04	4.0628E+03	-2.1730E+03	4.6942E+03	7.7744E+05
2.7572E+02	1.5425E+03	1.0730E+01	-4.4587E+04	6.5066E+04	1.5035E+04	-2.1730E+03	4.3030E+03	1.0329E+06
2.7572E+02	1.4853E+03	1.1929E+02	-4.4587E+04	5.8559E+04	1.7307E+04	-2.1730E+03	3.9118E+03	1.2179E+06
2.7572E+02	1.4282E+03	1.6020E+02	-4.4587E+04	5.2052E+04	4.4228E+04	-2.1730E+03	3.5206E+03	1.3817E+06
2.7572E+02	1.3711E+03	2.0978E+02	-4.4587E+04	4.5546E+04	9.2426E+04	-2.1730E+03	3.1295E+03	1.7103E+06
2.7572E+02	1.3140E+03	2.4238E+02	-4.4587E+04	3.9039E+04	3.4428E+05	-2.1730E+03	2.7383E+03	1.8337E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Energy Systems Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.7572E+02	1.2568E+03	5.8407E+02	-4.4587E+04	3.2533E+04	8.3323E+05	-2.1730E+03	2.3471E+03	1.9193E+06
2.7572E+02	1.1997E+03	4.8507E+02	-4.4587E+04	2.6026E+04	1.5547E+06	-2.1730E+03	1.9559E+03	1.7976E+06
2.7572E+02	1.1426E+03	7.7867E+02	-4.4587E+04	1.9520E+04	2.7847E+06	-2.1730E+03	1.5647E+03	1.8241E+06
2.7572E+02	1.0854E+03	8.9072E+02	-4.4587E+04	1.3013E+04	3.9761E+06	-2.1730E+03	1.1735E+03	2.1205E+06
2.7572E+02	1.0283E+03	9.4316E+02	-4.4587E+04	6.5066E+03	6.9026E+06	-2.1730E+03	7.8236E+02	3.5541E+06
2.7572E+02	9.7119E+02	1.9356E+03	-4.4587E+04	0.0000E+00	1.1319E+07	-2.1730E+03	3.9118E+02	7.8665E+06
2.7572E+02	9.1406E+02	2.9445E+03	-5.1883E+04	2.9279E+05	6.5105E+00	-2.1730E+03	0.0000E+00	1.4067E+07
2.7572E+02	8.5693E+02	4.6345E+03	-5.1883E+04	2.7328E+05	1.7500E+00	-2.6849E+03	1.7603E+04	6.2500E-01
2.7572E+02	7.9980E+02	8.5733E+03	-5.1883E+04	2.6677E+05	8.1909E+00	-2.6849E+03	1.6821E+04	1.9385E+00
2.7572E+02	7.4267E+02	1.0374E+04	-5.1883E+04	2.6026E+05	5.1108E+00	-2.6849E+03	1.6430E+04	2.0246E-01
2.7572E+02	6.8555E+02	2.3830E+04	-5.1883E+04	2.5376E+05	1.1691E+01	-2.6849E+03	1.6038E+04	3.6335E+00
2.7572E+02	6.2842E+02	3.9662E+04	-5.1883E+04	2.4725E+05	6.5105E+00	-2.6849E+03	1.5647E+04	6.8821E+01
2.7572E+02	5.7129E+02	9.2724E+04	-5.1883E+04	2.4074E+05	1.6804E+00	-2.6849E+03	1.5256E+04	1.3826E+00
2.7572E+02	5.1416E+02	1.9528E+05	-5.1883E+04	2.2773E+05	6.2500E-01	-2.6849E+03	1.4865E+04	2.5809E-01
2.7572E+02	4.5703E+02	3.4827E+05	-5.1883E+04	2.2122E+05	1.9106E+01	-2.6849E+03	1.4474E+04	2.0246E-01
2.7572E+02	3.9990E+02	8.7710E+05	-5.1883E+04	2.1472E+05	1.4817E+01	-2.6849E+03	1.4083E+04	1.4966E+01
2.7572E+02	3.4277E+02	1.6299E+06	-5.1883E+04	2.0821E+05	1.0359E+01	-2.6849E+03	1.3691E+04	1.3319E+01
2.7572E+02	2.8564E+02	2.7112E+06	-5.1883E+04	2.0170E+05	1.8748E+00	-2.6849E+03	1.3300E+04	2.4630E+01
2.7572E+02	2.2852E+02	4.5976E+06	-5.1883E+04	1.9520E+05	1.5383E+01	-2.6849E+03	1.2909E+04	3.6143E+01
2.7572E+02	1.7139E+02	6.9505E+06	-5.1883E+04	1.8869E+05	8.3043E-01	-2.6849E+03	1.2518E+04	6.2976E+01
2.7572E+02	1.1426E+02	8.9108E+06	-5.1883E+04	1.8218E+05	5.7924E+00	-2.6849E+03	1.2127E+04	8.5820E+01
2.7572E+02	5.7129E+01	1.3147E+07	-5.1883E+04	1.7568E+05	1.3274E+01	-2.6849E+03	1.1735E+04	9.4439E+01
2.7572E+02	0.0000E+00	3.9001E+07	-5.1883E+04	1.6917E+05	3.5660E-01	-2.6849E+03	1.1344E+04	6.6306E+01
2.1026E+02	2.8564E+03	1.7500E+00	-5.1883E+04	1.6266E+05	1.6873E+00	-2.6849E+03	1.0953E+04	5.0977E+02
2.1026E+02	2.6279E+03	1.6804E+00	-5.1883E+04	1.5616E+05	3.0097E-01	-2.6849E+03	1.0562E+04	5.9195E+02
2.1026E+02	2.5708E+03	1.6804E+00	-5.1883E+04	1.4965E+05	1.7326E+01	-2.6849E+03	1.0171E+04	3.3864E+02
2.1026E+02	2.5137E+03	1.7500E+00	-5.1883E+04	1.4314E+05	1.5584E+01	-2.6849E+03	9.7796E+03	5.8283E+02
2.1026E+02	2.3994E+03	1.6804E+00	-5.1883E+04	1.3664E+05	1.0540E+02	-2.6849E+03	9.3884E+03	1.2135E+03
2.1026E+02	2.3423E+03	1.7500E+00	-5.1883E+04	1.3013E+05	1.2107E+01	-2.6849E+03	8.9972E+03	9.1168E+02
2.1026E+02	2.2852E+03	5.0412E+00	-5.1883E+04	1.2362E+05	1.5322E+01	-2.6849E+03	8.6060E+03	3.1841E+02
2.1026E+02	2.2280E+03	5.1804E+00	-5.1883E+04	1.1712E+05	9.4125E+01	-2.6849E+03	8.2148E+03	6.3959E+03
2.1026E+02	2.1709E+03	1.0010E+01	-5.1883E+04	1.1061E+05	9.7372E+02	-2.6849E+03	7.8236E+03	1.5597E+04
2.1026E+02	2.1138E+03	8.6108E+00	-5.1883E+04	1.0410E+05	1.1333E+03	-2.6849E+03	7.4325E+03	3.4721E+04
2.1026E+02	2.0566E+03	1.1747E+01	-5.1883E+04	9.7598E+04	3.4245E+03	-2.6849E+03	7.0413E+03	3.8319E+04
2.1026E+02	1.9995E+03	1.7202E+01	-5.1883E+04	9.1092E+04	6.4921E+03	-2.6849E+03	6.6501E+03	9.2886E+04
2.1026E+02	1.9424E+03	3.4304E+00	-5.1883E+04	8.4585E+04	4.7904E+03	-2.6849E+03	6.2589E+03	1.3817E+05
2.1026E+02	1.8852E+03	6.5105E+00	-5.1883E+04	7.8079E+04	4.5153E+03	-2.6849E+03	5.8677E+03	1.7655E+05
2.1026E+02	1.8281E+03	1.3570E+01	-5.1883E+04	7.1572E+04	1.7437E+04	-2.6849E+03	5.4766E+03	2.8575E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.1026E+02	1.7710E+03	3.4164E+00	-5.1883E+04	6.5066E+04	1.9480E+04	-2.6849E+03	5.0854E+03	3.6461E+05
2.1026E+02	1.7139E+03	1.4108E+01	-5.1883E+04	5.8559E+04	3.6375E+04	-2.6849E+03	4.6942E+03	5.1023E+05
2.1026E+02	1.6567E+03	1.1622E+02	-5.1883E+04	5.2052E+04	5.6984E+04	-2.6849E+03	4.3030E+03	5.9504E+05
2.1026E+02	1.5996E+03	8.4221E+01	-5.1883E+04	4.5546E+04	1.5596E+05	-2.6849E+03	3.9118E+03	8.1131E+05
2.1026E+02	1.5425E+03	7.5475E+01	-5.1883E+04	3.9039E+04	2.6398E+05	-2.6849E+03	3.5206E+03	9.2324E+05
2.1026E+02	1.4853E+03	7.9265E+01	-5.1883E+04	3.2533E+04	7.7412E+05	-2.6849E+03	3.1295E+03	1.1657E+06
2.1026E+02	1.4282E+03	5.9804E+01	-5.1883E+04	2.6026E+04	1.7834E+06	-2.6849E+03	2.7383E+03	1.3102E+06
2.1026E+02	1.3711E+03	2.0693E+02	-5.1883E+04	1.9520E+04	2.5438E+06	-2.6849E+03	2.3471E+03	1.1731E+06
2.1026E+02	1.3140E+03	1.1065E+02	-5.1883E+04	1.3013E+04	4.8613E+06	-2.6849E+03	1.9559E+03	1.1828E+06
2.1026E+02	1.2568E+03	1.6120E+02	-5.1883E+04	6.5066E+03	8.1024E+06	-2.6849E+03	1.5647E+03	1.1212E+06
2.1026E+02	1.1997E+03	2.7316E+02	-5.1883E+04	0.0000E+00	1.1473E+07	-2.6849E+03	1.1735E+03	1.4082E+06
2.1026E+02	1.1426E+03	3.4616E+02	-5.9178E+04	2.7328E+05	9.8713E+00	-2.6849E+03	7.8236E+02	2.4003E+06
2.1026E+02	1.0854E+03	9.7714E+01	-5.9178E+04	2.5376E+05	6.5105E+00	-2.6849E+03	3.9118E+02	5.3063E+06
2.1026E+02	1.0283E+03	3.6331E+02	-5.9178E+04	2.4725E+05	1.6804E+00	-2.6849E+03	0.0000E+00	1.0104E+07
2.1026E+02	9.7119E+02	4.5819E+02	-5.9178E+04	2.4074E+05	2.0738E+01	-3.1969E+03	1.9559E+04	6.2500E-01
2.1026E+02	9.1406E+02	9.0243E+02	-5.9178E+04	2.3424E+05	8.1909E+00	-3.1969E+03	1.7994E+04	5.5625E-02
2.1026E+02	8.5693E+02	1.2961E+03	-5.9178E+04	2.2773E+05	6.5105E+00	-3.1969E+03	1.6430E+04	6.2500E-01
2.1026E+02	7.9980E+02	1.9192E+03	-5.9178E+04	2.1472E+05	1.6804E+00	-3.1969E+03	1.6038E+04	2.0246E-01
2.1026E+02	7.4267E+02	5.3335E+03	-5.9178E+04	2.0821E+05	1.5932E+01	-3.1969E+03	1.5256E+04	2.7261E+00
2.1026E+02	6.8555E+02	9.3001E+03	-5.9178E+04	2.0170E+05	2.2898E+01	-3.1969E+03	1.4865E+04	3.5660E-01
2.1026E+02	6.2842E+02	3.7516E+04	-5.9178E+04	1.9520E+05	2.6428E+01	-3.1969E+03	1.4474E+04	2.7056E+00
2.1026E+02	5.7129E+02	4.7434E+04	-5.9178E+04	1.8869E+05	3.9193E+01	-3.1969E+03	1.4083E+04	1.8829E+00
2.1026E+02	5.1416E+02	1.3342E+05	-5.9178E+04	1.8218E+05	7.2988E+00	-3.1969E+03	1.3691E+04	2.9637E+00
2.1026E+02	4.5703E+02	2.2489E+05	-5.9178E+04	1.7568E+05	5.3567E+00	-3.1969E+03	1.3300E+04	3.8857E+00
2.1026E+02	3.9990E+02	5.0206E+05	-5.9178E+04	1.6917E+05	1.1456E+01	-3.1969E+03	1.2909E+04	3.4786E+00
2.1026E+02	3.4277E+02	9.6048E+05	-5.9178E+04	1.6266E+05	2.1805E+01	-3.1969E+03	1.2518E+04	1.5771E+01
2.1026E+02	2.8564E+02	2.2522E+06	-5.9178E+04	1.5616E+05	4.5232E+00	-3.1969E+03	1.2127E+04	3.2572E+01
2.1026E+02	2.2852E+02	4.9780E+06	-5.9178E+04	1.4965E+05	5.1347E+00	-3.1969E+03	1.1735E+04	2.3353E+01
2.1026E+02	1.7139E+02	9.2499E+06	-5.9178E+04	1.4314E+05	1.3570E+01	-3.1969E+03	1.1344E+04	2.4166E+00
2.1026E+02	1.1426E+02	1.3694E+07	-5.9178E+04	1.3664E+05	1.3869E+02	-3.1969E+03	1.0953E+04	1.8260E+02
2.1026E+02	5.7129E+01	2.2574E+07	-5.9178E+04	1.3013E+05	2.1865E+03	-3.1969E+03	1.0562E+04	1.9353E+02
2.1026E+02	0.0000E+00	5.7700E+07	-5.9178E+04	1.2362E+05	7.6254E+02	-3.1969E+03	1.0171E+04	2.4492E+02
1.4479E+02	2.7422E+03	6.5105E+00	-5.9178E+04	1.1712E+05	2.8334E+03	-3.1969E+03	9.7796E+03	1.4010E+02
1.4479E+02	2.6851E+03	1.6804E+00	-5.9178E+04	1.1061E+05	1.1235E+04	-3.1969E+03	9.3884E+03	4.6827E+01
1.4479E+02	2.5137E+03	1.7500E+00	-5.9178E+04	1.0410E+05	1.8590E+03	-3.1969E+03	8.9972E+03	2.5569E+01
1.4479E+02	2.4565E+03	1.6804E+00	-5.9178E+04	9.7598E+04	1.4847E+03	-3.1969E+03	8.6060E+03	2.8852E+03
1.4479E+02	2.1709E+03	2.3750E+00	-5.9178E+04	9.1092E+04	1.7690E+04	-3.1969E+03	8.2148E+03	1.4164E+03
1.4479E+02	2.1138E+03	1.8056E+00	-5.9178E+04	8.4585E+04	2.9202E+04	-3.1969E+03	7.8236E+03	5.9292E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Energy Systems Tuborgvænkvej 8.2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.4479E+02	2.0566E+03	8.2605E+00	-5.9178E+04	7.8079E+04	2.7799E+04	-3.1969E+03	7.4325E+03	1.0508E+03
1.4479E+02	1.9995E+03	5.5625E-02	-5.9178E+04	7.1572E+04	3.5279E+04	-3.1969E+03	7.0413E+03	9.1441E+03
1.4479E+02	1.9424E+03	5.5625E-02	-5.9178E+04	6.5066E+04	2.4450E+04	-3.1969E+03	6.6501E+03	7.9733E+03
1.4479E+02	1.8852E+03	1.4771E+01	-5.9178E+04	5.8559E+04	5.2491E+04	-3.1969E+03	6.2589E+03	2.9725E+04
1.4479E+02	1.8281E+03	2.7792E+01	-5.9178E+04	5.2052E+04	5.9449E+04	-3.1969E+03	5.8677E+03	4.2597E+04
1.4479E+02	1.7710E+03	1.5396E+01	-5.9178E+04	4.5546E+04	9.2196E+04	-3.1969E+03	5.4766E+03	8.0474E+04
1.4479E+02	1.7139E+03	3.9063E+01	-5.9178E+04	3.9039E+04	2.8589E+05	-3.1969E+03	5.0854E+03	1.8894E+05
1.4479E+02	1.6567E+03	1.5545E+01	-5.9178E+04	3.2533E+04	6.3395E+05	-3.1969E+03	4.6942E+03	2.4637E+05
1.4479E+02	1.5996E+03	5.2968E+01	-5.9178E+04	2.6026E+04	1.8712E+06	-3.1969E+03	4.3030E+03	4.4039E+05
1.4479E+02	1.5425E+03	2.9338E+01	-5.9178E+04	1.9520E+04	3.4616E+06	-3.1969E+03	3.9118E+03	4.2917E+05
1.4479E+02	1.4853E+03	9.7295E+01	-5.9178E+04	1.3013E+04	5.6861E+06	-3.1969E+03	3.5206E+03	7.6722E+05
1.4479E+02	1.4282E+03	9.6725E+01	-5.9178E+04	6.5066E+03	9.5014E+06	-3.1969E+03	3.1295E+03	6.1110E+05
1.4479E+02	1.3711E+03	1.4098E+02	-5.9178E+04	0.0000E+00	1.3612E+07	-3.1969E+03	2.7383E+03	6.8582E+05
1.4479E+02	1.3140E+03	2.2674E+02	-6.6474E+04	2.4725E+05	6.5105E+00	-3.1969E+03	2.3471E+03	9.9259E+05
1.4479E+02	1.2568E+03	1.4564E+02	-6.6474E+04	2.3424E+05	3.3608E+00	-3.1969E+03	1.9559E+03	7.0906E+05
1.4479E+02	1.1997E+03	1.9652E+02	-6.6474E+04	2.2773E+05	1.0082E+01	-3.1969E+03	1.5647E+03	7.7107E+05
1.4479E+02	1.1426E+03	3.2417E+02	-6.6474E+04	2.2122E+05	3.5375E+00	-3.1969E+03	1.1735E+03	1.0094E+06
1.4479E+02	1.0854E+03	3.6503E+02	-6.6474E+04	2.1472E+05	1.9965E+01	-3.1969E+03	7.8236E+02	1.5390E+06
1.4479E+02	1.0283E+03	6.5633E+02	-6.6474E+04	2.0821E+05	3.0097E-01	-3.1969E+03	3.9118E+02	3.4384E+06
1.4479E+02	9.7119E+02	4.1486E+02	-6.6474E+04	2.0170E+05	1.6005E+01	-3.1969E+03	0.0000E+00	6.7294E+06
1.4479E+02	9.1406E+02	6.0588E+02	-6.6474E+04	1.9520E+05	3.4736E+01	-3.7089E+03	1.6038E+04	4.5615E+00
1.4479E+02	8.5693E+02	3.7416E+03	-6.6474E+04	1.8869E+05	5.1638E+01	-3.7089E+03	1.5647E+04	4.7084E+00
1.4479E+02	7.9980E+02	1.2758E+03	-6.6474E+04	1.8218E+05	2.9251E+01	-3.7089E+03	1.5256E+04	2.0246E-01
1.4479E+02	7.4267E+02	3.8226E+03	-6.6474E+04	1.7568E+05	1.8867E+01	-3.7089E+03	1.4865E+04	1.8041E+00
1.4479E+02	6.8555E+02	1.3216E+04	-6.6474E+04	1.6917E+05	3.3441E+01	-3.7089E+03	1.4474E+04	1.7485E+00
1.4479E+02	6.2842E+02	2.1174E+04	-6.6474E+04	1.6266E+05	3.4852E+01	-3.7089E+03	1.4083E+04	1.0311E+00
1.4479E+02	5.7129E+02	4.2000E+04	-6.6474E+04	1.5616E+05	1.2956E+01	-3.7089E+03	1.3300E+04	2.9081E+00
1.4479E+02	5.1416E+02	7.1355E+04	-6.6474E+04	1.4965E+05	5.6427E+01	-3.7089E+03	1.2909E+04	2.0246E-01
1.4479E+02	4.5703E+02	1.6191E+05	-6.6474E+04	1.4314E+05	5.9578E+02	-3.7089E+03	1.2518E+04	7.7480E-01
1.4479E+02	3.9990E+02	4.1485E+05	-6.6474E+04	1.3664E+05	1.3760E+03	-3.7089E+03	1.2127E+04	1.7817E+00
1.4479E+02	3.4277E+02	1.1138E+06	-6.6474E+04	1.3013E+05	1.4997E+02	-3.7089E+03	1.1735E+04	5.5216E+00
1.4479E+02	2.8564E+02	2.4192E+06	-6.6474E+04	1.2362E+05	1.4381E+03	-3.7089E+03	1.1344E+04	5.7362E+00
1.4479E+02	2.2852E+02	5.2287E+06	-6.6474E+04	1.1712E+05	7.4335E+02	-3.7089E+03	1.0953E+04	5.5625E-02
1.4479E+02	1.7139E+02	1.0642E+07	-6.6474E+04	1.1061E+05	4.7090E+03	-3.7089E+03	1.0562E+04	3.7362E+00
1.4479E+02	1.1426E+02	1.5902E+07	-6.6474E+04	1.0410E+05	6.0206E+03	-3.7089E+03	1.0171E+04	5.6620E+00
1.4479E+02	5.7129E+01	2.4302E+07	-6.6474E+04	9.7598E+04	6.7801E+03	-3.7089E+03	9.7796E+03	1.0479E+02
1.4479E+02	0.0000E+00	5.8436E+07	-6.6474E+04	9.1092E+04	1.8650E+04	-3.7089E+03	9.3884E+03	9.9273E+00
7.9318E+01	2.6279E+03	1.7500E+00	-6.6474E+04	8.4585E+04	1.9228E+04	-3.7089E+03	8.9972E+03	1.3117E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.9318E+01	2.5708E+03	6.5105E+00	-6.6474E+04	7.8079E+04	2.1625E+04	-3.7089E+03	8.6060E+03	4.0635E+01
7.9318E+01	2.4565E+03	1.7500E+00	-6.6474E+04	7.1572E+04	2.6893E+04	-3.7089E+03	8.2148E+03	1.9711E+01
7.9318E+01	2.3994E+03	3.4304E+00	-6.6474E+04	6.5066E+04	3.8230E+04	-3.7089E+03	7.8236E+03	3.0477E+02
7.9318E+01	2.2852E+03	1.7500E+00	-6.6474E+04	5.8559E+04	5.7314E+04	-3.7089E+03	7.4325E+03	5.8161E+02
7.9318E+01	2.2280E+03	1.7500E+00	-6.6474E+04	5.2052E+04	7.1987E+04	-3.7089E+03	7.0413E+03	2.3082E+03
7.9318E+01	2.1138E+03	1.7500E+00	-6.6474E+04	4.5546E+04	9.7488E+04	-3.7089E+03	6.6501E+03	9.3653E+03
7.9318E+01	2.0566E+03	6.2500E-01	-6.6474E+04	3.9039E+04	1.6481E+05	-3.7089E+03	6.2589E+03	1.1820E+04
7.9318E+01	1.9995E+03	5.5625E-02	-6.6474E+04	3.2533E+04	4.0098E+05	-3.7089E+03	5.8677E+03	8.3723E+03
7.9318E+01	1.7710E+03	2.6042E+01	-6.6474E+04	2.6026E+04	1.1304E+06	-3.7089E+03	5.4766E+03	1.9112E+04
7.9318E+01	1.7139E+03	3.5556E+00	-6.6474E+04	1.9520E+04	2.8643E+06	-3.7089E+03	5.0854E+03	3.8282E+04
7.9318E+01	1.6567E+03	1.3646E+01	-6.6474E+04	1.3013E+04	4.6024E+06	-3.7089E+03	4.6942E+03	7.0001E+04
7.9318E+01	1.5996E+03	2.6098E+01	-6.6474E+04	6.5066E+03	7.4345E+06	-3.7089E+03	4.3030E+03	1.0389E+05
7.9318E+01	1.5425E+03	3.9174E+01	-6.6474E+04	0.0000E+00	1.4167E+07	-3.7089E+03	3.9118E+03	1.4487E+05
7.9318E+01	1.4853E+03	4.5514E+01	-7.3770E+04	2.2773E+05	6.5105E+00	-3.7089E+03	3.5206E+03	2.9224E+05
7.9318E+01	1.4282E+03	2.9055E+01	-7.3770E+04	2.1472E+05	5.2179E+00	-3.7089E+03	3.1295E+03	3.5310E+05
7.9318E+01	1.3711E+03	4.2739E+01	-7.3770E+04	2.0821E+05	1.3067E+01	-3.7089E+03	2.7383E+03	3.7676E+05
7.9318E+01	1.3140E+03	5.4668E+01	-7.3770E+04	1.9520E+05	6.5240E+00	-3.7089E+03	2.3471E+03	5.0332E+05
7.9318E+01	1.2568E+03	6.8577E+01	-7.3770E+04	1.8869E+05	3.1806E+01	-3.7089E+03	1.9559E+03	3.2379E+05
7.9318E+01	1.1997E+03	7.2369E+01	-7.3770E+04	1.7568E+05	2.7242E+01	-3.7089E+03	1.5647E+03	4.5593E+05
7.9318E+01	1.1426E+03	1.0986E+02	-7.3770E+04	1.6917E+05	8.1063E+00	-3.7089E+03	1.1735E+03	5.2337E+05
7.9318E+01	1.0854E+03	1.3500E+02	-7.3770E+04	1.6266E+05	2.5781E+01	-3.7089E+03	7.8236E+02	8.2114E+05
7.9318E+01	1.0283E+03	1.5956E+02	-7.3770E+04	1.5616E+05	1.4712E+01	-3.7089E+03	3.9118E+02	2.0167E+06
7.9318E+01	9.7119E+02	1.5933E+02	-7.3770E+04	1.4965E+05	1.0191E+02	-3.7089E+03	0.0000E+00	4.2362E+06
7.9318E+01	9.1406E+02	2.4867E+02	-7.3770E+04	1.4314E+05	2.0554E+02	-4.2208E+03	1.6821E+04	5.5625E-02
7.9318E+01	8.5693E+02	3.4580E+02	-7.3770E+04	1.3664E+05	2.6944E+02	-4.2208E+03	1.5647E+04	6.2500E-01
7.9318E+01	7.9980E+02	3.3974E+02	-7.3770E+04	1.3013E+05	4.2868E+02	-4.2208E+03	1.4083E+04	1.0417E+02
7.9318E+01	7.4267E+02	2.3993E+03	-7.3770E+04	1.2362E+05	4.1307E+03	-4.2208E+03	1.2518E+04	5.5625E-02
7.9318E+01	6.8555E+02	5.3915E+03	-7.3770E+04	1.1712E+05	1.4272E+03	-4.2208E+03	1.1735E+04	5.5625E-02
7.9318E+01	6.2842E+02	1.0767E+04	-7.3770E+04	1.1061E+05	2.3419E+03	-4.2208E+03	1.1344E+04	2.7036E-02
7.9318E+01	5.7129E+02	1.1998E+04	-7.3770E+04	1.0410E+05	5.5869E+03	-4.2208E+03	1.0953E+04	5.5625E-02
7.9318E+01	5.1416E+02	2.9393E+04	-7.3770E+04	9.7598E+04	1.6404E+04	-4.2208E+03	1.0562E+04	6.2500E-01
7.9318E+01	4.5703E+02	1.0838E+05	-7.3770E+04	9.1092E+04	1.4258E+04	-4.2208E+03	1.0171E+04	5.7502E+00
7.9318E+01	3.9990E+02	2.4471E+05	-7.3770E+04	8.4585E+04	1.7189E+04	-4.2208E+03	9.7796E+03	3.3608E+00
7.9318E+01	3.4277E+02	5.7983E+05	-7.3770E+04	7.8079E+04	4.8287E+04	-4.2208E+03	9.3884E+03	5.2500E+00
7.9318E+01	2.8564E+02	1.0788E+06	-7.3770E+04	7.1572E+04	5.3447E+04	-4.2208E+03	8.9972E+03	5.0460E+00
7.9318E+01	2.2852E+02	1.8523E+06	-7.3770E+04	6.5066E+04	6.7067E+04	-4.2208E+03	8.6060E+03	6.5460E+00
7.9318E+01	1.7139E+02	2.8040E+06	-7.3770E+04	5.8559E+04	9.8616E+04	-4.2208E+03	8.2148E+03	3.7349E+01
7.9318E+01	1.1426E+02	3.9892E+06	-7.3770E+04	5.2052E+04	1.3510E+05	-4.2208E+03	7.8236E+03	4.2337E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.9318E+01	5.7129E+01	8.0179E+06	-7.3770E+04	4.5546E+04	1.9223E+05	-4.2208E+03	7.4325E+03	3.6587E+01
7.9318E+01	0.0000E+00	2.6945E+07	-7.3770E+04	3.9039E+04	2.8107E+05	-4.2208E+03	7.0413E+03	8.6253E+00
1.3850E+01	2.5708E+03	1.7500E+00	-7.3770E+04	3.2533E+04	4.9102E+05	-4.2208E+03	6.6501E+03	6.3196E+01
1.3850E+01	1.8852E+03	1.7360E+00	-7.3770E+04	2.6026E+04	1.2046E+06	-4.2208E+03	6.2589E+03	5.2198E+01
1.3850E+01	1.7710E+03	3.5000E+00	-7.3770E+04	1.9520E+04	3.2049E+06	-4.2208E+03	5.8677E+03	6.0547E+02
1.3850E+01	1.6567E+03	5.5625E-02	-7.3770E+04	1.3013E+04	4.9964E+06	-4.2208E+03	5.4766E+03	2.8208E+03
1.3850E+01	1.4853E+03	2.1433E+01	-7.3770E+04	6.5066E+03	7.4269E+06	-4.2208E+03	5.0854E+03	9.6317E+03
1.3850E+01	1.4282E+03	1.4840E+01	-7.3770E+04	0.0000E+00	1.8982E+07	-4.2208E+03	4.6942E+03	2.8778E+04
1.3850E+01	1.3711E+03	2.4306E+00	-8.1066E+04	2.0821E+05	1.6804E+00	-4.2208E+03	4.3030E+03	2.7078E+04
1.3850E+01	1.3140E+03	1.7917E+00	-8.1066E+04	1.9520E+05	1.2644E+01	-4.2208E+03	3.9118E+03	2.7277E+04
1.3850E+01	1.2568E+03	1.2353E+01	-8.1066E+04	1.8218E+05	1.2644E+01	-4.2208E+03	3.5206E+03	3.1258E+04
1.3850E+01	1.1997E+03	6.2695E+01	-8.1066E+04	1.7568E+05	3.3820E+01	-4.2208E+03	3.1295E+03	8.8570E+04
1.3850E+01	1.1426E+03	2.8031E+01	-8.1066E+04	1.6917E+05	1.3137E+01	-4.2208E+03	2.7383E+03	1.1293E+05
1.3850E+01	1.0854E+03	1.4871E+01	-8.1066E+04	1.6266E+05	8.4605E+01	-4.2208E+03	2.3471E+03	1.2541E+05
1.3850E+01	1.0283E+03	3.0623E+01	-8.1066E+04	1.5616E+05	1.1843E+02	-4.2208E+03	1.9559E+03	1.7218E+05
1.3850E+01	9.7119E+02	1.3685E+01	-8.1066E+04	1.4965E+05	1.3557E+02	-4.2208E+03	1.5647E+03	2.1556E+05
1.3850E+01	9.1406E+02	3.9360E+01	-8.1066E+04	1.4314E+05	3.4783E+02	-4.2208E+03	1.1735E+03	1.9660E+05
1.3850E+01	8.5693E+02	1.5111E+02	-8.1066E+04	1.3664E+05	8.7186E+02	-4.2208E+03	7.8236E+02	4.9910E+05
1.3850E+01	7.9980E+02	1.1252E+03	-8.1066E+04	1.3013E+05	2.1448E+03	-4.2208E+03	3.9118E+02	1.1586E+06
1.3850E+01	7.4267E+02	4.1643E+03	-8.1066E+04	1.2362E+05	4.0827E+03	-4.2208E+03	0.0000E+00	2.6922E+06
1.3850E+01	6.8555E+02	7.2777E+03	-8.1066E+04	1.1712E+05	6.5014E+03	-4.7328E+03	1.5647E+04	5.5625E-02
1.3850E+01	6.2842E+02	1.5303E+04	-8.1066E+04	1.1061E+05	1.1411E+04	-4.7328E+03	1.4474E+04	5.5625E-02
1.3850E+01	5.7129E+02	1.6412E+04	-8.1066E+04	1.0410E+05	1.2251E+04	-4.7328E+03	1.3691E+04	5.5625E-02
1.3850E+01	5.1416E+02	2.9083E+04	-8.1066E+04	9.7598E+04	1.7435E+04	-4.7328E+03	1.2909E+04	1.1125E-01
1.3850E+01	4.5703E+02	5.0672E+04	-8.1066E+04	9.1092E+04	3.7486E+04	-4.7328E+03	1.2518E+04	5.5625E-02
1.3850E+01	3.9990E+02	1.0610E+05	-8.1066E+04	8.4585E+04	5.4107E+04	-4.7328E+03	1.2127E+04	3.0097E-01
1.3850E+01	3.4277E+02	1.5863E+05	-8.1066E+04	7.8079E+04	8.3590E+04	-4.7328E+03	1.1735E+04	5.5625E-02
1.3850E+01	2.8564E+02	2.6189E+05	-8.1066E+04	7.1572E+04	1.3550E+05	-4.7328E+03	1.1344E+04	1.6804E+00
1.3850E+01	2.2852E+02	6.4924E+05	-8.1066E+04	6.5066E+04	1.6894E+05	-4.7328E+03	1.0953E+04	7.7480E-01
1.3850E+01	1.7139E+02	1.3631E+06	-8.1066E+04	5.8559E+04	2.8074E+05	-4.7328E+03	8.2148E+03	1.0032E+02
1.3850E+01	1.1426E+02	3.7736E+06	-8.1066E+04	5.2052E+04	3.5810E+05	-4.7328E+03	7.8236E+03	4.0492E-01
1.3850E+01	5.7129E+01	1.1565E+07	-8.1066E+04	4.5546E+04	5.2129E+05	-4.7328E+03	7.4325E+03	7.0661E+00
1.3850E+01	0.0000E+00	4.9032E+07	-8.1066E+04	3.9039E+04	7.1704E+05	-4.7328E+03	7.0413E+03	1.6562E+01
-5.1619E+01	2.3994E+03	1.7500E+00	-8.1066E+04	3.2533E+04	9.3404E+05	-4.7328E+03	6.6501E+03	1.2113E+01
-5.1619E+01	1.7710E+03	6.8063E-01	-8.1066E+04	2.6026E+04	1.6224E+06	-4.7328E+03	6.2589E+03	2.2918E+02
-5.1619E+01	1.7139E+03	3.6112E+00	-8.1066E+04	1.9520E+04	3.5534E+06	-4.7328E+03	5.8677E+03	7.5360E+01
-5.1619E+01	1.5996E+03	3.3608E+00	-8.1066E+04	1.3013E+04	4.9276E+06	-4.7328E+03	5.4766E+03	1.4739E+03
-5.1619E+01	1.5425E+03	5.5625E-02	-8.1066E+04	6.5066E+03	6.4877E+06	-4.7328E+03	5.0854E+03	9.9030E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-5.1619E+01	1.4853E+03	3.3608E+00	-8.1066E+04	0.0000E+00	1.8153E+07	-4.7328E+03	4.6942E+03	1.3964E+03
-5.1619E+01	1.4282E+03	7.4858E+00	-8.8361E+04	1.8869E+05	1.9361E+01	-4.7328E+03	4.3030E+03	3.8208E+03
-5.1619E+01	1.3711E+03	2.3808E+01	-8.8361E+04	1.7568E+05	9.0595E+02	-4.7328E+03	3.9118E+03	2.4962E+03
-5.1619E+01	1.3140E+03	5.7914E+00	-8.8361E+04	1.6917E+05	2.6275E+01	-4.7328E+03	3.5206E+03	3.1761E+03
-5.1619E+01	1.2568E+03	1.0500E+01	-8.8361E+04	1.6266E+05	1.3506E+03	-4.7328E+03	3.1295E+03	7.8442E+03
-5.1619E+01	1.1997E+03	1.4097E+01	-8.8361E+04	1.5616E+05	4.5566E+02	-4.7328E+03	2.7383E+03	1.1850E+04
-5.1619E+01	1.1426E+03	2.7416E+01	-8.8361E+04	1.4965E+05	2.0557E+02	-4.7328E+03	2.3471E+03	2.7711E+04
-5.1619E+01	1.0854E+03	1.1250E+01	-8.8361E+04	1.4314E+05	8.3781E+02	-4.7328E+03	1.9559E+03	3.4955E+04
-5.1619E+01	1.0283E+03	4.5370E+01	-8.8361E+04	1.3664E+05	1.9884E+03	-4.7328E+03	1.5647E+03	3.2615E+04
-5.1619E+01	9.7119E+02	2.2061E+01	-8.8361E+04	1.3013E+05	1.4294E+03	-4.7328E+03	1.1735E+03	6.8565E+04
-5.1619E+01	9.1406E+02	9.7478E+01	-8.8361E+04	1.2362E+05	2.7670E+03	-4.7328E+03	7.8236E+02	1.1747E+05
-5.1619E+01	8.5693E+02	7.8805E+01	-8.8361E+04	1.1712E+05	8.2413E+03	-4.7328E+03	3.9118E+02	4.3222E+05
-5.1619E+01	7.9980E+02	1.2725E+02	-8.8361E+04	1.1061E+05	1.2292E+04	-4.7328E+03	0.0000E+00	1.0540E+06
-5.1619E+01	7.4267E+02	1.0770E+03	-8.8361E+04	1.0410E+05	2.4374E+04	-5.2447E+03	1.4474E+04	1.1125E-01
-5.1619E+01	6.8555E+02	1.1538E+03	-8.8361E+04	9.7598E+04	4.1158E+04	-5.2447E+03	1.3300E+04	6.2500E-01
-5.1619E+01	6.2842E+02	1.3112E+03	-8.8361E+04	9.1092E+04	7.7817E+04	-5.2447E+03	1.2909E+04	6.2500E-01
-5.1619E+01	5.7129E+02	2.4015E+03	-8.8361E+04	8.4585E+04	9.3895E+04	-5.2447E+03	1.2518E+04	6.2500E-01
-5.1619E+01	5.1416E+02	3.4934E+03	-8.8361E+04	7.8079E+04	1.6702E+05	-5.2447E+03	1.1735E+04	1.6804E+00
-5.1619E+01	4.5703E+02	5.5501E+03	-8.8361E+04	7.1572E+04	2.5738E+05	-5.2447E+03	6.2589E+03	1.8521E+01
-5.1619E+01	3.9990E+02	1.7124E+04	-8.8361E+04	6.5066E+04	3.0803E+05	-5.2447E+03	5.8677E+03	2.2250E-01
-5.1619E+01	3.4277E+02	1.0977E+04	-8.8361E+04	5.8559E+04	5.0812E+05	-5.2447E+03	5.4766E+03	2.0969E+01
-5.1619E+01	2.8564E+02	1.8385E+04	-8.8361E+04	5.2052E+04	7.9302E+05	-5.2447E+03	5.0854E+03	2.8153E+02
-5.1619E+01	2.2852E+02	4.5690E+04	-8.8361E+04	4.5546E+04	1.0197E+06	-5.2447E+03	4.6942E+03	2.1519E+01
-5.1619E+01	1.7139E+02	1.1831E+05	-8.8361E+04	3.9039E+04	1.4292E+06	-5.2447E+03	4.3030E+03	5.5150E+01
-5.1619E+01	1.1426E+02	2.8575E+05	-8.8361E+04	3.2533E+04	1.9688E+06	-5.2447E+03	3.9118E+03	4.2481E+02
-5.1619E+01	5.7129E+01	1.6561E+06	-8.8361E+04	2.6026E+04	2.6454E+06	-5.2447E+03	3.5206E+03	2.3195E+02
-5.1619E+01	0.0000E+00	9.1198E+06	-8.8361E+04	1.9520E+04	3.5351E+06	-5.2447E+03	3.1295E+03	5.7968E+01
-1.1709E+02	1.8281E+03	1.7500E+00	-8.8361E+04	1.3013E+04	4.0134E+06	-5.2447E+03	2.7383E+03	1.7780E+03
-1.1709E+02	1.7139E+03	1.7500E+00	-8.8361E+04	6.5066E+03	4.8882E+06	-5.2447E+03	2.3471E+03	1.0536E+03
-1.1709E+02	1.6567E+03	6.2500E-01	-8.8361E+04	0.0000E+00	1.4417E+07	-5.2447E+03	1.9559E+03	1.8190E+03
-1.1709E+02	1.5425E+03	5.2500E+00	-9.5657E+04	1.8218E+05	7.0000E+02	-5.2447E+03	1.5647E+03	9.8781E+03
-1.1709E+02	1.4853E+03	8.7500E+00	-9.5657E+04	1.7568E+05	3.9237E+02	-5.2447E+03	1.1735E+03	1.1972E+04
-1.1709E+02	1.4282E+03	8.7360E+00	-9.5657E+04	1.6917E+05	5.4740E+02	-5.2447E+03	7.8236E+02	3.6884E+04
-1.1709E+02	1.3711E+03	2.4993E+01	-9.5657E+04	1.6266E+05	2.0900E+03	-5.2447E+03	3.9118E+02	1.0598E+05
-1.1709E+02	1.3140E+03	4.1250E+00	-9.5657E+04	1.5616E+05	3.5855E+02	-5.2447E+03	0.0000E+00	3.3445E+05
-1.1709E+02	1.2568E+03	1.4416E+01	-9.5657E+04	1.4965E+05	3.3820E+01	-5.7567E+03	1.4474E+04	6.2500E-01
-1.1709E+02	1.1997E+03	4.0956E+01	-9.5657E+04	1.4314E+05	1.6469E+03	-5.7567E+03	7.8236E+03	4.0492E-01
-1.1709E+02	1.1426E+03	2.2251E+01	-9.5657E+04	1.3664E+05	3.1684E+03	-5.7567E+03	6.2589E+03	2.0844E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.1709E+02	1.0854E+03	3.1429E+01	-9.5657E+04	1.3013E+05	4.5035E+03	-5.7567E+03	5.8677E+03	3.0734E+00
-1.1709E+02	1.0283E+03	2.6041E+01	-9.5657E+04	1.2362E+05	3.7113E+03	-5.7567E+03	5.4766E+03	1.1372E+01
-1.1709E+02	9.7119E+02	6.3169E+01	-9.5657E+04	1.1712E+05	9.5620E+03	-5.7567E+03	5.0854E+03	1.7293E+01
-1.1709E+02	9.1406E+02	3.3222E+01	-9.5657E+04	1.1061E+05	1.6367E+04	-5.7567E+03	4.6942E+03	2.4714E+00
-1.1709E+02	8.5693E+02	4.0999E+01	-9.5657E+04	1.0410E+05	2.4904E+04	-5.7567E+03	4.3030E+03	3.9439E+00
-1.1709E+02	7.9980E+02	1.0395E+02	-9.5657E+04	9.7598E+04	5.9342E+04	-5.7567E+03	3.9118E+03	1.8507E+01
-1.1709E+02	7.4267E+02	1.0099E+02	-9.5657E+04	9.1092E+04	7.9720E+04	-5.7567E+03	3.5206E+03	1.3099E+01
-1.1709E+02	6.8555E+02	1.0278E+02	-9.5657E+04	8.4585E+04	1.2146E+05	-5.7567E+03	3.1295E+03	8.7382E+00
-1.1709E+02	6.2842E+02	1.5741E+02	-9.5657E+04	7.8079E+04	2.3026E+05	-5.7567E+03	2.7383E+03	7.9877E+01
-1.1709E+02	5.7129E+02	1.2721E+02	-9.5657E+04	7.1572E+04	3.2770E+05	-5.7567E+03	2.3471E+03	4.6926E+01
-1.1709E+02	5.1416E+02	1.4037E+02	-9.5657E+04	6.5066E+04	5.2454E+05	-5.7567E+03	1.9559E+03	4.8597E+01
-1.1709E+02	4.5703E+02	3.8236E+02	-9.5657E+04	5.8559E+04	7.2896E+05	-5.7567E+03	1.5647E+03	2.1637E+02
-1.1709E+02	3.9990E+02	6.7810E+03	-9.5657E+04	5.2052E+04	1.1240E+06	-5.7567E+03	1.1735E+03	6.2860E+03
-1.1709E+02	3.4277E+02	2.5478E+03	-9.5657E+04	4.5546E+04	1.6003E+06	-5.7567E+03	7.8236E+02	1.3242E+03
-1.1709E+02	2.8564E+02	6.4696E+02	-9.5657E+04	3.9039E+04	2.3257E+06	-5.7567E+03	3.9118E+02	1.6829E+04
-1.1709E+02	2.2852E+02	1.1344E+04	-9.5657E+04	3.2533E+04	3.2734E+06	-5.7567E+03	0.0000E+00	8.0857E+04
-1.1709E+02	1.7139E+02	1.3671E+04	-9.5657E+04	2.6026E+04	4.5095E+06	-6.2687E+03	7.4325E+03	4.5232E+00
-1.1709E+02	1.1426E+02	3.7329E+04	-9.5657E+04	1.9520E+04	4.7410E+06	-6.2687E+03	6.6501E+03	1.1227E+01
-1.1709E+02	5.7129E+01	1.4353E+05	-9.5657E+04	1.3013E+04	5.0150E+06	-6.2687E+03	6.2589E+03	3.0920E+00
-1.1709E+02	0.0000E+00	6.6036E+05	-9.5657E+04	6.5066E+03	4.8444E+06	-6.2687E+03	5.4766E+03	6.2742E-01
-1.8256E+02	1.8852E+03	1.7500E+00	-9.5657E+04	0.0000E+00	1.4150E+07	-6.2687E+03	5.0854E+03	1.2324E+01
-1.8256E+02	1.7139E+03	5.2500E+00	-1.0295E+05	1.6917E+05	1.4000E+03	-6.2687E+03	4.6942E+03	5.4049E+00
-1.8256E+02	1.6567E+03	3.4304E+00	-1.0295E+05	1.6266E+05	2.1460E+03	-6.2687E+03	4.3030E+03	4.1486E+01
-1.8256E+02	1.5996E+03	1.6804E+00	-1.0295E+05	1.5616E+05	6.2377E+02	-6.2687E+03	3.9118E+03	1.4872E+01
-1.8256E+02	1.5425E+03	1.7500E+00	-1.0295E+05	1.4965E+05	2.3140E+02	-6.2687E+03	3.5206E+03	1.5908E+01
-1.8256E+02	1.4853E+03	5.2500E+00	-1.0295E+05	1.4314E+05	6.3326E+03	-6.2687E+03	3.1295E+03	7.6274E+00
-1.8256E+02	1.4282E+03	8.1108E+00	-1.0295E+05	1.3664E+05	5.0783E+03	-6.2687E+03	2.7383E+03	2.1205E+02
-1.8256E+02	1.3711E+03	1.6305E+01	-1.0295E+05	1.3013E+05	9.5409E+03	-6.2687E+03	2.3471E+03	4.3775E+01
-1.8256E+02	1.3140E+03	1.0500E+01	-1.0295E+05	1.2362E+05	1.3097E+04	-6.2687E+03	1.9559E+03	2.6115E+01
-1.8256E+02	1.2568E+03	1.2041E+01	-1.0295E+05	1.1712E+05	1.8325E+04	-6.2687E+03	1.5647E+03	2.0232E+01
-1.8256E+02	1.1997E+03	2.1709E+01	-1.0295E+05	1.1061E+05	2.6331E+04	-6.2687E+03	1.1735E+03	2.6585E+01
-1.8256E+02	1.1426E+03	1.5680E+01	-1.0295E+05	1.0410E+05	3.8035E+04	-6.2687E+03	7.8236E+02	7.5504E+01
-1.8256E+02	1.0854E+03	4.5071E+01	-1.0295E+05	9.7598E+04	6.4593E+04	-6.2687E+03	3.9118E+02	4.0349E+03
-1.8256E+02	1.0283E+03	1.6791E+01	-1.0295E+05	9.1092E+04	8.4452E+04	-6.2687E+03	0.0000E+00	1.7325E+04
-1.8256E+02	9.7119E+02	3.6611E+01	-1.0295E+05	8.4585E+04	1.3593E+05	-6.7806E+03	8.2148E+03	1.2500E+00
-1.8256E+02	9.1406E+02	3.2693E+01	-1.0295E+05	7.8079E+04	2.5717E+05	-6.7806E+03	7.0413E+03	1.1125E-01
-1.8256E+02	8.5693E+02	2.7972E+01	-1.0295E+05	7.1572E+04	3.2848E+05	-6.7806E+03	6.6501E+03	4.0492E-01
-1.8256E+02	7.9980E+02	5.1304E+01	-1.0295E+05	6.5066E+04	6.2407E+05	-6.7806E+03	5.8677E+03	2.0833E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.8256E+02	7.4267E+02	5.2576E+01	-1.0295E+05	5.8559E+04	9.6849E+05	-6.7806E+03	5.4766E+03	2.3602E+00
-1.8256E+02	6.8555E+02	4.5075E+01	-1.0295E+05	5.2052E+04	1.5001E+06	-6.7806E+03	4.6942E+03	2.7960E+00
-1.8256E+02	6.2842E+02	3.3554E+01	-1.0295E+05	4.5546E+04	2.3673E+06	-6.7806E+03	4.3030E+03	9.4167E+00
-1.8256E+02	5.7129E+02	6.6384E+01	-1.0295E+05	3.9039E+04	3.3671E+06	-6.7806E+03	3.9118E+03	1.0862E+01
-1.8256E+02	5.1416E+02	1.0607E+02	-1.0295E+05	3.2533E+04	4.7351E+06	-6.7806E+03	3.5206E+03	4.5082E+00
-1.8256E+02	4.5703E+02	5.3527E+01	-1.0295E+05	2.6026E+04	5.8966E+06	-6.7806E+03	3.1295E+03	4.0492E-01
-1.8256E+02	3.9990E+02	2.0024E+02	-1.0295E+05	1.9520E+04	5.7929E+06	-6.7806E+03	2.7383E+03	1.1616E+01
-1.8256E+02	3.4277E+02	1.0882E+02	-1.0295E+05	1.3013E+04	5.7429E+06	-6.7806E+03	2.3471E+03	3.2791E+01
-1.8256E+02	2.8564E+02	4.3530E+03	-1.0295E+05	6.5066E+03	5.4118E+06	-6.7806E+03	1.9559E+03	1.6609E+00
-1.8256E+02	2.2852E+02	2.1975E+02	-1.0295E+05	0.0000E+00	1.4564E+07	-6.7806E+03	1.5647E+03	3.6102E+00
-1.8256E+02	1.7139E+02	1.0679E+04	-1.1025E+05	1.8218E+05	3.5855E+02	-6.7806E+03	1.1735E+03	4.5975E+01
-1.8256E+02	1.1426E+02	4.5464E+03	-1.1025E+05	1.6917E+05	7.6980E+01	-6.7806E+03	7.8236E+02	8.2875E+01
-1.8256E+02	5.7129E+01	1.8449E+04	-1.1025E+05	1.6266E+05	1.5442E+02	-6.7806E+03	3.9118E+02	3.1917E+03
-1.8256E+02	0.0000E+00	7.4126E+04	-1.1025E+05	1.5616E+05	1.6717E+03	-6.7806E+03	0.0000E+00	4.0216E+03
-2.4802E+02	1.8281E+03	1.7500E+00	-1.1025E+05	1.4965E+05	2.4251E+03	-7.2926E+03	5.0854E+03	9.0118E+00
-2.4802E+02	1.7710E+03	3.5000E+00	-1.1025E+05	1.4314E+05	5.3871E+03	-7.2926E+03	4.3030E+03	1.1125E-01
-2.4802E+02	1.5996E+03	3.5000E+00	-1.1025E+05	1.3664E+05	1.3947E+03	-7.2926E+03	3.1295E+03	8.5157E+00
-2.4802E+02	1.5425E+03	5.2500E+00	-1.1025E+05	1.3013E+05	8.0699E+03	-7.2926E+03	2.7383E+03	1.6573E+00
-2.4802E+02	1.4853E+03	3.5000E+00	-1.1025E+05	1.2362E+05	2.4887E+04	-7.2926E+03	2.3471E+03	1.4464E+01
-2.4802E+02	1.4282E+03	1.7500E+00	-1.1025E+05	1.1712E+05	2.7685E+04	-7.2926E+03	1.9559E+03	7.0721E+00
-2.4802E+02	1.3711E+03	5.6662E+00	-1.1025E+05	1.1061E+05	3.7198E+04	-7.2926E+03	1.5647E+03	4.0492E-01
-2.4802E+02	1.3140E+03	8.4020E+00	-1.1025E+05	1.0410E+05	7.3652E+04	-7.2926E+03	1.1735E+03	1.4417E+01
-2.4802E+02	1.2568E+03	6.7912E+00	-1.1025E+05	9.7598E+04	7.8096E+04	-7.2926E+03	7.8236E+02	1.1854E+01
-2.4802E+02	1.1997E+03	1.3722E+01	-1.1025E+05	9.1092E+04	1.1268E+05	-7.2926E+03	3.9118E+02	1.6997E+01
-2.4802E+02	1.1426E+03	1.1972E+01	-1.1025E+05	8.4585E+04	1.9662E+05	-7.2926E+03	0.0000E+00	4.5783E+02
-2.4802E+02	1.0854E+03	7.0000E+00	-1.1025E+05	7.8079E+04	2.4521E+05	-7.8046E+03	6.2589E+03	3.3608E+00
-2.4802E+02	1.0283E+03	1.0430E+01	-1.1025E+05	7.1572E+04	4.6778E+05	-7.8046E+03	5.4766E+03	1.2500E+00
-2.4802E+02	9.7119E+02	1.5402E+01	-1.1025E+05	6.5066E+04	7.5759E+05	-7.8046E+03	5.0854E+03	1.1125E-01
-2.4802E+02	9.1406E+02	2.0582E+01	-1.1025E+05	5.8559E+04	1.1398E+06	-7.8046E+03	3.9118E+03	6.7216E+00
-2.4802E+02	8.5693E+02	2.5763E+01	-1.1025E+05	5.2052E+04	1.7074E+06	-7.8046E+03	3.1295E+03	1.1125E-01
-2.4802E+02	7.9980E+02	3.0382E+01	-1.1025E+05	4.5546E+04	2.8401E+06	-7.8046E+03	2.7383E+03	3.4720E+00
-2.4802E+02	7.4267E+02	6.0346E+01	-1.1025E+05	3.9039E+04	3.9190E+06	-7.8046E+03	1.5647E+03	2.3602E+00
-2.4802E+02	6.8555E+02	1.7361E+01	-1.1025E+05	3.2533E+04	5.2683E+06	-7.8046E+03	1.1735E+03	8.7214E+00
-2.4802E+02	6.2842E+02	4.8686E+01	-1.1025E+05	2.6026E+04	6.8427E+06	-7.8046E+03	7.8236E+02	5.8602E+00
-2.4802E+02	5.7129E+02	3.4694E+01	-1.1025E+05	1.9520E+04	6.9662E+06	-7.8046E+03	3.9118E+02	2.0043E+01
-2.4802E+02	5.1416E+02	3.7665E+01	-1.1025E+05	1.3013E+04	6.3830E+06	-7.8046E+03	0.0000E+00	1.1914E+02
-2.4802E+02	4.5703E+02	3.6327E+01	-1.1025E+05	6.5066E+03	5.2067E+06	-8.3165E+03	5.8677E+03	1.2500E+00
-2.4802E+02	3.9990E+02	3.2193E+01	-1.1025E+05	0.0000E+00	1.4544E+07	-8.3165E+03	2.3471E+03	1.2500E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.4802E+02	3.4277E+02	4.1666E+01	-1.1754E+05	1.5616E+05	1.0585E+03	-8.3165E+03	1.5647E+03	1.5460E+00
-2.4802E+02	2.8564E+02	2.0443E+01	-1.1754E+05	1.4965E+05	4.5394E+03	-8.3165E+03	7.8236E+02	2.3602E+00
-2.4802E+02	2.2852E+02	4.1165E+01	-1.1754E+05	1.4314E+05	2.3400E+03	-8.3165E+03	3.9118E+02	2.1471E+02
-2.4802E+02	1.7139E+02	7.1174E+01	-1.1754E+05	1.3664E+05	1.1695E+04	-8.3165E+03	0.0000E+00	4.1345E+01
-2.4802E+02	1.1426E+02	1.6482E+02	-1.1754E+05	1.3013E+05	1.2401E+04	-8.8285E+03	5.0854E+03	1.1125E-01
-2.4802E+02	5.7129E+01	4.5148E+03	-1.1754E+05	1.2362E+05	3.1169E+04	-8.8285E+03	2.7383E+03	1.2500E+00
-2.4802E+02	0.0000E+00	2.3334E+04	-1.1754E+05	1.1712E+05	2.0854E+04	-8.8285E+03	1.5647E+03	4.0492E-01
-3.1349E+02	1.9424E+03	1.7500E+00	-1.1754E+05	1.1061E+05	3.9813E+04	-8.8285E+03	7.8236E+02	2.2250E-01
-3.1349E+02	1.8852E+03	1.7500E+00	-1.1754E+05	1.0410E+05	8.2736E+04	-8.8285E+03	3.9118E+02	1.1125E-01
-3.1349E+02	1.6567E+03	1.7500E+00	-1.1754E+05	9.7598E+04	6.9173E+04	-8.8285E+03	0.0000E+00	1.5088E+01
-3.1349E+02	1.5996E+03	1.6804E+00	-1.1754E+05	9.1092E+04	1.1905E+05	-9.3405E+03	7.8236E+02	3.3608E+00
-3.1349E+02	1.4853E+03	1.0361E+01	-1.1754E+05	8.4585E+04	2.1466E+05	-9.3405E+03	3.9118E+02	1.2622E+01
-3.1349E+02	1.3711E+03	1.6804E+00	-1.1754E+05	7.8079E+04	3.1088E+05	-9.3405E+03	0.0000E+00	1.2593E+00
-3.1349E+02	1.3140E+03	5.2500E+00	-1.1754E+05	7.1572E+04	4.7413E+05	-9.8524E+03	5.0854E+03	1.1125E-01
-3.1349E+02	1.1997E+03	1.2111E+01	-1.1754E+05	6.5066E+04	6.4229E+05	-9.8524E+03	7.8236E+02	1.1125E-01
-3.1349E+02	1.1426E+03	1.7500E+00	-1.1754E+05	5.8559E+04	1.1025E+06	-9.8524E+03	0.0000E+00	9.5661E+00
-3.1349E+02	1.0854E+03	1.1611E+01	-1.1754E+05	5.2052E+04	1.7443E+06	-1.0364E+04	3.9118E+02	1.2500E+00
-3.1349E+02	1.0283E+03	6.3608E+00	-1.1754E+05	4.5546E+04	2.8089E+06	-1.0364E+04	0.0000E+00	2.4671E+00
-3.1349E+02	9.7119E+02	2.0021E+01	-1.1754E+05	3.9039E+04	4.3796E+06	-1.0876E+04	0.0000E+00	1.1125E-01
-3.1349E+02	9.1406E+02	1.0361E+01	-1.1754E+05	3.2533E+04	5.5203E+06			
-3.1349E+02	8.5693E+02	1.3722E+01	-1.1754E+05	2.6026E+04	6.7163E+06			
-3.1349E+02	7.9980E+02	7.0000E+00	-1.1754E+05	1.9520E+04	7.1063E+06			
-3.1349E+02	7.4267E+02	1.4000E+01	-1.1754E+05	1.3013E+04	6.4907E+06			
-3.1349E+02	6.8555E+02	2.0722E+01	-1.1754E+05	6.5066E+03	5.2127E+06			
-3.1349E+02	6.2842E+02	1.0222E+01	-1.1754E+05	0.0000E+00	1.5412E+07			
-3.1349E+02	5.7129E+02	1.3554E+01	-1.2484E+05	1.5616E+05	1.0585E+03			
-3.1349E+02	5.1416E+02	2.7554E+01	-1.2484E+05	1.4965E+05	1.7756E+03			
-3.1349E+02	4.5703E+02	1.8332E+01	-1.2484E+05	1.4314E+05	2.0319E+03			
-3.1349E+02	3.9990E+02	3.1082E+01	-1.2484E+05	1.3664E+05	5.6167E+03			
-3.1349E+02	3.4277E+02	4.9985E+01	-1.2484E+05	1.3013E+05	3.9443E+03			
-3.1349E+02	2.8564E+02	2.1804E+01	-1.2484E+05	1.2362E+05	1.2956E+04			
-3.1349E+02	2.2852E+02	3.0498E+01	-1.2484E+05	1.1712E+05	3.2407E+04			
-3.1349E+02	1.7139E+02	3.3998E+01	-1.2484E+05	1.1061E+05	2.7206E+04			
-3.1349E+02	1.1426E+02	4.7608E+01	-1.2484E+05	1.0410E+05	5.6002E+04			
-3.1349E+02	5.7129E+01	2.8710E+02	-1.2484E+05	9.7598E+04	1.0322E+05			
-3.1349E+02	0.0000E+00	6.4293E+03	-1.2484E+05	9.1092E+04	1.4441E+05			
-3.7896E+02	1.8281E+03	1.7500E+00	-1.2484E+05	8.4585E+04	2.4964E+05			
-3.7896E+02	1.7139E+03	1.7500E+00	-1.2484E+05	7.8079E+04	3.0774E+05			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.7896E+02	1.5425E+03	1.6804E+00	-1.2484E+05	7.1572E+04	5.4505E+05			
-3.7896E+02	1.3711E+03	1.7500E+00	-1.2484E+05	6.5066E+04	7.7532E+05			
-3.7896E+02	1.2568E+03	6.7216E+00	-1.2484E+05	5.8559E+04	1.2740E+06			
-3.7896E+02	1.1997E+03	3.5000E+00	-1.2484E+05	5.2052E+04	1.7735E+06			
-3.7896E+02	1.0854E+03	3.5000E+00	-1.2484E+05	4.5546E+04	2.9007E+06			
-3.7896E+02	1.0283E+03	8.6804E+00	-1.2484E+05	3.9039E+04	4.0162E+06			
-3.7896E+02	9.7119E+02	1.6382E+01	-1.2484E+05	3.2533E+04	5.4963E+06			
-3.7896E+02	9.1406E+02	1.0361E+01	-1.2484E+05	2.6026E+04	6.4011E+06			
-3.7896E+02	8.5693E+02	7.0000E+00	-1.2484E+05	1.9520E+04	6.6404E+06			
-3.7896E+02	7.9980E+02	3.5000E+00	-1.2484E+05	1.3013E+04	6.1518E+06			
-3.7896E+02	7.4267E+02	7.0000E+00	-1.2484E+05	6.5066E+03	4.4806E+06			
-3.7896E+02	6.8555E+02	1.0361E+01	-1.2484E+05	0.0000E+00	1.4810E+07			
-3.7896E+02	6.2842E+02	1.0361E+01	-1.3214E+05	1.4965E+05	1.0585E+03			
-3.7896E+02	5.7129E+02	3.3608E+00	-1.3214E+05	1.3664E+05	1.6887E+03			
-3.7896E+02	5.1416E+02	3.5000E+00	-1.3214E+05	1.3013E+05	1.7372E+03			
-3.7896E+02	4.5703E+02	1.3443E+01	-1.3214E+05	1.2362E+05	6.1464E+03			
-3.7896E+02	3.9990E+02	2.0582E+01	-1.3214E+05	1.1712E+05	2.0846E+04			
-3.7896E+02	3.4277E+02	3.7915E+01	-1.3214E+05	1.1061E+05	2.9772E+04			
-3.7896E+02	2.8564E+02	4.3547E+01	-1.3214E+05	1.0410E+05	5.2908E+04			
-3.7896E+02	2.2852E+02	2.7304E+01	-1.3214E+05	9.7598E+04	1.0297E+05			
-3.7896E+02	1.7139E+02	4.0970E+01	-1.3214E+05	9.1092E+04	1.4042E+05			
-3.7896E+02	1.1426E+02	8.0339E+01	-1.3214E+05	8.4585E+04	2.0958E+05			
-3.7896E+02	5.7129E+01	1.5849E+02	-1.3214E+05	7.8079E+04	3.3352E+05			
-3.7896E+02	0.0000E+00	3.3208E+02	-1.3214E+05	7.1572E+04	5.6377E+05			
-4.4443E+02	1.5996E+03	3.5000E+00	-1.3214E+05	6.5066E+04	9.3533E+05			
-4.4443E+02	1.5425E+03	1.6804E+00	-1.3214E+05	5.8559E+04	1.2694E+06			
-4.4443E+02	1.4853E+03	1.7500E+00	-1.3214E+05	5.2052E+04	1.9732E+06			
-4.4443E+02	1.4282E+03	3.5000E+00	-1.3214E+05	4.5546E+04	3.1874E+06			
-4.4443E+02	9.7119E+02	3.5000E+00	-1.3214E+05	3.9039E+04	4.5079E+06			
-4.4443E+02	7.4267E+02	3.5000E+00	-1.3214E+05	3.2533E+04	5.5432E+06			
-4.4443E+02	6.8555E+02	3.3608E+00	-1.3214E+05	2.6026E+04	6.4251E+06			
-4.4443E+02	6.2842E+02	6.8608E+00	-1.3214E+05	1.9520E+04	6.4695E+06			
-4.4443E+02	5.7129E+02	1.3582E+01	-1.3214E+05	1.3013E+04	5.6184E+06			
-4.4443E+02	5.1416E+02	6.8608E+00	-1.3214E+05	6.5066E+03	4.7101E+06			
-4.4443E+02	4.5703E+02	3.5000E+00	-1.3214E+05	0.0000E+00	1.4048E+07			
-4.4443E+02	3.9990E+02	1.4972E+01	-1.3943E+05	1.2362E+05	2.7816E+02			
-4.4443E+02	3.4277E+02	1.6804E+01	-1.3943E+05	1.1712E+05	1.0372E+03			
-4.4443E+02	2.8564E+02	1.0222E+01	-1.3943E+05	1.1061E+05	7.4798E+03			

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-4.4443E+02	2.2852E+02	1.7222E+01	-1.3943E+05	1.0410E+05	1.2817E+04			
-4.4443E+02	1.7139E+02	4.0747E+01	-1.3943E+05	9.7598E+04	2.8770E+04			
-4.4443E+02	1.1426E+02	9.6442E+01	-1.3943E+05	9.1092E+04	8.8067E+04			
-4.4443E+02	5.7129E+01	7.1212E+01	-1.3943E+05	8.4585E+04	1.1333E+05			
-4.4443E+02	0.0000E+00	1.4259E+02	-1.3943E+05	7.8079E+04	1.8578E+05			
-5.0990E+02	9.7119E+02	3.5000E+00	-1.3943E+05	7.1572E+04	2.8810E+05			
-5.0990E+02	6.8555E+02	3.3608E+00	-1.3943E+05	6.5066E+04	6.3852E+05			
-5.0990E+02	5.1416E+02	3.3608E+00	-1.3943E+05	5.8559E+04	9.8660E+05			
-5.0990E+02	4.5703E+02	6.8608E+00	-1.3943E+05	5.2052E+04	1.6042E+06			
-5.0990E+02	3.9990E+02	3.3608E+00	-1.3943E+05	4.5546E+04	2.7385E+06			
-5.0990E+02	3.4277E+02	6.7216E+00	-1.3943E+05	3.9039E+04	3.8381E+06			
-5.0990E+02	2.8564E+02	1.0082E+01	-1.3943E+05	3.2533E+04	4.8492E+06			
-5.0990E+02	2.2852E+02	1.0082E+01	-1.3943E+05	2.6026E+04	5.9413E+06			
-5.0990E+02	1.7139E+02	2.3943E+01	-1.3943E+05	1.9520E+04	6.3536E+06			
-5.0990E+02	1.1426E+02	1.7082E+01	-1.3943E+05	1.3013E+04	5.7873E+06			
-5.0990E+02	5.7129E+01	5.2497E+01	-1.3943E+05	6.5066E+03	4.8777E+06			
-5.0990E+02	0.0000E+00	1.6766E+02	-1.3943E+05	0.0000E+00	1.3890E+07			
-5.7537E+02	6.2842E+02	3.3608E+00	-1.4673E+05	1.1712E+05	2.7165E+02			
-5.7537E+02	3.9990E+02	1.0222E+01	-1.4673E+05	9.7598E+04	4.8906E+03			
-5.7537E+02	3.4277E+02	6.7216E+00	-1.4673E+05	9.1092E+04	1.6254E+03			
-5.7537E+02	2.2852E+02	1.0082E+01	-1.4673E+05	8.4585E+04	2.8910E+03			
-5.7537E+02	1.7139E+02	2.3776E+01	-1.4673E+05	7.8079E+04	3.4762E+04			
-5.7537E+02	1.1426E+02	2.7026E+01	-1.4673E+05	7.1572E+04	5.9358E+04			
-5.7537E+02	5.7129E+01	5.1629E+01	-1.4673E+05	6.5066E+04	1.8992E+05			
-5.7537E+02	0.0000E+00	4.8331E+01	-1.4673E+05	5.8559E+04	4.2456E+05			
-6.4084E+02	4.5703E+02	3.3608E+00	-1.4673E+05	5.2052E+04	7.2346E+05			
-6.4084E+02	3.4277E+02	3.3608E+00	-1.4673E+05	4.5546E+04	1.3642E+06			
-6.4084E+02	2.2852E+02	1.1125E-01	-1.4673E+05	3.9039E+04	2.1710E+06			
-6.4084E+02	1.7139E+02	3.3608E+00	-1.4673E+05	3.2533E+04	2.9638E+06			
-6.4084E+02	1.1426E+02	2.3804E+01	-1.4673E+05	2.6026E+04	4.2261E+06			
-6.4084E+02	5.7129E+01	3.1776E+01	-1.4673E+05	1.9520E+04	4.3954E+06			
-6.4084E+02	0.0000E+00	4.9132E+01	-1.4673E+05	1.3013E+04	4.2282E+06			
-7.0630E+02	5.7129E+02	3.3608E+00	-1.4673E+05	6.5066E+03	3.6841E+06			
-7.0630E+02	3.9990E+02	3.3608E+00	-1.4673E+05	0.0000E+00	1.0918E+07			
-7.0630E+02	2.2852E+02	3.3608E+00	-1.5402E+05	6.5066E+04	3.3021E+04			
-7.0630E+02	1.7139E+02	6.7216E+00	-1.5402E+05	5.8559E+04	1.0947E+05			
-7.0630E+02	1.1426E+02	1.0222E+01	-1.5402E+05	5.2052E+04	1.8974E+05			
-7.0630E+02	5.7129E+01	2.5054E+01	-1.5402E+05	4.5546E+04	5.1326E+05			

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Denmark A/S Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-7.0630E+02	0.0000E+00	1.4972E+01	-1.5402E+05	3.9039E+04	8.7142E+05			
-7.7177E+02	2.2852E+02	6.7216E+00	-1.5402E+05	3.2533E+04	1.3519E+06			
-7.7177E+02	1.1426E+02	3.3608E+00	-1.5402E+05	2.6026E+04	2.1248E+06			
-7.7177E+02	0.0000E+00	3.5271E+01	-1.5402E+05	1.9520E+04	2.3063E+06			
-8.3724E+02	3.9990E+02	3.3608E+00	-1.5402E+05	1.3013E+04	2.3470E+06			
-8.3724E+02	3.4277E+02	3.3608E+00	-1.5402E+05	6.5066E+03	1.9638E+06			
-8.3724E+02	1.7139E+02	6.8608E+00	-1.5402E+05	0.0000E+00	5.6865E+06			
-8.3724E+02	5.7129E+01	3.3608E+00	-1.6132E+05	7.8079E+04	1.6804E+00			
-8.3724E+02	0.0000E+00	1.0361E+01	-1.6132E+05	6.5066E+04	9.5829E+03			
-9.6818E+02	5.7129E+01	6.7216E+00	-1.6132E+05	5.2052E+04	3.8778E+04			
-9.6818E+02	0.0000E+00	3.3608E+00	-1.6132E+05	4.5546E+04	1.5920E+04			
-1.0336E+03	5.7129E+01	3.3608E+00	-1.6132E+05	3.9039E+04	6.0803E+04			
			-1.6132E+05	3.2533E+04	1.8217E+05			
			-1.6132E+05	2.6026E+04	2.9436E+05			
			-1.6132E+05	1.9520E+04	3.8859E+05			
			-1.6132E+05	1.3013E+04	4.7793E+05			
			-1.6132E+05	6.5066E+03	3.0809E+05			
			-1.6132E+05	0.0000E+00	1.8058E+06			
			-1.6861E+05	3.9039E+04	2.0744E+03			
			-1.6861E+05	3.2533E+04	3.0884E+02			
			-1.6861E+05	2.6026E+04	2.5912E+04			
			-1.6861E+05	1.9520E+04	2.3859E+04			
			-1.6861E+05	1.3013E+04	1.8930E+04			
			-1.6861E+05	6.5066E+03	1.5717E+04			
			-1.6861E+05	0.0000E+00	2.4635E+05			
			-1.7591E+05	0.0000E+00	3.5565E+04			
			-1.8321E+05	6.5066E+03	1.6804E+00			
			-1.8321E+05	0.0000E+00	1.4880E+03			

Table 5-14 [4] Markov Matrix

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Appendix G. Markov matrices – issued from [5]

This appendix contains the Markov Matrices for the shear force, the bending moment and the torsional moment in the bottom of the tower, from ref. [5]. Foundation design must be verified for the most critical Markov matrices.

Markov Matrices								
Tower shear, bottom F_y [kN]			**Tower bending, bottom M_x [kNm]**			**Tower torsion, bottom M_z [kNm]**		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.7809E+03	0.0000E+00	2.1020E+01	1.4758E+05	6.5285E+03	2.6717E+00	8.0968E+03	0.0000E+00	2.6717E+00
1.3916E+03	5.2962E+01	5.4112E+01	1.4068E+05	0.0000E+00	2.6717E+00	7.6281E+03	8.0834E+02	2.1020E+01
1.3916E+03	0.0000E+00	9.5619E+02	1.3379E+05	0.0000E+00	2.6717E+00	7.6281E+03	4.0417E+02	2.6717E+00
1.3268E+03	5.2962E+01	1.8214E+03	1.2689E+05	0.0000E+00	2.6717E+00	7.6281E+03	0.0000E+00	2.6717E+00
1.3268E+03	0.0000E+00	5.6821E+03	1.1999E+05	6.5285E+03	1.0625E-01	7.1594E+03	8.0834E+02	8.0260E+01
1.2619E+03	1.0592E+02	6.4257E+01	1.1999E+05	0.0000E+00	8.0151E+00	7.1594E+03	0.0000E+00	3.5000E+00
1.2619E+03	5.2962E+01	6.9322E+03	1.1309E+05	6.5285E+03	2.6717E+00	6.6907E+03	2.0209E+03	3.5000E+00
1.2619E+03	0.0000E+00	1.4774E+04	1.1309E+05	0.0000E+00	5.4496E+00	6.6907E+03	8.0834E+02	3.5000E+00
1.1970E+03	2.1185E+02	1.4046E+02	1.0619E+05	6.5285E+03	5.3434E+00	6.2221E+03	8.0834E+02	1.2629E+01
1.1970E+03	1.5888E+02	1.4995E+03	1.0619E+05	0.0000E+00	2.2202E+01	6.2221E+03	4.0417E+02	2.8091E+02
1.1970E+03	1.0592E+02	7.5154E+03	9.9297E+04	1.3057E+04	2.6717E+00	6.2221E+03	0.0000E+00	2.0161E+03
1.1970E+03	5.2962E+01	2.5460E+04	9.9297E+04	6.5285E+03	8.8434E+00	5.7534E+03	3.2334E+03	2.6717E+00
1.1970E+03	0.0000E+00	8.3441E+04	9.9297E+04	0.0000E+00	3.2515E+01	5.7534E+03	2.8292E+03	9.9571E+00
1.1321E+03	3.1777E+02	2.6717E+00	9.2400E+04	1.9585E+04	3.5000E+00	5.7534E+03	2.4250E+03	9.9571E+00
1.1321E+03	2.6481E+02	7.1471E+02	9.2400E+04	1.3057E+04	3.5000E+00	5.7534E+03	1.6167E+03	1.2500E+00
1.1321E+03	2.1185E+02	3.9606E+03	9.2400E+04	6.5285E+03	1.2343E+01	5.7534E+03	8.0834E+02	2.7310E+03
1.1321E+03	1.5888E+02	6.8751E+03	9.2400E+04	0.0000E+00	9.7109E+01	5.7534E+03	4.0417E+02	3.4916E+03
1.1321E+03	1.0592E+02	4.4334E+04	8.5502E+04	2.6114E+04	7.0000E+00	5.7534E+03	0.0000E+00	1.2962E+04
1.1321E+03	5.2962E+01	2.0189E+05	8.5502E+04	1.9585E+04	3.5000E+00	5.2847E+03	2.8292E+03	1.4237E+01
1.1321E+03	0.0000E+00	3.0073E+05	8.5502E+04	1.3057E+04	6.0000E+00	5.2847E+03	2.0209E+03	1.9914E+01
1.0673E+03	8.4739E+02	1.7124E+02	8.5502E+04	6.5285E+03	1.7500E+01	5.2847E+03	1.6167E+03	1.7124E+02
1.0673E+03	3.7073E+02	4.7435E+02	8.5502E+04	0.0000E+00	4.1593E+01	5.2847E+03	1.2125E+03	1.0737E+01
1.0673E+03	3.1777E+02	4.0130E+01	7.8605E+04	1.9585E+04	6.1717E+00	5.2847E+03	8.0834E+02	2.2970E+03
1.0673E+03	2.6481E+02	1.1522E+04	7.8605E+04	1.3057E+04	1.5015E+01	5.2847E+03	4.0417E+02	2.6612E+03
1.0673E+03	2.1185E+02	1.7959E+04	7.8605E+04	6.5285E+03	1.9343E+01	5.2847E+03	0.0000E+00	2.8853E+04
1.0673E+03	1.5888E+02	7.1708E+04	7.8605E+04	0.0000E+00	7.1682E+01	4.8161E+03	6.8709E+03	1.0625E-01
1.0673E+03	1.0592E+02	3.0400E+05	7.1707E+04	2.6114E+04	2.6717E+00	4.8161E+03	6.0626E+03	2.6717E+00
1.0673E+03	5.2962E+01	7.3893E+05	7.1707E+04	1.3057E+04	6.1717E+00	4.8161E+03	5.2542E+03	2.6717E+00
1.0673E+03	0.0000E+00	1.3496E+06	7.1707E+04	6.5285E+03	3.5104E+01	4.8161E+03	4.8500E+03	1.4441E+01
1.0024E+03	7.4146E+02	9.0092E+02	7.1707E+04	0.0000E+00	5.1622E+01	4.8161E+03	4.4459E+03	1.8882E+00
1.0024E+03	6.3554E+02	4.7429E+02	6.4810E+04	1.6974E+05	1.3359E+00	4.8161E+03	4.0417E+03	9.9571E+00
1.0024E+03	5.8258E+02	9.4602E+02	6.4810E+04	3.2642E+04	2.6717E+00	4.8161E+03	3.6375E+03	2.7056E+01
1.0024E+03	5.2962E+02	9.1540E+03	6.4810E+04	2.6114E+04	8.8434E+00	4.8161E+03	2.8292E+03	2.7633E+01
1.0024E+03	4.7665E+02	3.7767E+03	6.4810E+04	1.9585E+04	5.1717E+00	4.8161E+03	2.4250E+03	1.0625E-01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0024E+03	4.2369E+02	1.4379E+04	6.4810E+04	1.3057E+04	1.2871E+01	4.8161E+03	2.0209E+03	4.7500E+00
1.0024E+03	3.7073E+02	1.9341E+04	6.4810E+04	6.5285E+03	4.2525E+01	4.8161E+03	1.6167E+03	2.7390E+03
1.0024E+03	3.1777E+02	3.0445E+04	6.4810E+04	0.0000E+00	5.7940E+01	4.8161E+03	1.2125E+03	1.0042E+04
1.0024E+03	2.6481E+02	4.9028E+04	5.7912E+04	1.7627E+05	1.3359E+00	4.8161E+03	8.0834E+02	1.4411E+04
1.0024E+03	2.1185E+02	1.5183E+05	5.7912E+04	1.6321E+05	1.3359E+00	4.8161E+03	4.0417E+02	6.9721E+04
1.0024E+03	1.5888E+02	4.4470E+05	5.7912E+04	1.5668E+05	5.3434E+00	4.8161E+03	0.0000E+00	1.4710E+05
1.0024E+03	1.0592E+02	1.1061E+06	5.7912E+04	1.4363E+05	1.3359E+00	4.3474E+03	7.2751E+03	1.0625E-01
1.0024E+03	5.2962E+01	3.1201E+06	5.7912E+04	1.3710E+05	1.3359E+00	4.3474E+03	6.0626E+03	7.2371E+00
1.0024E+03	0.0000E+00	4.5233E+06	5.7912E+04	8.4870E+04	2.6717E+00	4.3474E+03	5.6584E+03	2.1020E+01
9.3753E+02	1.0063E+03	5.7983E+02	5.7912E+04	7.1813E+04	3.5000E+00	4.3474E+03	5.2542E+03	2.9956E+00
9.3753E+02	9.5331E+02	6.5385E+02	5.7912E+04	5.2228E+04	2.6717E+00	4.3474E+03	3.6375E+03	8.7614E+02
9.3753E+02	9.0035E+02	9.4335E+02	5.7912E+04	1.9585E+04	7.0000E+00	4.3474E+03	2.8292E+03	3.3510E+03
9.3753E+02	8.4739E+02	8.8557E+03	5.7912E+04	1.3057E+04	1.5672E+01	4.3474E+03	2.4250E+03	9.7997E+02
9.3753E+02	7.9442E+02	1.0409E+04	5.7912E+04	6.5285E+03	4.6049E+01	4.3474E+03	2.0209E+03	2.2980E+03
9.3753E+02	7.4146E+02	1.4562E+04	5.7912E+04	0.0000E+00	6.9801E+01	4.3474E+03	1.6167E+03	1.5226E+04
9.3753E+02	6.8850E+02	3.0581E+04	5.1015E+04	1.6321E+05	1.3359E+00	4.3474E+03	1.2125E+03	1.6448E+04
9.3753E+02	6.3554E+02	6.2821E+04	5.1015E+04	1.5668E+05	1.3359E+00	4.3474E+03	8.0834E+02	6.6528E+04
9.3753E+02	5.8258E+02	1.2371E+05	5.1015E+04	1.4363E+05	1.3359E+00	4.3474E+03	4.0417E+02	1.1398E+05
9.3753E+02	5.2962E+02	1.7041E+05	5.1015E+04	1.3710E+05	1.7500E+00	4.3474E+03	0.0000E+00	4.8757E+05
9.3753E+02	4.7665E+02	2.7879E+05	5.1015E+04	1.3057E+05	1.3359E+00	3.8787E+03	8.0834E+03	7.2094E+00
9.3753E+02	4.2369E+02	3.4969E+05	5.1015E+04	7.1813E+04	2.6717E+00	3.8787E+03	6.0626E+03	7.2371E+00
9.3753E+02	3.7073E+02	4.2677E+05	5.1015E+04	6.5285E+04	2.6717E+00	3.8787E+03	5.2542E+03	2.2763E+02
9.3753E+02	3.1777E+02	5.1811E+05	5.1015E+04	5.2228E+04	3.5000E+00	3.8787E+03	4.8500E+03	4.4793E+02
9.3753E+02	2.6481E+02	7.4483E+05	5.1015E+04	4.5699E+04	6.1717E+00	3.8787E+03	4.4459E+03	2.5241E+02
9.3753E+02	2.1185E+02	9.7721E+05	5.1015E+04	3.9171E+04	3.5000E+00	3.8787E+03	4.0417E+03	5.0692E+03
9.3753E+02	1.5888E+02	2.1322E+06	5.1015E+04	3.2642E+04	3.5000E+00	3.8787E+03	3.6375E+03	4.4766E+03
9.3753E+02	1.0592E+02	4.4770E+06	5.1015E+04	2.6114E+04	3.5000E+00	3.8787E+03	3.2334E+03	3.2730E+04
9.3753E+02	5.2962E+01	9.4094E+06	5.1015E+04	1.9585E+04	1.1028E+01	3.8787E+03	2.8292E+03	7.1320E+04
9.3753E+02	0.0000E+00	1.1614E+07	5.1015E+04	1.3057E+04	2.3672E+01	3.8787E+03	2.4250E+03	7.8927E+04
8.7265E+02	1.3770E+03	3.4249E+02	5.1015E+04	6.5285E+03	4.1271E+01	3.8787E+03	2.0209E+03	1.1509E+05
8.7265E+02	1.3240E+03	4.6602E+02	5.1015E+04	0.0000E+00	1.1400E+02	3.8787E+03	1.6167E+03	9.4187E+04
8.7265E+02	1.2711E+03	6.5385E+02	4.4117E+04	2.1544E+05	1.3890E+00	3.8787E+03	1.2125E+03	5.5644E+04
8.7265E+02	1.2181E+03	1.2858E+03	4.4117E+04	1.6321E+05	1.3359E+00	3.8787E+03	8.0834E+02	1.4204E+05
8.7265E+02	1.1652E+03	1.1361E+03	4.4117E+04	1.5668E+05	1.3359E+00	3.8787E+03	4.0417E+02	4.7434E+05
8.7265E+02	1.1122E+03	7.4149E+02	4.4117E+04	1.4363E+05	1.7500E+00	3.8787E+03	0.0000E+00	1.1898E+06
8.7265E+02	1.0592E+03	3.9446E+03	4.4117E+04	1.3710E+05	5.2500E+00	3.4100E+03	7.6792E+03	1.8882E+00
8.7265E+02	1.0063E+03	8.5005E+03	4.4117E+04	1.3057E+05	4.8358E+00	3.4100E+03	7.2751E+03	4.8357E+01
8.7265E+02	9.5331E+02	2.2000E+04	4.4117E+04	1.2404E+05	1.3359E+00	3.4100E+03	6.8709E+03	3.4359E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.7265E+02	9.0035E+02	2.5871E+04	4.4117E+04	1.1751E+05	5.2500E+00	3.4100E+03	6.4667E+03	1.0625E-01
8.7265E+02	8.4739E+02	5.7079E+04	4.4117E+04	1.1098E+05	6.1717E+00	3.4100E+03	6.0626E+03	8.7582E+02
8.7265E+02	7.9442E+02	8.1063E+04	4.4117E+04	9.7927E+04	2.6717E+00	3.4100E+03	5.2542E+03	6.8779E+03
8.7265E+02	7.4146E+02	2.1620E+05	4.4117E+04	8.4870E+04	2.6717E+00	3.4100E+03	4.8500E+03	1.3084E+04
8.7265E+02	6.8850E+02	2.8843E+05	4.4117E+04	7.8342E+04	2.6717E+00	3.4100E+03	4.4459E+03	3.4560E+04
8.7265E+02	6.3554E+02	5.0004E+05	4.4117E+04	7.1813E+04	1.2500E+00	3.4100E+03	4.0417E+03	4.7807E+04
8.7265E+02	5.8258E+02	7.5078E+05	4.4117E+04	5.8756E+04	3.5000E+00	3.4100E+03	3.6375E+03	1.0247E+05
8.7265E+02	5.2962E+02	1.2654E+06	4.4117E+04	5.2228E+04	3.5000E+00	3.4100E+03	3.2334E+03	9.5336E+04
8.7265E+02	4.7665E+02	1.9406E+06	4.4117E+04	4.5699E+04	5.3434E+00	3.4100E+03	2.8292E+03	1.8582E+05
8.7265E+02	4.2369E+02	2.4988E+06	4.4117E+04	3.9171E+04	9.6717E+00	3.4100E+03	2.4250E+03	1.0977E+05
8.7265E+02	3.7073E+02	2.9491E+06	4.4117E+04	3.2642E+04	7.0000E+00	3.4100E+03	2.0209E+03	2.1219E+05
8.7265E+02	3.1777E+02	3.3597E+06	4.4117E+04	2.6114E+04	1.8621E+01	3.4100E+03	1.6167E+03	2.2363E+05
8.7265E+02	2.6481E+02	3.7293E+06	4.4117E+04	1.9585E+04	3.3765E+01	3.4100E+03	1.2125E+03	2.0457E+05
8.7265E+02	2.1185E+02	4.4511E+06	4.4117E+04	1.3057E+04	2.3965E+01	3.4100E+03	8.0834E+02	4.3678E+05
8.7265E+02	1.5888E+02	7.0533E+06	4.4117E+04	6.5285E+03	8.4988E+01	3.4100E+03	4.0417E+02	1.2166E+06
8.7265E+02	1.0592E+02	1.1981E+07	4.4117E+04	0.0000E+00	3.2916E+03	3.4100E+03	0.0000E+00	2.1746E+06
8.7265E+02	5.2962E+01	2.1089E+07	3.7220E+04	1.5668E+05	5.3125E-02	2.9414E+03	1.1317E+04	1.7500E+00
8.7265E+02	0.0000E+00	2.1548E+07	3.7220E+04	1.5016E+05	1.3359E+00	2.9414E+03	8.0834E+03	3.6186E+00
8.0778E+02	1.6418E+03	5.3125E-02	3.7220E+04	1.4363E+05	7.5075E+00	2.9414E+03	7.2751E+03	1.0221E+01
8.0778E+02	1.5359E+03	5.4112E+01	3.7220E+04	1.3710E+05	1.0086E+01	2.9414E+03	6.8709E+03	6.8574E+02
8.0778E+02	1.4300E+03	7.1874E+02	3.7220E+04	1.3057E+05	7.0000E+00	2.9414E+03	6.4667E+03	3.4727E+03
8.0778E+02	1.3770E+03	3.4194E+03	3.7220E+04	1.2404E+05	3.5000E+00	2.9414E+03	6.0626E+03	9.1622E+03
8.0778E+02	1.3240E+03	3.4889E+02	3.7220E+04	1.1751E+05	1.0086E+01	2.9414E+03	5.6584E+03	3.2600E+04
8.0778E+02	1.2711E+03	8.4233E+02	3.7220E+04	1.1098E+05	3.0859E+00	2.9414E+03	5.2542E+03	5.6953E+04
8.0778E+02	1.2181E+03	6.7043E+03	3.7220E+04	9.7927E+04	3.5000E+00	2.9414E+03	4.8500E+03	8.0975E+04
8.0778E+02	1.1652E+03	4.8762E+03	3.7220E+04	7.8342E+04	3.5000E+00	2.9414E+03	4.4459E+03	1.0618E+05
8.0778E+02	1.1122E+03	1.9070E+04	3.7220E+04	7.1813E+04	2.6717E+00	2.9414E+03	4.0417E+03	2.3059E+05
8.0778E+02	1.0592E+03	2.9907E+04	3.7220E+04	6.5285E+04	3.5000E+00	2.9414E+03	3.6375E+03	2.5787E+05
8.0778E+02	1.0063E+03	6.0636E+04	3.7220E+04	5.2228E+04	3.5000E+00	2.9414E+03	3.2334E+03	3.0220E+05
8.0778E+02	9.5331E+02	8.2991E+04	3.7220E+04	4.5699E+04	3.5000E+00	2.9414E+03	2.8292E+03	3.4156E+05
8.0778E+02	9.0035E+02	1.4989E+05	3.7220E+04	3.9171E+04	3.1918E+01	2.9414E+03	2.4250E+03	3.8898E+05
8.0778E+02	8.4739E+02	2.3894E+05	3.7220E+04	3.2642E+04	1.7500E+01	2.9414E+03	2.0209E+03	3.6221E+05
8.0778E+02	7.9442E+02	4.5787E+05	3.7220E+04	2.6114E+04	7.5482E+01	2.9414E+03	1.6167E+03	3.3016E+05
8.0778E+02	7.4146E+02	5.7049E+05	3.7220E+04	1.9585E+04	4.0675E+01	2.9414E+03	1.2125E+03	3.5406E+05
8.0778E+02	6.8850E+02	1.0014E+06	3.7220E+04	1.3057E+04	2.4586E+02	2.9414E+03	8.0834E+02	7.9679E+05
8.0778E+02	6.3554E+02	1.5274E+06	3.7220E+04	6.5285E+03	1.8724E+03	2.9414E+03	4.0417E+02	1.9655E+06
8.0778E+02	5.8258E+02	2.1412E+06	3.7220E+04	0.0000E+00	8.1167E+03	2.9414E+03	0.0000E+00	3.8320E+06
8.0778E+02	5.2962E+02	3.2111E+06	3.0322E+04	1.6321E+05	6.2500E-01	2.4727E+03	1.4550E+04	5.3125E-02

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.0778E+02	4.7665E+02	4.5549E+06	3.0322E+04	1.4363E+05	3.0859E+00	2.4727E+03	1.3338E+04	6.2500E-01
8.0778E+02	4.2369E+02	5.7349E+06	3.0322E+04	1.3710E+05	2.6717E+00	2.4727E+03	1.1721E+04	1.3359E+00
8.0778E+02	3.7073E+02	7.3648E+06	3.0322E+04	1.3057E+05	7.0000E+00	2.4727E+03	1.1317E+04	1.3816E+01
8.0778E+02	3.1777E+02	7.6886E+06	3.0322E+04	1.2404E+05	5.2500E+00	2.4727E+03	1.0913E+04	4.0076E+00
8.0778E+02	2.6481E+02	8.2499E+06	3.0322E+04	1.1751E+05	3.5000E+00	2.4727E+03	1.0508E+04	1.4421E+00
8.0778E+02	2.1185E+02	9.3081E+06	3.0322E+04	1.1098E+05	4.8358E+00	2.4727E+03	1.0104E+04	4.9785E+00
8.0778E+02	1.5888E+02	1.1893E+07	3.0322E+04	1.0446E+05	4.4217E+00	2.4727E+03	9.2959E+03	2.4106E+01
8.0778E+02	1.0592E+02	1.8257E+07	3.0322E+04	9.1399E+04	3.1921E+00	2.4727E+03	8.8917E+03	2.1645E+01
8.0778E+02	5.2962E+01	3.0439E+07	3.0322E+04	8.4870E+04	3.0167E+01	2.4727E+03	8.4876E+03	2.7056E+01
8.0778E+02	0.0000E+00	3.0775E+07	3.0322E+04	7.8342E+04	8.7500E+00	2.4727E+03	8.0834E+03	5.4859E+02
7.4291E+02	2.3303E+03	8.0260E+01	3.0322E+04	7.1813E+04	1.0687E+01	2.4727E+03	7.6792E+03	4.6307E+03
7.4291E+02	2.0655E+03	4.0130E+01	3.0322E+04	6.5285E+04	1.6672E+01	2.4727E+03	7.2751E+03	7.7221E+03
7.4291E+02	1.8537E+03	1.4046E+02	3.0322E+04	5.8756E+04	2.5515E+01	2.4727E+03	6.8709E+03	1.5665E+04
7.4291E+02	1.8007E+03	2.7056E+01	3.0322E+04	5.2228E+04	1.4000E+01	2.4727E+03	6.4667E+03	1.8229E+04
7.4291E+02	1.7477E+03	1.2317E+02	3.0322E+04	4.5699E+04	5.1085E+01	2.4727E+03	6.0626E+03	8.0455E+04
7.4291E+02	1.6948E+03	1.0331E+02	3.0322E+04	3.9171E+04	1.3278E+01	2.4727E+03	5.6584E+03	7.9863E+04
7.4291E+02	1.6418E+03	1.2432E+02	3.0322E+04	3.2642E+04	2.5852E+01	2.4727E+03	5.2542E+03	1.1561E+05
7.4291E+02	1.5888E+03	3.1530E+01	3.0322E+04	2.6114E+04	1.1052E+02	2.4727E+03	4.8500E+03	1.5852E+05
7.4291E+02	1.5359E+03	1.3940E+03	3.0322E+04	1.9585E+04	2.4802E+02	2.4727E+03	4.4459E+03	2.6631E+05
7.4291E+02	1.4829E+03	1.8914E+03	3.0322E+04	1.3057E+04	3.6934E+03	2.4727E+03	4.0417E+03	4.1647E+05
7.4291E+02	1.4300E+03	5.4335E+02	3.0322E+04	6.5285E+03	1.3898E+04	2.4727E+03	3.6375E+03	4.3130E+05
7.4291E+02	1.3770E+03	1.2816E+03	3.0322E+04	0.0000E+00	1.8366E+04	2.4727E+03	3.2334E+03	5.3555E+05
7.4291E+02	1.3240E+03	2.7616E+03	2.3425E+04	1.8280E+05	6.2500E-01	2.4727E+03	2.8292E+03	6.4504E+05
7.4291E+02	1.2711E+03	6.1824E+03	2.3425E+04	1.7627E+05	6.2500E-01	2.4727E+03	2.4250E+03	6.2309E+05
7.4291E+02	1.2181E+03	1.4690E+04	2.3425E+04	1.5668E+05	2.6717E+00	2.4727E+03	2.0209E+03	7.4180E+05
7.4291E+02	1.1652E+03	2.2918E+04	2.3425E+04	1.3710E+05	1.8750E+00	2.4727E+03	1.6167E+03	7.3173E+05
7.4291E+02	1.1122E+03	5.1219E+04	2.3425E+04	1.3057E+05	1.3359E+00	2.4727E+03	1.2125E+03	9.2963E+05
7.4291E+02	1.0592E+03	6.3872E+04	2.3425E+04	1.2404E+05	3.7109E+00	2.4727E+03	8.0834E+02	1.2752E+06
7.4291E+02	1.0063E+03	9.5426E+04	2.3425E+04	1.1751E+05	6.5858E+00	2.4727E+03	4.0417E+02	3.4019E+06
7.4291E+02	9.5331E+02	1.7601E+05	2.3425E+04	1.1098E+05	6.2500E-01	2.4727E+03	0.0000E+00	6.0350E+06
7.4291E+02	9.0035E+02	2.4655E+05	2.3425E+04	1.0446E+05	7.0000E+00	2.0040E+03	1.4146E+04	6.2500E-01
7.4291E+02	8.4739E+02	3.6141E+05	2.3425E+04	9.7927E+04	3.2417E+01	2.0040E+03	1.2933E+04	3.6717E+00
7.4291E+02	7.9442E+02	5.1688E+05	2.3425E+04	9.1399E+04	4.8358E+00	2.0040E+03	1.2529E+04	5.3125E-02
7.4291E+02	7.4146E+02	7.4217E+05	2.3425E+04	8.4870E+04	1.1368E+01	2.0040E+03	1.2125E+04	2.3750E+00
7.4291E+02	6.8850E+02	1.2601E+06	2.3425E+04	7.8342E+04	7.0000E+00	2.0040E+03	1.1317E+04	4.9785E+00
7.4291E+02	6.3554E+02	1.6879E+06	2.3425E+04	7.1813E+04	7.1062E+00	2.0040E+03	1.0913E+04	8.2794E+02
7.4291E+02	5.8258E+02	2.5240E+06	2.3425E+04	6.5285E+04	1.7032E+01	2.0040E+03	1.0508E+04	6.4671E+01
7.4291E+02	5.2962E+02	3.6114E+06	2.3425E+04	5.8756E+04	7.0000E+00	2.0040E+03	9.2959E+03	6.8211E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Classification: Confidential
VESTAS PROPRIETARY NOTICE
DNV Business Assurance
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.4291E+02	4.7665E+02	4.6785E+06	2.3425E+04	5.2228E+04	8.8364E+01	2.0040E+03	8.8917E+03	8.2751E+02
7.4291E+02	4.2369E+02	5.6976E+06	2.3425E+04	4.5699E+04	7.0007E+01	2.0040E+03	8.4876E+03	7.9683E+00
7.4291E+02	3.7073E+02	6.6121E+06	2.3425E+04	3.9171E+04	1.1470E+02	2.0040E+03	8.0834E+03	8.6401E+03
7.4291E+02	3.1777E+02	7.3566E+06	2.3425E+04	3.2642E+04	1.3924E+02	2.0040E+03	7.6792E+03	1.0201E+04
7.4291E+02	2.6481E+02	7.4871E+06	2.3425E+04	2.6114E+04	3.6737E+03	2.0040E+03	7.2751E+03	1.8546E+04
7.4291E+02	2.1185E+02	8.1424E+06	2.3425E+04	1.9585E+04	7.1073E+03	2.0040E+03	6.8709E+03	5.9971E+04
7.4291E+02	1.5888E+02	1.1496E+07	2.3425E+04	1.3057E+04	1.4062E+04	2.0040E+03	6.4667E+03	9.5754E+04
7.4291E+02	1.0592E+02	1.8920E+07	2.3425E+04	6.5285E+03	1.4901E+04	2.0040E+03	6.0626E+03	1.3824E+05
7.4291E+02	5.2962E+01	3.2251E+07	2.3425E+04	0.0000E+00	5.8381E+04	2.0040E+03	5.6584E+03	1.6141E+05
7.4291E+02	0.0000E+00	3.3839E+07	1.6527E+04	1.5668E+05	1.3359E+00	2.0040E+03	5.2542E+03	2.5582E+05
6.7804E+02	2.4892E+03	3.6186E+00	1.6527E+04	1.4363E+05	1.3359E+00	2.0040E+03	4.8500E+03	3.7747E+05
6.7804E+02	2.1714E+03	5.0640E+01	1.6527E+04	1.3710E+05	5.3125E-02	2.0040E+03	4.4459E+03	4.0885E+05
6.7804E+02	1.9596E+03	1.1472E+03	1.6527E+04	1.3057E+05	5.3125E-02	2.0040E+03	4.0417E+03	6.2710E+05
6.7804E+02	1.9066E+03	2.7056E+01	1.6527E+04	1.2404E+05	1.2500E+00	2.0040E+03	3.6375E+03	6.3114E+05
6.7804E+02	1.8537E+03	1.2039E+02	1.6527E+04	1.1751E+05	1.2500E+00	2.0040E+03	3.2334E+03	8.8098E+05
6.7804E+02	1.8007E+03	3.3440E+03	1.6527E+04	1.1098E+05	6.2500E-01	2.0040E+03	2.8292E+03	1.0286E+06
6.7804E+02	1.7477E+03	1.7844E+02	1.6527E+04	1.0446E+05	2.5859E+00	2.0040E+03	2.4250E+03	1.0747E+06
6.7804E+02	1.6948E+03	2.2699E+02	1.6527E+04	9.7927E+04	8.3358E+00	2.0040E+03	2.0209E+03	1.0915E+06
6.7804E+02	1.6418E+03	3.6803E+03	1.6527E+04	9.1399E+04	8.2480E+00	2.0040E+03	1.6167E+03	1.0272E+06
6.7804E+02	1.5888E+03	2.9266E+03	1.6527E+04	8.4870E+04	1.1336E+01	2.0040E+03	1.2125E+03	1.5349E+06
6.7804E+02	1.5359E+03	1.6539E+03	1.6527E+04	7.8342E+04	2.8311E+01	2.0040E+03	8.0834E+02	2.1542E+06
6.7804E+02	1.4829E+03	7.0304E+03	1.6527E+04	7.1813E+04	7.0602E+01	2.0040E+03	4.0417E+02	4.5036E+06
6.7804E+02	1.4300E+03	2.3818E+03	1.6527E+04	6.5285E+04	4.5652E+01	2.0040E+03	0.0000E+00	9.1697E+06
6.7804E+02	1.3770E+03	1.7801E+04	1.6527E+04	5.8756E+04	1.0680E+02	1.5353E+03	1.6167E+04	1.0510E+01
6.7804E+02	1.3240E+03	1.5233E+04	1.6527E+04	5.2228E+04	1.8429E+03	1.5353E+03	1.3742E+04	5.3125E-02
6.7804E+02	1.2711E+03	5.3348E+04	1.6527E+04	4.5699E+04	5.1932E+03	1.5353E+03	1.3338E+04	1.9609E+00
6.7804E+02	1.2181E+03	5.3723E+04	1.6527E+04	3.9171E+04	2.0102E+03	1.5353E+03	1.2125E+04	3.2841E+01
6.7804E+02	1.1652E+03	5.6086E+04	1.6527E+04	3.2642E+04	5.1518E+02	1.5353E+03	1.1721E+04	9.4410E-01
6.7804E+02	1.1122E+03	8.5651E+04	1.6527E+04	2.6114E+04	7.3395E+03	1.5353E+03	1.1317E+04	1.0115E+01
6.7804E+02	1.0592E+03	1.0542E+05	1.6527E+04	1.9585E+04	7.7272E+03	1.5353E+03	1.0913E+04	4.3966E+02
6.7804E+02	1.0063E+03	1.5968E+05	1.6527E+04	1.3057E+04	1.5612E+04	1.5353E+03	1.0508E+04	2.6728E+03
6.7804E+02	9.5331E+02	2.3745E+05	1.6527E+04	6.5285E+03	6.1988E+04	1.5353E+03	1.0104E+04	1.3391E+03
6.7804E+02	9.0035E+02	3.5359E+05	1.6527E+04	0.0000E+00	2.1669E+05	1.5353E+03	9.7001E+03	4.3480E+02
6.7804E+02	8.4739E+02	4.3155E+05	9.6294E+03	1.4363E+05	5.3125E-02	1.5353E+03	9.2959E+03	6.1366E+03
6.7804E+02	7.9442E+02	5.4455E+05	9.6294E+03	1.3710E+05	4.6326E+00	1.5353E+03	8.8917E+03	1.1201E+04
6.7804E+02	7.4146E+02	9.0159E+05	9.6294E+03	1.3057E+05	5.3125E-02	1.5353E+03	8.4876E+03	2.1158E+04
6.7804E+02	6.8850E+02	1.3913E+06	9.6294E+03	1.2404E+05	1.3031E+00	1.5353E+03	8.0834E+03	2.6517E+04
6.7804E+02	6.3554E+02	1.7960E+06	9.6294E+03	1.1098E+05	6.2500E-01	1.5353E+03	7.6792E+03	4.2206E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.7804E+02	5.8258E+02	2.4814E+06	9.6294E+03	1.0446E+05	5.3125E-02	1.5353E+03	7.2751E+03	8.0708E+04
6.7804E+02	5.2962E+02	3.3671E+06	9.6294E+03	9.7927E+04	2.3890E+03	1.5353E+03	6.8709E+03	8.4207E+04
6.7804E+02	4.7665E+02	4.2383E+06	9.6294E+03	9.1399E+04	3.0610E+00	1.5353E+03	6.4667E+03	1.2283E+05
6.7804E+02	4.2369E+02	4.7891E+06	9.6294E+03	8.4870E+04	5.2625E+00	1.5353E+03	6.0626E+03	2.3087E+05
6.7804E+02	3.7073E+02	5.5035E+06	9.6294E+03	7.8342E+04	8.0389E+02	1.5353E+03	5.6584E+03	2.8599E+05
6.7804E+02	3.1777E+02	5.6689E+06	9.6294E+03	7.1813E+04	2.7845E+01	1.5353E+03	5.2542E+03	4.6170E+05
6.7804E+02	2.6481E+02	5.7363E+06	9.6294E+03	6.5285E+04	4.8174E+03	1.5353E+03	4.8500E+03	4.7934E+05
6.7804E+02	2.1185E+02	6.4198E+06	9.6294E+03	5.8756E+04	6.4451E+03	1.5353E+03	4.4459E+03	6.5962E+05
6.7804E+02	1.5888E+02	8.2523E+06	9.6294E+03	5.2228E+04	6.4621E+03	1.5353E+03	4.0417E+03	9.8788E+05
6.7804E+02	1.0592E+02	1.3986E+07	9.6294E+03	4.5699E+04	1.4818E+04	1.5353E+03	3.6375E+03	1.0277E+06
6.7804E+02	5.2962E+01	2.6755E+07	9.6294E+03	3.9171E+04	1.1840E+04	1.5353E+03	3.2334E+03	1.3454E+06
6.7804E+02	0.0000E+00	2.9997E+07	9.6294E+03	3.2642E+04	1.1479E+04	1.5353E+03	2.8292E+03	1.4709E+06
6.1317E+02	2.5951E+03	3.6186E+00	9.6294E+03	2.6114E+04	3.9050E+04	1.5353E+03	2.4250E+03	1.5456E+06
6.1317E+02	2.2773E+03	1.0510E+01	9.6294E+03	1.9585E+04	3.8507E+04	1.5353E+03	2.0209E+03	1.7368E+06
6.1317E+02	2.1714E+03	4.3791E+02	9.6294E+03	1.3057E+04	5.5148E+04	1.5353E+03	1.6167E+03	1.6634E+06
6.1317E+02	2.1185E+03	4.0183E+01	9.6294E+03	6.5285E+03	2.6800E+05	1.5353E+03	1.2125E+03	1.9934E+06
6.1317E+02	2.0655E+03	1.0510E+01	9.6294E+03	0.0000E+00	2.1014E+06	1.5353E+03	8.0834E+02	2.9867E+06
6.1317E+02	2.0125E+03	4.3791E+02	2.7319E+03	2.9378E+05	5.3125E-02	1.5353E+03	4.0417E+02	6.4784E+06
6.1317E+02	1.9596E+03	9.1097E+02	2.7319E+03	1.8280E+05	5.3125E-02	1.5353E+03	0.0000E+00	1.3824E+07
6.1317E+02	1.9066E+03	2.1138E+03	2.7319E+03	1.5668E+05	1.9825E+00	1.0667E+03	1.6975E+04	5.3125E-02
6.1317E+02	1.8537E+03	1.0463E+03	2.7319E+03	1.5016E+05	5.3125E-02	1.0667E+03	1.4954E+04	9.4410E-01
6.1317E+02	1.8007E+03	3.8062E+03	2.7319E+03	1.4363E+05	2.6717E+00	1.0667E+03	1.3742E+04	7.3765E+02
6.1317E+02	1.7477E+03	3.2753E+03	2.7319E+03	1.3710E+05	1.5938E-01	1.0667E+03	1.3338E+04	2.5936E+02
6.1317E+02	1.6948E+03	1.1069E+03	2.7319E+03	1.3057E+05	1.3359E+00	1.0667E+03	1.2933E+04	5.2085E+00
6.1317E+02	1.6418E+03	1.2452E+04	2.7319E+03	1.2404E+05	6.7813E-01	1.0667E+03	1.2529E+04	1.5183E+02
6.1317E+02	1.5888E+03	8.7551E+03	2.7319E+03	1.1751E+05	3.4561E+00	1.0667E+03	1.2125E+04	4.7442E+02
6.1317E+02	1.5359E+03	1.2539E+04	2.7319E+03	1.1098E+05	5.7844E+00	1.0667E+03	1.1721E+04	1.2031E+02
6.1317E+02	1.4829E+03	1.0815E+04	2.7319E+03	1.0446E+05	2.3517E+03	1.0667E+03	1.1317E+04	2.3424E+02
6.1317E+02	1.4300E+03	2.6602E+04	2.7319E+03	9.7927E+04	7.8830E+02	1.0667E+03	1.0913E+04	4.0128E+02
6.1317E+02	1.3770E+03	2.5925E+04	2.7319E+03	9.1399E+04	4.7073E+03	1.0667E+03	1.0508E+04	4.4761E+03
6.1317E+02	1.3240E+03	4.3136E+04	2.7319E+03	8.4870E+04	1.5810E+03	1.0667E+03	1.0104E+04	3.3654E+03
6.1317E+02	1.2711E+03	5.6527E+04	2.7319E+03	7.8342E+04	1.9863E+04	1.0667E+03	9.7001E+03	4.2715E+03
6.1317E+02	1.2181E+03	8.8795E+04	2.7319E+03	7.1813E+04	1.4157E+04	1.0667E+03	9.2959E+03	6.4064E+03
6.1317E+02	1.1652E+03	1.1679E+05	2.7319E+03	6.5285E+04	1.8921E+04	1.0667E+03	8.8917E+03	2.3458E+04
6.1317E+02	1.1122E+03	1.7851E+05	2.7319E+03	5.8756E+04	3.4779E+04	1.0667E+03	8.4876E+03	3.2702E+04
6.1317E+02	1.0592E+03	1.9104E+05	2.7319E+03	5.2228E+04	6.3094E+04	1.0667E+03	8.0834E+03	4.6141E+04
6.1317E+02	1.0063E+03	2.5126E+05	2.7319E+03	4.5699E+04	5.2367E+04	1.0667E+03	7.6792E+03	4.8923E+04
6.1317E+02	9.5331E+02	4.6887E+05	2.7319E+03	3.9171E+04	7.6434E+04	1.0667E+03	7.2751E+03	7.7349E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance
Tuborgvejen 6, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.1317E+02	9.0035E+02	4.7334E+05	2.7319E+03	3.2642E+04	1.5208E+05	1.0667E+03	6.8709E+03	1.2737E+05
6.1317E+02	8.4739E+02	7.0034E+05	2.7319E+03	2.6114E+04	2.3194E+05	1.0667E+03	6.4667E+03	2.4812E+05
6.1317E+02	7.9442E+02	8.8382E+05	2.7319E+03	1.9585E+04	8.6642E+05	1.0667E+03	6.0626E+03	3.2099E+05
6.1317E+02	7.4146E+02	1.1797E+06	2.7319E+03	1.3057E+04	1.8377E+06	1.0667E+03	5.6584E+03	4.3656E+05
6.1317E+02	6.8850E+02	1.4191E+06	2.7319E+03	6.5285E+03	4.3779E+06	1.0667E+03	5.2542E+03	4.5496E+05
6.1317E+02	6.3554E+02	1.9423E+06	2.7319E+03	0.0000E+00	1.0951E+07	1.0667E+03	4.8500E+03	7.1699E+05
6.1317E+02	5.8258E+02	2.2576E+06	-4.1656E+03	3.0684E+05	1.3359E+00	1.0667E+03	4.4459E+03	7.6116E+05
6.1317E+02	5.2962E+02	2.8066E+06	-4.1656E+03	2.8072E+05	1.3359E+00	1.0667E+03	4.0417E+03	1.0226E+06
6.1317E+02	4.7665E+02	3.3362E+06	-4.1656E+03	2.6767E+05	1.3359E+00	1.0667E+03	3.6375E+03	1.4315E+06
6.1317E+02	4.2369E+02	3.7806E+06	-4.1656E+03	2.4155E+05	2.3750E+00	1.0667E+03	3.2334E+03	1.5529E+06
6.1317E+02	3.7073E+02	3.7943E+06	-4.1656E+03	1.5016E+05	5.6836E-02	1.0667E+03	2.8292E+03	1.9637E+06
6.1317E+02	3.1777E+02	3.9741E+06	-4.1656E+03	1.3710E+05	8.6611E-02	1.0667E+03	2.4250E+03	2.4721E+06
6.1317E+02	2.6481E+02	3.6701E+06	-4.1656E+03	1.3057E+05	5.3125E-02	1.0667E+03	2.0209E+03	2.6157E+06
6.1317E+02	2.1185E+02	3.8317E+06	-4.1656E+03	1.2404E+05	2.3327E+00	1.0667E+03	1.6167E+03	2.9256E+06
6.1317E+02	1.5888E+02	5.0144E+06	-4.1656E+03	1.1751E+05	1.4168E+00	1.0667E+03	1.2125E+03	2.9062E+06
6.1317E+02	1.0592E+02	9.0202E+06	-4.1656E+03	1.1098E+05	5.6781E+00	1.0667E+03	8.0834E+02	4.4363E+06
6.1317E+02	5.2962E+01	1.9091E+07	-4.1656E+03	1.0446E+05	7.9532E+02	1.0667E+03	4.0417E+02	9.3793E+06
6.1317E+02	0.0000E+00	2.4463E+07	-4.1656E+03	9.7927E+04	2.3823E+03	1.0667E+03	0.0000E+00	1.9287E+07
5.4829E+02	2.4362E+03	4.8920E-01	-4.1656E+03	9.1399E+04	3.2844E+03	5.9799E+02	1.7379E+04	1.0510E+01
5.4829E+02	2.3833E+03	4.3791E+02	-4.1656E+03	8.4870E+04	3.5953E+01	5.9799E+02	1.6167E+04	2.7056E+01
5.4829E+02	2.1714E+03	1.3816E+01	-4.1656E+03	7.8342E+04	1.0163E+02	5.9799E+02	1.5763E+04	8.1168E+01
5.4829E+02	2.1185E+03	5.2744E+02	-4.1656E+03	7.1813E+04	2.6935E+03	5.9799E+02	1.5358E+04	3.7294E+02
5.4829E+02	2.0655E+03	1.8574E+03	-4.1656E+03	6.5285E+04	1.2823E+04	5.9799E+02	1.4954E+04	6.7515E+02
5.4829E+02	2.0125E+03	2.1675E+03	-4.1656E+03	5.8756E+04	1.7650E+04	5.9799E+02	1.4550E+04	1.6482E+02
5.4829E+02	1.9596E+03	5.3854E+02	-4.1656E+03	5.2228E+04	6.2812E+04	5.9799E+02	1.4146E+04	1.0331E+02
5.4829E+02	1.9066E+03	2.2496E+02	-4.1656E+03	4.5699E+04	7.1834E+04	5.9799E+02	1.3742E+04	2.4773E+02
5.4829E+02	1.8537E+03	1.7283E+03	-4.1656E+03	3.9171E+04	1.5755E+05	5.9799E+02	1.3338E+04	5.3255E+02
5.4829E+02	1.8007E+03	1.9696E+03	-4.1656E+03	3.2642E+04	2.6044E+05	5.9799E+02	1.2933E+04	1.5930E+03
5.4829E+02	1.7477E+03	2.4560E+03	-4.1656E+03	2.6114E+04	4.4961E+05	5.9799E+02	1.2529E+04	3.3939E+03
5.4829E+02	1.6948E+03	9.0256E+03	-4.1656E+03	1.9585E+04	6.7927E+05	5.9799E+02	1.2125E+04	4.7905E+03
5.4829E+02	1.6418E+03	1.1196E+04	-4.1656E+03	1.3057E+04	8.9269E+05	5.9799E+02	1.1721E+04	3.4985E+03
5.4829E+02	1.5888E+03	1.2538E+04	-4.1656E+03	6.5285E+03	1.2010E+06	5.9799E+02	1.1317E+04	3.7218E+03
5.4829E+02	1.5359E+03	9.1926E+03	-4.1656E+03	0.0000E+00	2.8128E+06	5.9799E+02	1.0913E+04	1.4863E+04
5.4829E+02	1.4829E+03	1.5963E+04	-1.1063E+04	3.2642E+05	1.3359E+00	5.9799E+02	1.0508E+04	1.4435E+04
5.4829E+02	1.4300E+03	2.6526E+04	-1.1063E+04	3.0684E+05	1.3359E+00	5.9799E+02	1.0104E+04	2.6706E+04
5.4829E+02	1.3770E+03	2.2556E+04	-1.1063E+04	3.0031E+05	1.3359E+00	5.9799E+02	9.7001E+03	1.4597E+04
5.4829E+02	1.3240E+03	3.8088E+04	-1.1063E+04	2.9378E+05	1.3359E+00	5.9799E+02	9.2959E+03	2.7133E+04
5.4829E+02	1.2711E+03	4.2351E+04	-1.1063E+04	2.8725E+05	1.3359E+00	5.9799E+02	8.8917E+03	5.8024E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.4829E+02	1.2181E+03	6.7104E+04	-1.1063E+04	2.4155E+05	6.2500E-01	5.9799E+02	8.4876E+03	5.9889E+04
5.4829E+02	1.1652E+03	1.1765E+05	-1.1063E+04	1.8280E+05	2.1628E-02	5.9799E+02	8.0834E+03	6.5168E+04
5.4829E+02	1.1122E+03	1.2955E+05	-1.1063E+04	1.6974E+05	5.3125E-02	5.9799E+02	7.6792E+03	9.8735E+04
5.4829E+02	1.0592E+03	1.5972E+05	-1.1063E+04	1.5668E+05	1.3927E+00	5.9799E+02	7.2751E+03	9.4375E+04
5.4829E+02	1.0063E+03	2.5051E+05	-1.1063E+04	1.5016E+05	1.0996E-01	5.9799E+02	6.8709E+03	1.7532E+05
5.4829E+02	9.5331E+02	2.5647E+05	-1.1063E+04	1.4363E+05	1.0625E-01	5.9799E+02	6.4667E+03	2.6229E+05
5.4829E+02	9.0035E+02	3.7379E+05	-1.1063E+04	1.3710E+05	1.7077E+00	5.9799E+02	6.0626E+03	3.8898E+05
5.4829E+02	8.4739E+02	5.0512E+05	-1.1063E+04	1.3057E+05	1.4421E+00	5.9799E+02	5.6584E+03	5.1529E+05
5.4829E+02	7.9442E+02	7.5349E+05	-1.1063E+04	1.2404E+05	2.1419E+00	5.9799E+02	5.2542E+03	6.5536E+05
5.4829E+02	7.4146E+02	8.6660E+05	-1.1063E+04	1.1751E+05	1.8527E+01	5.9799E+02	4.8500E+03	8.6842E+05
5.4829E+02	6.8850E+02	1.0326E+06	-1.1063E+04	1.1098E+05	9.9378E+01	5.9799E+02	4.4459E+03	1.1308E+06
5.4829E+02	6.3554E+02	1.4199E+06	-1.1063E+04	1.0446E+05	1.2298E+02	5.9799E+02	4.0417E+03	1.3498E+06
5.4829E+02	5.8258E+02	1.6996E+06	-1.1063E+04	9.7927E+04	1.7709E+03	5.9799E+02	3.6375E+03	1.6700E+06
5.4829E+02	5.2962E+02	1.8079E+06	-1.1063E+04	9.1399E+04	7.9381E+01	5.9799E+02	3.2334E+03	1.8730E+06
5.4829E+02	4.7665E+02	1.9418E+06	-1.1063E+04	8.4870E+04	5.9150E+01	5.9799E+02	2.8292E+03	2.4659E+06
5.4829E+02	4.2369E+02	2.3593E+06	-1.1063E+04	7.8342E+04	4.3534E+03	5.9799E+02	2.4250E+03	3.0465E+06
5.4829E+02	3.7073E+02	2.3584E+06	-1.1063E+04	7.1813E+04	2.5210E+03	5.9799E+02	2.0209E+03	3.6464E+06
5.4829E+02	3.1777E+02	2.6045E+06	-1.1063E+04	6.5285E+04	3.0616E+03	5.9799E+02	1.6167E+03	3.8988E+06
5.4829E+02	2.6481E+02	2.8367E+06	-1.1063E+04	5.8756E+04	8.8612E+03	5.9799E+02	1.2125E+03	4.0162E+06
5.4829E+02	2.1185E+02	2.6337E+06	-1.1063E+04	5.2228E+04	3.5458E+04	5.9799E+02	8.0834E+02	5.6007E+06
5.4829E+02	1.5888E+02	3.3412E+06	-1.1063E+04	4.5699E+04	8.0994E+04	5.9799E+02	4.0417E+02	1.2895E+07
5.4829E+02	1.0592E+02	5.3480E+06	-1.1063E+04	3.9171E+04	1.7409E+05	5.9799E+02	0.0000E+00	2.6464E+07
5.4829E+02	5.2962E+01	1.3247E+07	-1.1063E+04	3.2642E+04	4.4587E+05	1.2932E+02	1.6975E+04	3.6186E+00
5.4829E+02	0.0000E+00	2.0954E+07	-1.1063E+04	2.6114E+04	8.1436E+05	1.2932E+02	1.6167E+04	3.9125E+02
4.8342E+02	2.3303E+03	1.0510E+01	-1.1063E+04	1.9585E+04	1.2032E+06	1.2932E+02	1.5763E+04	4.7108E+00
4.8342E+02	2.2773E+03	1.4359E+01	-1.1063E+04	1.3057E+04	1.6629E+06	1.2932E+02	1.5358E+04	1.4946E+02
4.8342E+02	2.2244E+03	3.2071E+01	-1.1063E+04	6.5285E+03	2.2708E+06	1.2932E+02	1.4954E+04	6.2836E+02
4.8342E+02	2.1714E+03	4.4531E+02	-1.1063E+04	0.0000E+00	2.3125E+06	1.2932E+02	1.4550E+04	2.4740E+03
4.8342E+02	2.1185E+03	3.8489E+01	-1.7961E+04	3.0684E+05	1.3359E+00	1.2932E+02	1.4146E+04	2.5613E+03
4.8342E+02	2.0655E+03	3.3963E+01	-1.7961E+04	3.0031E+05	1.3359E+00	1.2932E+02	1.3742E+04	3.4943E+03
4.8342E+02	2.0125E+03	5.6681E+02	-1.7961E+04	2.9378E+05	1.3359E+00	1.2932E+02	1.3338E+04	7.5656E+03
4.8342E+02	1.9596E+03	9.8809E+01	-1.7961E+04	2.8725E+05	1.3359E+00	1.2932E+02	1.2933E+04	5.6873E+03
4.8342E+02	1.9066E+03	1.8958E+03	-1.7961E+04	2.8072E+05	4.4217E+00	1.2932E+02	1.2529E+04	8.7372E+03
4.8342E+02	1.8537E+03	5.3729E+02	-1.7961E+04	2.5461E+05	6.2500E-01	1.2932E+02	1.2125E+04	2.2674E+04
4.8342E+02	1.8007E+03	6.4652E+03	-1.7961E+04	2.4808E+05	5.2500E+00	1.2932E+02	1.1721E+04	2.6999E+04
4.8342E+02	1.7477E+03	4.5950E+03	-1.7961E+04	2.4155E+05	3.5000E+00	1.2932E+02	1.1317E+04	5.1838E+04
4.8342E+02	1.6948E+03	5.2296E+03	-1.7961E+04	2.2197E+05	1.7500E+00	1.2932E+02	1.0913E+04	4.7625E+04
4.8342E+02	1.6418E+03	3.1399E+03	-1.7961E+04	2.1544E+05	6.2500E-01	1.2932E+02	1.0508E+04	3.2985E+04

DNV Certificate No. TAS000033-2 Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.8342E+02	1.5888E+03	1.0284E+04	-1.7961E+04	2.0891E+05	1.7500E+00	1.2932E+02	1.0104E+04	3.5384E+04
4.8342E+02	1.5359E+03	1.0505E+04	-1.7961E+04	2.0238E+05	6.7813E-01	1.2932E+02	9.7001E+03	4.6093E+04
4.8342E+02	1.4829E+03	9.6700E+03	-1.7961E+04	1.8933E+05	1.8031E+00	1.2932E+02	9.2959E+03	5.2050E+04
4.8342E+02	1.4300E+03	1.4261E+04	-1.7961E+04	1.8280E+05	6.2500E-01	1.2932E+02	8.8917E+03	5.8497E+04
4.8342E+02	1.3770E+03	3.1007E+04	-1.7961E+04	1.7627E+05	6.2500E-01	1.2932E+02	8.4876E+03	8.7926E+04
4.8342E+02	1.3240E+03	3.3449E+04	-1.7961E+04	1.6321E+05	7.3125E-01	1.2932E+02	8.0834E+03	1.2188E+05
4.8342E+02	1.2711E+03	3.0393E+04	-1.7961E+04	1.5668E+05	2.1250E-01	1.2932E+02	7.6792E+03	1.5875E+05
4.8342E+02	1.2181E+03	4.2393E+04	-1.7961E+04	1.5016E+05	1.0625E-01	1.2932E+02	7.2751E+03	2.3774E+05
4.8342E+02	1.1652E+03	6.4201E+04	-1.7961E+04	1.4363E+05	2.5216E+00	1.2932E+02	6.8709E+03	2.2996E+05
4.8342E+02	1.1122E+03	7.5313E+04	-1.7961E+04	1.3710E+05	1.0625E-01	1.2932E+02	6.4667E+03	3.4449E+05
4.8342E+02	1.0592E+03	1.1433E+05	-1.7961E+04	1.3057E+05	8.7281E+01	1.2932E+02	6.0626E+03	4.6217E+05
4.8342E+02	1.0063E+03	1.3269E+05	-1.7961E+04	1.2404E+05	2.6100E+00	1.2932E+02	5.6584E+03	6.0660E+05
4.8342E+02	9.5331E+02	1.7087E+05	-1.7961E+04	1.1751E+05	1.3847E+01	1.2932E+02	5.2542E+03	6.9994E+05
4.8342E+02	9.0035E+02	1.7652E+05	-1.7961E+04	1.1098E+05	2.2970E+01	1.2932E+02	4.8500E+03	1.0374E+06
4.8342E+02	8.4739E+02	2.3817E+05	-1.7961E+04	1.0446E+05	1.7174E+03	1.2932E+02	4.4459E+03	1.3476E+06
4.8342E+02	7.9442E+02	3.4523E+05	-1.7961E+04	9.7927E+04	1.7206E+03	1.2932E+02	4.0417E+03	1.5180E+06
4.8342E+02	7.4146E+02	5.3130E+05	-1.7961E+04	9.1399E+04	2.6373E+02	1.2932E+02	3.6375E+03	1.8650E+06
4.8342E+02	6.8850E+02	6.9878E+05	-1.7961E+04	8.4870E+04	1.7712E+03	1.2932E+02	3.2334E+03	2.1573E+06
4.8342E+02	6.3554E+02	8.2039E+05	-1.7961E+04	7.8342E+04	2.9828E+03	1.2932E+02	2.8292E+03	2.8796E+06
4.8342E+02	5.8258E+02	8.8682E+05	-1.7961E+04	7.1813E+04	2.6838E+03	1.2932E+02	2.4250E+03	3.6036E+06
4.8342E+02	5.2962E+02	1.0531E+06	-1.7961E+04	6.5285E+04	4.9309E+03	1.2932E+02	2.0209E+03	4.3527E+06
4.8342E+02	4.7665E+02	1.4632E+06	-1.7961E+04	5.8756E+04	7.4239E+03	1.2932E+02	1.6167E+03	5.1386E+06
4.8342E+02	4.2369E+02	1.7542E+06	-1.7961E+04	5.2228E+04	1.8187E+04	1.2932E+02	1.2125E+03	5.6900E+06
4.8342E+02	3.7073E+02	2.1716E+06	-1.7961E+04	4.5699E+04	5.6094E+04	1.2932E+02	8.0834E+02	7.3282E+06
4.8342E+02	3.1777E+02	2.4672E+06	-1.7961E+04	3.9171E+04	2.2005E+05	1.2932E+02	4.0417E+02	1.7163E+07
4.8342E+02	2.6481E+02	3.0798E+06	-1.7961E+04	3.2642E+04	4.7766E+05	1.2932E+02	0.0000E+00	3.6832E+07
4.8342E+02	2.1185E+02	3.1881E+06	-1.7961E+04	2.6114E+04	1.1776E+06	-3.3936E+02	1.7783E+04	9.4410E-01
4.8342E+02	1.5888E+02	3.6027E+06	-1.7961E+04	1.9585E+04	2.3034E+06	-3.3936E+02	1.5763E+04	1.0856E+01
4.8342E+02	1.0592E+02	4.4188E+06	-1.7961E+04	1.3057E+04	3.8570E+06	-3.3936E+02	1.5358E+04	8.7389E+01
4.8342E+02	5.2962E+01	1.3264E+07	-1.7961E+04	6.5285E+03	6.5084E+06	-3.3936E+02	1.4954E+04	2.2604E+02
4.8342E+02	0.0000E+00	2.3611E+07	-1.7961E+04	0.0000E+00	5.9892E+06	-3.3936E+02	1.4550E+04	1.8740E+03
4.1855E+02	2.6481E+03	4.8920E-01	-2.4858E+04	3.0031E+05	1.3359E+00	-3.3936E+02	1.4146E+04	9.3973E+02
4.1855E+02	2.3833E+03	4.8920E-01	-2.4858E+04	2.7420E+05	4.8890E+00	-3.3936E+02	1.3742E+04	2.4123E+03
4.1855E+02	2.2773E+03	7.2371E+00	-2.4858E+04	2.6767E+05	1.1008E+01	-3.3936E+02	1.3338E+04	1.4647E+04
4.1855E+02	2.1714E+03	3.0287E+01	-2.4858E+04	2.6114E+05	6.9585E+00	-3.3936E+02	1.2933E+04	2.0489E+04
4.1855E+02	2.1185E+03	4.6947E+02	-2.4858E+04	2.5461E+05	6.5858E+00	-3.3936E+02	1.2529E+04	4.5237E+04
4.1855E+02	2.0655E+03	9.5627E+01	-2.4858E+04	2.4808E+05	6.5858E+00	-3.3936E+02	1.2125E+04	5.6921E+04
4.1855E+02	2.0125E+03	1.0351E+02	-2.4858E+04	2.4155E+05	1.2514E+01	-3.3936E+02	1.1721E+04	8.0047E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.1855E+02	1.9596E+03	1.3794E+02	-2.4858E+04	2.3503E+05	1.7500E+00	-3.3936E+02	1.1317E+04	1.1444E+05
4.1855E+02	1.9066E+03	6.2064E+02	-2.4858E+04	2.1544E+05	1.0625E-01	-3.3936E+02	1.0913E+04	8.5968E+04
4.1855E+02	1.8537E+03	2.5718E+02	-2.4858E+04	2.0891E+05	2.3750E+00	-3.3936E+02	1.0508E+04	6.1352E+04
4.1855E+02	1.8007E+03	4.1803E+02	-2.4858E+04	1.8933E+05	5.3125E-02	-3.3936E+02	1.0104E+04	6.4465E+04
4.1855E+02	1.7477E+03	9.7132E+02	-2.4858E+04	1.7627E+05	2.6563E-01	-3.3936E+02	9.7001E+03	8.3050E+04
4.1855E+02	1.6948E+03	4.8297E+02	-2.4858E+04	1.6974E+05	7.3125E-01	-3.3936E+02	9.2959E+03	1.2649E+05
4.1855E+02	1.6418E+03	7.8761E+02	-2.4858E+04	1.6321E+05	6.7813E-01	-3.3936E+02	8.8917E+03	9.3358E+04
4.1855E+02	1.5888E+03	2.7315E+03	-2.4858E+04	1.5668E+05	6.7813E-01	-3.3936E+02	8.4876E+03	9.6466E+04
4.1855E+02	1.5359E+03	4.0891E+03	-2.4858E+04	1.5016E+05	7.4753E-02	-3.3936E+02	8.0834E+03	1.1740E+05
4.1855E+02	1.4829E+03	5.7048E+03	-2.4858E+04	1.4363E+05	1.2748E+01	-3.3936E+02	7.6792E+03	2.1010E+05
4.1855E+02	1.4300E+03	8.2647E+03	-2.4858E+04	1.3710E+05	8.9093E+01	-3.3936E+02	7.2751E+03	2.1520E+05
4.1855E+02	1.3770E+03	1.0154E+04	-2.4858E+04	1.3057E+05	3.3866E+00	-3.3936E+02	6.8709E+03	2.6611E+05
4.1855E+02	1.3240E+03	9.7898E+03	-2.4858E+04	1.2404E+05	3.8927E+00	-3.3936E+02	6.4667E+03	3.4398E+05
4.1855E+02	1.2711E+03	1.9827E+04	-2.4858E+04	1.1751E+05	1.5988E+01	-3.3936E+02	6.0626E+03	4.7934E+05
4.1855E+02	1.2181E+03	1.7388E+04	-2.4858E+04	1.1098E+05	1.9402E+01	-3.3936E+02	5.6584E+03	7.2869E+05
4.1855E+02	1.1652E+03	1.9096E+04	-2.4858E+04	1.0446E+05	5.3506E+00	-3.3936E+02	5.2542E+03	8.3122E+05
4.1855E+02	1.1122E+03	2.5290E+04	-2.4858E+04	9.7927E+04	1.0729E+02	-3.3936E+02	4.8500E+03	1.1030E+06
4.1855E+02	1.0592E+03	3.0783E+04	-2.4858E+04	9.1399E+04	2.3846E+02	-3.3936E+02	4.4459E+03	1.4248E+06
4.1855E+02	1.0063E+03	5.7790E+04	-2.4858E+04	8.4870E+04	2.2597E+03	-3.3936E+02	4.0417E+03	1.7418E+06
4.1855E+02	9.5331E+02	5.6880E+04	-2.4858E+04	7.8342E+04	5.4324E+03	-3.3936E+02	3.6375E+03	2.2315E+06
4.1855E+02	9.0035E+02	8.0364E+04	-2.4858E+04	7.1813E+04	4.3476E+03	-3.3936E+02	3.2334E+03	2.7768E+06
4.1855E+02	8.4739E+02	1.1736E+05	-2.4858E+04	6.5285E+04	1.0119E+04	-3.3936E+02	2.8292E+03	3.2840E+06
4.1855E+02	7.9442E+02	1.2240E+05	-2.4858E+04	5.8756E+04	5.3793E+03	-3.3936E+02	2.4250E+03	3.7496E+06
4.1855E+02	7.4146E+02	2.0799E+05	-2.4858E+04	5.2228E+04	2.9687E+04	-3.3936E+02	2.0209E+03	4.3919E+06
4.1855E+02	6.8850E+02	1.8573E+05	-2.4858E+04	4.5699E+04	1.2135E+05	-3.3936E+02	1.6167E+03	4.8793E+06
4.1855E+02	6.3554E+02	2.7045E+05	-2.4858E+04	3.9171E+04	2.4184E+05	-3.3936E+02	1.2125E+03	5.5038E+06
4.1855E+02	5.8258E+02	3.7846E+05	-2.4858E+04	3.2642E+04	6.8106E+05	-3.3936E+02	8.0834E+02	6.6354E+06
4.1855E+02	5.2962E+02	6.6623E+05	-2.4858E+04	2.6114E+04	1.6369E+06	-3.3936E+02	4.0417E+02	1.5455E+07
4.1855E+02	4.7665E+02	6.0352E+05	-2.4858E+04	1.9585E+04	4.1228E+06	-3.3936E+02	0.0000E+00	3.2212E+07
4.1855E+02	4.2369E+02	9.0986E+05	-2.4858E+04	1.3057E+04	6.9770E+06	-8.0803E+02	1.7379E+04	1.8882E+00
4.1855E+02	3.7073E+02	1.6083E+06	-2.4858E+04	6.5285E+03	1.1881E+07	-8.0803E+02	1.6975E+04	1.6196E-01
4.1855E+02	3.1777E+02	1.9356E+06	-2.4858E+04	0.0000E+00	1.2643E+07	-8.0803E+02	1.6571E+04	1.0417E+00
4.1855E+02	2.6481E+02	2.8838E+06	-3.1756E+04	2.8072E+05	1.3359E+00	-8.0803E+02	1.6167E+04	2.1338E+01
4.1855E+02	2.1185E+02	3.5345E+06	-3.1756E+04	2.7420E+05	1.3359E+00	-8.0803E+02	1.5763E+04	9.0822E+01
4.1855E+02	1.5888E+02	4.2234E+06	-3.1756E+04	2.6767E+05	7.5075E+00	-8.0803E+02	1.5358E+04	9.6820E+01
4.1855E+02	1.0592E+02	4.9900E+06	-3.1756E+04	2.6114E+05	2.0461E+01	-8.0803E+02	1.4954E+04	9.4177E+02
4.1855E+02	5.2962E+01	1.4197E+07	-3.1756E+04	2.5461E+05	3.5000E+00	-8.0803E+02	1.4550E+04	1.2346E+03
4.1855E+02	0.0000E+00	2.9057E+07	-3.1756E+04	2.4808E+05	1.2208E+01	-8.0803E+02	1.4146E+04	4.0575E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.5368E+02	2.2773E+03	9.7840E-01	-3.1756E+04	2.4155E+05	9.3750E+00	-8.0803E+02	1.3742E+04	8.3568E+03
3.5368E+02	2.2244E+03	6.2500E-01	-3.1756E+04	2.3503E+05	4.1250E+00	-8.0803E+02	1.3338E+04	7.4835E+03
3.5368E+02	2.1714E+03	1.0625E-01	-3.1756E+04	2.2850E+05	6.7813E-01	-8.0803E+02	1.2933E+04	2.6532E+04
3.5368E+02	2.1185E+03	4.4609E+02	-3.1756E+04	2.2197E+05	1.7500E+00	-8.0803E+02	1.2529E+04	2.0703E+04
3.5368E+02	2.0655E+03	5.9667E-01	-3.1756E+04	2.1544E+05	6.7813E-01	-8.0803E+02	1.2125E+04	4.1978E+04
3.5368E+02	2.0125E+03	7.8895E+01	-3.1756E+04	2.0891E+05	1.2500E+00	-8.0803E+02	1.1721E+04	5.5429E+04
3.5368E+02	1.9596E+03	5.6509E+01	-3.1756E+04	2.0238E+05	5.3125E-02	-8.0803E+02	1.1317E+04	6.6640E+04
3.5368E+02	1.9066E+03	1.4735E+02	-3.1756E+04	1.9585E+05	1.0625E-01	-8.0803E+02	1.0913E+04	7.0773E+04
3.5368E+02	1.8537E+03	5.2701E+01	-3.1756E+04	1.8933E+05	6.2500E-01	-8.0803E+02	1.0508E+04	5.8390E+04
3.5368E+02	1.8007E+03	1.4260E+02	-3.1756E+04	1.8280E+05	8.1415E-01	-8.0803E+02	1.0104E+04	6.3742E+04
3.5368E+02	1.7477E+03	1.6441E+02	-3.1756E+04	1.7627E+05	8.3750E-01	-8.0803E+02	9.7001E+03	7.3621E+04
3.5368E+02	1.6948E+03	2.7262E+02	-3.1756E+04	1.6974E+05	1.3603E-01	-8.0803E+02	9.2959E+03	7.2984E+04
3.5368E+02	1.6418E+03	2.9868E+02	-3.1756E+04	1.6321E+05	6.2500E-01	-8.0803E+02	8.8917E+03	9.4394E+04
3.5368E+02	1.5888E+03	4.1542E+02	-3.1756E+04	1.5668E+05	9.1891E-01	-8.0803E+02	8.4876E+03	1.0611E+05
3.5368E+02	1.5359E+03	1.0901E+03	-3.1756E+04	1.5016E+05	1.1865E+01	-8.0803E+02	8.0834E+03	1.3838E+05
3.5368E+02	1.4829E+03	1.0764E+03	-3.1756E+04	1.4363E+05	2.5505E+00	-8.0803E+02	7.6792E+03	1.6214E+05
3.5368E+02	1.4300E+03	1.2788E+03	-3.1756E+04	1.3710E+05	2.2746E+01	-8.0803E+02	7.2751E+03	2.3994E+05
3.5368E+02	1.3770E+03	2.6488E+03	-3.1756E+04	1.3057E+05	7.2475E+00	-8.0803E+02	6.8709E+03	3.2196E+05
3.5368E+02	1.3240E+03	2.0789E+03	-3.1756E+04	1.2404E+05	1.0829E+01	-8.0803E+02	6.4667E+03	3.1159E+05
3.5368E+02	1.2711E+03	5.6942E+03	-3.1756E+04	1.1751E+05	2.1266E+02	-8.0803E+02	6.0626E+03	4.7980E+05
3.5368E+02	1.2181E+03	7.2278E+03	-3.1756E+04	1.1098E+05	1.2627E+02	-8.0803E+02	5.6584E+03	6.7418E+05
3.5368E+02	1.1652E+03	6.3146E+03	-3.1756E+04	1.0446E+05	1.6098E+02	-8.0803E+02	5.2542E+03	8.0591E+05
3.5368E+02	1.1122E+03	1.0351E+04	-3.1756E+04	9.7927E+04	1.0708E+03	-8.0803E+02	4.8500E+03	1.0190E+06
3.5368E+02	1.0592E+03	1.0394E+04	-3.1756E+04	9.1399E+04	8.1874E+02	-8.0803E+02	4.4459E+03	1.4077E+06
3.5368E+02	1.0063E+03	1.7885E+04	-3.1756E+04	8.4870E+04	1.7647E+03	-8.0803E+02	4.0417E+03	1.6627E+06
3.5368E+02	9.5331E+02	2.3464E+04	-3.1756E+04	7.8342E+04	8.0324E+03	-8.0803E+02	3.6375E+03	1.9434E+06
3.5368E+02	9.0035E+02	3.5344E+04	-3.1756E+04	7.1813E+04	7.4079E+03	-8.0803E+02	3.2334E+03	2.4068E+06
3.5368E+02	8.4739E+02	3.0243E+04	-3.1756E+04	6.5285E+04	1.4569E+04	-8.0803E+02	2.8292E+03	2.8145E+06
3.5368E+02	7.9442E+02	4.2852E+04	-3.1756E+04	5.8756E+04	1.8484E+04	-8.0803E+02	2.4250E+03	3.1230E+06
3.5368E+02	7.4146E+02	5.6887E+04	-3.1756E+04	5.2228E+04	4.9423E+04	-8.0803E+02	2.0209E+03	3.4167E+06
3.5368E+02	6.8850E+02	7.4681E+04	-3.1756E+04	4.5699E+04	7.8239E+04	-8.0803E+02	1.6167E+03	3.4588E+06
3.5368E+02	6.3554E+02	1.0228E+05	-3.1756E+04	3.9171E+04	1.5539E+05	-8.0803E+02	1.2125E+03	3.9886E+06
3.5368E+02	5.8258E+02	1.1443E+05	-3.1756E+04	3.2642E+04	4.1836E+05	-8.0803E+02	8.0834E+02	5.3917E+06
3.5368E+02	5.2962E+02	1.8099E+05	-3.1756E+04	2.6114E+04	1.0897E+06	-8.0803E+02	4.0417E+02	1.2560E+07
3.5368E+02	4.7665E+02	2.7293E+05	-3.1756E+04	1.9585E+04	2.8259E+06	-8.0803E+02	0.0000E+00	2.4871E+07
3.5368E+02	4.2369E+02	4.9697E+05	-3.1756E+04	1.3057E+04	5.4595E+06	-1.2767E+03	1.8188E+04	3.6186E+00
3.5368E+02	3.7073E+02	8.3804E+05	-3.1756E+04	6.5285E+03	9.4961E+06	-1.2767E+03	1.7783E+04	1.0417E+00
3.5368E+02	3.1777E+02	1.4727E+06	-3.1756E+04	0.0000E+00	9.7989E+06	-1.2767E+03	1.6571E+04	4.0755E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tåsinge Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.5368E+02	2.6481E+02	2.8517E+06	-3.8653E+04	2.7420E+05	2.6717E+00	-1.2767E+03	1.6167E+04	5.1017E+00
3.5368E+02	2.1185E+02	4.3533E+06	-3.8653E+04	2.6767E+05	4.0076E+00	-1.2767E+03	1.5763E+04	4.4491E+01
3.5368E+02	1.5888E+02	5.4403E+06	-3.8653E+04	2.6114E+05	5.2085E+00	-1.2767E+03	1.5358E+04	1.1075E+02
3.5368E+02	1.0592E+02	6.5077E+06	-3.8653E+04	2.5461E+05	4.8358E+00	-1.2767E+03	1.4954E+04	3.8935E+02
3.5368E+02	5.2962E+01	1.3483E+07	-3.8653E+04	2.4808E+05	4.4217E+00	-1.2767E+03	1.4550E+04	4.6224E+02
3.5368E+02	0.0000E+00	3.2566E+07	-3.8653E+04	2.4155E+05	1.3359E+00	-1.2767E+03	1.4146E+04	2.5474E+03
2.8881E+02	2.3833E+03	9.7840E-01	-3.8653E+04	2.3503E+05	9.6302E+00	-1.2767E+03	1.3742E+04	5.4289E+03
2.8881E+02	2.2773E+03	5.3125E-02	-3.8653E+04	2.2850E+05	5.2616E+00	-1.2767E+03	1.3338E+04	3.8855E+03
2.8881E+02	2.2244E+03	5.3125E-02	-3.8653E+04	2.2197E+05	1.8031E+00	-1.2767E+03	1.2933E+04	3.5600E+03
2.8881E+02	2.1185E+03	3.0859E+00	-3.8653E+04	2.1544E+05	1.5282E+01	-1.2767E+03	1.2529E+04	5.3357E+03
2.8881E+02	2.0655E+03	4.4421E+00	-3.8653E+04	2.0891E+05	6.7813E-01	-1.2767E+03	1.2125E+04	1.2258E+04
2.8881E+02	2.0125E+03	1.3556E+01	-3.8653E+04	2.0238E+05	8.2480E+00	-1.2767E+03	1.1721E+04	1.0596E+04
2.8881E+02	1.9596E+03	2.9991E+01	-3.8653E+04	1.9585E+05	3.0531E+00	-1.2767E+03	1.1317E+04	1.4514E+04
2.8881E+02	1.9066E+03	1.0476E+01	-3.8653E+04	1.8933E+05	1.0763E+01	-1.2767E+03	1.0913E+04	3.8709E+04
2.8881E+02	1.8537E+03	3.8212E+01	-3.8653E+04	1.8280E+05	1.9230E+00	-1.2767E+03	1.0508E+04	2.7900E+04
2.8881E+02	1.8007E+03	2.9877E+01	-3.8653E+04	1.7627E+05	2.6609E+00	-1.2767E+03	1.0104E+04	3.6106E+04
2.8881E+02	1.7477E+03	1.2087E+02	-3.8653E+04	1.6974E+05	3.0034E+01	-1.2767E+03	9.7001E+03	5.7667E+04
2.8881E+02	1.6948E+03	2.7510E+01	-3.8653E+04	1.6321E+05	3.6866E-01	-1.2767E+03	9.2959E+03	6.3538E+04
2.8881E+02	1.6418E+03	1.3919E+02	-3.8653E+04	1.5668E+05	8.0789E+00	-1.2767E+03	8.8917E+03	7.0486E+04
2.8881E+02	1.5888E+03	2.3085E+02	-3.8653E+04	1.5016E+05	3.9120E+00	-1.2767E+03	8.4876E+03	8.4695E+04
2.8881E+02	1.5359E+03	3.7042E+02	-3.8653E+04	1.4363E+05	1.2130E+01	-1.2767E+03	8.0834E+03	9.6879E+04
2.8881E+02	1.4829E+03	2.7973E+02	-3.8653E+04	1.3710E+05	1.9699E+01	-1.2767E+03	7.6792E+03	1.4788E+05
2.8881E+02	1.4300E+03	5.3260E+02	-3.8653E+04	1.3057E+05	1.0780E+02	-1.2767E+03	7.2751E+03	1.7735E+05
2.8881E+02	1.3770E+03	4.0000E+02	-3.8653E+04	1.2404E+05	9.7637E+01	-1.2767E+03	6.8709E+03	2.9280E+05
2.8881E+02	1.3240E+03	6.1380E+02	-3.8653E+04	1.1751E+05	3.1028E+02	-1.2767E+03	6.4667E+03	3.0955E+05
2.8881E+02	1.2711E+03	1.3777E+03	-3.8653E+04	1.1098E+05	3.4071E+02	-1.2767E+03	6.0626E+03	4.1856E+05
2.8881E+02	1.2181E+03	1.3412E+03	-3.8653E+04	1.0446E+05	2.4272E+02	-1.2767E+03	5.6584E+03	5.2413E+05
2.8881E+02	1.1652E+03	1.5422E+03	-3.8653E+04	9.7927E+04	4.7240E+02	-1.2767E+03	5.2542E+03	7.3832E+05
2.8881E+02	1.1122E+03	2.1040E+03	-3.8653E+04	9.1399E+04	9.5526E+02	-1.2767E+03	4.8500E+03	1.0209E+06
2.8881E+02	1.0592E+03	2.7755E+03	-3.8653E+04	8.4870E+04	3.4925E+03	-1.2767E+03	4.4459E+03	1.3617E+06
2.8881E+02	1.0063E+03	3.0639E+03	-3.8653E+04	7.8342E+04	2.8034E+03	-1.2767E+03	4.0417E+03	1.4458E+06
2.8881E+02	9.5331E+02	7.0882E+03	-3.8653E+04	7.1813E+04	3.8824E+03	-1.2767E+03	3.6375E+03	1.8025E+06
2.8881E+02	9.0035E+02	9.3509E+03	-3.8653E+04	6.5285E+04	9.5869E+03	-1.2767E+03	3.2334E+03	2.0420E+06
2.8881E+02	8.4739E+02	7.1481E+03	-3.8653E+04	5.8756E+04	2.2359E+04	-1.2767E+03	2.8292E+03	2.2232E+06
2.8881E+02	7.9442E+02	1.5422E+04	-3.8653E+04	5.2228E+04	4.1626E+04	-1.2767E+03	2.4250E+03	2.5481E+06
2.8881E+02	7.4146E+02	2.0795E+04	-3.8653E+04	4.5699E+04	7.2331E+04	-1.2767E+03	2.0209E+03	2.3713E+06
2.8881E+02	6.8850E+02	3.2758E+04	-3.8653E+04	3.9171E+04	2.0390E+05	-1.2767E+03	1.6167E+03	2.7408E+06
2.8881E+02	6.3554E+02	4.0857E+04	-3.8653E+04	3.2642E+04	4.6785E+05	-1.2767E+03	1.2125E+03	2.8967E+06

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.8881E+02	5.8258E+02	8.3190E+04	-3.8653E+04	2.6114E+04	1.2680E+06	-1.2767E+03	8.0834E+02	4.3705E+06
2.8881E+02	5.2962E+02	1.6639E+05	-3.8653E+04	1.9585E+04	2.3444E+06	-1.2767E+03	4.0417E+02	9.6021E+06
2.8881E+02	4.7665E+02	3.2749E+05	-3.8653E+04	1.3057E+04	4.2587E+06	-1.2767E+03	0.0000E+00	1.9151E+07
2.8881E+02	4.2369E+02	5.8211E+05	-3.8653E+04	6.5285E+03	6.8348E+06	-1.7454E+03	1.6975E+04	8.3335E+01
2.8881E+02	3.7073E+02	1.0880E+06	-3.8653E+04	0.0000E+00	8.2254E+06	-1.7454E+03	1.6571E+04	2.4639E+01
2.8881E+02	3.1777E+02	1.7828E+06	-4.5551E+04	2.6114E+05	1.3359E+00	-1.7454E+03	1.6167E+04	1.5691E+00
2.8881E+02	2.6481E+02	2.9423E+06	-4.5551E+04	2.5461E+05	5.2085E+00	-1.7454E+03	1.5763E+04	1.2708E+02
2.8881E+02	2.1185E+02	4.5580E+06	-4.5551E+04	2.4808E+05	1.4839E+01	-1.7454E+03	1.5358E+04	5.6523E+02
2.8881E+02	1.5888E+02	4.9869E+06	-4.5551E+04	2.3503E+05	1.3142E+01	-1.7454E+03	1.4954E+04	3.0055E+01
2.8881E+02	1.0592E+02	6.2860E+06	-4.5551E+04	2.2850E+05	6.5443E+00	-1.7454E+03	1.4550E+04	3.3614E+01
2.8881E+02	5.2962E+01	1.0213E+07	-4.5551E+04	2.2197E+05	1.1753E+01	-1.7454E+03	1.4146E+04	3.0077E+02
2.8881E+02	0.0000E+00	2.9555E+07	-4.5551E+04	2.1544E+05	1.1176E+01	-1.7454E+03	1.3742E+04	2.7527E+02
2.2393E+02	2.2773E+03	6.2500E-01	-4.5551E+04	2.0891E+05	5.3125E-02	-1.7454E+03	1.3338E+04	1.0645E+03
2.2393E+02	2.2244E+03	5.3125E-02	-4.5551E+04	2.0238E+05	2.8832E+00	-1.7454E+03	1.2933E+04	6.0505E+02
2.2393E+02	2.1714E+03	1.3359E+00	-4.5551E+04	1.9585E+05	2.6892E+01	-1.7454E+03	1.2529E+04	1.6683E+03
2.2393E+02	2.1185E+03	3.5531E+00	-4.5551E+04	1.8933E+05	1.5158E+01	-1.7454E+03	1.2125E+04	3.8194E+03
2.2393E+02	2.0655E+03	1.1195E+01	-4.5551E+04	1.8280E+05	8.7142E+00	-1.7454E+03	1.1721E+04	3.2012E+03
2.2393E+02	2.0125E+03	2.2920E+01	-4.5551E+04	1.7627E+05	2.3698E+00	-1.7454E+03	1.1317E+04	4.0588E+03
2.2393E+02	1.9596E+03	1.5294E+01	-4.5551E+04	1.6974E+05	1.1443E+01	-1.7454E+03	1.0913E+04	1.5409E+03
2.2393E+02	1.9066E+03	8.2736E+00	-4.5551E+04	1.6321E+05	8.6063E-01	-1.7454E+03	1.0508E+04	1.0800E+04
2.2393E+02	1.8537E+03	1.9523E+01	-4.5551E+04	1.5668E+05	1.0812E+01	-1.7454E+03	1.0104E+04	1.4615E+04
2.2393E+02	1.8007E+03	5.4786E+00	-4.5551E+04	1.5016E+05	8.8658E+01	-1.7454E+03	9.7001E+03	2.2459E+04
2.2393E+02	1.7477E+03	5.3562E+00	-4.5551E+04	1.4363E+05	1.3854E+01	-1.7454E+03	9.2959E+03	3.5795E+04
2.2393E+02	1.6948E+03	1.0533E+01	-4.5551E+04	1.3710E+05	3.2912E+01	-1.7454E+03	8.8917E+03	4.9758E+04
2.2393E+02	1.6418E+03	6.3014E+00	-4.5551E+04	1.3057E+05	7.5802E+01	-1.7454E+03	8.4876E+03	7.6564E+04
2.2393E+02	1.5888E+03	6.9135E+00	-4.5551E+04	1.2404E+05	1.1710E+02	-1.7454E+03	8.0834E+03	7.7047E+04
2.2393E+02	1.5359E+03	1.0744E+01	-4.5551E+04	1.1751E+05	1.0459E+02	-1.7454E+03	7.6792E+03	1.2332E+05
2.2393E+02	1.4829E+03	7.9207E+00	-4.5551E+04	1.1098E+05	1.8454E+02	-1.7454E+03	7.2751E+03	1.4720E+05
2.2393E+02	1.4300E+03	3.5656E+01	-4.5551E+04	1.0446E+05	4.2038E+02	-1.7454E+03	6.8709E+03	2.1548E+05
2.2393E+02	1.3770E+03	3.5442E+01	-4.5551E+04	9.7927E+04	7.1688E+02	-1.7454E+03	6.4667E+03	2.9566E+05
2.2393E+02	1.3240E+03	1.6829E+02	-4.5551E+04	9.1399E+04	1.3733E+03	-1.7454E+03	6.0626E+03	3.5860E+05
2.2393E+02	1.2711E+03	1.8472E+02	-4.5551E+04	8.4870E+04	2.0428E+03	-1.7454E+03	5.6584E+03	5.5137E+05
2.2393E+02	1.2181E+03	8.7864E+01	-4.5551E+04	7.8342E+04	3.4060E+03	-1.7454E+03	5.2542E+03	7.1572E+05
2.2393E+02	1.1652E+03	5.0938E+02	-4.5551E+04	7.1813E+04	4.0671E+03	-1.7454E+03	4.8500E+03	7.8244E+05
2.2393E+02	1.1122E+03	1.0190E+03	-4.5551E+04	6.5285E+04	4.6392E+03	-1.7454E+03	4.4459E+03	9.4388E+05
2.2393E+02	1.0592E+03	1.1440E+03	-4.5551E+04	5.8756E+04	1.0225E+04	-1.7454E+03	4.0417E+03	1.1157E+06
2.2393E+02	1.0063E+03	9.0171E+02	-4.5551E+04	5.2228E+04	2.4466E+04	-1.7454E+03	3.6375E+03	1.5707E+06
2.2393E+02	9.5331E+02	2.9118E+03	-4.5551E+04	4.5699E+04	6.5375E+04	-1.7454E+03	3.2334E+03	1.7110E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.2393E+02	9.0035E+02	2.8356E+03	-4.5551E+04	3.9171E+04	1.1755E+05	-1.7454E+03	2.8292E+03	1.9731E+06
2.2393E+02	8.4739E+02	3.9868E+03	-4.5551E+04	3.2642E+04	4.9505E+05	-1.7454E+03	2.4250E+03	1.9108E+06
2.2393E+02	7.9442E+02	7.5769E+03	-4.5551E+04	2.6114E+04	1.1042E+06	-1.7454E+03	2.0209E+03	1.8788E+06
2.2393E+02	7.4146E+02	1.4826E+04	-4.5551E+04	1.9585E+04	2.1819E+06	-1.7454E+03	1.6167E+03	1.8476E+06
2.2393E+02	6.8850E+02	2.5284E+04	-4.5551E+04	1.3057E+04	2.9376E+06	-1.7454E+03	1.2125E+03	2.1440E+06
2.2393E+02	6.3554E+02	4.1346E+04	-4.5551E+04	6.5285E+03	5.2771E+06	-1.7454E+03	8.0834E+02	3.5220E+06
2.2393E+02	5.8258E+02	1.3308E+05	-4.5551E+04	0.0000E+00	7.7959E+06	-1.7454E+03	4.0417E+02	7.9026E+06
2.2393E+02	5.2962E+02	2.0695E+05	-5.2448E+04	2.6114E+05	1.3359E+00	-1.7454E+03	0.0000E+00	1.4597E+07
2.2393E+02	4.7665E+02	3.9749E+05	-5.2448E+04	2.5461E+05	6.5443E+00	-2.2141E+03	1.8188E+04	9.4410E-01
2.2393E+02	4.2369E+02	7.4062E+05	-5.2448E+04	2.4808E+05	1.3359E+00	-2.2141E+03	1.7783E+04	6.1840E-01
2.2393E+02	3.7073E+02	1.3234E+06	-5.2448E+04	2.4155E+05	5.2085E+00	-2.2141E+03	1.6975E+04	1.6196E-01
2.2393E+02	3.1777E+02	2.2030E+06	-5.2448E+04	2.3503E+05	6.5443E+00	-2.2141E+03	1.6571E+04	1.6196E-01
2.2393E+02	2.6481E+02	3.7802E+06	-5.2448E+04	2.2850E+05	1.3359E+00	-2.2141E+03	1.6167E+04	5.3125E-02
2.2393E+02	2.1185E+02	6.0400E+06	-5.2448E+04	2.2197E+05	1.3359E+00	-2.2141E+03	1.5763E+04	2.8860E+01
2.2393E+02	1.5888E+02	7.7830E+06	-5.2448E+04	2.1544E+05	1.7500E+00	-2.2141E+03	1.5358E+04	4.4520E+00
2.2393E+02	1.0592E+02	8.9329E+06	-5.2448E+04	2.0891E+05	1.3149E+01	-2.2141E+03	1.4954E+04	9.8135E+00
2.2393E+02	5.2962E+01	9.8200E+06	-5.2448E+04	2.0238E+05	4.8358E+00	-2.2141E+03	1.4550E+04	3.0286E+02
2.2393E+02	0.0000E+00	2.9456E+07	-5.2448E+04	1.9585E+05	1.3908E+01	-2.2141E+03	1.4146E+04	6.0079E+02
1.5906E+02	2.3303E+03	2.6717E+00	-5.2448E+04	1.8933E+05	1.3732E+01	-2.2141E+03	1.3742E+04	4.9577E+01
1.5906E+02	2.2773E+03	1.3359E+00	-5.2448E+04	1.8280E+05	1.5684E+01	-2.2141E+03	1.3338E+04	3.4607E+01
1.5906E+02	2.2244E+03	1.7500E+00	-5.2448E+04	1.7627E+05	1.9116E+01	-2.2141E+03	1.2933E+04	9.4576E+01
1.5906E+02	2.1714E+03	3.0859E+00	-5.2448E+04	1.6974E+05	2.2262E+01	-2.2141E+03	1.2529E+04	1.5920E+02
1.5906E+02	2.1185E+03	4.9109E+00	-5.2448E+04	1.6321E+05	3.1604E+00	-2.2141E+03	1.2125E+04	6.0734E+02
1.5906E+02	2.0655E+03	1.3359E+00	-5.2448E+04	1.5668E+05	6.8392E+01	-2.2141E+03	1.1721E+04	7.2294E+02
1.5906E+02	2.0125E+03	8.3358E+00	-5.2448E+04	1.5016E+05	2.4143E+01	-2.2141E+03	1.1317E+04	8.5791E+02
1.5906E+02	1.9596E+03	3.6875E+00	-5.2448E+04	1.4363E+05	1.5391E+02	-2.2141E+03	1.0913E+04	2.0590E+03
1.5906E+02	1.9066E+03	6.2248E+00	-5.2448E+04	1.3710E+05	1.4987E+02	-2.2141E+03	1.0508E+04	3.8433E+03
1.5906E+02	1.8537E+03	5.2500E+00	-5.2448E+04	1.3057E+05	1.6347E+02	-2.2141E+03	1.0104E+04	6.2948E+03
1.5906E+02	1.8007E+03	2.3750E+00	-5.2448E+04	1.2404E+05	1.3967E+02	-2.2141E+03	9.7001E+03	4.9367E+03
1.5906E+02	1.7477E+03	5.3125E-02	-5.2448E+04	1.1751E+05	1.4334E+03	-2.2141E+03	9.2959E+03	1.2789E+04
1.5906E+02	1.6948E+03	1.2788E-01	-5.2448E+04	1.1098E+05	8.0155E+02	-2.2141E+03	8.8917E+03	2.9161E+04
1.5906E+02	1.6418E+03	1.0625E-01	-5.2448E+04	1.0446E+05	8.8850E+02	-2.2141E+03	8.4876E+03	1.4549E+04
1.5906E+02	1.5888E+03	2.4487E-01	-5.2448E+04	9.7927E+04	3.0776E+03	-2.2141E+03	8.0834E+03	3.7813E+04
1.5906E+02	1.5359E+03	1.7609E+00	-5.2448E+04	9.1399E+04	4.2451E+03	-2.2141E+03	7.6792E+03	6.8790E+04
1.5906E+02	1.4829E+03	4.0226E+00	-5.2448E+04	8.4870E+04	4.2655E+03	-2.2141E+03	7.2751E+03	8.8452E+04
1.5906E+02	1.4300E+03	1.2542E+00	-5.2448E+04	7.8342E+04	3.4568E+03	-2.2141E+03	6.8709E+03	1.5531E+05
1.5906E+02	1.3770E+03	1.3055E+01	-5.2448E+04	7.1813E+04	6.2889E+03	-2.2141E+03	6.4667E+03	2.2366E+05
1.5906E+02	1.3240E+03	8.0254E+00	-5.2448E+04	6.5285E+04	1.8132E+04	-2.2141E+03	6.0626E+03	2.3646E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.5906E+02	1.2711E+03	1.9130E+01	-5.2448E+04	5.8756E+04	2.0893E+04	-2.2141E+03	5.6584E+03	4.2656E+05
1.5906E+02	1.2181E+03	9.1511E+00	-5.2448E+04	5.2228E+04	3.0288E+04	-2.2141E+03	5.2542E+03	5.0234E+05
1.5906E+02	1.1652E+03	2.3387E+02	-5.2448E+04	4.5699E+04	4.5355E+04	-2.2141E+03	4.8500E+03	7.6951E+05
1.5906E+02	1.1122E+03	8.4534E+01	-5.2448E+04	3.9171E+04	1.1047E+05	-2.2141E+03	4.4459E+03	7.0321E+05
1.5906E+02	1.0592E+03	9.4102E+01	-5.2448E+04	3.2642E+04	2.5809E+05	-2.2141E+03	4.0417E+03	1.0448E+06
1.5906E+02	1.0063E+03	6.5891E+02	-5.2448E+04	2.6114E+04	8.3046E+05	-2.2141E+03	3.6375E+03	1.1144E+06
1.5906E+02	9.5331E+02	1.2947E+03	-5.2448E+04	1.9585E+04	1.7766E+06	-2.2141E+03	3.2334E+03	1.5899E+06
1.5906E+02	9.0035E+02	1.3416E+03	-5.2448E+04	1.3057E+04	2.9689E+06	-2.2141E+03	2.8292E+03	1.2931E+06
1.5906E+02	8.4739E+02	7.4887E+03	-5.2448E+04	6.5285E+03	4.7961E+06	-2.2141E+03	2.4250E+03	1.3064E+06
1.5906E+02	7.9442E+02	8.6619E+03	-5.2448E+04	0.0000E+00	9.2476E+06	-2.2141E+03	2.0209E+03	1.3197E+06
1.5906E+02	7.4146E+02	2.8070E+04	-5.9346E+04	2.6114E+05	1.3359E+00	-2.2141E+03	1.6167E+03	1.3297E+06
1.5906E+02	6.8850E+02	4.9389E+04	-5.9346E+04	2.5461E+05	1.3359E+00	-2.2141E+03	1.2125E+03	1.6074E+06
1.5906E+02	6.3554E+02	1.0237E+05	-5.9346E+04	2.4808E+05	6.5443E+00	-2.2141E+03	8.0834E+02	2.8983E+06
1.5906E+02	5.8258E+02	1.4267E+05	-5.9346E+04	2.3503E+05	4.0076E+00	-2.2141E+03	4.0417E+02	6.0953E+06
1.5906E+02	5.2962E+02	2.8481E+05	-5.9346E+04	2.2850E+05	4.0076E+00	-2.2141E+03	0.0000E+00	1.0388E+07
1.5906E+02	4.7665E+02	5.2428E+05	-5.9346E+04	2.2197E+05	1.3359E+00	-2.6827E+03	1.6975E+04	1.6196E-01
1.5906E+02	4.2369E+02	9.1152E+05	-5.9346E+04	2.1544E+05	1.3359E+00	-2.6827E+03	1.6571E+04	1.3978E+01
1.5906E+02	3.7073E+02	1.5925E+06	-5.9346E+04	2.0891E+05	5.3125E-02	-2.6827E+03	1.6167E+04	1.5938E-01
1.5906E+02	3.1777E+02	2.8751E+06	-5.9346E+04	2.0238E+05	1.1753E+01	-2.6827E+03	1.5763E+04	8.2187E+00
1.5906E+02	2.6481E+02	5.0161E+06	-5.9346E+04	1.9585E+05	1.0869E+01	-2.6827E+03	1.5358E+04	6.7153E-01
1.5906E+02	2.1185E+02	7.8785E+06	-5.9346E+04	1.8933E+05	2.4502E+01	-2.6827E+03	1.4954E+04	1.3952E+02
1.5906E+02	1.5888E+02	1.0601E+07	-5.9346E+04	1.8280E+05	3.4499E+00	-2.6827E+03	1.4550E+04	4.4029E+01
1.5906E+02	1.0592E+02	1.0742E+07	-5.9346E+04	1.7627E+05	3.5310E+01	-2.6827E+03	1.4146E+04	1.1024E+01
1.5906E+02	5.2962E+01	1.1438E+07	-5.9346E+04	1.6974E+05	2.7233E+00	-2.6827E+03	1.3742E+04	5.4120E+01
1.5906E+02	0.0000E+00	3.0999E+07	-5.9346E+04	1.6321E+05	1.3373E+01	-2.6827E+03	1.3338E+04	7.8559E+00
9.4190E+01	2.4892E+03	6.2500E-01	-5.9346E+04	1.5668E+05	3.9974E+01	-2.6827E+03	1.2933E+04	9.4894E+00
9.4190E+01	2.4362E+03	1.3359E+00	-5.9346E+04	1.5016E+05	2.9576E+01	-2.6827E+03	1.2529E+04	5.5581E+01
9.4190E+01	2.3303E+03	2.6717E+00	-5.9346E+04	1.4363E+05	4.6924E+01	-2.6827E+03	1.2125E+04	8.3204E+00
9.4190E+01	2.2773E+03	2.7248E+00	-5.9346E+04	1.3710E+05	1.0090E+02	-2.6827E+03	1.1721E+04	5.1028E+02
9.4190E+01	2.2244E+03	2.6717E+00	-5.9346E+04	1.3057E+05	1.1772E+03	-2.6827E+03	1.1317E+04	2.8937E+02
9.4190E+01	2.1714E+03	2.6717E+00	-5.9346E+04	1.2404E+05	6.3030E+02	-2.6827E+03	1.0913E+04	3.4785E+02
9.4190E+01	2.1185E+03	1.0625E-01	-5.9346E+04	1.1751E+05	4.8246E+02	-2.6827E+03	1.0508E+04	1.5285E+02
9.4190E+01	2.0655E+03	7.9217E+00	-5.9346E+04	1.1098E+05	1.0777E+03	-2.6827E+03	1.0104E+04	2.1471E+02
9.4190E+01	1.9596E+03	3.1390E+00	-5.9346E+04	1.0446E+05	3.3125E+03	-2.6827E+03	9.7001E+03	2.5353E+02
9.4190E+01	1.9066E+03	3.5000E+00	-5.9346E+04	9.7927E+04	3.8810E+03	-2.6827E+03	9.2959E+03	9.3256E+02
9.4190E+01	1.8537E+03	3.5000E+00	-5.9346E+04	9.1399E+04	2.5305E+03	-2.6827E+03	8.8917E+03	5.2328E+02
9.4190E+01	1.8007E+03	5.3125E-02	-5.9346E+04	8.4870E+04	3.0266E+04	-2.6827E+03	8.4876E+03	5.6105E+03
9.4190E+01	1.5888E+03	7.3125E-01	-5.9346E+04	7.8342E+04	1.1978E+04	-2.6827E+03	8.0834E+03	4.5382E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
9.4190E+01	1.5359E+03	1.0625E-01	-5.9346E+04	7.1813E+04	1.5865E+04	-2.6827E+03	7.6792E+03	1.2618E+04
9.4190E+01	1.4829E+03	1.5938E-01	-5.9346E+04	6.5285E+04	1.6810E+04	-2.6827E+03	7.2751E+03	4.9329E+04
9.4190E+01	1.4300E+03	8.8774E-01	-5.9346E+04	5.8756E+04	2.5633E+04	-2.6827E+03	6.8709E+03	6.4199E+04
9.4190E+01	1.3770E+03	1.6750E+00	-5.9346E+04	5.2228E+04	3.9792E+04	-2.6827E+03	6.4667E+03	1.1987E+05
9.4190E+01	1.3240E+03	3.9042E+00	-5.9346E+04	4.5699E+04	8.2129E+04	-2.6827E+03	6.0626E+03	1.3581E+05
9.4190E+01	1.2711E+03	3.1491E+00	-5.9346E+04	3.9171E+04	1.4770E+05	-2.6827E+03	5.6584E+03	2.2414E+05
9.4190E+01	1.2181E+03	1.6254E+01	-5.9346E+04	3.2642E+04	2.9246E+05	-2.6827E+03	5.2542E+03	3.4684E+05
9.4190E+01	1.1652E+03	4.0412E+00	-5.9346E+04	2.6114E+04	7.9619E+05	-2.6827E+03	4.8500E+03	4.0068E+05
9.4190E+01	1.1122E+03	3.3863E+01	-5.9346E+04	1.9585E+04	2.0149E+06	-2.6827E+03	4.4459E+03	5.5634E+05
9.4190E+01	1.0592E+03	6.1872E+01	-5.9346E+04	1.3057E+04	3.6236E+06	-2.6827E+03	4.0417E+03	6.4902E+05
9.4190E+01	1.0063E+03	8.2645E+02	-5.9346E+04	6.5285E+03	4.8331E+06	-2.6827E+03	3.6375E+03	8.4137E+05
9.4190E+01	9.5331E+02	2.1230E+02	-5.9346E+04	0.0000E+00	9.9697E+06	-2.6827E+03	3.2334E+03	1.0386E+06
9.4190E+01	9.0035E+02	3.7143E+03	-6.6243E+04	2.2197E+05	5.3125E-02	-2.6827E+03	2.8292E+03	9.6717E+05
9.4190E+01	8.4739E+02	9.2871E+03	-6.6243E+04	2.0891E+05	1.3017E+01	-2.6827E+03	2.4250E+03	1.1368E+06
9.4190E+01	7.9442E+02	7.0730E+03	-6.6243E+04	1.9585E+05	7.6502E+00	-2.6827E+03	2.0209E+03	9.6459E+05
9.4190E+01	7.4146E+02	3.1637E+04	-6.6243E+04	1.8933E+05	4.1659E+00	-2.6827E+03	1.6167E+03	1.0115E+06
9.4190E+01	6.8850E+02	4.2961E+04	-6.6243E+04	1.8280E+05	1.4012E+01	-2.6827E+03	1.2125E+03	1.3022E+06
9.4190E+01	6.3554E+02	9.4053E+04	-6.6243E+04	1.7627E+05	4.7994E+01	-2.6827E+03	8.0834E+02	2.0164E+06
9.4190E+01	5.8258E+02	1.8206E+05	-6.6243E+04	1.6974E+05	2.0382E+01	-2.6827E+03	4.0417E+02	4.3066E+06
9.4190E+01	5.2962E+02	2.5943E+05	-6.6243E+04	1.5668E+05	2.8291E+01	-2.6827E+03	0.0000E+00	7.8890E+06
9.4190E+01	4.7665E+02	4.6160E+05	-6.6243E+04	1.5016E+05	6.3786E+01	-3.1514E+03	1.8996E+04	1.6196E-01
9.4190E+01	4.2369E+02	8.1172E+05	-6.6243E+04	1.4363E+05	1.0467E+03	-3.1514E+03	1.7783E+04	9.4410E-01
9.4190E+01	3.7073E+02	1.1664E+06	-6.6243E+04	1.3710E+05	8.0774E+01	-3.1514E+03	1.6975E+04	6.1840E-01
9.4190E+01	3.1777E+02	1.6467E+06	-6.6243E+04	1.3057E+05	4.4213E+03	-3.1514E+03	1.6571E+04	6.7153E-01
9.4190E+01	2.6481E+02	2.3855E+06	-6.6243E+04	1.2404E+05	6.6774E+03	-3.1514E+03	1.6167E+04	6.1840E-01
9.4190E+01	2.1185E+02	2.8064E+06	-6.6243E+04	1.1751E+05	1.3239E+03	-3.1514E+03	1.5358E+04	1.9149E+00
9.4190E+01	1.5888E+02	3.1718E+06	-6.6243E+04	1.1098E+05	2.4841E+03	-3.1514E+03	1.4954E+04	7.3409E+00
9.4190E+01	1.0592E+02	3.0002E+06	-6.6243E+04	1.0446E+05	9.5273E+03	-3.1514E+03	1.4550E+04	6.1840E-01
9.4190E+01	5.2962E+01	3.7058E+06	-6.6243E+04	9.7927E+04	8.5921E+03	-3.1514E+03	1.4146E+04	4.3633E+00
9.4190E+01	0.0000E+00	1.5340E+07	-6.6243E+04	9.1399E+04	3.2300E+03	-3.1514E+03	1.3742E+04	3.2393E-01
2.9318E+01	2.4892E+03	5.3125E-02	-6.6243E+04	8.4870E+04	1.4064E+04	-3.1514E+03	1.3338E+04	1.3656E+00
2.9318E+01	2.2773E+03	1.3359E+00	-6.6243E+04	7.8342E+04	2.1339E+04	-3.1514E+03	1.2933E+04	1.2465E+01
2.9318E+01	2.2244E+03	1.9609E+00	-6.6243E+04	7.1813E+04	2.1633E+04	-3.1514E+03	1.2529E+04	2.1644E+00
2.9318E+01	2.1714E+03	1.9609E+00	-6.6243E+04	6.5285E+04	4.3952E+04	-3.1514E+03	1.2125E+04	9.4943E+00
2.9318E+01	2.0655E+03	1.7500E+00	-6.6243E+04	5.8756E+04	5.0643E+04	-3.1514E+03	1.1721E+04	2.7419E+01
2.9318E+01	1.9596E+03	1.3359E+00	-6.6243E+04	5.2228E+04	1.0950E+05	-3.1514E+03	1.1317E+04	9.4392E+01
2.9318E+01	1.9066E+03	1.3359E+00	-6.6243E+04	4.5699E+04	1.2375E+05	-3.1514E+03	1.0913E+04	1.0007E+01
2.9318E+01	1.7477E+03	5.3125E-02	-6.6243E+04	3.9171E+04	2.4239E+05	-3.1514E+03	1.0508E+04	5.5580E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance Tuborg Havnevej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.9318E+01	1.6948E+03	5.3125E-02	-6.6243E+04	3.2642E+04	3.7473E+05	-3.1514E+03	1.0104E+04	1.0656E+01
2.9318E+01	1.6418E+03	5.3125E-02	-6.6243E+04	2.6114E+04	9.2854E+05	-3.1514E+03	9.7001E+03	3.1154E+01
2.9318E+01	1.5888E+03	2.1621E-01	-6.6243E+04	1.9585E+04	1.8956E+06	-3.1514E+03	9.2959E+03	3.8851E+02
2.9318E+01	1.4829E+03	7.5288E-01	-6.6243E+04	1.3057E+04	3.1353E+06	-3.1514E+03	8.8917E+03	5.7150E+02
2.9318E+01	1.4300E+03	1.4094E+00	-6.6243E+04	6.5285E+03	3.8760E+06	-3.1514E+03	8.4876E+03	3.0039E+03
2.9318E+01	1.3770E+03	7.3125E-01	-6.6243E+04	0.0000E+00	8.5407E+06	-3.1514E+03	8.0834E+03	7.8572E+02
2.9318E+01	1.3240E+03	3.4765E+00	-7.3141E+04	2.2197E+05	1.3359E+00	-3.1514E+03	7.6792E+03	1.4067E+03
2.9318E+01	1.2711E+03	4.7061E+00	-7.3141E+04	1.9585E+05	4.8920E-01	-3.1514E+03	7.2751E+03	1.7578E+04
2.9318E+01	1.2181E+03	3.1621E+00	-7.3141E+04	1.7627E+05	1.3359E+00	-3.1514E+03	6.8709E+03	2.3032E+04
2.9318E+01	1.1652E+03	3.5594E+00	-7.3141E+04	1.6321E+05	1.3816E+01	-3.1514E+03	6.4667E+03	4.8229E+04
2.9318E+01	1.1122E+03	2.1184E+01	-7.3141E+04	1.5016E+05	1.0173E+03	-3.1514E+03	6.0626E+03	5.9447E+04
2.9318E+01	1.0592E+03	1.3988E+01	-7.3141E+04	1.4363E+05	3.6186E+00	-3.1514E+03	5.6584E+03	9.9796E+04
2.9318E+01	1.0063E+03	2.3244E+01	-7.3141E+04	1.3710E+05	5.0986E+01	-3.1514E+03	5.2542E+03	1.6065E+05
2.9318E+01	9.5331E+02	4.3008E+01	-7.3141E+04	1.3057E+05	2.4321E+02	-3.1514E+03	4.8500E+03	2.5741E+05
2.9318E+01	9.0035E+02	6.3778E+01	-7.3141E+04	1.2404E+05	2.9484E+03	-3.1514E+03	4.4459E+03	3.0170E+05
2.9318E+01	8.4739E+02	1.6428E+03	-7.3141E+04	1.1751E+05	4.0477E+02	-3.1514E+03	4.0417E+03	4.8056E+05
2.9318E+01	7.9442E+02	7.4615E+03	-7.3141E+04	1.1098E+05	5.9528E+03	-3.1514E+03	3.6375E+03	5.2253E+05
2.9318E+01	7.4146E+02	1.4737E+04	-7.3141E+04	1.0446E+05	1.5174E+04	-3.1514E+03	3.2334E+03	6.2187E+05
2.9318E+01	6.8850E+02	1.6044E+04	-7.3141E+04	9.7927E+04	4.5411E+03	-3.1514E+03	2.8292E+03	6.4851E+05
2.9318E+01	6.3554E+02	3.9087E+04	-7.3141E+04	9.1399E+04	7.9568E+03	-3.1514E+03	2.4250E+03	7.3563E+05
2.9318E+01	5.8258E+02	5.5452E+04	-7.3141E+04	8.4870E+04	1.9796E+04	-3.1514E+03	2.0209E+03	5.5047E+05
2.9318E+01	5.2962E+02	7.2988E+04	-7.3141E+04	7.8342E+04	1.7796E+04	-3.1514E+03	1.6167E+03	5.9416E+05
2.9318E+01	4.7665E+02	1.3894E+05	-7.3141E+04	7.1813E+04	3.1071E+04	-3.1514E+03	1.2125E+03	7.6533E+05
2.9318E+01	4.2369E+02	2.9612E+05	-7.3141E+04	6.5285E+04	3.2140E+04	-3.1514E+03	8.0834E+02	1.4711E+06
2.9318E+01	3.7073E+02	3.9822E+05	-7.3141E+04	5.8756E+04	8.7683E+04	-3.1514E+03	4.0417E+02	3.0227E+06
2.9318E+01	3.1777E+02	4.9308E+05	-7.3141E+04	5.2228E+04	1.2268E+05	-3.1514E+03	0.0000E+00	5.6453E+06
2.9318E+01	2.6481E+02	7.2833E+05	-7.3141E+04	4.5699E+04	2.6352E+05	-3.6201E+03	2.0209E+04	1.6196E-01
2.9318E+01	2.1185E+02	9.7585E+05	-7.3141E+04	3.9171E+04	3.6955E+05	-3.6201E+03	1.9804E+04	5.3125E-02
2.9318E+01	1.5888E+02	1.4492E+06	-7.3141E+04	3.2642E+04	7.5192E+05	-3.6201E+03	1.9400E+04	9.4410E-01
2.9318E+01	1.0592E+02	2.4302E+06	-7.3141E+04	2.6114E+04	1.3031E+06	-3.6201E+03	1.8592E+04	6.1840E-01
2.9318E+01	5.2962E+01	6.6405E+06	-7.3141E+04	1.9585E+04	2.3444E+06	-3.6201E+03	1.8188E+04	8.3388E+01
2.9318E+01	0.0000E+00	2.2272E+07	-7.3141E+04	1.3057E+04	3.4348E+06	-3.6201E+03	1.6167E+04	1.1061E+00
-3.5554E+01	2.6481E+03	1.3359E+00	-7.3141E+04	6.5285E+03	3.3944E+06	-3.6201E+03	1.5763E+04	4.5440E+00
-3.5554E+01	2.4362E+03	5.3125E-02	-7.3141E+04	0.0000E+00	7.8556E+06	-3.6201E+03	1.5358E+04	1.0504E+00
-3.5554E+01	2.0125E+03	5.3125E-02	-8.0039E+04	1.8933E+05	4.8920E-01	-3.6201E+03	1.4954E+04	1.6196E-01
-3.5554E+01	1.9066E+03	5.3125E-02	-8.0039E+04	1.6974E+05	7.2371E+00	-3.6201E+03	1.4146E+04	7.8036E-01
-3.5554E+01	1.8537E+03	5.3125E-02	-8.0039E+04	1.5016E+05	6.4456E+01	-3.6201E+03	1.3338E+04	1.1335E+01
-3.5554E+01	1.6418E+03	1.0625E-01	-8.0039E+04	1.4363E+05	2.1020E+01	-3.6201E+03	1.2933E+04	6.7813E-01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tåsinge Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.5554E+01	1.5888E+03	1.5938E-01	-8.0039E+04	1.3710E+05	5.7808E+02	-3.6201E+03	1.2529E+04	1.3359E+00
-3.5554E+01	1.4829E+03	1.3890E+00	-8.0039E+04	1.3057E+05	6.4457E+01	-3.6201E+03	1.2125E+04	1.4116E+01
-3.5554E+01	1.4300E+03	1.3396E+00	-8.0039E+04	1.2404E+05	1.9683E+02	-3.6201E+03	1.1721E+04	6.6391E+00
-3.5554E+01	1.3770E+03	3.1062E+00	-8.0039E+04	1.1751E+05	9.1709E+02	-3.6201E+03	1.1317E+04	5.3125E-02
-3.5554E+01	1.3240E+03	1.3031E+00	-8.0039E+04	1.1098E+05	3.1778E+03	-3.6201E+03	1.0913E+04	8.3960E+01
-3.5554E+01	1.2711E+03	6.7813E-01	-8.0039E+04	1.0446E+05	5.3762E+03	-3.6201E+03	1.0508E+04	3.4706E+00
-3.5554E+01	1.2181E+03	3.3734E+00	-8.0039E+04	9.7927E+04	7.5875E+03	-3.6201E+03	1.0104E+04	9.8034E+00
-3.5554E+01	1.1652E+03	8.7728E+00	-8.0039E+04	9.1399E+04	2.9668E+04	-3.6201E+03	9.7001E+03	2.9857E+01
-3.5554E+01	1.1122E+03	6.9507E+00	-8.0039E+04	8.4870E+04	1.5117E+04	-3.6201E+03	9.2959E+03	5.2324E+01
-3.5554E+01	1.0592E+03	4.5919E+00	-8.0039E+04	7.8342E+04	2.1538E+04	-3.6201E+03	8.8917E+03	4.5190E+02
-3.5554E+01	1.0063E+03	2.2010E+01	-8.0039E+04	7.1813E+04	4.2815E+04	-3.6201E+03	8.4876E+03	2.0202E+02
-3.5554E+01	9.5331E+02	3.3972E+01	-8.0039E+04	6.5285E+04	6.6195E+04	-3.6201E+03	8.0834E+03	8.0848E+02
-3.5554E+01	9.0035E+02	1.6320E+03	-8.0039E+04	5.8756E+04	1.1309E+05	-3.6201E+03	7.6792E+03	5.1871E+02
-3.5554E+01	8.4739E+02	1.6631E+03	-8.0039E+04	5.2228E+04	1.5919E+05	-3.6201E+03	7.2751E+03	7.9354E+03
-3.5554E+01	7.9442E+02	1.6449E+03	-8.0039E+04	4.5699E+04	3.9102E+05	-3.6201E+03	6.8709E+03	4.4557E+03
-3.5554E+01	7.4146E+02	2.6777E+03	-8.0039E+04	3.9171E+04	7.5580E+05	-3.6201E+03	6.4667E+03	9.6651E+03
-3.5554E+01	6.8850E+02	1.8174E+03	-8.0039E+04	3.2642E+04	1.1485E+06	-3.6201E+03	6.0626E+03	1.1670E+04
-3.5554E+01	6.3554E+02	1.8741E+03	-8.0039E+04	2.6114E+04	1.9207E+06	-3.6201E+03	5.6584E+03	1.4459E+04
-3.5554E+01	5.8258E+02	8.3388E+03	-8.0039E+04	1.9585E+04	3.0043E+06	-3.6201E+03	5.2542E+03	5.3836E+04
-3.5554E+01	5.2962E+02	1.2815E+04	-8.0039E+04	1.3057E+04	3.0889E+06	-3.6201E+03	4.8500E+03	1.4291E+05
-3.5554E+01	4.7665E+02	1.3869E+04	-8.0039E+04	6.5285E+03	3.5227E+06	-3.6201E+03	4.4459E+03	1.6222E+05
-3.5554E+01	4.2369E+02	3.0880E+04	-8.0039E+04	0.0000E+00	6.5706E+06	-3.6201E+03	4.0417E+03	1.8122E+05
-3.5554E+01	3.7073E+02	5.0708E+04	-8.6936E+04	1.6321E+05	1.0510E+01	-3.6201E+03	3.6375E+03	2.1147E+05
-3.5554E+01	3.1777E+02	5.4463E+04	-8.6936E+04	1.5016E+05	4.7995E+02	-3.6201E+03	3.2334E+03	3.5652E+05
-3.5554E+01	2.6481E+02	9.7785E+04	-8.6936E+04	1.4363E+05	1.0510E+01	-3.6201E+03	2.8292E+03	4.2316E+05
-3.5554E+01	2.1185E+02	1.9774E+05	-8.6936E+04	1.3710E+05	6.1945E+02	-3.6201E+03	2.4250E+03	4.2489E+05
-3.5554E+01	1.5888E+02	5.3538E+05	-8.6936E+04	1.3057E+05	1.1596E+03	-3.6201E+03	2.0209E+03	3.4935E+05
-3.5554E+01	1.0592E+02	1.4293E+06	-8.6936E+04	1.2404E+05	2.1087E+03	-3.6201E+03	1.6167E+03	4.5048E+05
-3.5554E+01	5.2962E+01	3.7648E+06	-8.6936E+04	1.1751E+05	5.1025E+03	-3.6201E+03	1.2125E+03	4.8302E+05
-3.5554E+01	0.0000E+00	1.2584E+07	-8.6936E+04	1.1098E+05	3.1662E+03	-3.6201E+03	8.0834E+02	9.1031E+05
-1.0043E+02	2.0125E+03	6.2500E-01	-8.6936E+04	1.0446E+05	5.9480E+03	-3.6201E+03	4.0417E+02	1.9226E+06
-1.0043E+02	1.9596E+03	5.3125E-02	-8.6936E+04	9.7927E+04	1.1000E+04	-3.6201E+03	0.0000E+00	3.7894E+06
-1.0043E+02	1.5359E+03	1.3359E+00	-8.6936E+04	9.1399E+04	1.9763E+04	-4.0887E+03	1.8592E+04	9.4410E-01
-1.0043E+02	1.4829E+03	2.3750E+00	-8.6936E+04	8.4870E+04	2.9710E+04	-4.0887E+03	1.8188E+04	3.6047E+00
-1.0043E+02	1.4300E+03	3.7109E+00	-8.6936E+04	7.8342E+04	4.0498E+04	-4.0887E+03	1.7783E+04	9.1230E-01
-1.0043E+02	1.3770E+03	8.5998E+00	-8.6936E+04	7.1813E+04	8.6517E+04	-4.0887E+03	1.6975E+04	1.6196E-01
-1.0043E+02	1.3240E+03	3.5000E+00	-8.6936E+04	6.5285E+04	1.2262E+05	-4.0887E+03	1.6571E+04	5.3125E-02
-1.0043E+02	1.2711E+03	6.9029E+00	-8.6936E+04	5.8756E+04	1.6829E+05	-4.0887E+03	1.4146E+04	1.8882E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance Tåsing Parkvej 8-12 DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.0043E+02	1.2181E+03	7.8358E+00	-8.6936E+04	5.2228E+04	2.8445E+05	-4.0887E+03	1.3338E+04	3.6582E+00
-1.0043E+02	1.1652E+03	7.0000E+00	-8.6936E+04	4.5699E+04	5.0909E+05	-4.0887E+03	1.2933E+04	2.4063E+00
-1.0043E+02	1.1122E+03	7.7312E+00	-8.6936E+04	3.9171E+04	1.0029E+06	-4.0887E+03	1.2529E+04	2.5339E-02
-1.0043E+02	1.0592E+03	2.0436E+01	-8.6936E+04	3.2642E+04	1.3808E+06	-4.0887E+03	1.1721E+04	6.2500E-01
-1.0043E+02	1.0063E+03	1.3247E+01	-8.6936E+04	2.6114E+04	2.1663E+06	-4.0887E+03	1.1317E+04	1.7348E+00
-1.0043E+02	9.5331E+02	1.6100E+01	-8.6936E+04	1.9585E+04	2.7416E+06	-4.0887E+03	1.0913E+04	1.9681E+00
-1.0043E+02	9.0035E+02	7.6413E+01	-8.6936E+04	1.3057E+04	3.2320E+06	-4.0887E+03	1.0508E+04	8.6029E+01
-1.0043E+02	8.4739E+02	8.7891E+01	-8.6936E+04	6.5285E+03	2.7718E+06	-4.0887E+03	1.0104E+04	5.3125E-02
-1.0043E+02	7.9442E+02	5.2857E+01	-8.6936E+04	0.0000E+00	6.0238E+06	-4.0887E+03	9.7001E+03	4.6528E+00
-1.0043E+02	7.4146E+02	7.3796E+01	-9.3834E+04	1.4363E+05	5.3125E-02	-4.0887E+03	9.2959E+03	2.6599E+01
-1.0043E+02	6.8850E+02	1.3746E+02	-9.3834E+04	1.3710E+05	2.1475E+03	-4.0887E+03	8.8917E+03	1.1481E+01
-1.0043E+02	6.3554E+02	1.1559E+02	-9.3834E+04	1.3057E+05	1.4080E+03	-4.0887E+03	8.4876E+03	1.6716E+02
-1.0043E+02	5.8258E+02	1.8982E+02	-9.3834E+04	1.2404E+05	6.0255E+03	-4.0887E+03	8.0834E+03	5.2907E+01
-1.0043E+02	5.2962E+02	1.8617E+02	-9.3834E+04	1.1751E+05	9.4304E+02	-4.0887E+03	7.6792E+03	2.9323E+01
-1.0043E+02	4.7665E+02	2.0333E+03	-9.3834E+04	1.1098E+05	3.6532E+03	-4.0887E+03	7.2751E+03	1.7101E+02
-1.0043E+02	4.2369E+02	4.1850E+03	-9.3834E+04	1.0446E+05	2.1098E+04	-4.0887E+03	6.8709E+03	1.8769E+02
-1.0043E+02	3.7073E+02	2.2696E+03	-9.3834E+04	9.7927E+04	1.8319E+04	-4.0887E+03	6.4667E+03	2.1031E+03
-1.0043E+02	3.1777E+02	1.0778E+04	-9.3834E+04	9.1399E+04	2.5797E+04	-4.0887E+03	6.0626E+03	8.9934E+02
-1.0043E+02	2.6481E+02	1.4344E+04	-9.3834E+04	8.4870E+04	2.9895E+04	-4.0887E+03	5.6584E+03	3.1664E+03
-1.0043E+02	2.1185E+02	1.8065E+04	-9.3834E+04	7.8342E+04	5.1077E+04	-4.0887E+03	5.2542E+03	1.5075E+04
-1.0043E+02	1.5888E+02	2.2083E+04	-9.3834E+04	7.1813E+04	7.9393E+04	-4.0887E+03	4.8500E+03	8.1691E+03
-1.0043E+02	1.0592E+02	5.7891E+04	-9.3834E+04	6.5285E+04	1.1171E+05	-4.0887E+03	4.4459E+03	1.6552E+04
-1.0043E+02	5.2962E+01	1.9789E+05	-9.3834E+04	5.8756E+04	2.4969E+05	-4.0887E+03	4.0417E+03	8.3043E+04
-1.0043E+02	0.0000E+00	7.8994E+05	-9.3834E+04	5.2228E+04	5.2548E+05	-4.0887E+03	3.6375E+03	9.2200E+04
-1.6530E+02	1.9066E+03	6.7813E-01	-9.3834E+04	4.5699E+04	7.3093E+05	-4.0887E+03	3.2334E+03	1.6280E+05
-1.6530E+02	1.8007E+03	6.2500E-01	-9.3834E+04	3.9171E+04	1.2900E+06	-4.0887E+03	2.8292E+03	1.8487E+05
-1.6530E+02	1.6948E+03	1.3359E+00	-9.3834E+04	3.2642E+04	2.0094E+06	-4.0887E+03	2.4250E+03	1.5062E+05
-1.6530E+02	1.6418E+03	4.3358E+00	-9.3834E+04	2.6114E+04	2.6815E+06	-4.0887E+03	2.0209E+03	2.0448E+05
-1.6530E+02	1.5359E+03	1.3359E+00	-9.3834E+04	1.9585E+04	2.9101E+06	-4.0887E+03	1.6167E+03	2.4287E+05
-1.6530E+02	1.4300E+03	3.0531E+00	-9.3834E+04	1.3057E+04	2.9393E+06	-4.0887E+03	1.2125E+03	2.3056E+05
-1.6530E+02	1.3770E+03	6.2500E-01	-9.3834E+04	6.5285E+03	2.8685E+06	-4.0887E+03	8.0834E+02	4.3720E+05
-1.6530E+02	1.3240E+03	3.5000E+00	-9.3834E+04	0.0000E+00	6.6583E+06	-4.0887E+03	4.0417E+02	1.2998E+06
-1.6530E+02	1.2711E+03	7.9217E+00	-1.0073E+05	1.6974E+05	2.1020E+01	-4.0887E+03	0.0000E+00	2.6946E+06
-1.6530E+02	1.2181E+03	7.0000E+00	-1.0073E+05	1.5016E+05	1.4046E+02	-4.5574E+03	1.8996E+04	1.6196E-01
-1.6530E+02	1.1652E+03	7.9217E+00	-1.0073E+05	1.3710E+05	3.3276E+02	-4.5574E+03	1.7379E+04	3.6047E+00
-1.6530E+02	1.1122E+03	1.9459E+01	-1.0073E+05	1.3057E+05	7.2716E+02	-4.5574E+03	1.5763E+04	8.3335E+01
-1.6530E+02	1.0592E+03	1.6118E+01	-1.0073E+05	1.2404E+05	4.6109E+03	-4.5574E+03	1.4146E+04	5.3125E-02
-1.6530E+02	1.0063E+03	1.8008E+01	-1.0073E+05	1.1751E+05	1.2524E+04	-4.5574E+03	1.3338E+04	1.0625E-01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.6530E+02	9.5331E+02	9.7651E+00	-1.0073E+05	1.1098E+05	6.8116E+03	-4.5574E+03	1.2933E+04	5.3125E-02
-1.6530E+02	9.0035E+02	3.4419E+01	-1.0073E+05	1.0446E+05	2.1507E+04	-4.5574E+03	1.2529E+04	1.0625E-01
-1.6530E+02	8.4739E+02	5.1555E+01	-1.0073E+05	9.7927E+04	5.2633E+03	-4.5574E+03	1.2125E+04	1.5388E+00
-1.6530E+02	7.9442E+02	5.3278E+01	-1.0073E+05	9.1399E+04	4.9641E+04	-4.5574E+03	1.1721E+04	5.3125E-02
-1.6530E+02	7.4146E+02	3.1008E+01	-1.0073E+05	8.4870E+04	3.1505E+04	-4.5574E+03	1.1317E+04	6.2500E-01
-1.6530E+02	6.8850E+02	3.7188E+01	-1.0073E+05	7.8342E+04	5.9638E+04	-4.5574E+03	1.0508E+04	1.3359E+00
-1.6530E+02	6.3554E+02	6.5277E+01	-1.0073E+05	7.1813E+04	8.1635E+04	-4.5574E+03	9.7001E+03	1.0625E-01
-1.6530E+02	5.8258E+02	9.0849E+01	-1.0073E+05	6.5285E+04	1.2286E+05	-4.5574E+03	9.2959E+03	1.5566E+01
-1.6530E+02	5.2962E+02	9.4795E+01	-1.0073E+05	5.8756E+04	3.1921E+05	-4.5574E+03	8.8917E+03	2.3229E+01
-1.6530E+02	4.7665E+02	9.7601E+01	-1.0073E+05	5.2228E+04	4.9310E+05	-4.5574E+03	8.4876E+03	1.0417E+00
-1.6530E+02	4.2369E+02	2.4251E+02	-1.0073E+05	4.5699E+04	1.1231E+06	-4.5574E+03	8.0834E+03	3.2393E-01
-1.6530E+02	3.7073E+02	3.5405E+03	-1.0073E+05	3.9171E+04	1.5311E+06	-4.5574E+03	7.6792E+03	5.2838E+01
-1.6530E+02	3.1777E+02	3.6383E+03	-1.0073E+05	3.2642E+04	2.3155E+06	-4.5574E+03	7.2751E+03	2.0100E+02
-1.6530E+02	2.6481E+02	3.7848E+03	-1.0073E+05	2.6114E+04	3.5711E+06	-4.5574E+03	6.8709E+03	1.6330E+01
-1.6530E+02	2.1185E+02	7.0289E+03	-1.0073E+05	1.9585E+04	3.8272E+06	-4.5574E+03	6.4667E+03	7.9020E+00
-1.6530E+02	1.5888E+02	8.6198E+03	-1.0073E+05	1.3057E+04	3.8467E+06	-4.5574E+03	6.0626E+03	1.3003E+02
-1.6530E+02	1.0592E+02	2.6020E+04	-1.0073E+05	6.5285E+03	3.7972E+06	-4.5574E+03	5.6584E+03	7.0805E+02
-1.6530E+02	5.2962E+01	3.1877E+04	-1.0073E+05	0.0000E+00	9.7492E+06	-4.5574E+03	5.2542E+03	6.5164E+02
-1.6530E+02	0.0000E+00	1.7717E+05	-1.0763E+05	1.5668E+05	8.0260E+01	-4.5574E+03	4.8500E+03	2.8860E+03
-2.3017E+02	2.1185E+03	5.3125E-02	-1.0763E+05	1.3710E+05	8.0597E+02	-4.5574E+03	4.4459E+03	4.9474E+03
-2.3017E+02	1.9596E+03	5.3125E-02	-1.0763E+05	1.3057E+05	1.2317E+02	-4.5574E+03	4.0417E+03	9.9632E+03
-2.3017E+02	1.4829E+03	1.3359E+00	-1.0763E+05	1.2404E+05	1.2317E+02	-4.5574E+03	3.6375E+03	9.1411E+03
-2.3017E+02	1.3770E+03	1.7500E+00	-1.0763E+05	1.1751E+05	3.7211E+03	-4.5574E+03	3.2334E+03	2.0708E+04
-2.3017E+02	1.3240E+03	4.3358E+00	-1.0763E+05	1.1098E+05	3.4894E+03	-4.5574E+03	2.8292E+03	4.4288E+04
-2.3017E+02	1.2711E+03	6.5858E+00	-1.0763E+05	1.0446E+05	1.5566E+04	-4.5574E+03	2.4250E+03	6.2457E+04
-2.3017E+02	1.2181E+03	7.9217E+00	-1.0763E+05	9.7927E+04	2.8328E+04	-4.5574E+03	2.0209E+03	8.8578E+04
-2.3017E+02	1.1122E+03	1.0086E+01	-1.0763E+05	9.1399E+04	4.5903E+04	-4.5574E+03	1.6167E+03	1.2067E+05
-2.3017E+02	1.0592E+03	1.0500E+01	-1.0763E+05	8.4870E+04	3.4601E+04	-4.5574E+03	1.2125E+03	1.3839E+05
-2.3017E+02	1.0063E+03	7.0000E+00	-1.0763E+05	7.8342E+04	7.0966E+04	-4.5574E+03	8.0834E+02	2.7475E+05
-2.3017E+02	9.0035E+02	7.9217E+00	-1.0763E+05	7.1813E+04	1.4167E+05	-4.5574E+03	4.0417E+02	6.1339E+05
-2.3017E+02	8.4739E+02	3.6063E+00	-1.0763E+05	6.5285E+04	1.5233E+05	-4.5574E+03	0.0000E+00	1.3983E+06
-2.3017E+02	7.9442E+02	9.7779E+00	-1.0763E+05	5.8756E+04	3.1729E+05	-5.0261E+03	1.5358E+04	6.2500E-01
-2.3017E+02	7.4146E+02	7.2125E+00	-1.0763E+05	5.2228E+04	4.3858E+05	-5.0261E+03	1.4954E+04	6.2500E-01
-2.3017E+02	6.8850E+02	1.1856E+01	-1.0763E+05	4.5699E+04	6.3361E+05	-5.0261E+03	1.3338E+04	5.3125E-02
-2.3017E+02	6.3554E+02	2.8715E+01	-1.0763E+05	3.9171E+04	1.3639E+06	-5.0261E+03	1.0508E+04	3.6186E+00
-2.3017E+02	5.8258E+02	4.0589E+01	-1.0763E+05	3.2642E+04	2.2732E+06	-5.0261E+03	9.2959E+03	1.0625E-01
-2.3017E+02	5.2962E+02	3.6842E+01	-1.0763E+05	2.6114E+04	4.0347E+06	-5.0261E+03	8.4876E+03	1.9945E+00
-2.3017E+02	4.7665E+02	4.8961E+01	-1.0763E+05	1.9585E+04	4.9463E+06	-5.0261E+03	8.0834E+03	6.4786E-01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Havnevej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.3017E+02	4.2369E+02	3.1117E+01	-1.0763E+05	1.3057E+04	5.1434E+06	-5.0261E+03	7.6792E+03	2.3184E+00
-2.3017E+02	3.7073E+02	3.3066E+01	-1.0763E+05	6.5285E+03	5.3772E+06	-5.0261E+03	7.2751E+03	3.5194E+01
-2.3017E+02	3.1777E+02	7.0698E+01	-1.0763E+05	0.0000E+00	1.3492E+07	-5.0261E+03	6.8709E+03	4.3018E-01
-2.3017E+02	2.6481E+02	1.4148E+02	-1.1453E+05	1.3057E+05	1.4185E+02	-5.0261E+03	6.4667E+03	4.7368E+00
-2.3017E+02	2.1185E+02	1.6805E+03	-1.1453E+05	1.2404E+05	4.8184E+02	-5.0261E+03	6.0626E+03	9.2015E+00
-2.3017E+02	1.5888E+02	1.0583E+02	-1.1453E+05	1.1751E+05	2.8689E+03	-5.0261E+03	5.6584E+03	3.2361E+01
-2.3017E+02	1.0592E+02	6.5557E+03	-1.1453E+05	1.1098E+05	4.0050E+03	-5.0261E+03	5.2542E+03	1.2489E+02
-2.3017E+02	5.2962E+01	8.3198E+03	-1.1453E+05	1.0446E+05	5.3013E+03	-5.0261E+03	4.8500E+03	1.3093E+02
-2.3017E+02	0.0000E+00	3.3813E+04	-1.1453E+05	9.7927E+04	1.6718E+04	-5.0261E+03	4.4459E+03	1.9248E+02
-2.9504E+02	1.5359E+03	1.3359E+00	-1.1453E+05	9.1399E+04	2.1710E+04	-5.0261E+03	4.0417E+03	3.8759E+02
-2.9504E+02	1.4829E+03	1.3359E+00	-1.1453E+05	8.4870E+04	2.6902E+04	-5.0261E+03	3.6375E+03	5.8063E+03
-2.9504E+02	1.4300E+03	4.0076E+00	-1.1453E+05	7.8342E+04	4.3488E+04	-5.0261E+03	3.2334E+03	1.5068E+03
-2.9504E+02	1.3770E+03	1.3359E+00	-1.1453E+05	7.1813E+04	4.5360E+04	-5.0261E+03	2.8292E+03	2.8698E+03
-2.9504E+02	1.3240E+03	4.8358E+00	-1.1453E+05	6.5285E+04	9.8712E+04	-5.0261E+03	2.4250E+03	1.3730E+04
-2.9504E+02	1.2711E+03	9.6717E+00	-1.1453E+05	5.8756E+04	1.4069E+05	-5.0261E+03	2.0209E+03	9.1907E+03
-2.9504E+02	1.2181E+03	1.3359E+00	-1.1453E+05	5.2228E+04	2.8629E+05	-5.0261E+03	1.6167E+03	4.6334E+03
-2.9504E+02	1.1652E+03	3.0859E+00	-1.1453E+05	4.5699E+04	6.0390E+05	-5.0261E+03	1.2125E+03	3.7372E+04
-2.9504E+02	1.1122E+03	1.3359E+00	-1.1453E+05	3.9171E+04	1.0737E+06	-5.0261E+03	8.0834E+02	1.1018E+05
-2.9504E+02	1.0592E+03	5.3434E+00	-1.1453E+05	3.2642E+04	2.2019E+06	-5.0261E+03	4.0417E+02	2.4144E+05
-2.9504E+02	1.0063E+03	6.5858E+00	-1.1453E+05	2.6114E+04	3.8309E+06	-5.0261E+03	0.0000E+00	5.6028E+05
-2.9504E+02	9.0035E+02	2.6717E+00	-1.1453E+05	1.9585E+04	5.4010E+06	-5.4948E+03	1.5358E+04	5.3125E-02
-2.9504E+02	8.4739E+02	6.5934E+00	-1.1453E+05	1.3057E+04	5.9197E+06	-5.4948E+03	1.4550E+04	2.9390E-01
-2.9504E+02	7.9442E+02	2.6717E+00	-1.1453E+05	6.5285E+03	6.8849E+06	-5.4948E+03	1.3338E+04	5.3125E-02
-2.9504E+02	6.8850E+02	3.5000E+00	-1.1453E+05	0.0000E+00	1.8220E+07	-5.4948E+03	8.4876E+03	1.2368E+00
-2.9504E+02	6.3554E+02	3.5000E+00	-1.2142E+05	1.3057E+05	1.8512E+02	-5.4948E+03	7.2751E+03	4.3289E+00
-2.9504E+02	5.8258E+02	1.1134E+01	-1.2142E+05	1.2404E+05	6.1585E+01	-5.4948E+03	6.8709E+03	2.1250E-01
-2.9504E+02	5.2962E+02	5.2779E+00	-1.2142E+05	1.1751E+05	1.0542E+03	-5.4948E+03	6.4667E+03	9.1174E-01
-2.9504E+02	4.7665E+02	2.4793E+01	-1.2142E+05	1.1098E+05	3.0820E+03	-5.4948E+03	6.0626E+03	4.0364E+00
-2.9504E+02	4.2369E+02	2.3478E+01	-1.2142E+05	1.0446E+05	4.4894E+03	-5.4948E+03	5.6584E+03	1.3376E+01
-2.9504E+02	3.7073E+02	8.8434E+00	-1.2142E+05	9.7927E+04	1.4682E+04	-5.4948E+03	5.2542E+03	3.5963E+01
-2.9504E+02	3.1777E+02	3.5955E+01	-1.2142E+05	9.1399E+04	1.9987E+04	-5.4948E+03	4.8500E+03	6.5774E+01
-2.9504E+02	2.6481E+02	6.5716E+01	-1.2142E+05	8.4870E+04	2.1343E+04	-5.4948E+03	4.4459E+03	3.6768E+01
-2.9504E+02	2.1185E+02	5.0152E+01	-1.2142E+05	7.8342E+04	2.9342E+04	-5.4948E+03	4.0417E+03	2.9757E+02
-2.9504E+02	1.5888E+02	7.0917E+01	-1.2142E+05	7.1813E+04	8.2373E+04	-5.4948E+03	3.6375E+03	1.2327E+02
-2.9504E+02	1.0592E+02	8.5625E+01	-1.2142E+05	6.5285E+04	1.2377E+05	-5.4948E+03	3.2334E+03	1.9662E+03
-2.9504E+02	5.2962E+01	3.5740E+03	-1.2142E+05	5.8756E+04	1.0552E+05	-5.4948E+03	2.8292E+03	1.5280E+03
-2.9504E+02	0.0000E+00	2.7222E+03	-1.2142E+05	5.2228E+04	2.5166E+05	-5.4948E+03	2.4250E+03	1.8732E+03
-3.5991E+02	1.9596E+03	1.3359E+00	-1.2142E+05	4.5699E+04	4.8752E+05	-5.4948E+03	2.0209E+03	4.9012E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.5991E+02	1.5888E+03	1.3359E+00	-1.2142E+05	3.9171E+04	9.4975E+05	-5.4948E+03	1.6167E+03	1.6365E+03
-3.5991E+02	1.4829E+03	2.6717E+00	-1.2142E+05	3.2642E+04	1.9100E+06	-5.4948E+03	1.2125E+03	1.5512E+04
-3.5991E+02	1.4300E+03	1.3359E+00	-1.2142E+05	2.6114E+04	3.7913E+06	-5.4948E+03	8.0834E+02	1.4139E+04
-3.5991E+02	1.3770E+03	1.3359E+00	-1.2142E+05	1.9585E+04	5.8735E+06	-5.4948E+03	4.0417E+02	4.9344E+04
-3.5991E+02	1.2711E+03	1.3359E+00	-1.2142E+05	1.3057E+04	6.8441E+06	-5.4948E+03	0.0000E+00	1.9310E+05
-3.5991E+02	8.4739E+02	2.6717E+00	-1.2142E+05	6.5285E+03	8.2889E+06	-5.9634E+03	1.4954E+04	5.3125E-02
-3.5991E+02	7.4146E+02	2.6717E+00	-1.2142E+05	0.0000E+00	2.2554E+07	-5.9634E+03	8.4876E+03	4.8463E+01
-3.5991E+02	6.8850E+02	6.1717E+00	-1.2832E+05	1.3057E+05	2.3514E+02	-5.9634E+03	7.6792E+03	1.2368E+00
-3.5991E+02	6.3554E+02	8.8434E+00	-1.2832E+05	1.1098E+05	9.4335E+02	-5.9634E+03	7.2751E+03	1.0625E-01
-3.5991E+02	5.8258E+02	7.4217E+00	-1.2832E+05	1.0446E+05	8.2711E+03	-5.9634E+03	6.8709E+03	3.2393E-01
-3.5991E+02	5.2962E+02	5.3434E+00	-1.2832E+05	9.7927E+04	1.8781E+04	-5.9634E+03	6.4667E+03	1.4770E+01
-3.5991E+02	4.7665E+02	1.0093E+01	-1.2832E+05	9.1399E+04	2.6442E+04	-5.9634E+03	6.0626E+03	2.7975E+00
-3.5991E+02	4.2369E+02	1.7515E+01	-1.2832E+05	8.4870E+04	5.2469E+04	-5.9634E+03	5.6584E+03	3.5000E+00
-3.5991E+02	3.7073E+02	1.5950E+01	-1.2832E+05	7.8342E+04	3.7894E+04	-5.9634E+03	5.2542E+03	2.0877E+02
-3.5991E+02	3.1777E+02	2.2649E+01	-1.2832E+05	7.1813E+04	5.5558E+04	-5.9634E+03	4.8500E+03	1.1625E+01
-3.5991E+02	2.6481E+02	1.5843E+01	-1.2832E+05	6.5285E+04	1.1445E+05	-5.9634E+03	4.4459E+03	3.3876E+02
-3.5991E+02	2.1185E+02	5.9794E+01	-1.2832E+05	5.8756E+04	1.2805E+05	-5.9634E+03	4.0417E+03	4.7315E+01
-3.5991E+02	1.5888E+02	3.4480E+01	-1.2832E+05	5.2228E+04	2.8331E+05	-5.9634E+03	3.6375E+03	6.7823E+01
-3.5991E+02	1.0592E+02	7.0060E+01	-1.2832E+05	4.5699E+04	5.2219E+05	-5.9634E+03	3.2334E+03	1.7336E+01
-3.5991E+02	5.2962E+01	1.5622E+02	-1.2832E+05	3.9171E+04	1.0086E+06	-5.9634E+03	2.8292E+03	1.2279E+01
-3.5991E+02	0.0000E+00	3.4537E+02	-1.2832E+05	3.2642E+04	2.2838E+06	-5.9634E+03	2.4250E+03	9.2051E+00
-4.2479E+02	1.3240E+03	1.3359E+00	-1.2832E+05	2.6114E+04	4.5915E+06	-5.9634E+03	2.0209E+03	1.2774E+01
-4.2479E+02	6.8850E+02	7.0000E+00	-1.2832E+05	1.9585E+04	7.0140E+06	-5.9634E+03	1.6167E+03	3.7940E+01
-4.2479E+02	6.3554E+02	5.3434E+00	-1.2832E+05	1.3057E+04	7.8881E+06	-5.9634E+03	1.2125E+03	2.3378E+03
-4.2479E+02	5.8258E+02	8.8434E+00	-1.2832E+05	6.5285E+03	1.0073E+07	-5.9634E+03	8.0834E+02	3.9778E+03
-4.2479E+02	4.7665E+02	8.8434E+00	-1.2832E+05	0.0000E+00	2.8504E+07	-5.9634E+03	4.0417E+02	1.8281E+04
-4.2479E+02	4.2369E+02	2.0700E+01	-1.3522E+05	1.0446E+05	7.1638E+02	-5.9634E+03	0.0000E+00	9.2934E+04
-4.2479E+02	3.7073E+02	1.3358E+01	-1.3522E+05	9.7927E+04	7.6645E+02	-6.4321E+03	6.8709E+03	1.8882E+00
-4.2479E+02	3.1777E+02	2.4839E+01	-1.3522E+05	9.1399E+04	4.6424E+03	-6.4321E+03	5.6584E+03	7.4568E+00
-4.2479E+02	2.6481E+02	1.5015E+01	-1.3522E+05	8.4870E+04	1.6994E+04	-6.4321E+03	5.2542E+03	1.6670E+00
-4.2479E+02	2.1185E+02	2.3687E+01	-1.3522E+05	7.8342E+04	3.1046E+04	-6.4321E+03	4.8500E+03	7.2861E+00
-4.2479E+02	1.5888E+02	3.5104E+01	-1.3522E+05	7.1813E+04	6.8827E+04	-6.4321E+03	4.4459E+03	6.4268E-01
-4.2479E+02	1.0592E+02	7.7039E+01	-1.3522E+05	6.5285E+04	6.5865E+04	-6.4321E+03	3.6375E+03	2.9305E+01
-4.2479E+02	5.2962E+01	9.0582E+01	-1.3522E+05	5.8756E+04	1.4168E+05	-6.4321E+03	3.2334E+03	1.1558E+03
-4.2479E+02	0.0000E+00	3.6108E+02	-1.3522E+05	5.2228E+04	2.2253E+05	-6.4321E+03	2.8292E+03	1.3885E+01
-4.8966E+02	6.3554E+02	3.5000E+00	-1.3522E+05	4.5699E+04	5.0438E+05	-6.4321E+03	2.4250E+03	1.8847E+00
-4.8966E+02	5.2962E+02	2.6717E+00	-1.3522E+05	3.9171E+04	1.0251E+06	-6.4321E+03	2.0209E+03	1.9944E+02
-4.8966E+02	4.7665E+02	3.5000E+00	-1.3522E+05	3.2642E+04	2.2829E+06	-6.4321E+03	1.6167E+03	3.0978E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-4.8966E+02	3.7073E+02	1.8515E+01	-1.3522E+05	2.6114E+04	4.6952E+06	-6.4321E+03	1.2125E+03	3.5701E+01
-4.8966E+02	3.1777E+02	1.5843E+01	-1.3522E+05	1.9585E+04	7.4714E+06	-6.4321E+03	8.0834E+02	1.6340E+02
-4.8966E+02	2.6481E+02	2.2843E+01	-1.3522E+05	1.3057E+04	9.0872E+06	-6.4321E+03	4.0417E+02	5.3900E+03
-4.8966E+02	2.1185E+02	1.3593E+01	-1.3522E+05	6.5285E+03	1.0926E+07	-6.4321E+03	0.0000E+00	1.0699E+04
-4.8966E+02	1.5888E+02	3.6882E+01	-1.3522E+05	0.0000E+00	3.1176E+07	-6.9008E+03	7.6792E+03	1.3816E+01
-4.8966E+02	1.0592E+02	6.1975E+01	-1.4212E+05	9.1399E+04	1.3359E+00	-6.9008E+03	7.2751E+03	1.0625E-01
-4.8966E+02	5.2962E+01	1.0346E+02	-1.4212E+05	8.4870E+04	9.1540E+03	-6.9008E+03	6.4667E+03	1.2368E+00
-4.8966E+02	0.0000E+00	9.7099E+01	-1.4212E+05	7.8342E+04	1.3359E+00	-6.9008E+03	6.0626E+03	3.6186E+00
-5.5453E+02	7.4146E+02	3.5000E+00	-1.4212E+05	7.1813E+04	2.2749E+03	-6.9008E+03	5.6584E+03	4.3018E-01
-5.5453E+02	5.8258E+02	3.5000E+00	-1.4212E+05	6.5285E+04	2.2203E+04	-6.9008E+03	4.8500E+03	1.4493E+00
-5.5453E+02	5.2962E+02	2.6717E+00	-1.4212E+05	5.8756E+04	3.3175E+04	-6.9008E+03	4.4459E+03	8.8102E+00
-5.5453E+02	4.2369E+02	3.5000E+00	-1.4212E+05	5.2228E+04	9.9937E+04	-6.9008E+03	4.0417E+03	4.3018E-01
-5.5453E+02	3.7073E+02	1.5843E+01	-1.4212E+05	4.5699E+04	2.1802E+05	-6.9008E+03	3.6375E+03	7.5333E+00
-5.5453E+02	3.1777E+02	1.5015E+01	-1.4212E+05	3.9171E+04	5.7792E+05	-6.9008E+03	3.2334E+03	2.0833E+00
-5.5453E+02	2.6481E+02	2.3858E+01	-1.4212E+05	3.2642E+04	1.1359E+06	-6.9008E+03	2.8292E+03	3.0233E+01
-5.5453E+02	2.1185E+02	3.2728E+01	-1.4212E+05	2.6114E+04	2.7483E+06	-6.9008E+03	2.4250E+03	2.8685E+01
-5.5453E+02	1.5888E+02	2.5432E+01	-1.4212E+05	1.9585E+04	4.5219E+06	-6.9008E+03	2.0209E+03	4.6476E+00
-5.5453E+02	1.0592E+02	3.7695E+01	-1.4212E+05	1.3057E+04	5.6010E+06	-6.9008E+03	1.6167E+03	5.5997E+00
-5.5453E+02	5.2962E+01	5.5503E+01	-1.4212E+05	6.5285E+03	7.3528E+06	-6.9008E+03	1.2125E+03	5.0014E+01
-5.5453E+02	0.0000E+00	6.8953E+01	-1.4212E+05	0.0000E+00	2.2090E+07	-6.9008E+03	8.0834E+02	8.1165E+01
-6.1940E+02	5.2962E+02	3.9217E+00	-1.4901E+05	7.1813E+04	1.3359E+00	-6.9008E+03	4.0417E+02	2.7989E+03
-6.1940E+02	4.7665E+02	5.3434E+00	-1.4901E+05	6.5285E+04	4.5770E+03	-6.9008E+03	0.0000E+00	6.5663E+03
-6.1940E+02	3.1777E+02	2.6717E+00	-1.4901E+05	5.8756E+04	1.3667E+04	-7.3695E+03	7.6792E+03	3.2393E-01
-6.1940E+02	2.6481E+02	1.2343E+01	-1.4901E+05	5.2228E+04	1.8919E+04	-7.3695E+03	6.0626E+03	1.7100E+02
-6.1940E+02	2.1185E+02	5.3434E+00	-1.4901E+05	4.5699E+04	4.7954E+04	-7.3695E+03	4.8500E+03	4.2324E+00
-6.1940E+02	1.5888E+02	2.7382E+01	-1.4901E+05	3.9171E+04	1.9965E+05	-7.3695E+03	3.6375E+03	7.2094E+00
-6.1940E+02	1.0592E+02	2.8187E+01	-1.4901E+05	3.2642E+04	5.1381E+05	-7.3695E+03	3.2334E+03	1.6866E+02
-6.1940E+02	5.2962E+01	2.1187E+01	-1.4901E+05	2.6114E+04	9.6476E+05	-7.3695E+03	2.8292E+03	7.2094E+00
-6.1940E+02	0.0000E+00	3.0478E+01	-1.4901E+05	1.9585E+04	1.7989E+06	-7.3695E+03	2.4250E+03	3.2470E+01
-6.8427E+02	4.2369E+02	2.7780E+00	-1.4901E+05	1.3057E+04	2.4382E+06	-7.3695E+03	2.0209E+03	9.4351E+00
-6.8427E+02	3.1777E+02	5.3434E+00	-1.4901E+05	6.5285E+03	3.3039E+06	-7.3695E+03	1.6167E+03	1.2881E+01
-6.8427E+02	2.6481E+02	5.3434E+00	-1.4901E+05	0.0000E+00	1.0560E+07	-7.3695E+03	1.2125E+03	2.4868E+00
-6.8427E+02	2.1185E+02	8.0151E+00	-1.5591E+05	3.9171E+04	2.5755E+04	-7.3695E+03	8.0834E+02	4.9222E+01
-6.8427E+02	1.5888E+02	6.1717E+00	-1.5591E+05	3.2642E+04	8.0992E+04	-7.3695E+03	4.0417E+02	6.3971E+01
-6.8427E+02	1.0592E+02	1.5843E+01	-1.5591E+05	2.6114E+04	2.6104E+05	-7.3695E+03	0.0000E+00	4.2707E+02
-6.8427E+02	5.2962E+01	2.7780E+01	-1.5591E+05	1.9585E+04	3.6736E+05	-7.8381E+03	6.4667E+03	1.2368E+00
-6.8427E+02	0.0000E+00	4.2073E+01	-1.5591E+05	1.3057E+04	5.2413E+05	-7.8381E+03	6.0626E+03	2.3698E+00
-7.4915E+02	4.7665E+02	2.6717E+00	-1.5591E+05	6.5285E+03	8.0981E+05	-7.8381E+03	5.2542E+03	8.4594E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-7.4915E+02	2.1185E+02	9.6717E+00	-1.5591E+05	0.0000E+00	3.1892E+06	-7.8381E+03	4.4459E+03	1.2397E+00
-7.4915E+02	1.5888E+02	1.5015E+01	-1.6281E+05	3.2642E+04	2.6717E+00	-7.8381E+03	3.6375E+03	8.4462E+00
-7.4915E+02	1.0592E+02	5.3434E+00	-1.6281E+05	2.6114E+04	1.4136E+03	-7.8381E+03	3.2334E+03	1.4493E+00
-7.4915E+02	5.2962E+01	1.6589E+01	-1.6281E+05	1.9585E+04	4.2223E+04	-7.8381E+03	2.4250E+03	7.2094E+00
-7.4915E+02	0.0000E+00	2.0465E+01	-1.6281E+05	1.3057E+04	3.7085E+04	-7.8381E+03	2.0209E+03	3.5552E+00
-8.1402E+02	3.7073E+02	2.6717E+00	-1.6281E+05	6.5285E+03	9.9938E+04	-7.8381E+03	1.6167E+03	3.2393E-01
-8.1402E+02	2.1185E+02	2.6717E+00	-1.6281E+05	0.0000E+00	7.4369E+05	-7.8381E+03	1.2125E+03	1.0375E+01
-8.1402E+02	1.0592E+02	5.4496E+00	-1.6971E+05	2.6114E+04	2.6717E+00	-7.8381E+03	8.0834E+02	2.7058E+01
-8.1402E+02	5.2962E+01	2.7780E+00	-1.6971E+05	1.3057E+04	5.3434E+00	-7.8381E+03	4.0417E+02	1.9455E+02
-8.1402E+02	0.0000E+00	5.3434E+00	-1.6971E+05	6.5285E+03	3.3124E+03	-7.8381E+03	0.0000E+00	1.8605E+02
-8.7889E+02	3.7073E+02	2.6717E+00	-1.6971E+05	0.0000E+00	4.8613E+04	-8.3068E+03	6.4667E+03	3.2393E-01
-8.7889E+02	3.1777E+02	2.6717E+00	-1.7660E+05	0.0000E+00	1.0687E+01	-8.3068E+03	3.6375E+03	1.8882E+00
-8.7889E+02	2.1185E+02	5.3434E+00	-1.8350E+05	0.0000E+00	5.3434E+00	-8.3068E+03	2.8292E+03	7.5333E+00
-8.7889E+02	5.2962E+01	8.8434E+00	-1.9040E+05	0.0000E+00	5.3434E+00	-8.3068E+03	2.4250E+03	3.2393E-01
-8.7889E+02	0.0000E+00	2.6717E+00				-8.3068E+03	1.2125E+03	1.0625E-01
-9.4376E+02	1.5888E+02	2.6717E+00				-8.3068E+03	8.0834E+02	9.5019E+00
-1.0086E+03	1.0592E+02	2.6717E+00				-8.3068E+03	4.0417E+02	1.0170E+01
-1.0086E+03	0.0000E+00	5.3434E+00				-8.3068E+03	0.0000E+00	5.4502E+01
						-8.7755E+03	5.6584E+03	1.0625E-01
						-8.7755E+03	3.2334E+03	3.2393E-01
						-8.7755E+03	2.4250E+03	1.8882E+00
						-8.7755E+03	1.2125E+03	5.5657E+00
						-8.7755E+03	8.0834E+02	3.2393E-01
						-8.7755E+03	4.0417E+02	7.5333E+00
						-8.7755E+03	0.0000E+00	3.4878E+02
						-9.2442E+03	1.2125E+03	1.5636E+00
						-9.2442E+03	8.0834E+02	1.2368E+00
						-9.2442E+03	4.0417E+02	3.2393E-01
						-9.2442E+03	0.0000E+00	2.3092E+01
						-9.7128E+03	6.8709E+03	1.0625E-01
						-9.7128E+03	1.6167E+03	1.8882E+00
						-9.7128E+03	1.2125E+03	1.2368E+00
						-9.7128E+03	0.0000E+00	2.9956E+00
						-1.0182E+04	8.0834E+02	3.2393E-01
						-1.0182E+04	0.0000E+00	1.5251E+01
						-1.0650E+04	0.0000E+00	4.2030E+00
						-1.1588E+04	4.0417E+02	1.0625E-01
						-1.1588E+04	0.0000E+00	1.0625E-01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices								
Tower shear, bottom F_y [kN]			**Tower bending, bottom M_x [kNm]**			**Tower torsion, bottom M_z [kNm]**		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
						-1.2525E+04	4.0417E+02	1.0625E-01

Table 5-15 [5] Markov Matrix

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Business Assurance Denmark A/S
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Appendix H. Markov matrices – issued from [6]

This appendix contains the Markov Matrices for the shear force, the bending moment and the torsional moment in the bottom of the tower, from ref. [6]. Foundation design must be verified for the most critical Markov matrices.

Markov Matrices								
Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.5311E+03	0.0000E+00	1.9250E+03	1.4819E+05	0.0000E+00	2.6717E+00	8.1369E+03	0.0000E+00	2.6717E+00
1.4633E+03	1.1374E+02	5.4112E+01	1.4094E+05	1.2907E+04	2.6717E+00	7.6480E+03	3.8365E+02	4.0279E+00
1.4633E+03	5.6870E+01	5.3125E-02	1.3370E+05	0.0000E+00	5.4496E+00	7.6480E+03	0.0000E+00	1.0625E-01
1.4633E+03	0.0000E+00	6.5228E+03	1.2646E+05	1.2907E+04	2.6717E+00	7.1592E+03	7.6729E+02	1.0128E+02
1.3955E+03	1.1374E+02	1.2593E+00	1.2646E+05	0.0000E+00	1.0625E-01	7.1592E+03	0.0000E+00	1.6080E+01
1.3955E+03	5.6870E+01	3.5000E+00	1.1921E+05	6.4537E+03	2.6717E+00	6.6703E+03	1.5346E+03	3.5000E+00
1.3955E+03	0.0000E+00	1.8611E+04	1.1921E+05	0.0000E+00	5.3434E+00	6.6703E+03	7.6729E+02	3.5000E+00
1.3277E+03	1.1374E+02	1.2889E+03	1.1197E+05	1.2907E+04	2.6717E+00	6.6703E+03	3.8365E+02	7.2371E+00
1.3277E+03	5.6870E+01	1.0738E+04	1.1197E+05	6.4537E+03	5.4496E+00	6.6703E+03	0.0000E+00	2.7784E+02
1.3277E+03	0.0000E+00	4.3087E+04	1.1197E+05	0.0000E+00	1.4187E+01	6.1814E+03	1.1509E+03	2.6717E+00
1.2600E+03	4.5496E+02	4.7167E+02	1.0473E+05	1.9361E+04	2.6717E+00	6.1814E+03	3.8365E+02	9.5988E+02
1.2600E+03	1.7061E+02	8.6180E+02	1.0473E+05	1.2907E+04	5.3434E+00	6.1814E+03	0.0000E+00	9.4734E+01
1.2600E+03	1.1374E+02	7.1453E+03	1.0473E+05	6.4537E+03	8.0151E+00	5.6926E+03	5.3710E+03	1.8882E+00
1.2600E+03	5.6870E+01	4.4116E+04	1.0473E+05	0.0000E+00	1.1515E+01	5.6926E+03	4.9874E+03	1.0625E-01
1.2600E+03	0.0000E+00	2.0621E+05	9.7483E+04	1.2907E+04	2.6717E+00	5.6926E+03	4.2201E+03	2.6717E+00
1.1922E+03	2.2748E+02	5.3125E-02	9.7483E+04	6.4537E+03	5.3434E+00	5.6926E+03	1.1509E+03	3.5000E+00
1.1922E+03	1.7061E+02	7.6080E+02	9.7483E+04	0.0000E+00	1.7687E+01	5.6926E+03	7.6729E+02	1.1012E+03
1.1922E+03	1.1374E+02	1.7721E+04	9.0240E+04	3.8722E+04	3.5000E+00	5.6926E+03	3.8365E+02	4.8600E+02
1.1922E+03	5.6870E+01	1.0149E+05	9.0240E+04	1.9361E+04	1.2500E+00	5.6926E+03	0.0000E+00	1.7702E+04
1.1922E+03	0.0000E+00	5.6305E+05	9.0240E+04	6.4537E+03	8.0151E+00	5.2037E+03	6.5220E+03	1.8882E+00
1.1244E+03	5.1183E+02	1.0331E+02	9.0240E+04	0.0000E+00	5.6291E+01	5.2037E+03	6.1383E+03	2.6717E+00
1.1244E+03	4.5496E+02	5.3125E-02	8.2996E+04	7.0990E+04	1.2500E+00	5.2037E+03	4.2201E+03	2.6717E+00
1.1244E+03	3.9809E+02	6.6007E+01	8.2996E+04	5.1629E+04	3.5000E+00	5.2037E+03	3.0692E+03	1.0737E+01
1.1244E+03	3.4122E+02	4.7167E+02	8.2996E+04	1.9361E+04	1.4000E+01	5.2037E+03	2.6855E+03	9.9571E+00
1.1244E+03	2.2748E+02	8.6328E+02	8.2996E+04	1.2907E+04	1.3172E+01	5.2037E+03	2.3019E+03	6.1717E+00
1.1244E+03	1.7061E+02	7.9830E+03	8.2996E+04	6.4537E+03	2.6450E+01	5.2037E+03	1.9182E+03	7.2371E+00
1.1244E+03	1.1374E+02	4.6699E+04	8.2996E+04	0.0000E+00	4.0717E+01	5.2037E+03	1.5346E+03	1.2500E+00
1.1244E+03	5.6870E+01	5.0353E+05	7.5753E+04	4.5176E+04	3.5000E+00	5.2037E+03	1.1509E+03	8.8466E+02
1.1244E+03	0.0000E+00	1.5138E+06	7.5753E+04	3.8722E+04	3.5000E+00	5.2037E+03	7.6729E+02	1.9918E+02
1.0566E+03	5.6870E+02	1.7913E+02	7.5753E+04	3.2268E+04	1.4000E+01	5.2037E+03	3.8365E+02	8.1107E+03
1.0566E+03	5.1183E+02	3.4729E+03	7.5753E+04	2.5815E+04	7.0000E+00	5.2037E+03	0.0000E+00	6.9656E+04
1.0566E+03	3.9809E+02	1.0138E+03	7.5753E+04	1.9361E+04	1.0093E+01	4.7148E+03	4.9874E+03	7.2371E+00
1.0566E+03	3.4122E+02	2.8152E+03	7.5753E+04	1.2907E+04	1.4187E+01	4.7148E+03	4.6038E+03	7.2094E+00
1.0566E+03	2.2748E+02	4.1802E+03	7.5753E+04	6.4537E+03	3.7217E+01	4.7148E+03	3.8365E+03	9.9571E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Denmark A/S Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0566E+03	1.7061E+02	2.7202E+04	7.5753E+04	0.0000E+00	7.4808E+01	4.7148E+03	3.4528E+03	4.6130E+00
1.0566E+03	1.1374E+02	1.9224E+05	6.8509E+04	9.0352E+04	2.6717E+00	4.7148E+03	3.0692E+03	3.5000E+00
1.0566E+03	5.6870E+01	1.4742E+06	6.8509E+04	3.8722E+04	2.6717E+00	4.7148E+03	2.6855E+03	1.7738E+02
1.0566E+03	0.0000E+00	3.7978E+06	6.8509E+04	3.2268E+04	7.0000E+00	4.7148E+03	2.3019E+03	5.3882E+00
9.8882E+02	1.4218E+03	1.1200E+03	6.8509E+04	2.5815E+04	8.8434E+00	4.7148E+03	1.9182E+03	3.2393E-01
9.8882E+02	9.0993E+02	3.6469E+03	6.8509E+04	1.9361E+04	2.3672E+01	4.7148E+03	1.5346E+03	2.8994E+03
9.8882E+02	8.5306E+02	6.4524E+03	6.8509E+04	1.2907E+04	1.9260E+01	4.7148E+03	1.1509E+03	2.1739E+03
9.8882E+02	7.9619E+02	7.4732E+03	6.8509E+04	6.4537E+03	2.8608E+01	4.7148E+03	7.6729E+02	2.3898E+04
9.8882E+02	7.3932E+02	6.9866E+03	6.8509E+04	0.0000E+00	7.5753E+01	4.7148E+03	3.8365E+02	8.2001E+04
9.8882E+02	6.8244E+02	2.4914E+03	6.1266E+04	1.7425E+05	1.3359E+00	4.7148E+03	0.0000E+00	2.0190E+05
9.8882E+02	5.6870E+02	7.1504E+03	6.1266E+04	1.6134E+05	1.3359E+00	4.2260E+03	6.1383E+03	2.0661E+02
9.8882E+02	5.1183E+02	1.7770E+04	6.1266E+04	1.5489E+05	1.3359E+00	4.2260E+03	5.7547E+03	7.2371E+00
9.8882E+02	4.5496E+02	1.3626E+04	6.1266E+04	7.7444E+04	2.6717E+00	4.2260E+03	5.3710E+03	2.6717E+00
9.8882E+02	3.9809E+02	2.1086E+04	6.1266E+04	7.0990E+04	2.6717E+00	4.2260E+03	4.9874E+03	3.7542E+01
9.8882E+02	3.4122E+02	1.8011E+04	6.1266E+04	6.4537E+04	2.6717E+00	4.2260E+03	4.6038E+03	2.1020E+01
9.8882E+02	2.8435E+02	2.0325E+04	6.1266E+04	4.5176E+04	3.5000E+00	4.2260E+03	4.2201E+03	8.7497E+01
9.8882E+02	2.2748E+02	4.2593E+04	6.1266E+04	3.8722E+04	1.4339E+01	4.2260E+03	3.8365E+03	1.2368E+00
9.8882E+02	1.7061E+02	1.9825E+05	6.1266E+04	3.2268E+04	9.2651E+00	4.2260E+03	3.4528E+03	7.2371E+00
9.8882E+02	1.1374E+02	9.0449E+05	6.1266E+04	2.5815E+04	1.9343E+01	4.2260E+03	3.0692E+03	4.2595E+03
9.8882E+02	5.6870E+01	4.3044E+06	6.1266E+04	1.9361E+04	6.1717E+00	4.2260E+03	2.6855E+03	3.3743E+03
9.8882E+02	0.0000E+00	8.3410E+06	6.1266E+04	1.2907E+04	1.2500E+00	4.2260E+03	2.3019E+03	1.4219E+04
9.2104E+02	1.9905E+03	1.7124E+02	6.1266E+04	6.4537E+03	2.9136E+01	4.2260E+03	1.9182E+03	1.3144E+04
9.2104E+02	1.9336E+03	3.4249E+02	6.1266E+04	0.0000E+00	6.1667E+01	4.2260E+03	1.5346E+03	2.9225E+04
9.2104E+02	1.8767E+03	1.7124E+02	5.4022E+04	1.8070E+05	1.3359E+00	4.2260E+03	1.1509E+03	3.6218E+04
9.2104E+02	1.8199E+03	6.7524E+02	5.4022E+04	1.6134E+05	1.3359E+00	4.2260E+03	7.6729E+02	6.5906E+04
9.2104E+02	1.7061E+03	3.4249E+02	5.4022E+04	1.5489E+05	1.3359E+00	4.2260E+03	3.8365E+02	1.8533E+05
9.2104E+02	1.6492E+03	6.5385E+02	5.4022E+04	1.3553E+05	1.3359E+00	4.2260E+03	0.0000E+00	7.2949E+05
9.2104E+02	1.4786E+03	4.7688E+02	5.4022E+04	7.7444E+04	2.6717E+00	3.7371E+03	1.1509E+04	1.3359E+00
9.2104E+02	1.4218E+03	2.8300E+03	5.4022E+04	6.4537E+04	3.5000E+00	3.7371E+03	6.9056E+03	7.3156E+00
9.2104E+02	1.3649E+03	1.2745E+03	5.4022E+04	5.1629E+04	2.6717E+00	3.7371E+03	6.1383E+03	7.2371E+00
9.2104E+02	1.3080E+03	3.2319E+03	5.4022E+04	3.8722E+04	6.1717E+00	3.7371E+03	5.7547E+03	9.0469E+02
9.2104E+02	1.2511E+03	1.2525E+04	5.4022E+04	3.2268E+04	1.4528E+01	3.7371E+03	5.3710E+03	2.6717E+00
9.2104E+02	1.1943E+03	1.8945E+04	5.4022E+04	2.5815E+04	2.4306E+01	3.7371E+03	4.9874E+03	3.3440E+03
9.2104E+02	1.1374E+03	1.2707E+04	5.4022E+04	1.9361E+04	4.2955E+01	3.7371E+03	4.6038E+03	6.9919E+03
9.2104E+02	1.0805E+03	1.2378E+04	5.4022E+04	1.2907E+04	2.0089E+01	3.7371E+03	4.2201E+03	3.7225E+03
9.2104E+02	1.0237E+03	2.1662E+04	5.4022E+04	6.4537E+03	3.8702E+01	3.7371E+03	3.8365E+03	1.6002E+04
9.2104E+02	9.6680E+02	2.4155E+04	5.4022E+04	0.0000E+00	1.4842E+02	3.7371E+03	3.4528E+03	1.7678E+04
9.2104E+02	9.0993E+02	5.3547E+04	4.6779E+04	1.8070E+05	5.3125E-02	3.7371E+03	3.0692E+03	7.0985E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
9.2104E+02	8.5306E+02	7.5614E+04	4.6779E+04	1.6780E+05	5.3125E-02	3.7371E+03	2.6855E+03	8.4166E+04
9.2104E+02	7.9619E+02	1.2283E+05	4.6779E+04	1.5489E+05	4.4217E+00	3.7371E+03	2.3019E+03	1.4062E+05
9.2104E+02	7.3932E+02	1.7447E+05	4.6779E+04	1.4843E+05	1.7500E+00	3.7371E+03	1.9182E+03	1.3806E+05
9.2104E+02	6.8244E+02	2.3853E+05	4.6779E+04	1.3553E+05	6.1717E+00	3.7371E+03	1.5346E+03	9.1832E+04
9.2104E+02	6.2557E+02	3.1176E+05	4.6779E+04	1.2907E+05	1.3359E+00	3.7371E+03	1.1509E+03	1.2294E+05
9.2104E+02	5.6870E+02	3.2730E+05	4.6779E+04	1.2262E+05	3.5000E+00	3.7371E+03	7.6729E+02	2.4322E+05
9.2104E+02	5.1183E+02	5.0982E+05	4.6779E+04	1.1617E+05	3.0859E+00	3.7371E+03	3.8365E+02	7.9918E+05
9.2104E+02	4.5496E+02	5.6018E+05	4.6779E+04	1.0971E+05	2.6717E+00	3.7371E+03	0.0000E+00	1.4373E+06
9.2104E+02	3.9809E+02	6.2175E+05	4.6779E+04	7.7444E+04	5.3434E+00	3.2482E+03	1.5729E+04	1.2500E+00
9.2104E+02	3.4122E+02	6.9428E+05	4.6779E+04	7.0990E+04	3.5000E+00	3.2482E+03	6.1383E+03	2.5410E+03
9.2104E+02	2.8435E+02	4.8349E+05	4.6779E+04	6.4537E+04	7.4217E+00	3.2482E+03	5.7547E+03	2.6220E+03
9.2104E+02	2.2748E+02	6.0382E+05	4.6779E+04	5.8083E+04	6.1717E+00	3.2482E+03	5.3710E+03	5.0940E+03
9.2104E+02	1.7061E+02	9.7525E+05	4.6779E+04	5.1629E+04	1.0922E+01	3.2482E+03	4.9874E+03	4.3606E+03
9.2104E+02	1.1374E+02	2.7407E+06	4.6779E+04	4.5176E+04	1.0500E+01	3.2482E+03	4.6038E+03	5.6160E+04
9.2104E+02	5.6870E+01	8.8764E+06	4.6779E+04	3.8722E+04	1.5015E+01	3.2482E+03	4.2201E+03	7.1696E+04
9.2104E+02	0.0000E+00	1.4733E+07	4.6779E+04	3.2268E+04	8.2500E+00	3.2482E+03	3.8365E+03	1.3348E+05
8.5326E+02	2.1042E+03	3.3276E+02	4.6779E+04	2.5815E+04	2.7172E+01	3.2482E+03	3.4528E+03	1.5921E+05
8.5326E+02	1.9905E+03	3.3276E+02	4.6779E+04	1.9361E+04	4.1700E+01	3.2482E+03	3.0692E+03	1.9972E+05
8.5326E+02	1.9336E+03	1.2354E+02	4.6779E+04	1.2907E+04	2.6450E+01	3.2482E+03	2.6855E+03	2.5766E+05
8.5326E+02	1.8767E+03	8.2509E+02	4.6779E+04	6.4537E+03	6.9801E+01	3.2482E+03	2.3019E+03	2.0238E+05
8.5326E+02	1.8199E+03	3.4878E+03	4.6779E+04	0.0000E+00	3.3390E+03	3.2482E+03	1.9182E+03	2.0110E+05
8.5326E+02	1.7630E+03	3.2839E+03	3.9535E+04	2.0006E+05	1.3359E+00	3.2482E+03	1.5346E+03	3.0730E+05
8.5326E+02	1.7061E+03	2.8013E+03	3.9535E+04	1.5489E+05	4.8358E+00	3.2482E+03	1.1509E+03	2.6121E+05
8.5326E+02	1.6492E+03	1.0037E+04	3.9535E+04	1.4843E+05	2.6717E+00	3.2482E+03	7.6729E+02	5.8074E+05
8.5326E+02	1.5924E+03	8.2170E+03	3.9535E+04	1.4198E+05	1.7500E+00	3.2482E+03	3.8365E+02	1.4922E+06
8.5326E+02	1.5355E+03	1.5513E+04	3.9535E+04	1.3553E+05	3.0859E+00	3.2482E+03	0.0000E+00	2.6735E+06
8.5326E+02	1.4786E+03	7.5045E+03	3.9535E+04	1.2907E+05	1.0500E+01	2.7594E+03	1.4962E+04	5.3125E-02
8.5326E+02	1.4218E+03	2.1195E+04	3.9535E+04	1.2262E+05	4.8358E+00	2.7594E+03	1.1893E+04	2.6717E+00
8.5326E+02	1.3649E+03	2.2567E+04	3.9535E+04	1.1617E+05	3.0859E+00	2.7594E+03	1.0742E+04	3.1921E+00
8.5326E+02	1.3080E+03	2.7642E+04	3.9535E+04	9.6805E+04	5.2500E+00	2.7594E+03	1.0358E+04	1.3359E+00
8.5326E+02	1.2511E+03	6.3348E+04	3.9535E+04	9.0352E+04	6.1717E+00	2.7594E+03	8.4402E+03	3.6186E+00
8.5326E+02	1.1943E+03	9.7213E+04	3.9535E+04	8.3898E+04	2.6717E+00	2.7594E+03	8.0566E+03	1.4419E+02
8.5326E+02	1.1374E+03	1.5521E+05	3.9535E+04	7.7444E+04	2.6717E+00	2.7594E+03	7.6729E+03	1.1754E+02
8.5326E+02	1.0805E+03	1.5487E+05	3.9535E+04	7.0990E+04	7.4217E+00	2.7594E+03	7.2893E+03	2.1253E+03
8.5326E+02	1.0237E+03	2.5376E+05	3.9535E+04	6.4537E+04	6.1717E+00	2.7594E+03	6.9056E+03	3.2604E+03
8.5326E+02	9.6680E+02	3.5114E+05	3.9535E+04	5.8083E+04	3.5418E+01	2.7594E+03	6.5220E+03	6.7192E+03
8.5326E+02	9.0993E+02	6.6898E+05	3.9535E+04	5.1629E+04	1.4422E+01	2.7594E+03	6.1383E+03	2.8426E+04
8.5326E+02	8.5306E+02	6.9892E+05	3.9535E+04	4.5176E+04	1.4000E+01	2.7594E+03	5.7547E+03	2.0506E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance Tåsing Parkvej 8-12 DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.5326E+02	7.9619E+02	1.0265E+06	3.9535E+04	3.8722E+04	3.9515E+01	2.7594E+03	5.3710E+03	8.1213E+04
8.5326E+02	7.3932E+02	1.2205E+06	3.9535E+04	3.2268E+04	3.3260E+01	2.7594E+03	4.9874E+03	7.8386E+04
8.5326E+02	6.8244E+02	1.7956E+06	3.9535E+04	2.5815E+04	4.6907E+01	2.7594E+03	4.6038E+03	1.3774E+05
8.5326E+02	6.2557E+02	2.2004E+06	3.9535E+04	1.9361E+04	6.8970E+01	2.7594E+03	4.2201E+03	2.6538E+05
8.5326E+02	5.6870E+02	2.3194E+06	3.9535E+04	1.2907E+04	8.0888E+01	2.7594E+03	3.8365E+03	2.7501E+05
8.5326E+02	5.1183E+02	2.9840E+06	3.9535E+04	6.4537E+03	8.3644E+01	2.7594E+03	3.4528E+03	3.4706E+05
8.5326E+02	4.5496E+02	3.4041E+06	3.9535E+04	0.0000E+00	1.9689E+03	2.7594E+03	3.0692E+03	4.2143E+05
8.5326E+02	3.9809E+02	3.5581E+06	3.2292E+04	2.0652E+05	6.2500E-01	2.7594E+03	2.6855E+03	4.4471E+05
8.5326E+02	3.4122E+02	3.6204E+06	3.2292E+04	1.6134E+05	1.7500E+00	2.7594E+03	2.3019E+03	4.5035E+05
8.5326E+02	2.8435E+02	3.0583E+06	3.2292E+04	1.4843E+05	1.7500E+00	2.7594E+03	1.9182E+03	4.6842E+05
8.5326E+02	2.2748E+02	2.7706E+06	3.2292E+04	1.4198E+05	7.5075E+00	2.7594E+03	1.5346E+03	4.7520E+05
8.5326E+02	1.7061E+02	3.2858E+06	3.2292E+04	1.3553E+05	1.3359E+00	2.7594E+03	1.1509E+03	5.0001E+05
8.5326E+02	1.1374E+02	6.1505E+06	3.2292E+04	1.2907E+05	8.5467E+00	2.7594E+03	7.6729E+02	1.0789E+06
8.5326E+02	5.6870E+01	1.5454E+07	3.2292E+04	1.2262E+05	4.8358E+00	2.7594E+03	3.8365E+02	2.5377E+06
8.5326E+02	0.0000E+00	2.1502E+07	3.2292E+04	1.1617E+05	6.5858E+00	2.7594E+03	0.0000E+00	4.7577E+06
7.8548E+02	2.2748E+03	3.3276E+02	3.2292E+04	1.0971E+05	1.2250E+01	2.2705E+03	1.2277E+04	1.7500E+00
7.8548E+02	2.2179E+03	3.9434E+02	3.2292E+04	1.0326E+05	4.4217E+00	2.2705E+03	1.1509E+04	9.4410E-01
7.8548E+02	2.1042E+03	3.4249E+02	3.2292E+04	9.6805E+04	1.7500E+00	2.2705E+03	1.1126E+04	4.9544E+00
7.8548E+02	2.0473E+03	2.1073E+03	3.2292E+04	9.0352E+04	1.2250E+01	2.2705E+03	1.0742E+04	6.1585E+01
7.8548E+02	1.9905E+03	1.6709E+03	3.2292E+04	8.3898E+04	6.4897E+00	2.2705E+03	1.0358E+04	1.0510E+01
7.8548E+02	1.9336E+03	4.9555E+03	3.2292E+04	7.7444E+04	3.5000E+00	2.2705E+03	9.2075E+03	2.5999E+01
7.8548E+02	1.8767E+03	4.2492E+03	3.2292E+04	7.0990E+04	2.1418E+01	2.2705E+03	8.8239E+03	1.7500E+00
7.8548E+02	1.8199E+03	4.1154E+03	3.2292E+04	6.4537E+04	1.1962E+01	2.2705E+03	8.4402E+03	6.2500E-01
7.8548E+02	1.7630E+03	7.1174E+03	3.2292E+04	5.8083E+04	3.1500E+01	2.2705E+03	8.0566E+03	3.3127E+03
7.8548E+02	1.7061E+03	1.3078E+04	3.2292E+04	5.1629E+04	2.2015E+01	2.2705E+03	7.6729E+03	4.6964E+03
7.8548E+02	1.6492E+03	1.6505E+04	3.2292E+04	4.5176E+04	4.5514E+01	2.2705E+03	7.2893E+03	7.4132E+03
7.8548E+02	1.5924E+03	2.2577E+04	3.2292E+04	3.8722E+04	1.8028E+01	2.2705E+03	6.9056E+03	2.2342E+04
7.8548E+02	1.5355E+03	3.1249E+04	3.2292E+04	3.2268E+04	2.9121E+01	2.2705E+03	6.5220E+03	6.2282E+04
7.8548E+02	1.4786E+03	6.2280E+04	3.2292E+04	2.5815E+04	1.1550E+02	2.2705E+03	6.1383E+03	6.9490E+04
7.8548E+02	1.4218E+03	9.1724E+04	3.2292E+04	1.9361E+04	2.5421E+02	2.2705E+03	5.7547E+03	1.1304E+05
7.8548E+02	1.3649E+03	9.9488E+04	3.2292E+04	1.2907E+04	3.6289E+03	2.2705E+03	5.3710E+03	2.4198E+05
7.8548E+02	1.3080E+03	2.1351E+05	3.2292E+04	6.4537E+03	1.0455E+04	2.2705E+03	4.9874E+03	2.0138E+05
7.8548E+02	1.2511E+03	2.3881E+05	3.2292E+04	0.0000E+00	1.2328E+04	2.2705E+03	4.6038E+03	2.6622E+05
7.8548E+02	1.1943E+03	3.9302E+05	2.5048E+04	1.5489E+05	6.2500E-01	2.2705E+03	4.2201E+03	4.2088E+05
7.8548E+02	1.1374E+03	5.0293E+05	2.5048E+04	1.4843E+05	5.8750E+00	2.2705E+03	3.8365E+03	4.9789E+05
7.8548E+02	1.0805E+03	6.7994E+05	2.5048E+04	1.4198E+05	6.2500E-01	2.2705E+03	3.4528E+03	6.6022E+05
7.8548E+02	1.0237E+03	8.5602E+05	2.5048E+04	1.3553E+05	4.8358E+00	2.2705E+03	3.0692E+03	6.8853E+05
7.8548E+02	9.6680E+02	1.1525E+06	2.5048E+04	1.2907E+05	3.5000E+00	2.2705E+03	2.6855E+03	7.9343E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.8548E+02	9.0993E+02	1.4743E+06	2.5048E+04	1.2262E+05	1.7500E+00	2.2705E+03	2.3019E+03	8.6631E+05
7.8548E+02	8.5306E+02	2.0351E+06	2.5048E+04	1.1617E+05	2.6717E+00	2.2705E+03	1.9182E+03	9.7431E+05
7.8548E+02	7.9619E+02	2.7475E+06	2.5048E+04	1.0971E+05	7.5075E+00	2.2705E+03	1.5346E+03	8.2211E+05
7.8548E+02	7.3932E+02	3.1870E+06	2.5048E+04	1.0326E+05	7.6230E+00	2.2705E+03	1.1509E+03	1.1312E+06
7.8548E+02	6.8244E+02	3.8825E+06	2.5048E+04	9.6805E+04	1.1123E+01	2.2705E+03	7.6729E+02	1.7617E+06
7.8548E+02	6.2557E+02	4.8409E+06	2.5048E+04	9.0352E+04	7.6230E+00	2.2705E+03	3.8365E+02	4.1200E+06
7.8548E+02	5.6870E+02	5.4940E+06	2.5048E+04	8.3898E+04	1.5246E+01	2.2705E+03	0.0000E+00	7.0010E+06
7.8548E+02	5.1183E+02	5.7616E+06	2.5048E+04	7.7444E+04	3.2190E+01	1.7816E+03	1.3811E+04	5.3125E-02
7.8548E+02	4.5496E+02	6.6064E+06	2.5048E+04	7.0990E+04	1.5856E+01	1.7816E+03	1.1126E+04	1.2609E+03
7.8548E+02	3.9809E+02	6.9419E+06	2.5048E+04	6.4537E+04	4.1121E+01	1.7816E+03	1.0742E+04	8.5833E+00
7.8548E+02	3.4122E+02	6.6347E+06	2.5048E+04	5.8083E+04	5.9341E+01	1.7816E+03	1.0358E+04	1.6720E+03
7.8548E+02	2.8435E+02	5.8011E+06	2.5048E+04	5.1629E+04	6.1902E+01	1.7816E+03	9.9748E+03	4.6497E+02
7.8548E+02	2.2748E+02	5.1756E+06	2.5048E+04	4.5176E+04	6.9093E+01	1.7816E+03	9.5912E+03	7.2810E+02
7.8548E+02	1.7061E+02	4.9075E+06	2.5048E+04	3.8722E+04	2.8417E+02	1.7816E+03	9.2075E+03	2.8040E+03
7.8548E+02	1.1374E+02	8.7682E+06	2.5048E+04	3.2268E+04	2.6433E+02	1.7816E+03	8.8239E+03	6.0696E+03
7.8548E+02	5.6870E+01	2.0915E+07	2.5048E+04	2.5815E+04	2.0611E+02	1.7816E+03	8.4402E+03	1.6678E+04
7.8548E+02	0.0000E+00	2.7032E+07	2.5048E+04	1.9361E+04	3.9316E+03	1.7816E+03	8.0566E+03	1.5080E+04
7.1769E+02	2.5592E+03	3.4327E+02	2.5048E+04	1.2907E+04	3.8163E+03	1.7816E+03	7.6729E+03	2.7144E+04
7.1769E+02	2.3317E+03	2.3539E+02	2.5048E+04	6.4537E+03	1.8302E+04	1.7816E+03	7.2893E+03	5.1731E+04
7.1769E+02	2.2179E+03	1.2317E+02	2.5048E+04	0.0000E+00	7.9808E+04	1.7816E+03	6.9056E+03	7.4321E+04
7.1769E+02	2.1611E+03	1.4556E+03	1.7805E+04	1.5489E+05	5.3125E-02	1.7816E+03	6.5220E+03	8.9896E+04
7.1769E+02	2.1042E+03	4.9875E+02	1.7805E+04	1.3553E+05	2.6717E+00	1.7816E+03	6.1383E+03	1.9835E+05
7.1769E+02	2.0473E+03	8.9411E+02	1.7805E+04	1.2907E+05	2.0140E+00	1.7816E+03	5.7547E+03	1.9148E+05
7.1769E+02	1.9905E+03	1.1908E+03	1.7805E+04	1.2262E+05	3.6781E+00	1.7816E+03	5.3710E+03	2.9386E+05
7.1769E+02	1.9336E+03	4.3561E+03	1.7805E+04	1.1617E+05	1.7500E+00	1.7816E+03	4.9874E+03	3.6596E+05
7.1769E+02	1.8767E+03	4.5375E+03	1.7805E+04	1.0971E+05	5.8750E+00	1.7816E+03	4.6038E+03	4.6341E+05
7.1769E+02	1.8199E+03	6.7420E+03	1.7805E+04	9.6805E+04	2.3831E+01	1.7816E+03	4.2201E+03	7.2010E+05
7.1769E+02	1.7630E+03	1.7413E+04	1.7805E+04	9.0352E+04	5.2500E+00	1.7816E+03	3.8365E+03	7.2474E+05
7.1769E+02	1.7061E+03	2.6607E+04	1.7805E+04	8.3898E+04	5.9949E+01	1.7816E+03	3.4528E+03	8.6442E+05
7.1769E+02	1.6492E+03	4.9935E+04	1.7805E+04	7.7444E+04	2.7832E+01	1.7816E+03	3.0692E+03	1.0653E+06
7.1769E+02	1.5924E+03	4.7005E+04	1.7805E+04	7.0990E+04	5.3809E+01	1.7816E+03	2.6855E+03	1.2662E+06
7.1769E+02	1.5355E+03	5.9078E+04	1.7805E+04	6.4537E+04	9.8005E+01	1.7816E+03	2.3019E+03	1.3506E+06
7.1769E+02	1.4786E+03	8.8838E+04	1.7805E+04	5.8083E+04	1.7107E+02	1.7816E+03	1.9182E+03	1.2640E+06
7.1769E+02	1.4218E+03	1.0069E+05	1.7805E+04	5.1629E+04	1.8233E+03	1.7816E+03	1.5346E+03	1.3418E+06
7.1769E+02	1.3649E+03	1.4824E+05	1.7805E+04	4.5176E+04	3.5618E+03	1.7816E+03	1.1509E+03	1.7970E+06
7.1769E+02	1.3080E+03	2.2133E+05	1.7805E+04	3.8722E+04	2.0549E+03	1.7816E+03	7.6729E+02	2.6548E+06
7.1769E+02	1.2511E+03	2.3733E+05	1.7805E+04	3.2268E+04	5.2348E+02	1.7816E+03	3.8365E+02	5.7941E+06
7.1769E+02	1.1943E+03	3.9305E+05	1.7805E+04	2.5815E+04	1.0754E+04	1.7816E+03	0.0000E+00	1.1421E+07

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.1769E+02	1.1374E+03	5.1296E+05	1.7805E+04	1.9361E+04	1.1242E+04	1.2928E+03	1.7264E+04	5.3125E-02
7.1769E+02	1.0805E+03	7.0284E+05	1.7805E+04	1.2907E+04	8.6094E+03	1.2928E+03	1.6880E+04	2.7056E+01
7.1769E+02	1.0237E+03	8.2355E+05	1.7805E+04	6.4537E+03	6.9472E+04	1.2928E+03	1.5729E+04	1.3359E+00
7.1769E+02	9.6680E+02	1.1331E+06	1.7805E+04	0.0000E+00	3.2151E+05	1.2928E+03	1.5346E+04	5.3125E-02
7.1769E+02	9.0993E+02	1.5813E+06	1.0561E+04	1.6780E+05	5.3125E-02	1.2928E+03	1.4195E+04	6.1840E-01
7.1769E+02	8.5306E+02	1.7991E+06	1.0561E+04	1.5489E+05	1.3359E+00	1.2928E+03	1.3428E+04	1.2616E+01
7.1769E+02	7.9619E+02	2.3389E+06	1.0561E+04	1.4843E+05	5.3125E-02	1.2928E+03	1.3044E+04	3.5751E+00
7.1769E+02	7.3932E+02	3.2579E+06	1.0561E+04	1.4198E+05	1.9609E+00	1.2928E+03	1.2660E+04	1.2354E+02
7.1769E+02	6.8244E+02	3.4296E+06	1.0561E+04	1.3553E+05	3.3498E+00	1.2928E+03	1.2277E+04	6.1703E+01
7.1769E+02	6.2557E+02	4.2975E+06	1.0561E+04	1.2907E+05	2.4281E+00	1.2928E+03	1.1893E+04	2.0787E+02
7.1769E+02	5.6870E+02	5.0461E+06	1.0561E+04	1.2262E+05	3.3498E+00	1.2928E+03	1.1509E+04	1.3443E+02
7.1769E+02	5.1183E+02	5.6306E+06	1.0561E+04	1.0971E+05	6.2500E-01	1.2928E+03	1.1126E+04	1.2729E+02
7.1769E+02	4.5496E+02	5.8651E+06	1.0561E+04	1.0326E+05	1.4421E+00	1.2928E+03	1.0742E+04	4.1138E+02
7.1769E+02	3.9809E+02	6.2016E+06	1.0561E+04	9.6805E+04	1.8046E+01	1.2928E+03	1.0358E+04	8.8729E+01
7.1769E+02	3.4122E+02	5.6767E+06	1.0561E+04	9.0352E+04	7.9897E+02	1.2928E+03	9.9748E+03	4.5522E+03
7.1769E+02	2.8435E+02	5.2687E+06	1.0561E+04	8.3898E+04	2.5543E+01	1.2928E+03	9.5912E+03	2.6572E+03
7.1769E+02	2.2748E+02	4.5966E+06	1.0561E+04	7.7444E+04	5.5263E+03	1.2928E+03	9.2075E+03	9.4020E+03
7.1769E+02	1.7061E+02	4.5052E+06	1.0561E+04	7.0990E+04	4.0551E+03	1.2928E+03	8.8239E+03	1.2002E+04
7.1769E+02	1.1374E+02	8.1764E+06	1.0561E+04	6.4537E+04	8.4073E+01	1.2928E+03	8.4402E+03	1.2968E+04
7.1769E+02	5.6870E+01	2.2202E+07	1.0561E+04	5.8083E+04	2.5809E+03	1.2928E+03	8.0566E+03	3.0288E+04
7.1769E+02	0.0000E+00	2.9399E+07	1.0561E+04	5.1629E+04	2.6801E+03	1.2928E+03	7.6729E+03	4.5936E+04
6.4991E+02	2.6729E+03	2.7056E+01	1.0561E+04	4.5176E+04	1.3407E+04	1.2928E+03	7.2893E+03	7.3579E+04
6.4991E+02	2.6160E+03	4.2140E+02	1.0561E+04	3.8722E+04	4.3969E+03	1.2928E+03	6.9056E+03	1.0672E+05
6.4991E+02	2.5592E+03	3.9434E+02	1.0561E+04	3.2268E+04	7.5907E+03	1.2928E+03	6.5220E+03	1.5507E+05
6.4991E+02	2.5023E+03	2.7056E+01	1.0561E+04	2.5815E+04	1.1867E+04	1.2928E+03	6.1383E+03	2.5165E+05
6.4991E+02	2.4454E+03	4.0130E+01	1.0561E+04	1.9361E+04	3.7008E+04	1.2928E+03	5.7547E+03	4.1347E+05
6.4991E+02	2.3886E+03	1.2317E+02	1.0561E+04	1.2907E+04	3.3724E+04	1.2928E+03	5.3710E+03	4.5190E+05
6.4991E+02	2.3317E+03	1.4806E+03	1.0561E+04	6.4537E+03	3.1568E+05	1.2928E+03	4.9874E+03	5.4977E+05
6.4991E+02	2.2748E+03	1.8159E+03	1.0561E+04	0.0000E+00	2.2680E+06	1.2928E+03	4.6038E+03	6.6514E+05
6.4991E+02	2.2179E+03	1.3869E+03	3.3177E+03	1.5489E+05	6.2500E-01	1.2928E+03	4.2201E+03	8.5431E+05
6.4991E+02	2.1611E+03	1.4051E+03	3.3177E+03	1.4843E+05	1.9557E+00	1.2928E+03	3.8365E+03	1.2183E+06
6.4991E+02	2.1042E+03	1.7864E+03	3.3177E+03	1.4198E+05	3.9217E+00	1.2928E+03	3.4528E+03	1.4043E+06
6.4991E+02	2.0473E+03	3.2480E+03	3.3177E+03	1.3553E+05	1.3890E+00	1.2928E+03	3.0692E+03	1.6534E+06
6.4991E+02	1.9905E+03	5.0383E+03	3.3177E+03	1.2907E+05	6.2500E-01	1.2928E+03	2.6855E+03	1.9125E+06
6.4991E+02	1.9336E+03	3.3941E+03	3.3177E+03	1.2262E+05	7.8549E+02	1.2928E+03	2.3019E+03	1.9581E+06
6.4991E+02	1.8767E+03	5.8295E+03	3.3177E+03	1.1617E+05	1.0625E-01	1.2928E+03	1.9182E+03	2.1265E+06
6.4991E+02	1.8199E+03	1.1450E+04	3.3177E+03	1.0971E+05	4.6989E+03	1.2928E+03	1.5346E+03	2.2945E+06
6.4991E+02	1.7630E+03	9.9364E+03	3.3177E+03	1.0326E+05	1.5723E+03	1.2928E+03	1.1509E+03	2.4520E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.4991E+02	1.7061E+03	9.6633E+03	3.3177E+03	9.6805E+04	3.9639E+03	1.2928E+03	7.6729E+02	3.7107E+06
6.4991E+02	1.6492E+03	2.7451E+04	3.3177E+03	9.0352E+04	7.0732E+03	1.2928E+03	3.8365E+02	8.3792E+06
6.4991E+02	1.5924E+03	5.0067E+04	3.3177E+03	8.3898E+04	9.5664E+03	1.2928E+03	0.0000E+00	1.6967E+07
6.4991E+02	1.5355E+03	6.6149E+04	3.3177E+03	7.7444E+04	1.1936E+04	8.0389E+02	1.7648E+04	2.7056E+01
6.4991E+02	1.4786E+03	5.6882E+04	3.3177E+03	7.0990E+04	1.1694E+04	8.0389E+02	1.5729E+04	1.1382E+02
6.4991E+02	1.4218E+03	1.4159E+05	3.3177E+03	6.4537E+04	1.8298E+04	8.0389E+02	1.5346E+04	1.0331E+02
6.4991E+02	1.3649E+03	1.3610E+05	3.3177E+03	5.8083E+04	1.8526E+04	8.0389E+02	1.4962E+04	4.6466E+01
6.4991E+02	1.3080E+03	1.6394E+05	3.3177E+03	5.1629E+04	2.8701E+04	8.0389E+02	1.4579E+04	6.5822E+01
6.4991E+02	1.2511E+03	2.3435E+05	3.3177E+03	4.5176E+04	4.9472E+04	8.0389E+02	1.4195E+04	3.6535E+02
6.4991E+02	1.1943E+03	3.6475E+05	3.3177E+03	3.8722E+04	5.9521E+04	8.0389E+02	1.3811E+04	4.3991E+01
6.4991E+02	1.1374E+03	3.8447E+05	3.3177E+03	3.2268E+04	1.6166E+05	8.0389E+02	1.3428E+04	1.0510E+01
6.4991E+02	1.0805E+03	5.5909E+05	3.3177E+03	2.5815E+04	3.9240E+05	8.0389E+02	1.3044E+04	6.3297E+02
6.4991E+02	1.0237E+03	7.0585E+05	3.3177E+03	1.9361E+04	8.6224E+05	8.0389E+02	1.2660E+04	5.9114E+02
6.4991E+02	9.6680E+02	8.7598E+05	3.3177E+03	1.2907E+04	1.8708E+06	8.0389E+02	1.2277E+04	1.4422E+03
6.4991E+02	9.0993E+02	1.2195E+06	3.3177E+03	6.4537E+03	4.7089E+06	8.0389E+02	1.1893E+04	2.7957E+02
6.4991E+02	8.5306E+02	1.4346E+06	3.3177E+03	0.0000E+00	1.6120E+07	8.0389E+02	1.1509E+04	5.4315E+02
6.4991E+02	7.9619E+02	1.7796E+06	-3.9258E+03	3.0332E+05	1.3359E+00	8.0389E+02	1.1126E+04	3.8396E+03
6.4991E+02	7.3932E+02	2.3267E+06	-3.9258E+03	2.8396E+05	5.3125E-02	8.0389E+02	1.0742E+04	2.5852E+03
6.4991E+02	6.8244E+02	2.9426E+06	-3.9258E+03	2.7751E+05	1.3359E+00	8.0389E+02	1.0358E+04	8.4753E+03
6.4991E+02	6.2557E+02	3.2048E+06	-3.9258E+03	1.5489E+05	1.0625E-01	8.0389E+02	9.9748E+03	8.6071E+03
6.4991E+02	5.6870E+02	4.0385E+06	-3.9258E+03	1.4843E+05	2.1628E-02	8.0389E+02	9.5912E+03	9.5017E+03
6.4991E+02	5.1183E+02	4.1914E+06	-3.9258E+03	1.4198E+05	1.4637E+00	8.0389E+02	9.2075E+03	1.1816E+04
6.4991E+02	4.5496E+02	4.1447E+06	-3.9258E+03	1.3553E+05	1.4951E-01	8.0389E+02	8.8239E+03	5.7273E+04
6.4991E+02	3.9809E+02	4.9622E+06	-3.9258E+03	1.2907E+05	1.5938E-01	8.0389E+02	8.4402E+03	4.8908E+04
6.4991E+02	3.4122E+02	4.8795E+06	-3.9258E+03	1.2262E+05	4.8440E+00	8.0389E+02	8.0566E+03	6.7058E+04
6.4991E+02	2.8435E+02	4.6768E+06	-3.9258E+03	1.1617E+05	7.9487E+02	8.0389E+02	7.6729E+03	6.3759E+04
6.4991E+02	2.2748E+02	3.7791E+06	-3.9258E+03	1.0971E+05	3.7783E+00	8.0389E+02	7.2893E+03	8.4061E+04
6.4991E+02	1.7061E+02	4.2996E+06	-3.9258E+03	1.0326E+05	9.4406E+01	8.0389E+02	6.9056E+03	1.4761E+05
6.4991E+02	1.1374E+02	6.7968E+06	-3.9258E+03	9.6805E+04	8.3911E+02	8.0389E+02	6.5220E+03	2.5693E+05
6.4991E+02	5.6870E+01	1.9549E+07	-3.9258E+03	9.0352E+04	3.3087E+03	8.0389E+02	6.1383E+03	3.3006E+05
6.4991E+02	0.0000E+00	2.7608E+07	-3.9258E+03	8.3898E+04	3.6029E+03	8.0389E+02	5.7547E+03	4.0853E+05
5.8213E+02	2.8435E+03	1.0510E+01	-3.9258E+03	7.7444E+04	2.8516E+03	8.0389E+02	5.3710E+03	4.9357E+05
5.8213E+02	2.6729E+03	2.1020E+01	-3.9258E+03	7.0990E+04	2.7160E+03	8.0389E+02	4.9874E+03	6.9994E+05
5.8213E+02	2.5592E+03	3.7566E+01	-3.9258E+03	6.4537E+04	2.3026E+04	8.0389E+02	4.6038E+03	1.0345E+06
5.8213E+02	2.5023E+03	8.8641E+01	-3.9258E+03	5.8083E+04	3.2222E+04	8.0389E+02	4.2201E+03	1.1362E+06
5.8213E+02	2.4454E+03	8.5642E+01	-3.9258E+03	5.1629E+04	5.6876E+04	8.0389E+02	3.8365E+03	1.2957E+06
5.8213E+02	2.3886E+03	1.0475E+02	-3.9258E+03	4.5176E+04	9.8519E+04	8.0389E+02	3.4528E+03	1.6651E+06
5.8213E+02	2.3317E+03	4.3652E+02	-3.9258E+03	3.8722E+04	1.9309E+05	8.0389E+02	3.0692E+03	1.9199E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.8213E+02	2.2748E+03	1.5038E+02	-3.9258E+03	3.2268E+04	2.9301E+05	8.0389E+02	2.6855E+03	2.5154E+06
5.8213E+02	2.2179E+03	2.0351E+02	-3.9258E+03	2.5815E+04	3.7314E+05	8.0389E+02	2.3019E+03	2.9334E+06
5.8213E+02	2.1611E+03	1.0700E+03	-3.9258E+03	1.9361E+04	4.2854E+05	8.0389E+02	1.9182E+03	3.4172E+06
5.8213E+02	2.1042E+03	1.2454E+03	-3.9258E+03	1.2907E+04	5.4536E+05	8.0389E+02	1.5346E+03	3.2511E+06
5.8213E+02	2.0473E+03	3.6649E+03	-3.9258E+03	6.4537E+03	1.1877E+06	8.0389E+02	1.1509E+03	3.5244E+06
5.8213E+02	1.9905E+03	2.3049E+03	-3.9258E+03	0.0000E+00	4.3042E+06	8.0389E+02	7.6729E+02	5.2082E+06
5.8213E+02	1.9336E+03	5.2552E+03	-1.1169E+04	3.0978E+05	1.3359E+00	8.0389E+02	3.8365E+02	1.1693E+07
5.8213E+02	1.8767E+03	1.1294E+04	-1.1169E+04	2.9042E+05	6.2500E-01	8.0389E+02	0.0000E+00	2.3665E+07
5.8213E+02	1.8199E+03	9.1832E+03	-1.1169E+04	2.6460E+05	3.0859E+00	3.1503E+02	1.7264E+04	1.1128E+01
5.8213E+02	1.7630E+03	1.3137E+04	-1.1169E+04	1.6780E+05	3.7105E-03	3.1503E+02	1.6497E+04	5.2626E+01
5.8213E+02	1.7061E+03	1.6701E+04	-1.1169E+04	1.6134E+05	1.3159E-01	3.1503E+02	1.5729E+04	1.0239E+02
5.8213E+02	1.6492E+03	2.7936E+04	-1.1169E+04	1.5489E+05	1.5169E+00	3.1503E+02	1.5346E+04	8.3335E+01
5.8213E+02	1.5924E+03	3.4905E+04	-1.1169E+04	1.4843E+05	1.0996E-01	3.1503E+02	1.4962E+04	3.9054E+02
5.8213E+02	1.5355E+03	3.5844E+04	-1.1169E+04	1.4198E+05	5.3125E-02	3.1503E+02	1.4579E+04	8.3917E+02
5.8213E+02	1.4786E+03	6.8721E+04	-1.1169E+04	1.3553E+05	1.5484E+00	3.1503E+02	1.4195E+04	6.4851E+01
5.8213E+02	1.4218E+03	5.4987E+04	-1.1169E+04	1.2907E+05	1.3964E+00	3.1503E+02	1.3811E+04	4.5382E+02
5.8213E+02	1.3649E+03	8.3670E+04	-1.1169E+04	1.2262E+05	7.3125E-01	3.1503E+02	1.3428E+04	4.5079E+03
5.8213E+02	1.3080E+03	1.0790E+05	-1.1169E+04	1.1617E+05	4.7129E+00	3.1503E+02	1.3044E+04	4.3186E+03
5.8213E+02	1.2511E+03	1.6745E+05	-1.1169E+04	1.0971E+05	8.4675E+01	3.1503E+02	1.2660E+04	3.1718E+03
5.8213E+02	1.1943E+03	2.1860E+05	-1.1169E+04	1.0326E+05	1.3230E+02	3.1503E+02	1.2277E+04	1.1240E+04
5.8213E+02	1.1374E+03	3.2420E+05	-1.1169E+04	9.6805E+04	1.9679E+03	3.1503E+02	1.1893E+04	1.7562E+04
5.8213E+02	1.0805E+03	3.7893E+05	-1.1169E+04	9.0352E+04	4.8142E+02	3.1503E+02	1.1509E+04	2.0709E+04
5.8213E+02	1.0237E+03	4.6115E+05	-1.1169E+04	8.3898E+04	1.6300E+03	3.1503E+02	1.1126E+04	3.9643E+04
5.8213E+02	9.6680E+02	5.5318E+05	-1.1169E+04	7.7444E+04	3.1647E+03	3.1503E+02	1.0742E+04	2.7863E+04
5.8213E+02	9.0993E+02	7.4971E+05	-1.1169E+04	7.0990E+04	3.9847E+03	3.1503E+02	1.0358E+04	2.7270E+04
5.8213E+02	8.5306E+02	9.9502E+05	-1.1169E+04	6.4537E+04	9.3330E+03	3.1503E+02	9.9748E+03	4.0862E+04
5.8213E+02	7.9619E+02	1.0983E+06	-1.1169E+04	5.8083E+04	1.1545E+04	3.1503E+02	9.5912E+03	3.2563E+04
5.8213E+02	7.3932E+02	1.5475E+06	-1.1169E+04	5.1629E+04	2.2027E+04	3.1503E+02	9.2075E+03	5.9810E+04
5.8213E+02	6.8244E+02	1.6546E+06	-1.1169E+04	4.5176E+04	1.0113E+05	3.1503E+02	8.8239E+03	4.5900E+04
5.8213E+02	6.2557E+02	2.1889E+06	-1.1169E+04	3.8722E+04	1.6751E+05	3.1503E+02	8.4402E+03	7.6294E+04
5.8213E+02	5.6870E+02	2.5240E+06	-1.1169E+04	3.2268E+04	3.5817E+05	3.1503E+02	8.0566E+03	7.5686E+04
5.8213E+02	5.1183E+02	2.8633E+06	-1.1169E+04	2.5815E+04	5.6537E+05	3.1503E+02	7.6729E+03	1.1238E+05
5.8213E+02	4.5496E+02	3.0398E+06	-1.1169E+04	1.9361E+04	8.6450E+05	3.1503E+02	7.2893E+03	2.0417E+05
5.8213E+02	3.9809E+02	3.2505E+06	-1.1169E+04	1.2907E+04	1.0449E+06	3.1503E+02	6.9056E+03	2.0480E+05
5.8213E+02	3.4122E+02	3.5334E+06	-1.1169E+04	6.4537E+03	2.2845E+06	3.1503E+02	6.5220E+03	2.8574E+05
5.8213E+02	2.8435E+02	3.4006E+06	-1.1169E+04	0.0000E+00	5.8429E+06	3.1503E+02	6.1383E+03	3.7179E+05
5.8213E+02	2.2748E+02	3.5976E+06	-1.8413E+04	3.2268E+05	2.6717E+00	3.1503E+02	5.7547E+03	5.7530E+05
5.8213E+02	1.7061E+02	3.6997E+06	-1.8413E+04	3.1623E+05	1.3359E+00	3.1503E+02	5.3710E+03	6.0740E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.8213E+02	1.1374E+02	6.0739E+06	-1.8413E+04	3.0332E+05	1.3890E+00	3.1503E+02	4.9874E+03	8.4958E+05
5.8213E+02	5.6870E+01	1.7806E+07	-1.8413E+04	2.6460E+05	1.7500E+00	3.1503E+02	4.6038E+03	1.0130E+06
5.8213E+02	0.0000E+00	2.9082E+07	-1.8413E+04	2.5815E+05	1.7500E+00	3.1503E+02	4.2201E+03	1.3479E+06
5.1434E+02	2.6160E+03	2.1020E+01	-1.8413E+04	2.5169E+05	1.7500E+00	3.1503E+02	3.8365E+03	1.4832E+06
5.1434E+02	2.5592E+03	1.0472E+02	-1.8413E+04	2.3233E+05	1.7500E+00	3.1503E+02	3.4528E+03	1.8824E+06
5.1434E+02	2.4454E+03	5.8586E+01	-1.8413E+04	2.0652E+05	6.2500E-01	3.1503E+02	3.0692E+03	2.1564E+06
5.1434E+02	2.3886E+03	8.2605E+01	-1.8413E+04	2.0006E+05	5.3125E-02	3.1503E+02	2.6855E+03	2.7723E+06
5.1434E+02	2.3317E+03	1.3181E+02	-1.8413E+04	1.8716E+05	1.8031E+00	3.1503E+02	2.3019E+03	3.0615E+06
5.1434E+02	2.2748E+03	1.8345E+02	-1.8413E+04	1.8070E+05	5.3125E-02	3.1503E+02	1.9182E+03	4.5412E+06
5.1434E+02	2.2179E+03	7.0561E+01	-1.8413E+04	1.7425E+05	1.0625E-01	3.1503E+02	1.5346E+03	4.6392E+06
5.1434E+02	2.1611E+03	3.5815E+02	-1.8413E+04	1.6134E+05	5.6836E-02	3.1503E+02	1.1509E+03	5.1107E+06
5.1434E+02	2.1042E+03	7.6635E+02	-1.8413E+04	1.5489E+05	1.0625E-01	3.1503E+02	7.6729E+02	6.9343E+06
5.1434E+02	2.0473E+03	1.8764E+03	-1.8413E+04	1.4843E+05	2.5531E+00	3.1503E+02	3.8365E+02	1.5951E+07
5.1434E+02	1.9905E+03	1.9233E+03	-1.8413E+04	1.4198E+05	2.6211E+00	3.1503E+02	0.0000E+00	3.1961E+07
5.1434E+02	1.9336E+03	2.2811E+03	-1.8413E+04	1.3553E+05	1.5026E+00	-1.7384E+02	1.7264E+04	9.4410E-01
5.1434E+02	1.8767E+03	3.3804E+03	-1.8413E+04	1.2907E+05	1.9067E+02	-1.7384E+02	1.6880E+04	9.4410E-01
5.1434E+02	1.8199E+03	4.9652E+03	-1.8413E+04	1.2262E+05	2.8493E+02	-1.7384E+02	1.6497E+04	3.6186E+00
5.1434E+02	1.7630E+03	9.1498E+03	-1.8413E+04	1.1617E+05	1.7340E+02	-1.7384E+02	1.6113E+04	3.4332E+02
5.1434E+02	1.7061E+03	5.9192E+03	-1.8413E+04	1.0971E+05	4.5498E+01	-1.7384E+02	1.5729E+04	3.9107E+01
5.1434E+02	1.6492E+03	1.2158E+04	-1.8413E+04	1.0326E+05	3.4945E+03	-1.7384E+02	1.5346E+04	4.0174E+02
5.1434E+02	1.5924E+03	1.4338E+04	-1.8413E+04	9.6805E+04	1.4312E+02	-1.7384E+02	1.4962E+04	6.8456E+01
5.1434E+02	1.5355E+03	1.7977E+04	-1.8413E+04	9.0352E+04	5.1225E+02	-1.7384E+02	1.4579E+04	2.1217E+03
5.1434E+02	1.4786E+03	2.7973E+04	-1.8413E+04	8.3898E+04	5.1845E+03	-1.7384E+02	1.4195E+04	2.8508E+03
5.1434E+02	1.4218E+03	3.1160E+04	-1.8413E+04	7.7444E+04	3.2626E+03	-1.7384E+02	1.3811E+04	4.3851E+03
5.1434E+02	1.3649E+03	5.7576E+04	-1.8413E+04	7.0990E+04	2.8762E+03	-1.7384E+02	1.3428E+04	7.6393E+03
5.1434E+02	1.3080E+03	6.5272E+04	-1.8413E+04	6.4537E+04	1.4152E+04	-1.7384E+02	1.3044E+04	1.1750E+04
5.1434E+02	1.2511E+03	7.7117E+04	-1.8413E+04	5.8083E+04	2.1656E+04	-1.7384E+02	1.2660E+04	2.1301E+04
5.1434E+02	1.1943E+03	1.3436E+05	-1.8413E+04	5.1629E+04	4.0513E+04	-1.7384E+02	1.2277E+04	4.5834E+04
5.1434E+02	1.1374E+03	1.4133E+05	-1.8413E+04	4.5176E+04	8.1974E+04	-1.7384E+02	1.1893E+04	7.0552E+04
5.1434E+02	1.0805E+03	1.5391E+05	-1.8413E+04	3.8722E+04	1.9789E+05	-1.7384E+02	1.1509E+04	8.1867E+04
5.1434E+02	1.0237E+03	2.3382E+05	-1.8413E+04	3.2268E+04	5.2172E+05	-1.7384E+02	1.1126E+04	6.5504E+04
5.1434E+02	9.6680E+02	2.6167E+05	-1.8413E+04	2.5815E+04	1.3142E+06	-1.7384E+02	1.0742E+04	5.1479E+04
5.1434E+02	9.0993E+02	3.4845E+05	-1.8413E+04	1.9361E+04	2.2375E+06	-1.7384E+02	1.0358E+04	3.2294E+04
5.1434E+02	8.5306E+02	3.2761E+05	-1.8413E+04	1.2907E+04	3.3107E+06	-1.7384E+02	9.9748E+03	7.3763E+04
5.1434E+02	7.9619E+02	4.2146E+05	-1.8413E+04	6.4537E+03	6.3074E+06	-1.7384E+02	9.5912E+03	7.7079E+04
5.1434E+02	7.3932E+02	5.7103E+05	-1.8413E+04	0.0000E+00	1.3870E+07	-1.7384E+02	9.2075E+03	1.0734E+05
5.1434E+02	6.8244E+02	5.8430E+05	-2.5656E+04	2.9687E+05	2.6717E+00	-1.7384E+02	8.8239E+03	8.5800E+04
5.1434E+02	6.2557E+02	8.6589E+05	-2.5656E+04	2.9042E+05	4.8358E+00	-1.7384E+02	8.4402E+03	9.8074E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.1434E+02	5.6870E+02	8.6619E+05	-2.5656E+04	2.8396E+05	3.0859E+00	-1.7384E+02	8.0566E+03	1.3025E+05
5.1434E+02	5.1183E+02	1.0854E+06	-2.5656E+04	2.7751E+05	4.0076E+00	-1.7384E+02	7.6729E+03	2.0778E+05
5.1434E+02	4.5496E+02	1.3353E+06	-2.5656E+04	2.7105E+05	4.8358E+00	-1.7384E+02	7.2893E+03	1.9283E+05
5.1434E+02	3.9809E+02	1.7743E+06	-2.5656E+04	2.6460E+05	5.2500E+00	-1.7384E+02	6.9056E+03	1.9908E+05
5.1434E+02	3.4122E+02	2.2030E+06	-2.5656E+04	2.5815E+05	8.9608E+00	-1.7384E+02	6.5220E+03	3.2792E+05
5.1434E+02	2.8435E+02	3.1424E+06	-2.5656E+04	2.5169E+05	1.7500E+00	-1.7384E+02	6.1383E+03	3.8140E+05
5.1434E+02	2.2748E+02	3.7207E+06	-2.5656E+04	2.4524E+05	6.2500E-01	-1.7384E+02	5.7547E+03	6.2304E+05
5.1434E+02	1.7061E+02	4.2178E+06	-2.5656E+04	2.3233E+05	1.8031E+00	-1.7384E+02	5.3710E+03	7.6134E+05
5.1434E+02	1.1374E+02	6.6108E+06	-2.5656E+04	2.2588E+05	1.7500E+00	-1.7384E+02	4.9874E+03	9.9192E+05
5.1434E+02	5.6870E+01	1.9480E+07	-2.5656E+04	2.0652E+05	6.7813E-01	-1.7384E+02	4.6038E+03	1.2788E+06
5.1434E+02	0.0000E+00	3.4601E+07	-2.5656E+04	1.8070E+05	6.7813E-01	-1.7384E+02	4.2201E+03	1.5359E+06
4.4656E+02	2.6729E+03	7.6230E+00	-2.5656E+04	1.7425E+05	1.0625E-01	-1.7384E+02	3.8365E+03	1.8874E+06
4.4656E+02	2.5023E+03	1.0510E+01	-2.5656E+04	1.6780E+05	1.2500E+00	-1.7384E+02	3.4528E+03	2.4854E+06
4.4656E+02	2.4454E+03	4.5204E+02	-2.5656E+04	1.6134E+05	1.0625E-01	-1.7384E+02	3.0692E+03	2.7464E+06
4.4656E+02	2.3886E+03	3.7619E+01	-2.5656E+04	1.5489E+05	1.8671E+00	-1.7384E+02	2.6855E+03	3.5396E+06
4.4656E+02	2.3317E+03	2.7945E+01	-2.5656E+04	1.4843E+05	2.9390E-01	-1.7384E+02	2.3019E+03	4.2040E+06
4.4656E+02	2.2748E+03	3.7343E+02	-2.5656E+04	1.4198E+05	1.2830E+01	-1.7384E+02	1.9182E+03	4.8476E+06
4.4656E+02	2.2179E+03	2.0627E+02	-2.5656E+04	1.3553E+05	1.1814E+01	-1.7384E+02	1.5346E+03	5.2686E+06
4.4656E+02	2.1611E+03	1.7920E+03	-2.5656E+04	1.2907E+05	2.0134E+01	-1.7384E+02	1.1509E+03	5.7901E+06
4.4656E+02	2.1042E+03	1.5717E+02	-2.5656E+04	1.2262E+05	1.4891E+01	-1.7384E+02	7.6729E+02	7.6316E+06
4.4656E+02	2.0473E+03	3.5934E+02	-2.5656E+04	1.1617E+05	1.8943E+01	-1.7384E+02	3.8365E+02	1.8107E+07
4.4656E+02	1.9905E+03	1.3395E+03	-2.5656E+04	1.0971E+05	3.3380E+01	-1.7384E+02	0.0000E+00	3.8169E+07
4.4656E+02	1.9336E+03	1.3577E+03	-2.5656E+04	1.0326E+05	8.3571E+02	-6.6271E+02	1.9182E+04	1.0417E+00
4.4656E+02	1.8767E+03	1.2100E+03	-2.5656E+04	9.6805E+04	2.2194E+02	-6.6271E+02	1.8799E+04	1.0510E+01
4.4656E+02	1.8199E+03	7.1651E+02	-2.5656E+04	9.0352E+04	1.1139E+03	-6.6271E+02	1.7264E+04	6.1840E-01
4.4656E+02	1.7630E+03	2.9963E+03	-2.5656E+04	8.3898E+04	3.7427E+03	-6.6271E+02	1.6880E+04	7.2371E+00
4.4656E+02	1.7061E+03	2.1384E+03	-2.5656E+04	7.7444E+04	4.1002E+03	-6.6271E+02	1.6113E+04	3.7667E+00
4.4656E+02	1.6492E+03	6.1151E+03	-2.5656E+04	7.0990E+04	6.9370E+03	-6.6271E+02	1.5729E+04	7.7858E+01
4.4656E+02	1.5924E+03	5.2622E+03	-2.5656E+04	6.4537E+04	1.6135E+04	-6.6271E+02	1.5346E+04	1.5677E+02
4.4656E+02	1.5355E+03	1.1693E+04	-2.5656E+04	5.8083E+04	2.6733E+04	-6.6271E+02	1.4962E+04	2.4328E+02
4.4656E+02	1.4786E+03	7.0408E+03	-2.5656E+04	5.1629E+04	7.1880E+04	-6.6271E+02	1.4579E+04	7.8941E+02
4.4656E+02	1.4218E+03	1.5022E+04	-2.5656E+04	4.5176E+04	1.4187E+05	-6.6271E+02	1.4195E+04	4.6065E+03
4.4656E+02	1.3649E+03	1.4993E+04	-2.5656E+04	3.8722E+04	3.3132E+05	-6.6271E+02	1.3811E+04	3.8778E+03
4.4656E+02	1.3080E+03	2.3185E+04	-2.5656E+04	3.2268E+04	6.5023E+05	-6.6271E+02	1.3428E+04	4.8964E+03
4.4656E+02	1.2511E+03	4.2864E+04	-2.5656E+04	2.5815E+04	1.5891E+06	-6.6271E+02	1.3044E+04	2.4966E+04
4.4656E+02	1.1943E+03	2.8130E+04	-2.5656E+04	1.9361E+04	4.0861E+06	-6.6271E+02	1.2660E+04	3.6729E+04
4.4656E+02	1.1374E+03	3.6917E+04	-2.5656E+04	1.2907E+04	5.7524E+06	-6.6271E+02	1.2277E+04	3.9412E+04
4.4656E+02	1.0805E+03	4.9389E+04	-2.5656E+04	6.4537E+03	1.0545E+07	-6.6271E+02	1.1893E+04	6.3606E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.4656E+02	1.0237E+03	4.7327E+04	-2.5656E+04	0.0000E+00	2.1337E+07	-6.6271E+02	1.1509E+04	9.0848E+04
4.4656E+02	9.6680E+02	5.9767E+04	-3.2900E+04	2.9687E+05	1.3359E+00	-6.6271E+02	1.1126E+04	7.7611E+04
4.4656E+02	9.0993E+02	1.0859E+05	-3.2900E+04	2.8396E+05	1.3359E+00	-6.6271E+02	1.0742E+04	7.9271E+04
4.4656E+02	8.5306E+02	1.2881E+05	-3.2900E+04	2.7751E+05	6.9585E+00	-6.6271E+02	1.0358E+04	5.6434E+04
4.4656E+02	7.9619E+02	1.2846E+05	-3.2900E+04	2.7105E+05	9.6302E+00	-6.6271E+02	9.9748E+03	5.1363E+04
4.4656E+02	7.3932E+02	1.4259E+05	-3.2900E+04	2.6460E+05	8.5467E+00	-6.6271E+02	9.5912E+03	8.0383E+04
4.4656E+02	6.8244E+02	1.6932E+05	-3.2900E+04	2.5815E+05	3.5000E+00	-6.6271E+02	9.2075E+03	6.9800E+04
4.4656E+02	6.2557E+02	2.6618E+05	-3.2900E+04	2.5169E+05	1.4169E+01	-6.6271E+02	8.8239E+03	8.1923E+04
4.4656E+02	5.6870E+02	2.8277E+05	-3.2900E+04	2.3879E+05	3.5000E+00	-6.6271E+02	8.4402E+03	8.9705E+04
4.4656E+02	5.1183E+02	4.3298E+05	-3.2900E+04	2.3233E+05	5.3125E-02	-6.6271E+02	8.0566E+03	1.1803E+05
4.4656E+02	4.5496E+02	5.4890E+05	-3.2900E+04	2.2588E+05	3.0000E+00	-6.6271E+02	7.6729E+03	1.9679E+05
4.4656E+02	3.9809E+02	1.1215E+06	-3.2900E+04	2.1943E+05	6.5531E+00	-6.6271E+02	7.2893E+03	1.9268E+05
4.4656E+02	3.4122E+02	1.9652E+06	-3.2900E+04	2.1297E+05	1.0625E-01	-6.6271E+02	6.9056E+03	3.6165E+05
4.4656E+02	2.8435E+02	3.4161E+06	-3.2900E+04	2.0006E+05	1.0625E-01	-6.6271E+02	6.5220E+03	3.5151E+05
4.4656E+02	2.2748E+02	4.7070E+06	-3.2900E+04	1.9361E+05	5.3125E-02	-6.6271E+02	6.1383E+03	4.2975E+05
4.4656E+02	1.7061E+02	6.1219E+06	-3.2900E+04	1.8716E+05	1.0032E+01	-6.6271E+02	5.7547E+03	6.4297E+05
4.4656E+02	1.1374E+02	7.8087E+06	-3.2900E+04	1.8070E+05	1.0138E+01	-6.6271E+02	5.3710E+03	7.5300E+05
4.4656E+02	5.6870E+01	1.8333E+07	-3.2900E+04	1.7425E+05	6.2500E-01	-6.6271E+02	4.9874E+03	8.8738E+05
4.4656E+02	0.0000E+00	3.6918E+07	-3.2900E+04	1.6780E+05	1.1375E+01	-6.6271E+02	4.6038E+03	1.2826E+06
3.7878E+02	2.5592E+03	1.3359E+00	-3.2900E+04	1.6134E+05	1.6451E+00	-6.6271E+02	4.2201E+03	1.5613E+06
3.7878E+02	2.5023E+03	5.2085E+00	-3.2900E+04	1.5489E+05	1.8438E+01	-6.6271E+02	3.8365E+03	1.7581E+06
3.7878E+02	2.4454E+03	1.0563E+01	-3.2900E+04	1.4843E+05	9.0312E+01	-6.6271E+02	3.4528E+03	2.1325E+06
3.7878E+02	2.3886E+03	2.6599E+01	-3.2900E+04	1.4198E+05	3.1133E+01	-6.6271E+02	3.0692E+03	2.5850E+06
3.7878E+02	2.3317E+03	1.9609E+00	-3.2900E+04	1.3553E+05	1.4671E+01	-6.6271E+02	2.6855E+03	3.0649E+06
3.7878E+02	2.2748E+03	1.0617E+02	-3.2900E+04	1.2907E+05	1.7828E+02	-6.6271E+02	2.3019E+03	3.4503E+06
3.7878E+02	2.2179E+03	2.1400E+01	-3.2900E+04	1.2262E+05	2.9958E+02	-6.6271E+02	1.9182E+03	3.5327E+06
3.7878E+02	2.1611E+03	3.3871E+02	-3.2900E+04	1.1617E+05	8.7428E+01	-6.6271E+02	1.5346E+03	3.5643E+06
3.7878E+02	2.1042E+03	2.3168E+01	-3.2900E+04	1.0971E+05	1.5077E+02	-6.6271E+02	1.1509E+03	4.5639E+06
3.7878E+02	2.0473E+03	2.7787E+01	-3.2900E+04	1.0326E+05	2.9615E+02	-6.6271E+02	7.6729E+02	6.2007E+06
3.7878E+02	1.9905E+03	3.0383E+01	-3.2900E+04	9.6805E+04	2.0284E+03	-6.6271E+02	3.8365E+02	1.3652E+07
3.7878E+02	1.9336E+03	4.4190E+01	-3.2900E+04	9.0352E+04	1.4805E+03	-6.6271E+02	0.0000E+00	2.7069E+07
3.7878E+02	1.8767E+03	9.5052E+01	-3.2900E+04	8.3898E+04	4.5431E+03	-1.1516E+03	1.7264E+04	4.0130E+01
3.7878E+02	1.8199E+03	8.3532E+02	-3.2900E+04	7.7444E+04	1.0946E+04	-1.1516E+03	1.6880E+04	3.2393E-01
3.7878E+02	1.7630E+03	5.9371E+03	-3.2900E+04	7.0990E+04	1.8666E+04	-1.1516E+03	1.6497E+04	1.4129E+01
3.7878E+02	1.7061E+03	3.6757E+02	-3.2900E+04	6.4537E+04	7.3992E+03	-1.1516E+03	1.6113E+04	1.7909E+01
3.7878E+02	1.6492E+03	1.3528E+03	-3.2900E+04	5.8083E+04	2.9244E+04	-1.1516E+03	1.5729E+04	2.1581E+02
3.7878E+02	1.5924E+03	1.2276E+03	-3.2900E+04	5.1629E+04	7.5609E+04	-1.1516E+03	1.5346E+04	3.5944E+02
3.7878E+02	1.5355E+03	1.9187E+03	-3.2900E+04	4.5176E+04	1.2714E+05	-1.1516E+03	1.4962E+04	3.3129E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance Tuborgvejen 6, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.7878E+02	1.4786E+03	3.5265E+03	-3.2900E+04	3.8722E+04	2.1387E+05	-1.1516E+03	1.4579E+04	8.0855E+02
3.7878E+02	1.4218E+03	4.7480E+03	-3.2900E+04	3.2268E+04	5.4696E+05	-1.1516E+03	1.4195E+04	4.3925E+02
3.7878E+02	1.3649E+03	3.8827E+03	-3.2900E+04	2.5815E+04	1.2914E+06	-1.1516E+03	1.3811E+04	5.2218E+03
3.7878E+02	1.3080E+03	3.6501E+03	-3.2900E+04	1.9361E+04	2.7865E+06	-1.1516E+03	1.3428E+04	6.1396E+03
3.7878E+02	1.2511E+03	4.9012E+03	-3.2900E+04	1.2907E+04	4.4554E+06	-1.1516E+03	1.3044E+04	4.5411E+03
3.7878E+02	1.1943E+03	8.0485E+03	-3.2900E+04	6.4537E+03	7.8381E+06	-1.1516E+03	1.2660E+04	6.5814E+03
3.7878E+02	1.1374E+03	1.6169E+04	-3.2900E+04	0.0000E+00	1.7275E+07	-1.1516E+03	1.2277E+04	7.0650E+03
3.7878E+02	1.0805E+03	1.1012E+04	-4.0143E+04	2.9687E+05	1.7500E+00	-1.1516E+03	1.1893E+04	1.6264E+04
3.7878E+02	1.0237E+03	2.3515E+04	-4.0143E+04	2.7751E+05	3.0859E+00	-1.1516E+03	1.1509E+04	2.1737E+04
3.7878E+02	9.6680E+02	2.4570E+04	-4.0143E+04	2.7105E+05	7.9217E+00	-1.1516E+03	1.1126E+04	2.5042E+04
3.7878E+02	9.0993E+02	3.3422E+04	-4.0143E+04	2.6460E+05	6.6390E+00	-1.1516E+03	1.0742E+04	4.8916E+04
3.7878E+02	8.5306E+02	4.3178E+04	-4.0143E+04	2.5815E+05	1.5253E+01	-1.1516E+03	1.0358E+04	4.9215E+04
3.7878E+02	7.9619E+02	4.2156E+04	-4.0143E+04	2.5169E+05	6.1717E+00	-1.1516E+03	9.9748E+03	6.9187E+04
3.7878E+02	7.3932E+02	7.2157E+04	-4.0143E+04	2.4524E+05	4.8358E+00	-1.1516E+03	9.5912E+03	4.5869E+04
3.7878E+02	6.8244E+02	1.3919E+05	-4.0143E+04	2.3879E+05	8.2085E+00	-1.1516E+03	9.2075E+03	8.3852E+04
3.7878E+02	6.2557E+02	1.5758E+05	-4.0143E+04	2.3233E+05	5.8815E+00	-1.1516E+03	8.8239E+03	8.3915E+04
3.7878E+02	5.6870E+02	2.0768E+05	-4.0143E+04	2.2588E+05	8.2480E+00	-1.1516E+03	8.4402E+03	7.2644E+04
3.7878E+02	5.1183E+02	3.3123E+05	-4.0143E+04	2.1943E+05	2.3750E+00	-1.1516E+03	8.0566E+03	1.2225E+05
3.7878E+02	4.5496E+02	5.4215E+05	-4.0143E+04	2.1297E+05	1.2500E+00	-1.1516E+03	7.6729E+03	1.6467E+05
3.7878E+02	3.9809E+02	1.0926E+06	-4.0143E+04	2.0006E+05	1.0710E+01	-1.1516E+03	7.2893E+03	1.9540E+05
3.7878E+02	3.4122E+02	1.8345E+06	-4.0143E+04	1.9361E+05	1.2500E+00	-1.1516E+03	6.9056E+03	2.7307E+05
3.7878E+02	2.8435E+02	3.3430E+06	-4.0143E+04	1.8716E+05	5.3125E-02	-1.1516E+03	6.5220E+03	3.0121E+05
3.7878E+02	2.2748E+02	5.4093E+06	-4.0143E+04	1.8070E+05	1.3511E+00	-1.1516E+03	6.1383E+03	4.5963E+05
3.7878E+02	1.7061E+02	6.3375E+06	-4.0143E+04	1.7425E+05	1.2500E+00	-1.1516E+03	5.7547E+03	4.8181E+05
3.7878E+02	1.1374E+02	7.3473E+06	-4.0143E+04	1.6780E+05	2.1509E-01	-1.1516E+03	5.3710E+03	7.3623E+05
3.7878E+02	5.6870E+01	1.3597E+07	-4.0143E+04	1.6134E+05	1.2732E+01	-1.1516E+03	4.9874E+03	9.7037E+05
3.7878E+02	0.0000E+00	3.2716E+07	-4.0143E+04	1.5489E+05	2.9989E+01	-1.1516E+03	4.6038E+03	1.2009E+06
3.1100E+02	2.7298E+03	1.7500E+00	-4.0143E+04	1.4843E+05	1.9010E+01	-1.1516E+03	4.2201E+03	1.5306E+06
3.1100E+02	2.4454E+03	6.2500E-01	-4.0143E+04	1.4198E+05	9.5354E+01	-1.1516E+03	3.8365E+03	1.6049E+06
3.1100E+02	2.3886E+03	3.5000E+00	-4.0143E+04	1.3553E+05	4.5838E+01	-1.1516E+03	3.4528E+03	2.0014E+06
3.1100E+02	2.3317E+03	2.9709E+01	-4.0143E+04	1.2907E+05	8.0246E+01	-1.1516E+03	3.0692E+03	2.0305E+06
3.1100E+02	2.2748E+03	4.2555E+00	-4.0143E+04	1.2262E+05	1.1476E+02	-1.1516E+03	2.6855E+03	2.6161E+06
3.1100E+02	2.2179E+03	2.3772E+01	-4.0143E+04	1.1617E+05	6.5266E+02	-1.1516E+03	2.3019E+03	2.6995E+06
3.1100E+02	2.1611E+03	1.5249E+01	-4.0143E+04	1.0971E+05	6.8894E+02	-1.1516E+03	1.9182E+03	2.7318E+06
3.1100E+02	2.1042E+03	9.2110E+02	-4.0143E+04	1.0326E+05	5.3868E+02	-1.1516E+03	1.5346E+03	2.9346E+06
3.1100E+02	2.0473E+03	4.7732E+01	-4.0143E+04	9.6805E+04	9.2640E+02	-1.1516E+03	1.1509E+03	3.1593E+06
3.1100E+02	1.9905E+03	1.8785E+01	-4.0143E+04	9.0352E+04	3.6107E+03	-1.1516E+03	7.6729E+02	4.9266E+06
3.1100E+02	1.9336E+03	3.1662E+01	-4.0143E+04	8.3898E+04	1.4953E+03	-1.1516E+03	3.8365E+02	1.0869E+07

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.1100E+02	1.8767E+03	9.3935E+00	-4.0143E+04	7.7444E+04	4.1729E+03	-1.1516E+03	0.0000E+00	2.1467E+07
3.1100E+02	1.8199E+03	1.6944E+03	-4.0143E+04	7.0990E+04	1.0408E+04	-1.6404E+03	1.6497E+04	5.5068E+00
3.1100E+02	1.7630E+03	7.0323E+01	-4.0143E+04	6.4537E+04	1.2897E+04	-1.6404E+03	1.6113E+04	9.2127E+01
3.1100E+02	1.7061E+03	5.2121E+02	-4.0143E+04	5.8083E+04	3.7743E+04	-1.6404E+03	1.5729E+04	2.5337E+01
3.1100E+02	1.6492E+03	6.1781E+01	-4.0143E+04	5.1629E+04	5.4656E+04	-1.6404E+03	1.5346E+04	8.4007E+01
3.1100E+02	1.5924E+03	3.5099E+02	-4.0143E+04	4.5176E+04	1.3443E+05	-1.6404E+03	1.4962E+04	3.3629E+01
3.1100E+02	1.5355E+03	1.5435E+02	-4.0143E+04	3.8722E+04	3.7835E+05	-1.6404E+03	1.4579E+04	1.7457E+02
3.1100E+02	1.4786E+03	1.3569E+02	-4.0143E+04	3.2268E+04	7.3563E+05	-1.6404E+03	1.4195E+04	1.4975E+02
3.1100E+02	1.4218E+03	4.3794E+02	-4.0143E+04	2.5815E+04	1.4710E+06	-1.6404E+03	1.3811E+04	1.1415E+03
3.1100E+02	1.3649E+03	1.1500E+03	-4.0143E+04	1.9361E+04	2.2255E+06	-1.6404E+03	1.3428E+04	8.1240E+02
3.1100E+02	1.3080E+03	1.6403E+03	-4.0143E+04	1.2907E+04	3.2413E+06	-1.6404E+03	1.3044E+04	1.6075E+03
3.1100E+02	1.2511E+03	1.0612E+03	-4.0143E+04	6.4537E+03	6.4575E+06	-1.6404E+03	1.2660E+04	3.3102E+03
3.1100E+02	1.1943E+03	1.5524E+03	-4.0143E+04	0.0000E+00	1.2066E+07	-1.6404E+03	1.2277E+04	1.4658E+03
3.1100E+02	1.1374E+03	2.3241E+03	-4.7387E+04	2.9042E+05	1.3359E+00	-1.6404E+03	1.1893E+04	8.7074E+02
3.1100E+02	1.0805E+03	5.2456E+03	-4.7387E+04	2.7751E+05	5.2085E+00	-1.6404E+03	1.1509E+04	3.3874E+03
3.1100E+02	1.0237E+03	5.9329E+03	-4.7387E+04	2.7105E+05	4.4217E+00	-1.6404E+03	1.1126E+04	9.4360E+03
3.1100E+02	9.6680E+02	7.2741E+03	-4.7387E+04	2.6460E+05	2.6717E+00	-1.6404E+03	1.0742E+04	7.8582E+03
3.1100E+02	9.0993E+02	6.7834E+03	-4.7387E+04	2.5815E+05	1.3359E+00	-1.6404E+03	1.0358E+04	2.5455E+04
3.1100E+02	8.5306E+02	1.0517E+04	-4.7387E+04	2.5169E+05	5.0467E+00	-1.6404E+03	9.9748E+03	1.2032E+04
3.1100E+02	7.9619E+02	1.8901E+04	-4.7387E+04	2.4524E+05	2.0712E+01	-1.6404E+03	9.5912E+03	4.5819E+04
3.1100E+02	7.3932E+02	3.1560E+04	-4.7387E+04	2.3879E+05	6.5443E+00	-1.6404E+03	9.2075E+03	3.3366E+04
3.1100E+02	6.8244E+02	5.0559E+04	-4.7387E+04	2.2588E+05	2.2075E+01	-1.6404E+03	8.8239E+03	5.8819E+04
3.1100E+02	6.2557E+02	1.1281E+05	-4.7387E+04	2.1943E+05	4.4748E+00	-1.6404E+03	8.4402E+03	7.8137E+04
3.1100E+02	5.6870E+02	1.6739E+05	-4.7387E+04	2.1297E+05	3.2140E+00	-1.6404E+03	8.0566E+03	7.4094E+04
3.1100E+02	5.1183E+02	3.4826E+05	-4.7387E+04	2.0652E+05	4.7500E+00	-1.6404E+03	7.6729E+03	1.1315E+05
3.1100E+02	4.5496E+02	6.0508E+05	-4.7387E+04	2.0006E+05	1.6444E+01	-1.6404E+03	7.2893E+03	1.4660E+05
3.1100E+02	3.9809E+02	8.9444E+05	-4.7387E+04	1.9361E+05	4.7225E+00	-1.6404E+03	6.9056E+03	1.9620E+05
3.1100E+02	3.4122E+02	2.1979E+06	-4.7387E+04	1.8716E+05	1.7479E+01	-1.6404E+03	6.5220E+03	3.0179E+05
3.1100E+02	2.8435E+02	3.2273E+06	-4.7387E+04	1.8070E+05	1.3603E-01	-1.6404E+03	6.1383E+03	3.7666E+05
3.1100E+02	2.2748E+02	4.4422E+06	-4.7387E+04	1.7425E+05	1.7314E+01	-1.6404E+03	5.7547E+03	4.5822E+05
3.1100E+02	1.7061E+02	6.4173E+06	-4.7387E+04	1.6780E+05	1.0247E+01	-1.6404E+03	5.3710E+03	6.5873E+05
3.1100E+02	1.1374E+02	7.0681E+06	-4.7387E+04	1.6134E+05	7.0463E+00	-1.6404E+03	4.9874E+03	8.7539E+05
3.1100E+02	5.6870E+01	1.1245E+07	-4.7387E+04	1.5489E+05	1.6184E+00	-1.6404E+03	4.6038E+03	8.0731E+05
3.1100E+02	0.0000E+00	3.1064E+07	-4.7387E+04	1.4843E+05	5.0097E+01	-1.6404E+03	4.2201E+03	1.1052E+06
2.4321E+02	2.4454E+03	3.7057E+00	-4.7387E+04	1.4198E+05	1.5998E+01	-1.6404E+03	3.8365E+03	1.2977E+06
2.4321E+02	2.3317E+03	1.5917E+01	-4.7387E+04	1.3553E+05	1.5257E+02	-1.6404E+03	3.4528E+03	1.7174E+06
2.4321E+02	2.2748E+03	3.7109E+00	-4.7387E+04	1.2907E+05	9.8802E+01	-1.6404E+03	3.0692E+03	1.8662E+06
2.4321E+02	2.2179E+03	1.1753E+01	-4.7387E+04	1.2262E+05	8.1632E+02	-1.6404E+03	2.6855E+03	1.9610E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.4321E+02	2.1611E+03	3.8545E+00	-4.7387E+04	1.1617E+05	8.5075E+02	-1.6404E+03	2.3019E+03	1.9174E+06
2.4321E+02	2.1042E+03	4.8358E+00	-4.7387E+04	1.0971E+05	9.8144E+02	-1.6404E+03	1.9182E+03	1.9061E+06
2.4321E+02	2.0473E+03	4.4646E+02	-4.7387E+04	1.0326E+05	8.5313E+02	-1.6404E+03	1.5346E+03	1.9967E+06
2.4321E+02	1.9905E+03	4.1637E+01	-4.7387E+04	9.6805E+04	5.3805E+03	-1.6404E+03	1.1509E+03	2.3378E+06
2.4321E+02	1.9336E+03	6.5582E+01	-4.7387E+04	9.0352E+04	1.6728E+03	-1.6404E+03	7.6729E+02	4.0469E+06
2.4321E+02	1.8767E+03	1.4028E+01	-4.7387E+04	8.3898E+04	3.2925E+03	-1.6404E+03	3.8365E+02	8.1989E+06
2.4321E+02	1.8199E+03	6.2229E+01	-4.7387E+04	7.7444E+04	3.5742E+03	-1.6404E+03	0.0000E+00	1.6079E+07
2.4321E+02	1.7630E+03	3.2432E+01	-4.7387E+04	7.0990E+04	7.8372E+03	-2.1293E+03	1.8799E+04	1.6196E-01
2.4321E+02	1.7061E+03	6.3658E+01	-4.7387E+04	6.4537E+04	2.1416E+04	-2.1293E+03	1.8415E+04	3.6186E+00
2.4321E+02	1.6492E+03	2.3160E+01	-4.7387E+04	5.8083E+04	2.6266E+04	-2.1293E+03	1.6880E+04	1.6196E-01
2.4321E+02	1.5924E+03	4.9065E+01	-4.7387E+04	5.1629E+04	5.5833E+04	-2.1293E+03	1.6497E+04	1.1592E+00
2.4321E+02	1.5355E+03	7.5881E+00	-4.7387E+04	4.5176E+04	1.2860E+05	-2.1293E+03	1.6113E+04	4.5627E+00
2.4321E+02	1.4786E+03	1.9517E+02	-4.7387E+04	3.8722E+04	3.3325E+05	-2.1293E+03	1.5729E+04	1.4446E+02
2.4321E+02	1.4218E+03	2.0103E+01	-4.7387E+04	3.2268E+04	6.8107E+05	-2.1293E+03	1.5346E+04	8.7579E+01
2.4321E+02	1.3649E+03	1.5608E+02	-4.7387E+04	2.5815E+04	1.5261E+06	-2.1293E+03	1.4962E+04	4.9259E+00
2.4321E+02	1.3080E+03	9.3204E+01	-4.7387E+04	1.9361E+04	2.3154E+06	-2.1293E+03	1.4579E+04	5.9328E+01
2.4321E+02	1.2511E+03	4.0053E+02	-4.7387E+04	1.2907E+04	3.6415E+06	-2.1293E+03	1.4195E+04	1.4499E+02
2.4321E+02	1.1943E+03	8.2765E+02	-4.7387E+04	6.4537E+03	5.6857E+06	-2.1293E+03	1.3811E+04	2.1597E+01
2.4321E+02	1.1374E+03	5.9322E+02	-4.7387E+04	0.0000E+00	9.4610E+06	-2.1293E+03	1.3428E+04	7.7511E+01
2.4321E+02	1.0805E+03	6.5021E+02	-5.4630E+04	2.7105E+05	1.3359E+00	-2.1293E+03	1.3044E+04	2.7695E+01
2.4321E+02	1.0237E+03	1.2921E+03	-5.4630E+04	2.6460E+05	6.5443E+00	-2.1293E+03	1.2660E+04	3.2089E+01
2.4321E+02	9.6680E+02	1.5770E+03	-5.4630E+04	2.5815E+05	6.5443E+00	-2.1293E+03	1.2277E+04	1.3194E+02
2.4321E+02	9.0993E+02	4.6380E+03	-5.4630E+04	2.5169E+05	1.9376E+01	-2.1293E+03	1.1893E+04	9.6983E+02
2.4321E+02	8.5306E+02	3.9533E+03	-5.4630E+04	2.4524E+05	1.3359E+00	-2.1293E+03	1.1509E+04	1.5577E+03
2.4321E+02	7.9619E+02	9.3803E+03	-5.4630E+04	2.3879E+05	3.1390E+00	-2.1293E+03	1.1126E+04	1.4985E+03
2.4321E+02	7.3932E+02	1.1174E+04	-5.4630E+04	2.3233E+05	3.0859E+00	-2.1293E+03	1.0742E+04	2.8105E+02
2.4321E+02	6.8244E+02	2.1397E+04	-5.4630E+04	2.2588E+05	8.9588E+00	-2.1293E+03	1.0358E+04	4.1048E+03
2.4321E+02	6.2557E+02	3.4839E+04	-5.4630E+04	2.1943E+05	1.8373E+01	-2.1293E+03	9.9748E+03	6.8598E+03
2.4321E+02	5.6870E+02	9.8272E+04	-5.4630E+04	2.1297E+05	1.9117E+01	-2.1293E+03	9.5912E+03	1.2861E+04
2.4321E+02	5.1183E+02	1.8768E+05	-5.4630E+04	2.0652E+05	3.4672E+01	-2.1293E+03	9.2075E+03	1.5153E+04
2.4321E+02	4.5496E+02	3.8135E+05	-5.4630E+04	2.0006E+05	1.5024E+01	-2.1293E+03	8.8239E+03	3.4700E+04
2.4321E+02	3.9809E+02	7.9915E+05	-5.4630E+04	1.9361E+05	1.3408E+01	-2.1293E+03	8.4402E+03	2.9366E+04
2.4321E+02	3.4122E+02	1.3442E+06	-5.4630E+04	1.8716E+05	4.9836E+01	-2.1293E+03	8.0566E+03	4.9130E+04
2.4321E+02	2.8435E+02	2.4558E+06	-5.4630E+04	1.8070E+05	2.4926E+01	-2.1293E+03	7.6729E+03	7.0329E+04
2.4321E+02	2.2748E+02	4.3671E+06	-5.4630E+04	1.7425E+05	4.8920E-01	-2.1293E+03	7.2893E+03	1.0942E+05
2.4321E+02	1.7061E+02	6.4520E+06	-5.4630E+04	1.6780E+05	1.4109E+00	-2.1293E+03	6.9056E+03	1.2328E+05
2.4321E+02	1.1374E+02	9.0659E+06	-5.4630E+04	1.6134E+05	9.8633E+00	-2.1293E+03	6.5220E+03	2.6909E+05
2.4321E+02	5.6870E+01	1.4315E+07	-5.4630E+04	1.5489E+05	8.4449E+01	-2.1293E+03	6.1383E+03	2.4606E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.4321E+02	0.0000E+00	3.9108E+07	-5.4630E+04	1.4843E+05	1.0997E+02	-2.1293E+03	5.7547E+03	3.6746E+05
1.7543E+02	2.5023E+03	3.5000E+00	-5.4630E+04	1.4198E+05	1.7290E+01	-2.1293E+03	5.3710E+03	5.2170E+05
1.7543E+02	2.4454E+03	1.3890E+00	-5.4630E+04	1.3553E+05	1.5169E+03	-2.1293E+03	4.9874E+03	7.3087E+05
1.7543E+02	2.3317E+03	3.0859E+00	-5.4630E+04	1.2907E+05	2.8616E+01	-2.1293E+03	4.6038E+03	7.6488E+05
1.7543E+02	2.2748E+03	4.8890E+00	-5.4630E+04	1.2262E+05	7.5632E+02	-2.1293E+03	4.2201E+03	1.0170E+06
1.7543E+02	2.2179E+03	9.6302E+00	-5.4630E+04	1.1617E+05	5.3233E+03	-2.1293E+03	3.8365E+03	1.1139E+06
1.7543E+02	2.1611E+03	9.3730E+00	-5.4630E+04	1.0971E+05	7.2067E+02	-2.1293E+03	3.4528E+03	1.3483E+06
1.7543E+02	2.1042E+03	1.3755E+01	-5.4630E+04	1.0326E+05	3.3093E+03	-2.1293E+03	3.0692E+03	1.5824E+06
1.7543E+02	2.0473E+03	1.9910E+01	-5.4630E+04	9.6805E+04	3.2463E+03	-2.1293E+03	2.6855E+03	1.5555E+06
1.7543E+02	1.9905E+03	1.2167E+01	-5.4630E+04	9.0352E+04	3.8506E+03	-2.1293E+03	2.3019E+03	1.3072E+06
1.7543E+02	1.9336E+03	3.2805E+01	-5.4630E+04	8.3898E+04	2.5094E+04	-2.1293E+03	1.9182E+03	1.4421E+06
1.7543E+02	1.8767E+03	1.0417E+01	-5.4630E+04	7.7444E+04	9.3912E+03	-2.1293E+03	1.5346E+03	1.4393E+06
1.7543E+02	1.8199E+03	1.1520E+01	-5.4630E+04	7.0990E+04	2.6015E+04	-2.1293E+03	1.1509E+03	1.8100E+06
1.7543E+02	1.7630E+03	3.0977E+01	-5.4630E+04	6.4537E+04	1.5468E+04	-2.1293E+03	7.6729E+02	3.2334E+06
1.7543E+02	1.7061E+03	3.5342E+00	-5.4630E+04	5.8083E+04	3.6651E+04	-2.1293E+03	3.8365E+02	6.6032E+06
1.7543E+02	1.6492E+03	1.0579E+01	-5.4630E+04	5.1629E+04	9.1598E+04	-2.1293E+03	0.0000E+00	1.1333E+07
1.7543E+02	1.5924E+03	6.8967E+01	-5.4630E+04	4.5176E+04	1.5818E+05	-2.6182E+03	1.8799E+04	8.3335E+01
1.7543E+02	1.5355E+03	9.8474E+01	-5.4630E+04	3.8722E+04	3.2444E+05	-2.6182E+03	1.7648E+04	6.1840E-01
1.7543E+02	1.4786E+03	2.0218E+02	-5.4630E+04	3.2268E+04	8.9591E+05	-2.6182E+03	1.7264E+04	9.4410E-01
1.7543E+02	1.4218E+03	6.5417E+01	-5.4630E+04	2.5815E+04	1.2387E+06	-2.6182E+03	1.6880E+04	5.4929E+00
1.7543E+02	1.3649E+03	1.0684E+02	-5.4630E+04	1.9361E+04	2.8994E+06	-2.6182E+03	1.6497E+04	3.2393E-01
1.7543E+02	1.3080E+03	6.0827E+01	-5.4630E+04	1.2907E+04	3.3630E+06	-2.6182E+03	1.6113E+04	1.6895E+00
1.7543E+02	1.2511E+03	1.4896E+02	-5.4630E+04	6.4537E+03	6.3982E+06	-2.6182E+03	1.5729E+04	2.3233E+01
1.7543E+02	1.1943E+03	2.0142E+02	-5.4630E+04	0.0000E+00	9.5287E+06	-2.6182E+03	1.5346E+04	1.0625E-01
1.7543E+02	1.1374E+03	1.5519E+02	-6.1874E+04	2.6460E+05	1.3359E+00	-2.6182E+03	1.4962E+04	9.8548E+01
1.7543E+02	1.0805E+03	4.0231E+02	-6.1874E+04	2.5815E+05	7.8802E+00	-2.6182E+03	1.4579E+04	5.3095E+00
1.7543E+02	1.0237E+03	4.2517E+02	-6.1874E+04	2.4524E+05	6.5443E+00	-2.6182E+03	1.4195E+04	1.9158E+01
1.7543E+02	9.6680E+02	1.1475E+03	-6.1874E+04	2.3879E+05	2.6717E+00	-2.6182E+03	1.3811E+04	2.2058E+01
1.7543E+02	9.0993E+02	1.8375E+03	-6.1874E+04	2.3233E+05	5.5247E+00	-2.6182E+03	1.3428E+04	1.4098E+01
1.7543E+02	8.5306E+02	3.5830E+03	-6.1874E+04	2.2588E+05	6.5443E+00	-2.6182E+03	1.3044E+04	8.0102E+00
1.7543E+02	7.9619E+02	1.6567E+03	-6.1874E+04	2.1943E+05	6.7298E-01	-2.6182E+03	1.2660E+04	4.9520E+01
1.7543E+02	7.3932E+02	1.1603E+04	-6.1874E+04	2.1297E+05	9.4384E+00	-2.6182E+03	1.2277E+04	4.3859E+01
1.7543E+02	6.8244E+02	2.6221E+04	-6.1874E+04	2.0652E+05	1.0428E+01	-2.6182E+03	1.1893E+04	2.9435E+02
1.7543E+02	6.2557E+02	3.6271E+04	-6.1874E+04	2.0006E+05	1.4428E+01	-2.6182E+03	1.1509E+04	1.8929E+02
1.7543E+02	5.6870E+02	7.3283E+04	-6.1874E+04	1.9361E+05	2.8832E+00	-2.6182E+03	1.1126E+04	4.1717E+03
1.7543E+02	5.1183E+02	1.1551E+05	-6.1874E+04	1.8716E+05	1.5943E+01	-2.6182E+03	1.0742E+04	1.7924E+02
1.7543E+02	4.5496E+02	2.5988E+05	-6.1874E+04	1.8070E+05	7.6096E+00	-2.6182E+03	1.0358E+04	1.7841E+03
1.7543E+02	3.9809E+02	5.1828E+05	-6.1874E+04	1.7425E+05	3.0231E+01	-2.6182E+03	9.9748E+03	4.6447E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.7543E+02	3.4122E+02	1.1766E+06	-6.1874E+04	1.6780E+05	5.2864E+01	-2.6182E+03	9.5912E+03	8.6552E+02
1.7543E+02	2.8435E+02	2.5301E+06	-6.1874E+04	1.6134E+05	5.0542E+01	-2.6182E+03	9.2075E+03	7.7756E+02
1.7543E+02	2.2748E+02	5.5925E+06	-6.1874E+04	1.5489E+05	2.2845E+01	-2.6182E+03	8.8239E+03	1.9840E+03
1.7543E+02	1.7061E+02	9.7593E+06	-6.1874E+04	1.4843E+05	5.7382E+02	-2.6182E+03	8.4402E+03	7.8834E+03
1.7543E+02	1.1374E+02	1.4073E+07	-6.1874E+04	1.4198E+05	1.1181E+03	-2.6182E+03	8.0566E+03	4.5950E+03
1.7543E+02	5.6870E+01	2.1381E+07	-6.1874E+04	1.3553E+05	1.5466E+02	-2.6182E+03	7.6729E+03	2.1611E+04
1.7543E+02	0.0000E+00	5.1507E+07	-6.1874E+04	1.2907E+05	3.5633E+02	-2.6182E+03	7.2893E+03	3.8481E+04
1.0765E+02	2.4454E+03	1.3359E+00	-6.1874E+04	1.2262E+05	6.1778E+03	-2.6182E+03	6.9056E+03	9.4491E+04
1.0765E+02	2.3317E+03	2.6717E+00	-6.1874E+04	1.1617E+05	2.1493E+03	-2.6182E+03	6.5220E+03	1.3739E+05
1.0765E+02	2.2179E+03	1.7500E+00	-6.1874E+04	1.0971E+05	1.8610E+03	-2.6182E+03	6.1383E+03	1.7227E+05
1.0765E+02	2.1611E+03	1.7500E+00	-6.1874E+04	1.0326E+05	4.7251E+03	-2.6182E+03	5.7547E+03	1.7835E+05
1.0765E+02	2.1042E+03	3.0859E+00	-6.1874E+04	9.6805E+04	7.1982E+03	-2.6182E+03	5.3710E+03	3.2711E+05
1.0765E+02	2.0473E+03	1.2167E+01	-6.1874E+04	9.0352E+04	1.6740E+04	-2.6182E+03	4.9874E+03	4.3732E+05
1.0765E+02	1.9905E+03	1.5246E+01	-6.1874E+04	8.3898E+04	1.8903E+04	-2.6182E+03	4.6038E+03	5.1719E+05
1.0765E+02	1.8767E+03	5.3125E-02	-6.1874E+04	7.7444E+04	3.1547E+04	-2.6182E+03	4.2201E+03	6.1662E+05
1.0765E+02	1.7630E+03	1.7292E+01	-6.1874E+04	7.0990E+04	2.1940E+04	-2.6182E+03	3.8365E+03	8.1894E+05
1.0765E+02	1.7061E+03	2.4440E+01	-6.1874E+04	6.4537E+04	4.3162E+04	-2.6182E+03	3.4528E+03	9.8737E+05
1.0765E+02	1.6492E+03	1.0470E+01	-6.1874E+04	5.8083E+04	4.1288E+04	-2.6182E+03	3.0692E+03	9.7856E+05
1.0765E+02	1.5924E+03	1.2500E+00	-6.1874E+04	5.1629E+04	5.3840E+04	-2.6182E+03	2.6855E+03	1.1975E+06
1.0765E+02	1.5355E+03	3.2828E+01	-6.1874E+04	4.5176E+04	1.0142E+05	-2.6182E+03	2.3019E+03	1.0854E+06
1.0765E+02	1.4786E+03	4.4721E+01	-6.1874E+04	3.8722E+04	2.6306E+05	-2.6182E+03	1.9182E+03	1.0280E+06
1.0765E+02	1.4218E+03	4.8141E+01	-6.1874E+04	3.2268E+04	6.1779E+05	-2.6182E+03	1.5346E+03	9.2844E+05
1.0765E+02	1.3649E+03	9.3135E+01	-6.1874E+04	2.5815E+04	1.5252E+06	-2.6182E+03	1.1509E+03	1.4940E+06
1.0765E+02	1.3080E+03	9.6961E+01	-6.1874E+04	1.9361E+04	2.6457E+06	-2.6182E+03	7.6729E+02	2.1799E+06
1.0765E+02	1.2511E+03	1.0099E+02	-6.1874E+04	1.2907E+04	4.3194E+06	-2.6182E+03	3.8365E+02	4.6402E+06
1.0765E+02	1.1943E+03	1.3418E+02	-6.1874E+04	6.4537E+03	6.3075E+06	-2.6182E+03	0.0000E+00	8.5087E+06
1.0765E+02	1.1374E+03	1.1199E+02	-6.1874E+04	0.0000E+00	1.0661E+07	-3.1070E+03	1.8415E+04	3.6047E+00
1.0765E+02	1.0805E+03	1.4145E+02	-6.9117E+04	2.5169E+05	1.3359E+00	-3.1070E+03	1.8031E+04	5.3125E-02
1.0765E+02	1.0237E+03	1.8588E+02	-6.9117E+04	2.3233E+05	2.6717E+00	-3.1070E+03	1.7648E+04	6.1840E-01
1.0765E+02	9.6680E+02	4.1166E+02	-6.9117E+04	2.2588E+05	1.3359E+00	-3.1070E+03	1.7264E+04	1.8882E+00
1.0765E+02	9.0993E+02	3.9436E+02	-6.9117E+04	2.1943E+05	4.1659E+00	-3.1070E+03	1.6880E+04	5.3125E-02
1.0765E+02	8.5306E+02	7.0934E+02	-6.9117E+04	2.1297E+05	1.0906E+01	-3.1070E+03	1.6497E+04	3.1184E+00
1.0765E+02	7.9619E+02	2.7595E+03	-6.9117E+04	2.0652E+05	1.4109E+00	-3.1070E+03	1.6113E+04	5.7080E+00
1.0765E+02	7.3932E+02	9.0636E+03	-6.9117E+04	2.0006E+05	1.6429E+01	-3.1070E+03	1.5729E+04	1.1061E+00
1.0765E+02	6.8244E+02	8.4716E+03	-6.9117E+04	1.9361E+05	1.8916E+01	-3.1070E+03	1.5346E+04	3.2425E+00
1.0765E+02	6.2557E+02	1.3686E+04	-6.9117E+04	1.8716E+05	2.3165E+01	-3.1070E+03	1.4962E+04	2.1644E+00
1.0765E+02	5.6870E+02	2.8712E+04	-6.9117E+04	1.8070E+05	3.4284E+01	-3.1070E+03	1.4579E+04	1.6852E+01
1.0765E+02	5.1183E+02	7.4893E+04	-6.9117E+04	1.7425E+05	2.0382E+01	-3.1070E+03	1.4195E+04	3.1086E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0765E+02	4.5496E+02	1.8096E+05	-6.9117E+04	1.6780E+05	1.5930E+01	-3.1070E+03	1.3811E+04	3.1184E+00
1.0765E+02	3.9809E+02	3.9372E+05	-6.9117E+04	1.6134E+05	1.6243E+01	-3.1070E+03	1.3428E+04	1.1335E+01
1.0765E+02	3.4122E+02	7.7657E+05	-6.9117E+04	1.5489E+05	9.8672E+02	-3.1070E+03	1.3044E+04	8.0398E+00
1.0765E+02	2.8435E+02	1.5010E+06	-6.9117E+04	1.4843E+05	1.1312E+02	-3.1070E+03	1.2660E+04	4.6804E+00
1.0765E+02	2.2748E+02	2.6601E+06	-6.9117E+04	1.4198E+05	2.4875E+03	-3.1070E+03	1.2277E+04	4.3289E+00
1.0765E+02	1.7061E+02	4.3590E+06	-6.9117E+04	1.3553E+05	3.7260E+02	-3.1070E+03	1.1893E+04	1.1045E+01
1.0765E+02	1.1374E+02	6.8560E+06	-6.9117E+04	1.2907E+05	8.4801E+02	-3.1070E+03	1.1509E+04	1.0393E+02
1.0765E+02	5.6870E+01	1.1374E+07	-6.9117E+04	1.2262E+05	2.7821E+03	-3.1070E+03	1.1126E+04	1.4716E+01
1.0765E+02	0.0000E+00	3.2364E+07	-6.9117E+04	1.1617E+05	6.2278E+03	-3.1070E+03	1.0742E+04	2.0884E+01
3.9865E+01	2.8435E+03	6.2500E-01	-6.9117E+04	1.0971E+05	4.9104E+03	-3.1070E+03	1.0358E+04	4.3712E+01
3.9865E+01	2.1042E+03	1.7500E+00	-6.9117E+04	1.0326E+05	1.5164E+04	-3.1070E+03	9.9748E+03	4.8451E+02
3.9865E+01	1.9905E+03	1.3359E+00	-6.9117E+04	9.6805E+04	7.4346E+03	-3.1070E+03	9.5912E+03	6.2013E+02
3.9865E+01	1.7630E+03	6.2500E-01	-6.9117E+04	9.0352E+04	2.1044E+04	-3.1070E+03	9.2075E+03	1.0507E+02
3.9865E+01	1.5924E+03	2.8832E+00	-6.9117E+04	8.3898E+04	2.7759E+04	-3.1070E+03	8.8239E+03	6.2251E+02
3.9865E+01	1.5355E+03	4.4668E+01	-6.9117E+04	7.7444E+04	3.5639E+04	-3.1070E+03	8.4402E+03	1.1111E+03
3.9865E+01	1.4786E+03	1.3867E+01	-6.9117E+04	7.0990E+04	3.2820E+04	-3.1070E+03	8.0566E+03	2.2684E+03
3.9865E+01	1.4218E+03	7.3125E-01	-6.9117E+04	6.4537E+04	4.1424E+04	-3.1070E+03	7.6729E+03	1.2304E+04
3.9865E+01	1.3649E+03	4.3060E+00	-6.9117E+04	5.8083E+04	6.5120E+04	-3.1070E+03	7.2893E+03	7.4437E+03
3.9865E+01	1.3080E+03	8.2919E+00	-6.9117E+04	5.1629E+04	7.6908E+04	-3.1070E+03	6.9056E+03	2.6160E+04
3.9865E+01	1.2511E+03	1.3429E+01	-6.9117E+04	4.5176E+04	1.5166E+05	-3.1070E+03	6.5220E+03	4.4016E+04
3.9865E+01	1.1943E+03	1.5148E+01	-6.9117E+04	3.8722E+04	2.3626E+05	-3.1070E+03	6.1383E+03	6.2518E+04
3.9865E+01	1.1374E+03	1.9094E+00	-6.9117E+04	3.2268E+04	4.6277E+05	-3.1070E+03	5.7547E+03	1.4590E+05
3.9865E+01	1.0805E+03	4.5058E+01	-6.9117E+04	2.5815E+04	1.2090E+06	-3.1070E+03	5.3710E+03	1.4843E+05
3.9865E+01	1.0237E+03	2.0112E+01	-6.9117E+04	1.9361E+04	2.4731E+06	-3.1070E+03	4.9874E+03	2.4851E+05
3.9865E+01	9.6680E+02	4.4829E+01	-6.9117E+04	1.2907E+04	3.2950E+06	-3.1070E+03	4.6038E+03	2.7554E+05
3.9865E+01	9.0993E+02	5.2183E+01	-6.9117E+04	6.4537E+03	5.3637E+06	-3.1070E+03	4.2201E+03	4.0846E+05
3.9865E+01	8.5306E+02	1.6813E+03	-6.9117E+04	0.0000E+00	1.2501E+07	-3.1070E+03	3.8365E+03	5.1208E+05
3.9865E+01	7.9619E+02	2.1908E+02	-7.6361E+04	2.0652E+05	4.2409E+00	-3.1070E+03	3.4528E+03	6.2519E+05
3.9865E+01	7.3932E+02	9.5751E+02	-7.6361E+04	1.9361E+05	1.4109E+00	-3.1070E+03	3.0692E+03	6.5745E+05
3.9865E+01	6.8244E+02	9.6257E+03	-7.6361E+04	1.8070E+05	2.8665E+00	-3.1070E+03	2.6855E+03	7.0773E+05
3.9865E+01	6.2557E+02	1.5799E+04	-7.6361E+04	1.7425E+05	1.0510E+01	-3.1070E+03	2.3019E+03	7.2192E+05
3.9865E+01	5.6870E+02	1.5099E+04	-7.6361E+04	1.6780E+05	3.3276E+02	-3.1070E+03	1.9182E+03	6.6269E+05
3.9865E+01	5.1183E+02	3.1628E+04	-7.6361E+04	1.6134E+05	1.1522E+02	-3.1070E+03	1.5346E+03	6.6445E+05
3.9865E+01	4.5496E+02	9.3410E+04	-7.6361E+04	1.5489E+05	7.1660E+01	-3.1070E+03	1.1509E+03	9.7696E+05
3.9865E+01	3.9809E+02	1.7914E+05	-7.6361E+04	1.4843E+05	2.3901E+02	-3.1070E+03	7.6729E+02	1.6172E+06
3.9865E+01	3.4122E+02	3.3614E+05	-7.6361E+04	1.4198E+05	3.8445E+02	-3.1070E+03	3.8365E+02	3.3650E+06
3.9865E+01	2.8435E+02	5.6469E+05	-7.6361E+04	1.3553E+05	9.7596E+02	-3.1070E+03	0.0000E+00	5.9028E+06
3.9865E+01	2.2748E+02	9.9096E+05	-7.6361E+04	1.2907E+05	7.4599E+02	-3.5959E+03	1.8799E+04	7.8036E-01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Business Assurance Denmark A/S Tåsing Parkvej 8-12 DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.9865E+01	1.7061E+02	1.2720E+06	-7.6361E+04	1.2262E+05	1.4601E+03	-3.5959E+03	1.8415E+04	1.6196E-01
3.9865E+01	1.1374E+02	2.1273E+06	-7.6361E+04	1.1617E+05	2.6015E+03	-3.5959E+03	1.7264E+04	3.7705E-01
3.9865E+01	5.6870E+01	5.8958E+06	-7.6361E+04	1.0971E+05	3.8743E+03	-3.5959E+03	1.6880E+04	6.7153E-01
3.9865E+01	0.0000E+00	2.4111E+07	-7.6361E+04	1.0326E+05	4.5531E+03	-3.5959E+03	1.6497E+04	2.3264E+00
-2.7918E+01	1.9336E+03	6.1985E-01	-7.6361E+04	9.6805E+04	1.1041E+04	-3.5959E+03	1.5729E+04	1.8552E+00
-2.7918E+01	1.5924E+03	2.4812E+00	-7.6361E+04	9.0352E+04	2.2545E+04	-3.5959E+03	1.5346E+04	3.2393E-01
-2.7918E+01	1.5355E+03	3.7859E+00	-7.6361E+04	8.3898E+04	4.5811E+04	-3.5959E+03	1.4962E+04	1.7245E+00
-2.7918E+01	1.4786E+03	5.3125E-02	-7.6361E+04	7.7444E+04	4.1256E+04	-3.5959E+03	1.4579E+04	7.8036E-01
-2.7918E+01	1.4218E+03	1.5379E+01	-7.6361E+04	7.0990E+04	6.6748E+04	-3.5959E+03	1.4195E+04	1.0417E+00
-2.7918E+01	1.3649E+03	8.1248E+00	-7.6361E+04	6.4537E+04	8.1666E+04	-3.5959E+03	1.3428E+04	6.1840E-01
-2.7918E+01	1.3080E+03	6.7813E-01	-7.6361E+04	5.8083E+04	1.1667E+05	-3.5959E+03	1.3044E+04	6.7298E-01
-2.7918E+01	1.2511E+03	5.6952E+00	-7.6361E+04	5.1629E+04	1.8089E+05	-3.5959E+03	1.2660E+04	9.6573E-01
-2.7918E+01	1.1943E+03	1.0928E+01	-7.6361E+04	4.5176E+04	1.6087E+05	-3.5959E+03	1.2277E+04	9.5264E-01
-2.7918E+01	1.1374E+03	4.7309E+01	-7.6361E+04	3.8722E+04	3.5072E+05	-3.5959E+03	1.1893E+04	2.4327E+00
-2.7918E+01	1.0805E+03	3.2958E+01	-7.6361E+04	3.2268E+04	5.5780E+05	-3.5959E+03	1.1509E+04	2.2074E+00
-2.7918E+01	1.0237E+03	3.1892E+01	-7.6361E+04	2.5815E+04	1.3091E+06	-3.5959E+03	1.1126E+04	3.1466E+00
-2.7918E+01	9.6680E+02	8.8931E+01	-7.6361E+04	1.9361E+04	2.9562E+06	-3.5959E+03	1.0742E+04	8.8405E+01
-2.7918E+01	9.0993E+02	9.1851E+01	-7.6361E+04	1.2907E+04	4.0901E+06	-3.5959E+03	1.0358E+04	2.8426E+00
-2.7918E+01	8.5306E+02	1.6080E+03	-7.6361E+04	6.4537E+03	5.1095E+06	-3.5959E+03	9.9748E+03	4.0528E+00
-2.7918E+01	7.9619E+02	4.0320E+03	-7.6361E+04	0.0000E+00	1.4317E+07	-3.5959E+03	9.5912E+03	4.7990E+01
-2.7918E+01	7.3932E+02	3.2449E+03	-8.3604E+04	1.9361E+05	4.3791E+02	-3.5959E+03	9.2075E+03	1.0838E+02
-2.7918E+01	6.8244E+02	7.4307E+03	-8.3604E+04	1.8070E+05	3.5788E+02	-3.5959E+03	8.8239E+03	5.4491E+01
-2.7918E+01	6.2557E+02	1.8801E+03	-8.3604E+04	1.7425E+05	1.4129E+01	-3.5959E+03	8.4402E+03	3.7888E+01
-2.7918E+01	5.6870E+02	1.0600E+04	-8.3604E+04	1.6780E+05	1.3483E+02	-3.5959E+03	8.0566E+03	1.1628E+03
-2.7918E+01	5.1183E+02	1.6471E+04	-8.3604E+04	1.6134E+05	2.4109E+02	-3.5959E+03	7.6729E+03	5.1559E+02
-2.7918E+01	4.5496E+02	1.7791E+04	-8.3604E+04	1.5489E+05	2.3942E+02	-3.5959E+03	7.2893E+03	7.7124E+03
-2.7918E+01	3.9809E+02	2.3330E+04	-8.3604E+04	1.4843E+05	6.5091E+02	-3.5959E+03	6.9056E+03	8.1812E+03
-2.7918E+01	3.4122E+02	3.2033E+04	-8.3604E+04	1.4198E+05	1.1654E+03	-3.5959E+03	6.5220E+03	7.4661E+02
-2.7918E+01	2.8435E+02	9.0055E+04	-8.3604E+04	1.3553E+05	1.3128E+03	-3.5959E+03	6.1383E+03	2.3866E+04
-2.7918E+01	2.2748E+02	2.3493E+05	-8.3604E+04	1.2907E+05	1.5284E+03	-3.5959E+03	5.7547E+03	2.0673E+04
-2.7918E+01	1.7061E+02	7.7159E+05	-8.3604E+04	1.2262E+05	3.7342E+03	-3.5959E+03	5.3710E+03	4.1576E+04
-2.7918E+01	1.1374E+02	2.3067E+06	-8.3604E+04	1.1617E+05	5.2231E+03	-3.5959E+03	4.9874E+03	1.0324E+05
-2.7918E+01	5.6870E+01	7.2411E+06	-8.3604E+04	1.0971E+05	1.2288E+04	-3.5959E+03	4.6038E+03	1.1479E+05
-2.7918E+01	0.0000E+00	2.7847E+07	-8.3604E+04	1.0326E+05	1.5607E+04	-3.5959E+03	4.2201E+03	2.0516E+05
-9.5701E+01	1.8199E+03	1.7500E+00	-8.3604E+04	9.6805E+04	2.3206E+04	-3.5959E+03	3.8365E+03	2.0934E+05
-9.5701E+01	1.6492E+03	6.2500E-01	-8.3604E+04	9.0352E+04	3.0256E+04	-3.5959E+03	3.4528E+03	3.1137E+05
-9.5701E+01	1.5355E+03	1.5871E+01	-8.3604E+04	8.3898E+04	4.0841E+04	-3.5959E+03	3.0692E+03	3.2793E+05
-9.5701E+01	1.4786E+03	5.3125E-02	-8.3604E+04	7.7444E+04	5.9101E+04	-3.5959E+03	2.6855E+03	5.1631E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-9.5701E+01	1.4218E+03	3.0000E+00	-8.3604E+04	7.0990E+04	1.4250E+05	-3.5959E+03	2.3019E+03	3.1267E+05
-9.5701E+01	1.3649E+03	6.2500E-01	-8.3604E+04	6.4537E+04	1.8608E+05	-3.5959E+03	1.9182E+03	4.2806E+05
-9.5701E+01	1.3080E+03	5.6717E+00	-8.3604E+04	5.8083E+04	2.2223E+05	-3.5959E+03	1.5346E+03	4.0575E+05
-9.5701E+01	1.2511E+03	2.0145E+01	-8.3604E+04	5.1629E+04	3.8164E+05	-3.5959E+03	1.1509E+03	5.1529E+05
-9.5701E+01	1.1943E+03	1.9766E+01	-8.3604E+04	4.5176E+04	4.5576E+05	-3.5959E+03	7.6729E+02	9.3655E+05
-9.5701E+01	1.1374E+03	3.1885E+01	-8.3604E+04	3.8722E+04	6.3454E+05	-3.5959E+03	3.8365E+02	2.3108E+06
-9.5701E+01	1.0805E+03	2.1519E+01	-8.3604E+04	3.2268E+04	9.0657E+05	-3.5959E+03	0.0000E+00	3.9910E+06
-9.5701E+01	1.0237E+03	5.0688E+01	-8.3604E+04	2.5815E+04	1.4810E+06	-4.0848E+03	1.7648E+04	6.1840E-01
-9.5701E+01	9.6680E+02	4.5137E+01	-8.3604E+04	1.9361E+04	2.8052E+06	-4.0848E+03	1.6880E+04	3.6047E+00
-9.5701E+01	9.0993E+02	3.6441E+01	-8.3604E+04	1.2907E+04	3.4020E+06	-4.0848E+03	1.6497E+04	2.4078E-01
-9.5701E+01	8.5306E+02	3.9178E+01	-8.3604E+04	6.4537E+03	4.5282E+06	-4.0848E+03	1.5729E+04	2.2176E+00
-9.5701E+01	7.9619E+02	6.9365E+01	-8.3604E+04	0.0000E+00	1.3663E+07	-4.0848E+03	1.5346E+04	8.3335E+01
-9.5701E+01	7.3932E+02	1.7426E+02	-9.0848E+04	2.0652E+05	1.0510E+01	-4.0848E+03	1.4579E+04	1.6196E-01
-9.5701E+01	6.8244E+02	1.6997E+02	-9.0848E+04	1.8716E+05	6.1150E+01	-4.0848E+03	1.4195E+04	6.1840E-01
-9.5701E+01	6.2557E+02	1.4509E+02	-9.0848E+04	1.8070E+05	2.7056E+01	-4.0848E+03	1.3428E+04	1.3988E+00
-9.5701E+01	5.6870E+02	2.0284E+02	-9.0848E+04	1.7425E+05	1.7662E+03	-4.0848E+03	1.3044E+04	1.0948E+00
-9.5701E+01	5.1183E+02	3.0864E+02	-9.0848E+04	1.6780E+05	5.0640E+01	-4.0848E+03	1.2660E+04	5.3125E-02
-9.5701E+01	4.5496E+02	2.1270E+03	-9.0848E+04	1.6134E+05	2.3661E+02	-4.0848E+03	1.1893E+04	3.2844E+00
-9.5701E+01	3.9809E+02	4.0172E+03	-9.0848E+04	1.5489E+05	2.1600E+02	-4.0848E+03	1.1509E+04	9.4053E-01
-9.5701E+01	3.4122E+02	5.9082E+03	-9.0848E+04	1.4843E+05	3.6303E+02	-4.0848E+03	1.1126E+04	5.3125E-02
-9.5701E+01	2.8435E+02	4.3547E+03	-9.0848E+04	1.4198E+05	1.7987E+03	-4.0848E+03	1.0742E+04	2.0890E+00
-9.5701E+01	2.2748E+02	1.9569E+04	-9.0848E+04	1.3553E+05	4.2054E+03	-4.0848E+03	1.0358E+04	7.3125E-01
-9.5701E+01	1.7061E+02	2.4620E+04	-9.0848E+04	1.2907E+05	4.2594E+03	-4.0848E+03	9.9748E+03	1.7500E+00
-9.5701E+01	1.1374E+02	7.8832E+04	-9.0848E+04	1.2262E+05	4.1374E+03	-4.0848E+03	9.5912E+03	1.4140E+01
-9.5701E+01	5.6870E+01	3.3247E+05	-9.0848E+04	1.1617E+05	1.1544E+04	-4.0848E+03	9.2075E+03	1.2863E+01
-9.5701E+01	0.0000E+00	1.3714E+06	-9.0848E+04	1.0971E+05	1.9991E+04	-4.0848E+03	8.8239E+03	2.1020E+01
-1.6348E+02	1.8199E+03	1.7500E+00	-9.0848E+04	1.0326E+05	2.1761E+04	-4.0848E+03	8.4402E+03	4.8681E+01
-1.6348E+02	1.7061E+03	1.7500E+00	-9.0848E+04	9.6805E+04	3.1209E+04	-4.0848E+03	8.0566E+03	2.0853E+02
-1.6348E+02	1.5924E+03	1.7500E+00	-9.0848E+04	9.0352E+04	5.9726E+04	-4.0848E+03	7.6729E+03	3.7608E+00
-1.6348E+02	1.5355E+03	1.2500E+00	-9.0848E+04	8.3898E+04	8.4759E+04	-4.0848E+03	7.2893E+03	4.5551E+02
-1.6348E+02	1.4786E+03	2.0611E+01	-9.0848E+04	7.7444E+04	1.5996E+05	-4.0848E+03	6.9056E+03	1.4073E+03
-1.6348E+02	1.4218E+03	4.4217E+00	-9.0848E+04	7.0990E+04	2.0342E+05	-4.0848E+03	6.5220E+03	2.1752E+03
-1.6348E+02	1.3649E+03	4.8890E+00	-9.0848E+04	6.4537E+04	3.2229E+05	-4.0848E+03	6.1383E+03	1.0230E+03
-1.6348E+02	1.3080E+03	8.9608E+00	-9.0848E+04	5.8083E+04	4.3755E+05	-4.0848E+03	5.7547E+03	7.4049E+02
-1.6348E+02	1.2511E+03	3.0859E+00	-9.0848E+04	5.1629E+04	6.2811E+05	-4.0848E+03	5.3710E+03	1.1726E+04
-1.6348E+02	1.1943E+03	1.4421E+01	-9.0848E+04	4.5176E+04	9.3878E+05	-4.0848E+03	4.9874E+03	1.4347E+04
-1.6348E+02	1.1374E+03	2.1868E+01	-9.0848E+04	3.8722E+04	1.3539E+06	-4.0848E+03	4.6038E+03	1.2927E+04
-1.6348E+02	1.0805E+03	3.4293E+01	-9.0848E+04	3.2268E+04	1.9746E+06	-4.0848E+03	4.2201E+03	6.8577E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tobaksvejen 23 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.6348E+02	1.0237E+03	2.8508E+01	-9.0848E+04	2.5815E+04	2.2601E+06	-4.0848E+03	3.8365E+03	6.6331E+04
-1.6348E+02	9.6680E+02	2.3265E+01	-9.0848E+04	1.9361E+04	2.7998E+06	-4.0848E+03	3.4528E+03	1.2755E+05
-1.6348E+02	9.0993E+02	3.4797E+01	-9.0848E+04	1.2907E+04	2.6347E+06	-4.0848E+03	3.0692E+03	1.4883E+05
-1.6348E+02	8.5306E+02	2.1720E+01	-9.0848E+04	6.4537E+03	3.5953E+06	-4.0848E+03	2.6855E+03	1.7500E+05
-1.6348E+02	7.9619E+02	3.9512E+01	-9.0848E+04	0.0000E+00	1.0879E+07	-4.0848E+03	2.3019E+03	1.9079E+05
-1.6348E+02	7.3932E+02	5.4858E+01	-9.8091E+04	1.6780E+05	3.8687E+02	-4.0848E+03	1.9182E+03	2.2212E+05
-1.6348E+02	6.8244E+02	8.2822E+01	-9.8091E+04	1.6134E+05	5.6412E+02	-4.0848E+03	1.5346E+03	2.2196E+05
-1.6348E+02	6.2557E+02	9.9712E+01	-9.8091E+04	1.5489E+05	1.8166E+03	-4.0848E+03	1.1509E+03	2.9465E+05
-1.6348E+02	5.6870E+02	4.9399E+01	-9.8091E+04	1.4843E+05	1.2264E+03	-4.0848E+03	7.6729E+02	5.5545E+05
-1.6348E+02	5.1183E+02	9.6825E+01	-9.8091E+04	1.4198E+05	3.4085E+03	-4.0848E+03	3.8365E+02	1.2439E+06
-1.6348E+02	4.5496E+02	1.8537E+02	-9.8091E+04	1.3553E+05	3.1729E+03	-4.0848E+03	0.0000E+00	2.8414E+06
-1.6348E+02	3.9809E+02	1.8575E+02	-9.8091E+04	1.2907E+05	6.3691E+03	-4.5736E+03	1.6880E+04	5.3125E-02
-1.6348E+02	3.4122E+02	2.9244E+02	-9.8091E+04	1.2262E+05	8.9067E+03	-4.5736E+03	1.3811E+04	5.3469E-01
-1.6348E+02	2.8435E+02	3.4915E+03	-9.8091E+04	1.1617E+05	8.4283E+03	-4.5736E+03	1.3044E+04	2.5531E+00
-1.6348E+02	2.2748E+02	1.9502E+03	-9.8091E+04	1.0971E+05	2.4044E+04	-4.5736E+03	1.1893E+04	5.3125E-02
-1.6348E+02	1.7061E+02	6.9579E+03	-9.8091E+04	1.0326E+05	4.3337E+04	-4.5736E+03	1.1509E+04	6.1985E-01
-1.6348E+02	1.1374E+02	2.5227E+04	-9.8091E+04	9.6805E+04	6.0256E+04	-4.5736E+03	1.1126E+04	1.9609E+00
-1.6348E+02	5.6870E+01	3.3203E+04	-9.8091E+04	9.0352E+04	7.2929E+04	-4.5736E+03	1.0358E+04	3.6186E+00
-1.6348E+02	0.0000E+00	1.2374E+05	-9.8091E+04	8.3898E+04	1.4061E+05	-4.5736E+03	9.5912E+03	8.5409E+01
-2.3127E+02	2.3317E+03	6.2500E-01	-9.8091E+04	7.7444E+04	1.9699E+05	-4.5736E+03	8.8239E+03	3.2393E-01
-2.3127E+02	1.7061E+03	1.3359E+00	-9.8091E+04	7.0990E+04	2.7324E+05	-4.5736E+03	8.4402E+03	1.5607E+00
-2.3127E+02	1.6492E+03	1.7500E+00	-9.8091E+04	6.4537E+04	4.4020E+05	-4.5736E+03	8.0566E+03	8.0908E+01
-2.3127E+02	1.5924E+03	1.7500E+00	-9.8091E+04	5.8083E+04	7.0490E+05	-4.5736E+03	7.6729E+03	2.1668E+01
-2.3127E+02	1.5355E+03	1.3359E+00	-9.8091E+04	5.1629E+04	1.0929E+06	-4.5736E+03	7.2893E+03	3.7447E+01
-2.3127E+02	1.4786E+03	1.3359E+00	-9.8091E+04	4.5176E+04	1.5067E+06	-4.5736E+03	6.9056E+03	8.3340E+01
-2.3127E+02	1.4218E+03	4.4217E+00	-9.8091E+04	3.8722E+04	2.0801E+06	-4.5736E+03	6.5220E+03	4.0846E+01
-2.3127E+02	1.3649E+03	4.4748E+00	-9.8091E+04	3.2268E+04	2.9820E+06	-4.5736E+03	6.1383E+03	1.2111E+02
-2.3127E+02	1.3080E+03	1.5131E+01	-9.8091E+04	2.5815E+04	3.4609E+06	-4.5736E+03	5.7547E+03	1.6000E+01
-2.3127E+02	1.2511E+03	7.5075E+00	-9.8091E+04	1.9361E+04	3.5810E+06	-4.5736E+03	5.3710E+03	5.2823E+02
-2.3127E+02	1.1943E+03	1.6881E+01	-9.8091E+04	1.2907E+04	3.4772E+06	-4.5736E+03	4.9874E+03	1.2684E+03
-2.3127E+02	1.1374E+03	9.1717E+00	-9.8091E+04	6.4537E+03	3.5680E+06	-4.5736E+03	4.6038E+03	1.5195E+03
-2.3127E+02	1.0805E+03	2.1922E+01	-9.8091E+04	0.0000E+00	1.0267E+07	-4.5736E+03	4.2201E+03	1.4201E+04
-2.3127E+02	1.0237E+03	1.5959E+01	-1.0533E+05	1.8070E+05	3.3276E+02	-4.5736E+03	3.8365E+03	1.6247E+03
-2.3127E+02	9.6680E+02	2.0295E+01	-1.0533E+05	1.7425E+05	1.0510E+01	-4.5736E+03	3.4528E+03	2.4665E+04
-2.3127E+02	9.0993E+02	2.0500E+01	-1.0533E+05	1.6780E+05	1.2317E+02	-4.5736E+03	3.0692E+03	2.1075E+04
-2.3127E+02	8.5306E+02	1.6672E+01	-1.0533E+05	1.6134E+05	3.6160E+02	-4.5736E+03	2.6855E+03	4.6919E+04
-2.3127E+02	7.9619E+02	3.5518E+01	-1.0533E+05	1.5489E+05	3.9434E+02	-4.5736E+03	2.3019E+03	6.1834E+04
-2.3127E+02	7.3932E+02	1.7093E+01	-1.0533E+05	1.4843E+05	2.4337E+03	-4.5736E+03	1.9182E+03	9.0818E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.3127E+02	6.8244E+02	1.3384E+01	-1.0533E+05	1.4198E+05	1.5568E+03	-4.5736E+03	1.5346E+03	6.3974E+04
-2.3127E+02	6.2557E+02	1.7687E+01	-1.0533E+05	1.3553E+05	1.1519E+04	-4.5736E+03	1.1509E+03	1.1833E+05
-2.3127E+02	5.6870E+02	2.9843E+01	-1.0533E+05	1.2907E+05	1.0854E+04	-4.5736E+03	7.6729E+02	1.9946E+05
-2.3127E+02	5.1183E+02	2.7157E+01	-1.0533E+05	1.2262E+05	2.5647E+04	-4.5736E+03	3.8365E+02	6.7497E+05
-2.3127E+02	4.5496E+02	4.0990E+01	-1.0533E+05	1.1617E+05	2.1266E+04	-4.5736E+03	0.0000E+00	1.1992E+06
-2.3127E+02	3.9809E+02	7.8763E+01	-1.0533E+05	1.0971E+05	2.3249E+04	-5.0625E+03	1.6497E+04	6.2500E-01
-2.3127E+02	3.4122E+02	5.2681E+01	-1.0533E+05	1.0326E+05	3.5488E+04	-5.0625E+03	1.5346E+04	5.3125E-02
-2.3127E+02	2.8435E+02	9.2087E+01	-1.0533E+05	9.6805E+04	6.2335E+04	-5.0625E+03	1.4579E+04	5.3125E-02
-2.3127E+02	2.2748E+02	5.2256E+01	-1.0533E+05	9.0352E+04	1.0981E+05	-5.0625E+03	1.3811E+04	1.0625E-01
-2.3127E+02	1.7061E+02	7.6673E+01	-1.0533E+05	8.3898E+04	1.6693E+05	-5.0625E+03	1.3428E+04	5.3125E-02
-2.3127E+02	1.1374E+02	1.7562E+02	-1.0533E+05	7.7444E+04	2.5306E+05	-5.0625E+03	8.8239E+03	2.1250E-01
-2.3127E+02	5.6870E+01	7.1691E+03	-1.0533E+05	7.0990E+04	4.1132E+05	-5.0625E+03	8.0566E+03	2.5135E+00
-2.3127E+02	0.0000E+00	3.2733E+04	-1.0533E+05	6.4537E+04	5.4090E+05	-5.0625E+03	7.6729E+03	3.4280E+01
-2.9905E+02	1.4786E+03	5.3125E-02	-1.0533E+05	5.8083E+04	8.6149E+05	-5.0625E+03	7.2893E+03	1.0625E-01
-2.9905E+02	1.3649E+03	3.0859E+00	-1.0533E+05	5.1629E+04	1.3758E+06	-5.0625E+03	6.9056E+03	1.7359E+00
-2.9905E+02	1.3080E+03	1.3359E+00	-1.0533E+05	4.5176E+04	2.0524E+06	-5.0625E+03	6.5220E+03	1.0753E+01
-2.9905E+02	1.2511E+03	4.8358E+00	-1.0533E+05	3.8722E+04	2.6959E+06	-5.0625E+03	6.1383E+03	6.1256E+00
-2.9905E+02	1.1943E+03	6.5858E+00	-1.0533E+05	3.2268E+04	3.6089E+06	-5.0625E+03	5.7547E+03	4.2193E+01
-2.9905E+02	1.1374E+03	5.2500E+00	-1.0533E+05	2.5815E+04	4.2508E+06	-5.0625E+03	5.3710E+03	2.0346E+02
-2.9905E+02	1.0805E+03	5.2500E+00	-1.0533E+05	1.9361E+04	4.5401E+06	-5.0625E+03	4.9874E+03	2.7329E+01
-2.9905E+02	1.0237E+03	2.6717E+00	-1.0533E+05	1.2907E+04	4.0832E+06	-5.0625E+03	4.6038E+03	1.0309E+02
-2.9905E+02	9.0993E+02	5.3434E+00	-1.0533E+05	6.4537E+03	3.5582E+06	-5.0625E+03	4.2201E+03	1.1883E+03
-2.9905E+02	8.5306E+02	3.6063E+00	-1.0533E+05	0.0000E+00	1.1125E+07	-5.0625E+03	3.8365E+03	2.4532E+02
-2.9905E+02	7.9619E+02	9.7779E+00	-1.1258E+05	1.6780E+05	2.3283E+02	-5.0625E+03	3.4528E+03	3.8940E+03
-2.9905E+02	7.3932E+02	1.0093E+01	-1.1258E+05	1.6134E+05	6.2948E+02	-5.0625E+03	3.0692E+03	3.3768E+02
-2.9905E+02	6.8244E+02	1.2384E+01	-1.1258E+05	1.5489E+05	1.9537E+03	-5.0625E+03	2.6855E+03	3.2440E+03
-2.9905E+02	6.2557E+02	3.5000E+00	-1.1258E+05	1.4843E+05	9.2621E+02	-5.0625E+03	2.3019E+03	2.8496E+03
-2.9905E+02	5.6870E+02	3.0030E+01	-1.1258E+05	1.4198E+05	4.3179E+03	-5.0625E+03	1.9182E+03	1.7429E+04
-2.9905E+02	5.1183E+02	2.7195E+01	-1.1258E+05	1.3553E+05	1.0784E+04	-5.0625E+03	1.5346E+03	1.0632E+04
-2.9905E+02	4.5496E+02	2.6260E+01	-1.1258E+05	1.2907E+05	8.9552E+03	-5.0625E+03	1.1509E+03	5.9212E+04
-2.9905E+02	3.9809E+02	2.5937E+01	-1.1258E+05	1.2262E+05	1.5549E+04	-5.0625E+03	7.6729E+02	8.2088E+04
-2.9905E+02	3.4122E+02	3.6730E+01	-1.1258E+05	1.1617E+05	2.6543E+04	-5.0625E+03	3.8365E+02	2.1350E+05
-2.9905E+02	2.8435E+02	5.4975E+01	-1.1258E+05	1.0971E+05	2.9943E+04	-5.0625E+03	0.0000E+00	5.8321E+05
-2.9905E+02	2.2748E+02	5.9814E+01	-1.1258E+05	1.0326E+05	5.1817E+04	-5.5514E+03	1.3811E+04	2.4078E-01
-2.9905E+02	1.7061E+02	3.2839E+01	-1.1258E+05	9.6805E+04	6.3004E+04	-5.5514E+03	1.3044E+04	5.3125E-02
-2.9905E+02	1.1374E+02	1.3358E+02	-1.1258E+05	9.0352E+04	1.2115E+05	-5.5514E+03	8.8239E+03	1.8882E+00
-2.9905E+02	5.6870E+01	2.3852E+02	-1.1258E+05	8.3898E+04	1.5131E+05	-5.5514E+03	8.4402E+03	3.1250E+00
-2.9905E+02	0.0000E+00	1.3633E+04	-1.1258E+05	7.7444E+04	2.6248E+05	-5.5514E+03	8.0566E+03	7.2371E+00

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.6683E+02	1.4218E+03	1.3359E+00	-1.1258E+05	7.0990E+04	4.2929E+05	-5.5514E+03	7.6729E+03	5.5566E+01
-3.6683E+02	1.3080E+03	1.3359E+00	-1.1258E+05	6.4537E+04	6.8198E+05	-5.5514E+03	6.9056E+03	5.8896E+00
-3.6683E+02	1.2511E+03	1.3359E+00	-1.1258E+05	5.8083E+04	9.8210E+05	-5.5514E+03	6.5220E+03	2.7999E+00
-3.6683E+02	1.1943E+03	1.7500E+00	-1.1258E+05	5.1629E+04	1.5552E+06	-5.5514E+03	6.1383E+03	4.4351E+00
-3.6683E+02	1.0805E+03	1.7500E+00	-1.1258E+05	4.5176E+04	2.3252E+06	-5.5514E+03	5.7547E+03	8.4753E+00
-3.6683E+02	1.0237E+03	1.2500E+00	-1.1258E+05	3.8722E+04	3.3459E+06	-5.5514E+03	5.3710E+03	1.2404E+01
-3.6683E+02	9.6680E+02	5.3434E+00	-1.1258E+05	3.2268E+04	4.2258E+06	-5.5514E+03	4.9874E+03	4.1328E+01
-3.6683E+02	7.9619E+02	1.0687E+01	-1.1258E+05	2.5815E+04	4.7456E+06	-5.5514E+03	4.6038E+03	4.4225E+01
-3.6683E+02	7.3932E+02	9.6717E+00	-1.1258E+05	1.9361E+04	5.0915E+06	-5.5514E+03	4.2201E+03	1.4617E+01
-3.6683E+02	6.8244E+02	2.6717E+00	-1.1258E+05	1.2907E+04	4.6118E+06	-5.5514E+03	3.8365E+03	4.6429E+02
-3.6683E+02	6.2557E+02	3.5932E+01	-1.1258E+05	6.4537E+03	4.1402E+06	-5.5514E+03	3.4528E+03	2.7153E+01
-3.6683E+02	5.6870E+02	9.6717E+00	-1.1258E+05	0.0000E+00	1.2795E+07	-5.5514E+03	3.0692E+03	3.8593E+02
-3.6683E+02	5.1183E+02	9.6717E+00	-1.1982E+05	1.5489E+05	9.7417E+02	-5.5514E+03	2.6855E+03	1.3222E+03
-3.6683E+02	4.5496E+02	1.5167E+01	-1.1982E+05	1.4843E+05	1.5544E+03	-5.5514E+03	2.3019E+03	2.1552E+03
-3.6683E+02	3.9809E+02	9.6717E+00	-1.1982E+05	1.4198E+05	1.5513E+03	-5.5514E+03	1.9182E+03	1.0468E+02
-3.6683E+02	3.4122E+02	1.4187E+01	-1.1982E+05	1.3553E+05	6.0167E+03	-5.5514E+03	1.5346E+03	1.1114E+03
-3.6683E+02	2.8435E+02	1.9765E+01	-1.1982E+05	1.2907E+05	1.3922E+04	-5.5514E+03	1.1509E+03	8.8104E+03
-3.6683E+02	2.2748E+02	4.7727E+01	-1.1982E+05	1.2262E+05	1.2570E+04	-5.5514E+03	7.6729E+02	1.8346E+04
-3.6683E+02	1.7061E+02	1.3384E+01	-1.1982E+05	1.1617E+05	3.3006E+04	-5.5514E+03	3.8365E+02	5.9921E+04
-3.6683E+02	1.1374E+02	5.6140E+01	-1.1982E+05	1.0971E+05	4.9580E+04	-5.5514E+03	0.0000E+00	1.6787E+05
-3.6683E+02	5.6870E+01	1.5711E+02	-1.1982E+05	1.0326E+05	5.0440E+04	-6.0402E+03	1.4579E+04	6.2500E-01
-3.6683E+02	0.0000E+00	5.2294E+03	-1.1982E+05	9.6805E+04	8.4951E+04	-6.0402E+03	8.4402E+03	1.0625E-01
-4.3461E+02	9.6680E+02	3.5000E+00	-1.1982E+05	9.0352E+04	1.1386E+05	-6.0402E+03	8.0566E+03	3.2393E-01
-4.3461E+02	9.0993E+02	2.6717E+00	-1.1982E+05	8.3898E+04	1.7224E+05	-6.0402E+03	6.5220E+03	1.8882E+00
-4.3461E+02	8.5306E+02	1.0417E+01	-1.1982E+05	7.7444E+04	3.0217E+05	-6.0402E+03	6.1383E+03	1.1538E+01
-4.3461E+02	7.9619E+02	7.0000E+00	-1.1982E+05	7.0990E+04	4.3014E+05	-6.0402E+03	5.7547E+03	1.7732E+00
-4.3461E+02	7.3932E+02	1.0500E+01	-1.1982E+05	6.4537E+04	6.8391E+05	-6.0402E+03	5.3710E+03	1.5950E+01
-4.3461E+02	6.8244E+02	9.6717E+00	-1.1982E+05	5.8083E+04	1.0713E+06	-6.0402E+03	4.9874E+03	1.7388E+02
-4.3461E+02	6.2557E+02	6.1717E+00	-1.1982E+05	5.1629E+04	1.6611E+06	-6.0402E+03	4.6038E+03	1.9741E+02
-4.3461E+02	5.6870E+02	6.1717E+00	-1.1982E+05	4.5176E+04	2.6589E+06	-6.0402E+03	4.2201E+03	1.4743E+01
-4.3461E+02	5.1183E+02	1.1750E+01	-1.1982E+05	3.8722E+04	3.7179E+06	-6.0402E+03	3.8365E+03	5.0086E+01
-4.3461E+02	4.5496E+02	5.3434E+00	-1.1982E+05	3.2268E+04	4.5939E+06	-6.0402E+03	3.4528E+03	3.7479E+01
-4.3461E+02	3.9809E+02	2.1187E+01	-1.1982E+05	2.5815E+04	5.6601E+06	-6.0402E+03	3.0692E+03	4.4581E+00
-4.3461E+02	3.4122E+02	9.6717E+00	-1.1982E+05	1.9361E+04	5.6237E+06	-6.0402E+03	2.6855E+03	6.6670E+00
-4.3461E+02	2.8435E+02	1.4293E+01	-1.1982E+05	1.2907E+04	4.5878E+06	-6.0402E+03	2.3019E+03	5.2282E+01
-4.3461E+02	2.2748E+02	1.8621E+01	-1.1982E+05	6.4537E+03	4.0826E+06	-6.0402E+03	1.9182E+03	1.2824E+02
-4.3461E+02	1.7061E+02	2.6530E+01	-1.1982E+05	0.0000E+00	1.4122E+07	-6.0402E+03	1.5346E+03	3.6076E+01
-4.3461E+02	1.1374E+02	3.5927E+01	-1.2707E+05	1.5489E+05	5.6000E+02	-6.0402E+03	1.1509E+03	1.1171E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-4.3461E+02	5.6870E+01	9.2801E+01	-1.2707E+05	1.4198E+05	6.1585E+01	-6.0402E+03	7.6729E+02	2.0332E+03
-4.3461E+02	0.0000E+00	2.6572E+03	-1.2707E+05	1.3553E+05	2.7043E+03	-6.0402E+03	3.8365E+02	1.1966E+04
-5.0240E+02	1.4218E+03	1.2500E+00	-1.2707E+05	1.2907E+05	8.3948E+03	-6.0402E+03	0.0000E+00	7.1128E+04
-5.0240E+02	9.6680E+02	3.5000E+00	-1.2707E+05	1.2262E+05	6.0948E+03	-6.5291E+03	6.9056E+03	1.3816E+01
-5.0240E+02	9.0993E+02	3.5000E+00	-1.2707E+05	1.1617E+05	2.1694E+04	-6.5291E+03	6.1383E+03	3.7729E+00
-5.0240E+02	8.5306E+02	3.5000E+00	-1.2707E+05	1.0971E+05	4.1562E+04	-6.5291E+03	5.7547E+03	3.2393E-01
-5.0240E+02	5.6870E+02	2.6717E+00	-1.2707E+05	1.0326E+05	6.8801E+04	-6.5291E+03	5.3710E+03	3.4489E+00
-5.0240E+02	5.1183E+02	7.0000E+00	-1.2707E+05	9.6805E+04	1.0914E+05	-6.5291E+03	4.9874E+03	1.0839E+01
-5.0240E+02	4.5496E+02	4.7500E+00	-1.2707E+05	9.0352E+04	1.6617E+05	-6.5291E+03	4.6038E+03	1.0395E+01
-5.0240E+02	3.9809E+02	1.5015E+01	-1.2707E+05	8.3898E+04	2.5728E+05	-6.5291E+03	4.2201E+03	1.0625E-01
-5.0240E+02	3.4122E+02	8.8434E+00	-1.2707E+05	7.7444E+04	3.6112E+05	-6.5291E+03	3.8365E+03	2.8136E+00
-5.0240E+02	2.8435E+02	7.4217E+00	-1.2707E+05	7.0990E+04	5.8182E+05	-6.5291E+03	3.4528E+03	2.4868E+00
-5.0240E+02	2.2748E+02	2.7058E+01	-1.2707E+05	6.4537E+04	9.8583E+05	-6.5291E+03	3.0692E+03	7.5411E-01
-5.0240E+02	1.7061E+02	1.1515E+01	-1.2707E+05	5.8083E+04	1.2696E+06	-6.5291E+03	2.6855E+03	3.4842E+01
-5.0240E+02	1.1374E+02	4.6060E+01	-1.2707E+05	5.1629E+04	2.1503E+06	-6.5291E+03	2.3019E+03	3.1093E+01
-5.0240E+02	5.6870E+01	7.0291E+01	-1.2707E+05	4.5176E+04	3.1537E+06	-6.5291E+03	1.9182E+03	3.3629E+01
-5.0240E+02	0.0000E+00	1.0221E+02	-1.2707E+05	3.8722E+04	4.4310E+06	-6.5291E+03	1.5346E+03	1.5688E+00
-5.7018E+02	4.5496E+02	1.0625E-01	-1.2707E+05	3.2268E+04	5.9422E+06	-6.5291E+03	1.1509E+03	7.0151E+01
-5.7018E+02	3.9809E+02	3.5000E+00	-1.2707E+05	2.5815E+04	6.4692E+06	-6.5291E+03	7.6729E+02	4.3468E+01
-5.7018E+02	3.4122E+02	2.6717E+00	-1.2707E+05	1.9361E+04	6.2889E+06	-6.5291E+03	3.8365E+02	2.3252E+03
-5.7018E+02	2.8435E+02	8.0151E+00	-1.2707E+05	1.2907E+04	5.6514E+06	-6.5291E+03	0.0000E+00	3.4732E+03
-5.7018E+02	2.2748E+02	8.8434E+00	-1.2707E+05	6.4537E+03	5.1774E+06	-7.0180E+03	8.0566E+03	3.6186E+00
-5.7018E+02	1.7061E+02	8.0151E+00	-1.2707E+05	0.0000E+00	1.6116E+07	-7.0180E+03	7.2893E+03	1.2368E+00
-5.7018E+02	1.1374E+02	2.8414E+01	-1.3431E+05	1.4198E+05	1.7124E+02	-7.0180E+03	6.1383E+03	3.2393E-01
-5.7018E+02	5.6870E+01	5.2003E+01	-1.3431E+05	1.3553E+05	9.0249E+02	-7.0180E+03	5.7547E+03	4.3289E+00
-5.7018E+02	0.0000E+00	5.7777E+01	-1.3431E+05	1.2907E+05	2.6320E+03	-7.0180E+03	5.3710E+03	1.2500E+00
-6.3796E+02	5.6870E+02	2.6717E+00	-1.3431E+05	1.2262E+05	4.3041E+03	-7.0180E+03	4.9874E+03	1.0625E-01
-6.3796E+02	5.1183E+02	2.6717E+00	-1.3431E+05	1.1617E+05	1.1859E+04	-7.0180E+03	4.2201E+03	1.8882E+00
-6.3796E+02	3.9809E+02	2.6717E+00	-1.3431E+05	1.0971E+05	8.9717E+03	-7.0180E+03	3.8365E+03	1.1538E+01
-6.3796E+02	3.4122E+02	2.6717E+00	-1.3431E+05	1.0326E+05	2.2705E+04	-7.0180E+03	3.4528E+03	8.8764E+00
-6.3796E+02	2.8435E+02	8.1214E+00	-1.3431E+05	9.6805E+04	5.6966E+04	-7.0180E+03	3.0692E+03	8.5830E+00
-6.3796E+02	2.2748E+02	8.0151E+00	-1.3431E+05	9.0352E+04	9.5653E+04	-7.0180E+03	2.6855E+03	1.8343E+02
-6.3796E+02	1.7061E+02	1.5015E+01	-1.3431E+05	8.3898E+04	1.5736E+05	-7.0180E+03	2.3019E+03	3.2766E+01
-6.3796E+02	1.1374E+02	8.0151E+00	-1.3431E+05	7.7444E+04	2.7385E+05	-7.0180E+03	1.9182E+03	3.8142E+01
-6.3796E+02	5.6870E+01	3.9960E+01	-1.3431E+05	7.0990E+04	5.2286E+05	-7.0180E+03	1.5346E+03	3.6648E+01
-6.3796E+02	0.0000E+00	3.7030E+01	-1.3431E+05	6.4537E+04	9.1413E+05	-7.0180E+03	1.1509E+03	3.7095E+01
-7.0575E+02	5.1183E+02	2.6717E+00	-1.3431E+05	5.8083E+04	1.4756E+06	-7.0180E+03	7.6729E+02	3.6639E+02
-7.0575E+02	3.9809E+02	2.6717E+00	-1.3431E+05	5.1629E+04	2.2452E+06	-7.0180E+03	3.8365E+02	2.8050E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-7.0575E+02	2.8435E+02	2.6717E+00	-1.3431E+05	4.5176E+04	3.3191E+06	-7.0180E+03	0.0000E+00	1.0586E+04
-7.0575E+02	2.2748E+02	2.6717E+00	-1.3431E+05	3.8722E+04	4.8221E+06	-7.5068E+03	7.2893E+03	1.6667E+02
-7.0575E+02	1.7061E+02	1.0625E-01	-1.3431E+05	3.2268E+04	6.2292E+06	-7.5068E+03	6.1383E+03	2.0423E+00
-7.0575E+02	1.1374E+02	6.1717E+00	-1.3431E+05	2.5815E+04	7.1337E+06	-7.5068E+03	5.7547E+03	1.0625E-01
-7.0575E+02	5.6870E+01	8.0151E+00	-1.3431E+05	1.9361E+04	7.5736E+06	-7.5068E+03	5.3710E+03	7.2094E+00
-7.0575E+02	0.0000E+00	2.5515E+01	-1.3431E+05	1.2907E+04	6.3406E+06	-7.5068E+03	4.6038E+03	2.6717E+00
-7.7353E+02	3.9809E+02	2.6717E+00	-1.3431E+05	6.4537E+03	5.6351E+06	-7.5068E+03	4.2201E+03	5.0000E+00
-7.7353E+02	3.4122E+02	2.6717E+00	-1.3431E+05	0.0000E+00	1.6091E+07	-7.5068E+03	3.0692E+03	1.2368E+00
-7.7353E+02	1.7061E+02	6.1717E+00	-1.4155E+05	1.4843E+05	1.7124E+02	-7.5068E+03	2.6855E+03	1.8882E+00
-7.7353E+02	1.1374E+02	2.7780E+00	-1.4155E+05	1.3553E+05	1.7124E+02	-7.5068E+03	1.9182E+03	1.2500E+00
-7.7353E+02	5.6870E+01	3.9217E+00	-1.4155E+05	1.2907E+05	1.7124E+02	-7.5068E+03	1.5346E+03	1.2368E+00
-7.7353E+02	0.0000E+00	1.5015E+01	-1.4155E+05	1.2262E+05	2.1328E+03	-7.5068E+03	1.1509E+03	3.4698E+01
-8.4131E+02	1.1374E+02	1.0625E-01	-1.4155E+05	1.1617E+05	2.1163E+03	-7.5068E+03	7.6729E+02	2.3755E+02
-8.4131E+02	5.6870E+01	1.0625E-01	-1.4155E+05	1.0971E+05	8.2494E+03	-7.5068E+03	3.8365E+02	3.8363E+01
-8.4131E+02	0.0000E+00	8.0151E+00	-1.4155E+05	1.0326E+05	3.0666E+03	-7.5068E+03	0.0000E+00	5.4545E+02
-9.0909E+02	1.7061E+02	2.6717E+00	-1.4155E+05	9.6805E+04	2.1771E+04	-7.9957E+03	3.0692E+03	2.2121E+00
-9.0909E+02	1.1374E+02	2.6717E+00	-1.4155E+05	9.0352E+04	2.9696E+04	-7.9957E+03	2.6855E+03	1.8882E+00
-9.0909E+02	5.6870E+01	8.9496E+00	-1.4155E+05	8.3898E+04	4.4090E+04	-7.9957E+03	2.3019E+03	7.2094E+00
-9.0909E+02	0.0000E+00	2.6717E+00	-1.4155E+05	7.7444E+04	7.9285E+04	-7.9957E+03	1.9182E+03	1.8882E+00
-9.7688E+02	5.6870E+01	5.3434E+00	-1.4155E+05	7.0990E+04	1.7270E+05	-7.9957E+03	1.5346E+03	4.5414E+00
			-1.4155E+05	6.4537E+04	3.4739E+05	-7.9957E+03	1.1509E+03	1.9945E+00
			-1.4155E+05	5.8083E+04	6.2063E+05	-7.9957E+03	7.6729E+02	2.6696E+01
			-1.4155E+05	5.1629E+04	1.0916E+06	-7.9957E+03	3.8365E+02	1.6599E+01
			-1.4155E+05	4.5176E+04	1.8025E+06	-7.9957E+03	0.0000E+00	2.6085E+02
			-1.4155E+05	3.8722E+04	2.6251E+06	-8.4846E+03	4.9874E+03	1.0625E-01
			-1.4155E+05	3.2268E+04	3.8329E+06	-8.4846E+03	4.2201E+03	2.5361E+00
			-1.4155E+05	2.5815E+04	4.4463E+06	-8.4846E+03	3.4528E+03	3.2393E-01
			-1.4155E+05	1.9361E+04	4.6964E+06	-8.4846E+03	1.5346E+03	1.2368E+00
			-1.4155E+05	1.2907E+04	4.1583E+06	-8.4846E+03	1.1509E+03	4.4351E+00
			-1.4155E+05	6.4537E+03	4.2812E+06	-8.4846E+03	7.6729E+02	8.4462E+00
			-1.4155E+05	0.0000E+00	1.2647E+07	-8.4846E+03	3.8365E+02	1.0069E+01
			-1.4880E+05	1.1617E+05	6.8498E+02	-8.4846E+03	0.0000E+00	2.0575E+02
			-1.4880E+05	1.0971E+05	1.7124E+02	-8.9734E+03	4.6038E+03	1.2500E+00
			-1.4880E+05	1.0326E+05	2.3040E+03	-8.9734E+03	2.6855E+03	1.0625E-01
			-1.4880E+05	9.6805E+04	3.3173E+03	-8.9734E+03	1.9182E+03	1.3460E+00
			-1.4880E+05	9.0352E+04	4.1370E+03	-8.9734E+03	1.1509E+03	3.7764E+00
			-1.4880E+05	8.3898E+04	9.5838E+03	-8.9734E+03	7.6729E+02	1.0625E-01
			-1.4880E+05	7.7444E+04	9.9829E+03	-8.9734E+03	3.8365E+02	7.4568E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
			-1.4880E+05	7.0990E+04	2.9680E+04	-8.9734E+03	0.0000E+00	2.3992E+01
			-1.4880E+05	6.4537E+04	5.4098E+04	-9.4623E+03	1.9182E+03	1.8882E+00
			-1.4880E+05	5.8083E+04	1.1619E+05	-9.4623E+03	1.5346E+03	3.2393E-01
			-1.4880E+05	5.1629E+04	3.5326E+05	-9.4623E+03	1.1509E+03	1.8882E+00
			-1.4880E+05	4.5176E+04	6.0329E+05	-9.4623E+03	3.8365E+02	1.2368E+00
			-1.4880E+05	3.8722E+04	8.8647E+05	-9.4623E+03	0.0000E+00	3.6755E+01
			-1.4880E+05	3.2268E+04	1.2822E+06	-9.9512E+03	4.6038E+03	1.0625E-01
			-1.4880E+05	2.5815E+04	1.7274E+06	-9.9512E+03	3.8365E+02	1.4419E+01
			-1.4880E+05	1.9361E+04	1.8311E+06	-9.9512E+03	0.0000E+00	1.0604E+01
			-1.4880E+05	1.2907E+04	1.7634E+06	-1.0440E+04	0.0000E+00	2.7975E+00
			-1.4880E+05	6.4537E+03	1.8388E+06	-1.1418E+04	7.6729E+02	1.0625E-01
			-1.4880E+05	0.0000E+00	6.5359E+06			
			-1.5604E+05	8.3898E+04	1.2432E+03			
			-1.5604E+05	7.7444E+04	2.4707E+02			
			-1.5604E+05	7.0990E+04	6.5974E+03			
			-1.5604E+05	6.4537E+04	8.5842E+03			
			-1.5604E+05	5.8083E+04	6.8167E+03			
			-1.5604E+05	5.1629E+04	2.0619E+04			
			-1.5604E+05	4.5176E+04	8.4437E+04			
			-1.5604E+05	3.8722E+04	9.4415E+04			
			-1.5604E+05	3.2268E+04	1.9465E+05			
			-1.5604E+05	2.5815E+04	3.7934E+05			
			-1.5604E+05	1.9361E+04	3.5552E+05			
			-1.5604E+05	1.2907E+04	3.4712E+05			
			-1.5604E+05	6.4537E+03	4.4901E+05			
			-1.5604E+05	0.0000E+00	2.2832E+06			
			-1.6328E+05	5.8083E+04	3.3017E+03			
			-1.6328E+05	5.1629E+04	4.5797E+03			
			-1.6328E+05	4.5176E+04	3.6455E+03			
			-1.6328E+05	3.8722E+04	9.1917E+03			
			-1.6328E+05	2.5815E+04	1.0394E+04			
			-1.6328E+05	1.9361E+04	3.4342E+04			
			-1.6328E+05	1.2907E+04	2.7423E+04			
			-1.6328E+05	6.4537E+03	4.8901E+04			
			-1.6328E+05	0.0000E+00	4.7411E+05			
			-1.7053E+05	2.5815E+04	5.3434E+00			
			-1.7053E+05	1.9361E+04	4.7167E+02			
			-1.7053E+05	1.2907E+04	4.0076E+00			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices								
Tower shear, bottom F_y [kN]			**Tower bending, bottom M_x [kNm]**			**Tower torsion, bottom M_z [kNm]**		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
			-1.7053E+05	6.4537E+03	5.3434E+00			
			-1.7053E+05	0.0000E+00	7.3888E+04			
			-1.7777E+05	1.9361E+04	2.6717E+00			
			-1.7777E+05	0.0000E+00	3.4516E+02			
			-1.8501E+05	0.0000E+00	2.6717E+00			

Table 5-16 [6] Markov Matrix

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Appendix I. Markov matrices – issued from [7]

This appendix contains the Markov Matrices for the shear force, the bending moment and the torsional moment in the bottom of the tower, from ref. [7]. Foundation design must be verified for the most critical Markov matrices.

Markov Matrices								
Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.5296E+03	0.0000E+00	1.1018E+03	1.4000E+05	0.0000E+00	6.6784E+00	7.5332E+03	3.6717E+02	6.6784E+00
1.4098E+03	4.8749E+01	1.4016E+01	1.3310E+05	6.2436E+03	3.3392E+00	7.0731E+03	7.3433E+02	1.3393E+01
1.3499E+03	0.0000E+00	9.7302E+02	1.2620E+05	0.0000E+00	1.0018E+01	7.0731E+03	0.0000E+00	3.3392E+00
1.2900E+03	9.7497E+01	1.3393E+01	1.1930E+05	1.2487E+04	6.6784E+00	6.6131E+03	3.6717E+03	3.3392E+00
1.2900E+03	4.8749E+01	3.4299E+02	1.1930E+05	6.2436E+03	3.3392E+00	6.6131E+03	7.3433E+02	5.7815E+01
1.2900E+03	0.0000E+00	4.7977E+02	1.1930E+05	0.0000E+00	1.0018E+01	6.6131E+03	0.0000E+00	6.8392E+00
1.2301E+03	9.7497E+01	2.4128E+02	1.1240E+05	1.2487E+04	3.3392E+00	6.1530E+03	5.5075E+03	3.3392E+00
1.2301E+03	4.8749E+01	4.1770E+03	1.1240E+05	6.2436E+03	1.3292E-01	6.1530E+03	4.4060E+03	3.3392E+00
1.2301E+03	0.0000E+00	1.0925E+04	1.1240E+05	0.0000E+00	1.6696E+01	6.1530E+03	1.8358E+03	3.5000E+00
1.1702E+03	1.9499E+02	3.6645E+02	1.0550E+05	6.2436E+03	3.6050E+00	6.1530E+03	7.3433E+02	3.5000E+00
1.1702E+03	1.4625E+02	3.4633E+02	1.0550E+05	0.0000E+00	3.0829E+01	6.1530E+03	3.6717E+02	7.8174E+02
1.1702E+03	9.7497E+01	1.1630E+04	9.8597E+04	1.2487E+04	6.6784E+00	6.1530E+03	0.0000E+00	1.7219E+03
1.1702E+03	4.8749E+01	3.7753E+04	9.8597E+04	6.2436E+03	2.3374E+01	5.6930E+03	3.6717E+03	3.3392E+00
1.1702E+03	0.0000E+00	1.0807E+05	9.8597E+04	0.0000E+00	4.4696E+01	5.6930E+03	2.2030E+03	3.3392E+00
1.1103E+03	3.4124E+02	3.3392E+00	9.1697E+04	1.2487E+04	6.8392E+00	5.6930E+03	7.3433E+02	1.0505E+02
1.1103E+03	2.9249E+02	4.8542E+02	9.1697E+04	6.2436E+03	2.4018E+01	5.6930E+03	3.6717E+02	5.8023E+03
1.1103E+03	2.4374E+02	5.0892E+00	9.1697E+04	0.0000E+00	7.9967E+01	5.6930E+03	0.0000E+00	6.2143E+03
1.1103E+03	1.9499E+02	2.0111E+03	8.4797E+04	1.8731E+04	7.0000E+00	5.2330E+03	5.1403E+03	3.3392E+00
1.1103E+03	1.4625E+02	9.1563E+03	8.4797E+04	1.2487E+04	1.3839E+01	5.2330E+03	1.8358E+03	2.9721E+03
1.1103E+03	9.7497E+01	5.6119E+04	8.4797E+04	6.2436E+03	4.4857E+01	5.2330E+03	1.4687E+03	1.0417E+02
1.1103E+03	4.8749E+01	2.3420E+05	8.4797E+04	0.0000E+00	6.0268E+01	5.2330E+03	1.1015E+03	1.4154E+01
1.1103E+03	0.0000E+00	4.1655E+05	7.7897E+04	2.4974E+04	7.0000E+00	5.2330E+03	7.3433E+02	1.4036E+03
1.0505E+03	3.8999E+02	6.9960E+02	7.7897E+04	1.8731E+04	1.2500E+00	5.2330E+03	3.6717E+02	4.0273E+03
1.0505E+03	3.4124E+02	9.0849E+02	7.7897E+04	1.2487E+04	7.0000E+00	5.2330E+03	0.0000E+00	1.6810E+04
1.0505E+03	2.9249E+02	2.7992E+03	7.7897E+04	6.2436E+03	3.3392E+00	4.7729E+03	2.2030E+03	4.7500E+00
1.0505E+03	2.4374E+02	9.2361E+03	7.7897E+04	0.0000E+00	6.1686E+01	4.7729E+03	1.8358E+03	5.4637E+01
1.0505E+03	1.9499E+02	2.5605E+04	7.0998E+04	1.8731E+04	3.3392E+00	4.7729E+03	1.4687E+03	3.8894E+00
1.0505E+03	1.4625E+02	9.0856E+04	7.0998E+04	6.2436E+03	4.1628E+01	4.7729E+03	1.1015E+03	4.2848E+03
1.0505E+03	9.7497E+01	3.8254E+05	7.0998E+04	0.0000E+00	5.0011E+01	4.7729E+03	7.3433E+02	1.5103E+04
1.0505E+03	4.8749E+01	1.0135E+06	6.4098E+04	1.8106E+05	1.6696E+00	4.7729E+03	3.6717E+02	3.8204E+04
1.0505E+03	0.0000E+00	1.7771E+06	6.4098E+04	1.6233E+05	3.3392E+00	4.7729E+03	0.0000E+00	1.8799E+05
9.9056E+02	7.7998E+02	9.0849E+02	6.4098E+04	1.5609E+05	1.6696E+00	4.3129E+03	5.5075E+03	4.1946E+00
9.9056E+02	7.3123E+02	1.8323E+02	6.4098E+04	1.4985E+05	1.6696E+00	4.3129E+03	5.1403E+03	3.3392E+00
9.9056E+02	6.3373E+02	3.4299E+02	6.4098E+04	4.9949E+04	3.3392E+00	4.3129E+03	3.6717E+03	4.6885E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Energy Systems Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
9.9056E+02	5.8498E+02	3.6663E+03	6.4098E+04	3.7461E+04	1.2500E+00	4.3129E+03	2.9373E+03	1.8909E+03
9.9056E+02	5.3623E+02	1.0577E+04	6.4098E+04	2.4974E+04	3.3392E+00	4.3129E+03	2.5702E+03	4.2279E+03
9.9056E+02	4.8749E+02	6.9554E+03	6.4098E+04	1.8731E+04	7.0000E+00	4.3129E+03	2.2030E+03	1.9383E+03
9.9056E+02	4.3874E+02	4.3616E+04	6.4098E+04	1.2487E+04	4.7221E+00	4.3129E+03	1.8358E+03	4.1647E+04
9.9056E+02	3.8999E+02	2.8104E+04	6.4098E+04	6.2436E+03	4.0035E+01	4.3129E+03	1.4687E+03	1.1189E+04
9.9056E+02	3.4124E+02	5.0771E+04	6.4098E+04	0.0000E+00	1.0431E+02	4.3129E+03	1.1015E+03	3.8697E+04
9.9056E+02	2.9249E+02	4.2250E+04	5.7198E+04	1.6858E+05	1.6696E+00	4.3129E+03	7.3433E+02	1.0122E+05
9.9056E+02	2.4374E+02	1.1618E+05	5.7198E+04	1.5609E+05	1.6696E+00	4.3129E+03	3.6717E+02	2.0884E+05
9.9056E+02	1.9499E+02	2.0882E+05	5.7198E+04	1.4360E+05	3.3392E+00	4.3129E+03	0.0000E+00	5.3790E+05
9.9056E+02	1.4625E+02	7.0955E+05	5.7198E+04	1.3736E+05	1.6696E+00	3.8528E+03	5.5075E+03	4.0215E+01
9.9056E+02	9.7497E+01	1.6755E+06	5.7198E+04	5.6192E+04	3.5000E+00	3.8528E+03	4.7732E+03	3.3392E+00
9.9056E+02	4.8749E+01	4.1470E+06	5.7198E+04	2.4974E+04	6.8392E+00	3.8528E+03	4.4060E+03	4.3460E+01
9.9056E+02	0.0000E+00	5.6631E+06	5.7198E+04	1.8731E+04	1.0178E+01	3.8528E+03	4.0388E+03	2.9368E+03
9.3066E+02	9.7497E+02	1.5100E+03	5.7198E+04	1.2487E+04	1.8561E+01	3.8528E+03	3.6717E+03	1.2295E+04
9.3066E+02	9.2622E+02	7.1716E+02	5.7198E+04	6.2436E+03	2.7196E+01	3.8528E+03	3.3045E+03	2.6472E+04
9.3066E+02	8.7747E+02	9.3754E+02	5.7198E+04	0.0000E+00	1.0440E+02	3.8528E+03	2.9373E+03	1.3850E+04
9.3066E+02	8.2873E+02	4.4373E+03	5.0298E+04	1.5609E+05	1.6696E+00	3.8528E+03	2.5702E+03	6.8468E+04
9.3066E+02	7.7998E+02	2.0692E+03	5.0298E+04	1.4985E+05	5.0088E+00	3.8528E+03	2.2030E+03	8.5088E+04
9.3066E+02	7.3123E+02	1.7551E+04	5.0298E+04	1.4360E+05	1.6696E+00	3.8528E+03	1.8358E+03	1.0045E+05
9.3066E+02	6.8248E+02	1.7240E+04	5.0298E+04	1.1863E+05	1.6696E+00	3.8528E+03	1.4687E+03	6.7022E+04
9.3066E+02	6.3373E+02	5.8765E+04	5.0298E+04	7.4923E+04	6.6784E+00	3.8528E+03	1.1015E+03	1.0577E+05
9.3066E+02	5.8498E+02	9.6277E+04	5.0298E+04	6.8679E+04	3.3392E+00	3.8528E+03	7.3433E+02	2.2755E+05
9.3066E+02	5.3623E+02	1.8490E+05	5.0298E+04	5.6192E+04	4.5892E+00	3.8528E+03	3.6717E+02	5.4532E+05
9.3066E+02	4.8749E+02	3.2114E+05	5.0298E+04	4.9949E+04	3.3392E+00	3.8528E+03	0.0000E+00	1.1550E+06
9.3066E+02	4.3874E+02	5.2328E+05	5.0298E+04	3.7461E+04	3.5000E+00	3.3928E+03	1.1749E+04	1.6696E+00
9.3066E+02	3.8999E+02	6.2517E+05	5.0298E+04	3.1218E+04	6.8392E+00	3.3928E+03	6.9762E+03	1.9447E+00
9.3066E+02	3.4124E+02	7.0375E+05	5.0298E+04	2.4974E+04	3.3392E+00	3.3928E+03	6.6090E+03	1.3292E-01
9.3066E+02	2.9249E+02	9.8551E+05	5.0298E+04	1.8731E+04	1.0500E+01	3.3928E+03	5.8747E+03	1.1432E+01
9.3066E+02	2.4374E+02	1.3367E+06	5.0298E+04	1.2487E+04	2.6490E+01	3.3928E+03	5.5075E+03	9.0849E+02
9.3066E+02	1.9499E+02	1.9129E+06	5.0298E+04	6.2436E+03	5.6710E+01	3.3928E+03	5.1403E+03	1.1529E+03
9.3066E+02	1.4625E+02	3.0774E+06	5.0298E+04	0.0000E+00	5.9674E+01	3.3928E+03	4.7732E+03	3.5368E+03
9.3066E+02	9.7497E+01	6.4922E+06	4.3398E+04	1.8106E+05	1.6696E+00	3.3928E+03	4.4060E+03	3.8278E+04
9.3066E+02	4.8749E+01	1.2092E+07	4.3398E+04	1.5609E+05	3.3392E+00	3.3928E+03	4.0388E+03	2.5634E+04
9.3066E+02	0.0000E+00	1.3576E+07	4.3398E+04	1.3736E+05	1.7500E+00	3.3928E+03	3.6717E+03	3.0308E+04
8.7076E+02	1.2675E+03	1.8323E+02	4.3398E+04	1.3112E+05	8.5088E+00	3.3928E+03	3.3045E+03	8.8768E+04
8.7076E+02	1.2187E+03	4.2117E+02	4.3398E+04	1.2487E+05	5.1696E+00	3.3928E+03	2.9373E+03	1.2803E+05
8.7076E+02	1.1700E+03	5.2525E+01	4.3398E+04	1.1863E+05	1.7500E+00	3.3928E+03	2.5702E+03	2.3091E+05
8.7076E+02	1.1212E+03	9.3967E+02	4.3398E+04	1.1238E+05	8.6696E+00	3.3928E+03	2.2030E+03	2.2642E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Denmark A/S Tåsingeparkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.7076E+02	1.0725E+03	1.8323E+02	4.3398E+04	9.9897E+04	1.7500E+00	3.3928E+03	1.8358E+03	2.5854E+05
8.7076E+02	1.0237E+03	1.3682E+03	4.3398E+04	8.1166E+04	3.3392E+00	3.3928E+03	1.4687E+03	1.6193E+05
8.7076E+02	9.7497E+02	3.9089E+03	4.3398E+04	6.8679E+04	6.6784E+00	3.3928E+03	1.1015E+03	2.4952E+05
8.7076E+02	9.2622E+02	1.1625E+04	4.3398E+04	6.2436E+04	3.3392E+00	3.3928E+03	7.3433E+02	3.6184E+05
8.7076E+02	8.7747E+02	1.8294E+04	4.3398E+04	4.9949E+04	3.5000E+00	3.3928E+03	3.6717E+02	1.2112E+06
8.7076E+02	8.2873E+02	3.7129E+04	4.3398E+04	4.3705E+04	6.8392E+00	3.3928E+03	0.0000E+00	2.3368E+06
8.7076E+02	7.7998E+02	6.4498E+04	4.3398E+04	3.7461E+04	3.3392E+00	2.9328E+03	1.4320E+04	1.6696E+00
8.7076E+02	7.3123E+02	1.2659E+05	4.3398E+04	3.1218E+04	1.0339E+01	2.9328E+03	9.9135E+03	1.6696E+00
8.7076E+02	6.8248E+02	2.2735E+05	4.3398E+04	2.4974E+04	7.2658E+00	2.9328E+03	8.4449E+03	1.6696E+00
8.7076E+02	6.3373E+02	3.9846E+05	4.3398E+04	1.8731E+04	3.0857E+01	2.9328E+03	7.3433E+03	7.4255E+00
8.7076E+02	5.8498E+02	6.5923E+05	4.3398E+04	1.2487E+04	4.5919E+01	2.9328E+03	6.9762E+03	1.3992E+03
8.7076E+02	5.3623E+02	1.0080E+06	4.3398E+04	6.2436E+03	5.7773E+01	2.9328E+03	6.6090E+03	7.7840E+02
8.7076E+02	4.8749E+02	1.7128E+06	4.3398E+04	0.0000E+00	4.6640E+03	2.9328E+03	6.2418E+03	2.4644E+03
8.7076E+02	4.3874E+02	2.2601E+06	3.6498E+04	1.8731E+05	6.6460E-02	2.9328E+03	5.8747E+03	1.0216E+04
8.7076E+02	3.8999E+02	3.3257E+06	3.6498E+04	1.5609E+05	3.3392E+00	2.9328E+03	5.5075E+03	3.3335E+03
8.7076E+02	3.4124E+02	3.7299E+06	3.6498E+04	1.4360E+05	3.5000E+00	2.9328E+03	5.1403E+03	3.0765E+04
8.7076E+02	2.9249E+02	4.3055E+06	3.6498E+04	1.3736E+05	7.0000E+00	2.9328E+03	4.7732E+03	7.7569E+04
8.7076E+02	2.4374E+02	4.6321E+06	3.6498E+04	1.3112E+05	1.2250E+01	2.9328E+03	4.4060E+03	9.5419E+04
8.7076E+02	1.9499E+02	5.9634E+06	3.6498E+04	1.2487E+05	6.9196E+00	2.9328E+03	4.0388E+03	1.8939E+05
8.7076E+02	1.4625E+02	8.3208E+06	3.6498E+04	1.1863E+05	7.0000E+00	2.9328E+03	3.6717E+03	2.0822E+05
8.7076E+02	9.7497E+01	1.4109E+07	3.6498E+04	1.1238E+05	1.2089E+01	2.9328E+03	3.3045E+03	2.6315E+05
8.7076E+02	4.8749E+01	2.3971E+07	3.6498E+04	1.0614E+05	1.6696E+00	2.9328E+03	2.9373E+03	3.8247E+05
8.7076E+02	0.0000E+00	2.5349E+07	3.6498E+04	9.9897E+04	1.7500E+00	2.9328E+03	2.5702E+03	4.0053E+05
8.1087E+02	2.0962E+03	2.5569E+01	3.6498E+04	7.4923E+04	6.8392E+00	2.9328E+03	2.2030E+03	4.5577E+05
8.1087E+02	1.4137E+03	2.3794E+02	3.6498E+04	6.8679E+04	3.5000E+00	2.9328E+03	1.8358E+03	4.2600E+05
8.1087E+02	1.3650E+03	2.3794E+02	3.6498E+04	6.2436E+04	1.0339E+01	2.9328E+03	1.4687E+03	3.3944E+05
8.1087E+02	1.3162E+03	3.5691E+02	3.6498E+04	5.6192E+04	1.0500E+01	2.9328E+03	1.1015E+03	4.0622E+05
8.1087E+02	1.2675E+03	2.0593E+03	3.6498E+04	4.9949E+04	1.0500E+01	2.9328E+03	7.3433E+02	8.6983E+05
8.1087E+02	1.2187E+03	9.3967E+02	3.6498E+04	4.3705E+04	3.5000E+00	2.9328E+03	3.6717E+02	1.9928E+06
8.1087E+02	1.1700E+03	2.3319E+03	3.6498E+04	3.7461E+04	1.0500E+01	2.9328E+03	0.0000E+00	3.7390E+06
8.1087E+02	1.1212E+03	2.3437E+03	3.6498E+04	3.1218E+04	6.4073E+01	2.4727E+03	1.3218E+04	1.6696E+00
8.1087E+02	1.0725E+03	8.2569E+03	3.6498E+04	2.4974E+04	3.1832E+01	2.4727E+03	1.1382E+04	4.6064E-01
8.1087E+02	1.0237E+03	1.3115E+04	3.6498E+04	1.8731E+04	5.3367E+01	2.4727E+03	1.1015E+04	1.6696E+00
8.1087E+02	9.7497E+02	3.6045E+04	3.6498E+04	1.2487E+04	3.6795E+02	2.4727E+03	1.0648E+04	1.6696E+00
8.1087E+02	9.2622E+02	4.5218E+04	3.6498E+04	6.2436E+03	4.3820E+03	2.4727E+03	9.9135E+03	1.7500E+00
8.1087E+02	8.7747E+02	1.2992E+05	3.6498E+04	0.0000E+00	4.7256E+03	2.4727E+03	8.0777E+03	1.1018E+03
8.1087E+02	8.2873E+02	1.7013E+05	2.9598E+04	1.6858E+05	6.9146E-01	2.4727E+03	7.7105E+03	5.3126E+03
8.1087E+02	7.7998E+02	2.7450E+05	2.9598E+04	1.4985E+05	6.2500E-01	2.4727E+03	7.3433E+03	1.1926E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.1087E+02	7.3123E+02	4.4526E+05	2.9598E+04	1.3112E+05	3.5000E+00	2.4727E+03	6.9762E+03	8.3874E+03
8.1087E+02	6.8248E+02	7.2714E+05	2.9598E+04	1.2487E+05	3.5000E+00	2.4727E+03	6.6090E+03	1.2325E+04
8.1087E+02	6.3373E+02	1.0988E+06	2.9598E+04	1.1863E+05	1.7500E+00	2.4727E+03	6.2418E+03	1.3985E+04
8.1087E+02	5.8498E+02	1.7452E+06	2.9598E+04	1.1238E+05	1.7500E+00	2.4727E+03	5.8747E+03	3.3743E+04
8.1087E+02	5.3623E+02	2.5092E+06	2.9598E+04	1.0614E+05	8.6696E+00	2.4727E+03	5.5075E+03	6.8072E+04
8.1087E+02	4.8749E+02	3.4050E+06	2.9598E+04	9.9897E+04	1.7500E+00	2.4727E+03	5.1403E+03	1.4645E+05
8.1087E+02	4.3874E+02	4.8501E+06	2.9598E+04	9.3654E+04	3.4196E+00	2.4727E+03	4.7732E+03	1.7162E+05
8.1087E+02	3.8999E+02	6.4371E+06	2.9598E+04	8.7410E+04	5.1696E+00	2.4727E+03	4.4060E+03	1.8731E+05
8.1087E+02	3.4124E+02	7.7654E+06	2.9598E+04	8.1166E+04	3.0799E+01	2.4727E+03	4.0388E+03	3.5781E+05
8.1087E+02	2.9249E+02	8.1241E+06	2.9598E+04	7.4923E+04	6.6784E+00	2.4727E+03	3.6717E+03	4.7728E+05
8.1087E+02	2.4374E+02	8.6577E+06	2.9598E+04	6.8679E+04	6.8392E+00	2.4727E+03	3.3045E+03	4.4146E+05
8.1087E+02	1.9499E+02	9.5603E+06	2.9598E+04	6.2436E+04	1.0339E+01	2.4727E+03	2.9373E+03	5.9620E+05
8.1087E+02	1.4625E+02	1.3056E+07	2.9598E+04	5.6192E+04	1.7339E+01	2.4727E+03	2.5702E+03	6.1589E+05
8.1087E+02	9.7497E+01	2.0239E+07	2.9598E+04	4.9949E+04	2.0678E+01	2.4727E+03	2.2030E+03	5.8465E+05
8.1087E+02	4.8749E+01	3.3823E+07	2.9598E+04	4.3705E+04	2.8304E+01	2.4727E+03	1.8358E+03	6.7213E+05
8.1087E+02	0.0000E+00	3.4124E+07	2.9598E+04	3.7461E+04	7.9012E+01	2.4727E+03	1.4687E+03	7.1870E+05
7.5097E+02	2.2424E+03	3.8962E+01	2.9598E+04	3.1218E+04	6.6627E+01	2.4727E+03	1.1015E+03	8.0750E+05
7.5097E+02	1.6575E+03	1.2971E+02	2.9598E+04	2.4974E+04	4.3253E+03	2.4727E+03	7.3433E+02	1.6162E+06
7.5097E+02	1.6087E+03	1.3393E+01	2.9598E+04	1.8731E+04	2.4608E+02	2.4727E+03	3.6717E+02	3.3555E+06
7.5097E+02	1.5112E+03	3.8920E+02	2.9598E+04	1.2487E+04	4.6720E+03	2.4727E+03	0.0000E+00	6.5876E+06
7.5097E+02	1.4137E+03	1.1897E+02	2.9598E+04	6.2436E+03	1.5929E+04	2.0127E+03	1.3218E+04	1.2500E+00
7.5097E+02	1.3650E+03	4.0840E+01	2.9598E+04	0.0000E+00	2.8378E+04	2.0127E+03	1.2484E+04	6.6460E-02
7.5097E+02	1.3162E+03	1.9261E+03	2.2698E+04	1.4360E+05	3.3392E+00	2.0127E+03	1.1382E+04	1.6696E+00
7.5097E+02	1.2675E+03	3.3990E+03	2.2698E+04	1.3736E+05	6.2500E-01	2.0127E+03	1.1015E+04	1.7500E+00
7.5097E+02	1.2187E+03	3.9656E+03	2.2698E+04	1.3112E+05	5.0892E+00	2.0127E+03	1.0281E+04	1.1856E+00
7.5097E+02	1.1700E+03	7.2045E+03	2.2698E+04	1.2487E+05	5.8750E+00	2.0127E+03	8.8120E+03	7.0167E+02
7.5097E+02	1.1212E+03	7.2807E+03	2.2698E+04	1.1863E+05	1.6696E+00	2.0127E+03	8.4449E+03	2.8241E+03
7.5097E+02	1.0725E+03	2.6065E+04	2.2698E+04	9.9897E+04	1.7500E+00	2.0127E+03	8.0777E+03	1.3530E+04
7.5097E+02	1.0237E+03	2.7784E+04	2.2698E+04	9.3654E+04	3.3667E+01	2.0127E+03	7.7105E+03	1.0200E+04
7.5097E+02	9.7497E+02	7.8478E+04	2.2698E+04	8.7410E+04	1.1848E+01	2.0127E+03	7.3433E+03	1.7599E+04
7.5097E+02	9.2622E+02	1.2105E+05	2.2698E+04	8.1166E+04	7.0000E+00	2.0127E+03	6.9762E+03	5.8617E+04
7.5097E+02	8.7747E+02	1.5266E+05	2.2698E+04	7.4923E+04	7.0000E+00	2.0127E+03	6.6090E+03	4.2743E+04
7.5097E+02	8.2873E+02	2.4146E+05	2.2698E+04	6.8679E+04	7.0000E+00	2.0127E+03	6.2418E+03	4.6395E+04
7.5097E+02	7.7998E+02	3.4553E+05	2.2698E+04	6.2436E+04	2.3120E+01	2.0127E+03	5.8747E+03	1.3519E+05
7.5097E+02	7.3123E+02	4.5439E+05	2.2698E+04	5.6192E+04	6.5922E+01	2.0127E+03	5.5075E+03	1.6852E+05
7.5097E+02	6.8248E+02	7.9427E+05	2.2698E+04	4.9949E+04	3.9520E+01	2.0127E+03	5.1403E+03	2.1766E+05
7.5097E+02	6.3373E+02	1.1052E+06	2.2698E+04	4.3705E+04	1.1084E+02	2.0127E+03	4.7732E+03	2.7908E+05
7.5097E+02	5.8498E+02	1.8023E+06	2.2698E+04	3.7461E+04	5.6480E+01	2.0127E+03	4.4060E+03	3.7978E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.5097E+02	5.3623E+02	2.7296E+06	2.2698E+04	3.1218E+04	2.7051E+02	2.0127E+03	4.0388E+03	4.8361E+05
7.5097E+02	4.8749E+02	3.5663E+06	2.2698E+04	2.4974E+04	4.4851E+02	2.0127E+03	3.6717E+03	6.4923E+05
7.5097E+02	4.3874E+02	4.5964E+06	2.2698E+04	1.8731E+04	8.8195E+03	2.0127E+03	3.3045E+03	7.7885E+05
7.5097E+02	3.8999E+02	6.0111E+06	2.2698E+04	1.2487E+04	1.3464E+04	2.0127E+03	2.9373E+03	9.3381E+05
7.5097E+02	3.4124E+02	7.0439E+06	2.2698E+04	6.2436E+03	2.7397E+04	2.0127E+03	2.5702E+03	1.0939E+06
7.5097E+02	2.9249E+02	7.5795E+06	2.2698E+04	0.0000E+00	4.9027E+04	2.0127E+03	2.2030E+03	1.1751E+06
7.5097E+02	2.4374E+02	7.5301E+06	1.5799E+04	1.5609E+05	2.2946E+00	2.0127E+03	1.8358E+03	1.2623E+06
7.5097E+02	1.9499E+02	9.0189E+06	1.5799E+04	1.4985E+05	1.6696E+00	2.0127E+03	1.4687E+03	1.1714E+06
7.5097E+02	1.4625E+02	1.1970E+07	1.5799E+04	1.3736E+05	1.6696E+00	2.0127E+03	1.1015E+03	1.4816E+06
7.5097E+02	9.7497E+01	2.0605E+07	1.5799E+04	1.3112E+05	1.2500E+00	2.0127E+03	7.3433E+02	2.4135E+06
7.5097E+02	4.8749E+01	3.4248E+07	1.5799E+04	1.2487E+05	6.9146E-01	2.0127E+03	3.6717E+02	5.0356E+06
7.5097E+02	0.0000E+00	3.6624E+07	1.5799E+04	1.1238E+05	5.8676E+00	2.0127E+03	0.0000E+00	9.8537E+06
6.9108E+02	1.8524E+03	5.1137E+01	1.5799E+04	1.0614E+05	2.2946E+00	1.5526E+03	1.7624E+04	1.6696E+00
6.9108E+02	1.7062E+03	1.1018E+03	1.5799E+04	9.9897E+04	1.2500E+00	1.5526E+03	1.2851E+04	4.6064E-01
6.9108E+02	1.6575E+03	5.4993E+02	1.5799E+04	9.3654E+04	3.5000E+00	1.5526E+03	1.2484E+04	6.6460E-02
6.9108E+02	1.6087E+03	2.1236E+03	1.5799E+04	8.7410E+04	1.4791E+01	1.5526E+03	1.2117E+04	6.6460E-02
6.9108E+02	1.5600E+03	1.2634E+02	1.5799E+04	8.1166E+04	3.4196E+00	1.5526E+03	1.1382E+04	1.2768E+01
6.9108E+02	1.5112E+03	2.2853E+03	1.5799E+04	7.4923E+04	4.4166E+01	1.5526E+03	1.1015E+04	7.0000E+02
6.9108E+02	1.4625E+03	7.9771E+03	1.5799E+04	6.8679E+04	9.1088E+01	1.5526E+03	1.0281E+04	7.0190E+02
6.9108E+02	1.4137E+03	2.0196E+03	1.5799E+04	6.2436E+04	3.5667E+01	1.5526E+03	9.9135E+03	5.5265E+02
6.9108E+02	1.3650E+03	8.0181E+03	1.5799E+04	5.6192E+04	1.6523E+02	1.5526E+03	9.5464E+03	1.3421E+03
6.9108E+02	1.3162E+03	7.1802E+02	1.5799E+04	4.9949E+04	2.2765E+03	1.5526E+03	9.1792E+03	4.2538E+03
6.9108E+02	1.2675E+03	2.0077E+04	1.5799E+04	4.3705E+04	6.5756E+03	1.5526E+03	8.8120E+03	8.4035E+03
6.9108E+02	1.2187E+03	1.4332E+04	1.5799E+04	3.7461E+04	2.9031E+02	1.5526E+03	8.4449E+03	3.4007E+03
6.9108E+02	1.1700E+03	2.0553E+04	1.5799E+04	3.1218E+04	7.9412E+03	1.5526E+03	8.0777E+03	8.0000E+03
6.9108E+02	1.1212E+03	6.5071E+04	1.5799E+04	2.4974E+04	9.1231E+03	1.5526E+03	7.7105E+03	3.8955E+04
6.9108E+02	1.0725E+03	4.6925E+04	1.5799E+04	1.8731E+04	9.6565E+03	1.5526E+03	7.3433E+03	6.0001E+04
6.9108E+02	1.0237E+03	9.8909E+04	1.5799E+04	1.2487E+04	3.0854E+04	1.5526E+03	6.9762E+03	3.8470E+04
6.9108E+02	9.7497E+02	8.7467E+04	1.5799E+04	6.2436E+03	6.6090E+04	1.5526E+03	6.6090E+03	8.2595E+04
6.9108E+02	9.2622E+02	1.4935E+05	1.5799E+04	0.0000E+00	3.6377E+05	1.5526E+03	6.2418E+03	1.1368E+05
6.9108E+02	8.7747E+02	1.5040E+05	8.8987E+03	1.6858E+05	6.2500E-01	1.5526E+03	5.8747E+03	2.1427E+05
6.9108E+02	8.2873E+02	2.9529E+05	8.8987E+03	1.5609E+05	1.6696E+00	1.5526E+03	5.5075E+03	3.3026E+05
6.9108E+02	7.7998E+02	4.9384E+05	8.8987E+03	1.4360E+05	6.2500E-01	1.5526E+03	5.1403E+03	3.6958E+05
6.9108E+02	7.3123E+02	5.5879E+05	8.8987E+03	1.3736E+05	1.6696E+00	1.5526E+03	4.7732E+03	4.6143E+05
6.9108E+02	6.8248E+02	9.0480E+05	8.8987E+03	1.3112E+05	1.8025E+00	1.5526E+03	4.4060E+03	5.0722E+05
6.9108E+02	6.3373E+02	1.2792E+06	8.8987E+03	1.1238E+05	4.1636E+00	1.5526E+03	4.0388E+03	9.0813E+05
6.9108E+02	5.8498E+02	1.7893E+06	8.8987E+03	1.0614E+05	2.1302E+00	1.5526E+03	3.6717E+03	1.0294E+06
6.9108E+02	5.3623E+02	2.5714E+06	8.8987E+03	9.9897E+04	3.3802E+00	1.5526E+03	3.3045E+03	1.1788E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.9108E+02	4.8749E+02	3.4138E+06	8.8987E+03	9.3654E+04	1.1508E+03	1.5526E+03	2.9373E+03	1.4673E+06
6.9108E+02	4.3874E+02	4.3039E+06	8.8987E+03	8.7410E+04	2.2173E+03	1.5526E+03	2.5702E+03	1.5657E+06
6.9108E+02	3.8999E+02	5.2787E+06	8.8987E+03	8.1166E+04	2.2244E+03	1.5526E+03	2.2030E+03	1.9327E+06
6.9108E+02	3.4124E+02	5.9160E+06	8.8987E+03	7.4923E+04	1.1199E+03	1.5526E+03	1.8358E+03	1.9434E+06
6.9108E+02	2.9249E+02	6.1879E+06	8.8987E+03	6.8679E+04	8.8560E+03	1.5526E+03	1.4687E+03	1.9270E+06
6.9108E+02	2.4374E+02	6.2146E+06	8.8987E+03	6.2436E+04	7.8777E+03	1.5526E+03	1.1015E+03	2.2941E+06
6.9108E+02	1.9499E+02	7.0535E+06	8.8987E+03	5.6192E+04	6.7828E+03	1.5526E+03	7.3433E+02	3.3542E+06
6.9108E+02	1.4625E+02	8.9529E+06	8.8987E+03	4.9949E+04	1.4674E+04	1.5526E+03	3.6717E+02	7.7905E+06
6.9108E+02	9.7497E+01	1.4704E+07	8.8987E+03	4.3705E+04	1.4004E+04	1.5526E+03	0.0000E+00	1.5825E+07
6.9108E+02	4.8749E+01	2.9063E+07	8.8987E+03	3.7461E+04	2.0988E+04	1.0926E+03	1.4687E+04	6.6460E-02
6.9108E+02	0.0000E+00	3.1978E+07	8.8987E+03	3.1218E+04	5.3710E+04	1.0926E+03	1.3585E+04	8.9490E+01
6.3118E+02	1.9012E+03	8.6412E+00	8.8987E+03	2.4974E+04	6.8542E+04	1.0926E+03	1.3218E+04	4.1848E+01
6.3118E+02	1.8524E+03	5.5090E+02	8.8987E+03	1.8731E+04	9.9673E+04	1.0926E+03	1.2851E+04	7.0167E+02
6.3118E+02	1.8037E+03	5.5090E+02	8.8987E+03	1.2487E+04	2.2157E+05	1.0926E+03	1.2117E+04	2.8409E+01
6.3118E+02	1.7549E+03	2.6745E+03	8.8987E+03	6.2436E+03	4.5567E+05	1.0926E+03	1.1382E+04	2.1867E+02
6.3118E+02	1.7062E+03	1.7472E+03	8.8987E+03	0.0000E+00	3.4776E+06	1.0926E+03	1.1015E+04	5.0615E+01
6.3118E+02	1.6575E+03	2.7451E+03	1.9988E+03	3.0594E+05	1.6696E+00	1.0926E+03	1.0648E+04	3.0993E+03
6.3118E+02	1.6087E+03	1.3103E+03	1.9988E+03	2.8720E+05	1.6696E+00	1.0926E+03	1.0281E+04	2.3338E+03
6.3118E+02	1.5600E+03	1.7666E+03	1.9988E+03	1.9355E+05	6.2500E-01	1.0926E+03	9.9135E+03	3.0475E+03
6.3118E+02	1.5112E+03	5.4988E+03	1.9988E+03	1.3736E+05	6.6460E-02	1.0926E+03	9.5464E+03	7.5465E+03
6.3118E+02	1.4625E+03	1.0960E+04	1.9988E+03	1.3112E+05	1.3292E-01	1.0926E+03	9.1792E+03	9.0549E+03
6.3118E+02	1.4137E+03	7.8478E+03	1.9988E+03	1.2487E+05	3.3392E+00	1.0926E+03	8.8120E+03	6.4195E+03
6.3118E+02	1.3650E+03	1.9117E+04	1.9988E+03	1.1863E+05	7.5792E-01	1.0926E+03	8.4449E+03	1.7509E+04
6.3118E+02	1.3162E+03	1.9998E+04	1.9988E+03	1.1238E+05	1.8750E+00	1.0926E+03	8.0777E+03	3.9980E+04
6.3118E+02	1.2675E+03	3.9509E+04	1.9988E+03	1.0614E+05	3.6111E+00	1.0926E+03	7.7105E+03	4.7059E+04
6.3118E+02	1.2187E+03	3.5641E+04	1.9988E+03	9.9897E+04	3.3160E+03	1.0926E+03	7.3433E+03	3.7584E+04
6.3118E+02	1.1700E+03	7.6438E+04	1.9988E+03	9.3654E+04	4.4238E+03	1.0926E+03	6.9762E+03	6.0984E+04
6.3118E+02	1.1212E+03	6.4237E+04	1.9988E+03	8.7410E+04	6.6313E+03	1.0926E+03	6.6090E+03	1.1909E+05
6.3118E+02	1.0725E+03	1.1857E+05	1.9988E+03	8.1166E+04	1.0976E+04	1.0926E+03	6.2418E+03	1.5781E+05
6.3118E+02	1.0237E+03	1.7680E+05	1.9988E+03	7.4923E+04	2.0961E+04	1.0926E+03	5.8747E+03	2.3313E+05
6.3118E+02	9.7497E+02	1.8929E+05	1.9988E+03	6.8679E+04	1.1142E+04	1.0926E+03	5.5075E+03	3.1530E+05
6.3118E+02	9.2622E+02	2.9329E+05	1.9988E+03	6.2436E+04	1.4486E+04	1.0926E+03	5.1403E+03	4.3736E+05
6.3118E+02	8.7747E+02	4.4256E+05	1.9988E+03	5.6192E+04	7.7576E+04	1.0926E+03	4.7732E+03	5.6970E+05
6.3118E+02	8.2873E+02	5.6429E+05	1.9988E+03	4.9949E+04	6.0305E+04	1.0926E+03	4.4060E+03	7.6070E+05
6.3118E+02	7.7998E+02	6.5666E+05	1.9988E+03	4.3705E+04	6.6469E+04	1.0926E+03	4.0388E+03	9.9942E+05
6.3118E+02	7.3123E+02	8.9469E+05	1.9988E+03	3.7461E+04	8.2395E+04	1.0926E+03	3.6717E+03	1.3900E+06
6.3118E+02	6.8248E+02	1.2308E+06	1.9988E+03	3.1218E+04	1.6706E+05	1.0926E+03	3.3045E+03	1.4646E+06
6.3118E+02	6.3373E+02	1.7486E+06	1.9988E+03	2.4974E+04	4.3074E+05	1.0926E+03	2.9373E+03	1.7319E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Energy Systems Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.3118E+02	5.8498E+02	1.9537E+06	1.9988E+03	1.8731E+04	1.0883E+06	1.0926E+03	2.5702E+03	2.4072E+06
6.3118E+02	5.3623E+02	2.4952E+06	1.9988E+03	1.2487E+04	2.5883E+06	1.0926E+03	2.2030E+03	2.8775E+06
6.3118E+02	4.8749E+02	3.2463E+06	1.9988E+03	6.2436E+03	6.0484E+06	1.0926E+03	1.8358E+03	3.0391E+06
6.3118E+02	4.3874E+02	3.7257E+06	1.9988E+03	0.0000E+00	1.4729E+07	1.0926E+03	1.4687E+03	3.2073E+06
6.3118E+02	3.8999E+02	4.0165E+06	-4.9011E+03	2.9345E+05	1.6696E+00	1.0926E+03	1.1015E+03	3.6203E+06
6.3118E+02	3.4124E+02	4.3221E+06	-4.9011E+03	2.6847E+05	1.7361E+00	1.0926E+03	7.3433E+02	5.1592E+06
6.3118E+02	2.9249E+02	4.1000E+06	-4.9011E+03	1.6858E+05	6.6460E-02	1.0926E+03	3.6717E+02	1.1230E+07
6.3118E+02	2.4374E+02	3.9324E+06	-4.9011E+03	1.5609E+05	1.3292E-01	1.0926E+03	0.0000E+00	2.3815E+07
6.3118E+02	1.9499E+02	4.3130E+06	-4.9011E+03	1.4985E+05	6.6460E-02	6.3255E+02	1.4687E+04	1.0358E+02
6.3118E+02	1.4625E+02	5.6339E+06	-4.9011E+03	1.4360E+05	6.6460E-02	6.3255E+02	1.4320E+04	9.1435E+01
6.3118E+02	9.7497E+01	9.7194E+06	-4.9011E+03	1.3736E+05	6.6460E-02	6.3255E+02	1.3952E+04	1.1365E+03
6.3118E+02	4.8749E+01	2.1364E+07	-4.9011E+03	1.3112E+05	6.6460E-02	6.3255E+02	1.3585E+04	1.4861E+03
6.3118E+02	0.0000E+00	2.5585E+07	-4.9011E+03	1.2487E+05	4.2096E+00	6.3255E+02	1.3218E+04	8.7077E+00
5.7129E+02	2.0474E+03	6.6965E+00	-4.9011E+03	1.1863E+05	1.3927E+00	6.3255E+02	1.2851E+04	2.8158E+01
5.7129E+02	1.9987E+03	5.5954E+02	-4.9011E+03	1.1238E+05	1.8690E+00	6.3255E+02	1.2484E+04	1.4124E+02
5.7129E+02	1.9499E+03	6.6965E+00	-4.9011E+03	1.0614E+05	4.5019E+00	6.3255E+02	1.2117E+04	1.1839E+03
5.7129E+02	1.9012E+03	6.5070E+02	-4.9011E+03	9.9897E+04	4.6922E+01	6.3255E+02	1.1749E+04	3.7818E+03
5.7129E+02	1.8524E+03	3.7942E+03	-4.9011E+03	9.3654E+04	2.2733E+03	6.3255E+02	1.1382E+04	2.5452E+03
5.7129E+02	1.8037E+03	5.5028E+01	-4.9011E+03	8.7410E+04	3.2485E+03	6.3255E+02	1.1015E+04	5.3970E+03
5.7129E+02	1.7549E+03	1.7051E+03	-4.9011E+03	8.1166E+04	3.0813E+01	6.3255E+02	1.0648E+04	2.1064E+04
5.7129E+02	1.7062E+03	3.4974E+03	-4.9011E+03	7.4923E+04	5.4983E+03	6.3255E+02	1.0281E+04	3.6941E+03
5.7129E+02	1.6575E+03	6.9274E+02	-4.9011E+03	6.8679E+04	5.2906E+03	6.3255E+02	9.9135E+03	6.5632E+03
5.7129E+02	1.6087E+03	1.6605E+03	-4.9011E+03	6.2436E+04	1.2369E+03	6.3255E+02	9.5464E+03	8.0387E+03
5.7129E+02	1.5600E+03	5.2054E+03	-4.9011E+03	5.6192E+04	3.2877E+03	6.3255E+02	9.1792E+03	1.7344E+04
5.7129E+02	1.5112E+03	8.6513E+03	-4.9011E+03	4.9949E+04	4.5178E+04	6.3255E+02	8.8120E+03	3.7185E+04
5.7129E+02	1.4625E+03	1.4128E+04	-4.9011E+03	4.3705E+04	1.1833E+05	6.3255E+02	8.4449E+03	2.9075E+04
5.7129E+02	1.4137E+03	7.5480E+03	-4.9011E+03	3.7461E+04	2.7777E+05	6.3255E+02	8.0777E+03	4.3409E+04
5.7129E+02	1.3650E+03	1.6167E+04	-4.9011E+03	3.1218E+04	4.1758E+05	6.3255E+02	7.7105E+03	5.0997E+04
5.7129E+02	1.3162E+03	1.8410E+04	-4.9011E+03	2.4974E+04	6.7468E+05	6.3255E+02	7.3433E+03	6.3839E+04
5.7129E+02	1.2675E+03	3.6786E+04	-4.9011E+03	1.8731E+04	9.7240E+05	6.3255E+02	6.9762E+03	1.0425E+05
5.7129E+02	1.2187E+03	4.0004E+04	-4.9011E+03	1.2487E+04	1.3136E+06	6.3255E+02	6.6090E+03	1.7303E+05
5.7129E+02	1.1700E+03	7.1581E+04	-4.9011E+03	6.2436E+03	1.7891E+06	6.3255E+02	6.2418E+03	2.2810E+05
5.7129E+02	1.1212E+03	7.5637E+04	-4.9011E+03	0.0000E+00	3.4298E+06	6.3255E+02	5.8747E+03	2.7468E+05
5.7129E+02	1.0725E+03	9.6252E+04	-1.1801E+04	3.1218E+05	1.6696E+00	6.3255E+02	5.5075E+03	3.7237E+05
5.7129E+02	1.0237E+03	1.6133E+05	-1.1801E+04	3.0594E+05	3.3392E+00	6.3255E+02	5.1403E+03	6.0647E+05
5.7129E+02	9.7497E+02	2.0609E+05	-1.1801E+04	2.9969E+05	1.6696E+00	6.3255E+02	4.7732E+03	6.9017E+05
5.7129E+02	9.2622E+02	2.0976E+05	-1.1801E+04	2.8720E+05	1.6696E+00	6.3255E+02	4.4060E+03	9.9655E+05
5.7129E+02	8.7747E+02	3.5128E+05	-1.1801E+04	2.8096E+05	1.6696E+00	6.3255E+02	4.0388E+03	1.1820E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Denmark A/S Tobaksvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.7129E+02	8.2873E+02	4.8174E+05	-1.1801E+04	2.4350E+05	6.2500E-01	6.3255E+02	3.6717E+03	1.6006E+06
5.7129E+02	7.7998E+02	6.5235E+05	-1.1801E+04	2.3726E+05	2.3750E+00	6.3255E+02	3.3045E+03	2.0768E+06
5.7129E+02	7.3123E+02	8.1592E+05	-1.1801E+04	2.1228E+05	6.2500E-01	6.3255E+02	2.9373E+03	2.1500E+06
5.7129E+02	6.8248E+02	9.3018E+05	-1.1801E+04	1.5609E+05	1.7361E+00	6.3255E+02	2.5702E+03	3.2535E+06
5.7129E+02	6.3373E+02	1.3616E+06	-1.1801E+04	1.3736E+05	1.1303E-02	6.3255E+02	2.2030E+03	4.0448E+06
5.7129E+02	5.8498E+02	1.6109E+06	-1.1801E+04	1.3112E+05	1.9938E-01	6.3255E+02	1.8358E+03	4.7858E+06
5.7129E+02	5.3623E+02	1.9624E+06	-1.1801E+04	1.2487E+05	2.6584E-01	6.3255E+02	1.4687E+03	4.6305E+06
5.7129E+02	4.8749E+02	2.0668E+06	-1.1801E+04	1.1863E+05	2.5604E+00	6.3255E+02	1.1015E+03	4.8871E+06
5.7129E+02	4.3874E+02	2.3334E+06	-1.1801E+04	1.1238E+05	1.8182E+01	6.3255E+02	7.3433E+02	6.7179E+06
5.7129E+02	3.8999E+02	2.6373E+06	-1.1801E+04	1.0614E+05	1.3024E+00	6.3255E+02	3.6717E+02	1.6234E+07
5.7129E+02	3.4124E+02	2.7264E+06	-1.1801E+04	9.9897E+04	2.1610E+03	6.3255E+02	0.0000E+00	3.3819E+07
5.7129E+02	2.9249E+02	2.6109E+06	-1.1801E+04	9.3654E+04	1.1139E+02	1.7251E+02	1.5788E+04	7.1242E+00
5.7129E+02	2.4374E+02	2.7246E+06	-1.1801E+04	8.7410E+04	3.3394E+02	1.7251E+02	1.5421E+04	2.0108E+01
5.7129E+02	1.9499E+02	2.5654E+06	-1.1801E+04	8.1166E+04	3.5232E+03	1.7251E+02	1.5054E+04	4.1714E+02
5.7129E+02	1.4625E+02	3.4305E+06	-1.1801E+04	7.4923E+04	1.8638E+03	1.7251E+02	1.4687E+04	1.5963E+03
5.7129E+02	9.7497E+01	5.5360E+06	-1.1801E+04	6.8679E+04	2.7418E+03	1.7251E+02	1.4320E+04	2.7540E+02
5.7129E+02	4.8749E+01	1.4076E+07	-1.1801E+04	6.2436E+04	6.5238E+02	1.7251E+02	1.3952E+04	1.7689E+03
5.7129E+02	0.0000E+00	2.3100E+07	-1.1801E+04	5.6192E+04	7.8701E+03	1.7251E+02	1.3585E+04	2.3105E+03
5.1139E+02	2.3399E+03	1.9447E+00	-1.1801E+04	4.9949E+04	4.4042E+04	1.7251E+02	1.3218E+04	2.7697E+03
5.1139E+02	2.1449E+03	3.1170E-01	-1.1801E+04	4.3705E+04	8.5131E+04	1.7251E+02	1.2851E+04	5.5138E+03
5.1139E+02	2.0962E+03	1.1018E+03	-1.1801E+04	3.7461E+04	2.6678E+05	1.7251E+02	1.2484E+04	9.8900E+03
5.1139E+02	2.0474E+03	6.6965E+00	-1.1801E+04	3.1218E+04	6.0130E+05	1.7251E+02	1.2117E+04	2.8958E+04
5.1139E+02	1.9987E+03	6.4594E+02	-1.1801E+04	2.4974E+04	1.1584E+06	1.7251E+02	1.1749E+04	1.8460E+04
5.1139E+02	1.9499E+03	5.7366E+02	-1.1801E+04	1.8731E+04	1.6578E+06	1.7251E+02	1.1382E+04	1.0716E+04
5.1139E+02	1.9012E+03	5.7080E+02	-1.1801E+04	1.2487E+04	2.4361E+06	1.7251E+02	1.1015E+04	2.3442E+04
5.1139E+02	1.8524E+03	1.1218E+03	-1.1801E+04	6.2436E+03	3.2952E+06	1.7251E+02	1.0648E+04	8.6345E+04
5.1139E+02	1.8037E+03	2.8651E+03	-1.1801E+04	0.0000E+00	3.0918E+06	1.7251E+02	1.0281E+04	2.9992E+04
5.1139E+02	1.7549E+03	1.3921E+03	-1.8701E+04	3.0594E+05	1.6696E+00	1.7251E+02	9.9135E+03	3.9395E+04
5.1139E+02	1.7062E+03	3.7089E+03	-1.8701E+04	2.9345E+05	3.3392E+00	1.7251E+02	9.5464E+03	4.9378E+04
5.1139E+02	1.6575E+03	1.2804E+03	-1.8701E+04	2.8720E+05	1.6696E+00	1.7251E+02	9.1792E+03	6.5991E+04
5.1139E+02	1.6087E+03	9.5773E+02	-1.8701E+04	2.8096E+05	3.3392E+00	1.7251E+02	8.8120E+03	4.1196E+04
5.1139E+02	1.5600E+03	4.6622E+03	-1.8701E+04	2.6847E+05	1.6696E+00	1.7251E+02	8.4449E+03	5.2316E+04
5.1139E+02	1.5112E+03	2.1476E+03	-1.8701E+04	2.5599E+05	6.2500E-01	1.7251E+02	8.0777E+03	9.1751E+04
5.1139E+02	1.4625E+03	1.0538E+04	-1.8701E+04	2.4974E+05	3.5000E+00	1.7251E+02	7.7105E+03	9.4235E+04
5.1139E+02	1.4137E+03	5.5447E+03	-1.8701E+04	2.4350E+05	5.2500E+00	1.7251E+02	7.3433E+03	1.4592E+05
5.1139E+02	1.3650E+03	1.2777E+04	-1.8701E+04	2.3726E+05	1.7500E+00	1.7251E+02	6.9762E+03	2.0382E+05
5.1139E+02	1.3162E+03	2.3425E+04	-1.8701E+04	2.3101E+05	1.7500E+00	1.7251E+02	6.6090E+03	3.1727E+05
5.1139E+02	1.2675E+03	1.6311E+04	-1.8701E+04	2.1228E+05	1.7500E+00	1.7251E+02	6.2418E+03	2.6556E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.1139E+02	1.2187E+03	3.9339E+04	-1.8701E+04	2.0604E+05	1.2500E+00	1.7251E+02	5.8747E+03	4.3312E+05
5.1139E+02	1.1700E+03	6.0382E+04	-1.8701E+04	1.9355E+05	2.4415E+00	1.7251E+02	5.5075E+03	5.4988E+05
5.1139E+02	1.1212E+03	4.2412E+04	-1.8701E+04	1.7482E+05	6.6460E-02	1.7251E+02	5.1403E+03	6.7494E+05
5.1139E+02	1.0725E+03	7.9150E+04	-1.8701E+04	1.6858E+05	1.9938E-01	1.7251E+02	4.7732E+03	8.4240E+05
5.1139E+02	1.0237E+03	7.1877E+04	-1.8701E+04	1.5609E+05	2.6584E-01	1.7251E+02	4.4060E+03	1.2529E+06
5.1139E+02	9.7497E+02	1.0900E+05	-1.8701E+04	1.4985E+05	1.5823E+00	1.7251E+02	4.0388E+03	1.4777E+06
5.1139E+02	9.2622E+02	1.4659E+05	-1.8701E+04	1.4360E+05	6.6460E-02	1.7251E+02	3.6717E+03	1.7305E+06
5.1139E+02	8.7747E+02	2.3149E+05	-1.8701E+04	1.3736E+05	1.3292E-01	1.7251E+02	3.3045E+03	2.2575E+06
5.1139E+02	8.2873E+02	2.8182E+05	-1.8701E+04	1.3112E+05	1.8690E+00	1.7251E+02	2.9373E+03	2.7181E+06
5.1139E+02	7.7998E+02	3.3185E+05	-1.8701E+04	1.2487E+05	1.3292E-01	1.7251E+02	2.5702E+03	3.6729E+06
5.1139E+02	7.3123E+02	4.3519E+05	-1.8701E+04	1.1863E+05	1.5130E+01	1.7251E+02	2.2030E+03	4.6857E+06
5.1139E+02	6.8248E+02	5.9386E+05	-1.8701E+04	1.1238E+05	3.2217E+01	1.7251E+02	1.8358E+03	5.8314E+06
5.1139E+02	6.3373E+02	7.1386E+05	-1.8701E+04	1.0614E+05	2.3368E+01	1.7251E+02	1.4687E+03	6.7560E+06
5.1139E+02	5.8498E+02	9.2772E+05	-1.8701E+04	9.9897E+04	2.8927E+00	1.7251E+02	1.1015E+03	6.9367E+06
5.1139E+02	5.3623E+02	1.1898E+06	-1.8701E+04	9.3654E+04	2.1376E+03	1.7251E+02	7.3433E+02	9.1080E+06
5.1139E+02	4.8749E+02	1.3914E+06	-1.8701E+04	8.7410E+04	1.4403E+01	1.7251E+02	3.6717E+02	2.1832E+07
5.1139E+02	4.3874E+02	1.7117E+06	-1.8701E+04	8.1166E+04	3.1340E+03	1.7251E+02	0.0000E+00	4.8760E+07
5.1139E+02	3.8999E+02	2.2780E+06	-1.8701E+04	7.4923E+04	2.5819E+03	-2.8753E+02	1.5788E+04	1.6331E+00
5.1139E+02	3.4124E+02	2.3101E+06	-1.8701E+04	6.8679E+04	6.8404E+03	-2.8753E+02	1.5054E+04	8.7069E+00
5.1139E+02	2.9249E+02	2.5523E+06	-1.8701E+04	6.2436E+04	9.1130E+03	-2.8753E+02	1.4687E+04	3.4229E+01
5.1139E+02	2.4374E+02	3.1107E+06	-1.8701E+04	5.6192E+04	1.0940E+04	-2.8753E+02	1.4320E+04	3.0802E+02
5.1139E+02	1.9499E+02	2.6477E+06	-1.8701E+04	4.9949E+04	2.0328E+04	-2.8753E+02	1.3952E+04	1.0742E+03
5.1139E+02	1.4625E+02	3.3720E+06	-1.8701E+04	4.3705E+04	7.7611E+04	-2.8753E+02	1.3585E+04	3.4646E+03
5.1139E+02	9.7497E+01	4.2509E+06	-1.8701E+04	3.7461E+04	2.8623E+05	-2.8753E+02	1.3218E+04	1.5259E+04
5.1139E+02	4.8749E+01	1.3780E+07	-1.8701E+04	3.1218E+04	6.8697E+05	-2.8753E+02	1.2851E+04	1.3631E+04
5.1139E+02	0.0000E+00	2.3780E+07	-1.8701E+04	2.4974E+04	1.6362E+06	-2.8753E+02	1.2484E+04	1.9984E+04
4.5150E+02	2.4374E+03	1.9447E+00	-1.8701E+04	1.8731E+04	3.2546E+06	-2.8753E+02	1.2117E+04	5.6142E+04
4.5150E+02	2.1937E+03	1.9447E+00	-1.8701E+04	1.2487E+04	5.8844E+06	-2.8753E+02	1.1749E+04	5.1489E+04
4.5150E+02	2.0962E+03	1.9447E+00	-1.8701E+04	6.2436E+03	1.0037E+07	-2.8753E+02	1.1382E+04	6.6104E+04
4.5150E+02	2.0474E+03	3.8894E+00	-1.8701E+04	0.0000E+00	9.4198E+06	-2.8753E+02	1.1015E+04	9.2386E+04
4.5150E+02	1.9987E+03	9.3669E-01	-2.5601E+04	2.9345E+05	1.6696E+00	-2.8753E+02	1.0648E+04	5.4694E+04
4.5150E+02	1.9499E+03	6.5592E+02	-2.5601E+04	2.8720E+05	1.6696E+00	-2.8753E+02	1.0281E+04	5.5642E+04
4.5150E+02	1.9012E+03	5.8592E+02	-2.5601E+04	2.7472E+05	3.4861E+00	-2.8753E+02	9.9135E+03	4.4627E+04
4.5150E+02	1.8524E+03	6.3612E+00	-2.5601E+04	2.6847E+05	1.0339E+01	-2.8753E+02	9.5464E+03	4.0370E+04
4.5150E+02	1.8037E+03	4.9993E+01	-2.5601E+04	2.6223E+05	1.2170E+01	-2.8753E+02	9.1792E+03	5.1736E+04
4.5150E+02	1.7549E+03	6.1500E+02	-2.5601E+04	2.5599E+05	1.0010E+01	-2.8753E+02	8.8120E+03	9.4745E+04
4.5150E+02	1.7062E+03	1.2911E+02	-2.5601E+04	2.4974E+05	7.0000E+00	-2.8753E+02	8.4449E+03	9.4108E+04
4.5150E+02	1.6575E+03	2.2015E+03	-2.5601E+04	2.4350E+05	6.9196E+00	-2.8753E+02	8.0777E+03	7.9386E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.5150E+02	1.6087E+03	4.5239E+03	-2.5601E+04	2.3726E+05	3.5000E+00	-2.8753E+02	7.7105E+03	1.2258E+05
4.5150E+02	1.5600E+03	8.1144E+02	-2.5601E+04	2.3101E+05	6.5000E+00	-2.8753E+02	7.3433E+03	1.6443E+05
4.5150E+02	1.5112E+03	1.7365E+03	-2.5601E+04	2.1853E+05	1.7500E+00	-2.8753E+02	6.9762E+03	1.7303E+05
4.5150E+02	1.4625E+03	1.8971E+03	-2.5601E+04	2.1228E+05	6.6460E-02	-2.8753E+02	6.6090E+03	2.4226E+05
4.5150E+02	1.4137E+03	8.4645E+03	-2.5601E+04	1.9979E+05	7.5792E-01	-2.8753E+02	6.2418E+03	3.0430E+05
4.5150E+02	1.3650E+03	5.1395E+03	-2.5601E+04	1.9355E+05	6.6460E-02	-2.8753E+02	5.8747E+03	3.9286E+05
4.5150E+02	1.3162E+03	4.3729E+03	-2.5601E+04	1.8731E+05	2.1987E-01	-2.8753E+02	5.5075E+03	4.4810E+05
4.5150E+02	1.2675E+03	1.1316E+04	-2.5601E+04	1.8106E+05	6.6460E-02	-2.8753E+02	5.1403E+03	8.6214E+05
4.5150E+02	1.2187E+03	1.5424E+04	-2.5601E+04	1.6858E+05	6.9146E-01	-2.8753E+02	4.7732E+03	1.0661E+06
4.5150E+02	1.1700E+03	1.4814E+04	-2.5601E+04	1.6233E+05	1.3165E+00	-2.8753E+02	4.4060E+03	1.1794E+06
4.5150E+02	1.1212E+03	2.0694E+04	-2.5601E+04	1.5609E+05	9.5730E-01	-2.8753E+02	4.0388E+03	1.6533E+06
4.5150E+02	1.0725E+03	2.1563E+04	-2.5601E+04	1.4985E+05	6.3480E-01	-2.8753E+02	3.6717E+03	1.9125E+06
4.5150E+02	1.0237E+03	4.9865E+04	-2.5601E+04	1.4360E+05	2.6329E+00	-2.8753E+02	3.3045E+03	2.7660E+06
4.5150E+02	9.7497E+02	4.7300E+04	-2.5601E+04	1.3736E+05	1.4829E+01	-2.8753E+02	2.9373E+03	3.3728E+06
4.5150E+02	9.2622E+02	8.9758E+04	-2.5601E+04	1.3112E+05	3.2092E-01	-2.8753E+02	2.5702E+03	4.0533E+06
4.5150E+02	8.7747E+02	9.8497E+04	-2.5601E+04	1.2487E+05	9.8611E+00	-2.8753E+02	2.2030E+03	5.5431E+06
4.5150E+02	8.2873E+02	1.0992E+05	-2.5601E+04	1.1863E+05	1.0756E+02	-2.8753E+02	1.8358E+03	5.8020E+06
4.5150E+02	7.7998E+02	1.4065E+05	-2.5601E+04	1.1238E+05	1.0461E+02	-2.8753E+02	1.4687E+03	6.5719E+06
4.5150E+02	7.3123E+02	1.6305E+05	-2.5601E+04	1.0614E+05	2.5984E+00	-2.8753E+02	1.1015E+03	6.6679E+06
4.5150E+02	6.8248E+02	2.6804E+05	-2.5601E+04	9.9897E+04	2.1109E+03	-2.8753E+02	7.3433E+02	9.3439E+06
4.5150E+02	6.3373E+02	2.9522E+05	-2.5601E+04	9.3654E+04	1.1076E+01	-2.8753E+02	3.6717E+02	2.0903E+07
4.5150E+02	5.8498E+02	5.5934E+05	-2.5601E+04	8.7410E+04	2.8785E+02	-2.8753E+02	0.0000E+00	4.4116E+07
4.5150E+02	5.3623E+02	7.2616E+05	-2.5601E+04	8.1166E+04	5.2219E+03	-7.4757E+02	1.5788E+04	6.5690E-02
4.5150E+02	4.8749E+02	8.8215E+05	-2.5601E+04	7.4923E+04	3.7627E+03	-7.4757E+02	1.5054E+04	6.2323E+01
4.5150E+02	4.3874E+02	1.2469E+06	-2.5601E+04	6.8679E+04	9.2673E+03	-7.4757E+02	1.4687E+04	6.3063E+02
4.5150E+02	3.8999E+02	1.4071E+06	-2.5601E+04	6.2436E+04	9.3857E+03	-7.4757E+02	1.4320E+04	2.0923E+02
4.5150E+02	3.4124E+02	2.0648E+06	-2.5601E+04	5.6192E+04	2.3603E+04	-7.4757E+02	1.3952E+04	1.4479E+03
4.5150E+02	2.9249E+02	2.7692E+06	-2.5601E+04	4.9949E+04	4.0000E+04	-7.4757E+02	1.3585E+04	3.5293E+03
4.5150E+02	2.4374E+02	3.6843E+06	-2.5601E+04	4.3705E+04	1.3402E+05	-7.4757E+02	1.3218E+04	3.8504E+03
4.5150E+02	1.9499E+02	4.5135E+06	-2.5601E+04	3.7461E+04	3.0403E+05	-7.4757E+02	1.2851E+04	7.7998E+03
4.5150E+02	1.4625E+02	4.8062E+06	-2.5601E+04	3.1218E+04	8.7341E+05	-7.4757E+02	1.2484E+04	2.5906E+04
4.5150E+02	9.7497E+01	5.6707E+06	-2.5601E+04	2.4974E+04	2.1925E+06	-7.4757E+02	1.2117E+04	2.0780E+04
4.5150E+02	4.8749E+01	1.5745E+07	-2.5601E+04	1.8731E+04	5.7168E+06	-7.4757E+02	1.1749E+04	3.0248E+04
4.5150E+02	0.0000E+00	3.0544E+07	-2.5601E+04	1.2487E+04	1.0566E+07	-7.4757E+02	1.1382E+04	5.2961E+04
3.9160E+02	2.2912E+03	3.1170E-01	-2.5601E+04	6.2436E+03	1.6951E+07	-7.4757E+02	1.1015E+04	5.2882E+04
3.9160E+02	2.1937E+03	1.9447E+00	-2.5601E+04	0.0000E+00	1.7465E+07	-7.4757E+02	1.0648E+04	6.3681E+04
3.9160E+02	2.1449E+03	2.2564E+00	-3.2501E+04	2.8720E+05	1.6696E+00	-7.4757E+02	1.0281E+04	7.6645E+04
3.9160E+02	2.0962E+03	3.8894E+00	-3.2501E+04	2.7472E+05	1.6696E+00	-7.4757E+02	9.9135E+03	6.2015E+04

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.9160E+02	2.0474E+03	1.6796E+01	-3.2501E+04	2.6847E+05	8.2605E+00	-7.4757E+02	9.5464E+03	4.8662E+04
3.9160E+02	1.9987E+03	6.6460E-02	-3.2501E+04	2.6223E+05	5.1696E+00	-7.4757E+02	9.1792E+03	7.8477E+04
3.9160E+02	1.9499E+03	3.9444E+01	-3.2501E+04	2.5599E+05	3.2801E+01	-7.4757E+02	8.8120E+03	5.1426E+04
3.9160E+02	1.9012E+03	6.5735E+00	-3.2501E+04	2.4974E+05	3.5000E+00	-7.4757E+02	8.4449E+03	1.2056E+05
3.9160E+02	1.8524E+03	2.3658E+01	-3.2501E+04	2.4350E+05	1.5180E+01	-7.4757E+02	8.0777E+03	1.2079E+05
3.9160E+02	1.8037E+03	5.0749E+01	-3.2501E+04	2.3726E+05	1.7500E+00	-7.4757E+02	7.7105E+03	1.2799E+05
3.9160E+02	1.7549E+03	7.0438E+01	-3.2501E+04	2.3101E+05	3.5000E+00	-7.4757E+02	7.3433E+03	1.1953E+05
3.9160E+02	1.7062E+03	6.2542E+02	-3.2501E+04	2.1853E+05	6.9146E-01	-7.4757E+02	6.9762E+03	1.7313E+05
3.9160E+02	1.6575E+03	5.3422E+01	-3.2501E+04	2.1228E+05	6.6460E-02	-7.4757E+02	6.6090E+03	2.6664E+05
3.9160E+02	1.6087E+03	9.3213E+01	-3.2501E+04	1.9979E+05	7.5792E-01	-7.4757E+02	6.2418E+03	3.5268E+05
3.9160E+02	1.5600E+03	1.9875E+02	-3.2501E+04	1.9355E+05	6.9146E-01	-7.4757E+02	5.8747E+03	3.8889E+05
3.9160E+02	1.5112E+03	1.6875E+02	-3.2501E+04	1.8731E+05	1.2500E+00	-7.4757E+02	5.5075E+03	5.7891E+05
3.9160E+02	1.4625E+03	3.0813E+02	-3.2501E+04	1.8106E+05	6.6460E-02	-7.4757E+02	5.1403E+03	6.4279E+05
3.9160E+02	1.4137E+03	1.2568E+03	-3.2501E+04	1.7482E+05	5.7165E-01	-7.4757E+02	4.7732E+03	9.8083E+05
3.9160E+02	1.3650E+03	5.7217E+02	-3.2501E+04	1.6233E+05	1.5341E-01	-7.4757E+02	4.4060E+03	1.3498E+06
3.9160E+02	1.3162E+03	1.6603E+03	-3.2501E+04	1.5609E+05	6.9146E-01	-7.4757E+02	4.0388E+03	1.4738E+06
3.9160E+02	1.2675E+03	2.5540E+03	-3.2501E+04	1.4360E+05	1.5622E+01	-7.4757E+02	3.6717E+03	1.8334E+06
3.9160E+02	1.2187E+03	4.2665E+03	-3.2501E+04	1.3736E+05	1.3335E+01	-7.4757E+02	3.3045E+03	2.2773E+06
3.9160E+02	1.1700E+03	2.7575E+03	-3.2501E+04	1.3112E+05	2.1582E+00	-7.4757E+02	2.9373E+03	2.8382E+06
3.9160E+02	1.1212E+03	9.2456E+03	-3.2501E+04	1.2487E+05	2.4993E+00	-7.4757E+02	2.5702E+03	3.5870E+06
3.9160E+02	1.0725E+03	1.1051E+04	-3.2501E+04	1.1863E+05	7.8680E+00	-7.4757E+02	2.2030E+03	4.0047E+06
3.9160E+02	1.0237E+03	1.1768E+04	-3.2501E+04	1.1238E+05	1.2069E+02	-7.4757E+02	1.8358E+03	4.2664E+06
3.9160E+02	9.7497E+02	1.4637E+04	-3.2501E+04	1.0614E+05	3.3918E+01	-7.4757E+02	1.4687E+03	4.4344E+06
3.9160E+02	9.2622E+02	2.4713E+04	-3.2501E+04	9.9897E+04	1.3327E+03	-7.4757E+02	1.1015E+03	5.1038E+06
3.9160E+02	8.7747E+02	2.7349E+04	-3.2501E+04	9.3654E+04	7.7200E+02	-7.4757E+02	7.3433E+02	6.9803E+06
3.9160E+02	8.2873E+02	3.4753E+04	-3.2501E+04	8.7410E+04	3.7942E+02	-7.4757E+02	3.6717E+02	1.6130E+07
3.9160E+02	7.7998E+02	5.8262E+04	-3.2501E+04	8.1166E+04	4.2829E+03	-7.4757E+02	0.0000E+00	3.1329E+07
3.9160E+02	7.3123E+02	6.9806E+04	-3.2501E+04	7.4923E+04	8.9110E+03	-1.2076E+03	1.7257E+04	6.2500E-01
3.9160E+02	6.8248E+02	1.2147E+05	-3.2501E+04	6.8679E+04	8.2001E+03	-1.2076E+03	1.5788E+04	4.2771E-01
3.9160E+02	6.3373E+02	1.0281E+05	-3.2501E+04	6.2436E+04	1.7430E+04	-1.2076E+03	1.5421E+04	3.8894E+00
3.9160E+02	5.8498E+02	1.3388E+05	-3.2501E+04	5.6192E+04	1.3880E+04	-1.2076E+03	1.5054E+04	6.1854E+01
3.9160E+02	5.3623E+02	2.2107E+05	-3.2501E+04	4.9949E+04	4.7156E+04	-1.2076E+03	1.4687E+04	2.0798E+02
3.9160E+02	4.8749E+02	3.1572E+05	-3.2501E+04	4.3705E+04	9.3455E+04	-1.2076E+03	1.4320E+04	8.6412E+00
3.9160E+02	4.3874E+02	3.5625E+05	-3.2501E+04	3.7461E+04	2.0365E+05	-1.2076E+03	1.3952E+04	3.0252E+02
3.9160E+02	3.8999E+02	8.2612E+05	-3.2501E+04	3.1218E+04	5.5934E+05	-1.2076E+03	1.3585E+04	4.5932E+03
3.9160E+02	3.4124E+02	1.1000E+06	-3.2501E+04	2.4974E+04	1.4562E+06	-1.2076E+03	1.3218E+04	2.4540E+03
3.9160E+02	2.9249E+02	1.9199E+06	-3.2501E+04	1.8731E+04	3.8045E+06	-1.2076E+03	1.2851E+04	4.0064E+03
3.9160E+02	2.4374E+02	3.2098E+06	-3.2501E+04	1.2487E+04	6.9308E+06	-1.2076E+03	1.2484E+04	8.9271E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.9160E+02	1.9499E+02	5.0573E+06	-3.2501E+04	6.2436E+03	1.2819E+07	-1.2076E+03	1.2117E+04	5.7824E+03
3.9160E+02	1.4625E+02	5.7145E+06	-3.2501E+04	0.0000E+00	1.3221E+07	-1.2076E+03	1.1749E+04	7.0834E+03
3.9160E+02	9.7497E+01	7.1904E+06	-3.9400E+04	2.6847E+05	1.6696E+00	-1.2076E+03	1.1382E+04	9.6287E+03
3.9160E+02	4.8749E+01	1.8367E+07	-3.9400E+04	2.6223E+05	5.0892E+00	-1.2076E+03	1.1015E+04	1.8914E+04
3.9160E+02	0.0000E+00	4.0170E+07	-3.9400E+04	2.5599E+05	5.0892E+00	-1.2076E+03	1.0648E+04	3.9920E+04
3.3171E+02	2.1937E+03	6.2500E-01	-3.9400E+04	2.4350E+05	1.0555E+01	-1.2076E+03	1.0281E+04	3.7397E+04
3.3171E+02	2.0474E+03	1.9813E+00	-3.9400E+04	2.3726E+05	1.3021E+01	-1.2076E+03	9.9135E+03	2.8211E+04
3.3171E+02	1.9987E+03	2.1740E+01	-3.9400E+04	2.3101E+05	5.1696E+00	-1.2076E+03	9.5464E+03	5.9552E+04
3.3171E+02	1.9499E+03	5.0753E+00	-3.9400E+04	2.2477E+05	3.4196E+00	-1.2076E+03	9.1792E+03	6.9565E+04
3.3171E+02	1.9012E+03	1.7609E+01	-3.9400E+04	2.1853E+05	3.5665E+00	-1.2076E+03	8.8120E+03	9.0611E+04
3.3171E+02	1.8524E+03	3.3566E+01	-3.9400E+04	2.1228E+05	2.4415E+00	-1.2076E+03	8.4449E+03	6.4932E+04
3.3171E+02	1.8037E+03	1.1854E+02	-3.9400E+04	1.9979E+05	9.5410E+00	-1.2076E+03	8.0777E+03	1.0511E+05
3.3171E+02	1.7549E+03	6.7963E+01	-3.9400E+04	1.9355E+05	3.4606E+00	-1.2076E+03	7.7105E+03	8.1538E+04
3.3171E+02	1.7062E+03	2.4675E+01	-3.9400E+04	1.8106E+05	6.6460E-02	-1.2076E+03	7.3433E+03	1.1039E+05
3.3171E+02	1.6575E+03	6.2281E+01	-3.9400E+04	1.7482E+05	1.0232E+01	-1.2076E+03	6.9762E+03	2.3107E+05
3.3171E+02	1.6087E+03	5.2384E+01	-3.9400E+04	1.6858E+05	1.7108E+01	-1.2076E+03	6.6090E+03	2.4647E+05
3.3171E+02	1.5600E+03	6.7253E+01	-3.9400E+04	1.6233E+05	7.7841E-01	-1.2076E+03	6.2418E+03	3.0382E+05
3.3171E+02	1.5112E+03	8.3384E+01	-3.9400E+04	1.5609E+05	7.5792E-01	-1.2076E+03	5.8747E+03	3.6529E+05
3.3171E+02	1.4625E+03	1.0283E+02	-3.9400E+04	1.4985E+05	1.3255E+01	-1.2076E+03	5.5075E+03	5.5240E+05
3.3171E+02	1.4137E+03	1.7763E+02	-3.9400E+04	1.4360E+05	1.7944E+01	-1.2076E+03	5.1403E+03	6.2067E+05
3.3171E+02	1.3650E+03	2.4532E+02	-3.9400E+04	1.3736E+05	6.0364E-01	-1.2076E+03	4.7732E+03	7.7003E+05
3.3171E+02	1.3162E+03	7.3878E+02	-3.9400E+04	1.3112E+05	2.4580E+01	-1.2076E+03	4.4060E+03	1.1797E+06
3.3171E+02	1.2675E+03	7.1039E+02	-3.9400E+04	1.2487E+05	4.5556E+01	-1.2076E+03	4.0388E+03	1.3995E+06
3.3171E+02	1.2187E+03	4.7393E+02	-3.9400E+04	1.1863E+05	1.6567E+01	-1.2076E+03	3.6717E+03	1.6556E+06
3.3171E+02	1.1700E+03	1.3167E+03	-3.9400E+04	1.1238E+05	2.7732E+02	-1.2076E+03	3.3045E+03	2.0839E+06
3.3171E+02	1.1212E+03	1.7758E+03	-3.9400E+04	1.0614E+05	6.1761E+01	-1.2076E+03	2.9373E+03	2.3548E+06
3.3171E+02	1.0725E+03	2.9122E+03	-3.9400E+04	9.9897E+04	1.8757E+02	-1.2076E+03	2.5702E+03	2.7588E+06
3.3171E+02	1.0237E+03	2.4587E+03	-3.9400E+04	9.3654E+04	2.8609E+02	-1.2076E+03	2.2030E+03	3.1112E+06
3.3171E+02	9.7497E+02	4.6270E+03	-3.9400E+04	8.7410E+04	3.3902E+02	-1.2076E+03	1.8358E+03	2.9879E+06
3.3171E+02	9.2622E+02	9.6479E+03	-3.9400E+04	8.1166E+04	1.0415E+03	-1.2076E+03	1.4687E+03	3.1083E+06
3.3171E+02	8.7747E+02	4.7559E+03	-3.9400E+04	7.4923E+04	2.6640E+03	-1.2076E+03	1.1015E+03	3.8155E+06
3.3171E+02	8.2873E+02	6.9319E+03	-3.9400E+04	6.8679E+04	3.2210E+03	-1.2076E+03	7.3433E+02	5.1301E+06
3.3171E+02	7.7998E+02	1.3624E+04	-3.9400E+04	6.2436E+04	1.4141E+04	-1.2076E+03	3.6717E+02	1.2101E+07
3.3171E+02	7.3123E+02	1.9471E+04	-3.9400E+04	5.6192E+04	1.5885E+04	-1.2076E+03	0.0000E+00	2.3709E+07
3.3171E+02	6.8248E+02	2.7467E+04	-3.9400E+04	4.9949E+04	4.3505E+04	-1.6676E+03	1.6523E+04	6.6965E+00
3.3171E+02	6.3373E+02	4.3275E+04	-3.9400E+04	4.3705E+04	9.0576E+04	-1.6676E+03	1.6155E+04	6.6965E+00
3.3171E+02	5.8498E+02	7.9857E+04	-3.9400E+04	3.7461E+04	2.2820E+05	-1.6676E+03	1.5421E+04	4.2771E-01
3.3171E+02	5.3623E+02	8.4901E+04	-3.9400E+04	3.1218E+04	6.0386E+05	-1.6676E+03	1.5054E+04	1.1166E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.3171E+02	4.8749E+02	1.7144E+05	-3.9400E+04	2.4974E+04	1.3982E+06	-1.6676E+03	1.4687E+04	1.4629E+02
3.3171E+02	4.3874E+02	2.1741E+05	-3.9400E+04	1.8731E+04	2.8809E+06	-1.6676E+03	1.4320E+04	2.2908E+01
3.3171E+02	3.8999E+02	4.9621E+05	-3.9400E+04	1.2487E+04	5.2451E+06	-1.6676E+03	1.3952E+04	7.9222E+02
3.3171E+02	3.4124E+02	9.2109E+05	-3.9400E+04	6.2436E+03	8.9904E+06	-1.6676E+03	1.3585E+04	1.4216E+02
3.3171E+02	2.9249E+02	1.8411E+06	-3.9400E+04	0.0000E+00	1.0171E+07	-1.6676E+03	1.3218E+04	9.3783E+02
3.3171E+02	2.4374E+02	3.5112E+06	-4.6300E+04	2.6847E+05	1.6696E+00	-1.6676E+03	1.2851E+04	9.7831E+01
3.3171E+02	1.9499E+02	5.2808E+06	-4.6300E+04	2.6223E+05	8.1801E+00	-1.6676E+03	1.2484E+04	2.3609E+02
3.3171E+02	1.4625E+02	6.3889E+06	-4.6300E+04	2.5599E+05	8.1801E+00	-1.6676E+03	1.2117E+04	6.1004E+02
3.3171E+02	9.7497E+01	8.0435E+06	-4.6300E+04	2.4974E+05	1.4691E+01	-1.6676E+03	1.1749E+04	5.4847E+03
3.3171E+02	4.8749E+01	1.6339E+07	-4.6300E+04	2.4350E+05	6.7588E+00	-1.6676E+03	1.1382E+04	1.5555E+03
3.3171E+02	0.0000E+00	3.9487E+07	-4.6300E+04	2.3726E+05	1.6360E+01	-1.6676E+03	1.1015E+04	5.7637E+03
2.7181E+02	2.1449E+03	2.5697E+00	-4.6300E+04	2.2477E+05	1.8030E+01	-1.6676E+03	1.0648E+04	5.2389E+03
2.7181E+02	2.0474E+03	6.5770E+00	-4.6300E+04	2.1853E+05	1.7361E+00	-1.6676E+03	1.0281E+04	1.3952E+04
2.7181E+02	1.9987E+03	5.2221E+00	-4.6300E+04	2.1228E+05	1.0666E+01	-1.6676E+03	9.9135E+03	1.9554E+04
2.7181E+02	1.9499E+03	5.2500E+00	-4.6300E+04	2.0604E+05	1.2687E+01	-1.6676E+03	9.5464E+03	3.0245E+04
2.7181E+02	1.9012E+03	2.9482E+01	-4.6300E+04	1.9979E+05	1.8829E+00	-1.6676E+03	9.1792E+03	2.2959E+04
2.7181E+02	1.8524E+03	1.4041E+01	-4.6300E+04	1.9355E+05	2.4328E+01	-1.6676E+03	8.8120E+03	3.9178E+04
2.7181E+02	1.8037E+03	3.6133E+01	-4.6300E+04	1.8731E+05	3.3844E+00	-1.6676E+03	8.4449E+03	5.1373E+04
2.7181E+02	1.7549E+03	2.2456E+01	-4.6300E+04	1.8106E+05	1.7515E+01	-1.6676E+03	8.0777E+03	5.7328E+04
2.7181E+02	1.7062E+03	7.0250E+00	-4.6300E+04	1.7482E+05	3.4643E+00	-1.6676E+03	7.7105E+03	7.2775E+04
2.7181E+02	1.6575E+03	1.1670E+01	-4.6300E+04	1.6858E+05	2.6598E+01	-1.6676E+03	7.3433E+03	8.5892E+04
2.7181E+02	1.6087E+03	2.1046E+01	-4.6300E+04	1.6233E+05	1.3312E+01	-1.6676E+03	6.9762E+03	1.4037E+05
2.7181E+02	1.5600E+03	1.8550E+01	-4.6300E+04	1.5609E+05	8.9756E+00	-1.6676E+03	6.6090E+03	1.8936E+05
2.7181E+02	1.5112E+03	1.3454E+01	-4.6300E+04	1.4360E+05	8.5542E-01	-1.6676E+03	6.2418E+03	2.8081E+05
2.7181E+02	1.4625E+03	6.6614E+00	-4.6300E+04	1.3736E+05	1.0605E+02	-1.6676E+03	5.8747E+03	3.7794E+05
2.7181E+02	1.4137E+03	3.0266E+01	-4.6300E+04	1.3112E+05	6.2287E+00	-1.6676E+03	5.5075E+03	5.3826E+05
2.7181E+02	1.3650E+03	2.2392E+01	-4.6300E+04	1.2487E+05	1.1997E+02	-1.6676E+03	5.1403E+03	6.2297E+05
2.7181E+02	1.3162E+03	4.6135E+01	-4.6300E+04	1.1863E+05	1.2494E+02	-1.6676E+03	4.7732E+03	8.1478E+05
2.7181E+02	1.2675E+03	3.2088E+01	-4.6300E+04	1.1238E+05	1.6618E+02	-1.6676E+03	4.4060E+03	1.1227E+06
2.7181E+02	1.2187E+03	2.0048E+02	-4.6300E+04	1.0614E+05	6.3075E+01	-1.6676E+03	4.0388E+03	1.0085E+06
2.7181E+02	1.1700E+03	4.1173E+02	-4.6300E+04	9.9897E+04	3.2072E+02	-1.6676E+03	3.6717E+03	1.4375E+06
2.7181E+02	1.1212E+03	7.7225E+02	-4.6300E+04	9.3654E+04	2.0565E+02	-1.6676E+03	3.3045E+03	1.6476E+06
2.7181E+02	1.0725E+03	2.8418E+02	-4.6300E+04	8.7410E+04	6.3455E+02	-1.6676E+03	2.9373E+03	1.9840E+06
2.7181E+02	1.0237E+03	5.4724E+02	-4.6300E+04	8.1166E+04	8.9843E+02	-1.6676E+03	2.5702E+03	2.1709E+06
2.7181E+02	9.7497E+02	8.6094E+02	-4.6300E+04	7.4923E+04	1.2380E+03	-1.6676E+03	2.2030E+03	2.1119E+06
2.7181E+02	9.2622E+02	1.5024E+03	-4.6300E+04	6.8679E+04	1.2618E+03	-1.6676E+03	1.8358E+03	2.2470E+06
2.7181E+02	8.7747E+02	1.9496E+03	-4.6300E+04	6.2436E+04	4.7711E+03	-1.6676E+03	1.4687E+03	2.3397E+06
2.7181E+02	8.2873E+02	5.5583E+03	-4.6300E+04	5.6192E+04	1.3780E+04	-1.6676E+03	1.1015E+03	2.4578E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.7181E+02	7.7998E+02	6.6996E+03	-4.6300E+04	4.9949E+04	9.8327E+03	-1.6676E+03	7.3433E+02	4.4141E+06
2.7181E+02	7.3123E+02	3.8987E+03	-4.6300E+04	4.3705E+04	5.5700E+04	-1.6676E+03	3.6717E+02	9.5308E+06
2.7181E+02	6.8248E+02	1.6055E+04	-4.6300E+04	3.7461E+04	1.6396E+05	-1.6676E+03	0.0000E+00	1.7285E+07
2.7181E+02	6.3373E+02	2.0236E+04	-4.6300E+04	3.1218E+04	4.8876E+05	-2.1277E+03	1.6155E+04	1.9447E+00
2.7181E+02	5.8498E+02	6.4824E+04	-4.6300E+04	2.4974E+04	1.1802E+06	-2.1277E+03	1.5788E+04	6.5690E-02
2.7181E+02	5.3623E+02	1.0730E+05	-4.6300E+04	1.8731E+04	2.7358E+06	-2.1277E+03	1.4687E+04	8.5282E+00
2.7181E+02	4.8749E+02	2.4469E+05	-4.6300E+04	1.2487E+04	4.0224E+06	-2.1277E+03	1.4320E+04	1.9624E+01
2.7181E+02	4.3874E+02	4.7831E+05	-4.6300E+04	6.2436E+03	6.0149E+06	-2.1277E+03	1.3952E+04	9.5015E+00
2.7181E+02	3.8999E+02	8.8513E+05	-4.6300E+04	0.0000E+00	1.0726E+07	-2.1277E+03	1.3585E+04	1.2138E+02
2.7181E+02	3.4124E+02	1.5074E+06	-5.3200E+04	2.4974E+05	1.6696E+00	-2.1277E+03	1.3218E+04	7.5658E+02
2.7181E+02	2.9249E+02	2.2531E+06	-5.3200E+04	2.4350E+05	1.6696E+00	-2.1277E+03	1.2851E+04	1.6455E+01
2.7181E+02	2.4374E+02	4.0797E+06	-5.3200E+04	2.3101E+05	6.5105E+00	-2.1277E+03	1.2484E+04	1.7629E+02
2.7181E+02	1.9499E+02	5.4183E+06	-5.3200E+04	2.2477E+05	1.6696E+00	-2.1277E+03	1.2117E+04	2.8227E+02
2.7181E+02	1.4625E+02	6.2677E+06	-5.3200E+04	2.1853E+05	3.4861E+00	-2.1277E+03	1.1749E+04	9.6988E+02
2.7181E+02	9.7497E+01	7.1912E+06	-5.3200E+04	2.1228E+05	8.2605E+00	-2.1277E+03	1.1382E+04	5.8355E+01
2.7181E+02	4.8749E+01	1.1894E+07	-5.3200E+04	2.0604E+05	8.0525E+00	-2.1277E+03	1.1015E+04	7.9123E+02
2.7181E+02	0.0000E+00	3.3812E+07	-5.3200E+04	1.9979E+05	1.2416E+01	-2.1277E+03	1.0648E+04	3.2608E+02
2.1192E+02	2.1449E+03	4.0446E+00	-5.3200E+04	1.9355E+05	1.8165E+00	-2.1277E+03	1.0281E+04	1.1854E+03
2.1192E+02	2.0962E+03	6.8392E+00	-5.3200E+04	1.8731E+05	3.6497E+01	-2.1277E+03	9.9135E+03	1.0079E+03
2.1192E+02	2.0474E+03	5.0088E+00	-5.3200E+04	1.8106E+05	2.0043E+01	-2.1277E+03	9.5464E+03	3.4243E+03
2.1192E+02	1.9987E+03	6.9861E+00	-5.3200E+04	1.7482E+05	2.5018E+01	-2.1277E+03	9.1792E+03	6.2182E+03
2.1192E+02	1.9499E+03	2.2302E+01	-5.3200E+04	1.6858E+05	1.4533E+01	-2.1277E+03	8.8120E+03	1.1893E+04
2.1192E+02	1.9012E+03	1.8600E+01	-5.3200E+04	1.6233E+05	1.4522E+01	-2.1277E+03	8.4449E+03	2.4605E+04
2.1192E+02	1.8524E+03	8.6799E+00	-5.3200E+04	1.5609E+05	3.7997E+01	-2.1277E+03	8.0777E+03	3.1599E+04
2.1192E+02	1.8037E+03	6.8985E-01	-5.3200E+04	1.4985E+05	1.9796E+01	-2.1277E+03	7.7105E+03	4.7836E+04
2.1192E+02	1.7549E+03	7.6775E+00	-5.3200E+04	1.4360E+05	3.8727E+01	-2.1277E+03	7.3433E+03	7.9172E+04
2.1192E+02	1.7062E+03	2.4415E+00	-5.3200E+04	1.3736E+05	6.2053E+01	-2.1277E+03	6.9762E+03	1.3393E+05
2.1192E+02	1.6575E+03	1.4350E+00	-5.3200E+04	1.3112E+05	2.1635E+02	-2.1277E+03	6.6090E+03	1.4350E+05
2.1192E+02	1.6087E+03	2.0600E+00	-5.3200E+04	1.2487E+05	1.6985E+02	-2.1277E+03	6.2418E+03	1.8976E+05
2.1192E+02	1.5600E+03	1.0738E+02	-5.3200E+04	1.1863E+05	2.4718E+02	-2.1277E+03	5.8747E+03	2.7835E+05
2.1192E+02	1.5112E+03	1.3292E-01	-5.3200E+04	1.1238E+05	1.3561E+03	-2.1277E+03	5.5075E+03	4.1243E+05
2.1192E+02	1.4625E+03	3.8917E+00	-5.3200E+04	1.0614E+05	3.4051E+02	-2.1277E+03	5.1403E+03	3.2586E+05
2.1192E+02	1.4137E+03	8.4911E-01	-5.3200E+04	9.9897E+04	9.8797E+02	-2.1277E+03	4.7732E+03	7.1404E+05
2.1192E+02	1.3650E+03	1.2374E+01	-5.3200E+04	9.3654E+04	4.8452E+02	-2.1277E+03	4.4060E+03	8.0446E+05
2.1192E+02	1.3162E+03	5.1217E+00	-5.3200E+04	8.7410E+04	1.3687E+03	-2.1277E+03	4.0388E+03	1.0334E+06
2.1192E+02	1.2675E+03	2.5328E+01	-5.3200E+04	8.1166E+04	4.2667E+03	-2.1277E+03	3.6717E+03	1.1102E+06
2.1192E+02	1.2187E+03	1.8038E+01	-5.3200E+04	7.4923E+04	4.3069E+03	-2.1277E+03	3.3045E+03	1.2341E+06
2.1192E+02	1.1700E+03	1.6194E+02	-5.3200E+04	6.8679E+04	2.9468E+03	-2.1277E+03	2.9373E+03	1.4897E+06

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.1192E+02	1.1212E+03	7.0303E+01	-5.3200E+04	6.2436E+04	1.8853E+04	-2.1277E+03	2.5702E+03	1.5954E+06
2.1192E+02	1.0725E+03	1.2792E+03	-5.3200E+04	5.6192E+04	1.3804E+04	-2.1277E+03	2.2030E+03	1.6641E+06
2.1192E+02	1.0237E+03	4.3419E+02	-5.3200E+04	4.9949E+04	2.5369E+04	-2.1277E+03	1.8358E+03	1.7423E+06
2.1192E+02	9.7497E+02	2.3409E+02	-5.3200E+04	4.3705E+04	6.1657E+04	-2.1277E+03	1.4687E+03	1.3618E+06
2.1192E+02	9.2622E+02	7.2058E+02	-5.3200E+04	3.7461E+04	8.0312E+04	-2.1277E+03	1.1015E+03	1.7511E+06
2.1192E+02	8.7747E+02	6.1296E+02	-5.3200E+04	3.1218E+04	2.5367E+05	-2.1277E+03	7.3433E+02	3.1732E+06
2.1192E+02	8.2873E+02	6.7232E+03	-5.3200E+04	2.4974E+04	8.8188E+05	-2.1277E+03	3.6717E+02	6.9644E+06
2.1192E+02	7.7998E+02	4.7213E+03	-5.3200E+04	1.8731E+04	2.1632E+06	-2.1277E+03	0.0000E+00	1.2800E+07
2.1192E+02	7.3123E+02	6.3565E+03	-5.3200E+04	1.2487E+04	4.1356E+06	-2.5877E+03	1.6155E+04	4.2771E-01
2.1192E+02	6.8248E+02	2.2223E+04	-5.3200E+04	6.2436E+03	6.5000E+06	-2.5877E+03	1.5788E+04	9.2111E-01
2.1192E+02	6.3373E+02	4.6601E+04	-5.3200E+04	0.0000E+00	1.3083E+07	-2.5877E+03	1.5421E+04	1.3215E-01
2.1192E+02	5.8498E+02	9.6952E+04	-6.0100E+04	2.5599E+05	1.6696E+00	-2.5877E+03	1.5054E+04	7.4912E+00
2.1192E+02	5.3623E+02	1.1894E+05	-6.0100E+04	2.4974E+05	6.5105E+00	-2.5877E+03	1.4687E+04	9.4206E-01
2.1192E+02	4.8749E+02	2.7620E+05	-6.0100E+04	2.3726E+05	3.3392E+00	-2.5877E+03	1.4320E+04	9.8750E+00
2.1192E+02	4.3874E+02	5.3741E+05	-6.0100E+04	2.3101E+05	1.6696E+00	-2.5877E+03	1.3952E+04	3.0031E+00
2.1192E+02	3.8999E+02	1.0364E+06	-6.0100E+04	2.2477E+05	9.8497E+00	-2.5877E+03	1.3585E+04	2.2037E+00
2.1192E+02	3.4124E+02	1.7934E+06	-6.0100E+04	2.1853E+05	1.6696E+00	-2.5877E+03	1.3218E+04	7.3479E+00
2.1192E+02	2.9249E+02	2.9365E+06	-6.0100E+04	2.1228E+05	6.9966E+00	-2.5877E+03	1.2851E+04	1.3450E+02
2.1192E+02	2.4374E+02	5.3606E+06	-6.0100E+04	2.0604E+05	1.4691E+01	-2.5877E+03	1.2484E+04	5.8474E+00
2.1192E+02	1.9499E+02	8.5804E+06	-6.0100E+04	1.9355E+05	1.2661E+01	-2.5877E+03	1.2117E+04	6.4819E+00
2.1192E+02	1.4625E+02	1.0955E+07	-6.0100E+04	1.8731E+05	8.1763E+00	-2.5877E+03	1.1749E+04	1.4928E+01
2.1192E+02	9.7497E+01	1.1690E+07	-6.0100E+04	1.8106E+05	1.5346E+01	-2.5877E+03	1.1382E+04	2.0564E+02
2.1192E+02	4.8749E+01	1.2102E+07	-6.0100E+04	1.7482E+05	1.0823E+01	-2.5877E+03	1.1015E+04	1.4604E+01
2.1192E+02	0.0000E+00	3.8492E+07	-6.0100E+04	1.6858E+05	3.4303E+01	-2.5877E+03	1.0648E+04	2.4066E+02
1.5202E+02	2.3399E+03	6.2500E-01	-6.0100E+04	1.6233E+05	1.4630E+00	-2.5877E+03	1.0281E+04	5.4719E+03
1.5202E+02	2.2912E+03	3.3392E+00	-6.0100E+04	1.5609E+05	7.6952E+00	-2.5877E+03	9.9135E+03	3.5263E+02
1.5202E+02	2.2424E+03	1.6696E+00	-6.0100E+04	1.4985E+05	3.3748E+01	-2.5877E+03	9.5464E+03	1.5545E+02
1.5202E+02	2.1937E+03	1.8165E+00	-6.0100E+04	1.4360E+05	9.3702E+00	-2.5877E+03	9.1792E+03	9.3771E+02
1.5202E+02	2.1449E+03	8.5753E+00	-6.0100E+04	1.3736E+05	3.2543E+01	-2.5877E+03	8.8120E+03	1.2236E+04
1.5202E+02	2.0962E+03	1.7500E+00	-6.0100E+04	1.3112E+05	5.5212E+01	-2.5877E+03	8.4449E+03	4.9152E+03
1.5202E+02	2.0474E+03	1.6696E+00	-6.0100E+04	1.2487E+05	6.7468E+02	-2.5877E+03	8.0777E+03	5.0619E+03
1.5202E+02	1.9987E+03	9.2946E+00	-6.0100E+04	1.1863E+05	1.0419E+02	-2.5877E+03	7.7105E+03	1.4913E+04
1.5202E+02	1.9499E+03	5.3165E+00	-6.0100E+04	1.1238E+05	8.4153E+02	-2.5877E+03	7.3433E+03	4.3076E+04
1.5202E+02	1.9012E+03	5.1696E+00	-6.0100E+04	1.0614E+05	4.6328E+02	-2.5877E+03	6.9762E+03	4.1798E+04
1.5202E+02	1.8524E+03	2.6859E+00	-6.0100E+04	9.9897E+04	5.5815E+03	-2.5877E+03	6.6090E+03	5.2361E+04
1.5202E+02	1.8037E+03	7.5446E+00	-6.0100E+04	9.3654E+04	1.2168E+04	-2.5877E+03	6.2418E+03	1.2455E+05
1.5202E+02	1.6575E+03	6.6460E-02	-6.0100E+04	8.7410E+04	1.2568E+04	-2.5877E+03	5.8747E+03	1.5443E+05
1.5202E+02	1.6087E+03	1.3292E-01	-6.0100E+04	8.1166E+04	3.6389E+04	-2.5877E+03	5.5075E+03	2.6135E+05

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.5202E+02	1.5600E+03	1.8165E+00	-6.0100E+04	7.4923E+04	1.3069E+04	-2.5877E+03	5.1403E+03	3.5416E+05
1.5202E+02	1.4625E+03	3.3244E+00	-6.0100E+04	6.8679E+04	2.2543E+04	-2.5877E+03	4.7732E+03	4.1386E+05
1.5202E+02	1.4137E+03	1.0214E+00	-6.0100E+04	6.2436E+04	7.9061E+03	-2.5877E+03	4.4060E+03	5.0689E+05
1.5202E+02	1.3650E+03	1.1272E+00	-6.0100E+04	5.6192E+04	2.4737E+04	-2.5877E+03	4.0388E+03	5.8801E+05
1.5202E+02	1.3162E+03	3.3230E-01	-6.0100E+04	4.9949E+04	1.9763E+04	-2.5877E+03	3.6717E+03	8.1316E+05
1.5202E+02	1.2675E+03	1.2536E+01	-6.0100E+04	4.3705E+04	5.2083E+04	-2.5877E+03	3.3045E+03	1.1129E+06
1.5202E+02	1.2187E+03	1.4340E+01	-6.0100E+04	3.7461E+04	1.5966E+05	-2.5877E+03	2.9373E+03	1.0742E+06
1.5202E+02	1.1700E+03	1.5435E+01	-6.0100E+04	3.1218E+04	3.9223E+05	-2.5877E+03	2.5702E+03	1.1135E+06
1.5202E+02	1.1212E+03	2.0308E+01	-6.0100E+04	2.4974E+04	8.5552E+05	-2.5877E+03	2.2030E+03	1.1014E+06
1.5202E+02	1.0725E+03	2.9784E+01	-6.0100E+04	1.8731E+04	2.5806E+06	-2.5877E+03	1.8358E+03	1.1329E+06
1.5202E+02	1.0237E+03	1.8739E+02	-6.0100E+04	1.2487E+04	5.1164E+06	-2.5877E+03	1.4687E+03	1.0538E+06
1.5202E+02	9.7497E+02	5.6667E+01	-6.0100E+04	6.2436E+03	6.9290E+06	-2.5877E+03	1.1015E+03	1.4417E+06
1.5202E+02	9.2622E+02	7.1046E+02	-6.0100E+04	0.0000E+00	1.4748E+07	-2.5877E+03	7.3433E+02	2.5632E+06
1.5202E+02	8.7747E+02	2.5801E+03	-6.7000E+04	2.0604E+05	9.7220E+00	-2.5877E+03	3.6717E+02	4.9907E+06
1.5202E+02	8.2873E+02	6.8344E+03	-6.7000E+04	1.8731E+05	1.2033E+00	-2.5877E+03	0.0000E+00	8.6772E+06
1.5202E+02	7.7998E+02	7.6895E+03	-6.7000E+04	1.8106E+05	1.3527E+01	-3.0478E+03	1.7624E+04	1.0417E+02
1.5202E+02	7.3123E+02	2.3375E+04	-6.7000E+04	1.7482E+05	3.7987E+01	-3.0478E+03	1.6155E+04	6.6460E-02
1.5202E+02	6.8248E+02	3.8118E+04	-6.7000E+04	1.6858E+05	1.0865E+01	-3.0478E+03	1.5421E+04	4.9340E-01
1.5202E+02	6.3373E+02	8.1832E+04	-6.7000E+04	1.6233E+05	2.5642E+01	-3.0478E+03	1.5054E+04	6.5690E-02
1.5202E+02	5.8498E+02	1.5129E+05	-6.7000E+04	1.5609E+05	1.0823E+01	-3.0478E+03	1.4687E+04	8.7714E-01
1.5202E+02	5.3623E+02	2.2746E+05	-6.7000E+04	1.4985E+05	2.0750E+01	-3.0478E+03	1.4320E+04	1.5671E+00
1.5202E+02	4.8749E+02	4.2985E+05	-6.7000E+04	1.4360E+05	4.5702E+01	-3.0478E+03	1.3585E+04	1.4335E+00
1.5202E+02	4.3874E+02	7.3656E+05	-6.7000E+04	1.3736E+05	6.6114E+02	-3.0478E+03	1.3218E+04	1.7298E+00
1.5202E+02	3.8999E+02	1.3099E+06	-6.7000E+04	1.3112E+05	3.7582E+03	-3.0478E+03	1.2851E+04	2.5082E-01
1.5202E+02	3.4124E+02	2.3213E+06	-6.7000E+04	1.2487E+05	8.9733E+01	-3.0478E+03	1.2484E+04	2.3089E+00
1.5202E+02	2.9249E+02	3.8579E+06	-6.7000E+04	1.1863E+05	3.2630E+03	-3.0478E+03	1.2117E+04	4.3847E+00
1.5202E+02	2.4374E+02	6.8025E+06	-6.7000E+04	1.1238E+05	7.5685E+03	-3.0478E+03	1.1749E+04	1.1626E+01
1.5202E+02	1.9499E+02	1.0128E+07	-6.7000E+04	1.0614E+05	3.4171E+03	-3.0478E+03	1.1382E+04	4.8501E+00
1.5202E+02	1.4625E+02	1.2947E+07	-6.7000E+04	9.9897E+04	5.0153E+02	-3.0478E+03	1.1015E+04	2.8600E+00
1.5202E+02	9.7497E+01	1.3156E+07	-6.7000E+04	9.3654E+04	1.2782E+03	-3.0478E+03	1.0648E+04	1.2487E+02
1.5202E+02	4.8749E+01	1.4544E+07	-6.7000E+04	8.7410E+04	1.1259E+03	-3.0478E+03	1.0281E+04	5.9599E+00
1.5202E+02	0.0000E+00	3.7819E+07	-6.7000E+04	8.1166E+04	6.8959E+03	-3.0478E+03	9.9135E+03	1.2144E+02
9.2129E+01	2.4374E+03	1.6696E+00	-6.7000E+04	7.4923E+04	2.7000E+04	-3.0478E+03	9.5464E+03	5.7233E+02
9.2129E+01	2.2912E+03	5.0088E+00	-6.7000E+04	6.8679E+04	3.4348E+04	-3.0478E+03	9.1792E+03	1.2105E+02
9.2129E+01	2.2424E+03	3.3392E+00	-6.7000E+04	6.2436E+04	2.2729E+04	-3.0478E+03	8.8120E+03	4.0876E+02
9.2129E+01	2.1937E+03	3.3392E+00	-6.7000E+04	5.6192E+04	5.7214E+04	-3.0478E+03	8.4449E+03	6.9466E+02
9.2129E+01	2.0962E+03	2.3611E+00	-6.7000E+04	4.9949E+04	8.3176E+04	-3.0478E+03	8.0777E+03	4.9278E+02
9.2129E+01	1.9987E+03	6.6460E-02	-6.7000E+04	4.3705E+04	1.3643E+05	-3.0478E+03	7.7105E+03	3.8812E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Energy Systems Tåsingeløkkvej 8-2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
9.2129E+01	1.9499E+03	3.4196E+00	-6.7000E+04	3.7461E+04	1.8744E+05	-3.0478E+03	7.3433E+03	3.1723E+03
9.2129E+01	1.9012E+03	3.5000E+00	-6.7000E+04	3.1218E+04	3.7420E+05	-3.0478E+03	6.9762E+03	1.6880E+04
9.2129E+01	1.8524E+03	3.1534E+00	-6.7000E+04	2.4974E+04	8.4807E+05	-3.0478E+03	6.6090E+03	9.3208E+03
9.2129E+01	1.7549E+03	1.7500E+00	-6.7000E+04	1.8731E+04	2.4300E+06	-3.0478E+03	6.2418E+03	3.9351E+04
9.2129E+01	1.5112E+03	1.3165E+00	-6.7000E+04	1.2487E+04	4.1883E+06	-3.0478E+03	5.8747E+03	7.2086E+04
9.2129E+01	1.4625E+03	1.4422E-01	-6.7000E+04	6.2436E+03	4.8934E+06	-3.0478E+03	5.5075E+03	1.1520E+05
9.2129E+01	1.4137E+03	2.6584E-01	-6.7000E+04	0.0000E+00	1.2432E+07	-3.0478E+03	5.1403E+03	1.9839E+05
9.2129E+01	1.3650E+03	6.9146E-01	-7.3900E+04	2.1853E+05	1.6696E+00	-3.0478E+03	4.7732E+03	1.6186E+05
9.2129E+01	1.3162E+03	1.4275E+00	-7.3900E+04	2.0604E+05	1.6696E+00	-3.0478E+03	4.4060E+03	3.2438E+05
9.2129E+01	1.2675E+03	2.1759E+00	-7.3900E+04	1.9979E+05	1.6696E+00	-3.0478E+03	4.0388E+03	4.7559E+05
9.2129E+01	1.2187E+03	5.6197E-01	-7.3900E+04	1.8731E+05	5.3270E+00	-3.0478E+03	3.6717E+03	6.6534E+05
9.2129E+01	1.1700E+03	1.8025E+00	-7.3900E+04	1.8106E+05	6.2339E-01	-3.0478E+03	3.3045E+03	6.2794E+05
9.2129E+01	1.1212E+03	7.4274E+00	-7.3900E+04	1.7482E+05	6.5303E+00	-3.0478E+03	2.9373E+03	7.8231E+05
9.2129E+01	1.0725E+03	6.1047E+00	-7.3900E+04	1.4985E+05	2.8938E+01	-3.0478E+03	2.5702E+03	8.1230E+05
9.2129E+01	1.0237E+03	8.7569E+00	-7.3900E+04	1.4360E+05	6.5264E+02	-3.0478E+03	2.2030E+03	7.3871E+05
9.2129E+01	9.7497E+02	5.9032E+01	-7.3900E+04	1.3736E+05	6.5070E+02	-3.0478E+03	1.8358E+03	7.2391E+05
9.2129E+01	9.2622E+02	1.1710E+03	-7.3900E+04	1.3112E+05	9.3702E+00	-3.0478E+03	1.4687E+03	7.6567E+05
9.2129E+01	8.7747E+02	2.3137E+03	-7.3900E+04	1.2487E+05	1.3064E+03	-3.0478E+03	1.1015E+03	8.6164E+05
9.2129E+01	8.2873E+02	5.0657E+03	-7.3900E+04	1.1863E+05	3.5425E+01	-3.0478E+03	7.3433E+02	1.6422E+06
9.2129E+01	7.7998E+02	8.7169E+03	-7.3900E+04	1.1238E+05	2.5779E+03	-3.0478E+03	3.6717E+02	3.7987E+06
9.2129E+01	7.3123E+02	2.5080E+04	-7.3900E+04	1.0614E+05	5.0697E+03	-3.0478E+03	0.0000E+00	6.1044E+06
9.2129E+01	6.8248E+02	4.1672E+04	-7.3900E+04	9.9897E+04	3.9096E+03	-3.5078E+03	1.8358E+04	6.6460E-02
9.2129E+01	6.3373E+02	6.6333E+04	-7.3900E+04	9.3654E+04	2.4529E+04	-3.5078E+03	1.7257E+04	6.5690E-02
9.2129E+01	5.8498E+02	1.3447E+05	-7.3900E+04	8.7410E+04	1.3734E+03	-3.5078E+03	1.6155E+04	2.5082E-01
9.2129E+01	5.3623E+02	2.4867E+05	-7.3900E+04	8.1166E+04	2.2896E+03	-3.5078E+03	1.5788E+04	3.1728E-01
9.2129E+01	4.8749E+02	4.4080E+05	-7.3900E+04	7.4923E+04	9.3617E+03	-3.5078E+03	1.4687E+04	6.6460E-02
9.2129E+01	4.3874E+02	6.1424E+05	-7.3900E+04	6.8679E+04	8.6669E+03	-3.5078E+03	1.3585E+04	2.5082E-01
9.2129E+01	3.8999E+02	1.1292E+06	-7.3900E+04	6.2436E+04	3.2269E+04	-3.5078E+03	1.3218E+04	6.5505E-01
9.2129E+01	3.4124E+02	1.4485E+06	-7.3900E+04	5.6192E+04	6.5807E+04	-3.5078E+03	1.2851E+04	3.1728E-01
9.2129E+01	2.9249E+02	2.1269E+06	-7.3900E+04	4.9949E+04	1.2846E+05	-3.5078E+03	1.2484E+04	1.0757E+00
9.2129E+01	2.4374E+02	2.6222E+06	-7.3900E+04	4.3705E+04	1.9428E+05	-3.5078E+03	1.2117E+04	1.1287E+00
9.2129E+01	1.9499E+02	3.5103E+06	-7.3900E+04	3.7461E+04	3.7422E+05	-3.5078E+03	1.1749E+04	1.9066E+00
9.2129E+01	1.4625E+02	3.5221E+06	-7.3900E+04	3.1218E+04	7.7038E+05	-3.5078E+03	1.1382E+04	1.3157E+00
9.2129E+01	9.7497E+01	3.3925E+06	-7.3900E+04	2.4974E+04	1.7463E+06	-3.5078E+03	1.1015E+04	7.6258E-02
9.2129E+01	4.8749E+01	4.0633E+06	-7.3900E+04	1.8731E+04	3.1481E+06	-3.5078E+03	1.0648E+04	2.0918E-01
9.2129E+01	0.0000E+00	1.7732E+07	-7.3900E+04	1.2487E+04	4.6192E+06	-3.5078E+03	1.0281E+04	6.6460E-02
3.2234E+01	2.2424E+03	6.6460E-02	-7.3900E+04	6.2436E+03	5.3955E+06	-3.5078E+03	9.9135E+03	3.1129E+00
3.2234E+01	2.1937E+03	3.3392E+00	-7.3900E+04	0.0000E+00	1.0749E+07	-3.5078E+03	9.5464E+03	1.1272E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.2234E+01	2.0962E+03	1.6696E+00	-8.0800E+04	2.2477E+05	1.6696E+00	-3.5078E+03	9.1792E+03	1.5059E+00
3.2234E+01	1.9499E+03	3.4196E+00	-8.0800E+04	2.0604E+05	1.6696E+00	-3.5078E+03	8.8120E+03	1.9092E+00
3.2234E+01	1.9012E+03	1.7500E+00	-8.0800E+04	1.4985E+05	6.6965E+00	-3.5078E+03	8.4449E+03	2.4095E+02
3.2234E+01	1.5600E+03	6.6460E-02	-8.0800E+04	1.3112E+05	1.1761E+02	-3.5078E+03	8.0777E+03	2.9564E+01
3.2234E+01	1.4137E+03	6.6460E-02	-8.0800E+04	1.2487E+05	7.5906E+02	-3.5078E+03	7.7105E+03	6.7590E+01
3.2234E+01	1.3650E+03	1.3442E-01	-8.0800E+04	1.1863E+05	5.8998E+02	-3.5078E+03	7.3433E+03	5.5378E+02
3.2234E+01	1.3162E+03	1.9938E-01	-8.0800E+04	1.1238E+05	8.4409E+02	-3.5078E+03	6.9762E+03	3.5536E+03
3.2234E+01	1.2675E+03	6.9146E-01	-8.0800E+04	1.0614E+05	5.2442E+03	-3.5078E+03	6.6090E+03	2.3432E+03
3.2234E+01	1.2187E+03	7.2738E+00	-8.0800E+04	9.9897E+04	3.6804E+03	-3.5078E+03	6.2418E+03	1.9146E+04
3.2234E+01	1.1700E+03	9.8207E+00	-8.0800E+04	9.3654E+04	6.6189E+03	-3.5078E+03	5.8747E+03	2.3736E+04
3.2234E+01	1.1212E+03	1.7129E+01	-8.0800E+04	8.7410E+04	1.1603E+04	-3.5078E+03	5.5075E+03	3.2931E+04
3.2234E+01	1.0725E+03	6.2215E+00	-8.0800E+04	8.1166E+04	1.6231E+04	-3.5078E+03	5.1403E+03	4.2682E+04
3.2234E+01	1.0237E+03	3.1282E+01	-8.0800E+04	7.4923E+04	2.2756E+04	-3.5078E+03	4.7732E+03	1.4198E+05
3.2234E+01	9.7497E+02	1.2537E+01	-8.0800E+04	6.8679E+04	4.2540E+04	-3.5078E+03	4.4060E+03	1.4789E+05
3.2234E+01	9.2622E+02	1.6178E+01	-8.0800E+04	6.2436E+04	5.2065E+04	-3.5078E+03	4.0388E+03	2.5838E+05
3.2234E+01	8.7747E+02	4.7541E+01	-8.0800E+04	5.6192E+04	7.6177E+04	-3.5078E+03	3.6717E+03	3.1705E+05
3.2234E+01	8.2873E+02	2.2558E+03	-8.0800E+04	4.9949E+04	1.9256E+05	-3.5078E+03	3.3045E+03	3.0608E+05
3.2234E+01	7.7998E+02	2.3203E+03	-8.0800E+04	4.3705E+04	3.2871E+05	-3.5078E+03	2.9373E+03	4.1769E+05
3.2234E+01	7.3123E+02	1.4261E+04	-8.0800E+04	3.7461E+04	7.3935E+05	-3.5078E+03	2.5702E+03	5.0801E+05
3.2234E+01	6.8248E+02	1.3019E+04	-8.0800E+04	3.1218E+04	1.3225E+06	-3.5078E+03	2.2030E+03	5.2461E+05
3.2234E+01	6.3373E+02	2.6456E+04	-8.0800E+04	2.4974E+04	2.3933E+06	-3.5078E+03	1.8358E+03	4.9743E+05
3.2234E+01	5.8498E+02	5.3154E+04	-8.0800E+04	1.8731E+04	3.1457E+06	-3.5078E+03	1.4687E+03	4.8171E+05
3.2234E+01	5.3623E+02	8.0241E+04	-8.0800E+04	1.2487E+04	4.2354E+06	-3.5078E+03	1.1015E+03	6.3154E+05
3.2234E+01	4.8749E+02	1.0009E+05	-8.0800E+04	6.2436E+03	4.1112E+06	-3.5078E+03	7.3433E+02	1.1321E+06
3.2234E+01	4.3874E+02	2.1768E+05	-8.0800E+04	0.0000E+00	7.9555E+06	-3.5078E+03	3.6717E+02	2.1951E+06
3.2234E+01	3.8999E+02	3.4809E+05	-8.7700E+04	1.4360E+05	5.5090E+02	-3.5078E+03	0.0000E+00	4.6493E+06
3.2234E+01	3.4124E+02	5.2471E+05	-8.7700E+04	1.3112E+05	4.5658E+01	-3.9678E+03	1.6890E+04	6.5690E-02
3.2234E+01	2.9249E+02	7.1629E+05	-8.7700E+04	1.2487E+05	6.2889E+02	-3.9678E+03	1.6523E+04	1.3021E+00
3.2234E+01	2.4374E+02	1.0235E+06	-8.7700E+04	1.1863E+05	7.7067E+02	-3.9678E+03	1.6155E+04	1.5341E-01
3.2234E+01	1.9499E+02	1.3298E+06	-8.7700E+04	1.1238E+05	2.8747E+03	-3.9678E+03	1.5788E+04	6.6460E-02
3.2234E+01	1.4625E+02	1.5543E+06	-8.7700E+04	1.0614E+05	2.1860E+03	-3.9678E+03	1.2851E+04	1.3593E-01
3.2234E+01	9.7497E+01	2.4469E+06	-8.7700E+04	9.9897E+04	4.5682E+03	-3.9678E+03	1.2117E+04	6.9146E-01
3.2234E+01	4.8749E+01	6.4557E+06	-8.7700E+04	9.3654E+04	1.1456E+04	-3.9678E+03	1.1749E+04	7.6772E-01
3.2234E+01	0.0000E+00	2.3538E+07	-8.7700E+04	8.7410E+04	1.7420E+04	-3.9678E+03	1.1382E+04	2.5763E+00
-2.7661E+01	2.1937E+03	1.6696E+00	-8.7700E+04	8.1166E+04	1.1716E+04	-3.9678E+03	1.1015E+04	3.7328E-01
-2.7661E+01	2.0962E+03	6.6460E-02	-8.7700E+04	7.4923E+04	4.6364E+04	-3.9678E+03	1.0648E+04	6.9146E-01
-2.7661E+01	2.0474E+03	6.2500E-01	-8.7700E+04	6.8679E+04	6.0694E+04	-3.9678E+03	1.0281E+04	7.6594E-01
-2.7661E+01	1.9987E+03	1.6696E+00	-8.7700E+04	6.2436E+04	1.0297E+05	-3.9678E+03	9.9135E+03	1.5808E+00

DNV
DNV Energy Systems
Tuborgvejen 6.2.
DK-2900 Hellerup
VAT No. DK89832314

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.7661E+01	1.6087E+03	1.7361E+00	-8.7700E+04	5.6192E+04	1.3149E+05	-3.9678E+03	9.5464E+03	5.6810E-01
-2.7661E+01	1.5600E+03	6.6460E-02	-8.7700E+04	4.9949E+04	2.5688E+05	-3.9678E+03	9.1792E+03	5.0164E-01
-2.7661E+01	1.4625E+03	6.9146E-01	-8.7700E+04	4.3705E+04	4.8794E+05	-3.9678E+03	8.8120E+03	2.2306E+02
-2.7661E+01	1.4137E+03	1.6696E+00	-8.7700E+04	3.7461E+04	9.6638E+05	-3.9678E+03	8.4449E+03	2.5025E+00
-2.7661E+01	1.3650E+03	6.6460E-02	-8.7700E+04	3.1218E+04	1.4438E+06	-3.9678E+03	8.0777E+03	1.2019E+00
-2.7661E+01	1.3162E+03	2.0158E+00	-8.7700E+04	2.4974E+04	2.2376E+06	-3.9678E+03	7.7105E+03	8.1655E+00
-2.7661E+01	1.2675E+03	1.3292E-01	-8.7700E+04	1.8731E+04	2.9994E+06	-3.9678E+03	7.3433E+03	1.8514E+02
-2.7661E+01	1.2187E+03	3.9565E+00	-8.7700E+04	1.2487E+04	3.3019E+06	-3.9678E+03	6.9762E+03	1.1881E+03
-2.7661E+01	1.1700E+03	5.2771E+00	-8.7700E+04	6.2436E+03	3.1197E+06	-3.9678E+03	6.6090E+03	1.4719E+03
-2.7661E+01	1.1212E+03	1.1335E+01	-8.7700E+04	0.0000E+00	5.9695E+06	-3.9678E+03	6.2418E+03	9.9914E+01
-2.7661E+01	1.0725E+03	6.6329E+00	-9.4599E+04	1.3112E+05	3.2119E+03	-3.9678E+03	5.8747E+03	6.1777E+03
-2.7661E+01	1.0237E+03	9.4661E+00	-9.4599E+04	1.2487E+05	1.1018E+03	-3.9678E+03	5.5075E+03	8.0581E+03
-2.7661E+01	9.7497E+02	7.7579E+00	-9.4599E+04	1.1863E+05	5.5150E+03	-3.9678E+03	5.1403E+03	5.4659E+03
-2.7661E+01	9.2622E+02	2.3728E+01	-9.4599E+04	1.1238E+05	2.3130E+03	-3.9678E+03	4.7732E+03	4.0168E+04
-2.7661E+01	8.7747E+02	3.9325E+01	-9.4599E+04	1.0614E+05	6.6334E+03	-3.9678E+03	4.4060E+03	2.9614E+04
-2.7661E+01	8.2873E+02	9.3854E+01	-9.4599E+04	9.9897E+04	1.4459E+04	-3.9678E+03	4.0388E+03	6.1477E+04
-2.7661E+01	7.7998E+02	5.6131E+03	-9.4599E+04	9.3654E+04	1.5061E+04	-3.9678E+03	3.6717E+03	1.1396E+05
-2.7661E+01	7.3123E+02	4.5500E+03	-9.4599E+04	8.7410E+04	2.1445E+04	-3.9678E+03	3.3045E+03	1.2282E+05
-2.7661E+01	6.8248E+02	5.7570E+03	-9.4599E+04	8.1166E+04	2.1551E+04	-3.9678E+03	2.9373E+03	1.7990E+05
-2.7661E+01	6.3373E+02	6.8501E+03	-9.4599E+04	7.4923E+04	6.0552E+04	-3.9678E+03	2.5702E+03	2.7887E+05
-2.7661E+01	5.8498E+02	1.1409E+04	-9.4599E+04	6.8679E+04	5.2521E+04	-3.9678E+03	2.2030E+03	3.2804E+05
-2.7661E+01	5.3623E+02	1.1552E+04	-9.4599E+04	6.2436E+04	1.2429E+05	-3.9678E+03	1.8358E+03	3.1999E+05
-2.7661E+01	4.8749E+02	1.6600E+04	-9.4599E+04	5.6192E+04	2.7799E+05	-3.9678E+03	1.4687E+03	2.4676E+05
-2.7661E+01	4.3874E+02	3.1449E+04	-9.4599E+04	4.9949E+04	4.6958E+05	-3.9678E+03	1.1015E+03	3.8777E+05
-2.7661E+01	3.8999E+02	5.4564E+04	-9.4599E+04	4.3705E+04	8.0790E+05	-3.9678E+03	7.3433E+02	6.4083E+05
-2.7661E+01	3.4124E+02	5.4271E+04	-9.4599E+04	3.7461E+04	1.2325E+06	-3.9678E+03	3.6717E+02	1.5146E+06
-2.7661E+01	2.9249E+02	9.1067E+04	-9.4599E+04	3.1218E+04	2.0885E+06	-3.9678E+03	0.0000E+00	3.1534E+06
-2.7661E+01	2.4374E+02	1.6368E+05	-9.4599E+04	2.4974E+04	2.8538E+06	-4.4279E+03	1.4687E+04	1.0417E+02
-2.7661E+01	1.9499E+02	4.0955E+05	-9.4599E+04	1.8731E+04	3.4493E+06	-4.4279E+03	1.3952E+04	6.2500E-01
-2.7661E+01	1.4625E+02	1.0340E+06	-9.4599E+04	1.2487E+04	3.2995E+06	-4.4279E+03	1.3218E+04	2.5665E+00
-2.7661E+01	9.7497E+01	2.8679E+06	-9.4599E+04	6.2436E+03	2.9692E+06	-4.4279E+03	1.2851E+04	2.5000E+00
-2.7661E+01	4.8749E+01	7.9409E+06	-9.4599E+04	0.0000E+00	6.6115E+06	-4.4279E+03	1.1382E+04	1.5341E-01
-2.7661E+01	0.0000E+00	2.2778E+07	-1.0150E+05	1.6858E+05	6.6965E+00	-4.4279E+03	1.0648E+04	5.2710E-01
-8.7556E+01	1.7549E+03	6.6460E-02	-1.0150E+05	1.6233E+05	6.6965E+00	-4.4279E+03	9.5464E+03	1.6696E+00
-8.7556E+01	1.6575E+03	6.2500E-01	-1.0150E+05	1.3112E+05	5.2525E+01	-4.4279E+03	8.8120E+03	1.9643E+00
-8.7556E+01	1.4625E+03	7.7841E-01	-1.0150E+05	1.2487E+05	8.2676E+02	-4.4279E+03	8.0777E+03	2.7424E+01
-8.7556E+01	1.4137E+03	3.4196E+00	-1.0150E+05	1.1863E+05	2.5530E+03	-4.4279E+03	7.7105E+03	5.3014E-01
-8.7556E+01	1.3650E+03	2.3750E+00	-1.0150E+05	1.1238E+05	1.1706E+04	-4.4279E+03	7.3433E+03	4.8876E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Digital Solutions Tuborgvænget 6-8, DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-8.7556E+01	1.3162E+03	1.7500E+00	-1.0150E+05	1.0614E+05	9.4371E+03	-4.4279E+03	6.9762E+03	3.1078E+01
-8.7556E+01	1.2675E+03	1.9415E+00	-1.0150E+05	9.9897E+04	2.6613E+04	-4.4279E+03	6.6090E+03	1.6811E+01
-8.7556E+01	1.2187E+03	4.0307E+00	-1.0150E+05	9.3654E+04	1.5943E+04	-4.4279E+03	6.2418E+03	4.6625E+01
-8.7556E+01	1.1700E+03	4.0446E+00	-1.0150E+05	8.7410E+04	2.4440E+04	-4.4279E+03	5.8747E+03	2.1596E+02
-8.7556E+01	1.1212E+03	5.0892E+00	-1.0150E+05	8.1166E+04	6.2929E+04	-4.4279E+03	5.5075E+03	3.1083E+01
-8.7556E+01	1.0725E+03	6.8733E+00	-1.0150E+05	7.4923E+04	4.2244E+04	-4.4279E+03	5.1403E+03	5.9318E+02
-8.7556E+01	1.0237E+03	3.0525E+00	-1.0150E+05	6.8679E+04	9.9536E+04	-4.4279E+03	4.7732E+03	2.4876E+02
-8.7556E+01	9.7497E+02	1.3817E+01	-1.0150E+05	6.2436E+04	1.3334E+05	-4.4279E+03	4.4060E+03	2.1456E+04
-8.7556E+01	9.2622E+02	1.8236E+01	-1.0150E+05	5.6192E+04	3.2832E+05	-4.4279E+03	4.0388E+03	2.3112E+04
-8.7556E+01	8.7747E+02	2.3839E+01	-1.0150E+05	4.9949E+04	4.9359E+05	-4.4279E+03	3.6717E+03	1.5876E+04
-8.7556E+01	8.2873E+02	5.1591E+01	-1.0150E+05	4.3705E+04	1.0284E+06	-4.4279E+03	3.3045E+03	3.5514E+04
-8.7556E+01	7.7998E+02	5.5608E+01	-1.0150E+05	3.7461E+04	1.7097E+06	-4.4279E+03	2.9373E+03	5.5479E+04
-8.7556E+01	7.3123E+02	6.4661E+01	-1.0150E+05	3.1218E+04	2.7326E+06	-4.4279E+03	2.5702E+03	6.5032E+04
-8.7556E+01	6.8248E+02	1.2391E+02	-1.0150E+05	2.4974E+04	3.9832E+06	-4.4279E+03	2.2030E+03	5.4256E+04
-8.7556E+01	6.3373E+02	1.2174E+02	-1.0150E+05	1.8731E+04	4.5703E+06	-4.4279E+03	1.8358E+03	7.2178E+04
-8.7556E+01	5.8498E+02	2.0575E+02	-1.0150E+05	1.2487E+04	4.5178E+06	-4.4279E+03	1.4687E+03	1.0623E+05
-8.7556E+01	5.3623E+02	2.0790E+02	-1.0150E+05	6.2436E+03	4.3510E+06	-4.4279E+03	1.1015E+03	2.1851E+05
-8.7556E+01	4.8749E+02	3.5055E+02	-1.0150E+05	0.0000E+00	1.0185E+07	-4.4279E+03	7.3433E+02	2.7205E+05
-8.7556E+01	4.3874E+02	2.5520E+03	-1.0840E+05	1.5609E+05	2.5569E+01	-4.4279E+03	3.6717E+02	6.4455E+05
-8.7556E+01	3.8999E+02	4.9650E+03	-1.0840E+05	1.4985E+05	2.5569E+01	-4.4279E+03	0.0000E+00	1.5674E+06
-8.7556E+01	3.4124E+02	2.7704E+03	-1.0840E+05	1.3736E+05	2.0055E+02	-4.8879E+03	1.4320E+04	1.3021E+00
-8.7556E+01	2.9249E+02	1.3441E+04	-1.0840E+05	1.1863E+05	1.8734E+03	-4.8879E+03	1.3585E+04	6.6460E-02
-8.7556E+01	2.4374E+02	2.2565E+04	-1.0840E+05	1.1238E+05	2.8044E+03	-4.8879E+03	1.3218E+04	6.6460E-02
-8.7556E+01	1.9499E+02	1.4437E+04	-1.0840E+05	1.0614E+05	3.2664E+03	-4.8879E+03	1.2484E+04	6.2500E-01
-8.7556E+01	1.4625E+02	3.5428E+04	-1.0840E+05	9.9897E+04	6.4933E+03	-4.8879E+03	1.1749E+04	6.6460E-02
-8.7556E+01	9.7497E+01	7.4372E+04	-1.0840E+05	9.3654E+04	4.7110E+04	-4.8879E+03	9.1792E+03	7.4255E+00
-8.7556E+01	4.8749E+01	4.0282E+05	-1.0840E+05	8.7410E+04	4.2256E+04	-4.8879E+03	6.9762E+03	3.5910E+00
-8.7556E+01	0.0000E+00	1.3218E+06	-1.0840E+05	8.1166E+04	2.7018E+04	-4.8879E+03	6.2418E+03	2.1728E+01
-1.4745E+02	1.9012E+03	6.6460E-02	-1.0840E+05	7.4923E+04	9.9346E+04	-4.8879E+03	5.8747E+03	5.8741E+00
-1.4745E+02	1.6575E+03	1.3292E-01	-1.0840E+05	6.8679E+04	8.8519E+04	-4.8879E+03	5.5075E+03	4.9149E+00
-1.4745E+02	1.6087E+03	1.6696E+00	-1.0840E+05	6.2436E+04	1.4982E+05	-4.8879E+03	5.1403E+03	2.1865E+01
-1.4745E+02	1.5600E+03	6.6460E-02	-1.0840E+05	5.6192E+04	2.2644E+05	-4.8879E+03	4.7732E+03	7.5594E+01
-1.4745E+02	1.4137E+03	1.6696E+00	-1.0840E+05	4.9949E+04	4.4439E+05	-4.8879E+03	4.4060E+03	3.1394E+01
-1.4745E+02	1.3650E+03	6.2500E-01	-1.0840E+05	4.3705E+04	7.3874E+05	-4.8879E+03	4.0388E+03	9.8300E+02
-1.4745E+02	1.3162E+03	3.0000E+00	-1.0840E+05	3.7461E+04	1.4414E+06	-4.8879E+03	3.6717E+03	2.3747E+03
-1.4745E+02	1.2675E+03	5.2500E+00	-1.0840E+05	3.1218E+04	2.7574E+06	-4.8879E+03	3.3045E+03	6.3706E+02
-1.4745E+02	1.2187E+03	3.5000E+00	-1.0840E+05	2.4974E+04	4.2945E+06	-4.8879E+03	2.9373E+03	7.4003E+03
-1.4745E+02	1.1700E+03	4.6696E+00	-1.0840E+05	1.8731E+04	5.6237E+06	-4.8879E+03	2.5702E+03	2.2161E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.4745E+02	1.1212E+03	1.2250E+01	-1.0840E+05	1.2487E+04	5.9603E+06	-4.8879E+03	2.2030E+03	9.2000E+03
-1.4745E+02	1.0725E+03	1.5755E+01	-1.0840E+05	6.2436E+03	5.7157E+06	-4.8879E+03	1.8358E+03	3.8989E+04
-1.4745E+02	1.0237E+03	1.1045E+01	-1.0840E+05	0.0000E+00	1.4873E+07	-4.8879E+03	1.4687E+03	2.7356E+04
-1.4745E+02	9.7497E+02	3.1876E+01	-1.1530E+05	1.2487E+05	8.3093E+02	-4.8879E+03	1.1015E+03	3.8062E+04
-1.4745E+02	9.2622E+02	1.8768E+01	-1.1530E+05	1.1863E+05	2.3794E+02	-4.8879E+03	7.3433E+02	9.7505E+04
-1.4745E+02	8.7747E+02	4.9728E+01	-1.1530E+05	1.1238E+05	2.1809E+03	-4.8879E+03	3.6717E+02	2.2133E+05
-1.4745E+02	8.2873E+02	5.4038E+01	-1.1530E+05	1.0614E+05	4.2282E+03	-4.8879E+03	0.0000E+00	6.8669E+05
-1.4745E+02	7.7998E+02	3.3329E+01	-1.1530E+05	9.9897E+04	4.1303E+03	-5.3480E+03	1.4687E+04	6.6460E-02
-1.4745E+02	7.3123E+02	7.2472E+01	-1.1530E+05	9.3654E+04	1.2448E+04	-5.3480E+03	1.3218E+04	1.5341E-01
-1.4745E+02	6.8248E+02	4.7753E+01	-1.1530E+05	8.7410E+04	8.5492E+03	-5.3480E+03	6.9762E+03	3.7678E+00
-1.4745E+02	6.3373E+02	6.5006E+01	-1.1530E+05	8.1166E+04	2.2381E+04	-5.3480E+03	6.6090E+03	2.6295E+01
-1.4745E+02	5.8498E+02	6.4934E+01	-1.1530E+05	7.4923E+04	3.5681E+04	-5.3480E+03	6.2418E+03	5.0000E+00
-1.4745E+02	5.3623E+02	1.4275E+02	-1.1530E+05	6.8679E+04	5.7035E+04	-5.3480E+03	5.8747E+03	5.6452E+00
-1.4745E+02	4.8749E+02	6.1247E+01	-1.1530E+05	6.2436E+04	1.1700E+05	-5.3480E+03	5.5075E+03	7.6594E-01
-1.4745E+02	4.3874E+02	9.5865E+01	-1.1530E+05	5.6192E+04	1.3742E+05	-5.3480E+03	5.1403E+03	1.5951E+01
-1.4745E+02	3.8999E+02	3.2245E+02	-1.1530E+05	4.9949E+04	2.1638E+05	-5.3480E+03	4.7732E+03	1.9887E+01
-1.4745E+02	3.4124E+02	4.5131E+03	-1.1530E+05	4.3705E+04	4.4447E+05	-5.3480E+03	4.4060E+03	1.1362E+00
-1.4745E+02	2.9249E+02	4.5576E+03	-1.1530E+05	3.7461E+04	1.1126E+06	-5.3480E+03	4.0388E+03	2.1786E+01
-1.4745E+02	2.4374E+02	4.6735E+03	-1.1530E+05	3.1218E+04	2.5247E+06	-5.3480E+03	3.6717E+03	5.1205E+01
-1.4745E+02	1.9499E+02	7.1231E+03	-1.1530E+05	2.4974E+04	4.2611E+06	-5.3480E+03	3.3045E+03	1.0511E+01
-1.4745E+02	1.4625E+02	7.4493E+03	-1.1530E+05	1.8731E+04	5.9879E+06	-5.3480E+03	2.9373E+03	1.4883E+01
-1.4745E+02	9.7497E+01	2.4997E+04	-1.1530E+05	1.2487E+04	7.1992E+06	-5.3480E+03	2.5702E+03	4.5909E+03
-1.4745E+02	4.8749E+01	5.1204E+04	-1.1530E+05	6.2436E+03	7.7361E+06	-5.3480E+03	2.2030E+03	9.0459E+02
-1.4745E+02	0.0000E+00	2.2065E+05	-1.1530E+05	0.0000E+00	1.9933E+07	-5.3480E+03	1.8358E+03	2.8575E+03
-2.0735E+02	1.7062E+03	1.7361E+00	-1.2220E+05	1.3112E+05	5.2525E+01	-5.3480E+03	1.4687E+03	6.6078E+03
-2.0735E+02	1.5112E+03	1.6696E+00	-1.2220E+05	1.1238E+05	1.0642E+03	-5.3480E+03	1.1015E+03	3.3320E+03
-2.0735E+02	1.4625E+03	3.0000E+00	-1.2220E+05	1.0614E+05	3.1215E+03	-5.3480E+03	7.3433E+02	2.5903E+04
-2.0735E+02	1.3650E+03	3.5000E+00	-1.2220E+05	9.9897E+04	6.6725E+03	-5.3480E+03	3.6717E+02	7.1759E+04
-2.0735E+02	1.3162E+03	5.1696E+00	-1.2220E+05	9.3654E+04	6.8903E+03	-5.3480E+03	0.0000E+00	3.4111E+05
-2.0735E+02	1.2675E+03	5.2500E+00	-1.2220E+05	8.7410E+04	2.3141E+04	-5.8080E+03	8.4449E+03	7.4255E+00
-2.0735E+02	1.1700E+03	1.7500E+00	-1.2220E+05	8.1166E+04	2.6287E+04	-5.8080E+03	7.7105E+03	1.3138E-01
-2.0735E+02	1.1212E+03	8.5088E+00	-1.2220E+05	7.4923E+04	5.1718E+04	-5.8080E+03	6.9762E+03	1.3292E-01
-2.0735E+02	1.0725E+03	1.2170E+01	-1.2220E+05	6.8679E+04	6.6943E+04	-5.8080E+03	6.2418E+03	1.3292E-01
-2.0735E+02	1.0237E+03	1.6696E+00	-1.2220E+05	6.2436E+04	1.2285E+05	-5.8080E+03	5.5075E+03	1.2500E+00
-2.0735E+02	9.7497E+02	5.2500E+00	-1.2220E+05	5.6192E+04	9.6712E+04	-5.8080E+03	5.1403E+03	1.3571E+00
-2.0735E+02	9.2622E+02	1.1928E+01	-1.2220E+05	4.9949E+04	2.0274E+05	-5.8080E+03	4.7732E+03	1.8438E+00
-2.0735E+02	8.7747E+02	8.7500E+00	-1.2220E+05	4.3705E+04	5.0269E+05	-5.8080E+03	4.4060E+03	1.0503E+01
-2.0735E+02	8.2873E+02	1.2222E+01	-1.2220E+05	3.7461E+04	8.5561E+05	-5.8080E+03	4.0388E+03	2.7576E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.0735E+02	7.7998E+02	1.2250E+01	-1.2220E+05	3.1218E+04	1.9724E+06	-5.8080E+03	3.6717E+03	7.6594E-01
-2.0735E+02	7.3123E+02	2.4416E+01	-1.2220E+05	2.4974E+04	4.0995E+06	-5.8080E+03	3.3045E+03	1.4063E+03
-2.0735E+02	6.8248E+02	6.8392E+00	-1.2220E+05	1.8731E+04	6.5430E+06	-5.8080E+03	2.9373E+03	1.4165E+03
-2.0735E+02	6.3373E+02	3.5741E+01	-1.2220E+05	1.2487E+04	7.9461E+06	-5.8080E+03	2.5702E+03	1.3840E+00
-2.0735E+02	5.8498E+02	1.3972E+01	-1.2220E+05	6.2436E+03	9.2915E+06	-5.8080E+03	2.2030E+03	4.4598E+00
-2.0735E+02	5.3623E+02	5.4225E+01	-1.2220E+05	0.0000E+00	2.5331E+07	-5.8080E+03	1.8358E+03	8.9153E+00
-2.0735E+02	4.8749E+02	3.6962E+01	-1.2910E+05	1.1238E+05	6.9218E+02	-5.8080E+03	1.4687E+03	1.6629E+01
-2.0735E+02	4.3874E+02	1.0937E+02	-1.2910E+05	1.0614E+05	3.6556E+03	-5.8080E+03	1.1015E+03	4.2242E+03
-2.0735E+02	3.8999E+02	5.5115E+01	-1.2910E+05	9.9897E+04	2.0314E+03	-5.8080E+03	7.3433E+02	1.6684E+04
-2.0735E+02	3.4124E+02	1.0163E+02	-1.2910E+05	9.3654E+04	1.1927E+04	-5.8080E+03	3.6717E+02	5.7365E+04
-2.0735E+02	2.9249E+02	6.0484E+01	-1.2910E+05	8.7410E+04	2.1065E+04	-5.8080E+03	0.0000E+00	8.4057E+04
-2.0735E+02	2.4374E+02	4.3948E+03	-1.2910E+05	8.1166E+04	3.9853E+04	-6.2680E+03	8.0777E+03	1.9447E+00
-2.0735E+02	1.9499E+02	1.4867E+02	-1.2910E+05	7.4923E+04	3.2603E+04	-6.2680E+03	6.2418E+03	2.0833E+02
-2.0735E+02	1.4625E+02	2.3769E+03	-1.2910E+05	6.8679E+04	6.3021E+04	-6.2680E+03	5.8747E+03	2.1210E+02
-2.0735E+02	9.7497E+01	4.7209E+03	-1.2910E+05	6.2436E+04	1.0349E+05	-6.2680E+03	5.5075E+03	2.6042E+00
-2.0735E+02	4.8749E+01	1.6029E+04	-1.2910E+05	5.6192E+04	1.5181E+05	-6.2680E+03	5.1403E+03	2.6584E-01
-2.0735E+02	0.0000E+00	5.3715E+04	-1.2910E+05	4.9949E+04	3.1380E+05	-6.2680E+03	4.7732E+03	3.5290E+00
-2.6724E+02	1.5112E+03	1.6696E+00	-1.2910E+05	4.3705E+04	4.5824E+05	-6.2680E+03	4.4060E+03	2.1054E+00
-2.6724E+02	1.4625E+03	1.6696E+00	-1.2910E+05	3.7461E+04	1.0262E+06	-6.2680E+03	4.0388E+03	3.9722E-01
-2.6724E+02	1.3650E+03	5.0892E+00	-1.2910E+05	3.1218E+04	2.3769E+06	-6.2680E+03	3.6717E+03	1.7108E+00
-2.6724E+02	1.2675E+03	3.5000E+00	-1.2910E+05	2.4974E+04	4.9650E+06	-6.2680E+03	3.3045E+03	4.3910E+00
-2.6724E+02	1.2187E+03	5.1696E+00	-1.2910E+05	1.8731E+04	7.7022E+06	-6.2680E+03	2.9373E+03	4.4914E+00
-2.6724E+02	1.1700E+03	6.4196E+00	-1.2910E+05	1.2487E+04	8.7419E+06	-6.2680E+03	2.5702E+03	1.3292E-01
-2.6724E+02	1.1212E+03	5.1696E+00	-1.2910E+05	6.2436E+03	1.1396E+07	-6.2680E+03	2.2030E+03	5.0164E-01
-2.6724E+02	1.0725E+03	8.4284E+00	-1.2910E+05	0.0000E+00	3.1919E+07	-6.2680E+03	1.8358E+03	8.2044E+00
-2.6724E+02	1.0237E+03	6.8392E+00	-1.3600E+05	1.0614E+05	5.2525E+01	-6.2680E+03	1.4687E+03	2.8107E+01
-2.6724E+02	9.7497E+02	1.7500E+00	-1.3600E+05	9.9897E+04	1.2064E+02	-6.2680E+03	1.1015E+03	2.2631E+02
-2.6724E+02	9.2622E+02	3.3392E+00	-1.3600E+05	9.3654E+04	1.3453E+03	-6.2680E+03	7.3433E+02	2.0752E+02
-2.6724E+02	8.7747E+02	3.5000E+00	-1.3600E+05	8.7410E+04	4.5657E+03	-6.2680E+03	3.6717E+02	6.9947E+03
-2.6724E+02	8.2873E+02	3.5000E+00	-1.3600E+05	8.1166E+04	1.2456E+04	-6.2680E+03	0.0000E+00	1.8782E+04
-2.6724E+02	7.7998E+02	6.6784E+00	-1.3600E+05	7.4923E+04	4.2508E+04	-6.7281E+03	5.8747E+03	1.3138E-01
-2.6724E+02	7.3123E+02	3.3392E+00	-1.3600E+05	6.8679E+04	4.9522E+04	-6.7281E+03	5.1403E+03	2.0835E+00
-2.6724E+02	6.3373E+02	3.3392E+00	-1.3600E+05	6.2436E+04	6.1765E+04	-6.7281E+03	4.4060E+03	3.9738E+00
-2.6724E+02	5.8498E+02	3.3392E+00	-1.3600E+05	5.6192E+04	1.1558E+05	-6.7281E+03	3.6717E+03	1.3292E-01
-2.6724E+02	5.3623E+02	1.1722E+01	-1.3600E+05	4.9949E+04	2.4245E+05	-6.7281E+03	3.3045E+03	2.1486E+02
-2.6724E+02	4.8749E+02	1.3811E+01	-1.3600E+05	4.3705E+04	5.7974E+05	-6.7281E+03	2.9373E+03	1.3138E-01
-2.6724E+02	4.3874E+02	1.4768E+01	-1.3600E+05	3.7461E+04	1.0074E+06	-6.7281E+03	2.5702E+03	6.9913E+00
-2.6724E+02	3.8999E+02	4.1357E+01	-1.3600E+05	3.1218E+04	2.4684E+06	-6.7281E+03	2.2030E+03	7.6748E-01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE
DNV Energy Systems Tuborgvaenget 6, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.6724E+02	3.4124E+02	2.3857E+01	-1.3600E+05	2.4974E+04	4.7433E+06	-6.7281E+03	1.8358E+03	1.8872E+00
-2.6724E+02	2.9249E+02	2.2360E+01	-1.3600E+05	1.8731E+04	8.2333E+06	-6.7281E+03	1.1015E+03	1.3319E+01
-2.6724E+02	2.4374E+02	4.9899E+01	-1.3600E+05	1.2487E+04	9.9492E+06	-6.7281E+03	7.3433E+02	2.6542E+01
-2.6724E+02	1.9499E+02	4.3857E+01	-1.3600E+05	6.2436E+03	1.2439E+07	-6.7281E+03	3.6717E+02	1.6922E+03
-2.6724E+02	1.4625E+02	7.0528E+01	-1.3600E+05	0.0000E+00	3.5418E+07	-6.7281E+03	0.0000E+00	6.8582E+02
-2.6724E+02	9.7497E+01	2.4136E+03	-1.4290E+05	9.3654E+04	1.6696E+00	-7.1881E+03	5.8747E+03	5.0164E-01
-2.6724E+02	4.8749E+01	2.6050E+03	-1.4290E+05	8.7410E+04	2.2894E+03	-7.1881E+03	4.4060E+03	1.3138E-01
-2.6724E+02	0.0000E+00	7.7530E+03	-1.4290E+05	8.1166E+04	4.8971E+03	-7.1881E+03	4.0388E+03	1.3138E-01
-3.2714E+02	1.4625E+03	1.6696E+00	-1.4290E+05	7.4923E+04	1.7143E+04	-7.1881E+03	3.6717E+03	8.5542E-01
-3.2714E+02	1.3650E+03	6.6784E+00	-1.4290E+05	6.8679E+04	8.5887E+03	-7.1881E+03	2.9373E+03	9.2128E-01
-3.2714E+02	1.3162E+03	1.6696E+00	-1.4290E+05	6.2436E+04	3.4669E+04	-7.1881E+03	2.5702E+03	1.7558E+00
-3.2714E+02	1.2675E+03	1.6696E+00	-1.4290E+05	5.6192E+04	4.7966E+04	-7.1881E+03	2.2030E+03	2.6584E-01
-3.2714E+02	1.1700E+03	1.6696E+00	-1.4290E+05	4.9949E+04	1.0970E+05	-7.1881E+03	1.8358E+03	1.3292E-01
-3.2714E+02	1.0237E+03	3.5000E+00	-1.4290E+05	4.3705E+04	2.7669E+05	-7.1881E+03	1.4687E+03	2.6430E-01
-3.2714E+02	9.2622E+02	1.2500E+00	-1.4290E+05	3.7461E+04	5.4143E+05	-7.1881E+03	1.1015E+03	2.0626E+00
-3.2714E+02	8.7747E+02	3.4196E+00	-1.4290E+05	3.1218E+04	1.2821E+06	-7.1881E+03	7.3433E+02	7.6686E+00
-3.2714E+02	8.2873E+02	1.3292E-01	-1.4290E+05	2.4974E+04	3.0365E+06	-7.1881E+03	3.6717E+02	1.2698E+02
-3.2714E+02	7.3123E+02	3.3392E+00	-1.4290E+05	1.8731E+04	5.3562E+06	-7.1881E+03	0.0000E+00	5.6012E+02
-3.2714E+02	6.8248E+02	7.0000E+00	-1.4290E+05	1.2487E+04	6.8670E+06	-7.6482E+03	6.2418E+03	1.3138E-01
-3.2714E+02	6.3373E+02	1.3357E+01	-1.4290E+05	6.2436E+03	9.3187E+06	-7.6482E+03	2.9373E+03	5.0164E-01
-3.2714E+02	5.3623E+02	6.8392E+00	-1.4290E+05	0.0000E+00	2.8041E+07	-7.6482E+03	2.2030E+03	1.3138E-01
-3.2714E+02	4.8749E+02	1.5222E+01	-1.4980E+05	7.4923E+04	1.6696E+00	-7.6482E+03	1.8358E+03	1.9767E+00
-3.2714E+02	4.3874E+02	2.0740E+01	-1.4980E+05	6.2436E+04	1.0661E+03	-7.6482E+03	1.4687E+03	5.0164E-01
-3.2714E+02	3.8999E+02	2.0839E+01	-1.4980E+05	5.6192E+04	9.9165E+03	-7.6482E+03	1.1015E+03	8.5542E-01
-3.2714E+02	3.4124E+02	2.8376E+01	-1.4980E+05	4.9949E+04	1.9974E+04	-7.6482E+03	7.3433E+02	3.8992E+00
-3.2714E+02	2.9249E+02	2.6699E+01	-1.4980E+05	4.3705E+04	3.9907E+04	-7.6482E+03	3.6717E+02	2.3218E+01
-3.2714E+02	2.4374E+02	2.5253E+01	-1.4980E+05	3.7461E+04	2.3255E+05	-7.6482E+03	0.0000E+00	4.5357E+02
-3.2714E+02	1.9499E+02	2.7035E+01	-1.4980E+05	3.1218E+04	6.2254E+05	-8.1082E+03	1.1015E+03	1.3292E-01
-3.2714E+02	1.4625E+02	8.0546E+01	-1.4980E+05	2.4974E+04	1.2981E+06	-8.1082E+03	7.3433E+02	6.3302E-01
-3.2714E+02	9.7497E+01	1.1499E+02	-1.4980E+05	1.8731E+04	2.6609E+06	-8.1082E+03	3.6717E+02	2.1245E+02
-3.2714E+02	4.8749E+01	1.9085E+02	-1.4980E+05	1.2487E+04	3.1845E+06	-8.1082E+03	0.0000E+00	4.3238E+01
-3.2714E+02	0.0000E+00	4.8083E+03	-1.4980E+05	6.2436E+03	4.4973E+06	-8.5682E+03	1.4687E+03	1.3829E+00
-3.8703E+02	1.4625E+03	3.3392E+00	-1.4980E+05	0.0000E+00	1.4172E+07	-8.5682E+03	1.1015E+03	1.7512E+00
-3.8703E+02	1.4137E+03	1.6696E+00	-1.5670E+05	5.6192E+04	2.4486E+03	-8.5682E+03	3.6717E+02	1.2870E+01
-3.8703E+02	1.3650E+03	1.6696E+00	-1.5670E+05	4.3705E+04	6.7141E+03	-8.5682E+03	0.0000E+00	3.7933E+00
-3.8703E+02	1.3162E+03	1.6696E+00	-1.5670E+05	3.7461E+04	2.0141E+04	-9.0283E+03	3.3045E+03	1.3292E-01
-3.8703E+02	1.2675E+03	1.6696E+00	-1.5670E+05	3.1218E+04	1.0810E+05	-9.0283E+03	1.8358E+03	1.3292E-01
-3.8703E+02	6.3373E+02	6.8392E+00	-1.5670E+05	2.4974E+04	2.6616E+05	-9.0283E+03	1.4687E+03	9.2128E-01

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV DNV Business Assurance Tåsinge Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.8703E+02	5.8498E+02	4.7500E+00	-1.5670E+05	1.8731E+04	6.7508E+05	-9.0283E+03	1.1015E+03	1.3138E-01
-3.8703E+02	5.3623E+02	3.5000E+00	-1.5670E+05	1.2487E+04	8.7501E+05	-9.0283E+03	3.6717E+02	3.5305E+00
-3.8703E+02	4.8749E+02	3.4721E+00	-1.5670E+05	6.2436E+03	1.4010E+06	-9.0283E+03	0.0000E+00	5.1193E+00
-3.8703E+02	4.3874E+02	1.1268E+01	-1.5670E+05	0.0000E+00	4.9123E+06	-9.4883E+03	5.8747E+03	1.3292E-01
-3.8703E+02	3.8999E+02	3.3392E+00	-1.6360E+05	3.7461E+04	1.3992E+03	-9.4883E+03	3.6717E+02	3.0682E-01
-3.8703E+02	3.4124E+02	1.6360E+01	-1.6360E+05	3.1218E+04	3.3392E+00	-9.4883E+03	0.0000E+00	2.5217E+00
-3.8703E+02	2.9249E+02	4.3556E+01	-1.6360E+05	2.4974E+04	7.3132E+03	-9.9484E+03	0.0000E+00	1.4884E+00
-3.8703E+02	2.4374E+02	9.1784E+00	-1.6360E+05	1.8731E+04	4.4108E+04	-1.0408E+04	0.0000E+00	1.3292E-01
-3.8703E+02	1.9499E+02	5.2707E+01	-1.6360E+05	1.2487E+04	3.6743E+04	-1.1328E+04	0.0000E+00	1.2500E+00
-3.8703E+02	1.4625E+02	5.7799E+01	-1.6360E+05	6.2436E+03	1.1574E+05			
-3.8703E+02	9.7497E+01	6.1105E+01	-1.6360E+05	0.0000E+00	1.0628E+06			
-3.8703E+02	4.8749E+01	9.2481E+01	-1.7050E+05	2.4974E+04	4.9004E+03			
-3.8703E+02	0.0000E+00	1.7015E+02	-1.7050E+05	1.8731E+04	9.0849E+02			
-4.4693E+02	5.8498E+02	3.5000E+00	-1.7050E+05	1.2487E+04	6.6784E+00			
-4.4693E+02	5.3623E+02	8.0892E+00	-1.7050E+05	6.2436E+03	9.0020E+03			
-4.4693E+02	4.3874E+02	6.8392E+00	-1.7050E+05	0.0000E+00	5.0960E+04			
-4.4693E+02	3.8999E+02	7.0000E+00	-1.7740E+05	0.0000E+00	9.3186E+02			
-4.4693E+02	3.4124E+02	3.1018E+01	-1.8430E+05	0.0000E+00	1.0018E+01			
-4.4693E+02	2.9249E+02	1.9699E+01	-1.9120E+05	0.0000E+00	3.3392E+00			
-4.4693E+02	2.4374E+02	2.3696E+01						
-4.4693E+02	1.9499E+02	3.8422E+01						
-4.4693E+02	1.4625E+02	4.7874E+01						
-4.4693E+02	9.7497E+01	6.0460E+01						
-4.4693E+02	4.8749E+01	8.6344E+01						
-4.4693E+02	0.0000E+00	1.4677E+02						
-5.0682E+02	4.3874E+02	1.0339E+01						
-5.0682E+02	3.8999E+02	3.5000E+00						
-5.0682E+02	3.4124E+02	1.3678E+01						
-5.0682E+02	2.9249E+02	1.0339E+01						
-5.0682E+02	2.4374E+02	2.7357E+01						
-5.0682E+02	1.9499E+02	2.3990E+01						
-5.0682E+02	1.4625E+02	2.0839E+01						
-5.0682E+02	9.7497E+01	4.4801E+01						
-5.0682E+02	4.8749E+01	7.2750E+01						
-5.0682E+02	0.0000E+00	1.5562E+02						
-5.6672E+02	4.8749E+02	3.5000E+00						
-5.6672E+02	4.3874E+02	1.3678E+01						
-5.6672E+02	3.8999E+02	1.3357E+01						

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tåsing Parkvej 8-12, DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-5.6672E+02	3.4124E+02	1.3811E+01						
-5.6672E+02	2.9249E+02	1.0178E+01						
-5.6672E+02	2.4374E+02	1.6857E+01						
-5.6672E+02	1.9499E+02	2.7035E+01						
-5.6672E+02	1.4625E+02	2.5722E+01						
-5.6672E+02	9.7497E+01	3.4678E+01						
-5.6672E+02	4.8749E+01	5.3023E+01						
-5.6672E+02	0.0000E+00	6.0028E+01						
-6.2661E+02	7.7998E+02	3.3392E+00						
-6.2661E+02	5.3623E+02	1.3292E-01						
-6.2661E+02	4.8749E+02	3.3392E+00						
-6.2661E+02	4.3874E+02	3.3392E+00						
-6.2661E+02	3.8999E+02	6.6784E+00						
-6.2661E+02	3.4124E+02	3.3392E+00						
-6.2661E+02	2.9249E+02	3.3392E+00						
-6.2661E+02	2.4374E+02	3.3392E+00						
-6.2661E+02	1.9499E+02	1.3811E+01						
-6.2661E+02	1.4625E+02	2.1110E+01						
-6.2661E+02	9.7497E+01	3.4761E+01						
-6.2661E+02	4.8749E+01	3.4301E+01						
-6.2661E+02	0.0000E+00	5.6418E+01						
-6.8651E+02	6.3373E+02	3.3392E+00						
-6.8651E+02	4.8749E+02	3.3392E+00						
-6.8651E+02	3.8999E+02	1.3292E-01						
-6.8651E+02	3.4124E+02	6.8392E+00						
-6.8651E+02	2.9249E+02	3.3392E+00						
-6.8651E+02	2.4374E+02	3.3392E+00						
-6.8651E+02	1.9499E+02	1.7018E+01						
-6.8651E+02	1.4625E+02	2.0518E+01						
-6.8651E+02	9.7497E+01	1.3518E+01						
-6.8651E+02	4.8749E+01	4.3967E+01						
-6.8651E+02	0.0000E+00	2.4018E+01						
-7.4640E+02	4.8749E+02	6.6784E+00						
-7.4640E+02	3.8999E+02	3.3392E+00						
-7.4640E+02	2.4374E+02	3.3392E+00						
-7.4640E+02	1.4625E+02	3.3392E+00						
-7.4640E+02	9.7497E+01	3.6329E+00						
-7.4640E+02	4.8749E+01	1.4928E+01						

DNV Denmark A/S Tåsinge Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices								
Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-7.4640E+02	0.0000E+00	1.6857E+01						
-8.0630E+02	3.8999E+02	3.3392E+00						
-8.0630E+02	3.4124E+02	3.3392E+00						
-8.0630E+02	2.4374E+02	3.3392E+00						
-8.0630E+02	1.9499E+02	6.6784E+00						
-8.0630E+02	1.4625E+02	1.3357E+01						
-8.0630E+02	4.8749E+01	1.8240E+01						
-8.0630E+02	0.0000E+00	1.0178E+01						
-8.6619E+02	2.9249E+02	3.3392E+00						
-8.6619E+02	1.9499E+02	3.3392E+00						
-8.6619E+02	9.7497E+01	3.3392E+00						
-8.6619E+02	4.8749E+01	3.3392E+00						
-8.6619E+02	0.0000E+00	3.3392E+00						
-9.2609E+02	9.7497E+01	3.3392E+00						
-9.2609E+02	4.8749E+01	3.3392E+00						
-9.2609E+02	0.0000E+00	3.3392E+00						
-9.8598E+02	4.8749E+01	3.3392E+00						
-9.8598E+02	0.0000E+00	6.6784E+00						

Table 5-17 [7] Markov Matrix

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Appendix J. Markov matrices – issued from [8]

This appendix contains the Markov Matrices for the shear force, the bending moment and the torsional moment in the bottom of the tower, from ref. [8]. Foundation design must be verified for the most critical Markov matrices.

Markov Matrices								
Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.5886E+03	0.0000E+00	3.6645E+02	1.4603E+05	0.0000E+00	3.3392E+00	6.9643E+03	1.0847E+03	1.3292E-01
1.4683E+03	0.0000E+00	2.0286E+03	1.3208E+05	0.0000E+00	3.3392E+00	6.9643E+03	3.6155E+02	1.3393E+01
1.4082E+03	5.1450E+01	7.7840E+02	1.2510E+05	6.4831E+03	3.3392E+00	6.9643E+03	0.0000E+00	3.3392E+00
1.4082E+03	0.0000E+00	1.0368E+04	1.2510E+05	0.0000E+00	3.3392E+00	6.4992E+03	5.4233E+03	3.3392E+00
1.3480E+03	5.1450E+01	2.2697E+03	1.1812E+05	6.4831E+03	6.6784E+00	6.4992E+03	0.0000E+00	5.4770E+01
1.3480E+03	0.0000E+00	1.6299E+04	1.1812E+05	0.0000E+00	2.0035E+01	6.0341E+03	3.6155E+03	3.3392E+00
1.2878E+03	1.0290E+02	4.5947E+03	1.1115E+05	1.9449E+04	3.3392E+00	6.0341E+03	2.5309E+03	3.3392E+00
1.2878E+03	5.1450E+01	1.1762E+04	1.1115E+05	1.2966E+04	3.3392E+00	6.0341E+03	1.4462E+03	3.5000E+00
1.2878E+03	0.0000E+00	6.1075E+04	1.1115E+05	6.4831E+03	1.0151E+01	6.0341E+03	7.2311E+02	3.5000E+00
1.2277E+03	5.1450E+02	1.1897E+02	1.1115E+05	0.0000E+00	1.3623E+01	6.0341E+03	3.6155E+02	7.8174E+02
1.2277E+03	4.1160E+02	7.0190E+02	1.0417E+05	1.2966E+04	1.3292E-01	6.0341E+03	0.0000E+00	1.5609E+03
1.2277E+03	1.5435E+02	1.1897E+02	1.0417E+05	6.4831E+03	3.3392E+00	5.5690E+03	7.2311E+02	1.0417E+02
1.2277E+03	1.0290E+02	7.0311E+03	1.0417E+05	0.0000E+00	3.3847E+01	5.5690E+03	3.6155E+02	2.9933E+02
1.2277E+03	5.1450E+01	4.6131E+04	9.7195E+04	2.5932E+04	3.3392E+00	5.5690E+03	0.0000E+00	9.0431E+03
1.2277E+03	0.0000E+00	2.3317E+05	9.7195E+04	1.2966E+04	3.5000E+00	5.1039E+03	5.4233E+03	3.3392E+00
1.1675E+03	4.1160E+02	9.3590E-01	9.7195E+04	6.4831E+03	2.0196E+01	5.1039E+03	1.4462E+03	2.9721E+03
1.1675E+03	3.0870E+02	1.7500E+00	9.7195E+04	0.0000E+00	2.0357E+01	5.1039E+03	1.0847E+03	2.5160E+03
1.1675E+03	1.5435E+02	3.2268E+03	9.0218E+04	6.4831E+03	2.3374E+01	5.1039E+03	3.6155E+02	1.7626E+04
1.1675E+03	1.0290E+02	1.7227E+04	9.0218E+04	0.0000E+00	5.1535E+01	5.1039E+03	0.0000E+00	7.5959E+04
1.1675E+03	5.1450E+01	1.5013E+05	8.3242E+04	3.8899E+04	3.5000E+00	4.6388E+03	5.4233E+03	3.3392E+00
1.1675E+03	0.0000E+00	6.7513E+05	8.3242E+04	1.9449E+04	7.0000E+00	4.6388E+03	5.0618E+03	3.3392E+00
1.1074E+03	4.1160E+02	1.6696E+00	8.3242E+04	1.2966E+04	1.0339E+01	4.6388E+03	3.2540E+03	8.5542E-01
1.1074E+03	3.6015E+02	3.3392E+00	8.3242E+04	6.4831E+03	2.4178E+01	4.6388E+03	2.8924E+03	3.4721E+00
1.1074E+03	3.0870E+02	6.5105E+00	8.3242E+04	0.0000E+00	4.7231E+01	4.6388E+03	2.5309E+03	1.1160E+03
1.1074E+03	2.5725E+02	5.9794E+03	7.6265E+04	3.8899E+04	3.5000E+00	4.6388E+03	2.1693E+03	1.1031E+03
1.1074E+03	2.0580E+02	4.0215E+01	7.6265E+04	2.5932E+04	3.8771E+01	4.6388E+03	1.8078E+03	1.0339E+01
1.1074E+03	1.5435E+02	7.2440E+03	7.6265E+04	1.9449E+04	3.5000E+00	4.6388E+03	1.4462E+03	1.4009E+03
1.1074E+03	1.0290E+02	8.4654E+04	7.6265E+04	1.2966E+04	7.0000E+00	4.6388E+03	1.0847E+03	3.0737E+04
1.1074E+03	5.1450E+01	5.3135E+05	7.6265E+04	6.4831E+03	2.7678E+01	4.6388E+03	7.2311E+02	2.3131E+04
1.1074E+03	0.0000E+00	1.6163E+06	7.6265E+04	0.0000E+00	7.1235E+01	4.6388E+03	3.6155E+02	7.1328E+04
1.0472E+03	6.1740E+02	9.0849E+02	6.9289E+04	5.1865E+04	3.3392E+00	4.6388E+03	0.0000E+00	3.0686E+05
1.0472E+03	5.1450E+02	3.4057E+00	6.9289E+04	3.8899E+04	3.3392E+00	4.1737E+03	8.3157E+03	1.3292E-01
1.0472E+03	4.1160E+02	1.8323E+02	6.9289E+04	3.2416E+04	3.5000E+00	4.1737E+03	6.1464E+03	4.0215E+01
1.0472E+03	3.6015E+02	5.0892E+00	6.9289E+04	2.5932E+04	6.8392E+00	4.1737E+03	4.7002E+03	3.3392E+00

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Certificate No. TAUS Tåsing Parkvej 8-12 DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.0472E+03	3.0870E+02	4.1898E+02	6.9289E+04	1.9449E+04	1.7018E+01	4.1737E+03	4.3386E+03	3.3392E+00
1.0472E+03	2.5725E+02	2.4369E+02	6.9289E+04	1.2966E+04	1.0339E+01	4.1737E+03	3.6155E+03	2.9721E+03
1.0472E+03	2.0580E+02	3.3508E+03	6.9289E+04	6.4831E+03	2.5107E+01	4.1737E+03	3.2540E+03	1.0654E+01
1.0472E+03	1.5435E+02	3.5394E+04	6.9289E+04	0.0000E+00	7.6132E+01	4.1737E+03	2.8924E+03	8.4171E+03
1.0472E+03	1.0290E+02	3.1392E+05	6.2312E+04	1.6856E+05	3.3392E+00	4.1737E+03	2.5309E+03	1.7617E+04
1.0472E+03	5.1450E+01	1.7768E+06	6.2312E+04	1.6208E+05	1.6696E+00	4.1737E+03	2.1693E+03	2.5567E+04
1.0472E+03	0.0000E+00	4.4508E+06	6.2312E+04	6.4831E+04	3.3392E+00	4.1737E+03	1.8078E+03	4.3333E+04
9.8707E+02	1.1319E+03	1.4000E+03	6.2312E+04	5.1865E+04	3.3392E+00	4.1737E+03	1.4462E+03	2.1707E+04
9.8707E+02	8.7465E+02	1.1340E+03	6.2312E+04	4.5382E+04	6.8392E+00	4.1737E+03	1.0847E+03	5.9368E+04
9.8707E+02	8.2320E+02	1.2749E+03	6.2312E+04	3.8899E+04	4.5892E+00	4.1737E+03	7.2311E+02	1.2218E+05
9.8707E+02	7.7175E+02	6.1720E+03	6.2312E+04	3.2416E+04	6.8392E+00	4.1737E+03	3.6155E+02	3.1890E+05
9.8707E+02	7.2030E+02	2.9046E+02	6.2312E+04	2.5932E+04	1.0178E+01	4.1737E+03	0.0000E+00	7.0249E+05
9.8707E+02	6.6885E+02	1.2699E+04	6.2312E+04	1.9449E+04	2.0678E+01	3.7086E+03	6.1464E+03	1.5355E+02
9.8707E+02	6.1740E+02	8.0801E+03	6.2312E+04	1.2966E+04	2.7518E+01	3.7086E+03	5.4233E+03	1.1568E+03
9.8707E+02	5.6595E+02	1.1184E+04	6.2312E+04	6.4831E+03	2.3535E+01	3.7086E+03	5.0618E+03	3.8894E+00
9.8707E+02	5.1450E+02	1.7264E+04	6.2312E+04	0.0000E+00	5.9737E+01	3.7086E+03	4.7002E+03	3.3392E+00
9.8707E+02	4.6305E+02	7.9948E+03	5.5336E+04	1.6856E+05	1.6696E+00	3.7086E+03	4.3386E+03	1.1415E+03
9.8707E+02	4.1160E+02	4.2930E+04	5.5336E+04	1.4263E+05	3.3392E+00	3.7086E+03	3.9771E+03	2.9598E+03
9.8707E+02	3.6015E+02	1.7085E+04	5.5336E+04	7.7797E+04	3.3392E+00	3.7086E+03	3.6155E+03	1.4537E+04
9.8707E+02	3.0870E+02	2.6911E+04	5.5336E+04	6.4831E+04	3.3392E+00	3.7086E+03	3.2540E+03	3.5178E+04
9.8707E+02	2.5725E+02	1.3382E+04	5.5336E+04	5.1865E+04	3.3392E+00	3.7086E+03	2.8924E+03	4.2413E+04
9.8707E+02	2.0580E+02	5.0780E+04	5.5336E+04	3.8899E+04	1.2500E+00	3.7086E+03	2.5309E+03	1.1018E+05
9.8707E+02	1.5435E+02	1.9379E+05	5.5336E+04	3.2416E+04	1.8268E+01	3.7086E+03	2.1693E+03	9.2248E+04
9.8707E+02	1.0290E+02	9.0353E+05	5.5336E+04	2.5932E+04	2.3360E+01	3.7086E+03	1.8078E+03	1.4312E+05
9.8707E+02	5.1450E+01	4.7025E+06	5.5336E+04	1.9449E+04	1.3678E+01	3.7086E+03	1.4462E+03	1.0392E+05
9.8707E+02	0.0000E+00	8.6240E+06	5.5336E+04	1.2966E+04	2.8537E+01	3.7086E+03	1.0847E+03	1.1378E+05
9.2691E+02	1.6978E+03	3.8920E+02	5.5336E+04	6.4831E+03	5.6689E+01	3.7086E+03	7.2311E+02	2.8815E+05
9.2691E+02	1.6464E+03	1.8323E+02	5.5336E+04	0.0000E+00	1.1379E+02	3.7086E+03	3.6155E+02	7.0206E+05
9.2691E+02	1.4920E+03	1.5182E+03	4.8360E+04	1.5559E+05	1.6696E+00	3.7086E+03	0.0000E+00	1.6204E+06
9.2691E+02	1.3377E+03	3.1407E+03	4.8360E+04	1.4911E+05	1.6696E+00	3.2435E+03	1.5185E+04	6.2500E-01
9.2691E+02	1.2862E+03	6.5105E+00	4.8360E+04	1.4263E+05	6.6784E+00	3.2435E+03	1.4824E+04	6.2500E-01
9.2691E+02	1.2348E+03	2.9244E+03	4.8360E+04	1.3615E+05	6.7588E+00	3.2435E+03	1.0124E+04	1.3292E-01
9.2691E+02	1.1833E+03	3.6645E+02	4.8360E+04	1.2966E+05	1.6696E+00	3.2435E+03	6.8695E+03	7.7853E+02
9.2691E+02	1.1319E+03	7.3290E+02	4.8360E+04	1.2318E+05	8.5892E+00	3.2435E+03	5.7849E+03	3.8894E+00
9.2691E+02	1.0804E+03	1.2415E+04	4.8360E+04	1.1670E+05	1.6696E+00	3.2435E+03	5.4233E+03	2.8105E+03
9.2691E+02	1.0290E+03	1.2696E+04	4.8360E+04	9.0764E+04	3.3392E+00	3.2435E+03	5.0618E+03	6.9099E+03
9.2691E+02	9.7755E+02	1.0048E+04	4.8360E+04	8.4281E+04	3.3392E+00	3.2435E+03	4.7002E+03	3.1152E+04
9.2691E+02	9.2610E+02	2.9541E+04	4.8360E+04	7.7797E+04	3.3392E+00	3.2435E+03	4.3386E+03	6.9365E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV DNV Energy Systems Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
9.2691E+02	8.7465E+02	2.8800E+04	4.8360E+04	7.1314E+04	3.3392E+00	3.2435E+03	3.9771E+03	1.3220E+05
9.2691E+02	8.2320E+02	5.9287E+04	4.8360E+04	6.4831E+04	3.3392E+00	3.2435E+03	3.6155E+03	8.7292E+04
9.2691E+02	7.7175E+02	8.1524E+04	4.8360E+04	5.1865E+04	3.3392E+00	3.2435E+03	3.2540E+03	1.5356E+05
9.2691E+02	7.2030E+02	1.5017E+05	4.8360E+04	4.5382E+04	8.2500E+00	3.2435E+03	2.8924E+03	2.7688E+05
9.2691E+02	6.6885E+02	1.3886E+05	4.8360E+04	3.8899E+04	7.0000E+00	3.2435E+03	2.5309E+03	2.7054E+05
9.2691E+02	6.1740E+02	2.6127E+05	4.8360E+04	3.2416E+04	2.6539E+01	3.2435E+03	2.1693E+03	2.6777E+05
9.2691E+02	5.6595E+02	3.1845E+05	4.8360E+04	2.5932E+04	4.2419E+01	3.2435E+03	1.8078E+03	3.1859E+05
9.2691E+02	5.1450E+02	4.8378E+05	4.8360E+04	1.9449E+04	3.3518E+01	3.2435E+03	1.4462E+03	3.3025E+05
9.2691E+02	4.6305E+02	5.3011E+05	4.8360E+04	1.2966E+04	2.1928E+01	3.2435E+03	1.0847E+03	2.5711E+05
9.2691E+02	4.1160E+02	6.1577E+05	4.8360E+04	6.4831E+03	4.8140E+01	3.2435E+03	7.2311E+02	5.1897E+05
9.2691E+02	3.6015E+02	7.2641E+05	4.8360E+04	0.0000E+00	1.7554E+02	3.2435E+03	3.6155E+02	1.3779E+06
9.2691E+02	3.0870E+02	7.4192E+05	4.1383E+04	1.5559E+05	3.4196E+00	3.2435E+03	0.0000E+00	2.8762E+06
9.2691E+02	2.5725E+02	6.5577E+05	4.1383E+04	1.4911E+05	3.9642E+00	2.7784E+03	1.4101E+04	1.6696E+00
9.2691E+02	2.0580E+02	7.0780E+05	4.1383E+04	1.2966E+05	7.0000E+00	2.7784E+03	9.7620E+03	1.6696E+00
9.2691E+02	1.5435E+02	1.0453E+06	4.1383E+04	1.2318E+05	8.6696E+00	2.7784E+03	7.2311E+03	3.7984E+02
9.2691E+02	1.0290E+02	3.0530E+06	4.1383E+04	1.1670E+05	6.9196E+00	2.7784E+03	6.8695E+03	1.1051E+03
9.2691E+02	5.1450E+01	9.2032E+06	4.1383E+04	9.0764E+04	1.7500E+00	2.7784E+03	6.5080E+03	1.6737E+03
9.2691E+02	0.0000E+00	1.4382E+07	4.1383E+04	7.1314E+04	6.8392E+00	2.7784E+03	6.1464E+03	8.0518E+03
8.6676E+02	1.8522E+03	1.1449E+03	4.1383E+04	6.4831E+04	6.8392E+00	2.7784E+03	5.7849E+03	1.1185E+04
8.6676E+02	1.8007E+03	6.2495E+02	4.1383E+04	5.8348E+04	2.8010E+01	2.7784E+03	5.4233E+03	2.1760E+04
8.6676E+02	1.7493E+03	3.6645E+02	4.1383E+04	5.1865E+04	1.5250E+01	2.7784E+03	5.0618E+03	8.2647E+04
8.6676E+02	1.6978E+03	1.9489E+03	4.1383E+04	4.5382E+04	1.3839E+01	2.7784E+03	4.7002E+03	5.6740E+04
8.6676E+02	1.6464E+03	7.0000E+02	4.1383E+04	3.8899E+04	2.0972E+01	2.7784E+03	4.3386E+03	1.3440E+05
8.6676E+02	1.5949E+03	1.5828E+03	4.1383E+04	3.2416E+04	3.2428E+01	2.7784E+03	3.9771E+03	1.8932E+05
8.6676E+02	1.5435E+03	2.8329E+03	4.1383E+04	2.5932E+04	7.0000E+00	2.7784E+03	3.6155E+03	3.1224E+05
8.6676E+02	1.4920E+03	2.8225E+03	4.1383E+04	1.9449E+04	1.2100E+02	2.7784E+03	3.2540E+03	3.4099E+05
8.6676E+02	1.4406E+03	5.2713E+03	4.1383E+04	1.2966E+04	7.3436E+01	2.7784E+03	2.8924E+03	3.9418E+05
8.6676E+02	1.3891E+03	1.1015E+04	4.1383E+04	6.4831E+03	4.4905E+01	2.7784E+03	2.5309E+03	4.5813E+05
8.6676E+02	1.3377E+03	5.2483E+03	4.1383E+04	0.0000E+00	2.1788E+02	2.7784E+03	2.1693E+03	4.6895E+05
8.6676E+02	1.2862E+03	1.1113E+04	3.4407E+04	1.7504E+05	6.6460E-02	2.7784E+03	1.8078E+03	4.3213E+05
8.6676E+02	1.2348E+03	2.5018E+04	3.4407E+04	1.6856E+05	6.6460E-02	2.7784E+03	1.4462E+03	4.0427E+05
8.6676E+02	1.1833E+03	2.9032E+04	3.4407E+04	1.4911E+05	1.7500E+00	2.7784E+03	1.0847E+03	5.9888E+05
8.6676E+02	1.1319E+03	2.8381E+04	3.4407E+04	1.4263E+05	7.0000E+00	2.7784E+03	7.2311E+02	8.9045E+05
8.6676E+02	1.0804E+03	5.7514E+04	3.4407E+04	1.2966E+05	8.5088E+00	2.7784E+03	3.6155E+02	2.9585E+06
8.6676E+02	1.0290E+03	1.1369E+05	3.4407E+04	1.2318E+05	1.7259E+01	2.7784E+03	0.0000E+00	4.6808E+06
8.6676E+02	9.7755E+02	1.8872E+05	3.4407E+04	1.1670E+05	1.7500E+00	2.3133E+03	1.3016E+04	6.6460E-02
8.6676E+02	9.2610E+02	2.2456E+05	3.4407E+04	1.1021E+05	6.8392E+00	2.3133E+03	1.2654E+04	6.6460E-02
8.6676E+02	8.7465E+02	3.7847E+05	3.4407E+04	9.7247E+04	3.4196E+00	2.3133E+03	1.1208E+04	1.6696E+00

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tåsing Parkvej 8-12 DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.6676E+02	8.2320E+02	4.1651E+05	3.4407E+04	8.4281E+04	1.0339E+01	2.3133E+03	1.0124E+04	3.4196E+00
8.6676E+02	7.7175E+02	6.2834E+05	3.4407E+04	7.7797E+04	6.8392E+00	2.3133E+03	9.0388E+03	1.6696E+00
8.6676E+02	7.2030E+02	8.3598E+05	3.4407E+04	6.4831E+04	2.2421E+01	2.3133E+03	8.3157E+03	7.0175E+02
8.6676E+02	6.6885E+02	1.2410E+06	3.4407E+04	5.8348E+04	1.3839E+01	2.3133E+03	7.9542E+03	1.3393E+01
8.6676E+02	6.1740E+02	1.5672E+06	3.4407E+04	5.1865E+04	1.4901E+01	2.3133E+03	7.5926E+03	2.0063E+02
8.6676E+02	5.6595E+02	2.0956E+06	3.4407E+04	4.5382E+04	5.8049E+01	2.3133E+03	7.2311E+03	1.1134E+04
8.6676E+02	5.1450E+02	2.4084E+06	3.4407E+04	3.8899E+04	4.2580E+01	2.3133E+03	6.8695E+03	1.0870E+04
8.6676E+02	4.6305E+02	2.7415E+06	3.4407E+04	3.2416E+04	4.1518E+01	2.3133E+03	6.5080E+03	2.4060E+04
8.6676E+02	4.1160E+02	3.2260E+06	3.4407E+04	2.5932E+04	1.1449E+02	2.3133E+03	6.1464E+03	2.9099E+04
8.6676E+02	3.6015E+02	3.2686E+06	3.4407E+04	1.9449E+04	2.1838E+02	2.3133E+03	5.7849E+03	1.0744E+05
8.6676E+02	3.0870E+02	3.2557E+06	3.4407E+04	1.2966E+04	2.9356E+02	2.3133E+03	5.4233E+03	1.2524E+05
8.6676E+02	2.5725E+02	2.9947E+06	3.4407E+04	6.4831E+03	8.8292E+03	2.3133E+03	5.0618E+03	1.5278E+05
8.6676E+02	2.0580E+02	2.8642E+06	3.4407E+04	0.0000E+00	5.5582E+03	2.3133E+03	4.7002E+03	2.5226E+05
8.6676E+02	1.5435E+02	3.3558E+06	2.7430E+04	1.4911E+05	6.2500E-01	2.3133E+03	4.3386E+03	2.7457E+05
8.6676E+02	1.0290E+02	5.9428E+06	2.7430E+04	1.4263E+05	5.1696E+00	2.3133E+03	3.9771E+03	4.3523E+05
8.6676E+02	5.1450E+01	1.6070E+07	2.7430E+04	1.3615E+05	3.4196E+00	2.3133E+03	3.6155E+03	6.0029E+05
8.6676E+02	0.0000E+00	2.2112E+07	2.7430E+04	1.2966E+05	1.7500E+00	2.3133E+03	3.2540E+03	6.1665E+05
8.0660E+02	2.1609E+03	1.1676E+03	2.7430E+04	1.2318E+05	3.5000E+00	2.3133E+03	2.8924E+03	6.9166E+05
8.0660E+02	1.9551E+03	7.7840E+02	2.7430E+04	1.1670E+05	7.0000E+00	2.3133E+03	2.5309E+03	7.0936E+05
8.0660E+02	1.8007E+03	9.4779E+02	2.7430E+04	1.0373E+05	6.7588E+00	2.3133E+03	2.1693E+03	7.2688E+05
8.0660E+02	1.7493E+03	8.9737E+02	2.7430E+04	9.7247E+04	3.4196E+00	2.3133E+03	1.8078E+03	1.0172E+06
8.0660E+02	1.6978E+03	2.6862E+03	2.7430E+04	9.0764E+04	1.9336E+01	2.3133E+03	1.4462E+03	7.9815E+05
8.0660E+02	1.6464E+03	5.4941E+03	2.7430E+04	8.4281E+04	3.5000E+00	2.3133E+03	1.0847E+03	1.0568E+06
8.0660E+02	1.5949E+03	5.1627E+03	2.7430E+04	7.7797E+04	3.7521E+01	2.3133E+03	7.2311E+02	1.9473E+06
8.0660E+02	1.5435E+03	1.3023E+04	2.7430E+04	7.1314E+04	6.8392E+00	2.3133E+03	3.6155E+02	3.7961E+06
8.0660E+02	1.4920E+03	1.7934E+04	2.7430E+04	6.4831E+04	1.7500E+01	2.3133E+03	0.0000E+00	7.6050E+06
8.0660E+02	1.4406E+03	2.6645E+04	2.7430E+04	5.8348E+04	6.0588E+01	1.8482E+03	1.3377E+04	1.3292E-01
8.0660E+02	1.3891E+03	3.5664E+04	2.7430E+04	5.1865E+04	2.0678E+01	1.8482E+03	1.0847E+04	2.2106E+00
8.0660E+02	1.3377E+03	3.2868E+04	2.7430E+04	4.5382E+04	2.9250E+01	1.8482E+03	1.0485E+04	1.6696E+00
8.0660E+02	1.2862E+03	5.5129E+04	2.7430E+04	3.8899E+04	2.1916E+02	1.8482E+03	1.0124E+04	1.2532E+03
8.0660E+02	1.2348E+03	1.1163E+05	2.7430E+04	3.2416E+04	7.0778E+01	1.8482E+03	9.7620E+03	4.0197E+01
8.0660E+02	1.1833E+03	1.3588E+05	2.7430E+04	2.5932E+04	8.7259E+01	1.8482E+03	9.4004E+03	3.3918E+03
8.0660E+02	1.1319E+03	2.6039E+05	2.7430E+04	1.9449E+04	4.4440E+03	1.8482E+03	9.0388E+03	2.3113E+03
8.0660E+02	1.0804E+03	3.6682E+05	2.7430E+04	1.2966E+04	4.6032E+03	1.8482E+03	8.6773E+03	2.7785E+02
8.0660E+02	1.0290E+03	4.6947E+05	2.7430E+04	6.4831E+03	1.0075E+04	1.8482E+03	8.3157E+03	3.6755E+03
8.0660E+02	9.7755E+02	7.1769E+05	2.7430E+04	0.0000E+00	5.4878E+04	1.8482E+03	7.9542E+03	1.3335E+04
8.0660E+02	9.2610E+02	8.8593E+05	2.0454E+04	1.4911E+05	6.2500E-01	1.8482E+03	7.5926E+03	2.5311E+04
8.0660E+02	8.7465E+02	1.2628E+06	2.0454E+04	1.4263E+05	3.4196E+00	1.8482E+03	7.2311E+03	4.0756E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.0660E+02	8.2320E+02	1.3367E+06	2.0454E+04	1.3615E+05	6.2500E-01	1.8482E+03	6.8695E+03	6.4997E+04
8.0660E+02	7.7175E+02	1.9362E+06	2.0454E+04	1.2966E+05	6.2500E-01	1.8482E+03	6.5080E+03	7.1970E+04
8.0660E+02	7.2030E+02	2.7315E+06	2.0454E+04	1.2318E+05	2.2946E+00	1.8482E+03	6.1464E+03	1.0474E+05
8.0660E+02	6.6885E+02	3.2164E+06	2.0454E+04	1.1670E+05	3.0000E+00	1.8482E+03	5.7849E+03	1.6476E+05
8.0660E+02	6.1740E+02	3.6892E+06	2.0454E+04	1.1021E+05	2.2946E+00	1.8482E+03	5.4233E+03	2.6297E+05
8.0660E+02	5.6595E+02	4.3966E+06	2.0454E+04	1.0373E+05	3.5000E+00	1.8482E+03	5.0618E+03	2.7384E+05
8.0660E+02	5.1450E+02	4.9489E+06	2.0454E+04	9.7247E+04	1.1291E+01	1.8482E+03	4.7002E+03	3.5457E+05
8.0660E+02	4.6305E+02	5.7723E+06	2.0454E+04	9.0764E+04	3.5418E+01	1.8482E+03	4.3386E+03	4.2658E+05
8.0660E+02	4.1160E+02	6.4918E+06	2.0454E+04	8.4281E+04	1.6120E+01	1.8482E+03	3.9771E+03	6.3621E+05
8.0660E+02	3.6015E+02	6.6743E+06	2.0454E+04	7.7797E+04	4.2252E+01	1.8482E+03	3.6155E+03	8.0784E+05
8.0660E+02	3.0870E+02	6.5434E+06	2.0454E+04	7.1314E+04	3.5045E+01	1.8482E+03	3.2540E+03	8.8687E+05
8.0660E+02	2.5725E+02	5.2194E+06	2.0454E+04	6.4831E+04	2.0339E+01	1.8482E+03	2.8924E+03	1.1131E+06
8.0660E+02	2.0580E+02	5.2300E+06	2.0454E+04	5.8348E+04	7.2040E+01	1.8482E+03	2.5309E+03	1.3285E+06
8.0660E+02	1.5435E+02	5.0860E+06	2.0454E+04	5.1865E+04	1.2355E+02	1.8482E+03	2.1693E+03	1.3134E+06
8.0660E+02	1.0290E+02	8.6952E+06	2.0454E+04	4.5382E+04	9.4469E+01	1.8482E+03	1.8078E+03	1.4311E+06
8.0660E+02	5.1450E+01	2.1017E+07	2.0454E+04	3.8899E+04	2.3610E+03	1.8482E+03	1.4462E+03	1.3942E+06
8.0660E+02	0.0000E+00	2.7366E+07	2.0454E+04	3.2416E+04	2.9966E+02	1.8482E+03	1.0847E+03	1.7894E+06
7.4645E+02	2.1609E+03	2.5569E+01	2.0454E+04	2.5932E+04	8.8544E+03	1.8482E+03	7.2311E+02	2.8886E+06
7.4645E+02	2.0065E+03	6.6965E+00	2.0454E+04	1.9449E+04	6.8551E+02	1.8482E+03	3.6155E+02	5.9579E+06
7.4645E+02	1.9036E+03	1.1018E+03	2.0454E+04	1.2966E+04	1.6043E+04	1.8482E+03	0.0000E+00	1.1429E+07
7.4645E+02	1.8522E+03	1.0163E+03	2.0454E+04	6.4831E+03	4.0027E+04	1.3831E+03	1.7355E+04	1.6696E+00
7.4645E+02	1.8007E+03	1.8203E+03	2.0454E+04	0.0000E+00	1.8722E+05	1.3831E+03	1.4462E+04	6.6460E-02
7.4645E+02	1.7493E+03	3.0473E+03	1.3477E+04	1.4911E+05	1.6696E+00	1.3831E+03	1.3739E+04	1.6331E+00
7.4645E+02	1.6978E+03	5.9670E+03	1.3477E+04	1.4263E+05	3.3392E+00	1.3831E+03	1.3016E+04	6.2500E-01
7.4645E+02	1.6464E+03	7.1974E+03	1.3477E+04	1.3615E+05	6.9146E-01	1.3831E+03	1.1931E+04	4.0215E+01
7.4645E+02	1.5949E+03	1.7375E+04	1.3477E+04	1.2318E+05	6.2500E-01	1.3831E+03	1.1570E+04	7.4255E+00
7.4645E+02	1.5435E+03	1.9907E+04	1.3477E+04	1.1670E+05	3.4196E+00	1.3831E+03	1.1208E+04	5.2073E+01
7.4645E+02	1.4920E+03	3.3198E+04	1.3477E+04	1.0373E+05	6.9146E-01	1.3831E+03	1.0847E+04	3.3520E+01
7.4645E+02	1.4406E+03	5.1023E+04	1.3477E+04	9.7247E+04	6.4196E+00	1.3831E+03	1.0485E+04	1.5355E+02
7.4645E+02	1.3891E+03	7.6667E+04	1.3477E+04	9.0764E+04	9.3750E+00	1.3831E+03	1.0124E+04	5.5817E+02
7.4645E+02	1.3377E+03	8.4109E+04	1.3477E+04	8.4281E+04	5.0586E+01	1.3831E+03	9.7620E+03	7.9312E+01
7.4645E+02	1.2862E+03	1.1173E+05	1.3477E+04	7.7797E+04	3.5830E+01	1.3831E+03	9.4004E+03	2.8765E+03
7.4645E+02	1.2348E+03	1.8777E+05	1.3477E+04	7.1314E+04	3.7040E+01	1.3831E+03	9.0388E+03	6.9769E+03
7.4645E+02	1.1833E+03	2.3408E+05	1.3477E+04	6.4831E+04	1.1283E+02	1.3831E+03	8.6773E+03	7.0707E+03
7.4645E+02	1.1319E+03	3.7907E+05	1.3477E+04	5.8348E+04	2.4396E+02	1.3831E+03	8.3157E+03	2.2974E+04
7.4645E+02	1.0804E+03	4.8992E+05	1.3477E+04	5.1865E+04	2.3054E+03	1.3831E+03	7.9542E+03	1.8955E+04
7.4645E+02	1.0290E+03	5.5785E+05	1.3477E+04	4.5382E+04	2.5486E+03	1.3831E+03	7.5926E+03	3.4072E+04
7.4645E+02	9.7755E+02	7.0117E+05	1.3477E+04	3.8899E+04	1.1609E+04	1.3831E+03	7.2311E+03	5.7787E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tåsborg Parkvej 8.2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
7.4645E+02	9.2610E+02	1.0099E+06	1.3477E+04	3.2416E+04	3.4264E+03	1.3831E+03	6.8695E+03	8.5071E+04
7.4645E+02	8.7465E+02	1.2834E+06	1.3477E+04	2.5932E+04	1.8233E+04	1.3831E+03	6.5080E+03	1.0485E+05
7.4645E+02	8.2320E+02	1.6859E+06	1.3477E+04	1.9449E+04	3.0618E+04	1.3831E+03	6.1464E+03	1.4633E+05
7.4645E+02	7.7175E+02	2.1925E+06	1.3477E+04	1.2966E+04	2.7021E+04	1.3831E+03	5.7849E+03	2.1029E+05
7.4645E+02	7.2030E+02	2.5212E+06	1.3477E+04	6.4831E+03	8.4710E+04	1.3831E+03	5.4233E+03	3.0287E+05
7.4645E+02	6.6885E+02	3.3441E+06	1.3477E+04	0.0000E+00	1.1641E+06	1.3831E+03	5.0618E+03	4.1399E+05
7.4645E+02	6.1740E+02	4.0458E+06	6.5008E+03	1.6208E+05	6.2500E-01	1.3831E+03	4.7002E+03	4.7194E+05
7.4645E+02	5.6595E+02	4.6047E+06	6.5008E+03	1.4911E+05	4.6064E-01	1.3831E+03	4.3386E+03	6.9155E+05
7.4645E+02	5.1450E+02	5.8126E+06	6.5008E+03	1.4263E+05	1.6696E+00	1.3831E+03	3.9771E+03	1.0292E+06
7.4645E+02	4.6305E+02	5.8343E+06	6.5008E+03	1.3615E+05	1.7361E+00	1.3831E+03	3.6155E+03	1.1369E+06
7.4645E+02	4.1160E+02	6.0878E+06	6.5008E+03	1.2966E+05	4.0307E+00	1.3831E+03	3.2540E+03	1.3941E+06
7.4645E+02	3.6015E+02	6.2317E+06	6.5008E+03	1.2318E+05	3.4057E+00	1.3831E+03	2.8924E+03	1.7095E+06
7.4645E+02	3.0870E+02	5.8462E+06	6.5008E+03	1.1670E+05	6.9146E-01	1.3831E+03	2.5309E+03	1.9458E+06
7.4645E+02	2.5725E+02	5.0120E+06	6.5008E+03	1.1021E+05	1.3165E+00	1.3831E+03	2.1693E+03	2.0695E+06
7.4645E+02	2.0580E+02	4.5354E+06	6.5008E+03	1.0373E+05	2.2102E+03	1.3831E+03	1.8078E+03	2.3847E+06
7.4645E+02	1.5435E+02	4.5353E+06	6.5008E+03	9.7247E+04	4.4207E+03	1.3831E+03	1.4462E+03	2.1692E+06
7.4645E+02	1.0290E+02	8.6777E+06	6.5008E+03	9.0764E+04	2.2138E+03	1.3831E+03	1.0847E+03	2.4289E+06
7.4645E+02	5.1450E+01	2.2600E+07	6.5008E+03	8.4281E+04	1.1230E+03	1.3831E+03	7.2311E+02	3.9452E+06
7.4645E+02	0.0000E+00	3.0525E+07	6.5008E+03	7.7797E+04	8.8176E+03	1.3831E+03	3.6155E+02	9.3140E+06
6.8629E+02	2.3667E+03	4.0931E+02	6.5008E+03	7.1314E+04	1.5557E+04	1.3831E+03	0.0000E+00	1.9577E+07
6.8629E+02	2.1609E+03	2.0108E+01	6.5008E+03	6.4831E+04	5.7590E+03	9.1799E+02	1.4462E+04	8.3472E+01
6.8629E+02	2.1094E+03	1.8852E+02	6.5008E+03	5.8348E+04	1.2805E+04	9.1799E+02	1.3739E+04	8.9918E+01
6.8629E+02	2.0065E+03	1.5386E+03	6.5008E+03	5.1865E+04	2.7080E+04	9.1799E+02	1.3377E+04	2.5569E+01
6.8629E+02	1.9551E+03	2.7570E+03	6.5008E+03	4.5382E+04	2.9054E+04	9.1799E+02	1.3016E+04	7.1146E-01
6.8629E+02	1.9036E+03	1.0625E+02	6.5008E+03	3.8899E+04	3.0414E+04	9.1799E+02	1.2654E+04	2.6504E+01
6.8629E+02	1.8522E+03	7.4271E+03	6.5008E+03	3.2416E+04	9.6389E+04	9.1799E+02	1.2293E+04	1.2064E+02
6.8629E+02	1.8007E+03	3.1812E+03	6.5008E+03	2.5932E+04	3.3567E+05	9.1799E+02	1.1570E+04	2.2964E+02
6.8629E+02	1.7493E+03	7.7137E+03	6.5008E+03	1.9449E+04	8.1633E+05	9.1799E+02	1.1208E+04	6.6562E+02
6.8629E+02	1.6978E+03	6.3471E+03	6.5008E+03	1.2966E+04	1.7926E+06	9.1799E+02	1.0847E+04	1.4540E+03
6.8629E+02	1.6464E+03	9.3160E+03	6.5008E+03	6.4831E+03	5.0333E+06	9.1799E+02	1.0485E+04	3.3301E+03
6.8629E+02	1.5949E+03	1.8611E+04	6.5008E+03	0.0000E+00	1.4855E+07	9.1799E+02	1.0124E+04	5.5698E+03
6.8629E+02	1.5435E+03	2.4055E+04	-4.7563E+02	1.4263E+05	6.6460E-02	9.1799E+02	9.7620E+03	9.4638E+03
6.8629E+02	1.4920E+03	5.0463E+04	-4.7563E+02	1.2966E+05	6.6460E-02	9.1799E+02	9.4004E+03	6.0760E+03
6.8629E+02	1.4406E+03	2.9312E+04	-4.7563E+02	1.2318E+05	7.5792E-01	9.1799E+02	9.0388E+03	4.0844E+03
6.8629E+02	1.3891E+03	4.6513E+04	-4.7563E+02	1.1670E+05	7.5792E-01	9.1799E+02	8.6773E+03	9.7531E+03
6.8629E+02	1.3377E+03	8.2621E+04	-4.7563E+02	1.1021E+05	2.2095E+03	9.1799E+02	8.3157E+03	1.6934E+04
6.8629E+02	1.2862E+03	1.0873E+05	-4.7563E+02	1.0373E+05	1.1106E+03	9.1799E+02	7.9542E+03	4.9742E+04
6.8629E+02	1.2348E+03	1.3991E+05	-4.7563E+02	9.7247E+04	1.1406E+03	9.1799E+02	7.5926E+03	5.0365E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV Denmark A/S Tåsingehøjvej 6.2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.8629E+02	1.1833E+03	1.9783E+05	-4.7563E+02	9.0764E+04	5.5749E+03	9.1799E+02	7.2311E+03	5.8649E+04
6.8629E+02	1.1319E+03	2.3918E+05	-4.7563E+02	8.4281E+04	7.6452E+03	9.1799E+02	6.8695E+03	8.4667E+04
6.8629E+02	1.0804E+03	2.9802E+05	-4.7563E+02	7.7797E+04	3.4306E+03	9.1799E+02	6.5080E+03	1.7719E+05
6.8629E+02	1.0290E+03	4.3523E+05	-4.7563E+02	7.1314E+04	1.0052E+04	9.1799E+02	6.1464E+03	1.5309E+05
6.8629E+02	9.7755E+02	5.6146E+05	-4.7563E+02	6.4831E+04	1.3535E+04	9.1799E+02	5.7849E+03	2.7165E+05
6.8629E+02	9.2610E+02	6.6671E+05	-4.7563E+02	5.8348E+04	5.6831E+04	9.1799E+02	5.4233E+03	4.3241E+05
6.8629E+02	8.7465E+02	1.0272E+06	-4.7563E+02	5.1865E+04	6.6013E+04	9.1799E+02	5.0618E+03	5.8487E+05
6.8629E+02	8.2320E+02	1.2995E+06	-4.7563E+02	4.5382E+04	1.0084E+05	9.1799E+02	4.7002E+03	6.5596E+05
6.8629E+02	7.7175E+02	1.4469E+06	-4.7563E+02	3.8899E+04	1.4218E+05	9.1799E+02	4.3386E+03	8.0017E+05
6.8629E+02	7.2030E+02	2.1067E+06	-4.7563E+02	3.2416E+04	2.1787E+05	9.1799E+02	3.9771E+03	1.1075E+06
6.8629E+02	6.6885E+02	2.5836E+06	-4.7563E+02	2.5932E+04	3.2049E+05	9.1799E+02	3.6155E+03	1.4626E+06
6.8629E+02	6.1740E+02	3.2636E+06	-4.7563E+02	1.9449E+04	6.2797E+05	9.1799E+02	3.2540E+03	1.8652E+06
6.8629E+02	5.6595E+02	3.9116E+06	-4.7563E+02	1.2966E+04	1.0938E+06	9.1799E+02	2.8924E+03	1.9953E+06
6.8629E+02	5.1450E+02	4.2785E+06	-4.7563E+02	6.4831E+03	2.3948E+06	9.1799E+02	2.5309E+03	2.5466E+06
6.8629E+02	4.6305E+02	4.8664E+06	-4.7563E+02	0.0000E+00	1.3447E+07	9.1799E+02	2.1693E+03	3.3380E+06
6.8629E+02	4.1160E+02	5.1031E+06	-7.4521E+03	3.0471E+05	1.6696E+00	9.1799E+02	1.8078E+03	4.0722E+06
6.8629E+02	3.6015E+02	5.0165E+06	-7.4521E+03	2.7877E+05	1.6696E+00	9.1799E+02	1.4462E+03	3.7691E+06
6.8629E+02	3.0870E+02	5.5745E+06	-7.4521E+03	2.6581E+05	1.6696E+00	9.1799E+02	1.0847E+03	4.0211E+06
6.8629E+02	2.5725E+02	4.6089E+06	-7.4521E+03	1.6208E+05	6.6460E-02	9.1799E+02	7.2311E+02	5.4589E+06
6.8629E+02	2.0580E+02	4.1613E+06	-7.4521E+03	1.4911E+05	1.6696E+00	9.1799E+02	3.6155E+02	1.2864E+07
6.8629E+02	1.5435E+02	4.5109E+06	-7.4521E+03	1.4263E+05	1.3292E-01	9.1799E+02	0.0000E+00	2.7496E+07
6.8629E+02	1.0290E+02	7.5732E+06	-7.4521E+03	1.3615E+05	7.5792E-01	4.5288E+02	1.6270E+04	6.6460E-02
6.8629E+02	5.1450E+01	2.1773E+07	-7.4521E+03	1.2966E+05	1.7459E+00	4.5288E+02	1.5547E+04	4.0215E+01
6.8629E+02	0.0000E+00	3.0315E+07	-7.4521E+03	1.2318E+05	1.8025E+00	4.5288E+02	1.5185E+04	6.2500E-01
6.2614E+02	2.5210E+03	3.8920E+02	-7.4521E+03	1.1670E+05	2.3707E+00	4.5288E+02	1.4824E+04	7.6841E+01
6.2614E+02	2.4696E+03	3.8920E+02	-7.4521E+03	1.1021E+05	4.6636E+01	4.5288E+02	1.4462E+04	2.5634E+01
6.2614E+02	2.3667E+03	2.5569E+01	-7.4521E+03	1.0373E+05	8.0336E+01	4.5288E+02	1.4101E+04	1.4927E+02
6.2614E+02	2.3152E+03	6.6965E+00	-7.4521E+03	9.7247E+04	3.4237E+01	4.5288E+02	1.3739E+04	4.0512E+02
6.2614E+02	2.2638E+03	1.0505E+02	-7.4521E+03	9.0764E+04	1.4878E+02	4.5288E+02	1.3377E+04	3.0872E+03
6.2614E+02	2.2123E+03	1.8521E+02	-7.4521E+03	8.4281E+04	6.6323E+03	4.5288E+02	1.3016E+04	6.3219E+01
6.2614E+02	2.1609E+03	3.6017E+02	-7.4521E+03	7.7797E+04	4.8255E+02	4.5288E+02	1.2654E+04	4.3367E+03
6.2614E+02	2.1094E+03	2.0055E+02	-7.4521E+03	7.1314E+04	8.4871E+03	4.5288E+02	1.2293E+04	1.7845E+03
6.2614E+02	2.0580E+03	4.0215E+01	-7.4521E+03	6.4831E+04	3.2172E+03	4.5288E+02	1.1931E+04	1.0888E+04
6.2614E+02	2.0065E+03	1.5434E+03	-7.4521E+03	5.8348E+04	4.5296E+03	4.5288E+02	1.1570E+04	6.6657E+03
6.2614E+02	1.9551E+03	6.9730E+02	-7.4521E+03	5.1865E+04	2.6739E+04	4.5288E+02	1.1208E+04	1.0915E+04
6.2614E+02	1.9036E+03	2.1012E+03	-7.4521E+03	4.5382E+04	9.2530E+04	4.5288E+02	1.0847E+04	2.8875E+04
6.2614E+02	1.8522E+03	3.6192E+03	-7.4521E+03	3.8899E+04	2.1001E+05	4.5288E+02	1.0485E+04	2.3887E+04
6.2614E+02	1.8007E+03	4.1135E+03	-7.4521E+03	3.2416E+04	4.0831E+05	4.5288E+02	1.0124E+04	2.5220E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tåsing Parkvej 8-12, DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
6.2614E+02	1.7493E+03	4.8589E+03	-7.4521E+03	2.5932E+04	6.0013E+05	4.5288E+02	9.7620E+03	2.2096E+04
6.2614E+02	1.6978E+03	3.0809E+03	-7.4521E+03	1.9449E+04	9.4858E+05	4.5288E+02	9.4004E+03	2.1876E+04
6.2614E+02	1.6464E+03	9.8611E+03	-7.4521E+03	1.2966E+04	1.0560E+06	4.5288E+02	9.0388E+03	2.5237E+04
6.2614E+02	1.5949E+03	1.8148E+04	-7.4521E+03	6.4831E+03	2.0242E+06	4.5288E+02	8.6773E+03	4.6469E+04
6.2614E+02	1.5435E+03	1.2082E+04	-7.4521E+03	0.0000E+00	6.3830E+06	4.5288E+02	8.3157E+03	2.9933E+04
6.2614E+02	1.4920E+03	4.1997E+04	-1.4429E+04	3.2416E+05	1.6696E+00	4.5288E+02	7.9542E+03	8.3722E+04
6.2614E+02	1.4406E+03	3.2853E+04	-1.4429E+04	3.1119E+05	1.6696E+00	4.5288E+02	7.5926E+03	4.2357E+04
6.2614E+02	1.3891E+03	6.2654E+04	-1.4429E+04	2.6581E+05	6.6460E-02	4.5288E+02	7.2311E+03	9.3317E+04
6.2614E+02	1.3377E+03	9.1605E+04	-1.4429E+04	2.5932E+05	1.7500E+00	4.5288E+02	6.8695E+03	1.3109E+05
6.2614E+02	1.2862E+03	7.9067E+04	-1.4429E+04	2.4636E+05	1.7500E+00	4.5288E+02	6.5080E+03	2.0990E+05
6.2614E+02	1.2348E+03	1.0249E+05	-1.4429E+04	1.9449E+05	6.2500E-01	4.5288E+02	6.1464E+03	2.3160E+05
6.2614E+02	1.1833E+03	1.4016E+05	-1.4429E+04	1.7504E+05	6.6460E-02	4.5288E+02	5.7849E+03	4.0597E+05
6.2614E+02	1.1319E+03	1.6944E+05	-1.4429E+04	1.5559E+05	1.9938E-01	4.5288E+02	5.4233E+03	4.0009E+05
6.2614E+02	1.0804E+03	2.5591E+05	-1.4429E+04	1.4911E+05	6.6460E-02	4.5288E+02	5.0618E+03	6.5927E+05
6.2614E+02	1.0290E+03	3.6743E+05	-1.4429E+04	1.4263E+05	1.4272E-01	4.5288E+02	4.7002E+03	8.0080E+05
6.2614E+02	9.7755E+02	4.2962E+05	-1.4429E+04	1.3615E+05	1.8025E+00	4.5288E+02	4.3386E+03	1.1033E+06
6.2614E+02	9.2610E+02	5.9573E+05	-1.4429E+04	1.2966E+05	1.3442E-01	4.5288E+02	3.9771E+03	1.4114E+06
6.2614E+02	8.7465E+02	8.2439E+05	-1.4429E+04	1.2318E+05	1.9369E+00	4.5288E+02	3.6155E+03	1.6383E+06
6.2614E+02	8.2320E+02	9.6650E+05	-1.4429E+04	1.1670E+05	2.8439E+01	4.5288E+02	3.2540E+03	2.2059E+06
6.2614E+02	7.7175E+02	1.3617E+06	-1.4429E+04	1.1021E+05	3.4908E+01	4.5288E+02	2.8924E+03	2.4606E+06
6.2614E+02	7.2030E+02	1.6616E+06	-1.4429E+04	1.0373E+05	2.4662E+01	4.5288E+02	2.5309E+03	3.7325E+06
6.2614E+02	6.6885E+02	2.0517E+06	-1.4429E+04	9.7247E+04	4.3686E+03	4.5288E+02	2.1693E+03	4.3242E+06
6.2614E+02	6.1740E+02	2.4058E+06	-1.4429E+04	9.0764E+04	1.7579E+02	4.5288E+02	1.8078E+03	5.3458E+06
6.2614E+02	5.6595E+02	2.7256E+06	-1.4429E+04	8.4281E+04	3.2959E+03	4.5288E+02	1.4462E+03	5.5177E+06
6.2614E+02	5.1450E+02	3.5104E+06	-1.4429E+04	7.7797E+04	3.6044E+03	4.5288E+02	1.0847E+03	5.7940E+06
6.2614E+02	4.6305E+02	3.7446E+06	-1.4429E+04	7.1314E+04	2.2759E+03	4.5288E+02	7.2311E+02	8.2355E+06
6.2614E+02	4.1160E+02	3.5693E+06	-1.4429E+04	6.4831E+04	1.0081E+04	4.5288E+02	3.6155E+02	1.8310E+07
6.2614E+02	3.6015E+02	4.3123E+06	-1.4429E+04	5.8348E+04	2.5326E+04	4.5288E+02	0.0000E+00	3.7637E+07
6.2614E+02	3.0870E+02	4.3617E+06	-1.4429E+04	5.1865E+04	4.0810E+04	-1.2223E+01	1.6631E+04	1.6331E+00
6.2614E+02	2.5725E+02	3.9914E+06	-1.4429E+04	4.5382E+04	6.5099E+04	-1.2223E+01	1.5908E+04	6.6965E+00
6.2614E+02	2.0580E+02	3.7803E+06	-1.4429E+04	3.8899E+04	2.1913E+05	-1.2223E+01	1.5547E+04	4.2771E-01
6.2614E+02	1.5435E+02	3.8747E+06	-1.4429E+04	3.2416E+04	4.8745E+05	-1.2223E+01	1.5185E+04	1.9447E+00
6.2614E+02	1.0290E+02	6.3803E+06	-1.4429E+04	2.5932E+04	1.0520E+06	-1.2223E+01	1.4824E+04	1.9264E+03
6.2614E+02	5.1450E+01	1.9123E+07	-1.4429E+04	1.9449E+04	1.3891E+06	-1.2223E+01	1.4462E+04	1.4861E+03
6.2614E+02	0.0000E+00	2.9585E+07	-1.4429E+04	1.2966E+04	2.0761E+06	-1.2223E+01	1.4101E+04	5.8351E+02
5.6598E+02	2.5725E+03	2.0108E+01	-1.4429E+04	6.4831E+03	4.3785E+06	-1.2223E+01	1.3739E+04	5.7148E+02
5.6598E+02	2.4181E+03	2.0090E+01	-1.4429E+04	0.0000E+00	1.0937E+07	-1.2223E+01	1.3377E+04	4.8611E+03
5.6598E+02	2.3667E+03	6.6965E+00	-2.1405E+04	3.2416E+05	1.6696E+00	-1.2223E+01	1.3016E+04	8.2772E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE
DNV Business Assurance Tåsborg Parkvej 8-2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.6598E+02	2.3152E+03	8.3472E+01	-2.1405E+04	2.9822E+05	1.6696E+00	-1.2223E+01	1.2654E+04	7.7161E+03
5.6598E+02	2.2638E+03	3.2265E+01	-2.1405E+04	2.9174E+05	6.6460E-02	-1.2223E+01	1.2293E+04	2.3871E+04
5.6598E+02	2.2123E+03	5.1137E+01	-2.1405E+04	2.8526E+05	6.6784E+00	-1.2223E+01	1.1931E+04	3.6428E+04
5.6598E+02	2.1609E+03	6.5766E+01	-2.1405E+04	2.7877E+05	1.6696E+00	-1.2223E+01	1.1570E+04	2.8094E+04
5.6598E+02	2.1094E+03	7.3836E+01	-2.1405E+04	2.6581E+05	6.2500E-01	-1.2223E+01	1.1208E+04	3.3797E+04
5.6598E+02	2.0580E+03	1.3723E+02	-2.1405E+04	2.5284E+05	1.0500E+01	-1.2223E+01	1.0847E+04	5.7429E+04
5.6598E+02	2.0065E+03	1.3708E+02	-2.1405E+04	2.4636E+05	1.7500E+00	-1.2223E+01	1.0485E+04	6.7615E+04
5.6598E+02	1.9551E+03	2.2434E+02	-2.1405E+04	2.2043E+05	1.7500E+00	-1.2223E+01	1.0124E+04	4.1611E+04
5.6598E+02	1.9036E+03	4.2250E+02	-2.1405E+04	1.8801E+05	1.7500E+00	-1.2223E+01	9.7620E+03	4.5938E+04
5.6598E+02	1.8522E+03	5.6240E+02	-2.1405E+04	1.8153E+05	6.6460E-02	-1.2223E+01	9.4004E+03	5.7711E+04
5.6598E+02	1.8007E+03	3.1713E+03	-2.1405E+04	1.7504E+05	1.3292E-01	-1.2223E+01	9.0388E+03	5.1335E+04
5.6598E+02	1.7493E+03	1.6788E+03	-2.1405E+04	1.6208E+05	8.2438E-01	-1.2223E+01	8.6773E+03	9.9874E+04
5.6598E+02	1.6978E+03	6.8127E+03	-2.1405E+04	1.5559E+05	6.6460E-02	-1.2223E+01	8.3157E+03	4.3104E+04
5.6598E+02	1.6464E+03	6.1662E+03	-2.1405E+04	1.4911E+05	1.4819E+01	-1.2223E+01	7.9542E+03	9.2517E+04
5.6598E+02	1.5949E+03	6.0231E+03	-2.1405E+04	1.4263E+05	6.6460E-02	-1.2223E+01	7.5926E+03	1.4769E+05
5.6598E+02	1.5435E+03	9.4919E+03	-2.1405E+04	1.3615E+05	2.6329E+00	-1.2223E+01	7.2311E+03	1.6261E+05
5.6598E+02	1.4920E+03	1.4111E+04	-2.1405E+04	1.2966E+05	1.3292E-01	-1.2223E+01	6.8695E+03	2.1835E+05
5.6598E+02	1.4406E+03	2.0749E+04	-2.1405E+04	1.2318E+05	9.7985E-03	-1.2223E+01	6.5080E+03	2.8266E+05
5.6598E+02	1.3891E+03	2.1394E+04	-2.1405E+04	1.1670E+05	1.6481E+02	-1.2223E+01	6.1464E+03	3.1425E+05
5.6598E+02	1.3377E+03	3.3982E+04	-2.1405E+04	1.1021E+05	2.8567E+02	-1.2223E+01	5.7849E+03	4.2399E+05
5.6598E+02	1.2862E+03	4.9479E+04	-2.1405E+04	1.0373E+05	2.4313E+03	-1.2223E+01	5.4233E+03	5.1011E+05
5.6598E+02	1.2348E+03	5.8122E+04	-2.1405E+04	9.7247E+04	1.8210E+02	-1.2223E+01	5.0618E+03	8.3204E+05
5.6598E+02	1.1833E+03	8.1795E+04	-2.1405E+04	9.0764E+04	1.4063E+02	-1.2223E+01	4.7002E+03	9.3362E+05
5.6598E+02	1.1319E+03	1.2002E+05	-2.1405E+04	8.4281E+04	1.3425E+02	-1.2223E+01	4.3386E+03	1.2825E+06
5.6598E+02	1.0804E+03	1.7452E+05	-2.1405E+04	7.7797E+04	6.1791E+03	-1.2223E+01	3.9771E+03	1.5796E+06
5.6598E+02	1.0290E+03	1.9461E+05	-2.1405E+04	7.1314E+04	3.1764E+03	-1.2223E+01	3.6155E+03	1.8811E+06
5.6598E+02	9.7755E+02	2.4251E+05	-2.1405E+04	6.4831E+04	9.9714E+03	-1.2223E+01	3.2540E+03	2.4928E+06
5.6598E+02	9.2610E+02	3.5183E+05	-2.1405E+04	5.8348E+04	2.8485E+04	-1.2223E+01	2.8924E+03	3.1971E+06
5.6598E+02	8.7465E+02	4.3087E+05	-2.1405E+04	5.1865E+04	4.3019E+04	-1.2223E+01	2.5309E+03	3.9015E+06
5.6598E+02	8.2320E+02	5.4528E+05	-2.1405E+04	4.5382E+04	7.0278E+04	-1.2223E+01	2.1693E+03	5.1508E+06
5.6598E+02	7.7175E+02	6.2653E+05	-2.1405E+04	3.8899E+04	2.6138E+05	-1.2223E+01	1.8078E+03	6.0569E+06
5.6598E+02	7.2030E+02	7.2381E+05	-2.1405E+04	3.2416E+04	6.8873E+05	-1.2223E+01	1.4462E+03	7.1516E+06
5.6598E+02	6.6885E+02	1.0001E+06	-2.1405E+04	2.5932E+04	1.8444E+06	-1.2223E+01	1.0847E+03	7.3418E+06
5.6598E+02	6.1740E+02	1.2537E+06	-2.1405E+04	1.9449E+04	4.6003E+06	-1.2223E+01	7.2311E+02	9.5669E+06
5.6598E+02	5.6595E+02	1.5548E+06	-2.1405E+04	1.2966E+04	6.7721E+06	-1.2223E+01	3.6155E+02	2.3316E+07
5.6598E+02	5.1450E+02	1.6559E+06	-2.1405E+04	6.4831E+03	1.1769E+07	-1.2223E+01	0.0000E+00	5.2930E+07
5.6598E+02	4.6305E+02	2.3389E+06	-2.1405E+04	0.0000E+00	2.5972E+07	-4.7733E+02	1.6270E+04	6.5690E-02
5.6598E+02	4.1160E+02	2.3956E+06	-2.8381E+04	3.0471E+05	1.6696E+00	-4.7733E+02	1.5908E+04	3.8220E-01

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tåsinge Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.6598E+02	3.6015E+02	2.6690E+06	-2.8381E+04	2.9822E+05	1.6696E+00	-4.7733E+02	1.5547E+04	7.1242E+00
5.6598E+02	3.0870E+02	3.2091E+06	-2.8381E+04	2.9174E+05	5.0088E+00	-4.7733E+02	1.5185E+04	1.3459E+01
5.6598E+02	2.5725E+02	3.5736E+06	-2.8381E+04	2.8526E+05	5.0892E+00	-4.7733E+02	1.4824E+04	1.3393E+01
5.6598E+02	2.0580E+02	3.3520E+06	-2.8381E+04	2.7877E+05	3.3392E+00	-4.7733E+02	1.4462E+04	7.4156E+02
5.6598E+02	1.5435E+02	3.5737E+06	-2.8381E+04	2.6581E+05	1.3839E+01	-4.7733E+02	1.4101E+04	1.9010E+03
5.6598E+02	1.0290E+02	5.7088E+06	-2.8381E+04	2.5932E+05	8.7500E+00	-4.7733E+02	1.3739E+04	1.2112E+03
5.6598E+02	5.1450E+01	1.8299E+07	-2.8381E+04	2.5284E+05	6.2500E-01	-4.7733E+02	1.3377E+04	5.4876E+03
5.6598E+02	0.0000E+00	3.0284E+07	-2.8381E+04	2.3988E+05	6.2500E-01	-4.7733E+02	1.3016E+04	7.0767E+03
5.0582E+02	2.3667E+03	6.6965E+00	-2.8381E+04	2.3339E+05	3.5000E+00	-4.7733E+02	1.2654E+04	2.3809E+04
5.0582E+02	2.3152E+03	3.2265E+01	-2.8381E+04	2.2043E+05	1.2500E+00	-4.7733E+02	1.2293E+04	3.5528E+04
5.0582E+02	2.2638E+03	7.8998E+00	-2.8381E+04	2.1394E+05	6.2500E-01	-4.7733E+02	1.1931E+04	4.4399E+04
5.0582E+02	2.2123E+03	6.6965E+00	-2.8381E+04	2.0098E+05	6.6460E-02	-4.7733E+02	1.1570E+04	8.0645E+04
5.0582E+02	2.1609E+03	2.6753E+01	-2.8381E+04	1.8801E+05	6.6460E-02	-4.7733E+02	1.1208E+04	6.0335E+04
5.0582E+02	2.1094E+03	4.2889E+02	-2.8381E+04	1.8153E+05	6.6460E-02	-4.7733E+02	1.0847E+04	7.5444E+04
5.0582E+02	2.0580E+03	9.4225E+01	-2.8381E+04	1.7504E+05	6.6460E-02	-4.7733E+02	1.0485E+04	9.1046E+04
5.0582E+02	2.0065E+03	4.4827E+02	-2.8381E+04	1.6856E+05	1.3292E-01	-4.7733E+02	1.0124E+04	5.4518E+04
5.0582E+02	1.9551E+03	2.3422E+03	-2.8381E+04	1.6208E+05	1.3829E+00	-4.7733E+02	9.7620E+03	4.0393E+04
5.0582E+02	1.9036E+03	7.8146E+02	-2.8381E+04	1.5559E+05	8.4487E-01	-4.7733E+02	9.4004E+03	4.6351E+04
5.0582E+02	1.8522E+03	1.1258E+03	-2.8381E+04	1.4911E+05	8.2438E-01	-4.7733E+02	9.0388E+03	5.7076E+04
5.0582E+02	1.8007E+03	1.1966E+03	-2.8381E+04	1.4263E+05	1.2732E+01	-4.7733E+02	8.6773E+03	1.0619E+05
5.0582E+02	1.7493E+03	1.5366E+03	-2.8381E+04	1.3615E+05	8.7873E-01	-4.7733E+02	8.3157E+03	1.2038E+05
5.0582E+02	1.6978E+03	1.6747E+03	-2.8381E+04	1.2966E+05	1.9846E+01	-4.7733E+02	7.9542E+03	8.5404E+04
5.0582E+02	1.6464E+03	1.2405E+03	-2.8381E+04	1.2318E+05	5.3572E+00	-4.7733E+02	7.5926E+03	1.0523E+05
5.0582E+02	1.5949E+03	3.4326E+03	-2.8381E+04	1.1670E+05	2.4481E+01	-4.7733E+02	7.2311E+03	1.0812E+05
5.0582E+02	1.5435E+03	8.7485E+03	-2.8381E+04	1.1021E+05	2.0036E+01	-4.7733E+02	6.8695E+03	2.1457E+05
5.0582E+02	1.4920E+03	8.6066E+03	-2.8381E+04	1.0373E+05	1.2578E+03	-4.7733E+02	6.5080E+03	3.0292E+05
5.0582E+02	1.4406E+03	7.4919E+03	-2.8381E+04	9.7247E+04	2.3647E+01	-4.7733E+02	6.1464E+03	2.6308E+05
5.0582E+02	1.3891E+03	1.5469E+04	-2.8381E+04	9.0764E+04	7.8540E+02	-4.7733E+02	5.7849E+03	4.0714E+05
5.0582E+02	1.3377E+03	1.8273E+04	-2.8381E+04	8.4281E+04	1.7284E+03	-4.7733E+02	5.4233E+03	6.9852E+05
5.0582E+02	1.2862E+03	2.2470E+04	-2.8381E+04	7.7797E+04	4.8937E+03	-4.7733E+02	5.0618E+03	7.5564E+05
5.0582E+02	1.2348E+03	3.7345E+04	-2.8381E+04	7.1314E+04	2.0578E+04	-4.7733E+02	4.7002E+03	9.9276E+05
5.0582E+02	1.1833E+03	2.9343E+04	-2.8381E+04	6.4831E+04	1.5149E+04	-4.7733E+02	4.3386E+03	1.3651E+06
5.0582E+02	1.1319E+03	4.4286E+04	-2.8381E+04	5.8348E+04	4.4622E+04	-4.7733E+02	3.9771E+03	1.7908E+06
5.0582E+02	1.0804E+03	6.0608E+04	-2.8381E+04	5.1865E+04	7.3178E+04	-4.7733E+02	3.6155E+03	1.9107E+06
5.0582E+02	1.0290E+03	1.1494E+05	-2.8381E+04	4.5382E+04	1.4884E+05	-4.7733E+02	3.2540E+03	2.7106E+06
5.0582E+02	9.7755E+02	1.0107E+05	-2.8381E+04	3.8899E+04	2.4667E+05	-4.7733E+02	2.8924E+03	3.2552E+06
5.0582E+02	9.2610E+02	9.4346E+04	-2.8381E+04	3.2416E+04	5.3720E+05	-4.7733E+02	2.5309E+03	4.1301E+06
5.0582E+02	8.7465E+02	1.5105E+05	-2.8381E+04	2.5932E+04	1.6697E+06	-4.7733E+02	2.1693E+03	4.7742E+06

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tåsborg Farkvej 8-2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
5.0582E+02	8.2320E+02	1.7670E+05	-2.8381E+04	1.9449E+04	4.2245E+06	-4.7733E+02	1.8078E+03	5.3507E+06
5.0582E+02	7.7175E+02	2.5115E+05	-2.8381E+04	1.2966E+04	7.4197E+06	-4.7733E+02	1.4462E+03	5.5571E+06
5.0582E+02	7.2030E+02	2.5334E+05	-2.8381E+04	6.4831E+03	1.3463E+07	-4.7733E+02	1.0847E+03	5.8864E+06
5.0582E+02	6.6885E+02	4.0016E+05	-2.8381E+04	0.0000E+00	2.8129E+07	-4.7733E+02	7.2311E+02	8.7755E+06
5.0582E+02	6.1740E+02	3.9737E+05	-3.5358E+04	2.9174E+05	1.7500E+00	-4.7733E+02	3.6155E+02	1.8760E+07
5.0582E+02	5.6595E+02	5.1245E+05	-3.5358E+04	2.8526E+05	1.7500E+00	-4.7733E+02	0.0000E+00	3.7382E+07
5.0582E+02	5.1450E+02	5.6029E+05	-3.5358E+04	2.7229E+05	1.0259E+01	-9.4243E+02	1.5908E+04	7.9986E+00
5.0582E+02	4.6305E+02	7.2548E+05	-3.5358E+04	2.6581E+05	8.5892E+00	-9.4243E+02	1.5547E+04	3.1403E+01
5.0582E+02	4.1160E+02	1.1008E+06	-3.5358E+04	2.5932E+05	2.1610E+01	-9.4243E+02	1.5185E+04	5.6414E+01
5.0582E+02	3.6015E+02	1.5643E+06	-3.5358E+04	2.5284E+05	1.8271E+01	-9.4243E+02	1.4824E+04	4.5676E+01
5.0582E+02	3.0870E+02	2.2451E+06	-3.5358E+04	2.4636E+05	5.3750E+00	-9.4243E+02	1.4462E+04	7.8672E+02
5.0582E+02	2.5725E+02	3.4429E+06	-3.5358E+04	2.3988E+05	1.6696E+00	-9.4243E+02	1.4101E+04	8.0236E+02
5.0582E+02	2.0580E+02	4.1572E+06	-3.5358E+04	2.3339E+05	2.2106E+00	-9.4243E+02	1.3739E+04	1.4672E+03
5.0582E+02	1.5435E+02	5.1948E+06	-3.5358E+04	2.2691E+05	1.7500E+00	-9.4243E+02	1.3377E+04	8.1925E+03
5.0582E+02	1.0290E+02	7.1062E+06	-3.5358E+04	2.2043E+05	2.4415E+00	-9.4243E+02	1.3016E+04	8.2143E+03
5.0582E+02	5.1450E+01	1.9980E+07	-3.5358E+04	2.1394E+05	3.1329E+00	-9.4243E+02	1.2654E+04	1.4101E+04
5.0582E+02	0.0000E+00	3.7085E+07	-3.5358E+04	1.9449E+05	6.2500E-01	-9.4243E+02	1.2293E+04	9.7468E+03
4.4567E+02	2.5725E+03	8.9160E+00	-3.5358E+04	1.8153E+05	1.2687E+01	-9.4243E+02	1.1931E+04	1.7122E+04
4.4567E+02	2.2123E+03	7.4255E+00	-3.5358E+04	1.7504E+05	4.6064E-01	-9.4243E+02	1.1570E+04	2.5709E+04
4.4567E+02	2.1609E+03	3.8962E+01	-3.5358E+04	1.6856E+05	2.8733E+00	-9.4243E+02	1.1208E+04	2.2261E+04
4.4567E+02	2.1094E+03	8.3661E+00	-3.5358E+04	1.6208E+05	1.5444E+01	-9.4243E+02	1.0847E+04	4.3073E+04
4.4567E+02	2.0580E+03	4.6004E+02	-3.5358E+04	1.5559E+05	6.9146E-01	-9.4243E+02	1.0485E+04	5.4674E+04
4.4567E+02	2.0065E+03	1.3393E+01	-3.5358E+04	1.4911E+05	1.9333E+01	-9.4243E+02	1.0124E+04	6.7256E+04
4.4567E+02	1.9551E+03	9.8104E+01	-3.5358E+04	1.4263E+05	2.4209E+00	-9.4243E+02	9.7620E+03	4.4487E+04
4.4567E+02	1.9036E+03	1.9972E+02	-3.5358E+04	1.3615E+05	1.7783E+01	-9.4243E+02	9.4004E+03	5.6270E+04
4.4567E+02	1.8522E+03	5.5118E+01	-3.5358E+04	1.2966E+05	1.1153E+02	-9.4243E+02	9.0388E+03	1.0590E+05
4.4567E+02	1.8007E+03	2.1676E+02	-3.5358E+04	1.2318E+05	2.5463E+01	-9.4243E+02	8.6773E+03	5.3341E+04
4.4567E+02	1.7493E+03	4.9874E+02	-3.5358E+04	1.1670E+05	4.3614E+02	-9.4243E+02	8.3157E+03	8.3425E+04
4.4567E+02	1.6978E+03	5.6116E+02	-3.5358E+04	1.1021E+05	1.9210E+01	-9.4243E+02	7.9542E+03	9.2930E+04
4.4567E+02	1.6464E+03	1.1232E+03	-3.5358E+04	1.0373E+05	9.8609E+01	-9.4243E+02	7.5926E+03	1.6186E+05
4.4567E+02	1.5949E+03	9.2834E+02	-3.5358E+04	9.7247E+04	8.5969E+02	-9.4243E+02	7.2311E+03	1.3160E+05
4.4567E+02	1.5435E+03	6.1974E+03	-3.5358E+04	9.0764E+04	1.9342E+03	-9.4243E+02	6.8695E+03	2.0719E+05
4.4567E+02	1.4920E+03	2.7107E+03	-3.5358E+04	8.4281E+04	4.7286E+03	-9.4243E+02	6.5080E+03	2.8425E+05
4.4567E+02	1.4406E+03	2.6997E+03	-3.5358E+04	7.7797E+04	4.1177E+03	-9.4243E+02	6.1464E+03	3.7526E+05
4.4567E+02	1.3891E+03	6.8520E+03	-3.5358E+04	7.1314E+04	1.4096E+04	-9.4243E+02	5.7849E+03	4.5025E+05
4.4567E+02	1.3377E+03	2.6163E+03	-3.5358E+04	6.4831E+04	7.5134E+03	-9.4243E+02	5.4233E+03	5.1823E+05
4.4567E+02	1.2862E+03	1.3456E+04	-3.5358E+04	5.8348E+04	1.0292E+04	-9.4243E+02	5.0618E+03	6.9995E+05
4.4567E+02	1.2348E+03	1.1800E+04	-3.5358E+04	5.1865E+04	4.0216E+04	-9.4243E+02	4.7002E+03	8.7763E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Denmark A/S Tåsinge Parkvej 6, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
4.4567E+02	1.1833E+03	9.6862E+03	-3.5358E+04	4.5382E+04	1.1442E+05	-9.4243E+02	4.3386E+03	1.3687E+06
4.4567E+02	1.1319E+03	2.3062E+04	-3.5358E+04	3.8899E+04	2.1066E+05	-9.4243E+02	3.9771E+03	1.5627E+06
4.4567E+02	1.0804E+03	8.2178E+03	-3.5358E+04	3.2416E+04	5.4849E+05	-9.4243E+02	3.6155E+03	1.7607E+06
4.4567E+02	1.0290E+03	3.0883E+04	-3.5358E+04	2.5932E+04	1.2889E+06	-9.4243E+02	3.2540E+03	2.2966E+06
4.4567E+02	9.7755E+02	2.4702E+04	-3.5358E+04	1.9449E+04	3.1355E+06	-9.4243E+02	2.8924E+03	2.6586E+06
4.4567E+02	9.2610E+02	3.2797E+04	-3.5358E+04	1.2966E+04	5.2283E+06	-9.4243E+02	2.5309E+03	3.2234E+06
4.4567E+02	8.7465E+02	4.6795E+04	-3.5358E+04	6.4831E+03	9.3465E+06	-9.4243E+02	2.1693E+03	3.8453E+06
4.4567E+02	8.2320E+02	7.0317E+04	-3.5358E+04	0.0000E+00	2.0496E+07	-9.4243E+02	1.8078E+03	3.4574E+06
4.4567E+02	7.7175E+02	6.4643E+04	-4.2334E+04	2.8526E+05	1.6696E+00	-9.4243E+02	1.4462E+03	3.8407E+06
4.4567E+02	7.2030E+02	6.8676E+04	-4.2334E+04	2.7877E+05	1.6696E+00	-9.4243E+02	1.0847E+03	4.4460E+06
4.4567E+02	6.6885E+02	8.3126E+04	-4.2334E+04	2.7229E+05	8.1801E+00	-9.4243E+02	7.2311E+02	6.1074E+06
4.4567E+02	6.1740E+02	1.0682E+05	-4.2334E+04	2.6581E+05	3.4196E+00	-9.4243E+02	3.6155E+02	1.3634E+07
4.4567E+02	5.6595E+02	1.9272E+05	-4.2334E+04	2.5932E+05	1.5180E+01	-9.4243E+02	0.0000E+00	2.8436E+07
4.4567E+02	5.1450E+02	2.5294E+05	-4.2334E+04	2.4636E+05	9.9966E+00	-1.4075E+03	1.5908E+04	1.9447E+00
4.4567E+02	4.6305E+02	3.2749E+05	-4.2334E+04	2.3988E+05	6.5105E+00	-1.4075E+03	1.5547E+04	2.0155E+01
4.4567E+02	4.1160E+02	6.5679E+05	-4.2334E+04	2.3339E+05	8.2605E+00	-1.4075E+03	1.5185E+04	1.9447E+00
4.4567E+02	3.6015E+02	1.2090E+06	-4.2334E+04	2.2691E+05	3.4196E+00	-1.4075E+03	1.4824E+04	1.1555E+02
4.4567E+02	3.0870E+02	2.0873E+06	-4.2334E+04	2.2043E+05	1.0732E+01	-1.4075E+03	1.4462E+04	5.1915E+00
4.4567E+02	2.5725E+02	3.7888E+06	-4.2334E+04	2.1394E+05	4.2500E+00	-1.4075E+03	1.4101E+04	2.8643E+02
4.4567E+02	2.0580E+02	5.7968E+06	-4.2334E+04	2.0746E+05	1.7500E+00	-1.4075E+03	1.3739E+04	2.6956E+02
4.4567E+02	1.5435E+02	7.0952E+06	-4.2334E+04	2.0098E+05	8.9160E+00	-1.4075E+03	1.3377E+04	1.8418E+03
4.4567E+02	1.0290E+02	8.9858E+06	-4.2334E+04	1.9449E+05	1.9938E-01	-1.4075E+03	1.3016E+04	2.4446E+03
4.4567E+02	5.1450E+01	2.1241E+07	-4.2334E+04	1.8801E+05	1.5620E+01	-1.4075E+03	1.2654E+04	3.6617E+03
4.4567E+02	0.0000E+00	4.1148E+07	-4.2334E+04	1.8153E+05	1.3312E+01	-1.4075E+03	1.2293E+04	4.6019E+03
3.8551E+02	2.2638E+03	5.7752E+02	-4.2334E+04	1.7504E+05	6.6460E-02	-1.4075E+03	1.1931E+04	4.3724E+03
3.8551E+02	2.2123E+03	1.9447E+00	-4.2334E+04	1.6856E+05	1.1101E-01	-1.4075E+03	1.1570E+04	3.8681E+03
3.8551E+02	2.1609E+03	6.6460E-02	-4.2334E+04	1.6208E+05	1.6668E+00	-1.4075E+03	1.1208E+04	3.9716E+03
3.8551E+02	2.1094E+03	1.6696E+00	-4.2334E+04	1.5559E+05	1.2884E+01	-1.4075E+03	1.0847E+04	9.9372E+03
3.8551E+02	2.0580E+03	7.3215E+00	-4.2334E+04	1.4911E+05	1.6566E+01	-1.4075E+03	1.0485E+04	1.0316E+04
3.8551E+02	2.0065E+03	8.7813E+01	-4.2334E+04	1.4263E+05	8.0951E+00	-1.4075E+03	1.0124E+04	2.0239E+04
3.8551E+02	1.9551E+03	4.9523E+01	-4.2334E+04	1.3615E+05	1.2553E+02	-1.4075E+03	9.7620E+03	4.7059E+04
3.8551E+02	1.9036E+03	1.1313E+03	-4.2334E+04	1.2966E+05	2.1611E+01	-1.4075E+03	9.4004E+03	2.8999E+04
3.8551E+02	1.8522E+03	9.0510E+02	-4.2334E+04	1.2318E+05	2.8896E+02	-1.4075E+03	9.0388E+03	6.8254E+04
3.8551E+02	1.8007E+03	7.9514E+00	-4.2334E+04	1.1670E+05	2.6193E+02	-1.4075E+03	8.6773E+03	5.1242E+04
3.8551E+02	1.7493E+03	7.0318E+01	-4.2334E+04	1.1021E+05	3.6200E+02	-1.4075E+03	8.3157E+03	7.8637E+04
3.8551E+02	1.6978E+03	7.7482E+01	-4.2334E+04	1.0373E+05	3.2999E+02	-1.4075E+03	7.9542E+03	7.7380E+04
3.8551E+02	1.6464E+03	3.7448E+01	-4.2334E+04	9.7247E+04	2.3904E+02	-1.4075E+03	7.5926E+03	8.8468E+04
3.8551E+02	1.5949E+03	1.7837E+03	-4.2334E+04	9.0764E+04	5.4989E+02	-1.4075E+03	7.2311E+03	1.2035E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tåsing Parkvej 8-12, DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.8551E+02	1.5435E+03	3.0509E+02	-4.2334E+04	8.4281E+04	1.2515E+03	-1.4075E+03	6.8695E+03	1.8990E+05
3.8551E+02	1.4920E+03	2.1279E+03	-4.2334E+04	7.7797E+04	1.2606E+03	-1.4075E+03	6.5080E+03	2.1290E+05
3.8551E+02	1.4406E+03	5.3704E+02	-4.2334E+04	7.1314E+04	4.5939E+03	-1.4075E+03	6.1464E+03	3.5062E+05
3.8551E+02	1.3891E+03	3.6518E+02	-4.2334E+04	6.4831E+04	7.8895E+03	-1.4075E+03	5.7849E+03	3.8483E+05
3.8551E+02	1.3377E+03	2.3184E+03	-4.2334E+04	5.8348E+04	2.2350E+04	-1.4075E+03	5.4233E+03	5.2339E+05
3.8551E+02	1.2862E+03	8.8765E+02	-4.2334E+04	5.1865E+04	5.5039E+04	-1.4075E+03	5.0618E+03	6.5241E+05
3.8551E+02	1.2348E+03	1.9343E+03	-4.2334E+04	4.5382E+04	9.6112E+04	-1.4075E+03	4.7002E+03	8.3022E+05
3.8551E+02	1.1833E+03	5.2081E+03	-4.2334E+04	3.8899E+04	3.1993E+05	-1.4075E+03	4.3386E+03	1.1011E+06
3.8551E+02	1.1319E+03	3.4202E+03	-4.2334E+04	3.2416E+04	8.8645E+05	-1.4075E+03	3.9771E+03	1.2956E+06
3.8551E+02	1.0804E+03	4.8445E+03	-4.2334E+04	2.5932E+04	1.7912E+06	-1.4075E+03	3.6155E+03	1.5796E+06
3.8551E+02	1.0290E+03	5.9844E+03	-4.2334E+04	1.9449E+04	2.9037E+06	-1.4075E+03	3.2540E+03	1.8572E+06
3.8551E+02	9.7755E+02	8.6531E+03	-4.2334E+04	1.2966E+04	3.7949E+06	-1.4075E+03	2.8924E+03	2.1803E+06
3.8551E+02	9.2610E+02	1.4936E+04	-4.2334E+04	6.4831E+03	7.5912E+06	-1.4075E+03	2.5309E+03	2.4132E+06
3.8551E+02	8.7465E+02	2.0869E+04	-4.2334E+04	0.0000E+00	1.3768E+07	-1.4075E+03	2.1693E+03	2.4917E+06
3.8551E+02	8.2320E+02	2.0670E+04	-4.9311E+04	2.7877E+05	1.6696E+00	-1.4075E+03	1.8078E+03	2.5912E+06
3.8551E+02	7.7175E+02	2.8741E+04	-4.9311E+04	2.7229E+05	1.6696E+00	-1.4075E+03	1.4462E+03	2.6330E+06
3.8551E+02	7.2030E+02	2.7547E+04	-4.9311E+04	2.6581E+05	1.6696E+00	-1.4075E+03	1.0847E+03	3.0762E+06
3.8551E+02	6.6885E+02	7.5973E+04	-4.9311E+04	2.5932E+05	1.4691E+01	-1.4075E+03	7.2311E+02	5.0373E+06
3.8551E+02	6.1740E+02	9.4443E+04	-4.9311E+04	2.5284E+05	8.1801E+00	-1.4075E+03	3.6155E+02	1.1045E+07
3.8551E+02	5.6595E+02	1.4556E+05	-4.9311E+04	2.4636E+05	9.8497E+00	-1.4075E+03	0.0000E+00	2.1196E+07
3.8551E+02	5.1450E+02	1.9679E+05	-4.9311E+04	2.3988E+05	2.7651E+01	-1.8726E+03	1.5547E+04	6.2500E-01
3.8551E+02	4.6305E+02	3.4306E+05	-4.9311E+04	2.2691E+05	8.1801E+00	-1.8726E+03	1.5185E+04	3.1651E-01
3.8551E+02	4.1160E+02	6.7049E+05	-4.9311E+04	2.2043E+05	2.6706E+01	-1.8726E+03	1.4824E+04	8.3296E+00
3.8551E+02	3.6015E+02	1.3314E+06	-4.9311E+04	2.1394E+05	3.5665E+00	-1.8726E+03	1.4462E+04	8.7133E+00
3.8551E+02	3.0870E+02	2.2029E+06	-4.9311E+04	2.0746E+05	6.2500E-01	-1.8726E+03	1.4101E+04	5.2313E+01
3.8551E+02	2.5725E+02	3.7450E+06	-4.9311E+04	2.0098E+05	1.2662E+01	-1.8726E+03	1.3739E+04	9.7181E+01
3.8551E+02	2.0580E+02	6.3185E+06	-4.9311E+04	1.9449E+05	1.8283E+00	-1.8726E+03	1.3377E+04	1.0089E+02
3.8551E+02	1.5435E+02	7.3022E+06	-4.9311E+04	1.8801E+05	4.2104E+00	-1.8726E+03	1.3016E+04	3.9386E+02
3.8551E+02	1.0290E+02	8.6654E+06	-4.9311E+04	1.8153E+05	1.9619E+01	-1.8726E+03	1.2654E+04	1.8927E+02
3.8551E+02	5.1450E+01	1.5832E+07	-4.9311E+04	1.7504E+05	4.9774E+00	-1.8726E+03	1.2293E+04	3.6613E+02
3.8551E+02	0.0000E+00	3.8168E+07	-4.9311E+04	1.6856E+05	2.1536E+01	-1.8726E+03	1.1931E+04	1.9155E+02
3.2536E+02	2.5725E+03	1.7500E+00	-4.9311E+04	1.6208E+05	9.8353E+00	-1.8726E+03	1.1570E+04	3.3396E+03
3.2536E+02	2.3152E+03	3.0000E+00	-4.9311E+04	1.5559E+05	1.9861E-01	-1.8726E+03	1.1208E+04	2.7131E+03
3.2536E+02	2.2638E+03	1.5755E+01	-4.9311E+04	1.4911E+05	2.6107E+01	-1.8726E+03	1.0847E+04	1.7755E+03
3.2536E+02	2.2123E+03	3.9642E+00	-4.9311E+04	1.4263E+05	8.9425E+00	-1.8726E+03	1.0485E+04	8.3204E+03
3.2536E+02	2.1609E+03	1.9865E+01	-4.9311E+04	1.3615E+05	1.8024E+01	-1.8726E+03	1.0124E+04	5.7025E+03
3.2536E+02	2.1094E+03	2.2235E+01	-4.9311E+04	1.2966E+05	5.6002E+00	-1.8726E+03	9.7620E+03	3.6216E+03
3.2536E+02	2.0580E+03	1.2416E+01	-4.9311E+04	1.2318E+05	2.1696E+02	-1.8726E+03	9.4004E+03	1.4520E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.2536E+02	2.0065E+03	1.9769E+01	-4.9311E+04	1.1670E+05	2.8437E+02	-1.8726E+03	9.0388E+03	2.6048E+04
3.2536E+02	1.9551E+03	2.8843E+01	-4.9311E+04	1.1021E+05	1.5575E+03	-1.8726E+03	8.6773E+03	1.8075E+04
3.2536E+02	1.9036E+03	1.8735E+01	-4.9311E+04	1.0373E+05	1.5840E+03	-1.8726E+03	8.3157E+03	4.0493E+04
3.2536E+02	1.8522E+03	3.3709E+01	-4.9311E+04	9.7247E+04	3.1631E+03	-1.8726E+03	7.9542E+03	6.8528E+04
3.2536E+02	1.8007E+03	3.5046E+01	-4.9311E+04	9.0764E+04	1.5166E+03	-1.8726E+03	7.5926E+03	5.5151E+04
3.2536E+02	1.7493E+03	9.4002E+01	-4.9311E+04	8.4281E+04	3.8901E+03	-1.8726E+03	7.2311E+03	8.2554E+04
3.2536E+02	1.6978E+03	2.1661E+03	-4.9311E+04	7.7797E+04	2.2691E+03	-1.8726E+03	6.8695E+03	1.6664E+05
3.2536E+02	1.6464E+03	7.3944E+01	-4.9311E+04	7.1314E+04	5.6514E+03	-1.8726E+03	6.5080E+03	1.6103E+05
3.2536E+02	1.5949E+03	1.3953E+02	-4.9311E+04	6.4831E+04	1.6365E+04	-1.8726E+03	6.1464E+03	2.5555E+05
3.2536E+02	1.5435E+03	7.4275E+01	-4.9311E+04	5.8348E+04	2.3488E+04	-1.8726E+03	5.7849E+03	3.3239E+05
3.2536E+02	1.4920E+03	7.6664E+01	-4.9311E+04	5.1865E+04	5.3494E+04	-1.8726E+03	5.4233E+03	5.1342E+05
3.2536E+02	1.4406E+03	1.2268E+02	-4.9311E+04	4.5382E+04	1.1722E+05	-1.8726E+03	5.0618E+03	5.1667E+05
3.2536E+02	1.3891E+03	2.6138E+02	-4.9311E+04	3.8899E+04	2.6961E+05	-1.8726E+03	4.7002E+03	8.6184E+05
3.2536E+02	1.3377E+03	3.2957E+02	-4.9311E+04	3.2416E+04	6.4541E+05	-1.8726E+03	4.3386E+03	9.7783E+05
3.2536E+02	1.2862E+03	3.3361E+02	-4.9311E+04	2.5932E+04	1.4012E+06	-1.8726E+03	3.9771E+03	1.1623E+06
3.2536E+02	1.2348E+03	7.2920E+02	-4.9311E+04	1.9449E+04	2.7361E+06	-1.8726E+03	3.6155E+03	1.2530E+06
3.2536E+02	1.1833E+03	5.2069E+02	-4.9311E+04	1.2966E+04	4.4472E+06	-1.8726E+03	3.2540E+03	1.7510E+06
3.2536E+02	1.1319E+03	1.1385E+03	-4.9311E+04	6.4831E+03	7.5979E+06	-1.8726E+03	2.8924E+03	1.8063E+06
3.2536E+02	1.0804E+03	1.5600E+03	-4.9311E+04	0.0000E+00	1.1564E+07	-1.8726E+03	2.5309E+03	1.9057E+06
3.2536E+02	1.0290E+03	1.9098E+03	-5.6287E+04	2.7229E+05	1.6696E+00	-1.8726E+03	2.1693E+03	1.9476E+06
3.2536E+02	9.7755E+02	3.2198E+03	-5.6287E+04	2.5932E+05	8.1801E+00	-1.8726E+03	1.8078E+03	1.8996E+06
3.2536E+02	9.2610E+02	3.5607E+03	-5.6287E+04	2.5284E+05	1.6696E+00	-1.8726E+03	1.4462E+03	1.9218E+06
3.2536E+02	8.7465E+02	8.3776E+03	-5.6287E+04	2.4636E+05	1.5427E+01	-1.8726E+03	1.0847E+03	1.8488E+06
3.2536E+02	8.2320E+02	8.9824E+03	-5.6287E+04	2.3988E+05	3.4196E+00	-1.8726E+03	7.2311E+02	4.0326E+06
3.2536E+02	7.7175E+02	1.7573E+04	-5.6287E+04	2.2691E+05	3.4196E+00	-1.8726E+03	3.6155E+02	8.3425E+06
3.2536E+02	7.2030E+02	1.9109E+04	-5.6287E+04	2.2043E+05	1.7220E+01	-1.8726E+03	0.0000E+00	1.5620E+07
3.2536E+02	6.6885E+02	2.8278E+04	-5.6287E+04	2.1394E+05	8.8270E+00	-2.3377E+03	1.8078E+04	1.0417E+02
3.2536E+02	6.1740E+02	8.0239E+04	-5.6287E+04	2.0746E+05	1.3636E+01	-2.3377E+03	1.7355E+04	4.2771E-01
3.2536E+02	5.6595E+02	1.5084E+05	-5.6287E+04	2.0098E+05	1.8935E+01	-2.3377E+03	1.5547E+04	9.9920E+00
3.2536E+02	5.1450E+02	2.1916E+05	-5.6287E+04	1.9449E+05	3.1487E+01	-2.3377E+03	1.5185E+04	4.9340E-01
3.2536E+02	4.6305E+02	4.9802E+05	-5.6287E+04	1.8801E+05	1.8666E+01	-2.3377E+03	1.4824E+04	3.1651E-01
3.2536E+02	4.1160E+02	7.8804E+05	-5.6287E+04	1.8153E+05	1.4752E+01	-2.3377E+03	1.4462E+04	1.4235E+00
3.2536E+02	3.6015E+02	1.3418E+06	-5.6287E+04	1.7504E+05	2.5113E+00	-2.3377E+03	1.4101E+04	1.3021E+00
3.2536E+02	3.0870E+02	2.4624E+06	-5.6287E+04	1.6856E+05	1.1536E+01	-2.3377E+03	1.3739E+04	7.7440E+00
3.2536E+02	2.5725E+02	4.1820E+06	-5.6287E+04	1.5559E+05	2.0848E+00	-2.3377E+03	1.3377E+04	1.1219E+02
3.2536E+02	2.0580E+02	6.2893E+06	-5.6287E+04	1.4911E+05	1.3072E+00	-2.3377E+03	1.3016E+04	3.0902E+01
3.2536E+02	1.5435E+02	7.2728E+06	-5.6287E+04	1.4263E+05	3.6944E+01	-2.3377E+03	1.2654E+04	1.2628E+01
3.2536E+02	1.0290E+02	8.5771E+06	-5.6287E+04	1.3615E+05	1.6919E+02	-2.3377E+03	1.2293E+04	4.3842E+01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Denmark A/S Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
3.2536E+02	5.1450E+01	1.2913E+07	-5.6287E+04	1.2966E+05	1.2963E+03	-2.3377E+03	1.1931E+04	5.6147E+01
3.2536E+02	0.0000E+00	3.5735E+07	-5.6287E+04	1.2318E+05	1.5853E+02	-2.3377E+03	1.1570E+04	7.8763E+01
2.6520E+02	2.5725E+03	1.6696E+00	-5.6287E+04	1.1670E+05	4.3797E+02	-2.3377E+03	1.1208E+04	9.4094E+02
2.6520E+02	2.4181E+03	1.6696E+00	-5.6287E+04	1.1021E+05	9.4301E+02	-2.3377E+03	1.0847E+04	7.3449E+02
2.6520E+02	2.3667E+03	1.7500E+00	-5.6287E+04	1.0373E+05	7.7063E+03	-2.3377E+03	1.0485E+04	7.7813E+02
2.6520E+02	2.3152E+03	6.2500E-01	-5.6287E+04	9.7247E+04	3.9767E+02	-2.3377E+03	1.0124E+04	5.7107E+03
2.6520E+02	2.2638E+03	5.6338E+00	-5.6287E+04	9.0764E+04	8.6267E+03	-2.3377E+03	9.7620E+03	3.8446E+02
2.6520E+02	2.2123E+03	6.5105E+00	-5.6287E+04	8.4281E+04	2.7775E+04	-2.3377E+03	9.4004E+03	1.4868E+03
2.6520E+02	2.1609E+03	1.8110E+01	-5.6287E+04	7.7797E+04	2.9992E+04	-2.3377E+03	9.0388E+03	3.9042E+03
2.6520E+02	2.1094E+03	1.6696E+00	-5.6287E+04	7.1314E+04	2.4415E+04	-2.3377E+03	8.6773E+03	7.3320E+03
2.6520E+02	2.0580E+03	1.7500E+00	-5.6287E+04	6.4831E+04	1.9464E+04	-2.3377E+03	8.3157E+03	1.5171E+04
2.6520E+02	2.0065E+03	2.8268E+01	-5.6287E+04	5.8348E+04	1.9066E+04	-2.3377E+03	7.9542E+03	2.6852E+04
2.6520E+02	1.9551E+03	5.7727E+02	-5.6287E+04	5.1865E+04	4.4887E+04	-2.3377E+03	7.5926E+03	3.2593E+04
2.6520E+02	1.9036E+03	7.2329E+00	-5.6287E+04	4.5382E+04	1.3066E+05	-2.3377E+03	7.2311E+03	7.9785E+04
2.6520E+02	1.8522E+03	1.1902E+01	-5.6287E+04	3.8899E+04	2.9550E+05	-2.3377E+03	6.8695E+03	1.0229E+05
2.6520E+02	1.8007E+03	9.1964E+00	-5.6287E+04	3.2416E+04	8.9037E+05	-2.3377E+03	6.5080E+03	1.3506E+05
2.6520E+02	1.7493E+03	1.0498E+01	-5.6287E+04	2.5932E+04	1.5870E+06	-2.3377E+03	6.1464E+03	1.6477E+05
2.6520E+02	1.6978E+03	2.4535E+01	-5.6287E+04	1.9449E+04	3.3190E+06	-2.3377E+03	5.7849E+03	2.8134E+05
2.6520E+02	1.6464E+03	1.8491E+01	-5.6287E+04	1.2966E+04	5.9079E+06	-2.3377E+03	5.4233E+03	2.6301E+05
2.6520E+02	1.5949E+03	1.1075E+01	-5.6287E+04	6.4831E+03	9.0789E+06	-2.3377E+03	5.0618E+03	3.8930E+05
2.6520E+02	1.5435E+03	3.8117E+01	-5.6287E+04	0.0000E+00	1.2811E+07	-2.3377E+03	4.7002E+03	4.8072E+05
2.6520E+02	1.4920E+03	6.2366E+01	-6.3264E+04	2.5284E+05	3.3392E+00	-2.3377E+03	4.3386E+03	7.6481E+05
2.6520E+02	1.4406E+03	4.0313E+01	-6.3264E+04	2.4636E+05	1.6696E+00	-2.3377E+03	3.9771E+03	7.8772E+05
2.6520E+02	1.3891E+03	9.7860E+01	-6.3264E+04	2.3339E+05	9.8497E+00	-2.3377E+03	3.6155E+03	1.1209E+06
2.6520E+02	1.3377E+03	1.5352E+01	-6.3264E+04	2.2691E+05	1.6696E+00	-2.3377E+03	3.2540E+03	1.0943E+06
2.6520E+02	1.2862E+03	2.0659E+02	-6.3264E+04	2.2043E+05	6.6460E-02	-2.3377E+03	2.8924E+03	1.2726E+06
2.6520E+02	1.2348E+03	4.8566E+02	-6.3264E+04	2.1394E+05	1.3021E+01	-2.3377E+03	2.5309E+03	1.4063E+06
2.6520E+02	1.1833E+03	7.6770E+01	-6.3264E+04	2.0746E+05	1.9720E+01	-2.3377E+03	2.1693E+03	1.3861E+06
2.6520E+02	1.1319E+03	1.9436E+02	-6.3264E+04	2.0098E+05	1.2390E+01	-2.3377E+03	1.8078E+03	1.4255E+06
2.6520E+02	1.0804E+03	2.7948E+02	-6.3264E+04	1.9449E+05	4.3951E+00	-2.3377E+03	1.4462E+03	1.2465E+06
2.6520E+02	1.0290E+03	8.6121E+02	-6.3264E+04	1.8801E+05	1.6999E+01	-2.3377E+03	1.0847E+03	1.7668E+06
2.6520E+02	9.7755E+02	1.5048E+03	-6.3264E+04	1.8153E+05	5.5375E+00	-2.3377E+03	7.2311E+02	2.9507E+06
2.6520E+02	9.2610E+02	8.9137E+02	-6.3264E+04	1.7504E+05	4.7767E+01	-2.3377E+03	3.6155E+02	6.1456E+06
2.6520E+02	8.7465E+02	1.8233E+03	-6.3264E+04	1.6856E+05	4.9985E+01	-2.3377E+03	0.0000E+00	1.0819E+07
2.6520E+02	8.2320E+02	3.5959E+03	-6.3264E+04	1.6208E+05	3.2399E+01	-2.8029E+03	1.7355E+04	6.6460E-02
2.6520E+02	7.7175E+02	4.5402E+03	-6.3264E+04	1.5559E+05	3.5881E+01	-2.8029E+03	1.6631E+04	6.5690E-02
2.6520E+02	7.2030E+02	9.8185E+03	-6.3264E+04	1.4911E+05	1.5276E+01	-2.8029E+03	1.5547E+04	4.9340E-01
2.6520E+02	6.6885E+02	1.1790E+04	-6.3264E+04	1.4263E+05	6.5926E+02	-2.8029E+03	1.5185E+04	2.5082E-01

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.6520E+02	6.1740E+02	2.5367E+04	-6.3264E+04	1.3615E+05	7.7678E+01	-2.8029E+03	1.4824E+04	2.0161E+00
2.6520E+02	5.6595E+02	6.7476E+04	-6.3264E+04	1.2966E+05	1.8373E+03	-2.8029E+03	1.4462E+04	2.8275E+00
2.6520E+02	5.1450E+02	1.1706E+05	-6.3264E+04	1.2318E+05	8.2867E+02	-2.8029E+03	1.4101E+04	4.2755E+00
2.6520E+02	4.6305E+02	2.3257E+05	-6.3264E+04	1.1670E+05	5.0926E+03	-2.8029E+03	1.3739E+04	1.6878E+00
2.6520E+02	4.1160E+02	6.4243E+05	-6.3264E+04	1.1021E+05	6.5502E+03	-2.8029E+03	1.3377E+04	1.0485E+01
2.6520E+02	3.6015E+02	1.1944E+06	-6.3264E+04	1.0373E+05	5.8113E+02	-2.8029E+03	1.3016E+04	2.0810E+00
2.6520E+02	3.0870E+02	1.8683E+06	-6.3264E+04	9.7247E+04	1.7728E+03	-2.8029E+03	1.2654E+04	1.3184E+01
2.6520E+02	2.5725E+02	3.1764E+06	-6.3264E+04	9.0764E+04	7.3582E+03	-2.8029E+03	1.2293E+04	3.0681E+00
2.6520E+02	2.0580E+02	5.2028E+06	-6.3264E+04	8.4281E+04	4.9735E+03	-2.8029E+03	1.1931E+04	5.6351E+01
2.6520E+02	1.5435E+02	6.3698E+06	-6.3264E+04	7.7797E+04	2.2975E+04	-2.8029E+03	1.1570E+04	4.1955E+00
2.6520E+02	1.0290E+02	8.8991E+06	-6.3264E+04	7.1314E+04	2.2367E+04	-2.8029E+03	1.1208E+04	8.3489E+00
2.6520E+02	5.1450E+01	1.2976E+07	-6.3264E+04	6.4831E+04	3.2449E+04	-2.8029E+03	1.0847E+04	1.1551E+01
2.6520E+02	0.0000E+00	3.9027E+07	-6.3264E+04	5.8348E+04	4.2280E+04	-2.8029E+03	1.0485E+04	1.3533E+02
2.0505E+02	2.4181E+03	2.2106E+00	-6.3264E+04	5.1865E+04	6.2380E+04	-2.8029E+03	1.0124E+04	4.9596E+02
2.0505E+02	2.3667E+03	1.6696E+00	-6.3264E+04	4.5382E+04	4.5011E+04	-2.8029E+03	9.7620E+03	6.1682E+01
2.0505E+02	2.3152E+03	8.9825E+00	-6.3264E+04	3.8899E+04	1.7572E+05	-2.8029E+03	9.4004E+03	1.1649E+03
2.0505E+02	2.2638E+03	3.4196E+00	-6.3264E+04	3.2416E+04	4.4423E+05	-2.8029E+03	9.0388E+03	1.4209E+02
2.0505E+02	2.2123E+03	1.7500E+00	-6.3264E+04	2.5932E+04	1.5381E+06	-2.8029E+03	8.6773E+03	8.6153E+03
2.0505E+02	2.1609E+03	3.3392E+00	-6.3264E+04	1.9449E+04	2.8666E+06	-2.8029E+03	8.3157E+03	6.8684E+02
2.0505E+02	2.1094E+03	8.5088E+00	-6.3264E+04	1.2966E+04	5.4037E+06	-2.8029E+03	7.9542E+03	6.0977E+03
2.0505E+02	2.0580E+03	1.1747E+01	-6.3264E+04	6.4831E+03	7.8847E+06	-2.8029E+03	7.5926E+03	6.9154E+03
2.0505E+02	2.0065E+03	1.0420E+01	-6.3264E+04	0.0000E+00	1.4097E+07	-2.8029E+03	7.2311E+03	3.1190E+04
2.0505E+02	1.9551E+03	1.6696E+00	-7.0240E+04	2.3988E+05	1.6696E+00	-2.8029E+03	6.8695E+03	1.9959E+04
2.0505E+02	1.9036E+03	1.0010E+01	-7.0240E+04	2.3339E+05	1.6696E+00	-2.8029E+03	6.5080E+03	4.9180E+04
2.0505E+02	1.8007E+03	1.0205E+01	-7.0240E+04	2.2691E+05	6.5105E+00	-2.8029E+03	6.1464E+03	9.4954E+04
2.0505E+02	1.7493E+03	7.2140E+01	-7.0240E+04	2.1394E+05	1.1663E+01	-2.8029E+03	5.7849E+03	1.4291E+05
2.0505E+02	1.6978E+03	3.8562E+01	-7.0240E+04	2.0746E+05	1.2033E+00	-2.8029E+03	5.4233E+03	2.2557E+05
2.0505E+02	1.5949E+03	2.6175E+01	-7.0240E+04	2.0098E+05	5.4804E+00	-2.8029E+03	5.0618E+03	2.7806E+05
2.0505E+02	1.5435E+03	2.9557E+01	-7.0240E+04	1.9449E+05	4.4851E+01	-2.8029E+03	4.7002E+03	3.1550E+05
2.0505E+02	1.4920E+03	5.4856E+01	-7.0240E+04	1.8801E+05	2.2081E+01	-2.8029E+03	4.3386E+03	4.4214E+05
2.0505E+02	1.4406E+03	3.2928E+01	-7.0240E+04	1.7504E+05	1.6696E+00	-2.8029E+03	3.9771E+03	5.5850E+05
2.0505E+02	1.3891E+03	1.9457E+02	-7.0240E+04	1.6856E+05	2.7587E+01	-2.8029E+03	3.6155E+03	7.6554E+05
2.0505E+02	1.3377E+03	6.4457E+01	-7.0240E+04	1.6208E+05	3.1450E+01	-2.8029E+03	3.2540E+03	8.2951E+05
2.0505E+02	1.2862E+03	1.3904E+01	-7.0240E+04	1.5559E+05	1.9447E+00	-2.8029E+03	2.8924E+03	9.2886E+05
2.0505E+02	1.2348E+03	1.9433E+02	-7.0240E+04	1.4911E+05	4.5910E+01	-2.8029E+03	2.5309E+03	8.7504E+05
2.0505E+02	1.1833E+03	1.7402E+02	-7.0240E+04	1.4263E+05	5.8386E+02	-2.8029E+03	2.1693E+03	9.9626E+05
2.0505E+02	1.1319E+03	8.5215E+01	-7.0240E+04	1.3615E+05	5.0847E+01	-2.8029E+03	1.8078E+03	9.3207E+05
2.0505E+02	1.0804E+03	9.3034E+01	-7.0240E+04	1.2966E+05	7.4844E+02	-2.8029E+03	1.4462E+03	9.6802E+05

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Denmark A/S Tuborgvejen 6, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.0505E+02	1.0290E+03	1.5140E+02	-7.0240E+04	1.2318E+05	8.1172E+02	-2.8029E+03	1.0847E+03	1.1455E+06
2.0505E+02	9.7755E+02	3.2016E+02	-7.0240E+04	1.1670E+05	3.3495E+02	-2.8029E+03	7.2311E+02	2.2058E+06
2.0505E+02	9.2610E+02	4.1700E+02	-7.0240E+04	1.1021E+05	3.7206E+03	-2.8029E+03	3.6155E+02	4.3256E+06
2.0505E+02	8.7465E+02	6.6449E+02	-7.0240E+04	1.0373E+05	3.7254E+03	-2.8029E+03	0.0000E+00	7.6868E+06
2.0505E+02	8.2320E+02	1.2592E+03	-7.0240E+04	9.7247E+04	1.9754E+04	-3.2680E+03	1.6631E+04	1.3021E+00
2.0505E+02	7.7175E+02	5.3378E+03	-7.0240E+04	9.0764E+04	6.9878E+03	-3.2680E+03	1.6270E+04	6.5690E-02
2.0505E+02	7.2030E+02	4.6700E+03	-7.0240E+04	8.4281E+04	1.5311E+04	-3.2680E+03	1.5908E+04	4.2771E-01
2.0505E+02	6.6885E+02	1.7594E+04	-7.0240E+04	7.7797E+04	1.3109E+04	-3.2680E+03	1.5547E+04	6.6460E-02
2.0505E+02	6.1740E+02	2.8800E+04	-7.0240E+04	7.1314E+04	9.9946E+03	-3.2680E+03	1.4462E+04	1.3021E+00
2.0505E+02	5.6595E+02	6.2117E+04	-7.0240E+04	6.4831E+04	2.4468E+04	-3.2680E+03	1.4101E+04	1.4350E+00
2.0505E+02	5.1450E+02	1.0035E+05	-7.0240E+04	5.8348E+04	5.7265E+04	-3.2680E+03	1.3739E+04	3.1651E-01
2.0505E+02	4.6305E+02	2.0728E+05	-7.0240E+04	5.1865E+04	4.6660E+04	-3.2680E+03	1.3377E+04	5.0164E-01
2.0505E+02	4.1160E+02	2.9335E+05	-7.0240E+04	4.5382E+04	6.2512E+04	-3.2680E+03	1.3016E+04	1.1944E+00
2.0505E+02	3.6015E+02	6.0446E+05	-7.0240E+04	3.8899E+04	1.4702E+05	-3.2680E+03	1.2654E+04	3.3664E+00
2.0505E+02	3.0870E+02	1.4648E+06	-7.0240E+04	3.2416E+04	3.1726E+05	-3.2680E+03	1.2293E+04	8.7940E-01
2.0505E+02	2.5725E+02	2.9786E+06	-7.0240E+04	2.5932E+04	1.1532E+06	-3.2680E+03	1.1931E+04	3.1456E+00
2.0505E+02	2.0580E+02	6.0444E+06	-7.0240E+04	1.9449E+04	2.7862E+06	-3.2680E+03	1.1570E+04	1.1549E+01
2.0505E+02	1.5435E+02	1.0041E+07	-7.0240E+04	1.2966E+04	4.8835E+06	-3.2680E+03	1.1208E+04	6.3480E-01
2.0505E+02	1.0290E+02	1.4526E+07	-7.0240E+04	6.4831E+03	7.8042E+06	-3.2680E+03	1.0847E+04	4.6499E+00
2.0505E+02	5.1450E+01	2.3209E+07	-7.0240E+04	0.0000E+00	1.7673E+07	-3.2680E+03	1.0485E+04	1.1962E+02
2.0505E+02	0.0000E+00	5.8055E+07	-7.7217E+04	2.1394E+05	1.6696E+00	-3.2680E+03	1.0124E+04	2.1737E+02
1.4489E+02	2.4696E+03	1.6696E+00	-7.7217E+04	2.0098E+05	1.2033E+00	-3.2680E+03	9.7620E+03	3.7053E+00
1.4489E+02	2.4181E+03	1.6696E+00	-7.7217E+04	1.7504E+05	2.4448E+00	-3.2680E+03	9.4004E+03	4.6020E+02
1.4489E+02	2.2638E+03	5.0892E+00	-7.7217E+04	1.6208E+05	2.5124E+01	-3.2680E+03	9.0388E+03	7.5701E+00
1.4489E+02	2.1609E+03	8.9160E+00	-7.7217E+04	1.5559E+05	4.0672E+02	-3.2680E+03	8.6773E+03	9.9098E+01
1.4489E+02	2.0580E+03	5.1696E+00	-7.7217E+04	1.4911E+05	2.0108E+01	-3.2680E+03	8.3157E+03	7.0406E+01
1.4489E+02	2.0065E+03	6.2500E-01	-7.7217E+04	1.4263E+05	1.4198E+02	-3.2680E+03	7.9542E+03	4.4958E+02
1.4489E+02	1.9551E+03	3.4196E+00	-7.7217E+04	1.3615E+05	1.7520E+02	-3.2680E+03	7.5926E+03	1.1525E+03
1.4489E+02	1.9036E+03	1.6696E+00	-7.7217E+04	1.2966E+05	8.7952E+02	-3.2680E+03	7.2311E+03	9.2130E+01
1.4489E+02	1.8522E+03	3.0919E+01	-7.7217E+04	1.2318E+05	2.3950E+03	-3.2680E+03	6.8695E+03	1.5163E+03
1.4489E+02	1.8007E+03	1.9865E+01	-7.7217E+04	1.1670E+05	7.2404E+02	-3.2680E+03	6.5080E+03	1.7361E+04
1.4489E+02	1.7493E+03	3.5000E+00	-7.7217E+04	1.1021E+05	8.7279E+02	-3.2680E+03	6.1464E+03	5.2197E+04
1.4489E+02	1.6464E+03	1.3154E+01	-7.7217E+04	1.0373E+05	1.1260E+03	-3.2680E+03	5.7849E+03	3.6179E+04
1.4489E+02	1.5949E+03	1.8115E+01	-7.7217E+04	9.7247E+04	6.9600E+03	-3.2680E+03	5.4233E+03	8.1586E+04
1.4489E+02	1.5435E+03	3.9797E+01	-7.7217E+04	9.0764E+04	1.0385E+04	-3.2680E+03	5.0618E+03	1.6011E+05
1.4489E+02	1.4920E+03	7.0233E+01	-7.7217E+04	8.4281E+04	8.3205E+03	-3.2680E+03	4.7002E+03	1.8078E+05
1.4489E+02	1.4406E+03	1.3220E+01	-7.7217E+04	7.7797E+04	4.2581E+04	-3.2680E+03	4.3386E+03	2.7916E+05
1.4489E+02	1.3891E+03	5.4210E+01	-7.7217E+04	7.1314E+04	4.0114E+04	-3.2680E+03	3.9771E+03	4.0348E+05

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
1.4489E+02	1.3377E+03	2.0853E+02	-7.7217E+04	6.4831E+04	3.2194E+04	-3.2680E+03	3.6155E+03	5.0988E+05
1.4489E+02	1.2862E+03	6.6172E+01	-7.7217E+04	5.8348E+04	9.4903E+04	-3.2680E+03	3.2540E+03	4.9886E+05
1.4489E+02	1.2348E+03	1.8288E+02	-7.7217E+04	5.1865E+04	1.1374E+05	-3.2680E+03	2.8924E+03	7.3996E+05
1.4489E+02	1.1833E+03	1.4763E+02	-7.7217E+04	4.5382E+04	1.3389E+05	-3.2680E+03	2.5309E+03	6.6863E+05
1.4489E+02	1.1319E+03	1.8961E+02	-7.7217E+04	3.8899E+04	2.8861E+05	-3.2680E+03	2.1693E+03	5.5429E+05
1.4489E+02	1.0804E+03	2.0499E+02	-7.7217E+04	3.2416E+04	4.9206E+05	-3.2680E+03	1.8078E+03	6.0000E+05
1.4489E+02	1.0290E+03	1.5348E+02	-7.7217E+04	2.5932E+04	1.2194E+06	-3.2680E+03	1.4462E+03	6.6689E+05
1.4489E+02	9.7755E+02	3.8612E+02	-7.7217E+04	1.9449E+04	3.1476E+06	-3.2680E+03	1.0847E+03	7.8920E+05
1.4489E+02	9.2610E+02	4.8107E+02	-7.7217E+04	1.2966E+04	5.1288E+06	-3.2680E+03	7.2311E+02	1.4304E+06
1.4489E+02	8.7465E+02	1.7441E+03	-7.7217E+04	6.4831E+03	6.5655E+06	-3.2680E+03	3.6155E+02	3.0451E+06
1.4489E+02	8.2320E+02	2.5629E+03	-7.7217E+04	0.0000E+00	1.8860E+07	-3.2680E+03	0.0000E+00	5.3415E+06
1.4489E+02	7.7175E+02	2.9167E+03	-8.4193E+04	1.8801E+05	1.2033E+00	-3.7331E+03	1.8078E+04	6.5690E-02
1.4489E+02	7.2030E+02	9.9763E+03	-8.4193E+04	1.7504E+05	5.5760E+02	-3.7331E+03	1.6993E+04	2.5082E-01
1.4489E+02	6.6885E+02	1.2053E+04	-8.4193E+04	1.6208E+05	4.5676E+01	-3.7331E+03	1.5908E+04	6.6460E-02
1.4489E+02	6.1740E+02	2.0878E+04	-8.4193E+04	1.5559E+05	6.5766E+01	-3.7331E+03	1.5547E+04	6.5690E-02
1.4489E+02	5.6595E+02	4.4260E+04	-8.4193E+04	1.4911E+05	7.4407E+01	-3.7331E+03	1.5185E+04	3.5048E-01
1.4489E+02	5.1450E+02	5.7630E+04	-8.4193E+04	1.4263E+05	1.7051E+02	-3.7331E+03	1.3377E+04	4.9340E-01
1.4489E+02	4.6305E+02	1.4534E+05	-8.4193E+04	1.3615E+05	1.8202E+02	-3.7331E+03	1.2654E+04	4.9417E-01
1.4489E+02	4.1160E+02	3.1620E+05	-8.4193E+04	1.2966E+05	4.5234E+02	-3.7331E+03	1.2293E+04	4.6064E-01
1.4489E+02	3.6015E+02	7.6813E+05	-8.4193E+04	1.2318E+05	9.0296E+02	-3.7331E+03	1.1931E+04	5.0164E-01
1.4489E+02	3.0870E+02	1.6092E+06	-8.4193E+04	1.1670E+05	2.3877E+03	-3.7331E+03	1.1570E+04	6.2650E-01
1.4489E+02	2.5725E+02	3.2265E+06	-8.4193E+04	1.1021E+05	4.0474E+03	-3.7331E+03	1.1208E+04	7.5792E-01
1.4489E+02	2.0580E+02	6.8370E+06	-8.4193E+04	1.0373E+05	4.7523E+03	-3.7331E+03	1.0847E+04	9.2113E-01
1.4489E+02	1.5435E+02	1.1450E+07	-8.4193E+04	9.7247E+04	6.3802E+03	-3.7331E+03	1.0485E+04	6.6460E-02
1.4489E+02	1.0290E+02	1.5531E+07	-8.4193E+04	9.0764E+04	1.3542E+04	-3.7331E+03	1.0124E+04	1.9938E-01
1.4489E+02	5.1450E+01	2.3346E+07	-8.4193E+04	8.4281E+04	2.0937E+04	-3.7331E+03	9.7620E+03	1.4494E+00
1.4489E+02	0.0000E+00	5.9227E+07	-8.4193E+04	7.7797E+04	4.4245E+04	-3.7331E+03	9.4004E+03	4.1216E+00
8.4738E+01	2.2123E+03	1.7500E+00	-8.4193E+04	7.1314E+04	4.8161E+04	-3.7331E+03	9.0388E+03	3.6808E+00
8.4738E+01	2.1094E+03	1.6696E+00	-8.4193E+04	6.4831E+04	1.0272E+05	-3.7331E+03	8.6773E+03	6.3827E+00
8.4738E+01	2.0065E+03	1.7500E+00	-8.4193E+04	5.8348E+04	1.2202E+05	-3.7331E+03	8.3157E+03	2.1611E+02
8.4738E+01	1.9551E+03	1.7500E+00	-8.4193E+04	5.1865E+04	2.0980E+05	-3.7331E+03	7.9542E+03	2.0088E+01
8.4738E+01	1.5435E+03	6.6460E-02	-8.4193E+04	4.5382E+04	3.3482E+05	-3.7331E+03	7.5926E+03	9.2541E+01
8.4738E+01	1.4920E+03	1.3712E+01	-8.4193E+04	3.8899E+04	4.6370E+05	-3.7331E+03	7.2311E+03	2.9157E+03
8.4738E+01	1.4406E+03	1.5879E+01	-8.4193E+04	3.2416E+04	7.7500E+05	-3.7331E+03	6.8695E+03	4.2026E+02
8.4738E+01	1.3891E+03	1.4404E+01	-8.4193E+04	2.5932E+04	1.3827E+06	-3.7331E+03	6.5080E+03	5.8934E+02
8.4738E+01	1.3377E+03	3.0775E+01	-8.4193E+04	1.9449E+04	2.9697E+06	-3.7331E+03	6.1464E+03	2.9154E+03
8.4738E+01	1.2862E+03	3.1495E+01	-8.4193E+04	1.2966E+04	4.0260E+06	-3.7331E+03	5.7849E+03	7.2193E+03
8.4738E+01	1.2348E+03	2.6374E+01	-8.4193E+04	6.4831E+03	5.7773E+06	-3.7331E+03	5.4233E+03	5.4696E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
8.4738E+01	1.1833E+03	7.2020E+01	-8.4193E+04	0.0000E+00	1.5423E+07	-3.7331E+03	5.0618E+03	3.0296E+04
8.4738E+01	1.1319E+03	3.0739E+01	-9.1170E+04	1.7504E+05	3.8920E+02	-3.7331E+03	4.7002E+03	8.8332E+04
8.4738E+01	1.0804E+03	3.9744E+00	-9.1170E+04	1.6856E+05	1.3393E+01	-3.7331E+03	4.3386E+03	1.2011E+05
8.4738E+01	1.0290E+03	7.3139E+01	-9.1170E+04	1.5559E+05	2.1236E+03	-3.7331E+03	3.9771E+03	1.2599E+05
8.4738E+01	9.7755E+02	1.1119E+02	-9.1170E+04	1.4911E+05	1.0234E+02	-3.7331E+03	3.6155E+03	1.7190E+05
8.4738E+01	9.2610E+02	6.5524E+01	-9.1170E+04	1.4263E+05	1.9914E+02	-3.7331E+03	3.2540E+03	2.9723E+05
8.4738E+01	8.7465E+02	1.3524E+02	-9.1170E+04	1.3615E+05	4.6053E+02	-3.7331E+03	2.8924E+03	2.8289E+05
8.4738E+01	8.2320E+02	3.0816E+02	-9.1170E+04	1.2966E+05	2.4400E+03	-3.7331E+03	2.5309E+03	3.7946E+05
8.4738E+01	7.7175E+02	2.4833E+03	-9.1170E+04	1.2318E+05	1.2726E+03	-3.7331E+03	2.1693E+03	4.4819E+05
8.4738E+01	7.2030E+02	1.6260E+03	-9.1170E+04	1.1670E+05	4.4311E+03	-3.7331E+03	1.8078E+03	4.4803E+05
8.4738E+01	6.6885E+02	6.9975E+03	-9.1170E+04	1.1021E+05	7.2535E+03	-3.7331E+03	1.4462E+03	2.8677E+05
8.4738E+01	6.1740E+02	1.1700E+04	-9.1170E+04	1.0373E+05	1.7128E+04	-3.7331E+03	1.0847E+03	5.0753E+05
8.4738E+01	5.6595E+02	1.6197E+04	-9.1170E+04	9.7247E+04	1.5206E+04	-3.7331E+03	7.2311E+02	7.9694E+05
8.4738E+01	5.1450E+02	3.3553E+04	-9.1170E+04	9.0764E+04	2.9925E+04	-3.7331E+03	3.6155E+02	1.9958E+06
8.4738E+01	4.6305E+02	1.0120E+05	-9.1170E+04	8.4281E+04	4.0062E+04	-3.7331E+03	0.0000E+00	3.8090E+06
8.4738E+01	4.1160E+02	1.8978E+05	-9.1170E+04	7.7797E+04	6.9774E+04	-4.1982E+03	1.6993E+04	6.5690E-02
8.4738E+01	3.6015E+02	4.9837E+05	-9.1170E+04	7.1314E+04	1.2843E+05	-4.1982E+03	1.5908E+04	2.5082E-01
8.4738E+01	3.0870E+02	8.0752E+05	-9.1170E+04	6.4831E+04	1.7473E+05	-4.1982E+03	1.4824E+04	6.2500E-01
8.4738E+01	2.5725E+02	1.4643E+06	-9.1170E+04	5.8348E+04	3.1864E+05	-4.1982E+03	1.4462E+04	1.0417E+02
8.4738E+01	2.0580E+02	2.2503E+06	-9.1170E+04	5.1865E+04	4.8001E+05	-4.1982E+03	1.3377E+04	2.5000E+00
8.4738E+01	1.5435E+02	2.9641E+06	-9.1170E+04	4.5382E+04	7.1542E+05	-4.1982E+03	1.3016E+04	6.6460E-02
8.4738E+01	1.0290E+02	4.6298E+06	-9.1170E+04	3.8899E+04	1.0867E+06	-4.1982E+03	1.2654E+04	2.8068E+00
8.4738E+01	5.1450E+01	8.7771E+06	-9.1170E+04	3.2416E+04	1.5491E+06	-4.1982E+03	1.2293E+04	2.5665E+00
8.4738E+01	0.0000E+00	2.8484E+07	-9.1170E+04	2.5932E+04	2.2451E+06	-4.1982E+03	1.0485E+04	6.6460E-02
2.4583E+01	1.6464E+03	6.6460E-02	-9.1170E+04	1.9449E+04	2.8042E+06	-4.1982E+03	1.0124E+04	6.6460E-02
2.4583E+01	1.4406E+03	1.9938E-01	-9.1170E+04	1.2966E+04	3.4678E+06	-4.1982E+03	9.4004E+03	2.0776E+00
2.4583E+01	1.3891E+03	1.6087E+01	-9.1170E+04	6.4831E+03	3.5411E+06	-4.1982E+03	9.0388E+03	5.0162E+00
2.4583E+01	1.3377E+03	1.4868E+01	-9.1170E+04	0.0000E+00	1.1424E+07	-4.1982E+03	8.6773E+03	3.0682E-01
2.4583E+01	1.2862E+03	3.6973E+00	-9.8146E+04	1.7504E+05	2.5569E+01	-4.1982E+03	8.3157E+03	7.4255E+00
2.4583E+01	1.2348E+03	1.0146E+01	-9.8146E+04	1.4911E+05	6.5144E+02	-4.1982E+03	7.9542E+03	1.9212E+01
2.4583E+01	1.1833E+03	1.4189E+01	-9.8146E+04	1.4263E+05	9.8201E+01	-4.1982E+03	7.2311E+03	2.4993E+00
2.4583E+01	1.1319E+03	3.0862E+00	-9.8146E+04	1.3615E+05	2.4972E+03	-4.1982E+03	6.8695E+03	1.9987E+02
2.4583E+01	1.0804E+03	1.7956E+01	-9.8146E+04	1.2966E+05	4.4321E+03	-4.1982E+03	6.5080E+03	9.9866E+01
2.4583E+01	1.0290E+03	4.5968E+00	-9.8146E+04	1.2318E+05	4.4240E+03	-4.1982E+03	6.1464E+03	1.2126E+01
2.4583E+01	9.7755E+02	4.3199E+01	-9.8146E+04	1.1670E+05	2.8964E+03	-4.1982E+03	5.7849E+03	1.1465E+03
2.4583E+01	9.2610E+02	4.0368E+01	-9.8146E+04	1.1021E+05	6.4398E+03	-4.1982E+03	5.4233E+03	1.6809E+03
2.4583E+01	8.7465E+02	6.6747E+01	-9.8146E+04	1.0373E+05	6.9476E+03	-4.1982E+03	5.0618E+03	4.7166E+03
2.4583E+01	8.2320E+02	9.4886E+01	-9.8146E+04	9.7247E+04	3.7781E+04	-4.1982E+03	4.7002E+03	1.2125E+04

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

VESTAS PROPRIETARY NOTICE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
2.4583E+01	7.7175E+02	3.3895E+03	-9.8146E+04	9.0764E+04	3.2525E+04	-4.1982E+03	4.3386E+03	2.7732E+04
2.4583E+01	7.2030E+02	1.2791E+03	-9.8146E+04	8.4281E+04	6.3726E+04	-4.1982E+03	3.9771E+03	2.5020E+04
2.4583E+01	6.6885E+02	1.0007E+04	-9.8146E+04	7.7797E+04	1.0769E+05	-4.1982E+03	3.6155E+03	6.6432E+04
2.4583E+01	6.1740E+02	1.4426E+04	-9.8146E+04	7.1314E+04	1.7544E+05	-4.1982E+03	3.2540E+03	3.4790E+04
2.4583E+01	5.6595E+02	1.3721E+04	-9.8146E+04	6.4831E+04	3.1754E+05	-4.1982E+03	2.8924E+03	1.1361E+05
2.4583E+01	5.1450E+02	2.1435E+04	-9.8146E+04	5.8348E+04	5.0813E+05	-4.1982E+03	2.5309E+03	1.6183E+05
2.4583E+01	4.6305E+02	4.6077E+04	-9.8146E+04	5.1865E+04	8.6490E+05	-4.1982E+03	2.1693E+03	1.5001E+05
2.4583E+01	4.1160E+02	8.8597E+04	-9.8146E+04	4.5382E+04	1.1946E+06	-4.1982E+03	1.8078E+03	2.1076E+05
2.4583E+01	3.6015E+02	1.3952E+05	-9.8146E+04	3.8899E+04	1.8908E+06	-4.1982E+03	1.4462E+03	1.8652E+05
2.4583E+01	3.0870E+02	3.0789E+05	-9.8146E+04	3.2416E+04	2.5424E+06	-4.1982E+03	1.0847E+03	2.9234E+05
2.4583E+01	2.5725E+02	4.6079E+05	-9.8146E+04	2.5932E+04	3.5136E+06	-4.1982E+03	7.2311E+02	4.2676E+05
2.4583E+01	2.0580E+02	8.8719E+05	-9.8146E+04	1.9449E+04	4.2788E+06	-4.1982E+03	3.6155E+02	1.0874E+06
2.4583E+01	1.5435E+02	1.7314E+06	-9.8146E+04	1.2966E+04	4.0869E+06	-4.1982E+03	0.0000E+00	2.2137E+06
2.4583E+01	1.0290E+02	3.8458E+06	-9.8146E+04	6.4831E+03	4.6207E+06	-4.6633E+03	1.4101E+04	1.3021E+00
2.4583E+01	5.1450E+01	1.1693E+07	-9.8146E+04	0.0000E+00	1.1933E+07	-4.6633E+03	1.2654E+04	6.6460E-02
2.4583E+01	0.0000E+00	4.4261E+07	-1.0512E+05	1.5559E+05	4.1477E+02	-4.6633E+03	1.1570E+04	6.6460E-02
-3.5572E+01	1.6978E+03	6.2500E-01	-1.0512E+05	1.4911E+05	1.5386E+03	-4.6633E+03	1.0485E+04	4.6064E-01
-3.5572E+01	1.4406E+03	2.3750E+00	-1.0512E+05	1.4263E+05	1.2516E+02	-4.6633E+03	9.4004E+03	1.3138E-01
-3.5572E+01	1.3377E+03	1.9494E+00	-1.0512E+05	1.3615E+05	1.2133E+03	-4.6633E+03	9.0388E+03	2.5989E+01
-3.5572E+01	1.2862E+03	3.6329E+00	-1.0512E+05	1.2966E+05	1.0462E+04	-4.6633E+03	7.5926E+03	1.4900E+00
-3.5572E+01	1.2348E+03	2.3750E+00	-1.0512E+05	1.2318E+05	5.9454E+03	-4.6633E+03	7.2311E+03	1.3138E-01
-3.5572E+01	1.1833E+03	6.4057E+00	-1.0512E+05	1.1670E+05	1.0586E+04	-4.6633E+03	6.8695E+03	1.2504E+01
-3.5572E+01	1.1319E+03	7.1448E+00	-1.0512E+05	1.1021E+05	1.6262E+04	-4.6633E+03	6.5080E+03	7.2999E+00
-3.5572E+01	1.0804E+03	2.9144E+01	-1.0512E+05	1.0373E+05	2.4354E+04	-4.6633E+03	6.1464E+03	8.3107E+00
-3.5572E+01	1.0290E+03	5.5906E+01	-1.0512E+05	9.7247E+04	3.1134E+04	-4.6633E+03	5.7849E+03	5.1842E+01
-3.5572E+01	9.7755E+02	2.6909E+01	-1.0512E+05	9.0764E+04	4.5373E+04	-4.6633E+03	5.4233E+03	6.6771E+00
-3.5572E+01	9.2610E+02	3.2598E+01	-1.0512E+05	8.4281E+04	1.3876E+05	-4.6633E+03	5.0618E+03	3.6980E+02
-3.5572E+01	8.7465E+02	4.7519E+01	-1.0512E+05	7.7797E+04	1.6256E+05	-4.6633E+03	4.7002E+03	1.6228E+03
-3.5572E+01	8.2320E+02	7.2591E+01	-1.0512E+05	7.1314E+04	2.1519E+05	-4.6633E+03	4.3386E+03	4.6099E+02
-3.5572E+01	7.7175E+02	1.6008E+02	-1.0512E+05	6.4831E+04	3.9062E+05	-4.6633E+03	3.9771E+03	2.0708E+04
-3.5572E+01	7.2030E+02	7.8522E+03	-1.0512E+05	5.8348E+04	6.4525E+05	-4.6633E+03	3.6155E+03	5.2355E+03
-3.5572E+01	6.6885E+02	1.9226E+02	-1.0512E+05	5.1865E+04	1.1510E+06	-4.6633E+03	3.2540E+03	2.3680E+03
-3.5572E+01	6.1740E+02	1.3310E+03	-1.0512E+05	4.5382E+04	1.7464E+06	-4.6633E+03	2.8924E+03	2.1718E+04
-3.5572E+01	5.6595E+02	5.9473E+03	-1.0512E+05	3.8899E+04	2.6834E+06	-4.6633E+03	2.5309E+03	4.4074E+03
-3.5572E+01	5.1450E+02	8.2648E+03	-1.0512E+05	3.2416E+04	3.7223E+06	-4.6633E+03	2.1693E+03	1.1429E+04
-3.5572E+01	4.6305E+02	9.4746E+03	-1.0512E+05	2.5932E+04	5.1776E+06	-4.6633E+03	1.8078E+03	4.1530E+04
-3.5572E+01	4.1160E+02	1.8302E+04	-1.0512E+05	1.9449E+04	5.2349E+06	-4.6633E+03	1.4462E+03	6.7961E+04
-3.5572E+01	3.6015E+02	3.1949E+04	-1.0512E+05	1.2966E+04	5.0262E+06	-4.6633E+03	1.0847E+03	1.3144E+05

VESTAS PROPRIETARY NOTICE

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.5572E+01	3.0870E+02	2.6442E+04	-1.0512E+05	6.4831E+03	4.1270E+06	-4.6633E+03	7.2311E+02	1.5446E+05
-3.5572E+01	2.5725E+02	6.7381E+04	-1.0512E+05	0.0000E+00	1.1942E+07	-4.6633E+03	3.6155E+02	5.0003E+05
-3.5572E+01	2.0580E+02	1.7454E+05	-1.1210E+05	1.6856E+05	3.8920E+02	-4.6633E+03	0.0000E+00	1.1041E+06
-3.5572E+01	1.5435E+02	6.2273E+05	-1.1210E+05	1.5559E+05	5.2525E+01	-5.1284E+03	1.3377E+04	6.6460E-02
-3.5572E+01	1.0290E+02	1.4356E+06	-1.1210E+05	1.4911E+05	6.9480E+02	-5.1284E+03	1.3016E+04	8.4487E-01
-3.5572E+01	5.1450E+01	4.2182E+06	-1.1210E+05	1.4263E+05	2.1469E+03	-5.1284E+03	6.8695E+03	8.5542E-01
-3.5572E+01	0.0000E+00	2.0393E+07	-1.1210E+05	1.3615E+05	4.4523E+03	-5.1284E+03	6.5080E+03	2.7591E+00
-9.5728E+01	1.8522E+03	4.6064E-01	-1.1210E+05	1.2966E+05	3.6333E+03	-5.1284E+03	6.1464E+03	4.0223E+00
-9.5728E+01	1.6978E+03	6.6460E-02	-1.1210E+05	1.2318E+05	1.5489E+04	-5.1284E+03	5.7849E+03	4.1537E+00
-9.5728E+01	1.6464E+03	1.7500E+00	-1.1210E+05	1.1670E+05	9.4206E+03	-5.1284E+03	5.4233E+03	1.2643E+01
-9.5728E+01	1.4406E+03	1.9502E+01	-1.1210E+05	1.1021E+05	1.5804E+04	-5.1284E+03	5.0618E+03	1.6306E+01
-9.5728E+01	1.3891E+03	2.5909E+00	-1.1210E+05	1.0373E+05	4.4050E+04	-5.1284E+03	4.7002E+03	1.8473E+01
-9.5728E+01	1.2862E+03	1.1111E+01	-1.1210E+05	9.7247E+04	4.9411E+04	-5.1284E+03	4.3386E+03	1.5777E+01
-9.5728E+01	1.2348E+03	1.6447E+01	-1.1210E+05	9.0764E+04	6.7840E+04	-5.1284E+03	3.9771E+03	3.8170E+01
-9.5728E+01	1.1833E+03	5.2946E+00	-1.1210E+05	8.4281E+04	9.0511E+04	-5.1284E+03	3.6155E+03	3.5353E+02
-9.5728E+01	1.1319E+03	2.8921E+01	-1.1210E+05	7.7797E+04	1.5531E+05	-5.1284E+03	3.2540E+03	3.6878E+02
-9.5728E+01	1.0804E+03	1.8589E+01	-1.1210E+05	7.1314E+04	2.9974E+05	-5.1284E+03	2.8924E+03	3.8633E+03
-9.5728E+01	1.0290E+03	1.2156E+01	-1.1210E+05	6.4831E+04	4.9228E+05	-5.1284E+03	2.5309E+03	2.3574E+03
-9.5728E+01	9.7755E+02	3.2220E+01	-1.1210E+05	5.8348E+04	8.1043E+05	-5.1284E+03	2.1693E+03	6.2480E+03
-9.5728E+01	9.2610E+02	1.9125E+01	-1.1210E+05	5.1865E+04	1.1941E+06	-5.1284E+03	1.8078E+03	1.4846E+04
-9.5728E+01	8.7465E+02	4.6952E+01	-1.1210E+05	4.5382E+04	2.0390E+06	-5.1284E+03	1.4462E+03	2.0165E+03
-9.5728E+01	8.2320E+02	8.2752E+01	-1.1210E+05	3.8899E+04	3.1962E+06	-5.1284E+03	1.0847E+03	3.2664E+04
-9.5728E+01	7.7175E+02	5.3187E+01	-1.1210E+05	3.2416E+04	4.5368E+06	-5.1284E+03	7.2311E+02	4.9542E+04
-9.5728E+01	7.2030E+02	5.2279E+01	-1.1210E+05	2.5932E+04	5.4739E+06	-5.1284E+03	3.6155E+02	1.4975E+05
-9.5728E+01	6.6885E+02	1.4151E+02	-1.1210E+05	1.9449E+04	5.8041E+06	-5.1284E+03	0.0000E+00	5.3737E+05
-9.5728E+01	6.1740E+02	1.8591E+02	-1.1210E+05	1.2966E+04	5.5817E+06	-5.5935E+03	7.5926E+03	2.0761E+00
-9.5728E+01	5.6595E+02	1.6759E+02	-1.1210E+05	6.4831E+03	4.8900E+06	-5.5935E+03	6.8695E+03	6.3302E-01
-9.5728E+01	5.1450E+02	2.3723E+02	-1.1210E+05	0.0000E+00	1.3515E+07	-5.5935E+03	6.5080E+03	1.2419E+01
-9.5728E+01	4.6305E+02	4.5382E+02	-1.1908E+05	1.4911E+05	1.2147E+03	-5.5935E+03	6.1464E+03	7.6748E-01
-9.5728E+01	4.1160E+02	2.5376E+03	-1.1908E+05	1.4263E+05	6.7967E+02	-5.5935E+03	5.7849E+03	2.1335E+02
-9.5728E+01	3.6015E+02	2.5855E+03	-1.1908E+05	1.3615E+05	5.0817E+02	-5.5935E+03	5.0618E+03	7.1430E+00
-9.5728E+01	3.0870E+02	6.8929E+03	-1.1908E+05	1.2966E+05	2.0798E+03	-5.5935E+03	4.7002E+03	7.1670E+00
-9.5728E+01	2.5725E+02	7.4825E+03	-1.1908E+05	1.2318E+05	1.0842E+04	-5.5935E+03	4.3386E+03	1.3909E+01
-9.5728E+01	2.0580E+02	3.5561E+04	-1.1908E+05	1.1670E+05	1.1001E+04	-5.5935E+03	3.9771E+03	6.3456E-01
-9.5728E+01	1.5435E+02	2.3629E+04	-1.1908E+05	1.1021E+05	2.9197E+04	-5.5935E+03	3.6155E+03	5.5947E+00
-9.5728E+01	1.0290E+02	5.9392E+04	-1.1908E+05	1.0373E+05	4.6193E+04	-5.5935E+03	3.2540E+03	6.6214E+00
-9.5728E+01	5.1450E+01	3.6771E+05	-1.1908E+05	9.7247E+04	4.5488E+04	-5.5935E+03	2.8924E+03	1.4143E+03
-9.5728E+01	0.0000E+00	1.5088E+06	-1.1908E+05	9.0764E+04	7.5843E+04	-5.5935E+03	2.5309E+03	1.4020E+03

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV Business Assurance Tuborg Parkvej 8, 2. DK-2900 Hellerup VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-1.5588E+02	1.5949E+03	3.5000E+00	-1.1908E+05	8.4281E+04	1.3932E+05	-5.5935E+03	2.1693E+03	4.8749E+01
-1.5588E+02	1.5435E+03	6.2500E-01	-1.1908E+05	7.7797E+04	1.5728E+05	-5.5935E+03	1.8078E+03	2.8660E+03
-1.5588E+02	1.3891E+03	2.3750E+00	-1.1908E+05	7.1314E+04	2.8623E+05	-5.5935E+03	1.4462E+03	5.4752E+02
-1.5588E+02	1.3377E+03	2.0127E+01	-1.1908E+05	6.4831E+04	5.0032E+05	-5.5935E+03	1.0847E+03	4.2719E+03
-1.5588E+02	1.2862E+03	1.7500E+00	-1.1908E+05	5.8348E+04	8.2955E+05	-5.5935E+03	7.2311E+02	9.6271E+03
-1.5588E+02	1.2348E+03	5.2500E+00	-1.1908E+05	5.1865E+04	1.1945E+06	-5.5935E+03	3.6155E+02	4.6207E+04
-1.5588E+02	1.1833E+03	3.5000E+00	-1.1908E+05	4.5382E+04	2.1081E+06	-5.5935E+03	0.0000E+00	1.3101E+05
-1.5588E+02	1.1319E+03	1.2336E+01	-1.1908E+05	3.8899E+04	3.4570E+06	-6.0586E+03	7.9542E+03	7.4255E+00
-1.5588E+02	1.0804E+03	1.9170E+01	-1.1908E+05	3.2416E+04	4.9384E+06	-6.0586E+03	6.5080E+03	5.0164E-01
-1.5588E+02	1.0290E+03	5.2221E+00	-1.1908E+05	2.5932E+04	5.8231E+06	-6.0586E+03	5.7849E+03	2.6042E+00
-1.5588E+02	9.7755E+02	4.4112E+01	-1.1908E+05	1.9449E+04	6.2941E+06	-6.0586E+03	5.4233E+03	5.0164E-01
-1.5588E+02	9.2610E+02	1.8509E+01	-1.1908E+05	1.2966E+04	5.8973E+06	-6.0586E+03	5.0618E+03	1.3138E-01
-1.5588E+02	8.7465E+02	1.3678E+01	-1.1908E+05	6.4831E+03	4.5427E+06	-6.0586E+03	4.7002E+03	4.9849E+00
-1.5588E+02	8.2320E+02	4.6187E+01	-1.1908E+05	0.0000E+00	1.4680E+07	-6.0586E+03	4.3386E+03	7.2325E+00
-1.5588E+02	7.7175E+02	3.5370E+01	-1.2605E+05	1.4263E+05	3.1952E+02	-6.0586E+03	3.9771E+03	3.5320E+00
-1.5588E+02	7.2030E+02	3.4651E+01	-1.2605E+05	1.3615E+05	1.3179E+03	-6.0586E+03	3.6155E+03	3.3991E+00
-1.5588E+02	6.6885E+02	8.8533E+01	-1.2605E+05	1.2966E+05	1.6293E+03	-6.0586E+03	3.2540E+03	1.4900E+00
-1.5588E+02	6.1740E+02	9.7402E+01	-1.2605E+05	1.2318E+05	4.6790E+03	-6.0586E+03	2.8924E+03	2.1925E+02
-1.5588E+02	5.6595E+02	8.8617E+01	-1.2605E+05	1.1670E+05	1.0328E+04	-6.0586E+03	2.5309E+03	9.1772E+00
-1.5588E+02	5.1450E+02	8.3393E+01	-1.2605E+05	1.1021E+05	2.2349E+04	-6.0586E+03	2.1693E+03	3.6634E+00
-1.5588E+02	4.6305E+02	8.8406E+01	-1.2605E+05	1.0373E+05	4.0711E+04	-6.0586E+03	1.8078E+03	4.4467E+01
-1.5588E+02	4.1160E+02	1.3046E+02	-1.2605E+05	9.7247E+04	8.3676E+04	-6.0586E+03	1.4462E+03	2.2484E+01
-1.5588E+02	3.6015E+02	2.2047E+03	-1.2605E+05	9.0764E+04	9.1695E+04	-6.0586E+03	1.0847E+03	2.4698E+01
-1.5588E+02	3.0870E+02	3.7315E+02	-1.2605E+05	8.4281E+04	1.3663E+05	-6.0586E+03	7.2311E+02	1.1599E+04
-1.5588E+02	2.5725E+02	4.5478E+03	-1.2605E+05	7.7797E+04	2.6022E+05	-6.0586E+03	3.6155E+02	2.1692E+04
-1.5588E+02	2.0580E+02	6.8149E+02	-1.2605E+05	7.1314E+04	3.7613E+05	-6.0586E+03	0.0000E+00	4.0783E+04
-1.5588E+02	1.5435E+02	1.1630E+04	-1.2605E+05	6.4831E+04	6.5994E+05	-6.5237E+03	6.8695E+03	1.3138E-01
-1.5588E+02	1.0290E+02	2.5071E+04	-1.2605E+05	5.8348E+04	1.0060E+06	-6.5237E+03	6.1464E+03	2.0833E+02
-1.5588E+02	5.1450E+01	3.0919E+04	-1.2605E+05	5.1865E+04	1.7782E+06	-6.5237E+03	5.4233E+03	8.5542E-01
-1.5588E+02	0.0000E+00	1.3482E+05	-1.2605E+05	4.5382E+04	2.8765E+06	-6.5237E+03	5.0618E+03	9.2128E-01
-2.1604E+02	1.5949E+03	1.7500E+00	-1.2605E+05	3.8899E+04	4.4145E+06	-6.5237E+03	4.3386E+03	2.6430E-01
-2.1604E+02	1.4920E+03	1.7500E+00	-1.2605E+05	3.2416E+04	5.9844E+06	-6.5237E+03	3.2540E+03	5.2863E+00
-2.1604E+02	1.4406E+03	1.7500E+00	-1.2605E+05	2.5932E+04	7.1455E+06	-6.5237E+03	2.8924E+03	1.5558E+00
-2.1604E+02	1.3891E+03	3.4196E+00	-1.2605E+05	1.9449E+04	7.1996E+06	-6.5237E+03	2.5309E+03	3.7637E+00
-2.1604E+02	1.3377E+03	5.0088E+00	-1.2605E+05	1.2966E+04	6.4715E+06	-6.5237E+03	2.1693E+03	3.4721E+00
-2.1604E+02	1.2862E+03	4.0307E+00	-1.2605E+05	6.4831E+03	5.3309E+06	-6.5237E+03	1.4462E+03	2.3888E+00
-2.1604E+02	1.2348E+03	1.9175E+01	-1.2605E+05	0.0000E+00	1.6695E+07	-6.5237E+03	1.0847E+03	1.7837E+01
-2.1604E+02	1.1833E+03	3.4196E+00	-1.3303E+05	1.3615E+05	4.5424E+02	-6.5237E+03	7.2311E+02	1.3004E+02

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.1604E+02	1.1319E+03	1.0666E+01	-1.3303E+05	1.2966E+05	3.8920E+02	-6.5237E+03	3.6155E+02	6.3402E+01
-2.1604E+02	1.0804E+03	1.3759E+01	-1.3303E+05	1.2318E+05	6.9960E+02	-6.5237E+03	0.0000E+00	9.4834E+03
-2.1604E+02	1.0290E+03	2.2675E+01	-1.3303E+05	1.1670E+05	8.7221E+03	-6.9888E+03	5.7849E+03	5.0164E-01
-2.1604E+02	9.7755E+02	1.6839E+01	-1.3303E+05	1.1021E+05	5.5204E+03	-6.9888E+03	5.0618E+03	5.0000E+00
-2.1604E+02	9.2610E+02	1.5589E+01	-1.3303E+05	1.0373E+05	1.8688E+04	-6.9888E+03	4.7002E+03	8.5542E-01
-2.1604E+02	8.7465E+02	1.9094E+01	-1.3303E+05	9.7247E+04	5.1543E+04	-6.9888E+03	4.3386E+03	3.0682E-01
-2.1604E+02	8.2320E+02	2.2268E+01	-1.3303E+05	9.0764E+04	6.1090E+04	-6.9888E+03	3.9771E+03	2.2783E+00
-2.1604E+02	7.7175E+02	5.0892E+00	-1.3303E+05	8.4281E+04	1.3874E+05	-6.9888E+03	3.6155E+03	3.2662E+00
-2.1604E+02	7.2030E+02	2.2401E+01	-1.3303E+05	7.7797E+04	2.2821E+05	-6.9888E+03	2.8924E+03	2.8670E+00
-2.1604E+02	6.6885E+02	2.2355E+01	-1.3303E+05	7.1314E+04	4.9937E+05	-6.9888E+03	2.1693E+03	1.3292E-01
-2.1604E+02	6.1740E+02	1.0339E+01	-1.3303E+05	6.4831E+04	7.5210E+05	-6.9888E+03	1.8078E+03	5.0164E-01
-2.1604E+02	5.6595E+02	5.6912E+01	-1.3303E+05	5.8348E+04	1.3653E+06	-6.9888E+03	1.4462E+03	1.3292E-01
-2.1604E+02	5.1450E+02	2.4178E+01	-1.3303E+05	5.1865E+04	2.0681E+06	-6.9888E+03	1.0847E+03	2.0466E+01
-2.1604E+02	4.6305E+02	4.6511E+01	-1.3303E+05	4.5382E+04	3.3578E+06	-6.9888E+03	7.2311E+02	1.4117E+03
-2.1604E+02	4.1160E+02	9.3243E+01	-1.3303E+05	3.8899E+04	5.0986E+06	-6.9888E+03	3.6155E+02	4.4183E+02
-2.1604E+02	3.6015E+02	6.7496E+01	-1.3303E+05	3.2416E+04	6.4211E+06	-6.9888E+03	0.0000E+00	2.3487E+03
-2.1604E+02	3.0870E+02	6.4347E+01	-1.3303E+05	2.5932E+04	8.3236E+06	-7.4539E+03	6.1464E+03	1.3138E-01
-2.1604E+02	2.5725E+02	2.3990E+01	-1.3303E+05	1.9449E+04	8.1644E+06	-7.4539E+03	5.4233E+03	1.3292E-01
-2.1604E+02	2.0580E+02	1.7204E+02	-1.3303E+05	1.2966E+04	7.4995E+06	-7.4539E+03	4.7002E+03	1.3292E-01
-2.1604E+02	1.5435E+02	1.0242E+02	-1.3303E+05	6.4831E+03	6.5234E+06	-7.4539E+03	3.9771E+03	5.0164E-01
-2.1604E+02	1.0290E+02	2.0080E+02	-1.3303E+05	0.0000E+00	1.8494E+07	-7.4539E+03	2.5309E+03	1.3138E-01
-2.1604E+02	5.1450E+01	2.7537E+03	-1.4000E+05	1.2318E+05	5.4968E+02	-7.4539E+03	1.8078E+03	2.7400E+00
-2.1604E+02	0.0000E+00	3.6178E+04	-1.4000E+05	1.1670E+05	2.5534E+03	-7.4539E+03	1.4462E+03	3.2662E+00
-2.7619E+02	1.3377E+03	1.7500E+00	-1.4000E+05	1.1021E+05	1.3053E+03	-7.4539E+03	1.0847E+03	2.6584E-01
-2.7619E+02	1.2862E+03	3.4196E+00	-1.4000E+05	1.0373E+05	4.3035E+03	-7.4539E+03	7.2311E+02	2.5395E+00
-2.7619E+02	1.2348E+03	6.6784E+00	-1.4000E+05	9.7247E+04	8.1671E+03	-7.4539E+03	3.6155E+02	2.4238E+02
-2.7619E+02	1.1319E+03	8.5892E+00	-1.4000E+05	9.0764E+04	2.7988E+04	-7.4539E+03	0.0000E+00	4.6560E+02
-2.7619E+02	1.0804E+03	1.5428E+01	-1.4000E+05	8.4281E+04	5.6405E+04	-7.9190E+03	4.7002E+03	1.3292E-01
-2.7619E+02	1.0290E+03	6.8392E+00	-1.4000E+05	7.7797E+04	1.0707E+05	-7.9190E+03	2.5309E+03	1.3138E-01
-2.7619E+02	9.7755E+02	6.8392E+00	-1.4000E+05	7.1314E+04	1.5400E+05	-7.9190E+03	1.4462E+03	3.3976E+00
-2.7619E+02	9.2610E+02	1.0178E+01	-1.4000E+05	6.4831E+04	3.3201E+05	-7.9190E+03	1.0847E+03	5.0000E+00
-2.7619E+02	8.7465E+02	6.2588E+00	-1.4000E+05	5.8348E+04	7.4992E+05	-7.9190E+03	7.2311E+02	4.5188E+00
-2.7619E+02	8.2320E+02	3.3392E+00	-1.4000E+05	5.1865E+04	1.2789E+06	-7.9190E+03	3.6155E+02	2.1302E+02
-2.7619E+02	7.7175E+02	4.7500E+00	-1.4000E+05	4.5382E+04	1.9232E+06	-7.9190E+03	0.0000E+00	2.7689E+01
-2.7619E+02	7.2030E+02	1.2500E+00	-1.4000E+05	3.8899E+04	3.4985E+06	-8.3841E+03	3.9771E+03	1.2500E+00
-2.7619E+02	6.6885E+02	2.7021E+01	-1.4000E+05	3.2416E+04	5.0785E+06	-8.3841E+03	3.6155E+03	1.3292E-01
-2.7619E+02	6.1740E+02	2.8607E+01	-1.4000E+05	2.5932E+04	6.5555E+06	-8.3841E+03	2.5309E+03	5.0000E+00
-2.7619E+02	5.6595E+02	1.8428E+01	-1.4000E+05	1.9449E+04	7.4456E+06	-8.3841E+03	2.1693E+03	5.0164E-01

DNV
DNV Energy Systems
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-2.7619E+02	5.1450E+02	4.2259E+01	-1.4000E+05	1.2966E+04	6.5271E+06	-8.3841E+03	1.4462E+03	9.8834E-01
-2.7619E+02	4.6305E+02	1.3811E+01	-1.4000E+05	6.4831E+03	6.1712E+06	-8.3841E+03	3.6155E+02	5.0164E-01
-2.7619E+02	4.1160E+02	8.0892E+00	-1.4000E+05	0.0000E+00	1.7313E+07	-8.3841E+03	0.0000E+00	3.3805E+01
-2.7619E+02	3.6015E+02	2.0811E+01	-1.4698E+05	1.1670E+05	1.8323E+02	-8.8492E+03	4.3386E+03	1.3292E-01
-2.7619E+02	3.0870E+02	5.5301E+01	-1.4698E+05	1.0373E+05	4.3974E+03	-8.8492E+03	1.4462E+03	9.2128E-01
-2.7619E+02	2.5725E+02	4.0056E+01	-1.4698E+05	9.7247E+04	3.1664E+03	-8.8492E+03	3.6155E+02	1.3292E-01
-2.7619E+02	2.0580E+02	2.9445E+01	-1.4698E+05	9.0764E+04	1.1578E+04	-8.8492E+03	0.0000E+00	1.1663E+01
-2.7619E+02	1.5435E+02	6.2577E+01	-1.4698E+05	8.4281E+04	6.9199E+03	-9.3143E+03	3.6155E+02	9.8680E-01
-2.7619E+02	1.0290E+02	6.1572E+01	-1.4698E+05	7.7797E+04	9.1637E+03	-9.3143E+03	0.0000E+00	1.3138E-01
-2.7619E+02	5.1450E+01	4.8280E+03	-1.4698E+05	7.1314E+04	3.0893E+04	-9.7794E+03	0.0000E+00	2.8905E+00
-2.7619E+02	0.0000E+00	7.2386E+03	-1.4698E+05	6.4831E+04	8.9923E+04	-1.0245E+04	3.6155E+02	1.3292E-01
-3.3635E+02	1.4920E+03	1.6696E+00	-1.4698E+05	5.8348E+04	2.0714E+05	-1.0710E+04	0.0000E+00	1.3138E-01
-3.3635E+02	1.4406E+03	1.6696E+00	-1.4698E+05	5.1865E+04	3.9133E+05			
-3.3635E+02	1.3377E+03	1.6696E+00	-1.4698E+05	4.5382E+04	8.4387E+05			
-3.3635E+02	1.2862E+03	3.4196E+00	-1.4698E+05	3.8899E+04	1.7433E+06			
-3.3635E+02	1.2348E+03	3.4196E+00	-1.4698E+05	3.2416E+04	2.4305E+06			
-3.3635E+02	1.1319E+03	1.6696E+00	-1.4698E+05	2.5932E+04	3.3032E+06			
-3.3635E+02	9.7755E+02	1.2500E+00	-1.4698E+05	1.9449E+04	4.1115E+06			
-3.3635E+02	8.2320E+02	6.6784E+00	-1.4698E+05	1.2966E+04	3.6282E+06			
-3.3635E+02	7.7175E+02	3.3392E+00	-1.4698E+05	6.4831E+03	3.6027E+06			
-3.3635E+02	7.2030E+02	1.0178E+01	-1.4698E+05	0.0000E+00	1.0662E+07			
-3.3635E+02	6.6885E+02	6.8392E+00	-1.5396E+05	9.0764E+04	2.4486E+03			
-3.3635E+02	6.1740E+02	1.7018E+01	-1.5396E+05	7.1314E+04	5.0565E+03			
-3.3635E+02	5.6595E+02	1.5089E+01	-1.5396E+05	6.4831E+04	1.9151E+04			
-3.3635E+02	5.1450E+02	1.2678E+01	-1.5396E+05	5.8348E+04	3.1793E+04			
-3.3635E+02	4.6305E+02	8.0892E+00	-1.5396E+05	5.1865E+04	8.6383E+04			
-3.3635E+02	4.1160E+02	3.6717E+01	-1.5396E+05	4.5382E+04	1.9029E+05			
-3.3635E+02	3.6015E+02	2.0949E+01	-1.5396E+05	3.8899E+04	3.7837E+05			
-3.3635E+02	3.0870E+02	1.7018E+01	-1.5396E+05	3.2416E+04	6.1520E+05			
-3.3635E+02	2.5725E+02	2.0651E+01	-1.5396E+05	2.5932E+04	1.2293E+06			
-3.3635E+02	2.0580E+02	3.7347E+01	-1.5396E+05	1.9449E+04	1.2446E+06			
-3.3635E+02	1.5435E+02	4.0378E+01	-1.5396E+05	1.2966E+04	1.2574E+06			
-3.3635E+02	1.0290E+02	9.1415E+01	-1.5396E+05	6.4831E+03	1.2664E+06			
-3.3635E+02	5.1450E+01	1.6701E+02	-1.5396E+05	0.0000E+00	5.0716E+06			
-3.3635E+02	0.0000E+00	3.5129E+02	-1.6093E+05	5.8348E+04	2.3794E+02			
-3.9650E+02	1.3891E+03	1.6696E+00	-1.6093E+05	5.1865E+04	7.3624E+02			
-3.9650E+02	9.2610E+02	3.5000E+00	-1.6093E+05	4.5382E+04	8.3512E+03			
-3.9650E+02	8.2320E+02	3.3392E+00	-1.6093E+05	3.8899E+04	2.2908E+04			

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-3.9650E+02	7.2030E+02	6.8392E+00	-1.6093E+05	3.2416E+04	4.7598E+04			
-3.9650E+02	6.6885E+02	1.3021E+01	-1.6093E+05	2.5932E+04	1.0078E+05			
-3.9650E+02	6.1740E+02	3.3392E+00	-1.6093E+05	1.9449E+04	1.3010E+05			
-3.9650E+02	5.6595E+02	1.0500E+01	-1.6093E+05	1.2966E+04	1.5345E+05			
-3.9650E+02	5.1450E+02	1.7018E+01	-1.6093E+05	6.4831E+03	1.5330E+05			
-3.9650E+02	4.6305E+02	2.0357E+01	-1.6093E+05	0.0000E+00	1.1554E+06			
-3.9650E+02	4.1160E+02	2.4178E+01	-1.6791E+05	4.5382E+04	3.3392E+00			
-3.9650E+02	3.6015E+02	2.1607E+01	-1.6791E+05	3.2416E+04	4.8971E+03			
-3.9650E+02	3.0870E+02	3.3392E+00	-1.6791E+05	2.5932E+04	1.2398E+02			
-3.9650E+02	2.5725E+02	1.8561E+01	-1.6791E+05	1.9449E+04	8.0852E+03			
-3.9650E+02	2.0580E+02	2.7490E+01	-1.6791E+05	1.2966E+04	1.3357E+01			
-3.9650E+02	1.5435E+02	4.0686E+01	-1.6791E+05	6.4831E+03	3.8281E+02			
-3.9650E+02	1.0290E+02	3.8785E+01	-1.6791E+05	0.0000E+00	1.6881E+05			
-3.9650E+02	5.1450E+01	1.2371E+02	-1.7489E+05	2.5932E+04	3.3392E+00			
-3.9650E+02	0.0000E+00	2.8465E+02	-1.7489E+05	1.2966E+04	3.3392E+00			
-4.5666E+02	8.2320E+02	3.5000E+00	-1.7489E+05	6.4831E+03	3.3392E+00			
-4.5666E+02	6.6885E+02	7.0000E+00	-1.7489E+05	0.0000E+00	2.6669E+04			
-4.5666E+02	6.1740E+02	8.2500E+00	-1.8186E+05	1.2966E+04	3.3392E+00			
-4.5666E+02	5.6595E+02	1.9860E+01	-1.8186E+05	0.0000E+00	3.3392E+00			
-4.5666E+02	4.1160E+02	1.7339E+01						
-4.5666E+02	3.6015E+02	6.8392E+00						
-4.5666E+02	3.0870E+02	1.0178E+01						
-4.5666E+02	2.5725E+02	2.7518E+01						
-4.5666E+02	2.0580E+02	1.7178E+01						
-4.5666E+02	1.5435E+02	2.7490E+01						
-4.5666E+02	1.0290E+02	3.3847E+01						
-4.5666E+02	5.1450E+01	9.1221E+01						
-4.5666E+02	0.0000E+00	1.0065E+02						
-5.1681E+02	8.2320E+02	3.5000E+00						
-5.1681E+02	7.7175E+02	3.5000E+00						
-5.1681E+02	6.1740E+02	3.5000E+00						
-5.1681E+02	4.1160E+02	6.6784E+00						
-5.1681E+02	3.6015E+02	1.6857E+01						
-5.1681E+02	2.5725E+02	6.8392E+00						
-5.1681E+02	2.0580E+02	2.0357E+01						
-5.1681E+02	1.5435E+02	1.6696E+01						
-5.1681E+02	1.0290E+02	1.3811E+01						
-5.1681E+02	5.1450E+01	6.7824E+01						

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2023-05-02 by KASOHE

Markov Matrices

Tower shear, bottom F_y [kN]			Tower bending, bottom M_x [kNm]			Tower torsion, bottom M_z [kNm]		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-5.1681E+02	0.0000E+00	1.1915E+02						
-5.7697E+02	5.6595E+02	3.3392E+00						
-5.7697E+02	4.1160E+02	3.3392E+00						
-5.7697E+02	3.6015E+02	6.6784E+00						
-5.7697E+02	3.0870E+02	1.0018E+01						
-5.7697E+02	2.5725E+02	1.6696E+01						
-5.7697E+02	2.0580E+02	2.0196E+01						
-5.7697E+02	1.5435E+02	1.3651E+01						
-5.7697E+02	1.0290E+02	2.3696E+01						
-5.7697E+02	5.1450E+01	7.3245E+01						
-5.7697E+02	0.0000E+00	3.2672E+01						
-6.3713E+02	5.6595E+02	3.3392E+00						
-6.3713E+02	4.6305E+02	3.4721E+00						
-6.3713E+02	4.1160E+02	3.3392E+00						
-6.3713E+02	3.0870E+02	1.3292E-01						
-6.3713E+02	2.5725E+02	2.0168E+01						
-6.3713E+02	2.0580E+02	6.6784E+00						
-6.3713E+02	1.5435E+02	1.0018E+01						
-6.3713E+02	1.0290E+02	1.4901E+01						
-6.3713E+02	5.1450E+01	3.7946E+01						
-6.3713E+02	0.0000E+00	4.0686E+01						
-6.9728E+02	5.1450E+02	3.3392E+00						
-6.9728E+02	4.1160E+02	3.3392E+00						
-6.9728E+02	2.5725E+02	3.3392E+00						
-6.9728E+02	2.0580E+02	1.0018E+01						
-6.9728E+02	1.5435E+02	6.9721E+00						
-6.9728E+02	1.0290E+02	1.3518E+01						
-6.9728E+02	5.1450E+01	2.3668E+01						
-6.9728E+02	0.0000E+00	1.6990E+01						
-7.5744E+02	1.5435E+02	3.3392E+00						
-7.5744E+02	1.0290E+02	6.6784E+00						
-7.5744E+02	5.1450E+01	1.3839E+01						
-7.5744E+02	0.0000E+00	2.5107E+01						
-8.1759E+02	1.0290E+02	3.3392E+00						
-8.1759E+02	5.1450E+01	3.3392E+00						
-8.1759E+02	0.0000E+00	1.2811E+01						
-8.7775E+02	0.0000E+00	6.8392E+00						
-9.3790E+02	5.1450E+01	3.3392E+00						

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

Markov Matrices								
Tower shear, bottom F_y [kN]			**Tower bending, bottom M_x [kNm]**			**Tower torsion, bottom M_z [kNm]**		
Level	Range	Cycles	Level	Range	Cycles	Level	Range	Cycles
-9.3790E+02	0.0000E+00	3.3392E+00						
-9.9806E+02	2.5725E+02	3.3392E+00						
-9.9806E+02	1.0290E+02	3.3392E+00						

Table 5-18 [8] Markov Matrix

T04 0122-8671 Ver 03 - Approved- Exported from DMS: 2025-05-02 by KASOHE

DNV
DNV Business Assurance
Tuborg Parkvej 8, 2.
DK-2900 Hellerup
VAT No. DK89832314

RESTRICTED

Industrie Service

Mehr Wert.
Mehr Vertrauen.

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

PRÜFAMT FÜR STANDSICHERHEIT FÜR DIE
BAUTECHNISCHE PRÜFUNG VON WINDENERGIEANLAGEN

Prüfbericht für eine Typenprüfung

Datum: 21.12.2023

Prüfnummer: **3667703-22-d Rev.2**

Objekt: **Prüfung der Standsicherheit - Flachgründung**
Windenergieanlage Vestas V162-6.8/7.2 MW
Turm: Hybridturm HA2A90A (T22)
Nabenhöhe: 169 m über GOK
Windzone S, Erdbebenzone 3
Lebensdauer: 25 Jahre

Hier: Ø = 25,50 m (rund) mit Auftrieb

Prüfgrundlage: DIBt-Richtlinie 2012

Hersteller Wind-energieanlage:
Vestas Wind Systems A/S
Hedeager 42
8200 Aarhus N
Dänemark

Konstruktion und Berechnung Fundament:
Max Bögl Wind AG
Max-Bögl-Straße 1
92369 Sengenthal

Auftraggeber:
Max Bögl Wind AG
Max-Bögl-Straße 1
92369 Sengenthal

Geltungsdauer: bis 30.08.2027

Unsere Zeichen:
IS-ESW-MUC/AME

Dokument:
3667703-22-d-Rev.2_Vestas_V162_6.8-7.2MW_HH169m_FGmA_25,5m_25y.docx

Das Dokument besteht aus 8 Seiten.
Seite 1 von 8

Die auszugsweise Wiedergabe des Dokumentes und die Verwendung zu Werbezwecken bedürfen der schriftlichen Genehmigung der TÜV SÜD Industrie Service GmbH.

Die Prüfergebnisse beziehen sich ausschließlich auf die untersuchten Prüfgegenstände.

Sitz: München
Amtsgericht München HRB 96 869
USt-IdNr. DE129484218
Informationen gemäß § 2 Abs. 1 DL-InfoV unter www.tuvsud.com/impressum

Aufsichtsrat:
Reiner Block (Vors.)
Geschäftsführer:
Ferdinand Neuwieser (Sprecher),
Thomas Kainz, Simon Kellerer

Telefon: +49 89 5791-3146
Telefax: +49 89 5791-2956
www.tuvsud.com/de-is

TÜV SÜD Industrie Service GmbH
Prüfamt für Standsicherheit für die Bautechnische Prüfung von Windenergieanlagen
Westendstraße 199
80686 München
Deutschland

T05 0131-8556 Ver 02 - Approved- Exported from DMS: 2024-05-02 by INVOL

Document: 3667703-22-d-Rev.2_Vestas_V162_6.8-7.2MW_HH169m_FGmA_25,5m_25y.docx - Property of Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Revision	Datum	Änderungen
0	31.08.2022	Erstfassung
1	16.09.2022	Dateiname angepasst
2	21.12.2023	Dokumente [1] bis [3], [6] und [8] bis [10] aktualisiert. Dokumente [4] und [5] ergänzt.

Inhaltsverzeichnis

1. Unterlagen 3
1.1. Geprüfte Unterlagen 3
1.2. Eingesehene Unterlagen 3
2. Prüfgrundlage 4
3. Beschreibung 5
3.1. Baustoffe 5
3.2. Lastannahmen 5
3.3. Baugrund 5
4. Prüfumfang 6
5. Prüfbemerkungen 6
6. Prüfergebnis 7
Auflagen 7

T05 0131-8556 Ver 02 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

1. Unterlagen

1.1. Geprüfte Unterlagen

Folgende Dokumente alle von Max Bögl Wind AG erstellt, wurden zur Prüfung vorgelegt:

[1] Statische Berechnung Max Bögl Hybridturm T22, Bauteil: Fundament mit Auftrieb D=25,5m, Windenergieanlage: V162-6.8/7.2MW, Nabenhöhe: 169 m“,
Dokument Nr. D00282008, Rev. 03, Datum 2023-12-14

[2] „Schalplan Fundament Ø25,50m“,
Dokument Nr. DE_T22_005_XX_X, Rev. c, Datum 2023-12-11

[3] „Bewehrung Fundament Ø25.50m“,
Dokument Nr. DE_T22_006_XX_X, Rev. c, Datum 2023-12-11

[4] „Schalplan Fundament Ø25,50m mit Arbeitsfuge“,
Dokument Nr. DE_T22_1005_XX_X, Rev. a, Datum 2023-12-18

[5] „Bewehrung Fundament Ø25.50m mit Arbeitsfuge“,
Dokument Nr. DE_T22_1006_XX_X, Rev. -, Datum 2023-12-11

1.2. Eingesehene Unterlagen

Folgende Dokumente wurden im Rahmen der Prüfung zusätzlich herangezogen:

[6] „Anforderungen an das Fundamentdesign Max Bögl Hybridturm T22“, erstellt von Max Bögl Wind AG,
Dokument Nr. D00282001, Rev. 03, Datum 2023-12-18

[7] „Statische Berechnung für den Max Bögl Hybridturm RT 2.0, Bauteil: Spannglied-verankerung“, erstellt von Max Bögl Wind AG,
Projekt Nr. 21683, Rev. i, Datum 2021-03-02

[8] „Gutachtliche Stellungnahme Hybridtürme für Windenergieanlagen – Bauteile für Spanngliedverankerung 3.0 – Statischer Nachweis der Bauteile für die untere Spanngliedverankerung von Hybridtürmen für Windenergieanlagen gemäß DIBt Richtlinie Fassung Oktober 2015“, erstellt von TÜV NORD CERT GmbH,
Dokument Nr. 8118 409 048-6 D, Rev. 2, Datum 2022-03-22

[9] „Übersichtsplan Gesamtturm“, erstellt von Max Bögl Wind AG,
Dokument Nr. DE_T22_001_XX_X_Uebersicht, Rev. b, Datum 2023-08-30

[10] „Prüfbericht für eine Typenprüfung – Prüfung der Standsicherheit – Hybridturm HA2A90A (T22), Windenergieanlage V162-6.8/7.2MW, 169 m Nabenhöhe, Windzone S, Erbebenzone 3, Lebensdauer: 25 Jahre“, erstellt von TÜV SÜD Industrie Service GmbH,
Dokument Nr. 3667703-12-d, Rev. 1, Datum 2023-12-21

T05 0131-8556 Ver 02 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

2. Prüfgrundlage

Die Prüfung der Unterlagen erfolgte gemäß folgender Richtlinie:

/1/ „Richtlinie für Windenergieanlagen“, herausgegeben vom Deutschen Institut für Bautechnik (DIBt), Ausgabe Oktober 2012, korrigierte Fassung März 2015

Zur Prüfung wurden zusätzlich folgende Normen und Richtlinien herangezogen:

/2/ DIN EN 1991-1-1:2010 „Eurocode 1: Einwirkung auf Tragwerke – Teil 1-1: Allgemeine Einwirkungen auf Tragwerke - Wichten, Eigengewicht und Nutzlasten im Hochbau; Deutsche Fassung EN 1991-1-1:2002 + AC:2009“, mit nationalem Anhang DIN EN 1991-1-1/NA:2010 + DIN EN 1991-1-1/NA/A1:2015

/3/ DIN EN 1992-1-1:2011 „Eurocode 2: Bemessung und Konstruktion von Stahlbeton- und Spannbetonbauwerken –Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau; Deutsche Fassung EN 1992-1-1:2004 + AC:2010“ + DIN EN 1992-1-1/A1:2015, mit nationalem Anhang DIN EN 1992-1-1/NA:2013 + DIN EN 1992-1-1/NA/A1:2015

/4/ DIN EN 1997-1:2009 „Eurocode 7: Entwurf, Berechnung und Bemessung in der Geotechnik - Teil 1: Allgemeine Regeln; Deutsche Fassung EN 1997-1:2004 + AC: 2009“, mit nationalem Anhang DIN EN 1997-1/NA:2010

/5/ DIN 1054:2010 „Baugrund – Sicherheitsnachweise im Erd- und Grundbau – Ergänzende Regelungen zu DIN EN 1997-1“ + DIN 1054/A1:2012 und DIN 1054/A2:2015

/6/ DIN EN 1998-1:2010 „Eurocode 8: Auslegung von Bauwerken gegen Erdbeben – Teil 1: Grundlagen, Erdbebeneinwirkungen und Regeln für Hochbauten; Deutsche Fassung EN 1998-1:2004 + AC:2009“, mit nationalem Anhang DIN EN 1998-1/NA:2011

/7/ DIN 4149:2005 „Bauten in deutschen Erdbebengebieten – Lastannahmen, Bemessung und Ausführung üblicher Hochbauten“

/8/ Deutscher Ausschuss für Stahlbeton Heft 439 „Ermüdungsfestigkeit von Stahlbeton- und Spannbetonbauteilen mit Erläuterungen zu den Nachweisen gemäß CEB-FIP Model Code 1990“, Ausgabe 1994

/9/ Deutscher Ausschuss für Stahlbeton Heft 600 „Erläuterungen zu DIN EN 1992-1-1 und DIN EN 1992-1-1/NA (Eurocode 2)“, Ausgabe 2012

T05 0131-8556 Ver 02 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

3. Beschreibung

Der Hybridturm für die Windenergieanlage vom Typ Vestas V162-6.8/7.2 MW mit 169 m Nabenhöhe wird mit Spanngliedern extern vorgespannt und im Fundamentsockel mit einer Ankerstangenkonstruktion mit Ankerplatten verankert.

Die Flachgründung besteht aus einer kreisförmigen Fundamentplatte mit 25,50 m Außendurchmesser mit veränderlicher Höhe sowie einem darauf aufgesetzten Sockel. Zwischen Turmfuß und Sockel ist eine Mörtelausgleichsschicht angeordnet.

Die Fundamentplatte wird mit Erdreich überschüttet, um die statisch erforderliche Auflast zu erreichen.

Das Fundament kann wahlweise ohne Arbeitsfugen gemäß [2] oder abschnittsweise gemäß [4] hergestellt werden.

Die genauen Abmessungen des Fundaments können den Schalplänen [2] und [4] entnommen werden.

3.1. Baustoffe

Beton für Fundament	C30/37 mit Expositionsklassen XC4, XD1, XF1 gemäß DIN EN 1992-1-1 /3/
Beton für Sockel	C40/50 mit Expositionsklassen XC4, XD1, XF1 gemäß DIN EN 1992-1-1 /3/
Betonstahl	B500B gemäß DIN EN 1992-1-1 /3/

3.2. Lastannahmen

Die dimensionierenden Lasten für die Fundamentauslegung sind im Fundamentlastdokument [6] angegeben. Diese Lasten wurden mit dem Prüfbericht zum Turm [10] bestätigt und werden als richtig vorausgesetzt. Die angesetzte Entwurfslebensdauer der Windenergieanlage beträgt 25 Jahre.

Einwirkungen aus Erdbeben sind gemäß Dokument [10] auf Basis der DIN EN 1998-1 /6/ für alle Erdbebenzonen sowie Baugrund- und Untergrundklassen in Deutschland abgedeckt. Hiermit sind auch alle Erdbebenzonen sowie Baugrund- und Untergrundklassen nach DIN 4149 /7/ in Deutschland abgedeckt.

Auf der Oberseite des Sockels wurde eine Verkehrslast von 10 kN/m² berücksichtigt.

Eigengewichte wurden gemäß DIN EN 1991-1-1 /2/ und nach Herstellerangaben berücksichtigt.

3.3. Baugrund

Die Mindestwerte der dynamischen und statischen Drehfedersteifigkeit des Gesamtsystems aus Boden und Fundament betragen gemäß Zeichnungen [2] und [4] $k_{\varphi,dyn} \geq 200$ GNm/rad und $k_{\varphi,stat} \geq 40$ GNm/rad.

Der höchste für den Auftrieb maßgebende Wasserstand liegt 0,38 m über Fundamentunterkante.

T05 0131-8556 Ver 02 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

4. Prüfumfang

Dieser Prüfbericht für eine Typenprüfung umfasst die Prüfung hinsichtlich der Standsicherheit der in Abschnitt 3 beschriebenen Flachgründung mit Auftrieb auf Basis der in Abschnitt 2 genannten Prüfgrundlagen.

Für eine vollständige Typenprüfung sind alle in Dokument /1/, Kapitel 3 im Abschnitt I gelisteten gutachtlichen Stellungnahmen sowie ein zusammenfassender Prüfbescheid zur Typenprüfung von Turm und Fundament erforderlich. Diese können bis spätestens zu Baubeginn der ersten Anlage nachgereicht werden.

Die Überprüfung der Standorteignung sowie des Blitzschutz- und Erdungskonzepts ist nicht Gegenstand dieses Berichts.

Abweichungen von den geprüften Unterlagen und Prüfgrundlagen bezüglich Konstruktion, Lastannahmen, Randbedingungen und Ausführung, die Einfluss auf die Standsicherheit haben, sind durch diesen Bericht nicht abgedeckt und erfordern eine Überarbeitung der Berechnung und deren Prüfung.

5. Prüfbemerkungen

Die vorgelegten Nachweise wurden durch eigene Vergleichsrechnungen überprüft. Auf Basis der eingereichten Unterlagen und unserer Vergleichsrechnungen können ausreichende Sicherheiten bestätigt werden. Die Zeichnungen wurden auf Übereinstimmung mit den Annahmen der Berechnungen sowie den Vorgaben der in Abschnitt 2 genannten Prüfgrundlagen geprüft.

Schnittstellen:

Die Nachweise der Lasteinleitung in den Vergussmörtel am Turmfuß wurden in der statischen Berechnung des Turms geführt und in [10] bestätigt.

Die Nachweise der Lasteinleitung in den Beton des Fundaments werden mit diesem Prüfbericht bestätigt.

Die Nachweise der oberen und unteren Ankerplatten sowie der Ankerstangen der Spanngliedverankerung wurden in Dokument [7] mit exemplarischen Lasten geführt und mit der gutachtlichen Stellungnahme [8] bestätigt. Mit diesem Prüfbericht wird bestätigt, dass die in [7] getroffenen Annahmen mit den Randbedingungen dieses Fundamentes übereinstimmen und die Prüfaussage in [8] für dieses Fundament gültig ist.

Teilsicherheitsbeiwerte:

In [1] wurde abweichend von den Regelungen in /1/ der Teilsicherheitsbeiwert für günstig wirkendes Eigengewicht für die Fundamentplatte mit 0,95 im Grenzzustand der Tragfähigkeit angesetzt. Die daraus resultierende minimale Wichte des Fundamentkörpers von 23,7 kN/m³ ist durch entsprechende Qualitätssicherung auf der Baustelle sicher nachzuweisen, siehe Auflage 8.

Imperfektionen:

Die Lasten aus [6] enthalten bereits Effekte aus einer Turmschiefstellung, Differenzsetzungen des Fundaments von 3 mm/m sowie aus einer zusätzlichen Schiefstellung infolge der Berücksichtigung statischer Bodenkennwerte.

Abweichend von /1/ wurden in der statischen Berechnung für die Turmschiefstellung lediglich 200 mm an der Oberkante des Adapters statt 5 mm/m angesetzt. Dieser Ansatz wurde mit [10] bestätigt.

T05 0131-8556 Ver 02 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Änderungen in der letzten Revision dieses Prüfberichts:

Der Schal- und Bewehrungsplan wurde für zwei Ausführungsvarianten getrennt erstellt:

- Ausführungsvariante ohne Fuge (Pläne [2] und [3])
- Ausführungsvariante mit Fuge (Pläne [4] und [5])

Der Nachweis und die Bewehrung der Ausführungsvariante mit Fuge wurden angepasst, um eine glatte Fuge zu berücksichtigen. Mit diesem Prüfbericht werden die Nachweise bestätigt.

In [10] wurde bestätigt, dass das Fundamentdesign auch für die neue Revision von Dokument [6] gültig ist.

6. Prüfergebnis

Die Berechnungen und die zugehörigen Konstruktions- und Bewehrungszeichnungen für das Fundament entsprechen den in Abschnitt 2 genannten Normen und Richtlinien und sind im Wesentlichen vollständig und richtig.

Die Anforderungen an die Standsicherheit der Gründung sind erfüllt, vorausgesetzt, die nachstehenden Auflagen sowie alle Auflagen und Bemerkungen der zugehörigen Prüfberichte und Gutachten werden beachtet bzw. vollzogen.

Die Prüfung der technischen Unterlagen für das Fundament ist hiermit abgeschlossen.

Auflagen

Baugrund

1. Die vorhandenen Bodenkennwerte, die Zuordnung des Bodens zu Expositionsklassen nach DIN EN 1992-1-1 /3/ und der höchste für den Auftrieb maßgebende Wasserstand sind für den jeweiligen Standort zu ermitteln und im geotechnischen Untersuchungsbericht zu beschreiben.
2. Grundbautechnische Berechnungen sind im Rahmen des geotechnischen Entwurfsberichts durchzuführen. Die Schnittgrößen an Fundamentunterkante sind in [2] und [4] angegeben.
3. Die Mindestwerte der dynamischen und statischen Drehfedersteifigkeit des Gesamtsystems aus Boden und Fundament gemäß Abschnitt 3.3. müssen für den jeweiligen Standort nachgewiesen werden. Dabei kann das Fundament in guter Näherung als Starrkörper angenommen werden.
4. Die im geotechnischen Entwurfsbericht angenommenen Baugrundverhältnisse sind beim Baugrubenaushub vom Bodengutachter zu überprüfen und zu bestätigen. Vor Aufbringen der Sauberkeitsschicht ist die Tragfähigkeit der Baugrubensohle durch den Bodengutachter zu bestätigen.

Ausführung Fundament

5. Sollte Expositionsklasse XA oder XS gemäß DIN EN 1992-1-1 /3/ abweichend von den gewählten Expositionsklassen gemäß Abschnitt 3.1. am Standort zu berücksichtigen sein, so sind gegebenenfalls zusätzliche Maßnahmen zum Schutz des Betons und der Bewehrung zu ergreifen.
6. Zur Begrenzung der Rissbildung infolge Hydratationswärmeentwicklung sind geeignete betontechnologische Maßnahmen zu ergreifen.

T05 0131-8556 Ver 02 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

7. Der Zeitpunkt des Erreichens der erforderlichen Festigkeit des Vergussmörtels und Betons für das Vorspannen ist zu bestimmen und durch fachgerecht, unter Berücksichtigung der standortspezifischen Umgebungsbedingungen gelagerte Proben zu überprüfen und zu dokumentieren.

8. Die in der Berechnung angesetzte Wichte des Stahlbetons des Fundaments von 23,7 kN/m³ ist durch entsprechende Qualitätssicherung und im Rahmen der Bauüberwachung zu bestätigen.

9. Das in [2] spezifizierte Gesamtgewicht der Überschüttung muss zur Gewährleistung der Standsicherheit mindestens erreicht werden. Die Überschüttung muss gleichmäßig über den Umfang verteilt sein. Die Ausführung der Überschüttung muss in Abstimmung mit dem Bodengutachter gewählt werden.

Prüfintervalle

10. Die Anforderungen an die wiederkehrenden Prüfungen gemäß DIBt-Richtlinie /1/ sind zu beachten.

Für die Verlängerung der Typenprüfung sind die Zeichnungen und die Berechnungen zu einer erneuten Überprüfung hinsichtlich geänderter Vorschriften oder Richtlinien vorzulegen.

TÜV SÜD Industrie Service GmbH
Prüfamt für Standsicherheit für die
bautechnische Prüfung von Windenergieanlagen

Der Bearbeiter

A. Molins Estellés

Der Leiter

i.V. S. Mayer

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

T05 0131-8556 Ver 02 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

Durch Vergleichsrechnung geprüft

Statische Berechnung

Max Bögl Hybridturm T22

Structural design Max Bögl hybrid tower T22

3667703-22-d Rev.2
In bautechnischer Hinsicht geprüft.
Siehe Prüfbericht vom 21.12.2023
München 21.12.2023
TÜV SÜD Industrie Service GmbH
Prüfamt für Standsicherheit
von Windenergieanlagen
Der Bearbeiter: Der Leiter:

Projektnummer / *Project number*:	21683-T22
Documentnummer / *Document number*	D00282008
Anlagenhersteller / *Wind turbine manufacturer*:	Vestas Wind Systems A/S Hedeager 44 DK-8200 Aarhus
Windenergieanlage / *Wind turbine generator*:	V162-6.8/7.2MW
Nabenhöhe / *Hub height*:	169 m
Bauteil / *Component*:	Fundament mit Auftrieb D=25,5m *Foundation with Buoyancy* *D=25,5m*
Verfasser / *Author*:	Max Bögl Wind AG Max-Bögl-Str. 1 DE-92369 Sengenthal
Datum / *Date*:	14.12.2023
Revision / *Revision*:	03

TYPENPRÜFUNG Geltungsdauer
5 Jahre/Wiedervorlage bis 30.08.2027

Bauteil / *Component*:	Fundament D=25,5m/ *Foundation D=25,5m*
Block / *Chapter*:	

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

Document no.: 0058.0022.02 Document owner: Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

Änderungsverzeichnis / *Table of revision*

Revision / *Revision*	Datum / *Date*	Beschreibung / *Description*	Bearbeiter / *Author*
-	15.07.2022	Erstausgabe / *First release*	J. Goycoolea
01	22.08.2022	Alle Markov Matrizen wurden berücksichtigt / *All Markov Matrix are considered*	J. Goycoolea
02	04.09.2023	Betonierfuge Nachweis entsprechend neue Betonierfuge angepasst (Kap.8) / *Foundation construction joint verification adapted according to the new construction joint (Chapt. 8)*	J. Goycoolea
03	14.12.2023	Betonierfuge und Scherbewehrung entsprechend TÜV Prüfanmerkungen von 29.11.2023 angepasst / *Construction joint and shear reinforcement according to TÜV comments from 29.11.2023 adapted.*	J. Goycoolea

Datum / *Date*: 14.12.2023

Aufgestellt / *Prepared by*: i.A. Joaquin Goycoolea

Geprüft / *Checked by:* i.A. Christoph von Oesen

Geprüft und freigegeben / *Checked and approved by*: i.A. Thorsten Betz

Bauteil / *Component*: Fundament / *Foundation*	Seite/ *Page*: Rev03
Block / *Chapter*: Änderungsverzeichnis / Table of revision	

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Inhaltsverzeichnis / *Table of contents*

Änderungsverzeichnis / *Table of revision* 2

Inhaltsverzeichnis / *Table of contents* 3

1 Allgemeines / *General* 6
1.1 Vorbemerkungen / *Preliminary remarks* 6
1.2 Geometrie / *Geometry* 8
1.3 Materialien / *Materials* 10
1.4 Unterlagen, Vorschriften und Literatur / *Documents, regulations and literature* 11

2 FE-Modell / *FE model* 12
2.1 Allgemeine Beschreibung / *General description* 12
2.2 Geometrie und Elementierung / *Geometry and elements* 14
2.3 Materialien / *Materials* 16
2.4 Bettung / *Bedding* 17

3 Lasten / *Loads* 18
3.1 Eigengewicht / *Dead weight* 19
3.2 Erdüberschüttung / *Backfill cover* 20
3.3 Auftrieb / *Buoyancy* 21
3.4 Nutzlast / *Live load* 22
3.5 Vorspannung / *Prestressing* 23
3.6 Turmlasten / *Tower loads* 26

4 Nachweise des Baugrunds / *Geotechnical design* 32
4.1 Lasten / *Loads* 32
4.2 Nachweis gegen Klaffen / *Gapping* 33
4.3 Randdruckspannung / *Soil edge pressure* 38
4.4 Baugrundanforderungen / *Subsoil requirement* 43
4.5 Nachweis der Bodendrehfedersteifigkeit / *Verification of the ground rotational stiffness* 45
4.5.1 Statische Drehfedersteifigkeit / *Static rotational stiffness* 46
4.5.2 Dynamische Drehfedersteifigkeit / *Dynamic rotational stiffness* 47

5 Bemessungsschnittgrößen / *Design internal forces* 48
5.1 Lastfallkombinationen / *Load combination* 48
5.2 Grenzzustand der Tragfähigkeit / *Ultimate limit state* 51
5.3 Grenzzustand der Gebrauchstauglichkeit / *Serviceability limit state* 52

6 Bemessung im GZT und GZG / *ULS and SLS reinforcement design*..... 53
6.1 Bemessungsverfahren / *Design procedure* 53
6.1.1 Bemessungsvorgaben für GZT / *ULS design specifications* 54
6.1.2 Bemessungsvorgaben für GZG / *SLS design specifications* 55
6.2 GZT: erforderliche Bewehrung (FE-Modell) / *ULS: required reinforcement (FE model)* 57
6.3 GZG: erforderliche Bewehrung zur Beschränkung der Rissbreite (FE-Modell) / *SLS: required reinforcement for crack width control (FE model)* 58
6.4 Mindestbewehrung / *Minimum reinforcement* 59
6.4.1 Mindestbewehrung für duktiles Bauteilverhalten / *Minimum reinforcement for ductile behavior* 59
6.4.2 Mindestbewehrung zur Beschränkung der Rissbreite / *Minimum reinforcement for crack width control* 61
6.5 Erforderliche Bewehrung / *Required reinforcement* 64
6.6 Lasteinleitung / *Load introduction* 65
6.6.1 Windzugseite / *Wind tension side* 65
6.6.2 Winddruckseite / *Wind compression side* 68
6.6.3 Betonpressung am Turmfuß / *Concrete compression at tower base* 71
6.6.4 Spaltzugbewehrung oberhalb der Ankerplatte / *Splitting tensile reinforcement above the anchor plate* 72
6.7 Gewählte Bewehrung, Übersicht und Skizze / *Chosen reinforcement summary and sketch* 73

7 Ermüdungsnachweise / *Fatigue design* 77
7.1 Allgemeines / *General* 77
7.2 Biege- und Schubbewehrung / *Bending and shear reinforcement* 79
7.3 Lasteinleitung / *Load introduction* 84
7.3.1 Bewehrung an der Windzugseite / Reinforcement at wind tension side 84
7.3.2 Beton am Turmfuß / *Concrete at tower base* 87
7.3.3 Beton oberhalb der Ankerplatte / *Concrete above the anchor plate* 88

8 Betonierfuge / *Construction joint*..... 91
8.1 Allgemeines / *General* 91
8.2 Fugentragfähigkeit in GZT erste Fuge/ First *joint resistance in ULS* 92
8.3 Fugentragfähigkeit in GZT zweite Fuge/ Second *joint resistance in ULS* 95
8.4 Fugentragfähigkeit unter Ermüdung / *Joint resistance under fatigue* 97

Anahng A: FE-System / *Annex A: FE system* .....

Anhang B: Lasten / *Annex B: Loads* .....

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

Anhang C: Schnittgrößen / *Annex C: Internal forces* .....

Anhang D: Bewehrung / *Annex D: Reinforcement* .....

Bauteil / *Component*: Fundament / *Foundation*	Seite/ *Page*: 5 REV03
Block / *Chapter*: Inhaltsverzeichnis / Table of contents	

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

1 Allgemeines / *General*

1.1 Vorbemerkungen / *Preliminary remarks*

Für den nachfolgend beschriebenen Hybridturm wird in dem vorliegenden Dokument das Fundament ausgelegt.

This documents contains the structural design of the foundation for the next stated hybrid tower.

Anlagenhersteller / *Wind turbine manufacturer*:	Vestas Wind Systems A/S
Windenergieanlage / *Wind turbine*:	V162-6.8/7.2MW
Hybridturm / *Hybrid Tower*:	T22
Nabenhöhe / *Hub Height*:	169 m
Starterring / *Starter ring*:	C33
Gesamtlänge / *Total tower length*:	163,850 m
Stahlturmlänge / *Steel tower length*:	69,160 m
Betonturmlänge / *Concrete tower length*:	94,690 m
Vorspannsystem / *Prestressing system*:	24x SUSPA EX-84
Höhe der Fundamentoberkante / *Foundation upper edge height*:	2,520

Die genaue Geometrie des Hybridturmes kann dem folgenden Übersichtsplan entnommen werden.

Further detailed information on the geometry of the hybrid tower is defined on the following general overview drawing.

DE_T22_001_XX_X_Uebersicht

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Das Fundament wird für die in dem Fundamentanforderungen-Dokument [G-1] angegebenen Lasten und Anforderungen ausgelegt.	The foundation is designed for the loads and requirements specified in the Foundation Design Requirements document [G-1].
Die Lebensdauer beträgt:	The design lifetime is:

Lebendauer / *Design lifetime*: 20, 25 Jahre / *years*

1.2 Geometrie / *Geometry*

Die Fundamentgeometrie wird nachfolgend definiert. Die angegebenen Werte entsprechen die in der Abbildung / Figure 1 angegebenen Parameter.

The geometry of the foundation is defined with the next values in accordance to Abbildung / Figure 1.

Geometrie / *Geometry*

Betonkörper / *Concrete body*

Außendurchmesser / *Outer diameter*	d_s	=	25,50	m
Sockeldurchmesser / *Base diameter*	d_{so}	=	11,88	m
Weichschichtdurchmesser / *Soft layer diameter*	d_{Ws}	=	4,40	m
Innere Weichschichtsringdurchmesser / *Soft layer ring inner diameter*	$d_{Wsr,i}$	=	11,88	m
Äußere Weichschichtsringdurchmesser / *Soft layer ring outer diameter*	$d_{Wsr,a}$	=	15,88	m
Fundamenthöhe / *Foundation height*	h_{ges}	=	2,90	m
Spornhöhe / *Outer height*	h_{sp}	=	0,70	m
Spornneigunghöhe / *Nose incline height*	h_n	=	1,60	m
Sockelhöhe / *Base height*	h_{so}	=	0,60	m
Abstand Fundamentoberkante - Grundoberkante / *Separation foundation top edge - ground level*	h_{GOK}	=	2,520	m
Abstand Fundamentoberkante - Überschüttungoberkante / *Separation foundation top edge - soil cover top edge*	h_{Auf}	=	0,10	m
Weichschichtsdicke / *Soft layer thickness*	h_{Ws}	=	0,05	m

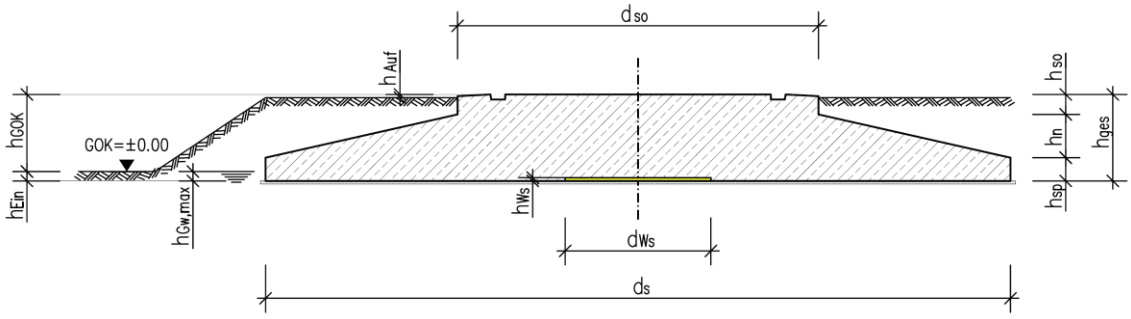


Abbildung / *Figure* 1: Fundamentgeometrie, wesentliche Parameter / *Geometry of the foundation, key parameters*

Die nachfolgenden Erdüberschüttungen und Grundwasserstände (Auftrieb) werden in der Fundamentplanung berücksichtigt.

The following backfill and groundwater level (buoyancy) are to be considered for the foundation design.

Überschüttung / *Backfill*

TÜV SÜD Industrie Service GmbH MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

Höhe Erdüberschüttung innen / *Inner thickness backfill* $t_{MaxÜs,inn}$ = 0,500 m
Höhe Erdüberschüttung außen / *Outer thickness backfill* $t_{MaxÜs,aus}$ = 2,100 m

Auftrieb / *Buoyancy*

Höhe Wassersäule / *Buoyancy height* $h_{Gw,max}$ = 0,380 m

Wie in der Abbildung / Figure 1 dargestellt, wird unter dem inneren Bereich eine Weichschicht mit einem Durchmesser von 4,4 m angeordnet. Der Bereich über der Weichschicht wird unbewehrt ausgeführt. Das Fundament wirkt dadurch statisch als Kreisringplatte.

Der Betonteil des Hybridturmes wird mit externen Spannglieder vorgespannt. Diese werden im Fundament verankert. Die Geometrie, Eigenschaften und Design des Verankerungssystem sind in der statischen Berechnung der Spanngliedverankerung [G-3] angegeben.

As it can be seen in Abbildung / Figure 1, a soft layer with a diameter of 4,4 m is arranged below the inner area. The area above the soft layer is executed without reinforcement. The foundation performs statically as a circular ring plate.

The concrete segment of the hybrid tower is prestressed with external tendons. These are anchored in the foundation. The geometry, properties and design of the anchoring system are detailed in its structural calculation document [G-3].

1.3 Materialien / *Materials*

Die Materialien des Fundaments werden nachfolgend aufgelistet.	The foundation materials are listed next.

Materialien / *Materials*

Beton / *Concrete*

Betongüte Sockelbereich / *Concrete strength base area*	C40/50
Betongüte Plattenbereich / *Concrete strength plate area*	C30/37

Betonstahl / *Reinforcement steel*

Betonstahlgüte / *Reinforcement strength*	B 500B

1.4 Unterlagen, Vorschriften und Literatur / *Documents, regulations and literature*

Dokumente und Gutachten / Documents and reports

[G-1] Max Bögl Wind AG: Anforderungen an das Fundamentdesign. Max Bögl Hybridturm T22. Dokumentnummer D00282001-T22. Dezember 2023.

[G-2] Max Bögl Wind AG: Spezifikation für den Max Bögl Hybridturm, Revision i, Juni 2021.

[G-3] Max Bögl Wind AG: Statische Berechnung für den Max Bögl Hybridturm RT 2.0. Bauteil: Spanngliedverankerung. Februar 2021.

Technische Vorschriften und Richtlinien / *Technical regulations and guidelines*

[T-1] DIBt RiLi WEA 2012, Deutsches Institut für Bautechnik, Richtlinie für Windenergieanlagen, Oktober 2012.

[T-2] DIN EN 61400-1 (VDE 0127-1). Windenergieanlagen – Teil 1: Auslegungsanforderungen (IEC 61400-1:2005 + A1:2010); Deutsche Fassung EN 61400-1:2005 + A1:2010. August 2011.

[T-3] IEC 61400-6 ED1 (88/751/FDIS): Wind energy generation systems – Part 6: Tower and foundation design requirements. Date of circulation 2019-12-27.

[T-4] DIN EN 1992-1-1: Eurocode 2: Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken – Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau; Deutsche Fassung EN 1992-1-1:2004 + AC:2010. Januar 2011.

[T-5] DIN EN 1992-1-1/NA: Nationaler Anhang - National festgelegte Parameter - Eurocode 2: Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken - Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau, April 2013

[T-6] DIN EN 1997-1: Eurocode 7 – Entwurf, Berechnung und Bemessung in der Geotechnik – Teil 1: Allgemeine Regeln; Deutsche Fassung EN 1997-1:2004 + AC:2009 + A1:2013. März 2014.

[T-7] DIN EN 1997-1/NA: Nationaler Anhang – National festgelegte Parameter – Eurocode 7: Entwurf, Berechnung und Bemessung in der Geotechnik – Teil 1: Allgemeine Regeln. Dezember 2010.

[T-8] CEB-FIP Model Code 1990, Comité Euro-International du Béton. 1993.

Literatur / *Literatur*

[L-1] Witt: Grundbau-Taschenbuch. Teil 3: Gründungen und geotechnische Bauwerke. 2009.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

2 FE-Modell / *FE model*

2.1 Allgemeine Beschreibung / *General description*

Die Schnittgrößen und die erforderliche Bewehrung werden mittels eines FE-Modells mit dem Programm Sofistik ermittelt.

Hierzu wird das Fundament mit Schalelemente (Sofistik „QUAD“-Element) modelliert. Exzentrische Schalenelemente mit variable Dicke bilden den Fundamentkörper ab.

Das Fundament wird als Kreisringplatte mit ungebetteten Bereichen modelliert. Der innere unbewehrte Bereich des Fundaments wird auf der sicheren Seite nicht im FE-System abgebildet.

Der Boden wird über das Steifemodulverfahren als elastischer Halbraum abgebildet.

The internal forces and the required reinforcement are computed in a FE model on the structural design software Sofistik.

The foundation body is modeled with shell elements (Sofistik’s ”QUAD” element). Eccentric shell elements and variable thickness are chosen for this purpose.

The foundation is modeled as a circular ring plate. The inner unreinforced and non-bedded area of the foundation is conservatively not included.

The soil interaction is represented using the constrained modulus method, in which the soil is modelled as an elastic half-space.

In der Abbildung / Figure 2 ist eine isometrische Ansicht der Elementgeometrie des FE-Modells zu finden.

Abbildung / Figure 2 shows an isometric view of the tridimesional visualization of the FE model geometry as presented from Sofistik.

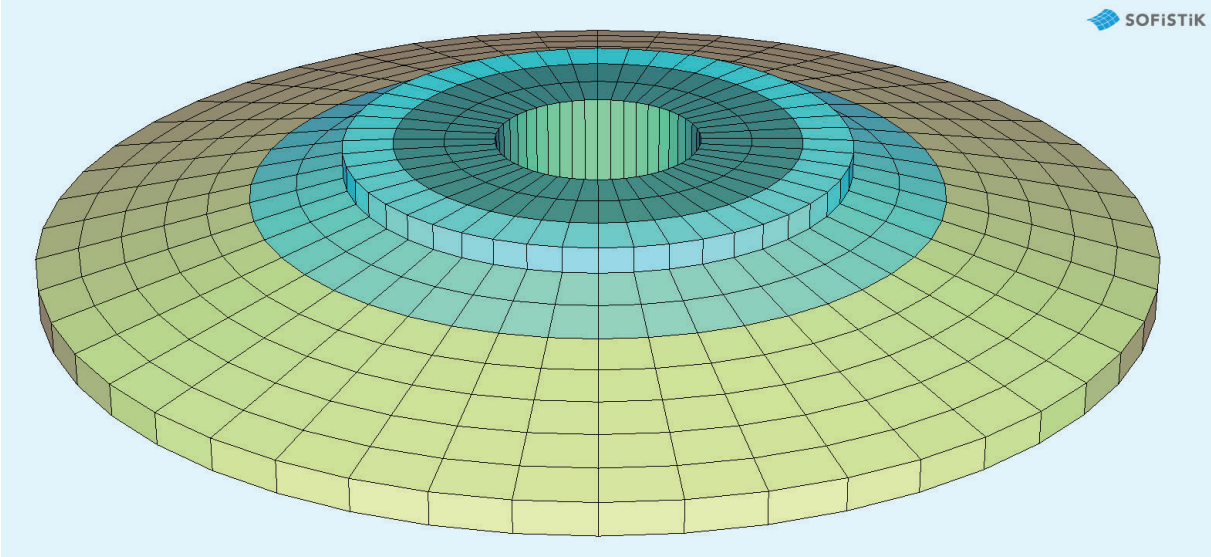


Abbildung / *Figure 2:* 3D-Ansicht der Geometrie des FE-Modells / *Tridimensional visualization of the FE model geometry*

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

2.2 Geometrie und Elementierung / *Geometry and elements*

Zur Abbildung des Kreisringfundamentes werden die Schalelemente in einem radial-tangentialem Raster angeordnet. Die Elementanzahl beträgt 48 Elemente in Umfangsrichtung. In Radial Richtung wird die Anzahl gemäß Abbildung / Figure 3 möglichst gleichmäßig gewählt.

The shell elements are arranged in a radial-tangential grid. This grid consists of 48 elements equal-sized in the circumferential direction. In radial direction the elements are chosen as even as possible resulting in the dimensions shown in Abbildung / Figure 3.

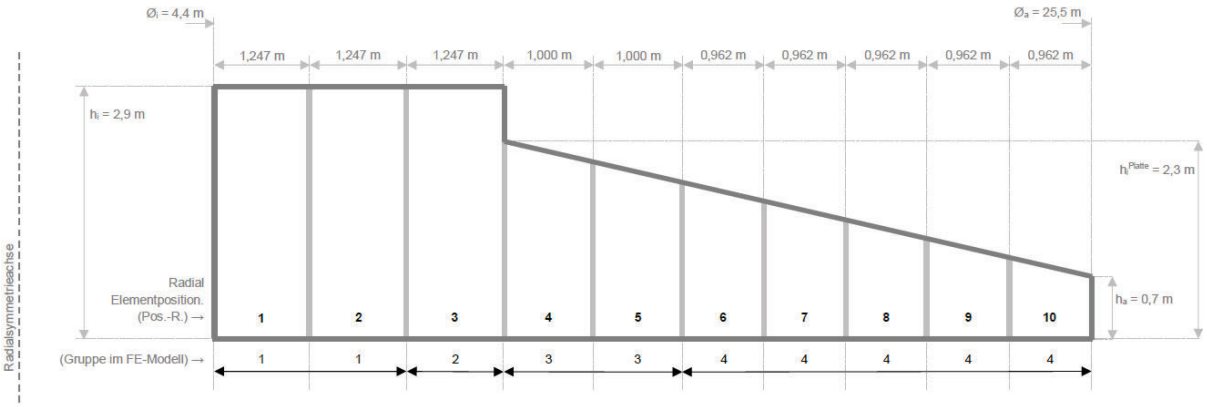


Abbildung / *Figure* 3*:* Elementgeometrie in Radialrichtung / *Element geometry in radial direction*

Für die Auswertung werden die Elemente in Gruppen eingeteilt (siehe Abbildung / Figure 3). Die Elemente der Gruppe 1 und 2 (Pos.-R 1 bis 3) bilden den Sockelbereich ab. Die Elemente der Gruppe 3 und 4 (Pos. R 4 bis 10) modellieren die Platte.

Weitere Information der Modellierung des Fundaments sind im „Anhang A: FE-System“ angegeben.

The elements are grouped on its radial position for analytical purposes (see Abbildung / Figure 3). The elements of groups 1 and 2 (Pos.-R 1 to 3) represent the area where the base is. The elements of groups 3 and 4 (Pos.-R 4 to 10) model the plate.

Further information on the modeling of the foundation can be found in “Annex A: FE system”.

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

Die geometrischen Eigenschaften der Elemente sind in der folgenden Tabelle angegeben.

The geometric properties of the elements are detailed in the following table.

Pos.-R	Ri	Ra	b-R	b-U	A	Mitt.-R	Mitt.-U	H
Numm.	*m*	*m*	*m*	*m*	*m²*	*m*	*m*	*m*
1	2,200	3,447	1,247	0,369	0,46	2,823	17,740	2,900
2	3,447	4,693	1,247	0,532	0,66	4,070	25,573	2,900
3	4,693	5,940	1,247	0,695	0,87	5,317	33,406	2,875
4	5,940	6,940	1,000	0,842	0,84	6,440	40,464	2,090
5	6,940	7,940	1,000	0,973	0,97	7,440	46,747	1,870
6	7,940	8,902	0,962	1,102	1,06	8,421	52,911	1,654
7	8,902	9,864	0,962	1,227	1,18	9,383	58,955	1,442
8	9,864	10,826	0,962	1,353	1,30	10,345	65,000	1,230
9	10,826	11,788	0,962	1,479	1,42	11,307	71,044	1,018
10	11,788	12,750	0,962	1,605	1,54	12,269	77,088	0,806

Pos.-R: Elementposition in radialer Richtung / *Element position in radial direction*
Ri: Innerer Radius des Elementkreises / *Inner radius of the element circle*
Ra: Äußerer Radius des Elementkreises / *Outer radius of the element circle*
b-R: Breite eines Elements in radialer Richtung / *Element width in radial direction*
b-U: Mittlere Breite eines Elements in Umfangsrichtung / *Element middle width in circunferential direction*
A: Fläche eines Elements / *Area of an element*
Mitt.-R: Mittlerer Radius des Elementkreises / *Middle radius of the element circle*
Mitt.-U: Mittlerer Umfang des Elementkreises / *Middle circumference of the element circle*
H: Mittlere Höhe (Dicke) des Elementkreises / *Middle height (thickness) of the element circle*

2.3 Materialien / *Materials*

Alle Elemente werden mit den gleichen Materialeigenschaften modelliert.

All elements are modeled using the same material properties.

Modelliertes Beton / *Modelled reinforcement*: C30/37

Modelliertes Betonstahl / *Modelled reinforcement*: B 500B

Die im FE-Modell benutzten Parameter und Eigenschaften sind in Abbildung / Figure 4 definiert.

The material parameters and properties used in the FE-model are listed in Abbildung / Figure 4.

Mat 11 C 30/37 (EN 1992)

Elastizitätsmodul	E	32837	[N/mm2]	Materialsicherheit		1.50	[-]
Querdehnzahl	μ	0.20	[-]	Rechenfestigkeit	fc	25.50	[MPa]
Schubmodul	G	13682	[N/mm2]	Nennfestigkeit	fck	30.00	[MPa]
Kompressionsmodul	K	18243	[N/mm2]	Zugfestigkeit	fctm	2.90	[MPa]
Nominelle Wichte	γ	25.0	[kN/m3]	Zugfestigkeit	fctk,05	2.03	[MPa]
Rohdichte	ρ	2400.0	[kg/m3]	Zugfestigkeit	fctk,95	3.77	[MPa]
Ausdehnungskoeffizient	α	1.00E-05	[1/K]	Verbundspannung	fbd	3.04	[MPa]
				Gebrauchsfestigkeit	fcm	38.00	[MPa]
				Ermüdungsfestigkeit	fcd,fat	14.96	[MPa]
				Zugfestigkeit	fctd	1.15	[MPa]
				Zugbruchenergie	Gf	0.14	[N/mm]

Mat 10 B 500 B (EN 1992)

Elastizitätsmodul	E	200000	[N/mm2]	Materialsicherheit		1.15	[-]
Querdehnzahl	μ	0.30	[-]	Fließgrenze	fy	500.00	[MPa]
Schubmodul	G	76923	[N/mm2]	Druckfließgrenze	fyc	500.00	[MPa]
Kompressionsmodul	K	166667	[N/mm2]	Zugfestigkeit	ft	540.00	[MPa]
Nominelle Wichte	γ	78.5	[kN/m3]	Druckfestigkeit	fc	540.00	[MPa]
Rohdichte	ρ	7850.0	[kg/m3]	Bruchdehnung		50.00	[o/oo]
Ausdehnungskoeffizient	α	1.20E-05	[1/K]	Verbundwert relativ		1.00	[-]
max. Erzeugnisdicke	t-max	32.00	[mm]	Verbundwert k1 (EN1992)k1		0.80	[-]
				Verfestigungsmodul	Eh	0.00	[MPa]
				Proportionalitätsgrenzefp		500.00	[MPa]
				Schwingbreite	σ-dyn	152.17	[MPa]

Abbildung / *Figure* 4*:* Materialieneigenschaften / *Material properties*

2.4 Bettung / *Bedding*

Da das Fundament an möglichst vielen Standorten eingesetzt werden soll, wird auf der sicheren Seite folgende Bodensteifigkeiten im FE-Modell angesetzt:

Given that the foundation should be used in so many locations as possible, the following soil stiffness is conservatively set in the FE model.

Steifemodul / *Constrained modulus*: E_b = 20 MN/m²

Alle gebetteten Elemente bekommen das gleiche Steifemodul zugewiesen.

The static constrained modulus stated above is assigned to all elements.

Der Einfluss der Bodensteifigkeit auf die Berechnungsergebnisse wurde in hier nicht aufgeführten Vergleichsrechnungen untersucht. Die gewählten Bewehrungsmengen decken die umhüllenden Berechnungsergebnisse ab.

The influence of the soil stiffness on the results is considered in comparative calculations which are not included in this document. The chosen reinforcement covers the required reinforcement obtained from each of the performed calculations.

Die Ergebnisse werden nachfolgend beispielhaft für die Berechnung mit dem o.g. Steifemodul dokumentiert.

The results are next documented exemplary for the calculation with the aforementioned constrained modulus.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

3 Lasten / *Loads*

Graphische Auszüge der Lasteingabe im FE-Modell sind im „Anhang B: Lasten“ dargestellt.	Graphical extracts of the load inputs in the FE model are included in “Annex B: Loads”.

3.1 Eigengewicht / *Dead weight*

Die angesetzte Wichte und das gesamte Eigengewicht werden nachfolgend angegeben.

The considered specific weight and the total own weight load are stated next.

Betongewicht / *Concrete weight*

Gesamtvolumen / *Total volume*	V_c	=	881,6	m³
Betonwichte / *Concrete specific weight*	γ_c	=	25,0	kN/m³
Betongewicht / *Concrete weight*	G_c	=	22 041	kN

Das Eigengewicht wird programmintern ermittelt (LF10).

The dead weight is internally determined by the software (LC10).

Das Gewicht des unbewehrten und nicht modellierten Betonbereiches in Fundamentmitte wird als Eingabelast am inneren Elementrand angesetzt (LF11). Die Ausmitte des Last-Schwerpunkts zum Angriffspunkt wird über ein gleichmäßiges verteiltes Torsionsmoment erfasst.

The weight of the unreinforced concrete area in the middle of the foundation, which is not modeled, is set as an input load on the inner edge of the elements (LC11). The eccentricity of this load is covered by applying a uniform distributed torsional moment on the inner element edge.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

3.2 Erdüberschüttung / *Backfill cover*

Die maximale Erdüberschüttungslast wird nach den folgenden Parameter definiert.

The maximum backfill cover load is defined according to the next parameters.

Überschüttung / *Backfill cover*

Höhe Erdüberschüttung innen / *Inner thickness backfill*	$t_{MaxÜs,inn}$	=	0,500	m
Höhe Erdüberschüttung außen / *Outer thickness backfill*	$t_{MaxÜs,aus}$	=	2,100	m
Volumen Erdüberschüttung / *Volume soil cover*	$V_{MaxÜs}$	=	558,7	m³
Bodenwichte / *Soil specific weight*	$\gamma_{Üs}$	=	18,0	kN/m³
Gewicht Erdüberschüttung / *Soil cover weight*	$G_{MaxÜs}$	=	10 056	kN

Im FE-Modell wird diese als freie Flächenlast definiert (LF42).

In the FE model this load is defined as a free surface load (LC42).

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

3.3 Auftrieb / *Buoyancy*

Die Auftrieblast wird nach den folgenden Parameter definiert.

The buoyancy load is defined according to the next parameters.

Auftrieb / *Buoyancy*

Höhe Wassersäule / *Buoyancy height*	h_{Gw}	=	0,380	m
Volumen Grundwasser / *Volume ground water*	V_{Gw}	=	194,07	m³
Wasserwichte / *Water specific weight*	γ_W	=	10,0	kN/m³
Auftriebskraft / *Buoyancy force*	G_{Gw}	=	-1 941	kN

Im FE-Modell wird diese als freie Flächenlast definiert (LF52).

Analog zum Eigengewicht wird die Auftriebslast im nicht modellierten unbewehrten Bereich auf der Elementinnenkante aufgebracht, einschließlich eines linearen Torsionsmoments.

In the FE model this load is defined as a free surface load (LC52).

Analogically to the dead weight load definition, the loads on the non-modeled unreinforced area are placed on the element's inner edge, including a linear torsional moment.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

3.4 Nutzlast / *Live load*

Die Nutzlasten im Turminnenraum (LF60) werden bei ungünstiger Wirkung im FE-Modell berücksichtigt. Die folgende Flächenlast q_{NL} wird auf der gesamten inneren Fläche des Anfangsringes definiert.

In the FE model live loads inside the tower are considered (LC60) when unfavourable. The following live load value q_{NL} is defined on the foundation area corresponding to the entire inner surface of the tower starting ring.

$$q_{NL} = 10 \text{ kN/m}^2$$

Analog zum Eigengewicht werden die Nutzlasten im nicht modellierten unbewehrten Bereich auf der Elementinnenkante aufgebracht einschließlich eines linearen Torsionsmoments.

Analogically to the dead weight load definition, the loads on the non-modeled unreinforced area are placed on the element's inner edge, including a linear torsional moment.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

3.5 Vorspannung / *Prestressing*

Die Vorspannung vom Betonturm tritt als Fundamentlast durch die Kontaktfläche mit dem Anfangsring und durch die Spanngliederverankerung auf.

Die Gesamtlast von den Spannglieder gemäß des Fundamentanforderungen-Dokument [G-1] ist nachfolgend angegeben.

The prestressing loads of the concrete tower tendons are introduced in the foundation through the contact surface with the starter ring and through the tendon anchoring.

The total prestressing load of the tendons P_{ges} is defined in the foundation design requirements document [G-1] and is included next.

$$P_{ges} = 98\,960 \text{ kN}$$

Die Last wird im FE-Modell als freie Flächenlasten im Bereich der Turmwand und der Ankerringplatte aufgebracht (LF70). Eine Lastausbreitung bis auf die Fundamentmittelebene mit einem Lastausbreitungswinkel von α = 45° (Abbildung / Figure 5) wird berücksichtigt.

In the FE model the load is defined as surface free loads (LC70). The above stated value is applied on each the tower base and the anchor ring plate. A load distribution to the foundation body middle level with a load distribution angle α = 45° (Abbildung / Figure 5) is considered.

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	Datum / *Date*: 14.12.2023

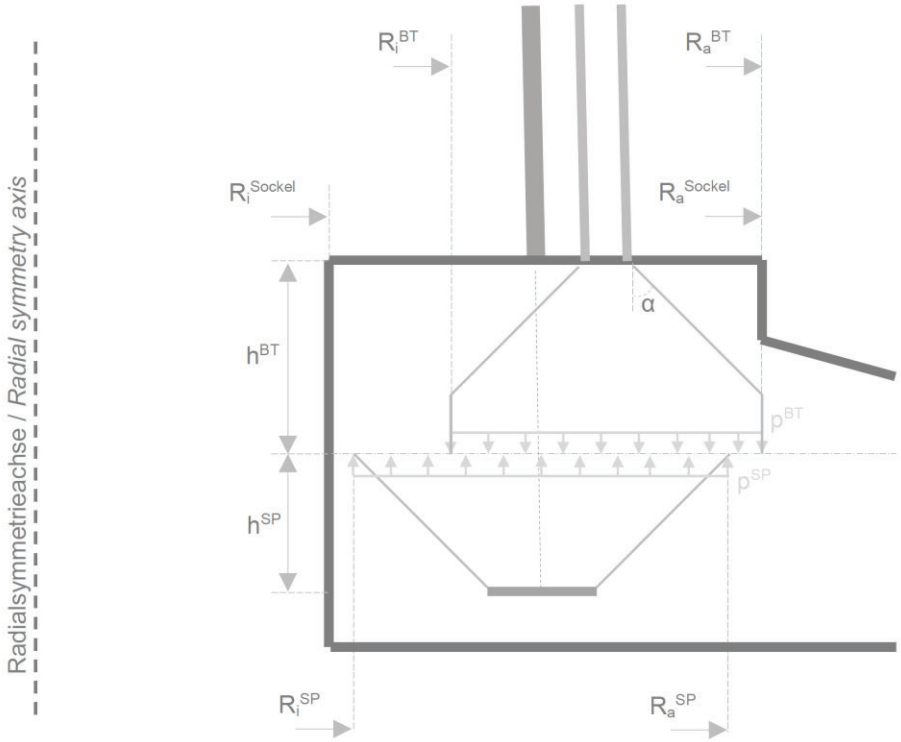


Abbildung / *Figure 5:* Lastausbreitung der Vorspannkräfte / *Load distribution of the prestressing forces*

Eine detaillierte Ermittlung der im FE-Modell aufgebrachten Flächenalastwerte ist nachfolgend angegeben.

A detailed determination of the area load values applied in the FE model is included next.

Legende

XXX	→	Eingabe
BT	→	Betonturm
SP	→	Spannglieder

Eingabe

Lasten

P	=	98 960	kN	Gesamtvorspannkraft

Geometrie

R_i^{Sockel}	=	2,200	m	
R_a^{Sockel}	=	5,940	m	
R_m^{BT}	=	4,424	m	Mittlere Radius Betonturm
b_0^{BT}	=	0,300	m	Breite Betonturm
h^{BT}	=	1,400	m	
R_m^{SP}	=	3,882	m	Mittlere Radius Spannglieder
b_0^{SP}	=	0,780	m	Breite Spannglieder
h^{SP}	=	0,620	m	

Berechnungsvorgaben

Bauteil / *Component*:	Fundament / *Foundation*	Seite / *Page*: 24
Block / *Chapter*:	3 Lasten / Loads	Rev03

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

α = 45 °

Berechnung

b^{BT}	=	3,033	m	=	$MIN(b_0^{BT} + 2 \cdot h^{BT} \cdot \tan(\alpha) ; ; 2 \cdot (R_a^{Sockel} - R_m^{BT}) ; 2 \cdot (R_m^{BT} - R_i^{Sockel}))$
R_i^{BT}	=	2,908	m	=	$R_m^{BT} - b^{BT} / 2$
R_a^{BT}	=	5,940	m	=	$R_m^{BT} + b^{BT} / 2$
b^{SP}	=	2,020	m	=	$MIN(b_0^{SP} + 2 \cdot h^{SP} \cdot \tan(\alpha) ; ; 2 \cdot (R_a^{Sockel} - R_m^{SP}) ; 2 \cdot (R_m^{SP} - R_i^{Sockel}))$
R_i^{SP}	=	2,872	m	=	$R_m^{SP} - b^{SP} / 2$
R_a^{SP}	=	4,892	m	=	$R_m^{SP} + b^{SP} / 2$
A^{BT}	=	84,289	m²	=	$\pi \cdot ((R_a^{BT})^2 - (R_i^{BT})^2)$
A^{SP}	=	49,269	m²	=	$\pi \cdot ((R_a^{SP})^2 - (R_i^{SP})^2)$
p^{BT}	=	1 174	kN/m²	=	P / A^{BT}
p^{SP}	=	2 009	kN/m²	=	P / A^{SP}

3.6 Turmlasten / *Tower loads*

Die Belastung aus dem Hybridturm ist in dem Fundamentanforderungen-Dokument [G-1] definiert. Die Lasten werden als Schnittgröße an Fundamentoberkante angegeben.

Die Schnittgrößenkombinationen, die in der folgenden Tabelle angegeben sind, werden berücksichtigt.

The loads from the hybrid tower are defined in the foundation design requirements document [G-1]. These are given as actions on the top of the foundation.

The considered combinations of loads from the hybrid tower are defined in the next table.

LF-Nr. / *LC No.*	**N_d**	**F_h**	**M_t**	**M_b**	**γ_E**	**LF-Beschreibung / *LC description***
Numm.	*kN*	*kN*	*kNm*	*kNm*	-	-
101	21 654	2 212	1 529	312 546	1,10	GZT: Max. Biegemoment + zugehörige (Max. N) / *ULS: Max. bending moment + contemporary (Max. N)*
102	19 686	2 212	1 529	312 546	1,10	GZT: Max. Biegemoment + zugehörige (Min. N) / ULS: Max. bending moment + contemporary (Min. N)
103	21 654	2 212	10 325	281 291	1,10	GZT: 0,9x Max. Biegemom. + 0,6x Max. Torsionsmom. (Max. N) / *ULS: 0.9x Max. bending moment + 0.6x Max. torsional moment (Max. N)*
104	19 686	2 212	10 325	281 291	1,10	GZT: 0,9x Max. Biegemom. + 0,6x Max. Torsionsmom. (Min. N) / *ULS: 0.9x Max. bending moment + 0.6x Max. torsional moment (Min. N)*
105	21 654	2 212	15 487	187 528	1,10	GZT: 0,6x Max. Biegemom. + 0,9x Max. Torsionsmom. (Max. N) / *ULS: 0.6x Max. bending moment + 0.9x Max. torsional moment (Max. N)*
106	19 686	2 212	15 487	187 528	1,10	GZT: 0,6x Max. Biegemom. + 0,9x Max. Torsionsmom. (Min. N) / *ULS: 0.6x Max. bending moment + 0.9x Max. torsional moment (Min. N)*
107	26 541	828	17 208	90 117	1,35	GZT: Max. Torsionsmoment + zugehörige (Max. N) / *ULS: Max. torsional moment + contemporary (Max. N)*
108	19 660	828	17 208	90 117	1,35	GZT: Max. Torsionsmoment + zugehörige (Min. N) / *ULS: Max. torsional moment + contemporary (Min. N)*
301	19 898	1 175	4 488	169 820	1,00	D.3 (Max. N) (quasi-ständige Kombination) / *D.3 (Max. N) (quasi-permanent combination)*
302	19 898	1 175	4 488	169 820	1,00	D.3 (Min. N) (quasi-ständige Kombination) / *D.3 (Min. N) (quasi-permanent combination)*

LF / *LC*: Lastfall / *Loadcase*
N: Normalkraft / *Normal load*
F_h: Horizontalkraft / *Horizontal load*
M_t: Torsionsmoment / *Torsional moment*
M_b: Biegemoment / *Bending moment*
γ: Sicherheitsbeiwert / *Safety factor*
GZT / *ULS*: Grenzzustand der Tragfähigkeit / *Ultimate limit state*

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

Die Belastung wird im FE-Modell als freie Flächenlasten eingegeben. Diese sind entsprechend dem Elementraster im Umfangsrichtung ermittelt. Die Lasten werden auf dem Durchmeser der Turmunterkante definiert. Eine Lastausbreitung bis zu Fundamentmittelebene mit einem Winkel von α = 45° (Abbildung / Figure 6) wird für die Belastung in vertikaler Richtung angesetzt.

Das Zusatzbiegemoment aus dem Abstand zwischen Fundamentoberkante und Knotenebene (Fundamentunterkante) wird angesetzt.

In the FE model these loads are defined as free area loads. The determination of its values is done discretely for each circumferential grid element. The loads are defined on the tower bottom diameter position. A load distribution to the foundation body middle level with a load distri-bution angle α = 45° (Abbildung / Figure 6) is considered for the vertical loading.

The additional bending moment due to the distance between foundation top and node level (foundation bottom) is internally taken into account.

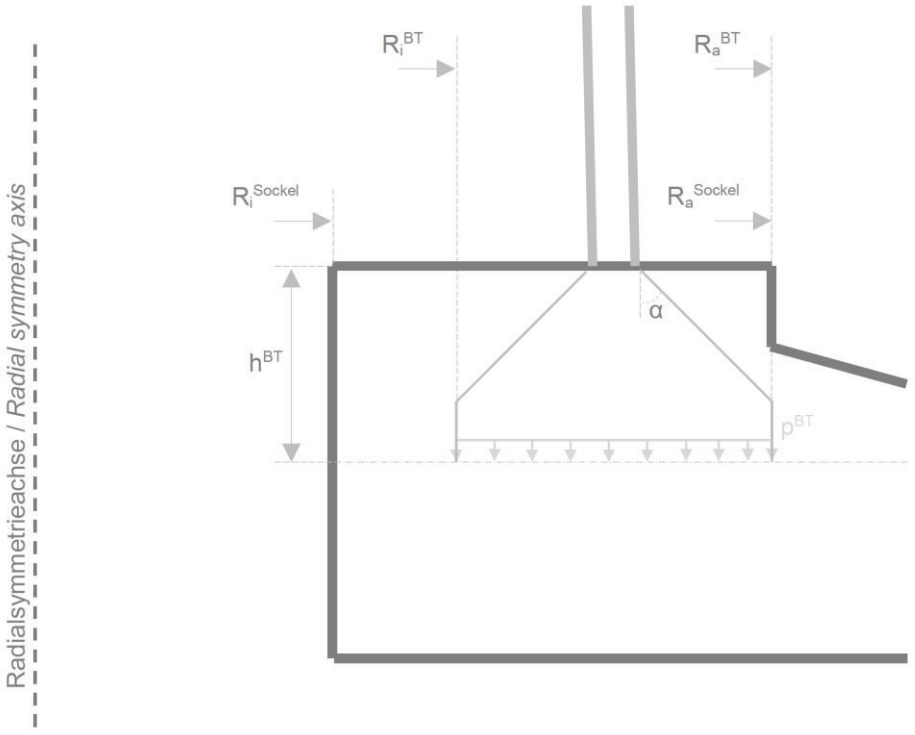


Abbildung / *Figure* 6: Lastausbreitung der Turmlasten / *Load distribution of the tower forces*

Eine detaillierte Berechnung der eingegebenen Flächenlasten für das Schalenelement an der Winddruckseite (0°) für den Lastfall 101 ist nachfolgend beispielhaft angegeben.

A detailed calculation of the introduced area loads for the element on the circumferential position corresponding to the compression side (0°) for the load case 101 is exemplary included next.

Legende

XXX	→	Eingabe
AR	→	Anfangsring
BT	→	Betonturm
FOK	→	Fundamentoberkante
KE	→	Knotenebene

Eingabe

Geometrie

R_i^{Sockel}	=	2,200	m	
R_a^{Sockel}	=	5,940	m	
h^{Sockel}	=	2,900	m	
AR	=	C33		
R_m^{BT}	=	4,424	m	Mittlere Radius Betonturm
b_0^{BT}	=	0,300	m	Breite Betonturm
h^{BT}	=	1,400	m	

Berechnungsvorgaben

α	=	45	°	

Berechnung

Lastausbreitung-Parameter

A_0^{BT}	=	8,339	m²	=	$2 \cdot \pi \cdot R_m^{BT} \cdot b_0^{BT}$
I_0^{BT}	=	81,685	m⁴	=	$(\pi / 4) \cdot ((R_m^{BT} + b_0^{BT} / 2)^4 - (R_m^{BT} - b_0^{BT} / 2)^4)$
b^{BT}	=	3,033	m	=	$MIN(b_0^{BT} + 2 \cdot h^{BT} \cdot \tan(\alpha) ; ; 2 \cdot (R_a^{Sockel} - R_m^{BT}) ; 2 \cdot (R_m^{BT} - R_i^{Sockel}))$
R_i^{BT}	=	2,908	m	=	$R_m^{BT} - b^{BT} / 2$
R_a^{BT}	=	5,940	m	=	$R_m^{BT} + b^{BT} / 2$
A_1^{BT}	=	84,289	m²	=	$\pi \cdot ((R_a^{BT})^2 - (R_i^{BT})^2)$

Betonturm-Belastung

N_d^{FOK}	=	21 642	kN		LF101
$M_{y,d}^{FOK}$	=	312 546	kNm		LF101
$F_{x,d}^{FOK}$	=	2 212	kN		LF101
$M_{t,d}^{FOK}$	=	1 529	kNm		LF101
$M_{y,d}^{KE}$	=	318 936	kNm	=	$M_{y,d}^{FOK} + F_{h,d}^{FOK} \cdot h^{Sockel}$

FE-Eingabe-Flächenlast

θ	=	0	°		Winkel zur Winddruckrichtung in UZS
$p_{\theta,z}^{N}$	=	257	kN/m²	=	N_d^{FOK} / A_1^{BT}
$p_{\theta,z}^{My}$	=	1 709	kN/m²	=	$(M_{y,d}^{KE} / I_0^{BT}) \cdot (R_m^{BT} \cdot \cos(\theta)) \cdot (A_0^{BT} / A_1^{BT})$
$p_{\theta,x}^{Fx}$	=	265	kN/m²	=	$F_{x,d}^{FOK} / A_0^{BT}$
$p_{\theta,x}^{Mt}$	=	0	kN/m²	=	$- ((M_{t,d}^{FOK} / R_m^{BT}) / A_0^{BT}) \cdot \sin(\theta)$
$p_{\theta,y}^{Mt}$	=	41	kN/m²	=	$+ ((M_{t,d}^{FOK} / R_m^{BT}) / A_0^{BT}) \cdot \cos(\theta)$
$p_{\theta,x}$	=	265	kN/m²	=	$p_{\theta,x}^{Fx} + p_{\theta,x}^{Mt}$
$p_{\theta,y}$	=	41	kN/m²	=	$p_{\theta,y}^{Mt}$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

$p_{\theta,z}$ = 1 965 kN/m² = $p_{\theta,z}^{N} + p_{\theta,z}^{My}$

Nachfolgend werden die Ergebnisse der Ermittlung der Werte der freien Flächenlast (siehe oben) für den Lastfall 101 tabellarisch dargestellt.

Subsequently a table with the results of the computation of the free area load values (see above) for the load case 101 is presented.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Verfasser / *Author*:		Proj.-Nr. / *No.*: 21683-T22
	MAX BÖGL Fortschritt baut man aus Ideen	Datum / *Date*: 14.12.2023

WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22

Pos.-U	**θ**	$p_{\theta,z}^{N}$	$p_{\theta,z}^{My}$	$p_{\theta,x}^{Fx}$	$p_{\theta,x}^{Mt}$	$p_{\theta,y}^{Mt}$	$p_{\theta,x}$	$p_{\theta,y}$	$p_{\theta,z}$
Numm.	°	*kN/m²*	*kN/m²*	*kN/m²*	*kN/m²*	*kN/m²*	*kN/m²*	*kN/m²*	*kN/m²*
1	0,0	257	1 709	265	0	41	265	41	1 966
2	7,5	257	1 694	265	- 5	41	260	41	1 951
3	15,0	257	1 651	265	- 11	40	255	40	1 907
4	22,5	257	1 579	265	- 16	38	249	38	1 836
5	30,0	257	1 480	265	- 21	36	245	36	1 737
6	37,5	257	1 356	265	- 25	33	240	33	1 612
7	45,0	257	1 208	265	- 29	29	236	29	1 465
8	52,5	257	1 040	265	- 33	25	232	25	1 297
9	60,0	257	854	265	- 36	21	229	21	1 111
10	67,5	257	654	265	- 38	16	227	16	911
11	75,0	257	442	265	- 40	11	225	11	699
12	82,5	257	223	265	- 41	5	224	5	480
13	90,0	257	0	265	- 41	0	224	0	257
14	97,5	257	- 223	265	- 41	- 5	224	- 5	34
15	105,0	257	- 442	265	- 40	- 11	225	- 11	- 186
16	112,5	257	- 654	265	- 38	- 16	227	- 16	- 397
17	120,0	257	- 854	265	- 36	- 21	229	- 21	- 598
18	127,5	257	-1 040	265	- 33	- 25	232	- 25	- 784
19	135,0	257	-1 208	265	- 29	- 29	236	- 29	- 952
20	142,5	257	-1 356	265	- 25	- 33	240	- 33	-1 099
21	150,0	257	-1 480	265	- 21	- 36	245	- 36	-1 223
22	157,5	257	-1 579	265	- 16	- 38	249	- 38	-1 322
23	165,0	257	-1 651	265	- 11	- 40	255	- 40	-1 394
24	172,5	257	-1 694	265	- 5	- 41	260	- 41	-1 437

Bauteil / *Component*:	Fundament / *Foundation*	Seite/ *Page*: 31 REV03
Block / *Chapter*:	3 Lasten / Loads	

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Die eingegebenen vertikalen Lasten für den Lastfall 101 sind beispielhaft in der Abbildung / Figure 7 als Sofistik-Auszug graphisch dargestellt.

The defined vertical loads for the load case 101 are exemplary presented in the Abbildung / Figure 7 as a Sofstik-generated graphic.

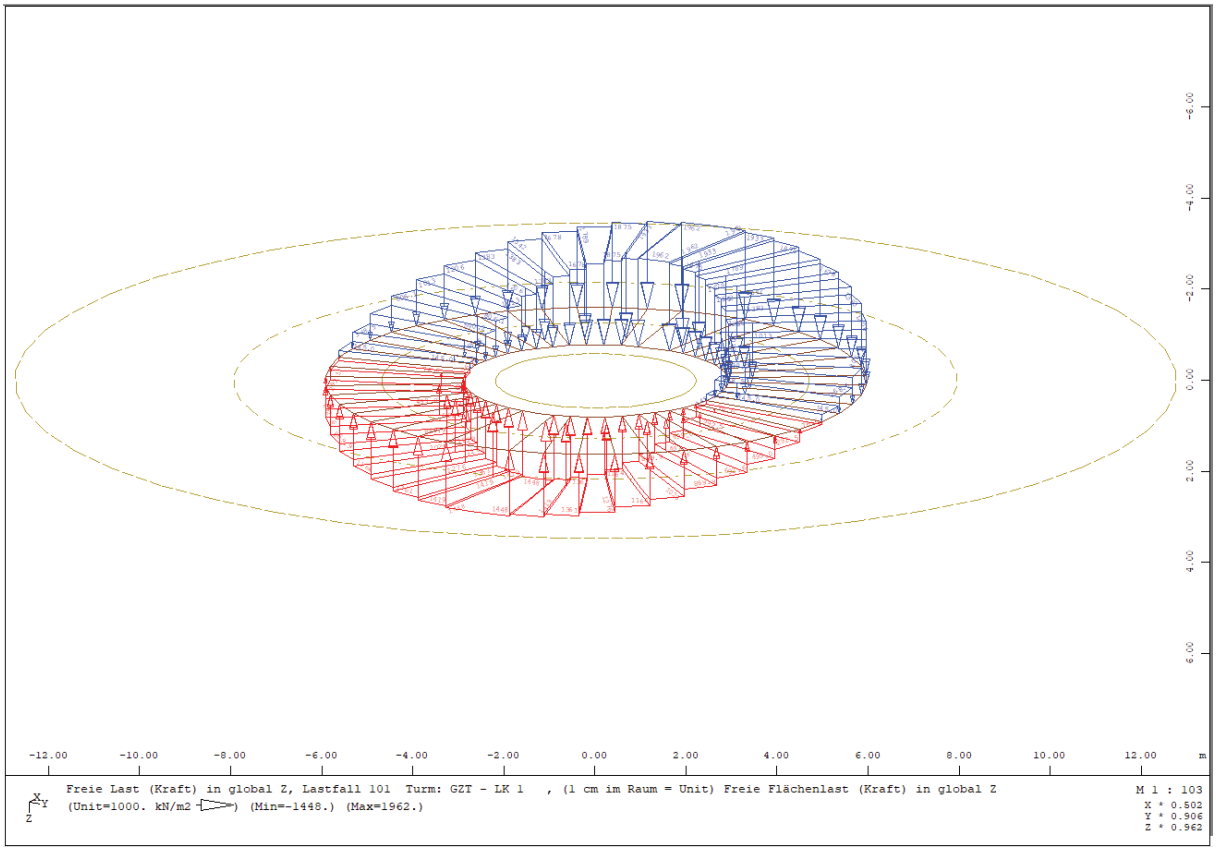


Abbildung / *Figure 7: Visualisierung in Sofistik der vertikalen Belastung des Lastfalls 101 / Sofistik visualization of the vertical loading corresponding to the load case 101*

4 Nachweise des Baugrunds / *Geotechnical design*

4.1 Lasten / *Loads*

Nachfolgend ist die Belastung für die geotechnischen Nachweise aufgelistet.

Die Turmlasten sind gemäß des Fundamentanforderungen-Dokuments [G-1] an Fundamentoberkante angegeben.

The loads considered for the geotechnical design are listed next.

The tower loads are given at the top of the foundation as defined in the Foundation Design Requirements document [G-1].

Allgemeines / *General*

Betongewicht / *Concrete weight*	G_c	=	22 041	kN
Erdüberschüttunggewicht / *Soil cover weight*	$G_{MaxÜs}$	=	10 056	kN
Auftriebkraft / *Buoyancy force*	G_{Gw}	=	-1 941	kN

S3 Einwirkungskombination / *Action combination S3*

Normalkraft S3 / Normal force S3	N_{S3}	=	19 898	kN
Querkraft S3 / Shear force S3	$F_{h,r,S3}$	=	1 175	kN
Biegemoment S3 / Bending moment S3	$M_{b,r,S3}$	=	169 820	kNm

BS-P

Normalkraft BS-P / Normal force BS-P	N_{BS-P}	=	19 808	kN
Querkraft BS-P / Shear force BS-P	$F_{h,r,BS-P}$	=	2 162	kN
Biegemoment BS-P / Bending moment BS-P	$M_{b,r,BS-P}$	=	225 985	kNm

BS-A

Normalkraft BS-A / Normal force BS-A	N_{BS-A}	=	19 686	kN
Querkraft BS-A / Shear force BS-A	$F_{h,r,BS-A}$	=	2 011	kN
Biegemoment BS-A / Bending moment BS-A	$M_{b,r,BS-A}$	=	284 133	kNm

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

4.2 Nachweis gegen Klaffen / *Gapping*

Die folgenden Nachweise gegen Klaffen werden in diesem Absatz durchgeführt.

The following gapping verifications are taken to term in this chapter.

Nr. / *No.*	**Einwirkungskombination oder Bemessungssituation / *Action combination or design situation***	**Zulässiges Klaffen / *Allowed gapping***	**Kommentar / *Comment***
1	D.3 (quasi-ständig / *quasi-permanent*)	0 % (1. Kernweite / *1st core range*)	Gemäß / *According* to DIBt-Richtlinie 12.2.3.2 [T-1]. IEC 61400-6 Ch. 8.5.3.4 [T-3] ist abgedeckt / *is covered*.
2	Bemessungssituation BS-P / *Load combination BS-P*	50 % (2. Kernweite / *2nd core range*)	Gemäß / *According* to DIBt-Richtlinie 12.2.3.2 [T-1]. IEC 61400-6 [T-3] ist abgedeckt / *is covered*.

Die Nachweise werden mittels Kernweite gemäß [L-1] Ch. 3.1.3 durchgeführt.

The verifications are performed using the core ranges (*Kernweite*) as defined in [L-1] Ch. 3.1.3.

Die Kernweite werden mittels eine Diskretisierung der Fundamentunterkantefläche durchgeführt, die die im Abs. 1.2 beschrieben Weichschichten berücksichgt. Die Bodensteifigkeit auf den Weichschichten wird vernachlässigt. Die Diskretisierung besteht aus 999 Streifen mit der gleichen Dicke.

The core ranges are computed using a discretization of the foundation bottom area which takes into account the soft layers described in Ch. 1.2. The soil stiffness on the soft layers area is neglected. The discretization consists of 999 same thickness stripes.

Die Kernweite werden durch die Modellierung der Grenzzustände, die sich aus jedem zulässigen Klaffen ergeben, ermittelt. Die Modellierung besteht aus einer linearen Verteilung der Vertikalspannungen auf den Streifen ohne Klaffen. Am äußersten Rand

The core ranges are obtained by modelling the limit situations given by the allowed gapping of each verification. The modelling consists on a linear distribution of the vertical stresses on the stripes with no gapping, assuming zero stress at the bending moment

TÜV SÜD Industrie Service GmbH MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

der Biegemomentzugseite wird Null Spannung angesetzt, am äußersten Rand der Biegemomentdruckseite wird 1 MPa angesetr. Die Normalkraft und Biegemoment, die das modellierte Grenzzustand hervorursachen, werden mittels die Flächen, Kräfte, Hebelarme und Spannungen jeder Streife ermittelt. Das Verhältnis zwischen Biegemoment und Normalkraft ergibt die Kernweite für den modellierte Klaffenstand (Grenzwert). Die ist unabhängig von den in der Spannungsaufteilung angesetzten 1 MPa.

Die Streifendiskretisierung und ihre Parameter wurden auf einer Tabelle ermittelt. Ein Auszug davon und die Beschreibung der benutzten Parameter werden dargestellt.

"tension side" limit and 1 MPa at the bending moment "compression side" limit. The normal force and bending moment which produce the modelled situation are computed using the areas, forces, lever arms and stresses on each stripe. The relation between bending moment and normal force results into the core range for the considered gapping situation (limit value), which is independent from the 1 MPa assumed as maximum of the stress distribution.

The stripe discretization and its parameters have been computed using a tabular schema. An extract and a description of the parameters used in it are include..

Gapping verification

H	=	2,90	m	
G_c	=	22 041	kN	
$G_{MaxÜs}$	=	10 056	kN	
G_{Gw}	=	-1 941	kN	
N_{Fund}	=	30 156	kN	= $G_c + G_{MaxÜs} + G_{Gw}$
1st verification (S3, 0 % gapping allowed)				
N_{S3}	=	19 898	kN	
$F_{h,r,S3}$	=	1 175	kN	
$M_{b,r,S3}$	=	169 820	kNm	
$M_{b,Fund,S3}$	=	3 408	kNm	= $F_{h,r,S3} \cdot H$
$M_{b,FUK,S3}$	=	173 228	kNm	= $M_{b,r,S3} + M_{b,Fund,S3}$
$N_{FUK,S3}$	=	50 054	kN	= $N_{S3} + N_{Fund}$
e_{S3}	=	3,461	m	= $M_{b,FUK,S3} / N_{FUK,S3}$
$R_{1,E}$	=	3,461	m	= e_{S3}
$\Sigma F_{1,j}$	=	204,2	MN	
$\Sigma M_{1,j}$	=	729,2	MNm	
R_1	=	3,572	m	= $\Sigma M_{1,i} / \Sigma R_{1,i}$
η_1	=	**0,97**		= $R_{1,E} / R_1 \leq$ **1,00**
2nd verification (BS-P, 50 % gapping allowed)				
N_{BS-P}	=	19 808	kN	
$F_{h,r,BS-P}$	=	2 162	kN	
$M_{b,r,BS-P}$	=	225 985	kNm	
$M_{b,Fund,BS-P}$	=	6 270	kNm	= $F_{h,r,BS-P} \cdot H$
$M_{b,FUK,BS-P}$	=	232 255	kNm	= $M_{b,r,BS-P} + M_{b,Fund,BS-P}$
$N_{FUK,BS-P}$	=	49 964	kN	= $N_{BS-P} + N_{Fund}$
e_{BS-P}	=	4,648	m	= $M_{b,FUK,BS-P} / N_{FUK,BS-P}$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

$R_{2,E}$	=	4,648	m	= e_{BS-P}
$\Sigma F_{2,i}$	=	92,6	MN	
$\Sigma M_{2,i}$	=	729,2	MN	
R_2	=	7,874	m	= $\Sigma M_{2,i} / \Sigma R_{2,i}$
η_2	**=**	**0,59**		= $R_{2,E} / R_2 \leq$ **1,00**

Bauteil / *Component*:	Fundament / *Foundation*	Seite / *Page*: 35 REV03
Block / *Chapter*:	4 Nachweise des Baugrunds / Geotechnical design	

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Tabellarische Diskretisierung / *Tabular discretization*

Parameter / *Parameters*

i Linie-Index oder Streife-Index /
Line index or stripe index

x_i X-Koordinate der Linie /
X Coordinate of the line i $= - R1 \cdot \cos((i / (n_{Streifen} + 1)) \cdot 180)$

$x_{m,j}$ X-Koordinate der Streifenmitte /
X Coordinate of the stripe j middle $= (x_i + x_{i-1}) / 2$ for i = j

$y_{aus,i}$ Y-Koordinate außen der Fundamentfläche auf der Linie /
Outer Y Coordinate of the fundament perimeter on the line i $= (R1^2 - x_i^2)^{0,5}$

$y_{inn,i}$ Y-Koordinate innen der Fundamentfläche auf der Linie /
Inner Y Coordinate of the fundament perimeter on the line i $= (R2^2 - x_i^2)^{0,5}$ if $ABS(x_i) < R2$

$y_{Wsr,aus,i}$ Y-Koordinate außen der Weichschichtsringfläche auf der Linie /
Y Coordinate of the soft layer ring outer perimeter on the line i $= (R_{Wsr,a}^2 - x_i^2)^{0,5}$ if $ABS(x_i) < R_{Wsr,a}$

$y_{Wsr,aus,i}$ Y-Koordinate innen der Weichschichtsringfläche auf der Linie /
Y Coordinate of the soft layer ring inner perimeter on the line i $= (R_{Wsr,i}^2 - x_i^2)^{0,5}$ if $ABS(x_i) < R_{Wsr,i}$

A_j Teilfläche der Fundamentfläche auf der Streife /
Fundament area part on the stripe j
$= ((y_{aus,i-1} + y_{aus,i}) - (y_{inn,i-1} + y_{inn,i}) - ((y_{Wsr,aus,i-1} + y_{Wsr,aus,i}) - (y_{Wsr,inn,i-1} + y_{Wsr,inn,i})) \cdot (x_{i-1} + x_i)$ für i = j

$\sigma_{1,j}$ Spannung in der Streifemitte für die Ermittlung der 1. Kernw eite /
Vertical stress in the stripe middle for the calculation of the limit state of the 1st verification
$= (R1 + x_{m,j}) / (2 \cdot R1)$

$F_{1,j}$ Kraft in der Streife für die Ermittlung der 1. Kernw eite /
Force in the stripe middle for the calculation of the limit state of the 1st verification $= \sigma_{1,j} \cdot A_j$

$M_{1,j}$ Momentbeitrag der Streife für die Ermittlung der 1. Kernw eite /
Moment contribution of the stripe for the calculation of the limit state of the 1st verification
$= F_{1,j} \cdot x_{m,j}$

$\sigma_{2,j}$ Spannung in der Streifemitte für die Ermittlung der 2. Kernw eite /
Vertical stress in the stripe middle for the calculation of the limit state of the 2nd verification
$= 0$ if $x_{m,j} < 0$; $x_{m,j} / R1$ if $x_{m,j} > 0$

$F_{2,j}$ Kraft in der Streife für die Ermittlung der 2. Kernw eite /
Force in the stripe middle for the calculation of the limit state of the 2nd verification $= \sigma_{2,j} \cdot A_j$

$M_{2,j}$ Momentbeitrag der Streife für die Ermittlung der 2. Kernw eite /
Moment contribution of the stripe for the calculation of the limit state of the 2nd verification
$= F_{2,j} \cdot x_{m,j}$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Verfasser / *Author*:		Proj.-Nr. / *No.*: 21683-T22
	MAX BÖGL Fortschritt baut man aus Ideen	Datum / *Date*: 14.12.2023

WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22

Line i / Stripe j	x_i	$x_{m,j}$	$y_{aus,i}$	$y_{inn,i}$	$y_{Wsr,aus,i}$	$y_{Wsr,aus,i}$	A_j	$\sigma_{1,j}$	$F_{1,j}$	$M_{1,j}$	$\sigma_{2,j}$	$F_{2,j}$	$M_{2,j}$
	m	*m*	*m*	*m*	*m*	*m*	*mm²*	*MPa*	*MN*	*MNm*	*MPa*	*MN*	*MNm*
0	-12,750		0,000	0,000	0,000	0,000							
1	-12,750	-12,750	0,040	0,000	0,000	0,000	3	0,000	0,000	0,000	0,000	0,000	0,000
2	-12,750	-12,750	0,080	0,000	0,000	0,000	23	0,000	0,000	0,000	0,000	0,000	0,000
3	-12,749	-12,750	0,120	0,000	0,000	0,000	63	0,000	0,000	0,000	0,000	0,000	0,000
4	-12,749	-12,749	0,160	0,000	0,000	0,000	123	0,000	0,000	0,000	0,000	0,000	0,000
5	-12,748	-12,749	0,200	0,000	0,000	0,000	204	0,000	0,000	0,000	0,000	0,000	0,000
6	-12,748	-12,748	0,240	0,000	0,000	0,000	305	0,000	0,000	0,000	0,000	0,000	0,000
7	-12,747	-12,747	0,280	0,000	0,000	0,000	426	0,000	0,000	0,000	0,000	0,000	0,000
8	-12,746	-12,746	0,320	0,000	0,000	0,000	567	0,000	0,000	0,000	0,000	0,000	0,000
9	-12,745	-12,745	0,360	0,000	0,000	0,000	728	0,000	0,000	0,000	0,000	0,000	0,000
10	-12,744	-12,744	0,400	0,000	0,000	0,000	910	0,000	0,000	0,000	0,000	0,000	0,000
495	-0,200	-0,220	12,748	2,191	7,937	5,937	685 499	0,491	0,337	-0,074	0,000	0,000	0,000
496	-0,160	-0,180	12,749	2,194	7,938	5,938	685 318	0,493	0,338	-0,061	0,000	0,000	0,000
497	-0,120	-0,140	12,749	2,197	7,939	5,939	685 172	0,495	0,339	-0,047	0,000	0,000	0,000
498	-0,080	-0,100	12,750	2,199	7,940	5,939	685 064	0,496	0,340	-0,034	0,000	0,000	0,000
499	-0,040	-0,060	12,750	2,200	7,940	5,940	684 991	0,498	0,341	-0,020	0,000	0,000	0,000
500	0,000	-0,020	12,750	2,200	7,940	5,940	684 955	0,499	0,342	-0,007	-0,002	-0,001	0,000
501	0,040	0,020	12,750	2,200	7,940	5,940	684 955	0,501	0,343	0,007	0,002	0,001	0,000
502	0,080	0,060	12,750	2,199	7,940	5,939	684 991	0,502	0,344	0,021	0,005	0,003	0,000
503	0,120	0,100	12,749	2,197	7,939	5,939	685 064	0,504	0,345	0,035	0,008	0,005	0,001
504	0,160	0,140	12,749	2,194	7,938	5,938	685 172	0,505	0,346	0,049	0,011	0,008	0,001
505	0,200	0,180	12,748	2,191	7,937	5,937	685 318	0,507	0,348	0,063	0,014	0,010	0,002
991	12,745	12,744	0,360	0,000	0,000	0,000	910	1,000	0,001	0,012	1,000	0,001	0,012
992	12,746	12,745	0,320	0,000	0,000	0,000	728	1,000	0,001	0,009	1,000	0,001	0,009
993	12,747	12,746	0,280	0,000	0,000	0,000	567	1,000	0,001	0,007	1,000	0,001	0,007
994	12,748	12,747	0,240	0,000	0,000	0,000	426	1,000	0,000	0,005	1,000	0,000	0,005
995	12,748	12,748	0,200	0,000	0,000	0,000	305	1,000	0,000	0,004	1,000	0,000	0,004
996	12,749	12,749	0,160	0,000	0,000	0,000	204	1,000	0,000	0,003	1,000	0,000	0,003
997	12,749	12,749	0,120	0,000	0,000	0,000	123	1,000	0,000	0,002	1,000	0,000	0,002
998	12,750	12,750	0,080	0,000	0,000	0,000	63	1,000	0,000	0,001	1,000	0,000	0,001
999	12,750	12,750	0,040	0,000	0,000	0,000	23	1,000	0,000	0,000	1,000	0,000	0,000
1000	12,750	12,750	0,000	0,000	0,000	0,000	3	1,000	0,000	0,000	1,000	0,000	0,000

Bauteil / *Component*:	Fundament / *Foundation*	Seite / *Page*: 3 REV03
Block / *Chapter*:	4 Nachweise des Baugrunds / Geotechnical design	

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

4.3 Randdruckspannung / *Soil edge pressure*

Die Randdruckspannungen (maximale) werden für die folgenden Lastenkombinationen ermittelt.

The soil edge pressure (maximal) is computed for the following load combinations.

1. Charakteristiche Bemessungssituation BS-P / *Characteristic design situation BS-P*
2. Charakteristiche Bemessungssituation BS-A / *Characteristic design situation BS-A*

Jede Lastkombination wird mit der minimalen und maximalen Normalkraft (Auftrieb jeweils berücksichtigt und nicht berücksichtigt) berechnet.

Each of them is computed in combination with minimal and maximal normal load (buoyancy consided and not considered respectively).

Eine Diskretisierung wie die vom Klaffennachweis (siehe 4.2) wird benutzt um die Weichschichte bei der Berechnung des Klaffen jeder Kombination zu berücksichtigen.

A discretization as the one used for the gapping verification (see 4.2) is used to take into account the soft layers when computing the corresponding gapping for each load combination.

Eine lineare Verteilung der Vertikalspannungen auf den Bereichen ohne Klaffen wird angesetzt. Gegeben eine Klaffenlänge Δx ab der Fundamentaußerkante; die Fläche ohne Klaffen A_{eff}, das Biegemoment und die Normalkraft werden in dieser Tabelle berechnet. Die Spannungsverteilung setzt Spannung gleich null an der Kante der Biegezugseite und $\sigma_N = N / A_{eff}$ auf einem Abstand $e = M_{b,E} / N_E$ von Fundamentmitte in der Richtung der Biegedruckseite an.

A linear distribution of the vertical stresses in the not gapping areas will be as well considered. Given a gapping length Δx starting at the foundation outer edge; the non-gapping area A_{eff}, the bending moment, and the normal force are computed in the table. The stress distribution considers stress equal to 0 at the bending moment “tension side” limit and $\sigma_N = N / A_{eff}$ at a distance $e = M_{b,E} / N_E$ of the middle of the foundation in the direction of the bending moment “compression side”.

Das aus jeder kombination sich ergebende Klaffen wird iterativ berechnet mit der Bedingung, dass das Biegemoment aus der Diskretisierung gleich das einwirkende Biegemoment sein muss.

The gapping resulting of each load combination is iteratively computed, given the condition that the bending moment resulting from the discretitzation has to be equal to the acting bending moment.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Wenn das Klaffen ermittelt ist, die (maximale) Randdruckspannung wird aus der linearen Spannungsverteilung direkt berechnet.

Once the gapping has been obtained, the soil edge (maximum) pressure is directly computed from the linear stress distribution.

Die Flächen und Spannungen jeder Streife der Diskretisierung werden tabellarisch ermittelt. Die detaillierte Berechnung der Randdruckspannungen für die Kombinationen mit minimalen Normalkraft werden nachfolgend dargestellt. Ein Auszug und die Beschreibung der benutzten Parameter folgen.

The areas and stress of the stripes driscretization have been computed using a tabular schema. The detailed calculation of the soil edge pressures for the combinations with minimal normal load is subsequently provided. An extract and a description of the parameters used in it follow.

Die resultierenden maximalen Randdruckspannungen sind in der nachfolgenden Tabelle angegeben.

The resulting maximal soil edge pressures are given in the following table.

$\sigma_{max,k}$ [kN/m²]	**Min. N**	**Max. N**
BS-P	278	278
BS-A	367	361

Soil edge pressure

H	=	2,90	m		
G_c	=	22 041	kN		
$G_{MaxÜs}$	=	10 056	kN		
G_{Gw}	=	-1 941	kN		
N_{Fund}	=	30 156	kN	=	$G_c + G_{MaxÜs} + G_{Gw}$
$\Delta M_{b,zul}$	=	500	kNm		
BS-P					
N_{BS-P}	=	19 808	kN		
$F_{h,r,BS-P}$	=	2 162	kN		
$M_{b,r,BS-P}$	=	225 985	kNm		
$M_{b,Fund,BS-P}$	=	6 270	kNm	=	$F_{h,r,BS-P} \cdot H$
$M_{b,FUK,BS-P}$	=	232 255	kNm	=	$M_{b,r,BS-P} + M_{b,Fund,BS-P}$
$N_{FUK,BS-P}$	=	49 964	kN	=	$N_{BS-P} + N_{Fund}$
$M_{b,E,BS-P}$	=	232,3	MNm	=	$M_{b,FUK,BS-P}$
$N_{E,BS-P}$	=	50,0	MN	=	$N_{FUK,BS-P}$
e_{BS-P}	=	4,648	m	=	$M_{b,E,BS-P} / N_{E,BS-P}$
Δx_{BS-P}	=	6,625	m		(iterative determined)

$A_{eff,BS-P}$	=	315,2	m²	=	ΣA_j wenn $\sigma_{BS-P,j} \neq 0$
$\sigma_{N,BS-P}$	=	158,5	kN/m²	=	$N_{E,BS-P} / A_{eff,BS-P}$
$\sigma_{max,BS-P}$	**=**	**278**	**kN/m²**	=	$((2 \cdot R1 - \Delta x_{BS-P}) / (R1 - - \Delta x_{BS-P} + e_{BS-P})) \cdot \sigma_{N,BS-P}$
$M_{b,TAB,BS-P}$	=	232,5	MNm	=	$\Sigma M_{b,BS-P,i} \cdot \sigma_{N,BS-P}$
$\Delta M_{b,BS-P}$	=	-269	kNm	=	$M_{b,E,BS-P} - M_{b,TAB,BS-P}$
BS-A					
N_{BS-A}	=	19 686	kN		
$F_{h,r,BS-A}$	=	2 011	kN		
$M_{b,r,BS-A}$	=	284 133	kNm		
$M_{b,Fund,BS-A}$	=	5 832	kNm	=	$F_{h,r,BS-A} \cdot H$
$M_{b,FUK,BS-A}$	=	289 965	kNm	=	$M_{b,r,BS-A} + M_{b,Fund,BS-A}$
$N_{FUK,BS-A}$	=	49 842	kN	=	$N_{BS-A} + N_{Fund}$
$M_{b,E,BS-A}$	=	290,0	MNm	=	$M_{b,FUK,BS-P}$
$N_{E,BS-A}$	=	49,8	MN	=	$N_{FUK,BS-P}$
e_{BS-A}	=	5,818	m	=	$M_{b,E,BS-A} / N_{E,BS-A}$
Δx_{BS-A}	=	10,145	m		(iterative determined)
$A_{eff,BS-A}$	=	251,4	m²	=	ΣA_j wenn $\sigma_{BS-A,j} \neq 0$
$\sigma_{N,BS-A}$	=	198,2	kN/m²	=	N_{BS-A} / A_{BS-A}
$\sigma_{max,BS-A}$	**=**	**361**	**kN/m²**	=	$((2 \cdot R1 - \Delta x_{BS-A}) / (R1 - - \Delta x_{BS-A} + e_{BS-A})) \cdot \sigma_{N,BS-A}$
$M_{b,TAB,BS-A}$	=	290,0	MNm	=	$\Sigma M_{b,BS-A,i} \cdot \sigma_{N,BS-A}$
$\Delta M_{b,BS-A}$	=	-2	kNm	=	$M_{b,E,BS-A} - \Sigma M_{b,TAB,BS-A}$

Eine Toleranz $\Delta M_{b,zul}$ wurde definiert, da wegen rechnerischen Gründe eine perfekte Konvergenz $\Delta M_b = 0$ kann nicht immer erreicht werden.

A tolerance $\Delta M_{b,zul}$ is defined, given that for computational reasons a perfect convergence $\Delta M_b = 0$ cannot always be obtained.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Tabellarische Diskretisierung / *Tabular discretization*

Parameter / *Parameters*

x_i X-Koordinate der Linie / *X Coordinate of the line i*
$= - R1 \cdot \cos((i / (n_{Streifen} + 1)) \cdot 180)$

$x_{m,j}$ X-Koordinate der Streifenmitte / *X Coordinate of the stripe j middle*
$= (x_i + x_{i-1}) / 2$ für $i = j$

$y_{aus,i}$ Y-Koordinate außen der Fundamentfläche auf der Linie / *Outer Y Coordinate of the fundament perimeter on the line i*
$= (R1^2 - x_i^2)^{0,5}$

$y_{inn,i}$ Y-Koordinate innen der Fundamentfläche auf der Linie / *Inner Y Coordinate of the fundament perimeter on the line i*
$= (R2^2 - x_i^2)^{0,5}$ wenn $ABS(x_i) < R2$

$y_{Wsr,aus,i}$ Y-Koordinate außen der Weichschichtsringfläche auf der Linie / *Y Coordinate of the soft layer ring outer perimeter on the line i*
$= (R_{Wsr,a}^2 - x_i^2)^{0,5}$ wenn $ABS(x_i) < R_{Wsr,a}$

$y_{Wsr,aus,i}$ Y-Koordinate innen der Weichschichtsringfläche auf der Linie / *Y Coordinate of the soft layer ring inner perimeter on the line i*
$= (R_{Wsr,i}^2 - x_i^2)^{0,5}$ wenn $ABS(x_i) < R_{Wsr,i}$

A_j Teilfläche der Fundamentfläche auf der Streife / *Fundament area part on the stripe j*
$= ((y_{aus,i-1} + y_{aus,i}) - (y_{inn,i-1} + y_{inn,i}) - ((y_{Wsr,aus,i-1} + y_{Wsr,aus,i}) - (y_{Wsr,inn,i-1} + y_{Wsr,inn,i})) \cdot (x_{i-1} + x_i)$ für $i = j$

$\sigma_{k,BS\text{-}P,j}$ Vertical stress in the stripe middle for the calculation of the BS-P soil edge pressure / *Vertikale Spannung auf Streifenmitte für die Berechnung der BS-P Kantenpressungen*
$= 0$ if $(R1 + x_{m,j}) < \Delta x_{k,BS\text{-}P}$; $(R1 - \Delta x_{k,BS\text{-}P} + x_{m,j}) / (R1 - \Delta x_{k,BS\text{-}P} + e_{k,BS\text{-}P})$ if $(R1 + x_{m,j}) > \Delta x_{k,BS\text{-}P}$

$M_{k,BS\text{-}P,j}$ Bending moment contribution of the stripe middle for the calculation of the BS-P soil edge pressure / *Biegemomentbeitrag der Streifenmitte für die Berechnung der BS-P Kantenpressungen*
$= \sigma_{k,BS\text{-}P,j} \cdot A_j \cdot x_{m,j}$

$\sigma_{k,BS\text{-}A,j}$ Vertical stress in the stripe middle for the calculation of the BS-A soil edge pressure / *Vertikale Spannung auf Streifenmitte für die Berechnung der BS-A Kantenpressungen*
$= 0$ if $(R1 + x_{m,j}) < \Delta x_{k,BS\text{-}A}$; $(R1 - \Delta x_{k,BS\text{-}A} + x_{m,j}) / (R1 - \Delta x_{k,BS\text{-}A} + e_{k,BS\text{-}A})$ if $(R1 + x_{m,j}) > \Delta x_{k,BS\text{-}A}$

$M_{k,BS\text{-}A,j}$ Bending moment contribution of the stripe middle for the calculation of the BS-A soil edge pressure / *Biegemomentbeitrag der Streifenmitte für die Berechnung der BS-A Kantenpressungen*
$= \sigma_{k,BS\text{-}A,j} \cdot A_j \cdot x_{m,j}$

$\sigma_{k,BS\text{-}T,j}$ Vertical stress in the stripe middle for the calculation of the BS-T soil edge pressure / *Vertikale Spannung auf Streifenmitte für die Berechnung der BS-T Kantenpressungen*
$= 0$ if $(R1 + x_{m,j}) < \Delta x_{k,BS\text{-}T}$; $(R1 - \Delta x_{k,BS\text{-}T} + x_{m,j}) / (R1 - \Delta x_{k,BS\text{-}T} + e_{k,BS\text{-}T})$ if $(R1 + x_{m,j}) > \Delta x_{k,BS\text{-}T}$

$M_{k,BS\text{-}T,j}$ Bending moment contribution of the stripe middle for the calculation of the BS-T soil edge pressure / *Biegemomentbeitrag der Streifenmitte für die Berechnung der BS-T Kantenpressungen*
$= \sigma_{k,BS\text{-}T,j} \cdot A_j \cdot x_{m,j}$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Verfasser / *Author*:		Proj.-Nr. / *No.*: 21683-T22
	MAX BÖGL Fortschritt baut man aus Ideen	Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22

Line i / Stripe j	x_i	$x_{m,j}$	$y_{aus,i}$	$y_{inn,i}$	$y_{Wsr,aus,i}$	$y_{Wsr,aus,i}$	A_j	$\sigma_{BS\text{-}P,j}$	$M_{BS\text{-}P,j}$	$\sigma_{BS\text{-}A,j}$	$M_{BS\text{-}A,j}$
	m	*m*	*m*	*m*	*m*	*m*	*mm²*	*MPa*	*MNm*	*MPa*	*MNm*
0	-12,750		0,000	0,000	0,000	0,000					
1	-12,750	-12,750	0,040	0,000	0,000	0,000	3	0,000	0,000	0,000	0,000
2	-12,750	-12,750	0,080	0,000	0,000	0,000	23	0,000	0,000	0,000	0,000
3	-12,749	-12,750	0,120	0,000	0,000	0,000	63	0,000	0,000	0,000	0,000
4	-12,749	-12,749	0,160	0,000	0,000	0,000	123	0,000	0,000	0,000	0,000
5	-12,748	-12,749	0,200	0,000	0,000	0,000	204	0,000	0,000	0,000	0,000
6	-12,748	-12,748	0,240	0,000	0,000	0,000	305	0,000	0,000	0,000	0,000
7	-12,747	-12,747	0,280	0,000	0,000	0,000	426	0,000	0,000	0,000	0,000
8	-12,746	-12,746	0,320	0,000	0,000	0,000	567	0,000	0,000	0,000	0,000
9	-12,745	-12,745	0,360	0,000	0,000	0,000	728	0,000	0,000	0,000	0,000
10	-12,744	-12,744	0,400	0,000	0,000	0,000	910	0,000	0,000	0,000	0,000
495	-0,200	-0,220	12,748	2,191	7,937	5,937	685 499	0,548	-0,083	0,283	-0,043
496	-0,160	-0,180	12,749	2,194	7,938	5,938	685 318	0,552	-0,068	0,288	-0,036
497	-0,120	-0,140	12,749	2,197	7,939	5,939	685 172	0,556	-0,053	0,293	-0,028
498	-0,080	-0,100	12,750	2,199	7,940	5,939	685 064	0,559	-0,038	0,297	-0,020
499	-0,040	-0,060	12,750	2,200	7,940	5,940	684 991	0,563	-0,023	0,302	-0,012
500	0,000	-0,020	12,750	2,200	7,940	5,940	684 955	0,567	-0,008	0,307	-0,004
501	0,040	0,020	12,750	2,200	7,940	5,940	684 955	0,570	0,008	0,312	0,004
502	0,080	0,060	12,750	2,199	7,940	5,939	684 991	0,574	0,024	0,316	0,013
503	0,120	0,100	12,749	2,197	7,939	5,939	685 064	0,578	0,040	0,321	0,022
504	0,160	0,140	12,749	2,194	7,938	5,938	685 172	0,582	0,056	0,326	0,031
505	0,200	0,180	12,748	2,191	7,937	5,937	685 318	0,585	0,072	0,331	0,041
991	12,745	12,744	0,360	0,000	0,000	0,000	910	1,751	0,020	1,822	0,021
992	12,746	12,745	0,320	0,000	0,000	0,000	728	1,752	0,016	1,823	0,017
993	12,747	12,746	0,280	0,000	0,000	0,000	567	1,752	0,013	1,823	0,013
994	12,748	12,747	0,240	0,000	0,000	0,000	426	1,752	0,010	1,823	0,010
995	12,748	12,748	0,200	0,000	0,000	0,000	305	1,752	0,007	1,823	0,007
996	12,749	12,749	0,160	0,000	0,000	0,000	204	1,752	0,005	1,823	0,005
997	12,749	12,749	0,120	0,000	0,000	0,000	123	1,752	0,003	1,823	0,003
998	12,750	12,750	0,080	0,000	0,000	0,000	63	1,752	0,001	1,823	0,001
999	12,750	12,750	0,040	0,000	0,000	0,000	23	1,752	0,001	1,823	0,001
1000	12,750	12,750	0,000	0,000	0,000	0,000	3	1,752	0,000	1,823	0,000

4.4 Baugrundanforderungen / *Subsoil requirement*

Die Anforderungen an dem Baugrund werden nachfolgend definiert. Diese müssen für jeden Standort durch einen Sachverständigen für Geotechnik nachgewiesen werden.

The requirements to be applied for the subsoil are defined next. These requirements must be confirmed by the geotechnical expert for the respective locations of the wind turbine.

Bodendrehfeder / *Rotational spring stiffness*				
Mindestwert / *Minimal value*				
Statische Bodendrehfeder / *Static rotational spring*	$k_{\varphi,stat}$	=	40 000	MNm/rad
Dynamische Bodendrehfeder / *Dynamic rotational spring*	$k_{\varphi,dyn}$	=	200 000	MNm/rad
Zulässige Schiefstellung / *Allowed out-of-vertical deviation*				
Maximal zulässige Schiefstellung für 25 Jahre/ *Maximal allowed out-of-vertical inclination for 25 years*	Δs_{max}	=	3	mm/m
Bodenpressung / *Soil bearing pressure*				
Erforderliche Tragfähigkeit / *Required resistance*				
Maximal zulässige Bodenpressung in BS-P (charakt.) / *Maximal allowed soil pressure in BS-P (characteristic)*	$\sigma_{max,k,BS-P}$	=	278	kN/m²
Maximal zulässige Bodenpressung in BS-A (charakt.) / *Maximal allowed soil pressure in BS-A (characteristic)*	$\sigma_{max,k,BS-A}$	=	367	kN/m²

TÜV SÜD Industrie Service GmbH MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Zusätzlich müssen die folgenden Nachweise für die standortspezifischen Bodenkennwerte von einem Sachverständigen für Geotechnik geführt werden.

In addition the following verifications have to be performed by the geotechnical expert considering the sitespecific soil characteristics:

- Nachweis der erforderlichen Drehfedersteifigkeit der Flachgründung (statisch und dynamisch) / *Verfication of the required rotational stiffness of the foundation (static and dynamic)*
- Nachweis gegen Grundbruch / *Verification against ground fracture*
- Nachweis gegen Gleiten / *Verification against slide*

4.5 Nachweis der Bodendrehfedersteifigkeit / *Verification of the ground rotational stiffness*

Nachfolgend wird die Einhaltung der Mindestdrehfedersteifigkeit des Fundaments gemäß dem Fundamentanforderungen-Dokument [G-1] unter der Annahme eines homogen geschichteten Baugrunds mit dem u.a. Steifemodul nachgewiesen.

The compliance of the minimum rotational stiffness of the foundation according to the Foundation Design Requirements document [G-1] assuming a homogeneous layered soil is verified with the below indicated constrained modulus in this chapter.

Hierzu wird ein Lastfall (LF8000) im FE-System definiert. Dieser Lastfall beinhaltet die folgenden Lasten:

A load case (LF8000) is defined in the FE model containing the following loads:

- Turmlast / *Tower loads:*
  - $N = N_{D.3}$
  - M_b = 100 000 kNm
  - $F_h = 0$
  - $M_t = 0$
- Eigengenwicht / *Dead weight*
- Vorspannung / *Prestressing*
- Maximale Überschüttung / *Maximum soil cover*

Zur Ermittlung der Drehfedersteifigkeit der Gründung wird ein Steifemodul angesetzt:

For the determiniation of the rotational stiffness a constrained modulus is applied:

$$E_{s,sta} = 20 \text{ MN/m}^2$$

$$E_{s,dyn} = 5 * E_{s,sta} = 100 \text{ MN/m}^2$$

Aus den Knotenverschiebungen, Abbildung / Figure 8 und Abbildung / Figure 9, in vertikaler Richtung wird die Fundamentverdrehung berechnet.

The rotation of the foundation is calculated from the resulting vertical displacements in the FE model calculation, detailed in Abbildung / Figure 8 and Abbildung / Figure 9.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

4.5.1 Statische Drehfedersteifigkeit / *Static rotational stiffness*

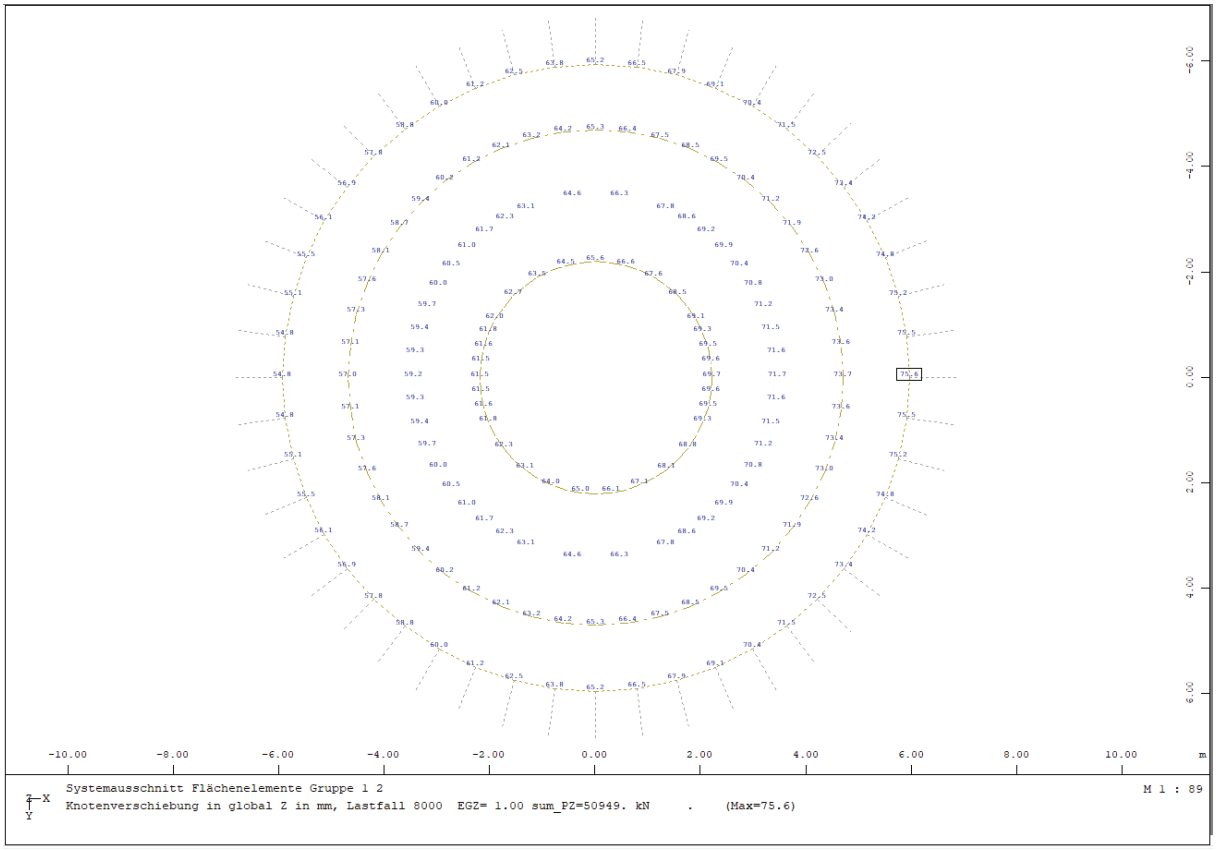


Abbildung */ Figure 8:* Vertikale Knotenverschiebung im Sockelbereich aus dem LF8000 des FE-Modells ermittelt mit $E_{s,sta}$ / *Vertical node displacement on the base area from LF8000 of the FE model computed with* $E_{s,sta}$

$\varphi_{k,sta} = M_b$ / atan(($V_{Z,Max} - V_{Z,Min}$) / Ø) =

= 100 MNm / atan ((75,60 mm – 54,80 mm) / 11,88 m) =

= 57 115 MNm/rad ≥

≥ $\varphi_{k,sta,MIN}$ = 40 000 MNm/rad

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

4.5.2 Dynamische Drehfedersteifigkeit / *Dynamic rotational stiffness*

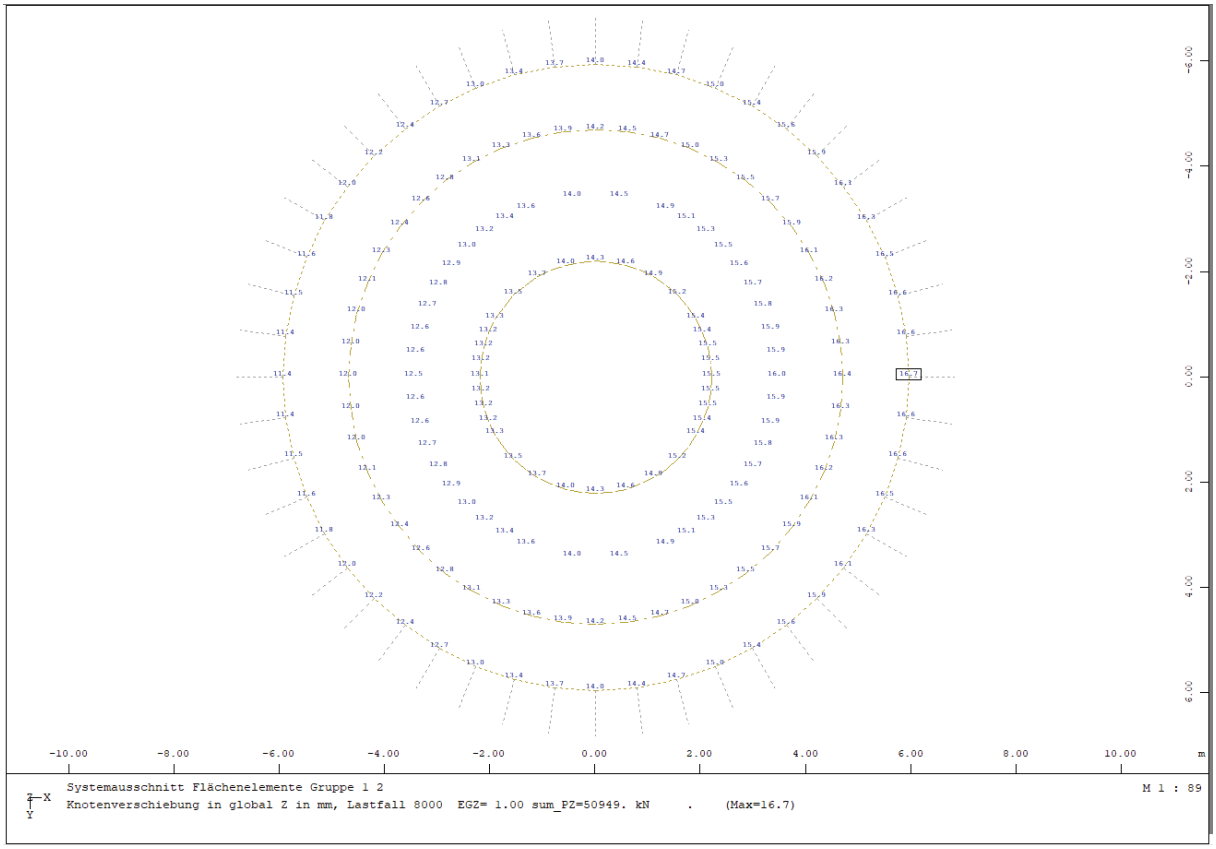


Abbildung */ Figure* 9*:* Vertikale Knotenverschiebung im Sockelbereich aus dem LF8000 des FE-Modells ermittelt mit $E_{s,dyn}$ / *Vertical node displacement on the base area from LF8000 of the FE model computed with* $E_{s,dyn}$

$\varphi_{k,dyn} = M_b$ / atan(($V_{Z,Max} - V_{Z,Min}$) / Ø) =

= 100 MNm / atan ((16,70 mm – 11,40 mm) / 11,88 m) =

= 224 151 MNm/rad ≥

≥ $\varphi_{k,dyn,MIN}$ = 200 000 MNm/rad

TÜV SÜD Industrie Service GmbH MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

5 Bemessungsschnittgrößen / *Design internal forces*

5.1 Lastfallkombinationen / *Load combination*

Zur Ermittlung der Bemessungsschnittgrößen werden die Einwirkungen aus Kapitel 3 kombiniert um die Grenzzustände der Bemessung abzudecken.

Die Teilsicherheitsbewerte werden gemäß DIBt-Richtlinie Kap. 10 [T-1] angesetzt. Diese decken die Anforderungen vom DIN EN 61400-1 [T-2] (Abs. 7.6.2.1) ab. Abweichend hiervon werden die folgenden Teilsicherheitsbeiwerte gemäß der Spezifikation gewählt [G-2].

For the determination of the design internal forces the loads specified in Chapter 3 are combined in order to cover design limit states.

The combination coefficients are defined on the DIBt-Richtlinie Ch. 10 [T-1]. These cover the requirements of the DIN EN 61400-1 [T-2] (Ch. 7.6.2.1). Differing from it, the following partial safety factors are chosen according to the Specification [G-2].

- Günstige Fundamenteigengewicht / *Favorable dead weight of the foundation*
  $\gamma_{G,fav} = 0{,}95$.

- Vorspannung / *Prestressing*
  $\gamma_{P,unfav} = \gamma_{P,fav} = 1{,}00$.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

In der nachfolgenden Tabelle sind die Lastfallkombinationen, Lastfall 1001-1008 für den GZT und Lastfall 3001-3002, dargestellt.

The following table shows the load combinations load case 1001-1008 for ULS and load case 3001-3002 for SLS.

LF-Bez. / *LC Name* →	**EG**	**MaÜS**	**Au**	**P**	**TL**	
LF-Nr.: / *LC No.* →	10,11	42	52	70		
LF-Nr / *LC No.*	*Fakt.*	*Fakt.*	*Fakt.*	*Fakt.*	-	**LC description**
1001	1,35	1,35	-	1,00	*101*	GZT: Max. Biegemoment + zugehörige + Max. N / *ULS: Max. bending moment + corresponding + Max. N*
1002	0,95	1,00	1,35	1,00	*102*	GZT: Max. Biegemoment + zugehörige + Min. N / *ULS: Max. Biegemoment + corresponding + Min. N*
1003	1,35	1,35	-	1,00	*103*	GZT: 0,9x Max. Biegemoment + 0,6x Max. Torsionsmoment + Max. N / *ULS: 0,9x Max. bending moment + 0,6x Max. torsional moment + Max. N*
1004	0,95	1,00	1,35	1,00	*104*	GZT: 0,9x Max. Biegemoment + 0,6x Max. Torsionsmoment + Min. N / *ULS: 0,9x Max. bending moment + 0,6x Max. torsional moment + Min. N*
1005	1,35	1,35	-	1,00	*105*	GZT: 0,6x Max. Biegemoment + 0,9x Max. Torsionsmoment + Max. N / *ULS: 0,6x Max. bending moment + 0,9x Max. torsional moment + Max. N*
1006	0,95	1,00	1,35	1,00	*106*	GZT: 0,6x Max. Biegemoment + 0,9x Max. Torsionsmoment + Min. N / *ULS: 0,6x Max. bending moment + 0,9x Max. torsional moment + Min. N*
1007	1,35	1,35	-	1,00	*107*	GZT: Max. Torsionsmoment + zugehörige + Max. N / *ULS: Max. torsional moment + corresponding + Max. N*
1008	0,95	1,00	1,35	1,00	*108*	GZT: Max. Torsionsmoment + zugehörige + Min. N / *ULS: Max. torsional moment + corresponding + Min. N*
3001	1,00	1,00	-	1,00	*301*	D.3: Max. N (quasi-ständige Kombination) / *D.3: Max. N (quasi-permament combination)*
3002	1,00	1,00	1,00	1,00	*302*	D.3: Min. N (quasi-ständige Kombination) / *D.3: Min. N (quasi- permament combination)*

EG: Eigengewicht / *Own weight*
MaÜS: Maximale Erdüberschüttung / *Maximal backfill cover*
Au: Auftrieb / *Buoyancy*
P: Vorspannung / *Prestressing*
TL: Turmlasten / *Tower loads*
N: Normalkraft / *Normal force*

Die in der obigen Tabelle angegebenen Lastfallkombinationen 1001-1008 and 3001-3002 werden automatisch von Sofistik mit der Nutzlast (LF60) in den Lastfällen 10001 bis 10016 für den GZT und 30001-30016 für den GZG kombiniert. Für die Nutzlast wird bei ungünstiger Wirkung ein Teilsicherheitsbeiwert von 1,5 und bei günstiger Wirkung von 0 angesetzt.

In den Lastfällen 10001-10016 und 30001-30016 werden aus den maßgebenden kombinierten Schalenelementschnittgrößen aller Lastfälle erzeugt, siehe nachfolgende Tabelle.

The above presented load combinations 1001-1008 and 3001-3002 are automatically combined in Sofistik with the live load (LC60) resulting in load cases 10001-10016 for ULS and 30001-30016 for SLS. The combination coefficient for the live load is 1,5 in case of a unfavorable effect, and 0 in case of favorable effect.

The load cases 10001-10016 and 30001-30006 result from combinations based on a decisive shell elment internal force, see the following table.

LF / *LC*	**Maßgebende Schnittgröße / *Decisive internal force***
-	-
-01	Max. MXX
-02	Min. MXX
-03	Max. MYY
-04	Min. MYY
-05	Max. MXY
-06	Min. MXY
-07	Max. VX
-08	Min. VX
-09	Max. VY
-10	Min. VY
-11	Max. NXX
-12	Min. NXX
-13	Max. NYY
-14	Min. NYY
-15	Max. NXY
-16	Min. NXY

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

5.2 Grenzzustand der Tragfähigkeit / *Ultimate limit state*

Die Schnittgrößen der Lastfallkombinationen 10001-10016 werden für die FE interne Bruchbemessung im GZT angesetzt.

Die Elementschnittgrößen im GZT sind im „Anhang C: Schnittgrößen“ exemplarisch für die Lastfälle 10, 1001 und 10009 angegeben.

The load case combinations 10001-10016 are used in Sofistik for the internal ULS dimensioning of the shell elements.

The shell element internal forces for the ULS load cases 10, 1001 and 10009 are included in “Annex C: Internal forces” as an example.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

5.3 Grenzzustand der Gebrauchstauglichkeit / *Serviceability limit state*

Die Lastfallkombinationen 30001-30016 werden für die FE interne Rissbreitenbegrenzungnachweis (GZG) der Schalenelemente angesetzt.

Die Schalenelementschnittgrößen im GZG sind im „Anhang C: Schnittgrößen“ exemplarisch für die Lastfälle 3001 und 30009 angegeben.

The load case combinations 30001-30016 are used in Sofistik for the internal crack width control dimensioning (SLS) of the shell elements.

The shell element internal forces for the SLS load cases 3001 and 30009 are included in “Annex C: Internal forces” as an example.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6 Bemessung im GZT und GZG / *ULS and SLS reinforcement design*

6.1 Bemessungsverfahren / *Design procedure*

Die Bemessung des Fundaments erfolgt nach Eurocode 2 [T-4] und [T-5] wie in der DIBt-Richtilinie Abs. 12.1.3 [T-1] vorgeschrieben. Die Anforderungen vom IEC 61400-6 [T-3] (Benutzung eines „reference standard“) sind abgedeckt.

The foundation is dimensioned according to Eurocode 2 [T-4] and [T-5], as defined in the DIBt-Richtilinie Ch. 12.1.3 [T-1]. The requirements of the IEC 61400-6 [T-3] (use of a “reference standard“) are covered.

Die folgenden Nachweise im GZT und GZG werden durchgeführt:

The following verifications in ULS and SLS are carried out:

- Bemessung in Bruchzustand: Ermittlung der erforderlichen Biege- und Querkraftbewehrung / *Design in ULS state. Determination of the required bending and shear reinforcement*
- Begrenzung der Rissbreite / *Crack width control*
- Mindestbewehrung zur Robustheit / *Minimum reinforcement for robustness*
- Mindestbewehrung zur Begrenzung der Rissbreite / *Minimum reinforcement for crack width control*
- Nachweise zur Lasteinleitung / *Verification of the load introduction*

Die Bemessung im Bruchzustand (GZT) und die Begrenzung der Rissbreite (GZG) werden im FE-Modell von Sofistik automatisch durchgeführt. Die Nachweise zur Lasteinleitung werden analytisch geführt.

The dimensioning based on ULS and crack width control (SLS) is automatically carried out in the FE model in Sofistik. The verifications of the load introduction are performed analytically.

Die Ermüdungsnachweise werden in Kapitel 7 geführt.

The fatigue verifications are performed in Chapter 7.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.1.1 Bemessungsvorgaben für GZT / *ULS design specifications*

Die erforderliche Biegebewehrung (radial und tangential) sowie die Querkraftbewehrung in GZT (Bruchzustand) werden im FE-Modell von Sofistik schalelementweise ermittelt.

The required bending (radial and tangential) and shear reinforcement in ULS are determined in Sofistik for each shell element.

Die Bemessung erfolgt nach dem Baumann-Verfahren. Mehr Information hierzu ist dem Sofistik BEMESS-Handbuch zu entnehmen.

The design is carried out using the Baumann method. More information can be found in the Sofisik BEMESS manual.

Für die Bemessung wurden die folgenden Abstände zwischen Rand und Bewehrungsachse $e_{Rand\text{-}Achse}$ gewählt:

The following edge to reinforcement axis distances $e_{Rand\text{-}Achse}$ are considered in the dimensioning.

$e_{Rand\text{-}Achse}$ [mm]	**Radial / *Radial***		**Umlaufend / *Circumferential***	
	Sockel / Base	*Platte / Plate*	*Sockel / Base*	*Platte / Plate*
Obere / *Upper*	275	85	303	105
Untere / *Lower*	97		125	

Die Bemessung unter Querkraft wird mit dem folgenden Parameter durchgeführt.

The shear force design is performed with the following parameter.

$$\cot(\theta) = 1{,}75$$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.1.2 Bemessungsvorgaben für GZG / *SLS design specifications*

Die erforderliche Biegebewehrung (radial und tangential) in GZG (Begrenzung der Rissbreite) wird im FE-Modell von Sofistik schalelementweise ermittelt.

Sofistik wendet Kapitel „7.3.4 Berechnung der Rissbreite“ des Eurocodes 2 [T-4] und [T-5] an.

Hierbei werden die folgenden Eisendurchmesser ϕ_{Rb} angesetzt:

The required bending reinforcement (radial and tangential) in SLS (crack width control) are determined in Sofistik for each shell element.

Sofistik applies the chapter "7.3.4 Calculation of crack widths" of Eurocode 2 [T-4] and [T-5].

The following rebar diameters ϕ_{Rb} are considered in the calculation:

ϕ_{Rb} [mm]	**Radial / *Radial***		**Umlaufend / *Circumferential***	
	Sockel / Base	*Platte / Plate*	*Sockel / Base*	*Platte / Plate*
Obere / *Upper*	28	20	28	25
Untere / *Lower*	28		28	

TÜV SÜD Industrie Service GmbH TÜ 12 REV03 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Die zulässige rechnerische Rissbreite $w_{k,zul}$ wird gemäß DIBt-Richtilinie [T-1] wie folgt angesetzt. Die Anforderungen des IEC 61400-6 Abs. 7.9.3 [T-3] (Benutzung eines „reference standard“) bzw. des Eurocode 2 Abs. 7.3.1 [T-4] und [T-5] sind abgedeckt.

The allowed crack width $w_{k,zul}$ used in the calculations is set in accordance with the DIBt-Richtlinie [T-1] as follows. The requirementsof the IEC 61400-6 Ch. 7.9.3 [T-3] (use of a „reference standard“) or Eurocode 2 Abs. 7.3.1 [T-4] and [T-5] are covered.

- Bauteile, die höchstens einen halben Meter in das Erdreich hineinreichen / *Components which extend maximum half meter into the ground*:
  $w_{k,zul}$ = 0,2 mm

- Sonstige Bauteile / *Other components*:
  $w_{k,zul}$ = 0,3 mm

	$W_{k,zul}$ [mm]	
	Sockel / Base	*Platte / Plate*
Obere / *Upper*	0,2	0,3
Untere / *Lower*	0,3	

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.2 GZT: erforderliche Bewehrung (FE-Modell) / *ULS: required reinforcement (FE model)*

Sofistik speichert die Ergebnisse der Bruchbemessung in GZT in dem Bemessungslastfall (BLF) 21.

Sofistik stores the results of the ULS design under the design load case (DLC) 21.

Die maximal erforderliche Bewehrung im GZT ist in der folgenden Tabelle angegeben.

The required reinforcement in ULS is detailed in the following table.

BLF-Nr. / *DLC No.*	Pos.-R	ASO	ASOQ	ASUQ	ASU	ASS
-	-	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m²*
21	1	18,9	53,6	58,1	37,8	31,5
21	2	32,6	52,3	61,5	66,4	13,9
21	3	29,3	50,6	54,2	67,0	9,0
21	4	25,2	20,2	55,2	83,5	15,1
21	5	18,2	17,9	51,6	65,4	14,7
21	6	12,6	13,2	48,0	52,1	14,0
21	7	8,3	9,1	42,9	39,5	13,2
21	8	5,3	5,8	37,9	27,8	12,7
21	9	2,7	4,8	32,3	17,0	11,6
21	10	1,7	9,2	25,0	6,2	8,5

BLF-Nr. / *DLC No.*: Bemessungslastfallnummer / *Design load case number*
Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*
ASO: Radialbewehrung Oben / *Upper radial reinforcement*
ASOQ: Umfangsbewehrung Oben / *Upper circumferential reinforcement*
ASUQ: Umfangsbewehrung Unten / *Lower circumferential reinforcement*
ASU: Radialbewehrung Unten / *Lower radial reinforcement*
ASS: Schubbewehrung / *Shear force reinforcement*

Die Ergebnisse der Sofistik-Bemessung sind als graphische Auszüge im „Anhang D: Bewehrung" dokumentiert.

The detailed results of the design of Sofistik are documented graphically in "Annex D: Reinforcement".

Die Querbewehrung in der Platte darf nach Eurocode 2 9.3.2 (3) [T-4] und [T-5] vollständig aus Schubzulagen bestehen, da die folgende Bedingung erfüllt ist (siehe „Anhang D: Bewehrung")

According to Eurocode 2 9.3.2 (3) [T-4] and [T-5], the shear reinforcement in the plate can consist entirely of bent-up bars as the following condtion is fulfilled (see "Annex D: Reinforcement").

$$V_{Ed} \leq 1/3\ V_{Rd,\,max}$$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.3 GZG: erforderliche Bewehrung zur Beschränkung der Rissbreite (FE-Modell) / *SLS: required reinforcement for crack width control (FE model)*

Sofistik ermittelt die Rissbreite auf den Bewehrungsmengen des Bemessungslastfalls 21 (GZT-Bruchbemessung) gemäß dem Absatz 6.1.2 und erhöht diese, falls der Nachweis nicht eingehalten ist. Der Bemessungslastfall 22 beinhaltet dementsprechend das Maximum aus der Bruch- und Rissbreitebemessungen.

Sofistik determines the crack width on the required reinforcement of the design load case (DLC) 21 (ULS design) as specified in paragraph 6.1.2. In case the verification is not fulfilled, the reinforcement will be increased. The resulting reinforcement is stored in the DLC 22, which consequently includes the maximum required reinforcement from ULS design and crack width control.

Die maximal erforderliche Bewehrung aus den Grenzzuständen der Tragfähigkeit und der Gebrauchstauglichkeit ist in der folgenden Tabelle (BLF 22) angegeben.

The maximum required reinforcement in ultimate and serviceability limit state is detailed in the following table (DLC 22).

BLF-Nr. / *DLC No.*	Pos.-R	ASO	ASOQ	ASUQ	ASU	ASS
-	-	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m²*
22	1	29,6	53,6	62,0	40,5	31,5
22	2	46,0	52,3	61,5	66,4	13,9
22	3	34,4	50,6	54,2	67,0	9,0
22	4	25,2	20,2	64,6	83,5	15,1
22	5	18,2	17,9	62,3	66,1	14,7
22	6	12,6	13,2	60,2	56,9	14,0
22	7	8,3	9,1	57,3	47,2	13,2
22	8	5,3	5,8	54,1	39,6	12,7
22	9	2,7	5,1	50,2	26,0	11,6
22	10	1,7	11,8	41,4	9,2	8,5

BLF-Nr. / *DLC No.*: Bemessungslastfallnummer / *Design load case number*
Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*
ASO: Radialbewehrung Oben / *Upper radial reinforcement*
ASOQ: Umfangsbewehrung Oben / *Upper circumferential reinforcement*
ASUQ: Umfangsbewehrung Unten / *Lower circumferential reinforcement*
ASU: Radialbewehrung Unten / *Lower radial reinforcement*
ASS: Schubbewehrung / *Shear force reinforcement*

Die Ergebnisse der Sofistik-Bemessung sind als graphische Auszuge in „Anhang D: Bewehrung“ dokumentiert.

The detailed results of the design of Sofistik are documented graphically in “Annex D: Reinforcement”.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.4 Mindestbewehrung / *Minimum reinforcement*

6.4.1 Mindestbewehrung für duktiles Bauteilverhalten / *Minimum reinforcement for ductile behavior*

Die erforderliche Mindestbewehrung für ein duktiles Bauteilverhalten in Umfangsrichtung nach Eurocode 2 Abs. 9.2.1.1 [T-4] and [T-5] wird festgelegt.

Beispielhaft wird die Mindestbewehrung für den Sockel ermittelt. Die Ergebnisse für alle Elemente werden tabellarisch angegeben (BLF “MiBe-Dukt”).

The minimum reinforcement in circumferential direction to ensure a ductile behavior is determined according to Eurocode 2 Par. 9.2.1.1 [T-4] and [T-5].

Exemplary, a detailed calculation of the minimum reinforcement for the base area is included. The results for all elements are subsequently detailed in tabular form (DLC “MiBe-Dukt”).

Legende / *Legend*

XXX	→	Eingabe / *Input*
DE	→	Eingabe / *Input*

Eingabe / *Input*

Material / *Material*

f_{ck}	=	40	MPa		
f_{ctm}	=	3,5	MPa	=	$0{,}30 \cdot f_{ck}^{2/3} \leq C50/60$
f_{yk}	=	500	MPa		

Geometrie / *Geometry*

h	=	2,900	m		Element-Mittelhöhe / *Element middel height*
b_t	=	1,000	m		Einheitliche Breite / *Unit width*
d_1	=	0,303	m		Randachsabstand der Bewehrung / *Reinforcement edge-axis separation*
d	=	2,597	m	=	$h - d_1$
W_c	=	1,402	m³	=	$b_t \cdot h^2 / 6$

Berechnung / *Calculation*

$a_{s,min,Duk}$	=	42,0	cm²/m	=	Wc · fctm / (0,9 · d · fyk) · 10^4

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Erforderliche Bewehrung / *Required reinforcement*

Pos.-R	f_{ck}	f_{ctm}	f_{yk}	**h**	b_t	d_1	**d**	W_c	$a_{s,min,Duk}$
Numm.	*MPa*	*MPa*	*MPa*	*m*	*m*	*m*	*m*	*m³*	*cm²/m*
1	40	3,5	500	2,900	1,000	0,303	2,597	1,402	**42,0**
2	40	3,5	500	2,900	1,000	0,303	2,597	1,402	**42,0**
3	40	3,5	500	2,875	1,000	0,303	2,572	1,378	**41,7**
4	30	2,9	500	2,090	1,000	0,105	1,985	0,728	**23,6**
5	30	2,9	500	1,870	1,000	0,105	1,765	0,583	**21,3**
6	30	2,9	500	1,654	1,000	0,105	1,549	0,456	**19,0**
7	30	2,9	500	1,442	1,000	0,105	1,337	0,346	**16,7**
8	30	2,9	500	1,230	1,000	0,105	1,125	0,252	**14,4**
9	30	2,9	500	1,018	1,000	0,105	0,913	0,173	**12,2**
10	30	2,9	500	0,806	1,000	0,105	0,701	0,108	**10,0**

Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*

Zusammenfassung / *Summary*

BLF-Nr. / *DLC No.*	**Pos.-R**	**ASO**	**ASOQ**	**ASUQ**	**ASU**	**ASS**
Numm.	*Numm.*	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m²*
MiBe-Dukt	1	0,0	42,0	42,0	0,0	0,0
MiBe-Dukt	2	0,0	42,0	42,0	0,0	0,0
MiBe-Dukt	3	0,0	41,7	41,7	0,0	0,0
MiBe-Dukt	4	0,0	23,6	23,6	0,0	0,0
MiBe-Dukt	5	0,0	21,3	21,3	0,0	0,0
MiBe-Dukt	6	0,0	19,0	19,0	0,0	0,0
MiBe-Dukt	7	0,0	16,7	16,7	0,0	0,0
MiBe-Dukt	8	0,0	14,4	14,4	0,0	0,0
MiBe-Dukt	9	0,0	12,2	12,2	0,0	0,0
MiBe-Dukt	10	0,0	10,0	10,0	0,0	0,0

BLF-Nr. / *DLC No.*: Bemessungslastfallnummer / *Design load case number*

Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*

ASO: Radialbewehrung Oben / *Upper radial reinforcement*

ASOQ: Umfangsbewehrung Oben / *Upper circumferential reinforcement*

ASUQ: Umfangsbewehrung Unten / *Lower circumferential reinforcement*

ASU: Radialbewehrung Unten / *Lower radial reinforcement*

ASS: Schubbewehrung / *Shear force reinforcement*

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.4.2 Mindestbewehrung zur Beschränkung der Rissbreite / *Minimum reinforcement for crack width control*

Nachfolgend wird die erforderliche Mindestbewehrung zur Beschränkung der Rissbreite in Umfangsrichtung gemäß Eurocode 2 Abs. 7.3.2 [T-4] und [T-5] ermittelt.

Beispielhaft wird die Mindestbewehrung für den Sockel ermittelt. Die Ergebnisse für alle Elemente werden tabellarisch angegeben (BLF “MiBe-Riss”).

The minimum reinforcement in circumferential direction to control the crack width is determined according to Eurocode 2 Par. 7.3.2 [T-4] and [T-5].

Exemplary, a detailed calculation of the minimum reinforcement for the base area is included. The results for all elements are subsequently detailed in tabular form (DLC “MiBe-Riss”).

Legende / *Legend*

XXX	→	Eingabe / *Input*
DE	→	Region / *Region*

Eingabe / *Input*

Material / *Material*

f_{ck}	=	40	MPa		
f_{ctm}	=	3,5	MPa	=	$0{,}30 \cdot f_{ck}^{2/3} \le C50/60$
$f_{ct,0}$	=	3,5	MPa	=	f_{ctm}
$f_{ct,eff}$	=	1,8	MPa	=	$0{,}50 \cdot f_{ctm}$

Geometrie / *Geometry*

h	=	2,900	m		Element-Mittelhöhe / *Element mean height*
b	=	1,000	m		Einheitliche Breite / *Unit width*
d	=	2,803	m	=	$h\text{-}e_{Rand\text{-}Achse}$
A_{ct}	=	1,450	m²	=	$h / 2 \cdot b$
$A_{c,eff}$	=	0,484	m²	=	$b \cdot h_{c,eff}$
d_s	=	28	mm		Eisendurchmesser / *Stab diameter*
$e_{Rand\text{-}Achse,O}$	=	8,50	cm		Abstand zwischen Rand und Bewehrungsachse oben / *Edge to upper reinforcement axis distance*
$e_{Rand\text{-}Achse,U}$	=	9,70	cm		Abstand zwischen Rand und Bewehrungsachse unten / *Edge to lower reinforcement axis distance*

Berechnung / *Calculation*

$w_{k,zul}$	=	0,2	mm		Zulässige Rissbreite / *Permittted crack width*
k_c	=	0,40	-		mit $\sigma_c = 0$ / *with* $\sigma_c = 0$
k	=	0,50	-		selbst hervorgerufene Zwang, h ≥ 800 mm / *non-uniform self-equilibrating stresses, h ≥ 800 mm*
$d_{s,St}$	=	56	mm	=	$d_s \cdot f_{ct0} / f_{ct,eff}$
σ_s	=	111,5	MPa	=	$(w_{k,zul} \cdot 3{,}48 \cdot 10^6 / d_{s,St})^{1/2}$
$a_{s,min,Ris}$	=	45,5	cm²/m	=	kc · k · Act · 10^4 · fct,eff / σs

Erforderliche Bewehrung oben / *Required upper reinforcement*

Pos.-R	f_{ck}	h	b	A_{ct}	d_s	$w_{k,zul}$	k_c	k	σ_s	$a_{s,min,Ris,O}$
Numm.	*MPa*	*m*	*m*	*m*	*mm*	*mm*	-	-	*MPa*	*cm²/m*
1	40	2,900	1,000	1,5	28	0,2	0,4	0,50	111,5	**45,5**
2	40	2,900	1,000	1,5	28	0,2	0,4	0,50	111,5	**45,5**
3	40	2,875	1,000	1,4	28	0,2	0,4	0,50	111,5	**45,1**
4	30	2,090	1,000	1,0	25	0,3	0,4	0,50	144,5	**21,0**
5	30	1,870	1,000	0,9	25	0,3	0,4	0,50	144,5	**18,8**
6	30	1,654	1,000	0,8	25	0,3	0,4	0,50	144,5	**16,6**
7	30	1,442	1,000	0,7	25	0,3	0,4	0,50	144,5	**14,5**
8	30	1,230	1,000	0,6	25	0,3	0,4	0,50	144,5	**12,3**
9	30	1,018	1,000	0,5	25	0,3	0,4	0,50	144,5	**10,2**
10	30	0,806	1,000	0,4	25	0,3	0,4	0,50	144,5	**8,1**

Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*

Erforderliche Bewehrung unten / *Required lower reinforcement*

Pos.-R	f_{ck}	h	b	A_{ct}	d_s	$w_{k,zul}$	k_c	k	σ_s	$a_{s,min,Ris,U}$
Numm.	*MPa*	*m*	*m*	*m*	*mm*	*mm*	-	-	*MPa*	*cm²/m*
1	30	2,900	1,000	1,5	28	0,3	0,4	0,50	136,5	**30,8**
2	30	2,900	1,000	1,5	28	0,3	0,4	0,50	136,5	**30,8**
3	30	2,875	1,000	1,4	28	0,3	0,4	0,50	136,5	**30,5**
4	30	2,090	1,000	1,0	28	0,3	0,4	0,50	136,5	**22,2**
5	30	1,870	1,000	0,9	28	0,3	0,4	0,50	136,5	**19,9**
6	30	1,654	1,000	0,8	28	0,3	0,4	0,50	136,5	**17,6**
7	30	1,442	1,000	0,7	28	0,3	0,4	0,50	136,5	**15,3**
8	30	1,230	1,000	0,6	28	0,3	0,4	0,50	136,5	**13,1**
9	30	1,018	1,000	0,5	28	0,3	0,4	0,50	136,5	**10,8**
10	30	0,806	1,000	0,4	28	0,3	0,4	0,50	136,5	**8,6**

Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*

Zusammenfassung / *Summary*

BLF-Nr. / *DLC No.*	Pos.-R	ASO	ASOQ	ASUQ	ASU	ASS
Numm.	*Numm.*	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m²*
MiBe-Riss	1	0,0	45,5	30,8	0,0	0,0
MiBe-Riss	2	0,0	45,5	30,8	0,0	0,0
MiBe-Riss	3	0,0	45,1	30,5	0,0	0,0

MiBe-Riss	4	0,0	21,0	22,2	0,0	0,0
MiBe-Riss	5	0,0	18,8	19,9	0,0	0,0
MiBe-Riss	6	0,0	16,6	17,6	0,0	0,0
MiBe-Riss	7	0,0	14,5	15,3	0,0	0,0
MiBe-Riss	8	0,0	12,3	13,1	0,0	0,0
MiBe-Riss	9	0,0	10,2	10,8	0,0	0,0
MiBe-Riss	10	0,0	8,1	8,6	0,0	0,0

BLF-Nr. / *DLC No.*: Bemessungslastfallnummer / *Design load case number*

Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*

ASO: Radialbewehrung Oben / *Upper radial reinforcement*

ASOQ: Umfangsbewehrung Oben / *Upper circumferential reinforcement*

ASUQ: Umfangsbewehrung Unten / *Lower circumferential reinforcement*

ASU: Radialbewehrung Unten / *Lower radial reinforcement*

ASS: Schubbewehrung / *Shear force reinforcement*

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.5 Erforderliche Bewehrung / *Required reinforcement*

Die erforderliche Biege- und Schubbewehrung aus dem FE-Modell (GZT und GZG) und aus der Mindestbewehrung wird unter der Bemessungslastfall „ERF“ gespeichert und ist in nachfolgender Tabelle angegeben.

The required reinforcement resulting from the bending and shear reinforcement computed in the FE model for ULS and SLS, and from the minimum reinforcement, is stored in the design load case "ERF" which is summarized in the following table.

BLF-Nr. / *DLC No.*	**Pos.-R**	**ASO**	**ASOQ**	**ASUQ**	**ASU**	**ASS**
-	-	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m²*
ERF	1	53,7	61,7	62,0	55,8	31,5
ERF	2	66,2	75,5	61,5	73,7	13,9
ERF	3	74,2	75,0	54,2	70,6	9,0
ERF	4	45,5	34,6	64,6	83,5	24,1
ERF	5	33,3	23,6	62,3	66,1	22,3
ERF	6	24,1	19,0	60,2	56,9	14,0
ERF	7	16,5	16,7	57,3	47,2	13,2
ERF	8	10,3	14,4	54,1	39,6	12,7
ERF	9	5,4	12,2	50,2	26,0	11,6
ERF	10	1,7	11,8	41,4	9,2	8,5

BLF-Nr. / *DLC No.*: Bemessungslastfallnummer / *Design load case number*
Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*
ASO: Radialbewehrung Oben / *Upper radial reinforcement*
ASOQ: Umfangsbewehrung Oben / *Upper circumferential reinforcement*
ASUQ: Umfangsbewehrung Unten / *Lower circumferential reinforcement*
ASU: Radialbewehrung Unten / *Lower radial reinforcement*
ASS: Schubbewehrung / *Shear force reinforcement*

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.6 Lasteinleitung / *Load introduction*

6.6.1 Windzugseite / *Wind tension side*

Auf der dem Wind zugewandten Seite wird auf der sicheren Seite angenommen, dass die Fuge zwischen Turmfuß und Fundament klafft. Es tritt nur die Zugkraft in den Spanngliedern auf, die in die Platte weitergeleitet wird.

On the windward side gapping is conservatively assumed between tower bottom and foundation in ULS. The tension force of the tendons is the only load being transferred to the plate.

Das in Abbildung / Figure 10 dargestellte Stabwerksmodell wird gewählt um die Tragfähigkeit des Fundaments gegen diese Last nachzuweisen.

The strut-and-tie model in Abbildung / Figure 10 is considered to design the foundation against this load.

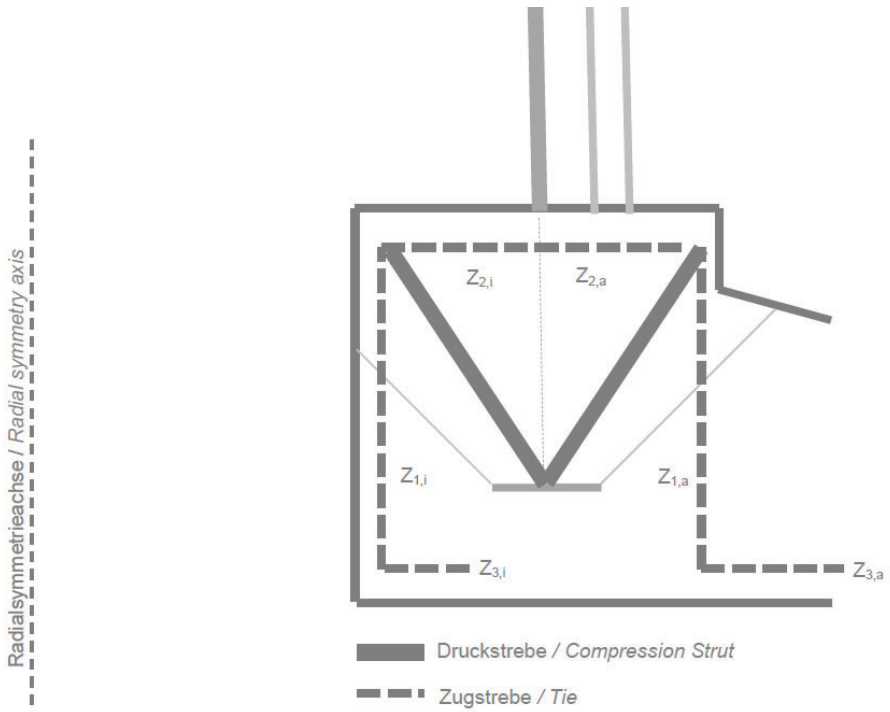


Abbildung / *Figure* 10*:* Stabwerksmodell für die Lasteinleitung auf der Windzugseite / *Strut-and-tie model for the load introduction on the wind tension side*

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Der Teilsicherheitsbeiwert $\gamma_{P,unfav}$ wird nach dem IEC 61400-6 Abs. 5.4.4.1 [T-3] („local effects“) gewählt. Der deckt die Anforderungen vom Eurocode 2 [T-4] und [T-5] (Abs. 2.4.2.2), DIBt-Richtilinie [T-1] (Abs. 10.2) und Spezifikation [G-2] (Abs. 4.2) ab.

The partial safety factor $\gamma_{P,unfav}$ is chosen according to the IEC 61400-6 Ch. 5.4.4.1 [T-3] („local effects“). It covers the requirements from the Eurocode 2 [T-4] and [T-5] (Ch. 2.4.2.2), DIBt-Richtilinie [T-1] (Ch. 10.2) ans Specification [G-2] (Ch. 4.2).

Legende / *Legend*

XXX → Eingabe / *Input*

Eingabe / *Input*

Lasten / *Loads*

P_{Ges}	=	98 960	kN		
$\gamma_{P,unfav}$	=	1,10			

Material / *Material*

f_{yk}	=	500	MPa		
γ_S	=	1,15			
f_{yd}	=	434,8	MPa	=	f_{yk} / γ_S

Geometrie / *Geometry*

D_P	=	7,627	m		Spanngliederdurchmesser / *Prestressing tendon diameter*
R_P	=	3,813	m	=	$D_P / 2$
U_P	=	23,959	m	=	$\pi \cdot D_P$

Lasteinleitungsvorgaben / *Load application specifications*

α	=	45	°		Lastausbreitungswinkel / *Load distribution angle*
h_{eff}	=	1,745	m		Lastausbreitungshöhe / *Load distribution height*
$R_{Z,i}$	=	2,068	m	=	$R_P - h_{eff} \cdot \tan(\alpha)$
$R_{Z,a}$	=	5,558	m	=	$R_P + h_{eff} \cdot \tan(\alpha)$

Berechnung / *Calculation*

Zugkraft Z_1 / *Tensile force* Z_1

$Z_{1,a,d}$	=	54 428	kN	=	$P_{ges} \cdot \gamma_{P,unfav} / 2$
$A_{s1,erf,a}$	=	1251,8	cm²	=	$Z_{1,a,d} / (f_{yd} / 10)$
$A_{s1,vor,a}$	=	2881,7	cm²		88Φ28 88Φ28 88Φ28 104Φ28 100Φ28
$\eta_{1,a}$	=	0,43		=	$A_{s1,erf,a} / A_{s1,vorh,a} \leq 1,00$
$Z_{1,i,d}$	=	54 428	kN	=	$P_{ges} \cdot \gamma_{P,unfav} / 2$
$A_{s1,erf,i}$	=	1251,8	cm²	=	$Z_{1,i,d} / (f_{yd} / 10)$
$A_{s1,vor,i}$	=	2881,7	cm²		88Φ28 88Φ28 88Φ28 104Φ28 100Φ28
$\eta_{1,i}$	=	0,43		=	$A_{s1,erf,i} / A_{s1,vorh,i} \leq 1,00$

Zugkraft Z_2 / *Tensile force* Z_2

$Z_{2,a,d}$	=	54 428	kN	=	$Z_{1,a,d} \cdot (R_{Z,a} - R_P) / h_{eff}$
$A_{s2,erf,a}$	=	1251,8	cm²	=	$Z_{2,a,d} / (f_{yd} / 10)$
$A_{s2,vor,a}$	=	2561,5	cm²		120Φ28 120Φ28 88Φ28 88Φ28
$\eta_{2,a}$	=	0,49		=	$A_{s2,erf,a} / A_{s2,vorh,a} \leq 1,00$
$Z_{2,i,d}$	=	54 428	kN	=	$Z_{1,i,d} \cdot (R_P - R_{Z,i}) / h_{eff}$
$A_{s2,erf,i}$	=	1251,8	cm²	=	$Z_{2,i,d} / (f_{yd} / 10)$
$A_{s2,vor,i}$	=	2561,5	cm²		120Φ28 120Φ28 88Φ28 88Φ28
$\eta_{2,i}$	=	0,49		=	$A_{s2,erf,i} / A_{s2,vorh,i} \leq 1,00$

Zugkraft Z_3 / *Tensile force* Z_3

$Z_{3,a,d}$	=	54 428	kN	=	$Z_{2,a,d}$

$A_{s3,erf,a}$	=	1251,8	cm²	=	$Z_{3,a,d}$ / (f_{yd} / 10)
$A_{s3,vor,a}$	=	1477,8	cm²		120Φ28 120Φ28
$\eta_{3,a}$	=	0,85		=	$A_{s3,erf,a}$ / $A_{s3,vorh,a}$ ≤ 1,00
$Z_{3,i,d}$	=	54 428	kN	=	$Z_{2,i,d}$
$A_{s3,erf,i}$	=	1251,8	cm²	=	$Z_{3,i,d}$ / (f_{yd} / 10)
$A_{s3,vor,i}$	=	2805,8	cm²		120Φ28 120Φ28 120Φ28 120Φ25
$\eta_{3,i}$	=	0,45		=	$A_{s3,erf,i}$ / $A_{s3,vorh,i}$ ≤ 1,00

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.6.2 Winddruckseite / *Wind compression side*

Auf der windabgewandten Seite wird die Druckkraft aus dem Turm über eine Druckstrebe vom Sockel in die Platte eingeleitet.

Das Stabwerksmodell in Abbildung / Figure 11 wird benutzt um das Fundament gegen dieser Last zu bemessen.

Die horizontale Lastkomponente unter dem Turmfuß wird durch eine Ringdruckkraft aufgenommen. Die erforderliche lokale Spaltzugbewehrung aus der Lasteinleitung wird ebenfalls nachgewiesen.

At the leeward side the compression force from the tower is transferred from the base into the plate via a compression strut.

The strut-and-tie modell in Abbildung / Figure 11 is used to design the foundation against this load.

The circumferential component of the load is absorbed through a compression ring under the tower bottom. A resulting required local splitting tensile reinforcement is considered and designed below.

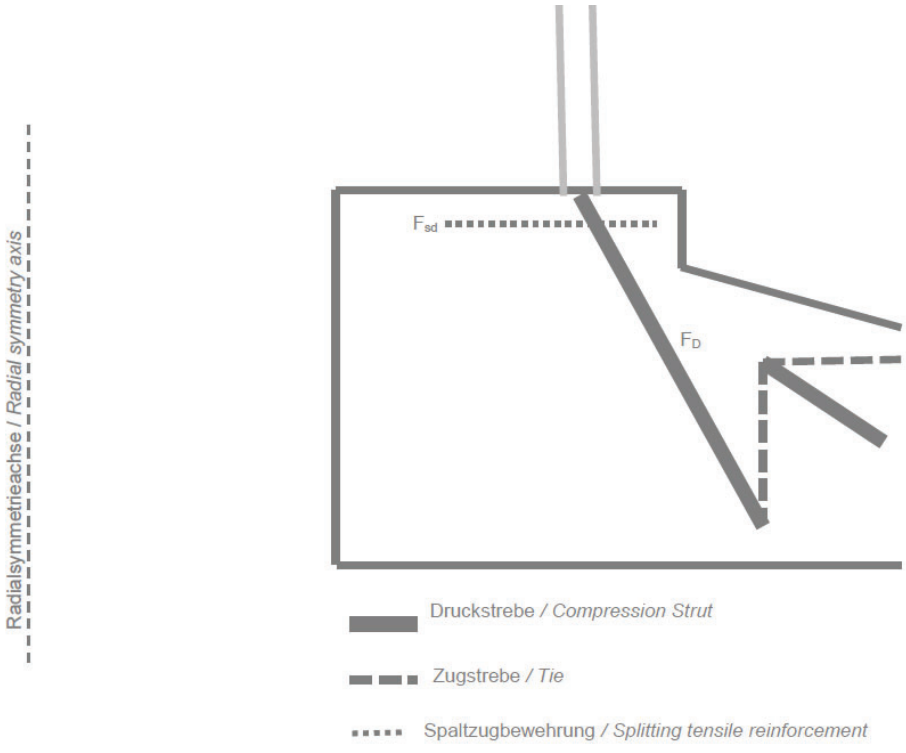


Abbildung / *Figure* 11: Stabwerksmodell für die Lasteinleitung auf der Winddruckseite / *Strut-and-tie model for the load introduction on the wind compression side*

TÜV SÜD Industrie Service GmbH MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Der Teilsicherheitsbeiwert $\gamma_{P,unfav}$ wird nach Spezifikation Abs. 4.2 [G-2] gewählt. Der deckt die Anforderungen vom Eurocode 2 [T-4] und [T-5] (Abs. 2.4.2.2), IEC 61400-6 [T-3] (Abs. 5.4.4.1) und DIBt-Richtilinie [T-1] (Abs. 10.2) ab.

The partial safety factor $\gamma_{P,unfav}$ is chosen accordingly to the Specification Ch. 4.2 [G-2]. It coverst he requirements of the Eurocode 2 [T-4] and [T-5] (Ch. 2.4.2.2), IEC 61400-6 [T-3] (Ch. 5.4.4.1) and DIBt-Richtilinie [T-1] (Abs. 10.2).

Legende / *Legend*

XXX	→	Eingabe / *Input*
FOK	→	Fundamentoberkante / *Upper edge of the foundation*

Eingabe / *Input*

Lasten / *Loads*

P_{ges}	=	98 960	kN		
$\gamma_{P,unfav}$	=	1,35			
N_d^{FOK}	=	21 642	kN		Turmnormalkraft / *Tower normal force*
F_{hd}^{FOK}	=	2 212	kN		Turmhorizontalkraft / *Tower horizontal force*
M_{bd}^{FOK}	=	312 521	kNm		Turmbiegemoment / *Tower bending moment*

Material / *Material*

f_{yk}	=	500	MPa		
γ_S	=	1,15			
f_{yd}	=	434,8	MPa	=	f_{yk} / γ_S
f_{ck}	=	40	MPa		
α_{cc}	=	0,85			
γ_c	=	1,50			
f_{cd}	=	22,7	MPa	=	$\alpha_{cc} \cdot f_{ck} / \gamma_c$

Geometrie / *Geometry*

h	=	2,900	m		Fundamenthöhe an der Lasteinleitung / *Foundation height at the load application*
$D_{TUK,a}$	=	9,148	m		Turmunterkanteaußendurchmesser / *Tower bottom outer diameter*
b_{TUK}	=	0,300	m		Turmunterkantedicke / *Tower bottom thickness*
$D_{TUK,m}$	=	8,848	m	=	$D_{TUK,a} - b_{TUK}$
$R_{TUK,m}$	=	4,424	m	=	$D_{TUK,m} / 2$
$U_{TUK,m}$	=	27,795	m	=	$\pi \cdot D_{TUK}$

Berechnung / *Calculation*

Radiale Spaltzugbewehrung / *Radial splitting tensile reinforcement*

F_D	=	10 773	kN/m	=	$(P_{ges} * \gamma_{P,unfav} + N_d^{FOK}) / (2 \cdot \pi \cdot R_{TUK,m}) + (M_{bd}^{FOK} + F_{hd}^{FOK} \cdot h) / (\pi \cdot R_{TUK,m}^2)$
F_{sd}	=	2 498	kN/m	=	$(F_D / 4) \cdot (1 - 0,7 \cdot (b_{TUK} / h))$
$a_{s,erf}$	=	57,5	cm²/m	=	$F_{sd} / (f_{yd} / 10)$
$A_{s,erf}$	=	1597,0	cm²	=	$a_{s,erf} \cdot U_{TUK,m}$
$A_{s,vor}$	=	2561,5	cm²		120Φ28 120Φ28 88Φ28 88Φ28
$\eta_{1,a}$	=	0,62		=	$A_{s1,erf,a} / A_{s1,vorh,a} \leq 1,00$

Ringdruckkraft-Nachweis / *Verification of the ring compression force*

D_{Fd}	=	5 966	kN/m	=	$(N_d^{FOK}) / (2 \cdot \pi \cdot R_{TUK,m}) + (M_{bd}^{FOK} + F_{hd}^{FOK} \cdot h) / (\pi \cdot R_{TUK,m}^2)$

D_{ring}	=	26 393	kN/m	=	$D_{Fd} \cdot R_{TUK,m}$
h_{wir}	=	0,600	m		Wirkhöhe / *Active height*
b_{wir}	=	2,000	m		Wirkbreite / *Active width*
A_{wir}	=	1,200	m²	=	$h_{wir} \cdot b_{wir}$
σ_{ring}	=	22,0	MPa	=	$D_{ring} / (A_{wir} \cdot 1000)$
η	=	0,97		=	$\sigma_{ring} / f_{cd} \leq 1,00$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.6.3 Betonpressung am Turmfuß / *Concrete compression at tower base*

Die maximale Betonpressung am Turmfuß wird nachgewiesen. Diese entsteht aus dem maximalen Biegemoment.

Es wird eine Teilflächenpressung gemäß Eurocode 2 [T-4] und [T-5] angesetzt.

The resistance against the maximum concrete pressure at the base of the tower, which results from the maximum bending moment, is verifed.

Partially loaded areas are considered according to Eurocode 2 [T-4] and [T-5]

Legende / *Legend*

XXX	→	Eingabe / *Input*
FOK	→	Fundamentoberkante / *Upper edge of the foundation*

Eingabe / *Input*

Lasten / *Loads*

P_{ges}	=	98 960	kN	
N_d^{FOK}	=	21 642	kN	Turmnormalkraft / *Tower normal force*
F_{hd}^{FOK}	=	2 212	kN	Turmhorizontalkraft / *Tower horizontal force*
M_{bd}^{FOK}	=	312 546	kNm	Turmbiegemoment / *Tower bending moment*

Material / *Material*

f_{ck}	=	40	MPa	
α_{cc}	=	0,85		
γ_c	=	1,50		
f_{cd}	=	22,7	MPa	= $\alpha_{cc} \cdot f_{ck} / \gamma_c$

Geometrie / *Geometry*

h	=	2,650	m	Fundamenthöhe an der Lasteinleitung / *Foundation height at the load application*
b_{TUK}	=	0,300	m	Turmunterkantedicke / *Tower bottom thickness*
A_c	=	7,934	m²	Turmunterkantefläche (Tür abgezogen) / *Tower bottom area (door substracted)*
W_c	=	16,127	m³	Turmunterkantewiderstandsmoment (Tür abgezogen) / *Tower bottom section modulus (door substracted)*

Berechnung / *Calculation*

Teilflächenpressung / *Partially loaded areas*

σ_{cd}	=	34,9	MPa	= $(P_{ges} + N_d^{FOK}) / (A_c) + + (M_{bd}^{FOK} + F_{hd}^{FOK} \cdot h) / (W_c)$
b_1	=	0,300	m	= b_{TUK}
b_2	=	0,900	m	= MIN ($b_1 + h$; $3 \cdot b_1$)
β	=	1,73		= MIN ($(b_2 / b_1)^{1/2}$; 3,0)
σ_{Rd}	=	39,3	MPa	= $\beta \cdot f_{cd}$
η	=	0,89		= $\sigma_{cd} / \sigma_{Rd} \leq 1{,}00$

VESTAS PROPRIETARY NOTICE

TÜV SÜD Industrie Service GmbH MÜNCHEN TÜ 12

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

6.6.4 Spaltzugbewehrung oberhalb der Ankerplatte / *Splitting tensile reinforcement above the anchor plate*

Die Spaltzugbewehrung oberhalb der Ankerplatte wird nachgewiesen.

Es wird nach Eurocode 2 [T-4] und [T-5] Kap. 6.5.3 (3) berechnet.

The splitting tensile reinforcement above the anchor plate is verified.

The calculation is done according to Eurocode 2 [T-4] and [T-5] ch. 6.5.3 (3).

P_{m0}	=		=	4123	[kN]
N_{Ed}	=	$1{,}35*P_{m0}$	=	5567	[kN]
l_{AP}	=	(anchor plate length)	=	780	[mm]
a	=	l_{AP}	=	780	[mm]
H	=	$2{,}55*l_{AP}$	=	1989	[mm]
T	=	NEd/4*(1-0,7*a/H)	=	1010	[kN]
$A_{s,erf}$	=	Fsd/43,5	=	23,2	[cm²]
Chosen:			4x	ϕ28	
$A_{s,vorh}$			=	24,63	[cm²]
η		0,94	<=	1,00	

In den Bereichen mit einem im Umfangsrichtung vergrößerten Abstand zwischen Ankerplatten (Tür- und Tür gegenüberliegende Bereich) werden 4ϕ28 in Umfangsrichtung konstruktiv zugelegt.

At the areas in which a larger separation in circumferential direction between anchor plates is present (door area and its opposite side) 4ϕ28 are added in circumferential direction as constructive reinforcement.

TÜV SÜD Industrie Service GmbH MÜNCHEN TÜ 12

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

6.7 Gewählte Bewehrung, Übersicht und Skizze / *Chosen reinforcement summary and sketch*

Die gewählte Bewehrung wird in den folgenden Tabellen zusammengefasst (BLF-Nr.: „GEW“).

The chosen reinforcement is summarized in the following tables (DLC No.: “GEW”).

Die gewählte Bewehrung deckt die Nachweise im GZT und GZG inkl. die zu berücksichtigende Mindestbewehrung und die erforderliche Bewehrung aus den Lasteinleitungnachweisen ab. Außerdem werden die Ermüdungsnachweise aus Kapitel 7 berücksichtigt.

The chosen reinforcement covers the required reinforcement in ULS ans SLS, including the minimum reinforcement, as well as the reinforcement required for the load introduction. Furthermore it considers the fatigue verifications in Chapter 7.

Der Einfluss der Bodensteifigkeiten wird durch der gewählte Bewehrung abgedeckt.

The influence of the soil stiffness is covered by the chosen reinforcement.

TÜV SÜD Industrie Service GmbH MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Pos.-R	ASO	ASOQ	ASUQ	ASU	ASS
Numm.	-	-	-	-	-
1	L1:88Φ28 L2:88Φ28 L3: 88Φ28 L4: 88Φ28 L5: 88Φ25	53ϕ28	ϕ28/7,5	L1:120Φ28 L2: 120Φ28	52sΦ28+ +50sΦ28
2	L1:88Φ28 L2:88Φ28 L3: 88Φ28 L4: 88Φ28 L5: 88Φ25		ϕ28/10	L1: 120Φ28+120Φ28 L2:120Φ28	-
3	L1:88Φ28 L2:88Φ28 L3: 88Φ28 L4: 88Φ28 L5: 88Φ25		ϕ28/10	L1:120Φ28+120Φ28 L2:120Φ28 + 120Φ25	50sΦ28+ +50sΦ28
4	L1:120Φ28+120Φ25 L2:120Φ25	ϕ25/10	ϕ28/7,5	L1:120Φ28+120Φ28 L2:120Φ28 + 120Φ25 L3: 120Φ25	88sΦ28
5	L1:120Φ28+120Φ25 L2:120Φ25	ϕ25/15	ϕ28/10	L1:120Φ28+120Φ28 L2:120Φ28 + 120Φ25 L3: 120Φ25	95sΦ28
6	L1:120Φ28 L2:120Φ25	ϕ25/20	ϕ28/10	L1:120Φ28+120Φ28 L2:120Φ28 + 120Φ25 L3: 120Φ25	97sΦ28
7	L1:120Φ28 L2:120Φ25	ϕ25/25	ϕ28/10	L1:120Φ28+120Φ28 L2:120Φ28 + 120Φ25	99sΦ28
8	L1:120Φ28 L2:120Φ25	ϕ20/20	ϕ28/10	L1:120Φ28+120Φ28 L2:120Φ28 + 120Φ25	101sΦ28
9	L1:120Φ28 L2:120Φ25	ϕ20/25	ϕ28/10	L1: 120Φ28+120Φ28 L2:120Φ28	98sΦ28
10	L1:120Φ28 L2:120Φ25	ϕ20/25	ϕ25/10	L1:240Φ20	74sΦ28

Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*
ASO: Radialbewehrung Oben / *Upper radial reinforcement*
ASOQ: Umfangsbewehrung Oben / *Upper circumferential reinforcement*
ASUQ: Umfangsbewehrung Unten / *Lower circumferential reinforcement*
ASU: Radialbewehrung Unten / *Lower radial reinforcement*
ASS: Schubbewehrung / *Shear force reinforcement*
L: Lage (z.B. L1 = 1. Lage) / *Layer (e.g. L1 = 1st layer)*
S: Steher. Ein Steher beinhaltet 2 vertikale Eisen. / *"Steher". A "Steher" includes 2 vertical rebars.*

TÜV SÜD Industrie Service GmbH MÜNCHEN TÜ 12

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

BLF-Nr. / *DLC No.*	**Pos.-R**	**ASO**	**ASOQ**	**ASUQ**	**ASU**	**ASS**
Numm.	*Numm.*	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m*	*cm²/m²*
GEW	1	146,5	87,3	82,1	83,3	86,9
GEW	2	101,6	87,3	61,6	86,7	60,3
GEW	3	77,8	87,3	61,6	84,0	46,2
GEW	4	47,4	49,1	82,1	83,9	26,8
GEW	5	41,0	32,7	61,6	72,6	25,0
GEW	6	25,1	24,5	61,6	64,2	23,5
GEW	7	22,5	19,6	61,6	47,6	21,5
GEW	8	20,4	15,7	61,6	43,2	19,9
GEW	9	18,7	12,6	61,6	31,2	17,7
GEW	10	17,2	12,6	49,1	9,8	12,3

BLF-Nr. / *DLC No.*: Bemessungslastfallnummer / *Design load case number*
Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*
ASO: Radialbewehrung Oben / *Upper radial reinforcement*
ASOQ: Umfangsbewehrung Oben / *Upper circumferential reinforcement*
ASUQ: Umfangsbewehrung Unten / *Lower circumferential reinforcement*
ASU: Radialbewehrung Unten / *Lower radial reinforcement*
ASS: Schubbewehrung / *Shear force reinforcement*

Die in der Bewehrungsskizze definierte vertikale Bewehrung im Sockel (Abbildung / Figure 12) deckt die erforderliche Bewehrung aus dem FE-Modell (siehe 6.5) und die erforderliche Rückhängebewehrung aus der Lasteinleitung (siehe 6.6.1)

The defined vertical reinforcement on the reinforcement sketch (Abbildung / Figure 12) covers the required shear reinforcement from the FE model (see 6.5) and the required suspended reinforcement for the load introduction (see 6.6.1).

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

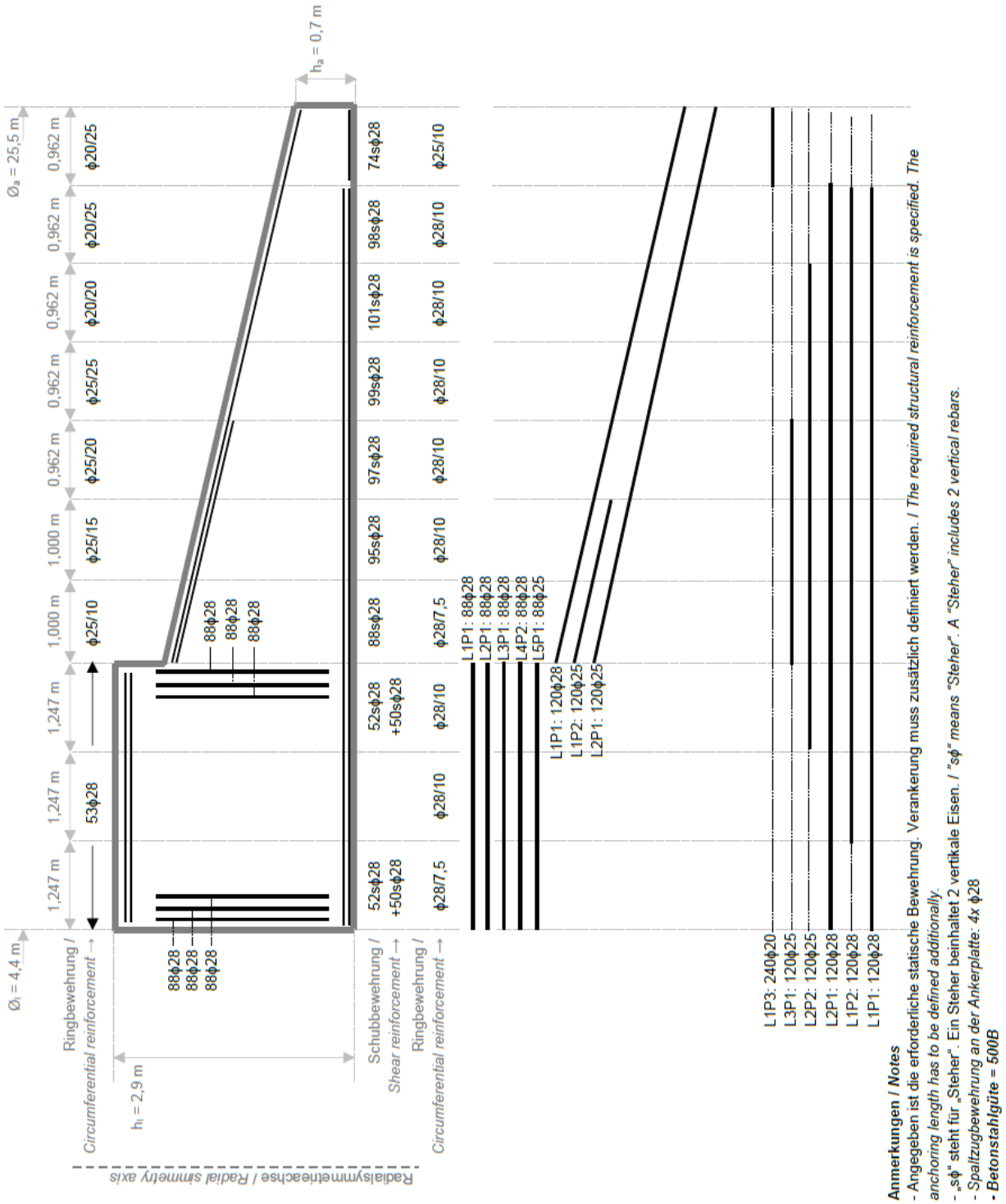


Abbildung / *Figure* 12: Bewehrungsskizze / *Reinforcement sketch*

TÜV SÜD Industrie Service GmbH MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

7 Ermüdungsnachweise / *Fatigue design*

7.1 Allgemeines / *General*

Der Betonstahl wird in diesem Kapitel unter Ermüdung nachgewiesen.	The chosen reinforcement bars are verified under fatigue in this chapter.
Die Betonstahlspannungen werden anhand das FE-Modell von Sofistik ermittelt. Die Schädigungen werden dann händisch mit einem Tabellenkalkulationsprogramm berechnet.	The stresses in the reinforcement are determined in the FE model. The resulting damages are then calculated with a spreadsheet application.
Die Belastung während der Lebensdauer wird vom Anlagehersteller in Form von Markov-Matrixen zur Verfügung gestellt (siehe [G-1]).	The loading during the design lifetime is defined in form of Markov matrixes provided by the turbine manufacturer (see [G-1]).
Der Nachweise erfolgen nach DIBt-Richlinie [T-1] und nach Eurocode 2 Abs. 6.8.4. [T-4] und [T-5]. Die Anforderungen vom IEC 61400-6 [T-3] (Benutzung eines „reference standard“) sind abgedeckt. Die Schädigungen werden nach der Palmgren-Miner-Regel addiert.	The verifications are performed according to the DIBt-Richlinie [T-1] and the Eurocode 2 Ch. 6.8.4 [T-4] and [T-5]. The requirements of the IEC 61400-6 [T-3] (use of a “reference standard“) are covered. The damages are superimposed according to the Palmgren-Miner rule.
Folgende Ermüdungsnachweise werden auf der Bewehrung durchgeführt:	The following fatigue verifications are carried out for the reinforcement.

- Biegebewehrung (Radial- und Umfangsrichtung) / *Bending reinforcement (radial and circumferential direction)*
- Querkraftbewehrung/ *Shear reinforcement*
- Vertikale Zugbewehrung (Lasteinleitung) / *Vertical tensile reinforcement (load introduction)*

Folgenden Markov-Matrixen werden mit einen Faktor von 1,02 auf den „Range“ und „Mean“ nachgewiesen:	The following Markov matrixes are verified with a 1,02 factor for the “mean” and “range” column:

VESTAS PROPRIETARY NOTICE

TÜV SÜD Industrie Service GmbH MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	Datum / *Date*: 14.12.2023

Nr. / *No.*	Bezeichnung / *designation*
1	_combineloads.zip\MAR-KOV\1_MK1B_EV162_6800kW_HH169_dibt_STD_20y_HA2A90A_soft\0448_Mxt3.mko
2	_combineloads.zip\MAR-KOV\2_MK1B_EV162_6800kW_HH169_dibt_STD_20y_HA2A90A_stiff\0448_Mxt3.mko
3	_combineloads.zip\MAR-KOV\3_MK1B_EV162_6800kW_HH169_dibt_STD_25y_HA2A90A_soft\0448_Mxt3.mko
4	_combineloads.zip\MAR-KOV\4_MK1B_EV162_6800kW_HH169_dibt_STD_25y_HA2A90A_stiff\0448_Mxt3.mko
5	_combineloads.zip\MAR-KOV\5_MK1B_EV162_7200kW_HH169_dibt_STD_20y_HA2A90A_soft\0448_Mxt3.mko
6	_combineloads.zip\MAR-KOV\6_MK1B_EV162_7200kW_HH169_dibt_STD_20y_HA2A90A_stiff\0448_Mxt3.mko
7	_combineloads.zip\MAR-KOV\7_MK1B_EV162_7200kW_HH169_dibt_STD_25y_HA2A90A_soft\0448_Mxt3.mko
8	_combineloads.zip\MAR-KOV\8_MK1B_EV162_7200kW_HH169_dibt_STD_25y_HA2A90A_stiff\0448_Mxt3.mko

7.2 Biege- und Schubbewehrung / *Bending and shear reinforcement*

Die Betonstahlspannungen werden anhand das FE-Modell in Sofistik ermittelt. Eine repräsentative Anzahl von Belastungsstufen (Biegemoment) werden dabei berechnet, woraus sich ein Multilinear-Verlauf der Betonstahlspannungen auf dem Biegemoment für jedes Schalelement und Bewehrungsrichtung/-Position ergibt. Durch Interpolation der in der Markov-Matrixen definierten Biegemomente werden die Spannungsschwingungsweiten realitätsnah berechnet.

The stresses in the reinforcement bars are computed for a representative number of bending moment load levels using the FE model in Sofistik. This results in a multi-linear distribution of the reinforcement stresses on the bending moment for each shell element and reinforcement direction/position. The reinforcement stress variations is calculated realistically by interpolating the bending moments defined in the Markov matrix.

Folgendes Spektrum der Biegemomentbelastung wird berücksichtigt:

The following spectrum of bending moment load levels is considered:

$$M_{b,Min}^{FOK} = -250\ MNm$$

$$M_{b,Max}^{FOK} = +250\ MNm$$

$$\Delta M_b^{FOK} = 25\ MNm$$

Die Biegemomente M_b^{FOK} beziehen sich auf der Fundamentoberkante.

The bending moments M_b^{FOK} refer to the foundation upper edge.

Die zugehörige Belastung aus dem Turm zu berechnen mit jedem Biegemoment wird wie folgt definiert:

The contemporaneous loads from the tower to be computed with each bending moment load level are defined as follows:

$$N = N_{D.3}$$

$$M_{b,i} = \text{Variable}$$

$$F_{h,i} = F_{h,D.3} \cdot (M_{b,i} / M_{b,Max})$$

$$M_t = M_{t,D.3}$$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Die Lastfälle werden zusätzlich in Kombination mit folgenden Einwirkungen berücksichtigt:	Additionally, each bending moment load level is combined with the rest of loads as follows:

- 1.: + 1,00xEG + 1,00xP + 1,00xMaxÜS
- 2.: + 1,00xEG + 1,00xP + 1,00xMaxÜS + 1,00xAu

Die Bewehrung wird für die Spannungen aus alle Kombinationen nachgewiesen.	The reinforcement is verified for the stresses resulting from all combinations.
Die Betonstahlspannungen in der Schubbewehrung werden im FE-Modell mit folgender Druckstrebeneigung nach Eurocode 2 Abs. 6.8.2 (3) [T-4] and [T-5] ermittelt.	The stresses in the shear reinforcement are determined as well in the FE model, for which the following concrete inclined strut according to Eurocode 2 Par. 6.8.2 (3) [T-4] and [T-5] is considered.

$$\cot(\theta_{fat}) = \cot^{1/2}(\theta)$$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Die Ermittlung der Schädigung erfolgt mittels der im Eurocode 2 Abs. 6.8.4. [T-4] and [T-5] definierten Wöhler-Kurven.

In den folgenden Tabelle sind die anzusetzenden Kurvenparameter und die Bewehrungspositionen wo die angesetzt werden definiert.

The damage is determined applying the S-N-curves defined in Eurocode 2 Ch. 6.8.4. [T-4] and [T-5].

The parameters of the considered S-N-curves and the reinforcement positions where each of them is considered are defined next.

Nr.	N*	k_1	k_2	ξ	$\Delta\sigma_{Rsk}(N^*)$	$\gamma_{s,Fat}$	$\Delta\sigma_{Rsd}(N^*)$
Numm.	*Numm.*	-	-	-	*MPa*	-	*MPa*
1	1E+6	5	6	1,00	175,0	1,15	152,2
2	1E+6	5	6	0,74	175,0	1,15	112,6
3	1E+6	5	9	0,74	175,0	1,15	112,6

Pos.-R	S-N-ASO	S-N-ASOQ	S-N-ASUQ	S-N-ASU	S-N-ASS
-	*S-N-curve-No.*	*S-N-curve-No.*	*S-N-curve-No.*	*S-N-curve-No.*	*S-N-curve-No.*
1	2	1	1	2	3
2	1	1	1	1	3
3	2	1	1	1	3
4	1	1	1	1	3
5	1	1	1	1	3
6	1	1	1	1	3
7	1	1	1	1	3
8	1	1	1	1	3
9	1	1	1	1	3
10	1	1	1	1	3

Pos.-R: Schalenelementkreisposition in Radialrichtung /
Shell element circle position in radial direction
S-N-ASO: S-N-Kurvennummer für die Radialbewehrung Oben /
Number of the S-N-Curve for the upper radial reinforcement
S-N-ASOQ: S-N-Kurvennummer für die Umfangsbewehrung Oben /
Number of the S-N-Curve for the upper circumferential reinforcement
S-N-ASUQ: S-N-Kurvennummer für die Umfangsbewehrung Unten
/ *Number of the S-N-Curve for the lower circumferential reinforcement*
S-N-ASU: S-N-Kurvennummer für die Radialbewehrung Unten /
Number of the S-N-Curve for the lower radial reinforcement
S-N-ASS: S-N-Kurvennummer für die Schubbewehrung /
Number of the S-N-Curve for the shear force reinforcement

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Mit diesem Verfahren ergeben sich auf der gewählten Bewehrung (Abs. 0) die maximalen Schädigungen der nachfolgenden Tabelle.

In the next table the resulting maximum damages computed on the chosen reinforcement (see Ch. 0) are presented.

BLF-Nr. / *DLC No.*	Pos.-R	D-ASO	D-ASOQ	D-ASUQ	D-ASU	D-ASS
-	-	-	-	-	-	-
GEW	1	0,00	0,02	0,14	0,09	0,00
GEW	2	0,03	0,32	0,71	0,37	0,00
GEW	3	0,23	0,34	0,24	0,35	0,00
GEW	4	0,15	0,08	0,04	0,85	0,42
GEW	5	0,05	0,07	0,12	0,49	0,72
GEW	6	0,11	0,09	0,07	0,26	0,00
GEW	7	0,03	0,07	0,03	0,31	0,00
GEW	8	0,11	0,02	0,01	0,06	0,00
GEW	9	0,00	0,01	0,01	0,01	0,00
GEW	10	0,00	0,01	0,01	0,00	0,00

BLF-Nr. / *DLC No.*: Bemessungslastfallnummer / *Design load case number*
Pos.-R: Schalenelementkreisposition in Radialrichtung / *Shell element circle position in radial direction*
D-ASO: Schädigungssumme in der Radialbewehrung Oben /
Maximal accumulated damage for the upper radial reinforcement
D-ASOQ: Schädigungssumme in der Umfangsbewehrung Oben /
Maximal accumulated damage for the upper circumferential reinforcement
D-ASUQ: Schädigungssumme in der Umfangsbewehrung Unten /
Maximal accumulated damage for the lower circumferential reinforcement
D-ASU: Schädigungssumme in der Radialbewehrung Unten /
Maximal accumulated damage for the lower radial reinforcement
D-ASS: Schädigungssumme in der Schubbewehrung /
Maximal accumulated damage for the shear force reinforcement

Der Nachweis ist erfüllt, da die folgende Bedingung erfüllt wird.

The verification is fulfilled as the results comply with the following condition.

$$D_{MAX} \leq D_{zul} = 1{,}00$$

Beispielhaft wird in der folgenden Tabelle ein Auszug der detaillierten Berechnung der Schädigung für einige Zeilen einer Markov-Matrix angegeben. Die Ergebnisse gehören

Exemplarly an abstract of the detailed damage calculation for some Markov matrix rows is included next. Results are included for the upper radial reinforcement (label “-O”). The

zu der oberen Bewehrung in Radialrichtung (Kennzeichnung „-O“). Die Schädigung jeder Zeile wird für ein Schalenelement, eine Elementkreisposition, eine Wöhler-Kurve und eine Lastenkombination wie angegeben berechnet.

damage computed on each row corresponds to a specific shell element, position in radial direction, S N-curve and load combination as given.

Mean	Range	ni	M-Unt.	M-Obe.	Quad	Pos.-R	WK-Nr.-O	LFK-O	Δσ-O	Ni-O	Di-O
kNm	*kNm*	*Anz.*	*kNm*	*kNm*	*Numm.*	*Numm.*	*Numm.*	*Numm.*	*MPa*	*Anz.*	-
164 261	6 948	8,1	160 787	167 735	301001	4	1	2	1,0	1,431E+19	5,637E-19
164 261	0	2,7	164 261	164 261	301001	4	1	2			
156 233	13 896	2,7	149 285	163 182	301001	4	1	2	2,0	2,255E+17	1,192E-17
156 233	6 948	2,7	152 759	159 708	301001	4	1	2	1,0	1,431E+19	1,879E-19
156 233	0	5,4	156 233	156 233	301001	4	1	2			
148 206	0	2,7	148 206	148 206	301001	4	1	2			
140 179	6 948	5,4	136 704	143 653	301001	4	1	2	1,0	1,689E+19	3,184E-19
140 179	0	2,7	140 179	140 179	301001	4	1	2			
132 141	6 948	5,4	128 667	135 615	301001	4	1	2	1,0	1,689E+19	3,184E-19
132 141	0	5,4	132 141	132 141	301001	4	1	2			
124 114	13 896	2,7	117 165	131 062	301001	4	1	2	1,9	2,551E+17	1,054E-17
124 114	6 948	10,8	120 639	127 588	301001	4	1	2	1,0	1,626E+19	6,613E-19
124 114	0	16,1	124 114	124 114	301001	4	1	2			

7.3 Lasteinleitung / *Load introduction*

7.3.1 Bewehrung an der Windzugseite / Reinforcement at wind tension side

Nachfolgend wird der Ermüdungsnachweis für die Bewehrung zur Lasteinleitung auf der Windzugseite (siehe 6.6.1) geführt.

In Betriebszustand klafft die Fuge zwischen Betonturm und Fundament nicht. Die Kraft aus den Spanngliedern schließt sich mit der Kraft aus der Turmwand kurz. Die Kraft in der Spanngliedern wird dann über das Stabwerksmodell aus Kapitel 6.6.1 von der vertikalen Rückhängebewehrung aufgenommen.

Die Wöhlerkurve-Nummer 3 (definiert in 7.2) wird angewendet.

In den folgenden Berechnungen sind die angesetzte Parameter und beispielhaft die Ermittlung der Einzelschädigung für eine Zeile der Markov-Matrix dargestellt.

The fatigue verification on the reinforcement for the load application on the windward side (see 6.6.1) is performed.

While on service the joint between concrete tower bottom and foundation does not open. The force introduced by the tendons shorts with the force introduced by the tower wall. The difference between the force of the tower wall and the force of the tendons will be absorbed by the vertical reinforcement after the strut tie model in chapter 6.6.1.

The S-N-curve number 3 (defined in 7.2) is applied.

The considered parameters and an example on the damage computation for a Markov matrix row can be found in the following calculations.

Legende / *Legend*

XXX	→	Eingabe / *Input*
SPGL	→	Spannglied / *Tendons*
FOK	→	Fundamentoberkante / *Upper edge of the foundation*

Eingabe / *Input*

Geometrie / *Geometry*

$D_{TUK,a}$	=	9,148	m		Turmunterkanteaußendurchmesser / *Tower bottom outer diameter*
b_{TUK}	=	0,300	m		Turmunterkantedicke / *Tower bottom thickness*
$D_{TUK,m}$	=	8,848	m	=	$D_{TUK,a} - b_{TUK}$
R_T	=	4,424	m	=	$D_{TUK,m} / 2$
U_T	=	27,795	m	=	$\pi \cdot D_{TUK}$
n_{SPGL}	=	24			Spanngliedanzhal im Modell / *Prestressing tendon number in model*
D_P	=	7,627	m		Spanngliederdurchmesser / *Prestressing tendon diameter*
R_P	=	3,813	m	=	$D_P / 2$
U_P	=	23,959	m	=	$\pi \cdot D_P$
R_M	=	4,119	m	=	$(R_T + R_P) / 2$
U_M	=	25,877	m	=	$2 \cdot \pi \cdot R_M$

Lasten / *Loads*

$N_{FOK,D.3}$	=	19 797	kN	Normalkraft in D.3 / *Normal force in D.3*

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

N_{Fund}		1 970	kN	=	$h_{eff} \cdot \gamma_{Fund} \cdot (Rz_{,a} - Rz_{,i}) \cdot U_m / 2$
N	=	841	kN/m	=	$(N_{FOK,D.3} + N_{Fund}) / U_M$
P	=	3 824	kN/m	=	P_{Ges} / U_M
$M_{b,D.1}^{FOK}$	=	226 228	kNm		LF2103
$P_{D.1}$	=	4 298	kN / Spgl.		LF2103
P_0	=	4 123	kN / Spgl.		
$\Delta P_{Ein,P}$	=	7,734E-04	1 / m²	=	$(P_{D.1} - P_0) / M_{b,D.1}^{FOK} / (U_P / n_{SPGL})$
$\Delta P_{Ein,M}$	=	7,161E-04	1 / m²	=	$(P_{D.1} - P_0) / M_{b,D.1}^{FOK} / (U_M / n_{SPGL})$

Bewehrung / *Reinforcement*

$A_{s1,vor,a}$	=	2881,7	cm²	88Φ28	88Φ28	88Φ28	104Φ28	100Φ28	
$A_{s1,vor,i}$	=	2881,7	cm²	88Φ28	88Φ28	88Φ28	104Φ28	100Φ28	
$A_{s1,vor}$	=	5763,4	cm²	= $A_{s1,vor,a} + A_{s1,vor,i}$					
$a_{s1,vor}$	=	222,7	cm²/m	= $A_{s1,vor} / U_M$					

Ermüdungsvorgaben / Fatigue specifications

N*	=	1E+06	-	
k_1	=	5	-	
k_2	=	9	-	
ξ	=	0,74	-	
$\Delta\sigma_{Rsk}(N^*)$	=	175,00	MPa	
$\gamma_{s,Fat}$	=	1,15	-	
$\Delta\sigma_{Rsd}(N^*)$	=	112,6	MPa	= $\Delta\sigma_{Rsk}(N^*) \cdot \xi / \gamma_{s,Fat}$

Beispielsberechnung / *Calculation example*

M_i	=	164 261	kNm		Schwingungsmittlewert / *Cycle mean*
R_i	=	6 948	kNm		Schwingweite / *Cycle width*
n_i	=	8			Spielanzahl / *Number of cycles*
$M_{Unt,i}$	=	160 787	kNm	=	$M_i - R_i / 2$
$M_{Obe,i}$	=	167 735	kNm	=	$M_i + R_i / 2$
$\Delta P_{Unt,i}^{x+}$	=	- 115	kN/m	=	$- (M_{Unt,i} \cdot \Delta P_{Ein,M})$
$\Delta P_{Obe,i}^{x+}$	=	- 120	kN/m	=	$- (M_{Obe,i} \cdot \Delta P_{Ein,M})$
$F_{Unt,i}^{x+}$	=	3 858	kN/m	=	$M_{Unt,i} / (\pi \cdot R_M^2) + N + P + \Delta P_{Unt,i}^{x+} - (P + \Delta P_{Unt,i}^{x+})$
$F_{Obe,i}^{x+}$	=	3 989	kN/m	=	$M_{Obe,i} / (\pi \cdot R_M^2) + N + P + \Delta P_{Obe,i}^{x+} - (P + \Delta P_{Obe,i}^{x+})$
ΔZ_i^{x+}	=	0	kN/m	=	0 ; wenn $F_{Obe,i}^{x+} > 0$ und $F_{Unt,i}^{x+} > 0$ - $F_{Unt,i}^{x+}$; wenn $F_{Obe,i}^{x+} > 0$ und $F_{Unt,i}^{x+} < 0$ - $F_{Obe,i}^{x+}$; wenn $F_{Obe,i}^{x+} < 0$ und $F_{Unt,i}^{x+} > 0$ $Abs(F_{Obe,i}^{x+} - F_{Unt,i}^{x+})$; wenn $F_{Obe,i}^{x+} < 0$ und $F_{Unt,i}^{x+} < 0$
$\Delta\sigma_i^{x+}$	=	0,0	MPa	=	$\Delta Z_i^{x+} / a_{s1,vor}$
N_i^{x+}	=	-		=	wenn $\Delta\sigma_i^{x+} > 0$: $10 \wedge (\log_{10}(N^*) - (- \log_{10}(\Delta\sigma_{Rsd}(N^*)) + \log_{10}(\Delta\sigma_i^{x+})) \cdot k_1))$; wenn $\Delta\sigma_i^{x+} > \Delta\sigma_{Rsd}(N^*)$ $10 \wedge (\log_{10}(N^*) + (\log_{10}(\Delta\sigma_{Rsd}(N^*)) - \log_{10}(\Delta\sigma_i^{x+})) \cdot k_2))$; wenn $\Delta\sigma_i^{x+} \le \Delta\sigma_{Rsd}(N^*)$
D_i^{x+}	=	0		=	wenn $\Delta\sigma_i^{x+} > 0$; n_i / N_i^{x+}
$\Delta P_{Unt,i}^{x-}$	=	115	kN/m	=	$+ (M_{Unt,i} \cdot \Delta P_{Ein,M})$
$\Delta P_{Obe,i}^{x-}$	=	120	kN/m	=	$+ (M_{Obe,i} \cdot \Delta P_{Ein,M})$
$F_{Unt,i}^{x-}$	=	-2 176	kN/m	=	$- M_{Unt,i} / (\pi \cdot R_M^2) + N + P + \Delta P_{Unt,i}^{x-} -$

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

				- (P + $\Delta P_{Unt,i}^{x-}$)
$F_{Obe,i}^{x-}$	=	-2 307	kN/m	= - $M_{Obe,i}$ / (π · R_M ²) + N + P + $\Delta P_{Obe,i}^{x-}$ - - (P + $\Delta P_{Obe,i}^{x-}$)
ΔZ_i^{x+}	=	130	kN/m	= 0 ; wenn $F_{Obe,i}^{x+} > 0$ und $F_{Unt,i}^{x+} > 0$ - $F_{Unt,i}^{x+}$; wenn $F_{Obe,i}^{x+} > 0$ und $F_{Unt,i}^{x+} < 0$ - $F_{Obe,i}^{x+}$; wenn $F_{Obe,i}^{x+} < 0$ und $F_{Unt,i}^{x+} > 0$ Abs($F_{Obe,i}^{x+}$ - $F_{Unt,i}^{x+}$) ; wenn $F_{Obe,i}^{x+} < 0$ und $F_{Unt,i}^{x+} < 0$
$\Delta\sigma_i^{x+}$	=	5,85	MPa	= ΔZ_i^{x+} / $a_{s1,vor}$
N_i^{x+}	=	3,60E+17		= wenn $\Delta\sigma_i^{x+} > 0$: 10 ^ ($\log_{10}$(N*) - (- $\log_{10}$($\Delta\sigma_{Rsd}$(N*)) + + $\log_{10}$($\Delta\sigma_i^{x+}$)) · k_1)) ; wenn $\Delta\sigma_i^{x+} > \Delta\sigma_{Rsd}$(N*) 10 ^ ($\log_{10}$(N*) + ($\log_{10}$($\Delta\sigma_{Rsd}$(N*)) - - $\log_{10}$($\Delta\sigma_i^{x+}$)) · k_2)) ; wenn $\Delta\sigma_i^{x+} \leq \Delta\sigma_{Rsd}$(N*)
D_i^{x+}	=	2,2E-17		= wenn $\Delta\sigma_i^{x+} > 0$; n_i / N_i^{x+}

Die nachfolgend angegebene Markov-Matrix (aus der Liste in 7.1) ist maßgebend.	The next specified Markov matrix (defined in the list in 7.1) is authoritative.

Maßgebende / *Authoritative* Markov-Matrix: Nr. 2

Die Schädigungssumme D_{ges} ergibt sich zu:	The resulting total damage D_{ges} is given next.

$$D_{ges} = 8{,}69E\text{-}01 \leq D_{zul} = 1{,}00$$

Der Nachweis ist erfüllt.	The verification is fulfilled.

7.3.2 Beton am Turmfuß / *Concrete at tower base*

Der Beton am Turmfuß wird unter Ermüdung nachgewiesen.	The concrete at the tower base is verified under the fatigue.
Teilflächenpressung gemäß Eurocode 2 [T-4] and [T-5] wird angesetzt.	Partially loaded areas according to Eurocode 2 [T-4] and [T-5] are considered.
Die Wöhlerkurve aus dem Model Code 1990 [T-8] wird angesetzt.	The S-N-curve of the Model Code 1990 [T-8] is considered.
Die nachfolgend angegebene Markov-Matrix (aus der Liste in 7.1) ist maßgebend.	The next specified Markov matrix (defined in the list in 7.1) is authoritative.

Maßgebende / *Authoritative* Markov-Matrix: Nr. 2

Nachweis am Element	**C33**	unten				
Durchmesser außen	D_a	=	9287,5	[mm]		
Durchmesser innen	D_u	=	8447,5	[mm]		
Fläche	A_c	=	1,11E+07	[mm²]		
Flächenträgheitsmoment	I_c	=	1,04E+14	[mm⁴]		
Widerstandsmoment	W_c	=	2,24E+10	[mm³]		
Türbreite		=	1350	[mm]		
Eigengewicht am Nachweisschnitt	G	=	-19898	[kN]		
$\sigma_{c,G}$ = G/Ac				=	-1,787	[N/mm²]
Vorspannkraft je Spgl.	P_{m0}	=	4123,33	[kN]		
Anzahl Spannglieder	N_{SPGL}	=	24	[-]		
Streuungsbeiwert	r_{sup}	=	1,05	[-]		
Spannkraftverluste	r_{skr}	=	0,10	[-]		
$P_{m,Erm} = r_{sup}*P_{m0}*N_{spang}*(1-r_{skr}/2)$				=	98713	[kN]
$\sigma_{c,P} = -P_{m,Erm}/A_c$				=	-8,866	[N/mm²]
Material						
Festigkeit	f_{ck}	=	40	[N/mm²]		
Teilsicherheitsbeiwert	$\gamma_{M,c}$	=	1,50	[-]		
Abminderungsbeiwert	α_{cc}	=	0,85	[-]		
Betonalter zu Belastungsbeginn	t	=	28	[Tage]		
Zementbeiwert	s	=	0,38	[-]	Klasse R	
Ermüdungsfestigkeit Beton						
$\beta_{cc,t} = EXP(s*(1-\sqrt{(28/t)}))$				=	1,000	[-]
$f_{cd,fat} = \alpha_{cc}*\beta_{cc,t}*f_{ck}*(1-f_{ck}/250)/\gamma_{M,c}*\beta$				=	32,939	
	β			=	1,73	
Teilsicherheitsbeiwert für Modellungenauigkeiten						
	γ_{SD}	=	1,10	[-]		
Schädigungssumme						
ΣD_i =				**=**	**2,16E-03**	**< 1,00**

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

7.3.3 Beton oberhalb der Ankerplatte / *Concrete above the anchor plate*

Der Beton oberhalb der Ankerplatte wird unter Ermüdung nachgewiesen.

Die Kraftschwingung ergibt sich aus den Änderungen der Kraft im Spannglied. Die ist im Fundamentanforderungen-Dokument [G-1] als ein linear Verhältnis zwischen Biegemoment und Spanngliedkraft definiert.

Teilflächenpressung wird gemäß Eurocode 2 [T-4] and [T-5] angesetzt.

Die Wöhlerkurve aus dem Model Code 1990 [T-8] wird angesetzt.

Die Schädigung wird einzeln für die Moment-positiv- und -negativ-Seiten ermittelt.

In den folgenden Berechnungen sind die angesetzte Parameter und beispielhaft die Ermittlung der Einzelschädigung für eine Zeile der Markov-Matrix auf der Moment-Positiv-Seite dargestellt.

The concrete above the anchor plate is verified under fatigue.

The load oscillation corresponds to the variation of the tendon force, which is defined in the Foundation Design Requirements document [G-1] by means of a linear relation between the tower bottom bending moment and the tendon force

Partially loaded areas according to Eurocode 2 [T-4] and [T-5] are considered.

The S-N-curve of the Model Code 1990 [T-8] is considered.

The damage will be calculated for both positive and negative moment sides.

The considered parameters and an example on the damage computation for a row of the markov matrix on the positive moment side are provided next.

Legende / *Legend*

XXX	→	Eingabe / *Input*
SPGL	→	Spannglied / *Tendon*
AP	→	Ankerplatte / *Anchorplate*
HR	→	Hüllrohr / *Cladding tube*

Eingabe / *Input*

Geometrie / *Geometry*

n_{SPGL}	=	24			Spanngliedanzahl / *Number of tendons*
D_{AP}^{m}	=	7 486	mm		Mittige Ankerplattedurchmesser / *Middle anchor plate diameter*
U_{AP}	=	23 518	mm	=	$\pi \cdot D_{AP}^{m}$
s_{SPGL}	=	980	mm	=	U_{AP} / n_{SPGL}
b_{AP}	=	400	mm		Breite / *Width*
l_{AP}	=	780	mm		Länge / *Length*
d_{HR}	=	160	mm		Durchmesser / *Diameter*

Material / *Material*

f_{ck}	=	30	MPa
α_{cc}	=	0,85	
γ_c	=	1,50	

s	=	0,38			Zementtyp-Beiwert / *Cement type coefficient*
t	=	28	Tage		Betonalter zu Beslastungsbeginn / *Concrete age at first load*
$\beta_{cc,t}$	=	1,000		=	exp (s · (1 - (28 / t) $^{1/2}$))
$f_{cd,fat}$	=	15,0	MPa	=	$\alpha_{cc} \cdot \beta_{cc,t} \cdot f_{ck} \cdot (1 - f_{ck} / 250) / \gamma_c$

Einwirkung / *Action*

$M_{b,D.1}^{FOK}$	=	225 979	kNm		LF2103
$P_{D.1}$	=	4 310	kN / Spgl.		LF2103
P_0	=	4 123	kN / Spgl.		
ΔP / ΔM	=	8,275E-04	kN / kNm	=	($P_{D.1}$ - P_0) / $M_{b,D.1}^{FOK}$

Lastausbreitungsvorgaben / *Load introduction specifications*

b_1	=	400	mm	=	b_{AP}
d_1	=	780	mm	=	l_{AP}
h	=	620	mm		Ausbreitungshöhe / *Height of the load dsitribution*
tan α_c	=	0,5			Lastausbreitungswinkel im Beton / *Concrete load distribution angle*
b_2	=	980	mm	=	MIN (b_1 + 2 · h · tan α_c ; s_{SPGL} ; 3 · b_1)
d_2	=	1 400	mm	=	MIN (d_1 + 2 · h · tan α_c ; 3 · d_1)
β	=	1,730		=	MIN (((b_2 · d_2) / (b_1 · d_1)) $^{1/2}$; 1,73)
A_{c1}^{SPGL}	=	499 548	mm²	=	$\beta \cdot b_{AP} \cdot l_{AP}$ - 2 · (π · (d_{HR} / 2) ^{2})

Beispielsberechnung / *Calculation example*

M_i	=	164 261	kNm		Schwingungsmittlewert / *Cycle mean*
R_i	=	6 948	kNm		Schwingweite / *Cycle width*
n_i	=	8			Spielanzahl / *Number of cycles*
M_{unt}	=	160 787	kNm	=	M_i - R_i / 2
M_{obe}	=	167 735	kNm	=	M_i + R_i / 2
F_{unt}^{x+}	=	4 247	kN	=	P_0 + (ΔP / ΔM) · M_{unt}
F_{obe}^{x+}	=	4 253	kN	=	P_0 + (ΔP / ΔM) · M_{obe}
$\sigma_{c,min}^{x+}$	=	8,50	MPa	=	F_{unt} / A_{c1}^{SPGL}
$\sigma_{c,max}^{x+}$	=	8,51	MPa	=	F_{obe} / A_{c1}^{SPGL}
γ_{Sd}	=	1,10			
η_c	=	1,000			(Auf der sicheren Seite / *On the safe side*)
$S_{cd,min}^{x+}$	=	0,625		=	$\gamma_{Sd} \cdot \sigma_{c,min} \cdot \eta_c / f_{cd,fat}$
$S_{cd,max}^{x+}$	=	0,626		=	$\gamma_{Sd} \cdot \sigma_{c,max} \cdot \eta_c / f_{cd,fat}$
ΔS_{cd}^{x+}	=	0,001		=	$S_{cd,max}$ - $S_{cd,min}$
log N_1^{x+}	=	9,399		=	(12 + 16 · $S_{cd,min}$ + 8 · $S_{cd,min}^2$) · (1 - $S_{cd,max}$) ; wenn 0 < < $S_{cd,min}$ < 0,8
log N_2^{x+}	=	15,789		=	0,2 · log N_1 · (log N_1 - 1) ; wenn 0 < $S_{cd,min}$ < 0,8
log N_3^{x+}	=	1310,676		=	log N_2 · (0,3 - (3 · $S_{cd,min}$ / 8)) / ΔS_{cd} ; wenn 0 < < $S_{cd,min}$ < 0,8
log N^{x+}	=	1310,676		=	log N_1 ; wenn 0 < $S_{cd,min}$ < 0,8 ; und log N_1 ≤ 6 log N_2 ; wenn 0 < $S_{cd,min}$ < 0,8 ; und log N_1 > 6 ; und ΔS_{cd} ≥ ≥ 0,3 - (3 · $S_{cd,min}$ / 8) log N_3 ; wenn 0 < $S_{cd,min}$ < 0,8 ; und log N_1 > 6 ; und ΔS_{cd} < < 0,3 - (3 · $S_{cd,min}$ / 8) 6 - ΔS_{cd} · 30 ; wenn $S_{cd,min}$ ≥ 0,8
N^{x+}	=	1,00E+308		=	10 $^{\log N}$ (wenn log N > 308 ; N = 308)

D_i^{x+} = 8,07E-308 = n_i / N

Die nachfolgend angegebene Markov-Matrix (aus der Liste in 7.1) und Momentseite sind maßgebend.	The next specified Markov matrix (defined in the list in 7.1) and moment side is authoritative.

Maßgebende / *Authoritative*: Markov-Matrix Nr. / *No.* 1

Die Schädigungssumme D_{ges} ergibt sich zu:	The resulting total damage D_{ges} is given next.

$$D_{ges} = 2{,}01E\text{-}26 \leq D_{zul} = 1{,}00$$

Der Nachweis ist erfüllt.	The verification is fulfilled.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

8 Betonierfuge / *Construction joint*

8.1 Allgemeines / *General*

Am unteren rand sowie am Sockelhöhe des Fundaments kann eine Arbeitsfuge vorgesehen werden. Die mittige Sektion zwischen 0,30 m und 2,30 m vom FUK können dann in einem zweiten Schritt betoniert werden. Den oberen Bereich vom Sockel (letzte 0,60 m) können in einem dritten Schritt betoniert werden.	A construction joint can be executed at the bottom so as at the base of the foundation. The middle section between 0,30 m and 2,30 m are then poured in a second step meanwhile the upper 0,6 m are poured in a third step.
Nachfolgend werden die Nachweise der Arbeitsfuge im Grenzzustand der Tragfähigkeit und unter Emüdung geführt.	The verifications for the construction joint in ultimate limit state an under fatigue are performed in this chapter.
Der Nachweis wird nach Eurocode 2 Ch. 6.2.5. [T-4] and [T-5] geführt.	The verification is performed according to the Eurocode 2 Ch. 6.2.5. [T-4] and [T-5].
Die Fuge wird als „glatt“ gemäß Eurocode 2 Abs. 6.2.5. [T-4] and [T-5] nachgewiesen. Eine Behandlung der Fugenoberfläche ist nicht erforderlich.	The joint is verified as “smooth” according to the Eurocode 2 Ch. 6.2.5 [T-4] and [T-5]. No treatment of its surface is therefore required.
Aufgrund der dynamischen Beanspruchung wird der Adhäsionstraganteil des Betonverbundes nicht berücksichtigt werden (c = 0).	Due to the dynamic loads the adhesion factor is not considered (c = 0).
Für die Normalspannung senkrecht zu der Fuge wird auf der sicheren Seite liegend nur das Betoneigengewicht berücksichtigt.	Conservatively only the weight of the concrete is considered as a normal stress vertical to the interface.
Der Bemessungswert der einwirkenden Querkraft wird anhand des FE-Modells ermittelt (siehe „Anhang C: Schnittgrößen“).	The design value of the shear force is determined in the FE model (see “Annex C: Internal forces”).

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

8.2 Fugentragfähigkeit in erste Fuge/ First *joint resistance in ULS*

Folgende wird die Tabelle der untersten Fuge auf die höhe zwischen 0,30 m und 1,31 m im Außenbereich des Fundaments und zwischen 1,31 m und 1,55 m in Inneren Bereich von der Fundamentbasis gezeigt.

Der Nachweis wird in alle Radiale Elemente geführt, nur im Sockel Bereich wird der Nachweis in den 3 Elemente zusammengeführt. Die Tabelle unten zeigt eine Zusammenfassung aller Nachweise. Als Beispiel wird der Nachweis der ersten drei Elementen gezeigt.

The following Table shows the first joint at a height between 0,30 m and 1,31 m at the outer area of the foundation and between 1,31 m and 1,55 m in the inside area measured from the foundation bottom.

The verification was carried on in all radial elements, only in the pedestal the verification was carried on combining the 3 first radial elements. The table below shows a summary of all verifications. As example the verification of the first three elements is shown.

Pos.-R (FE)	R_i	R_a	b	A	k	H	d	z	$v_{Ed,FE}$	$v^i_{Ed,FE}$	v_{Ed}
Numm.	*m*	*m*	*m*	*m²*	-	*m*	*m*	*m*	*kN/m*	*kN/m*	*kN/m²*
1	2,200	3,447	1,247	22,12	0,23	2,900	2,775	2,498	4301	2062	828
2	3,447	4,693	1,247	31,88	0,33	2,900	2,775	2,498	1994		
3	4,693	5,940	1,247	41,65	0,44	2,875	2,750	2,475	925		
4	5,940	6,940	1,000	40,46	1,00	2,090	1,965	1,768	1564	1564	884
5	6,940	7,940	1,000	46,75	1,00	1,870	1,745	1,570	1357	1357	864
6	7,940	8,902	0,962	50,90	1,00	1,654	1,529	1,376	1134	1134	824
7	8,902	9,864	0,962	56,71	1,00	1,442	1,317	1,185	913	913	771
8	9,864	10,826	0,962	62,53	1,00	1,230	1,105	0,994	723	723	727
9	10,826	11,788	0,962	68,34	1,00	1,018	0,893	0,804	526	526	655
10	11,788	12,750	0,962	74,16	1,00	0,806	0,681	0,613	284	284	464

Pos.-R (FE)	Φ	$A_{s,vor}$	$a_{s,vor}$	ρ	σ_n	v_{Rd}	v_{Ed} / v_{Rd}
Numm.	-	*cm²*	*cm²/m²*	-	*kN/m²*	*kN/m²*	-
1	468Φ28	2882	60	0,0060	36,75	1700	0,49
2		0					
3	468Φ28	2882					
4	176Φ28	1084	27	0,0027	32,12	1037	0,85
5	190Φ28	1170	25	0,0025	28,47	968	0,89
6	194Φ28	1195	23	0,0023	24,92	907	0,91
7	198Φ28	1219	21	0,0021	21,41	829	0,93
8	202Φ28	1244	20	0,0020	17,89	766	0,95
9	196Φ28	1207	18	0,0018	14,38	679	0,96
10	148Φ28	911	12	0,0012	10,87	473	0,98

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Unterste Fuge / *Lowest joint*

Legende / *Legend*

XXX → Eingabe / *Input*

Eingabe / *Input*

Geometrie / *Geometry*

$R_i^{Pos.R-1}$	=	2,200	m	
$R_a^{Pos.R-1}$	=	3,447	m	
$H^{Pos.R-1}$	=	2,900	m	
$d_1^{Pos.R-1}$	=	0,125	m	
$H_{Fuge,Außen}$	=	0,300	m	
$H_{Fuge,Knick}$	=	1,310	m	
$H_{Fuge,Mitte}$	=	1,550	m	
$b^{Pos.R-1}$	=	1,247	m	$= R_a^{Pos.R-1} - R_i^{Pos.R-1}$
$A^{Pos.R-1}$	=	22,115	m^2	$= \pi \cdot ((R_a^{Pos.-R-1})^2 - (R_i^{Pos.-R-1})^2)$
$A^{Pos.R-2}$	=	31,880	m^2	$= \pi \cdot ((R_a^{Pos.-R-2})^2 - (R_i^{Pos.-R-2})^2)$
$A^{Pos.R-3}$	=	41,646	m^2	$= \pi \cdot ((R_a^{Pos.-R-3})^2 - (R_i^{Pos.-R-3})^2)$
A_{Sockel}^{TOT}	=	95,641	m^2	$= A^{Pos.R-1} + A^{Pos.R-2} + A^{Pos.R-3}$
$d^{Pos.R-1}$	=	2,775	m	$= H^{Pos.R-1} - d_1^{Pos.R-1}$
$z^{Pos.R-1}$	=	2,498	m	$= 0,9 \cdot d^{Pos.R-1}$
$z^{Pos.R-2}$	=	2,498	m	$= 0,9 \cdot d^{Pos.R-2}$
$z^{Pos.R-3}$	=	2,475	m	$= 0,9 \cdot d^{Pos.R-3}$
$k^{Pos.R-1}$	=	0,23		$= A^{Pos.-R-1} / A_{Sockel}^{TOT}$
$k^{Pos.R-2}$	=	0,33		$= A^{Pos.-R-2} / A_{Sockel}^{TOT}$
$k^{Pos.R-3}$	=	0,44		$= A^{Pos.-R-3} / A_{Sockel}^{TOT}$

Lasten / *Loads*

$v_{Ed}^{Pos.R-1}$	=	4 301	kN/m	
$v_{Ed}^{Pos.R-2}$	=	1 994	kN/m	
$v_{Ed}^{Pos.R-3}$	=	925	kN/m	
$v_{Ed,Sockel}$	=	2 062	kN/m	$= k^{Pos.-R-1} \cdot v_{Ed}^{Pos.-R-1} + k^{Pos.-R-2} \cdot v_{Ed}^{Pos.-R-2} + + k^{Pos.-R-3} \cdot v_{Ed}^{Pos.-R-3}$

Material / *Material*

f_{yk}	=	500	MPa	
γ_S	=	1,00		
f_{yd}	=	500,0	MPa	$= f_{yk} / \gamma_S$
f_{ck}	=	30	MPa	
α_{cc}	=	0,85		
Y_c	=	1,50		
f_{cd}	=	17,0	MPa	$= \alpha_{cc} \cdot f_{ck} / Y_c$

Vorhandende Bewehrung innen / *Existing reinforcement inside*

$A_{s,vor}^{Pos.R-1}$	=	5763,4	cm^2	468Φ28 468Φ28
$a_{s,vor}^{Pos.R-1}$	=	60,3	cm^2/m^2	$= A_{s,vor} / A_{Sockel}^{TOT}$
$\rho^{Pos.R-1}$	=	0,0060		$= a_{s,vor}$
$v_{Ed}^{Pos.R-1}$	=	828	kN/m^2	$= \beta \cdot v_{Ed,Sockel} / (z^{Pos.R-1} + z^{Pos.R-2} + z^{Pos.R-3}) / 3$

Berechnung / *Calculation*

β	=	1,00	[-]	(Sichere Seite)
α_{Mitte}	=	87,69	°	$= Arctan (R_{a,Knick} / (H_{Fuge,Mitte} - H_{Fuge,Knick}))$
$\alpha_{außen}$	=	81,56	°	$= Arctan (R_a / (H_{Fuge,Knick} - H_{Fuge,Mitte}))$
c	=	0,00	[-]	dynamische Beanspruchung
μ	=	0,60	[-]	Glatte Fuge

v	=	0,20	[-]	Glatte Fuge
$\sigma_n^{Pos.R-1}$	=	36,75	kN/m²	= ($H^{Pos.R-1}$ - $H_{Fuge}^{Pos.R-1}$) · 25 kN/m³
$v_{Rd,Fuge}^{Pos.R-1}$	=	2 311	kN/m²	= $\mu \cdot \sigma_n + \rho_{innen} \cdot f_{yd} \cdot (1{,}2\ \mu \cdot \sin(\alpha_{innen}) + \cos(\alpha_{innen}))$
	≤	1 700	kN/m²	= ≤ 0,5 · v · f_{cd}
η	=	0,49		= v_{Ed} / $v_{Rd,Fuge}$ ≤ 1,00

8.3 Fugentragfähigkeit in GZT zweite Fuge / Second *joint resistance in ULS*

Folgende wird die Tabelle der zweite Fuge auf die höhe von Fundamentsockel gezeigt.

The following Table shows the second joint at the height of foundation base.

Ditten Schritt / *Third step*

Legende / *Legend*

XXX → Eingabe / *Input*

Eingabe / *Input*

Geometrie / *Geometry*

h_{Sockel}	=	0,600	m	
$R_i^{Pos.-R-1}$	=	2,200	m	
$R_a^{Pos.-R-1}$	=	3,447	m	
$R_a^{Pos.-R-2}$	=	4,693	m	
$R_a^{Pos.-R-3}$	=	5,940	m	
$A^{Pos.-R-1}$	=	22,12	m²	= $\pi \cdot ((R_a^{Pos.-R-1})^2 - (R_i^{Pos.-R-1})^2)$
$A^{Pos.-R-2}$	=	31,88	m²	= $\pi \cdot ((R_a^{Pos.-R-2})^2 - (R_a^{Pos.-R-1})^2)$
$A^{Pos.-R-3}$	=	41,65	m²	= $\pi \cdot ((R_a^{Pos.-R-3})^2 - (R_a^{Pos.-R-2})^2)$
A^{TOT}	=	95,64	m²	= $A^{Pos.-R-1} + A^{Pos.-R-2} + A^{Pos.-R-3}$
$k^{Pos.-R-1}$	=	0,23		= $A^{Pos.-R-1} / A^{TOT}$
$k^{Pos.-R-2}$	=	0,33		= $A^{Pos.-R-2} / A^{TOT}$
$k^{Pos.-R-3}$	=	0,44		= $A^{Pos.-R-3} / A^{TOT}$
h	=	2,900	m	
d_1	=	0,125	m	
d	=	2,775	m	= $h - d_1$
z	=	2,498	m	= $0,9 \cdot d$

Lasten / *Loads*

$v_{Ed}^{Pos.-R-1}$	=	4 301	kN/m	
$v_{Ed}^{Pos.-R-2}$	=	1 994	kN/m	
$v_{Ed}^{Pos.-R-3}$	=	925	kN/m	
v_{Ed}	=	2 062	kN/m	= $k^{Pos.-R-1} \cdot v_{Ed}^{Pos.-R-1} + k^{Pos.-R-2} \cdot v_{Ed}^{Pos.-R-2} + k^{Pos.-R-3} \cdot v_{Ed}^{Pos.-R-3}$

Material / *Material*

f_{yk}	=	500	MPa	
γ_S	=	1		
f_{yd}	=	434,8	MPa	= f_{yk} / γ_S
f_{ck}	=	30	MPa	
α_{cc}	=	0,85		
γ_c	=	1,50		
f_{cd}	=	17,0	MPa	= $\alpha_{cc} \cdot f_{ck} / \gamma_c$

Vorhandende Bewehrung / *Existing reinforcement*

α	=	90	°	
$A_{s,vor}$	=	5763,4	cm²	936Φ28
$a_{s,vor}$	=	60,3	cm²/m²	= $A_{s,vor} / A^{TOT}$
ρ	=	0,0060		= $a_{s,vor}$

Berechnung / *Calculation*

β	=	1,00	(Sichere Seite)
c	=	0,00	dynamische Beanspruchung
μ	=	0,60	Glatte Fuge

v	=	0,20			Glatte Fuge
σ_n	=	15	kN/m²	=	$h_{Sockel} \cdot 25$ kN/m³ (Sichere Seite)
v_{Ed}	=	826	kN/m²	=	$\beta \cdot v_{Ed} / z$
$v_{Rd,Fuge}$	=	1 895	kN/m²		$\mu \cdot \sigma_n + \rho \cdot f_{yd} \cdot (1{,}2\ \mu \cdot \sin(\alpha) + \cos(\alpha)) \leq$
	≤	1 700	kN/m²	=	$0{,}5 \cdot v \cdot f_{cd}$
η	=	0,49		=	$v_{Ed} / v_{Rd,Fuge} \leq 1{,}00$

8.4 Fugentragfähigkeit unter Ermüdung / *Joint resistance under fatigue*

Das gewählte Nachweisverfahren ist analog zu den Ermüdungsnachweisen der Biegebewehrung in Kapitel 7.2. Es werden mehrere Biegemoment-Niveaus und mehrere Lastfallkombinationen berücksichtigt.

The verification is analogically performed to the fatigue verifications of the bending reinforcement. The bending moment load levels and load combinations defined in chapter 7.2 are considered.

Die Querkraft wird analog zu dem Nachweis in GZT nach Flächenanteil gemittelt.

The shear force is determined with average areas analogically to the ULS verification.

Die Bewehrungsspannung wird nach der folgenden Formel berechnet. Die Abkürzungen entsprechen die aus dem GZT-Nachweis (siehe Abs. 8.2).

The reinforcement stresses are calculated with the following formula. The abbreviations correspond to the ones used in the ULS verifications (see Ch. 8.2).

$$\sigma_s = q\ [kN/m] / (z \cdot \rho \cdot 1{,}2 \cdot \mu)$$

Die Wöhler-Kurve Nummer 3 (definiert in 7.2) wird angesetzt mit der Ausnahme von $\Delta\sigma_{Rsk}$. Dieser Parameter wurde mit einem Faktor von 1/0,6 multipliziert.

The S-N-curve number 3 (defined in 7.2) is applied with the exception of $\Delta\sigma_{Rsk}$. This parameter was multiplied with a factor of 1/0,6.

Die nachfolgend angegebene Markov-Matrix (aus der Liste in 7.1) ist maßgebend.

The next specified Markov matrix (defined in the list in 7.1) is authoritative.

Maßgebende / *Authoritative* Markov-Matrix: Nr. 2

Die Schädigungssumme der 1. Fuge $D_{ges,1}$ für alle Elemente ergibt sich zu:

The resulting total damage of the 1st joint $D_{ges,1}$ of all elements is given below.

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Pos.-R (FE)	**$\Sigma D_{ges,1}$**
Numm.	
1	3,95E-03
2	
3	
4	9,89E-01
5	9,33E-01
6	9,34E-01
7	9,69E-01
8	9,89E-01
9	9,38E-01
10	9,12E-01

Die Schädigungssumme der 2. Fuge $D_{ges,2}$ ergibt sich zu:

The resulting total damage of the 2nd phase $D_{ges,2}$ is given next.

$$D_{ges,2} = 3{,}84E\text{-}03 \leq D_{zul} = 1{,}00$$

Der Nachweis ist erfüllt.

The verification is fulfilled.

In der folgenden Tabelle sind die Einzelschädigungen für einige Zeilen der Markov-Matrixen beispielhaft dargestellt.

Exemplarly the damage for some Markov matrix row are included next.

Mean	**Range**	**ni**	**M_{Unt}**	**M_{Obe}**	**ΔσTOT**	**N**	**D**
kNm	*kNm*	*Anz.*	*kNm*	*kNm*	*MPa*	-	-
167 300	7 008	5	163 797	170 804	5,2	9,885E+19	5,440E-20
167 300	0	3	167 300	167 300	0,0		0,000E+00
159 242	7 008	3	155 739	162 746	5,2	9,885E+19	2,720E-20
159 242	0	3	159 242	159 242	0,0		0,000E+00
151 184	14 016	3	144 176	158 192	10,4	2,009E+17	1,339E-17
151 184	7 008	3	147 681	154 688	5,2	1,020E+20	2,635E-20
151 184	0	8	151 184	151 184	0,0		0,000E+00
143 137	14 016	3	136 129	150 145	10,3	2,123E+17	1,267E-17
143 137	7 008	3	139 633	146 640	5,2	1,088E+20	2,471E-20
143 137	0	3	143 137	143 137	0,0		0,000E+00
135 079	7 008	5	131 575	138 582	5,2	1,088E+20	4,941E-20
135 079	0	5	135 079	135 079	0,0		0,000E+00
127 021	14 016	3	120 013	134 029	10,3	2,232E+17	1,204E-17
127 021	7 008	5	123 517	130 524	5,2	1,121E+20	4,799E-20

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

Anahng A: FE-System / *Annex A: FE system*

Siehe	Please refer to

220713_Anhang_A_System.pdf

Bauteil / *Component*:	Fundament / *Foundation*	Seite/ *Page*: 99 REV03
Block / *Chapter*:	Anahng A: FE-System / Annex A: FE system	

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

Anhang B: Lasten / *Annex B: Loads*

Siehe	Please refer to

220713_Anhang_B_Lasten.pdf

Bauteil / *Component*:	Fundament / *Foundation*	Seite / *Page*: 150 REV03
Block / *Chapter*:	Anhang B: Lasten / Annex B: Loads	

TÜV SÜD Industrie Service GmbH TÜ 12 MÜNCHEN

T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

VESTAS PROPRIETARY NOTICE

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

Anhang C: Schnittgrößen / *Annex C: Internal forces*

Siehe	Please refer to

220713_Anhang_C_Schnittgrößen.pdf

Verfasser / *Author*: MAX BÖGL Fortschritt baut man aus Ideen			Proj.-Nr. / *No.*: 21683-T22
			Datum / *Date*: 14.12.2023
WEA / *WT*: V162-6.8/7.2MW	NH / *HH*: 169 m	Hybridturm / *Hybrid tower*: T22	

Anhang D: Bewehrung / *Annex D: Reinforcement*

Siehe	Please refer to

220713_Anhang_D_Bewehrung.pdf

VESTAS PROPRIETARY NOTICE

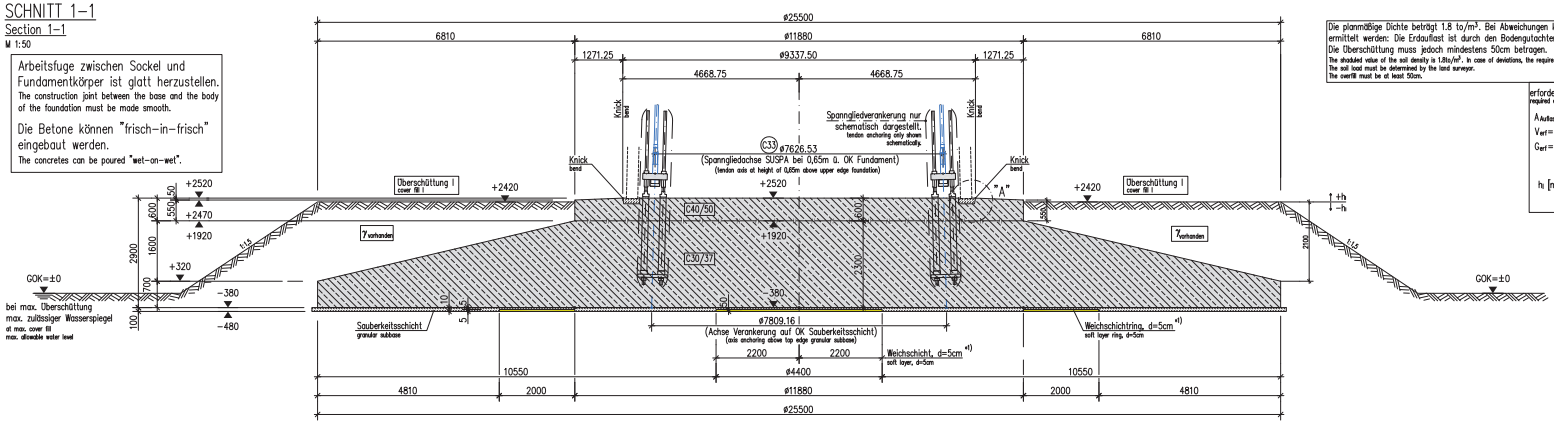
T04 0146-9413 Ver 01 - Approved- Exported from DMS: 2024-04-18 by INVOL

CONFIDENTIAL

SCHNITT 1–1
Section 1–1
M 1:50

Arbeitsfuge zwischen Sockel und Fundamentkörper ist glatt herzustellen.
The construction joint between the base and the body of the foundation must be made smooth.

Die Betone können "frisch-in-frisch" eingebaut werden.
The concretes can be poured "wet-on-wet".



Die plansmäßige Dichte beträgt 1,8 to/m³. Bei Abweichungen kann die erforderliche Überschüttung mit nachfolgender Formel ermittelt werden: Die Erdauflast ist durch den Bodengutachter festzulegen.
Die Überschüttung muss jedoch mindestens 50cm betragen.
The shouldet value of the soil density is 1,8ts/m³. In case of deviations, the required overfill can be calculated with following formula:
The soil load must be determined by the land surveyor.
The overfill must be of least 50cm.

erforderliche Erdauflast auf dem Fundamentkörper für Überschüttung I:
required earth cover on the foundation body for the cover fill I:

$A_{Auflast} = \frac{\pi}{4} \times (25{,}50^2 - 11{,}88^2) = 399{,}9\ m^2$

$V_{erf} = 558{,}7\ m^3$

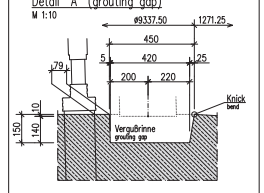
$G_{erf} = V \times \gamma = 558{,}7\ m^3 \times 1{,}8\ to/m^3 = 1005{,}7\ to$

$h\ [m] = \frac{G_{erf} - V_{erf}}{A_{Auflast}} = \frac{1005{,}7\ [to]}{399{,}9\ [m^2]} - \frac{V_{erh}\ [to/m^3]}{} = 558{,}7\ [m^3]$

Volumen Beton:
volume concrete: 880m³
Fundamentkopf = 64m³
Fundamentplatte = 816m³
Gewicht: weight: 22000kN

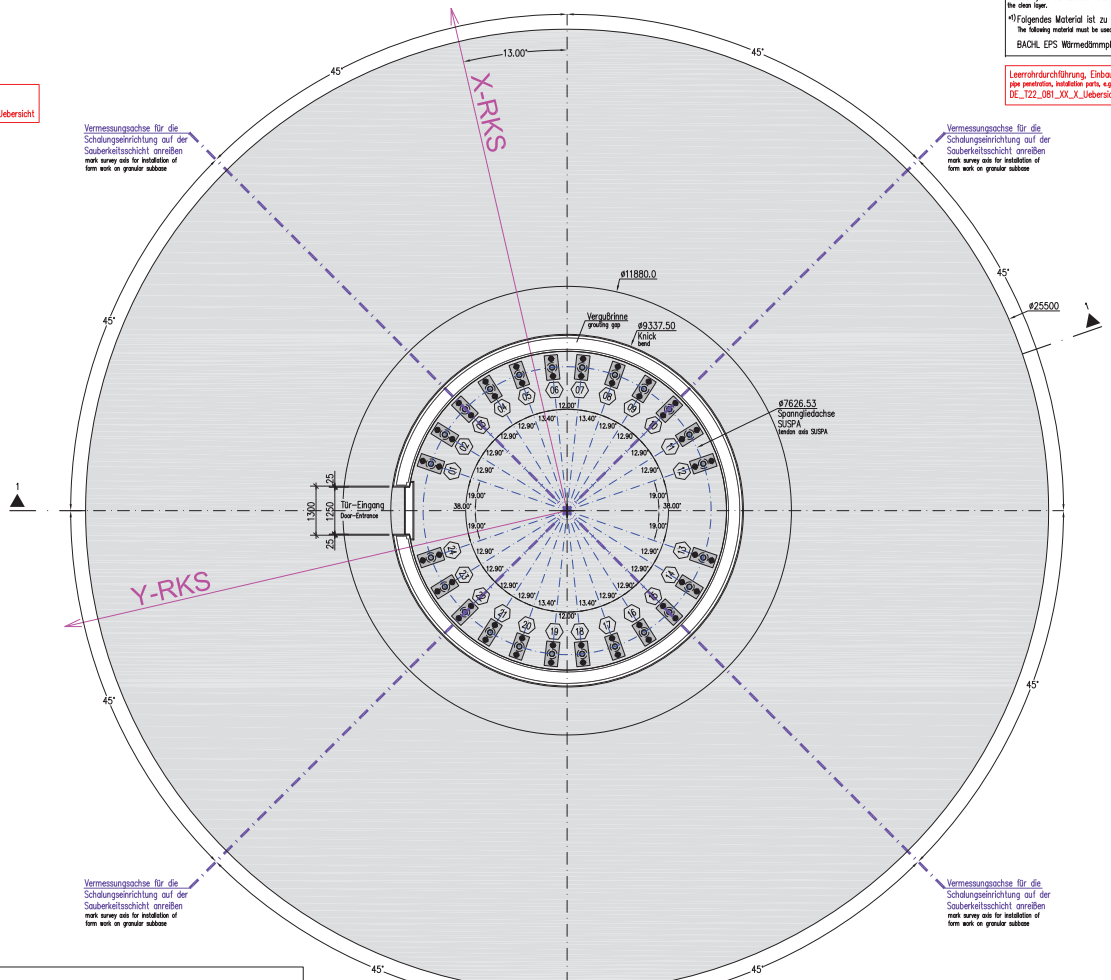
C40/50
C30/37

Detail "A" (Vergußrinne)
Detail "A" (grouting gap)
M 1:10



DRAUFSICHT
TOP VIEW
M 1:50

Detail Tür "Vergußbrett"
Detail door "Overmoulding board"
siehe Plan DE_T22_081_XX_X_Uebersicht



Achtung:
Spanngliedernummerierung auf Fundament kennzeichnen!
Attention:
Mark the numbers of the tendons on the foundation!

Sichtbare Betonkanten 1,0/1,0cm fasen
Visible concrete edges chamfer 1,0/1,0cm

Die Weichschicht in der Fundamentmitte kann in oder auf der Sauberkeitsschicht angeordnet werden.
The soft layer in the foundation center can be placed in or on top of the clean layer.
*1) Folgendes Material ist zu verwenden:
The following material must be used:
BACHL EPS Wärmedämmplatten EPS040 W/DI

Leerrohrdurchführung, Einbauteile, etc. siehe Plan
pipe penetration, installation parts, e.g. see plan
DE_T22_081_XX_X_Uebersicht

3667703-22-d Rev.2
in bautechnischer Hinsicht geprüft.
Siehe Prüfbericht vom 21.12.2023
München 21.12.2023
TÜV SÜD Industrie Service GmbH
Prüfamt für Standsicherheit
von Windenergieanlagen
Der Bearbeiter / Der Leiter

TYPENPRÜFUNG Geltungsdauer
5 Jahre/Wiedervorlage bis 30.08.2027

Die erforderliche Erdanschüttung auf dem Fundament, im Errichtungszustand, ist aus dem Statikkapitel "Bauzustände" zu entnehmen.
The required earth fill on the foundation in the erection process can be taken from the structural analysis, chapter "construction stages".

Die maximale Schiefstellung infolge Baugrundsetzungen dueerfen gemaeß der DIBt–Richtlinie, Fassung Oktober 2012, folgenden Wert nicht überschreiten:
The maximum tilt due to differential settlements must not exceed the following value, according to DIBt–guidline, edition october 2012:

In 25 Jahren	3mm/m
in 25 years	3mm/m

Im Lastfall BS–P nach DIN 1054:2010 ergibt sich rechnerisch folgende max. charakteristische Kantenpressung:
In loadcase BS–P, DIN 1054:2010, a maximum characteristic edge pressure has been calculated: σ_{RA} =278 kN/m²

Im Lastfall BS–T nach DIN 1054:2010 ergibt sich rechnerisch folgende max. charakteristische Kantenpressung:
In loadcase BS–T, DIN 1054:2010, a maximum characteristic edge pressure has been calculated: σ_{RA} =201 kN/m²

Im Lastfall BS–A nach DIN 1054:2010 ergibt sich rechnerisch folgende max. charakteristische Kantenpressung:
In loadcase BS–A, DIN 1054:2010, a maximum characteristic edge pressure has been calculated: σ_{RA} =361 kN/m²

Alle Werte sind durch den Baugrundgutachter für den jeweiligen Standort zu bestätigen.
All values has to be verified by the building geotechnical expert for the specific location.

Der Grundbruchnachweis ist vom Baugrundgutachter zu erbringen. Dabei ist die mittlere Bodenpressung mit den Lasten aus folgender Tabelle zu ermitteln:
Zusätzlich sind die Lasten der Erdüberschüttung und des Auftriebs gemäß den Planungen für den jeweiligen Standort der Windenergieanlagen anzusetzen.
The verification against soil rupture has to be carried out by the building geotechnical expert. For this, the mean soil pressure has to be calculated with the loads given in the following table:
Additionally the loads stemming from the earth cover and the buoyancy according to the design need to be taken into account for the respective wind turbine location.

Maximale charakteristische Lasten (γ=1,00) in der Sohlfuge der Gründung (inkl. Erdüberschuettung, Auftrieb und etwaiger Anbauteile)
Maximum characteristic loads (γ=1,00) in the joint between bottom of foundation and soil (incl. earth cover fill, hydrostatic uplift and possible mounting parts)

	BS–P (DIN 1054:2010)	BS–T (DIN 1054:2010)	BS–A (DIN 1054:2010)
Vk [kN]	41849	41849	41727
Hk [kN]	2162	1027	2011
Mk [kNm]	232255	140397	289965

Zementsorte: grade of cement:	CEM II–Zemente ohne (exclusively) oder CEM II–Zemente mit Flugasche (cement with fly ash) oder CEM I– und CEM II–Zemente mit Flugasche (cement with fly ash)
Ausführung: execution:	Massenbeton nach DAfStb–Richtlinie: Massige Bauteile aus Beton Fundamentausführung nach / Bulk concrete according to DAfStb–guideline: concrete structural elements Foundation construction according to DIN EN 206–1 i.Vm. DIN 1045–2, DIN EN 1992–1–1 & DIN EN 13670 i.Vm. DIN 1045–3

Fugenausbildung mit einem Vergussmortel siehe zugehörigen Ueberschichtplan

Grundlegende Anforderungen
Mennwert des Grosdurms der Gesteinskoernung:
Fundamentkopf
verbleibender Fundamentsockel } siehe Betonogekonzept
Klasse des Chloridgehaltes: Cl 0,20
Frischbetontemperatur nach Angabe Betontechnologe jedoch maximal 30°C

Zusaetzliche Anforderungen
brisch– und schwindarmen Beton für die Außenbauteile.
Geringe Hydratationswaerme.
Wegen der großen Betondruckspannungen ist zur Vermeidung schaedlicher Auswirkungen infolge Abbindewaerme und Schwindverkürzung ein Betontechnologe einzuschalten.
Betonrezeptur mit geringer Wärmeentwicklung während des Hydrationsprozesses waehlen.
Probekörper sind gemaeß bauteilenbezogenen Prüfplan zu erstellen.
Fundamentoberfläche nachverdichten.

Der Auftragnehmer ist fuer alle Maßnahmen sowie die korrekte Arbeitsausführung vor Ort verantwortlich.
Es sind nur eingegebene Maßnahmen zu verwenden.
Jegliche Unstimmigkeiten muessen dem Bauleiter gemeldet werden bevor die Arbeit fortgesetzt wird.

Die Aushubarbeiten sind von einem Fachingenieur zu ueberwachen.
Die Betonzusammensetzung ist durch entsprechende Lieferzeugnisse zu bestätigen.

Die Nachbehandlungsmaßnahmen sind mit dem Betontechnologen auf die Betoneigenschaften und die Witterungsverhaeltnisse abzustimmen.

Joint construction with a grouting mortar see associated layout complete tower

Fundamental requirements
maximal grain size of the aggregate:
foundation cap
remaining foundation body } see casting concept
class of the chlorid concentration: Cl 0,20
Temperature of fresh concrete according to expert for concrete technology but not higher than 30°C

Additional requirements
low shrinking and creeping concrete shall be used for outside comp.
low heat of hydration.
An expert on concrete technology has to be consulted to avoid damage due to shrinkage, hydration or possible aggressive components of the ground.
A concrete formula with low thermal development during the hydration process has to be chosen.
Concrete test–specimens must be produced in accordance to the building–site related inspection plan.
Repress and mechanical abrade the foundation surface.

The contractor is responsible for all dimensions and for the correct setting out of the work on site.
Only figured dimensions are to be used.
Any discrepancies are to be reported to the engineer before proceeding.

All excavations have to be inspected by a qualified engineer.
The composition of the concrete has to be confirmed by the delivery certification.

The after–treatment measures have to be adjusted and written down in consultation with the concrete technology expert according to the concrete properties and weather conditions.

Biege– und Verlegeanweisung
Bending– and installation instruction
nach/according: EC2 + NA

Mindestbiegerollendurchmesser / Minimum mandrel diameters



Betonfestigkeitsklasse ≤ C50/60	> 100 mm und > 3 x d	$d_{m,min} = 4\,d$
	≤ 100 mm und > 3 x d	$d_{m,min} = 7\,d$
	≤ 35 mm und ≤ 3 x d	$d_{m,min} = 10\,d$
concrete strength class ≤ C50/60		$d_{m,min} \geq 10\,d$ für < 20 mm for < 20 mm
		$d_{m,min} \geq 7\,d$ für ≥ 20 mm for ≥ 20 mm

Die Gesamtlängen der Auszüge beziehen sich auf Außenmaße
All total lengths of bar profiles show outside dimensions

Baustoffe
Building materials

letzte Stabstahlposition final steel bar position	–	Betonstahl: B500B reinforcement steel: gemäß/according to DIN 488–1 + DIN EN 10080
letzte Mattenposition final mesh position	–	Betonfestigkeitsklasse: C30/37 & C40/50 Concrete strengths: gemäß/according to DIN EN 1992–1–1

Betondeckung [mm]
Concrete cover

	Expositionsklassen Exposure classes	Vorhaltemaß c_v Laying measurement c_v	Vorhaltemaß Δc_{dev} Allowance measurement Δc_{dev}
innen inside	XC4, XD1, WT1, WF	55	15
außen/innen/unten outside/top/lower	XC4, XD1, WT1, WF	55/55/55	15/15/15
seitlich lateral	XC4, XD1, WT1, WF	55	15

Anmerkung: Expositionsklasse XD1 nur in Außenbereich ohne Erdüberdeckung erforderlich.
Note: Exposure class XD1 in outside areas without backfill / earth cover

– dynamische Drehfeder der Gründung: dynamic rotational stiffness	$K_{dyn} \geq 200000$ MNm/rad
– statische Drehfeder der Gründung: statical rotational stiffness	$K_{stat} \geq 40000$ MNm/rad

ZUGEHÖRIGE PLÄNE	ASSOCIATED DRAWINGS
Plan NR. :	Planbezeichnung
DE_T22_001_XX_X_Uebersicht	Übersichtsplan Gesamtturm / layout complete tower
DE_T22_003_XX_X_Erdung	Erdungskonzept Übersichtsplan / general plan with earthing concept
DE_T22_004_XX_X_Erdung	Erdung für Fundament / grounding for foundation
DE_T22_006_XX_X_Bewehrung	Bewehrungsplan Fundament / foundation reinforcement plan
DE_T22_081_XX_X_Uebersicht	Übersichtsplan Leerrohraustritt / layout pipe penetration
M578	Spanngliedverankerung 3,0 / tendon anchoring 3,0
VA_XXX_MXYZ–C33_SegW–3–E_Montageplan	Absteckung Montagerahmen / staking out mounting frame

VESTAS Windenergieanlage
WEA VESTAS V162
Stahl–Betonhybridturm (T22)
169m NH
Rotorblattdurchmesser 162m
DIBt 2

VESTAS wind turbine
WEC VESTAS V162
steel concrete hybrid tower (T22)
169mm HH
rotor blade diameter 162m
DIBt 2

Änderung:	Bezeichnung	ersetzt:	Datum:
A			
B			
C			
D			
E			
F			
G			
H			
I			
J			
K			
L			
M			
N			
O			
P			
Q			
R			
S			
T			
U			
V			
W			
X			
Y			
Z			
AA			
AB			
AC			
AD			
AE			
AF			
AG			
AH			
AI			
AJ			
AK			
AL			
AM			
AN			
AO			
AP			
AQ			
AR			
AS			
AT			
AU			
AV			
AW			
AX			
AY			
AZ			
BA			
BB			
BC			
BD			
BE			
BF			
BG			
BH			
BI			
BJ			
BK			
BL			
BM			
BN			
BO			
BP			
BQ			
BR			
BS			
BT			
BU			
BV			
BW			
BX			
BY			
BZ			
CA			
CB			
CC			
CD			
CE			
CF			
CG			
CH			
CI			
CJ			
CK			
CL			
CM			
CN			
CO			
CP			
CQ			
CR			
CS			
CT			
CU			
CV			
CW			
CX			
CY			
CZ			
DA			
DB			
DC			
DD			
DE			
DF			
DG			
DH			
DI			
DJ			
DK			
DL			
DM			
DN			
DO			
DP			
DQ			
DR			
DS			
DT			
DU			
DV			
DW			
DX			
DY			
DZ			
EA			
EB			
EC			
ED			
EE			
EF			
EG			
EH			
EI			
EJ			
EK			
EL			
EM			
EN			
EO			
EP			
EQ			
ER			
ES			
ET			
EU			
EV			
EW			
EX			
EY			
EZ			
FA			
FB			
FC			
FD			
FE			
FF			
FG			
FH			
FI			
FJ			
FK			
FL			
FM			
FN			
FO			
FP			
FQ			
FR			
FS			
FT			
FU			
FV			
FW			
FX			
FY			
FZ			
GA			
GB			
GC			
GD			
GE			
GF			
GG			
GH			
GI			
GJ			
GK			
GL			
GM			
GN			
GO			
GP			
GQ			
GR			
GS			
GT			
GU			
GV			
GW			
GX			
GY			
GZ			
HA			
HB			
HC			
HD			
HE			
HF			
HG			
HH			
HI			
HJ			
HK			
HL			
HM			
HN			
HO			
HP			
HQ			
HR			
HS			
HT			
HU			
HV			
HW			
HX			
HY			
HZ			
IA			
IB			
IC			
ID			
IE			
IF			
IG			
IH			
II			
IJ			
IK			
IL			
IM			
IN			
IO			
IP			
IQ			
IR			
IS			
IT			
IU			
IV			
IW			
IX			
IY			
IZ			
JA			
JB			
JC			
JD			
JE			
JF			
JG			
JH			
JI			
JJ			
JK			
JL			
JM			
JN			
JO			
JP			
JQ			
JR			
JS			
JT			
JU			
JV			
JW			
JX			
JY			
JZ			
KA			
KB			
KC			
KD			
KE			
KF			
KG			
KH			
KI			
KJ			
KK			
KL			
KM			
KN			
KO			
KP			
KQ			
KR			
KS			
KT			
KU			
KV			
KW			
KX			
KY			
KZ			
LA			
LB			
LC			
LD			
LE			
LF			
LG			
LH			
LI			
LJ			
LK			
LL			
LM			
LN			
LO			
LP			
LQ			
LR			
LS			
LT			
LU			
LV			
LW			
LX			
LY			
LZ			
MA			
MB			
MC			
MD			
ME			
MF			
MG			
MH			
MI			
MJ			
MK			
ML			
MM			
MN			
MO			
MP			
MQ			
MR			
MS			
MT			
MU			
MV			
MW			
MX			
MY			
MZ			
NA			
NB			
NC			
ND			
NE			
NF			
NG			
NH			
NI			
NJ			
NK			
NL			
NM			
NN			
NO			
NP			
NQ			
NR			
NS			
NT			
NU			
NV			
NW			
NX			
NY			
NZ			
OA			
OB			
OC			
OD			
OE			
OF			
OG			
OH			
OI			
OJ			
OK			
OL			
OM			
ON			
OO			
OP			
OQ			
OR			
OS			
OT			
OU			
OV			
OW			
OX			
OY			
OZ			
PA			
PB			
PC			
PD			
PE			
PF			
PG			
PH			
PI			
PJ			
PK			
PL			
PM			
PN			
PO			
PP			
PQ			
PR			
PS			
PT			
PU			
PV			
PW			
PX			
PY			
PZ			
QA			
QB			
QC			
QD			
QE			
QF			
QG			
QH			
QI			
QJ			
QK			
QL			
QM			
QN			
QO			
QP			
QQ			
QR			
QS			
QT			
QU			
QV			
QW			
QX			
QY			
QZ			
RA			
RB			
RC			
RD			
RE			
RF			
RG			
RH			
RI			
RJ			
RK			
RL			
RM			
RN			
RO			
RP			
RQ			
RR			
RS			
RT			
RU			
RV			
RW			
RX			
RY			
RZ			
SA			
SB			
SC			
SD			
SE			
SF			
SG			
SH			
SI			
SJ			
SK			
SL			
SM			
SN			
SO			
SP			
SQ			
SR			
SS			
ST			
SU			
SV			
SW			
SX			
SY			
SZ			
TA			
TB			
TC			
TD			
TE			
TF			
TG			
TH			
TI			
TJ			
TK			
TL			
TM			
TN			
TO			
TP			
TQ			
TR			
TS			
TT			
TU			
TV			
TW			
TX			
TY			
TZ			
UA			
UB			
UC			
UD			
UE			
UF			
UG			
UH			
UI			
UJ			
UK			
UL			
UM			
UN			
UO			
UP			
UQ			
UR			
US			
UT			
UU			
UV			
UW			
UX			
UY			
UZ			
VA			
VB			
VC			
VD			
VE			
VF			
VG			
VH			
VI			
VJ			
VK			
VL			
VM			
VN			
VO			
VP			
VQ			
VR			
VS			
VT			
VU			
VV			
VW			
VX			
VY			
VZ			
WA			
WB			
WC			
WD			
WE			
WF			
WG			
WH			
WI			
WJ			
WK			
WL			
WM			
WN			
WO			
WP			
WQ			
WR			
WS			
WT			
WU			
WV			
WW			
WX			
WY			
WZ			
XA			
XB			
XC			
XD			
XE			
XF			
XG			
XH			
XI			
XJ			
XK			
XL			
XM			
XN			
XO			
XP			
XQ			
XR			
XS			
XT			
XU			
XV			
XW			
XX			
XY			
XZ			
YA			
YB			
YC			
YD			
YE			
YF			
YG			
YH			
YI			
YJ			
YK			
YL			
YM			
YN			
YO			
YP			
YQ			
YR			
YS			
YT			
YU			
YV			
YW			
YX			
YY			
YZ			
ZA			
ZB			
ZC			
ZD			
ZE			
ZF			
ZG			
ZH			
ZI			
ZJ			
ZK			
ZL			
ZM			
ZN			
ZO			
ZP			
ZQ			
ZR			
ZS			
ZT			
ZU			
ZV			
ZW			
ZX			
ZY			
ZZ			

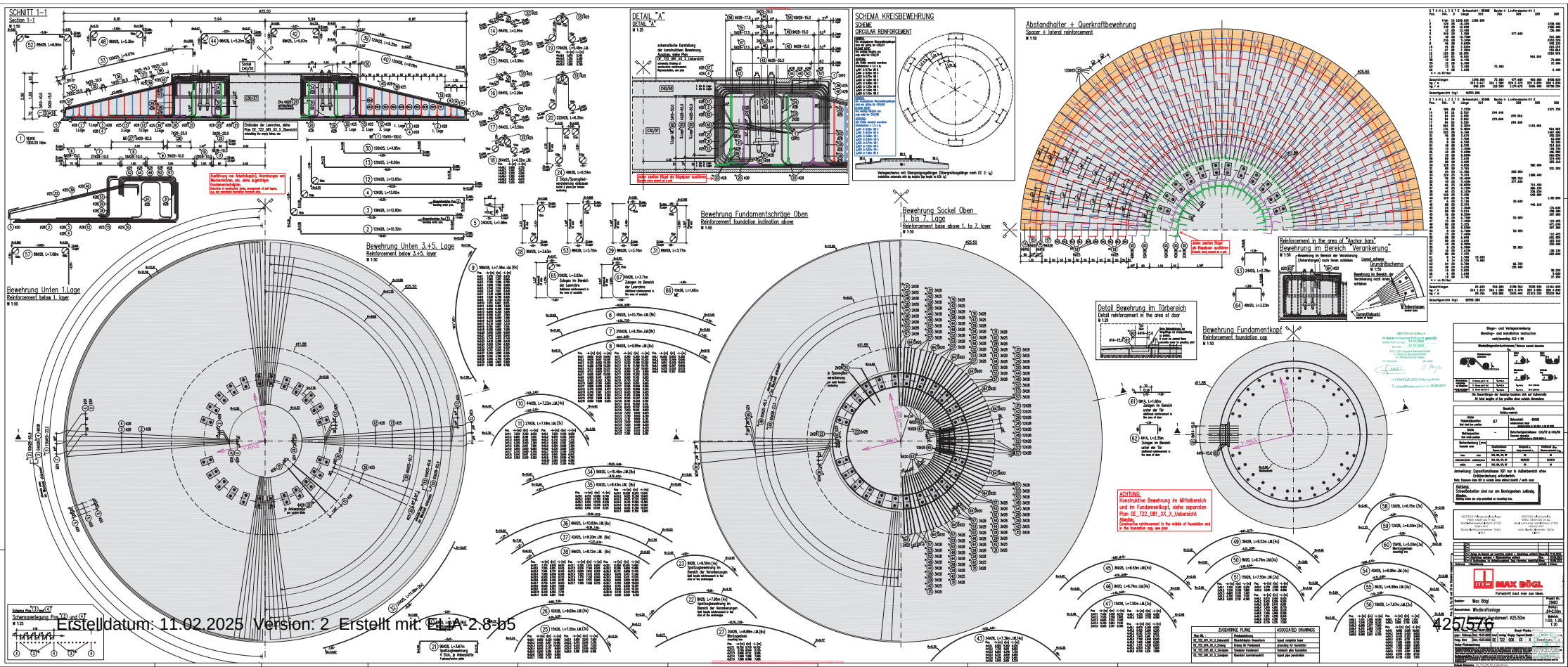
MAX BÖGL
Fortschritt baut man aus Ideen.

Bauherr:	Max Bögl	Projekt Nr.:	21683
Bauvorhaben:	Windkraftanlage wind turbine generator	Blattgr.:	1.19x.84m
Bauteile:	Schalplan Fundament ø25,50m formwork plan foundation	Maßstab:	1:50; 1:25; 1:10

erst.: Moos.	Dat.: 04.07.2022	Boegl–Planbezeichnung			
gepr.: Reiterup.	Dat.: 05.07.2022	Level	Variante	Ringtyp	Segment	Bauabschnitt	Index
freig.: Betz	Dat.: 05.07.2022	X	X	Schalplan	X	X	X
Version–Planbezeichnung		15	10	01			

Softpad–Dateiname: DE_T22_XXX_XX_X_Schalplan

Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: ELiA-2.8-b5

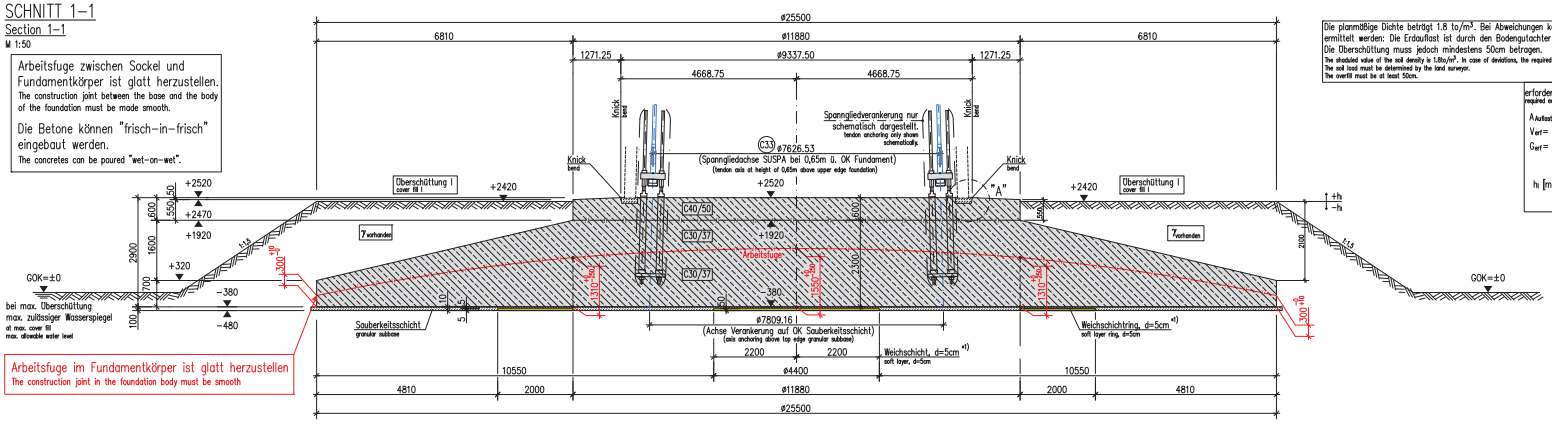

SCHNITT 1–1
Section 1–1
DETAIL "A"
DETAIL "A"
SCHEMA KREISBEWEHRUNG
SCHEME
CIRCULAR REINFORCEMENT
Abstandhalter + Querkraftbewehrung
Spacer + lateral reinforcement
Bewehrung Fundamentschräge Oben
Reinforcement foundation inclination above
Bewehrung Sockel Oben
1. bis 7. Lage
Reinforcement base above 1. to 7. layer
Bewehrung Unten 1.Lage
Reinforcement below 1. layer
Bewehrung Unten 3.+5. Lage
Reinforcement below 3.+5. layer
Reinforcement in the area of "Anchor bars"
Bewehrung im Bereich "Verankerung"
Detail Bewehrung im Türbereich
Detail reinforcement in the area of door
Bewehrung Fundamentkopf
Reinforcement foundation cap
ACHTUNG:
Konstruktive Bewehrung im Mittelbereich und im Fundamentkopf, siehe separaten Plan DE_T22_081_XX_X_Übersicht
Attention:
Constructive reinforcement in the middle of foundation and in the foundation cap, see plan
Schema Pos. 6 und 7
Schemaverlegung Pos. 6 und 7
Steiger- und Verlegeanweisung
Bending- and installation instruction
Max Bögl
Windkraftanlage
Fundamentkopf ø25.50m
ZUGEHÖRIGE PLÄNE
ASSOCIATED DRAWINGS
Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: CLIA 2.8-b5
425/576

CONFIDENTIAL

SCHNITT 1–1
Section 1–1
M 1:50

Arbeitsfuge zwischen Sockel und Fundamentkörper ist glatt herzustellen.
The construction joint between the base and the body of the foundation must be made smooth.

Die Betone können "frisch–in–frisch" eingebaut werden.
The concretes can be poured "wet–on–wet".



Arbeitsfuge im Fundamentkörper ist glatt herzustellen
The construction joint in the foundation body must be smooth

Die planmäßige Dichte beträgt 1.8 to/m³. Bei Abweichungen kann die erforderliche Überschüttung mit nachfolgender Formel ermittelt werden: Die Erdauflast ist durch den Bodengutachter festzulegen.
Die Überschüttung muss jedoch mindestens 50cm betragen.
The stipulated value of the soil density is 1.8to/m³. In case of deviations, the required overfill can be calculated with following formula:
The soil load must be determined by the land surveyor.
The overfill must be at least 50cm.

erforderliche Endauflast auf dem Fundamentkörper für Überschüttung I:
required earth cover on the foundation body for the cover fill I:

$A_{Auflast} = \frac{\pi}{4} \times (25{,}50^2 - 11{,}88^2) = 399{,}9\ m^2$

$V_{erf} = 558{,}7\ m^3$

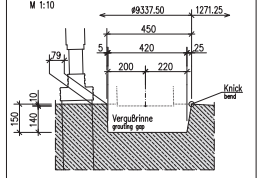
$G_{erf} = V \times \gamma = 558{,}7\ m^3 \times 1{,}8\ to/m^3 = 1005{,}7\ to$

$$h\,[m] = \frac{G_{erf} - V_{erf}}{A_{Auflast}} = \frac{\gamma_{earth}\,[to/m^3]}{399{,}9\ [m^2]} = \frac{1005{,}7\ [to]}{399{,}9\ [m^2]} - 558{,}7\ [m^3]$$

Volumen Beton:
volume concrete: 880m³
Fundamentkopf = 64m³
Fundamentplatte = 816m³
↳ BA1 = 464m³
↳ BA2 = 352m³
Gewicht: weight: 22000kN

C30/37 BA2 | C40/50 | C30/37 BA1

Detail "A" (Vergußrinne)
Detail "A" (grouting gap)
M 1:10



Die Weichschicht in der Fundamentmitte kann in oder auf der Sauberkeitsschicht angeordnet werden.
The soft layer in the foundation center can be placed in or on top of the clean layer.

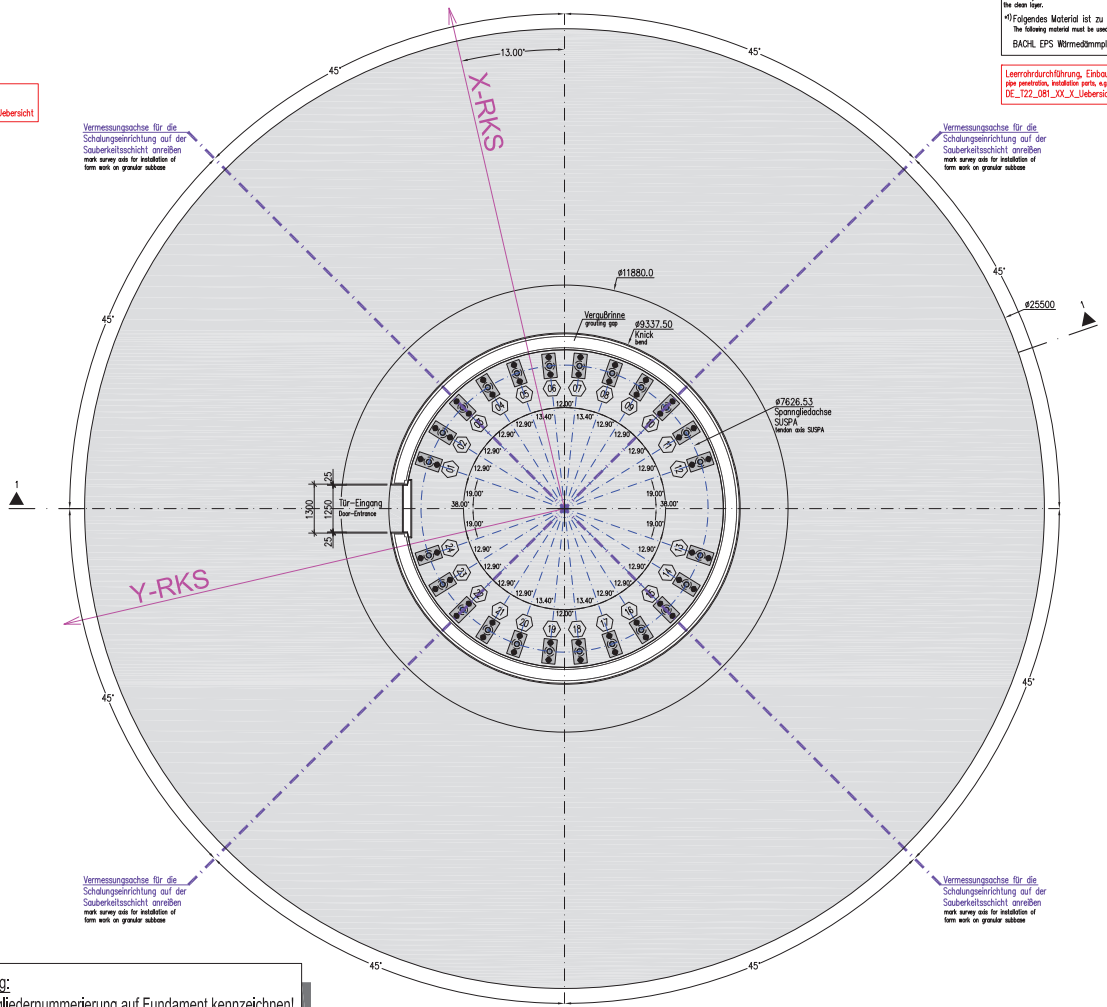
*1) Folgendes Material ist zu verwenden:
The following material must be used:
BACHL EPS Wärmedämmplatten EPS040 W/DI

Leerrohrdurchführung, Einbauteile, etc. siehe Plan
pipe penetration, installation parts, e.g. see plan
DE_T22_081_XX_X_Uebersicht

3667703-22-d Rev.2
in bautechnischer Hinsicht geprüft.
Siehe Prüfbericht vom 21.12.2023
München, 21.12.2023
TÜV SÜD Industrie Service GmbH
Prüfamt für Standsicherheit von Windenergieanlagen
Der Prüfer: Der Leiter:
TYPENPRÜFUNG Geltungsdauer 5 Jahre/Wiedervorlage bis 30.08.2027

DRAUFSICHT
TOP VIEW
M 1:50

Detail Tür "Vergußbrett"
Detail door "Overmaulding board"
siehe Plan DE_T22_081_XX_X_Uebersicht



Vermessungsachse für die Schalungseinrichtung auf der Sauberkeitsschicht anreißen
mark survey axis for installation of form work on granular subbase

Achtung:
Spanngliedernummerierung auf Fundament kennzeichnen!
Attention:
Mark the numbers of the tendons on the foundation!

Sichtbare Betonkanten 1,0/1,0cm fasen
Visible concrete edges chamfer 1,0/1,0cm

Die erforderliche Erdanschüttung auf dem Fundament, im Errichtungszustand, ist aus dem Statikkapitel "Bauzustände" zu entnehmen.
The required earth fill on the foundation in the erection process can be taken from the structural analysis, chapter "construction stages".

Die maximale Schiefstellung infolge Baugrundsetzungen dueerfen gemaeß der DIBt–Richtlinie, Fassung Oktober 2012, folgenden Wert nicht überschreiten: The maximum tilt due to differential settlements must not exceed the following value, according to DIBt–guidline, edition october 2012:	in 25 Jahren 3mm/m in 25 years 3mm/m
Im Lastfall BS–P nach DIN 1054:2010 ergibt sich rechnerisch folgende max. charakteristische Kantenpressung: In loadcase BS–P, DIN 1054:2010, a maximum characteristic edge pressure has been calculated:	σ_{RA} =278 kN/m²
Im Lastfall BS–T nach DIN 1054:2010 ergibt sich rechnerisch folgende max. charakteristische Kantenpressung: In loadcase BS–T, DIN 1054:2010, a maximum characteristic edge pressure has been calculated:	σ_{RA} =201 kN/m²
Im Lastfall BS–A nach DIN 1054:2010 ergibt sich rechnerisch folgende max. charakteristische Kantenpressung: In loadcase BS–A, DIN 1054:2010, a maximum characteristic edge pressure has been calculated:	σ_{RA} =361 kN/m²
Alle Werte sind durch den Baugrundgutachter für den jeweiligen Standort zu bestätigen. All values has to be verified by the building geotechnical expert for the specific location.	

Der Grundbruchnachweis ist vom Baugrundgutachter zu erbringen. Dabei ist die mittlere Bodenpressung mit den Lasten aus folgender Tabelle zu ermitteln:
Zusätzlich sind die Lasten der Erdüberschüttung und des Auftriebs gemäß den Planungen für den jeweiligen Standort der Windenergieanlagen anzusetzen.
The verification against soil rupture has to be carried out by the building geotechnical expert. For this, the mean soil pressure has to be calculated with the loads given in the following table:
Additionally the loads stemming from the earth cover and the buoyancy according to the design need to be taken into account for the respective wind turbine location.

Maximale charakteristische Lasten (γ_F=1,00) in der Sohlfuge der Gründung (exkl. Erdueberschuettung, Auftrieb und ev. Bodenplatte)
Maximum characteristic loads (γ_F=1,00) in the joint between bottom of foundation and soil (excl. earth cover fill, hydrostatic uplift and possible mounting parts)

	BS–P (DIN 1054:2010)	BS–T (DIN 1054:2010)	BS–A (DIN 1054:2010)
V_k [kN]	41849	41849	41727
H_k [kN]	2162	1027	2011
M_k [kNm]	232255	140397	289965

Zementsorte: grade of cement:	CEM III–Zemente ohne (exclusively) oder CEM II–Zemente mit Flugasche (cement with fly ash) oder CEM I– und CEM II–Zemente mit Flugasche (cement with fly ash)
Ausführung: execution:	Massenbeton nach DAfStb–Richtlinie: Massige Bauteile aus Beton Fundamentausführung nach / Bulk concrete according to DAfStb–guideline: concrete structural elements Foundation construction according to: DIN EN 206–1 i.Vm. DIN 1045–2; DIN EN 1992–1–1 & DIN EN 13670 i.Vm. DIN 1045–3

Fugenausbildung mit einem Vergussmoertel siehe zugehoerigen Uebersichtsplan

Grundlegende Anforderungen
Nennwert des Grießkorns der Gesteinskoernung: Fundamentkopf → siehe Betonsgebkonzept
verbleibender Fundamentkoerper
Klasse des Chloridgehaltes: Cl 0,20
Frischbetontemperatur nach Angabe Betontechnologe jedoch maximal 30°C

Zusaetzliche Anforderungen
krisch– und schwindarmen Beton für die Außenbauteile.
Geringe Hydratationswaerme.
Wegen der großen Betonabmessungen ist zur Vermeidung schaedlicher Auswirkungen infolge Abbindewaerme und Schwindreirkung ein Betontechnologe einzuschalten.
Betonrezeptur mit geringer Wärmeentwicklung während des Hydratationsprozesses waehlen.
Probekörper sind gemaß bauteilbezogenen Prüfplan zu erstellen.
Fundamentoberfläche nachverdichten.

Der Auftragnehmer ist fuer alle Maßnahmen sowie die korrekte Arbeitsausführung vor Ort verantwortlich.
Es sind nur angegebene Maßnahmen zu verwenden.
Jegliche Unstimmigkeiten muessen dem Bauleiter gemeldet werden bevor die Arbeit fortgesetzt wird.

Die Ausführarbeiten sind von einem Fachingenieur zu ueberwachen.
Die Betonzusammensetzung ist durch entsprechende Lieferzeugnisse zu bestätigen.

Die Nachbehandlungsmaßnahmen sind mit dem Betontechnologen auf die Betoneigenschaften und die Witterungsverhaeltnisse abzustimmen.

Joint construction with a grouting mortar see associated layout complete tower

Fundamental requirements
maximal grain size of the aggregate: foundation cap → see casting concept
remaining foundation body
class of the chlorid concentration: Cl 0,20
Temperature of fresh concrete according to expert for concrete technology but not higher than 30°C

Additional requirements
low shrinking and creeping concrete shall be used for outside comp.
low heat of hydration.
An expert on concrete technology has to be consulted to avoid damage due to shrinkage, hydration or possible aggressive components of the ground.
A concrete formula with low thermal development during the hydration process has to be chosen.
Concrete test–specimens must be produced in accordance to the building–site related inspection plan.
Repress and mechanical abrade the foundation surface.

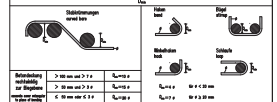
The contractor is responsible for all dimensions and for the correct setting out of the work on site.
Only figured dimensions are to be used.
Any discrepancies are to be reported to the engineer before proceeding.

All excavations have to be inspected by a qualified engineer.
The composition of the concrete has to be confirmed by the delivery certification.

The after–treatment measures have to be adjusted and written down in consultation with the concrete technology expert according to the concrete properties and weather conditions.

Biege– und Verlegeanweisung
Bending– and installation instruction
nach/according: EC2 + NA

Mindestbiegerollendurchmesser / Minimum mandrel diameters D_{min}



Betonfestigkeitsklasse ≤ C50/60		
Betonstahl ≤ B500	$D_{min} \geq 4\,\phi$	$D_{min} \geq 7\,\phi$
Betonstahl > B500	$D_{min} \geq 7\,\phi$	$D_{min} \geq 10\,\phi$

Die Gesamtlängen der Auszüge beziehen sich auf Außenmaße
All total lengths of bar profiles show outside dimensions

Baustoffe
Building materials

letzte Stabstahlposition final steel bar position	–	Betonstahl: B500B reinforcement steel: gemäß/according to: DIN 488–1 + DIN EN 10080
letzte Mattenposition final mesh position	–	Betonfestigkeitsklasse: C30/37 & C40/50 Concrete strength: gemäß/According to: DIN EN 1992–1–1

Betondeckung [mm] Concrete cover

		Expositionsklassen Exposure classes	Nutzgewicht γ_c Laying measurement γ_c	Verkehrslast β_{RK} Abrasion measurement β_{RK}
innen	inside	XC4, XD1, XF1, XF	25	15
außen/über/unter	outside/top/base	XC4, XD1, XF1, XF	25/35/35	15/15/15
seitlich	lateral	XC4, XD1, XF1, XF	30	15

Anmerkung: Expositionsklasse XD1 nur in Außenbereich ohne Erdüberdeckung erforderlich.
Note: Exposure class XD1 in outside areas without backfill / earth cover

– dynamische Drehfeder der Gründung: dynamic rotational stiffness	$K_{dyn} \geq 200000$ MNm/rad
– statische Drehfeder der Gründung: statical rotational stiffness	$K_{stat} \geq 40000$ MNm/rad

ZUGEHÖRIGE PLÄNE		ASSOCIATED DRAWINGS
Plan Nr. :	Planbezeichnung	
DE_T22_001_XX_X_Uebersicht	Übersichtsplan Gesamtturm	layout complete tower
DE_T22_003_XX_X_Erdung	Erdungskonzept Übersichtsplan	general plan with earthing concept
DE_T22_004_XX_X_Erdung	Erdung für Fundament	grounding for foundation
DE_T22_1006_XX_X_Bewehrung	Bewehrungsplan Fundament mit AF	foundation reinforcement plan with CF
DE_T22_081_XX_X_Uebersicht	Übersichtsplan Leerrohraustritt	layout pipe penetration
M578	Spanngliedverankerung 3.0	tendon anchoring 3.0
VX_XXI_9093–C33_Sg6f–3–3_Montageplan	Absteckung Montagerahmen	staking out mounting frame

VESTAS Windenergieanlage
WEA VESTAS V162
Stahl–Beton–Hybridturm (T22)
169m NH
Rotorblattdurchmesser 162m
DIBt 2

VESTAS wind turbine
WEC VESTAS V162
steel concrete hybrid tower (T22)
169mm HH
rotor blade diameter 162m
DIBt 2

Änderung	Bezeichnung	erstellt	Datum
V1			
V2			
V3			
V4			
V5			
V6	Volumen der Betonierabschnitte ergänzt	Ernst	18.12.2023

MAX BÖGL
Fortschritt baut man aus Ideen.

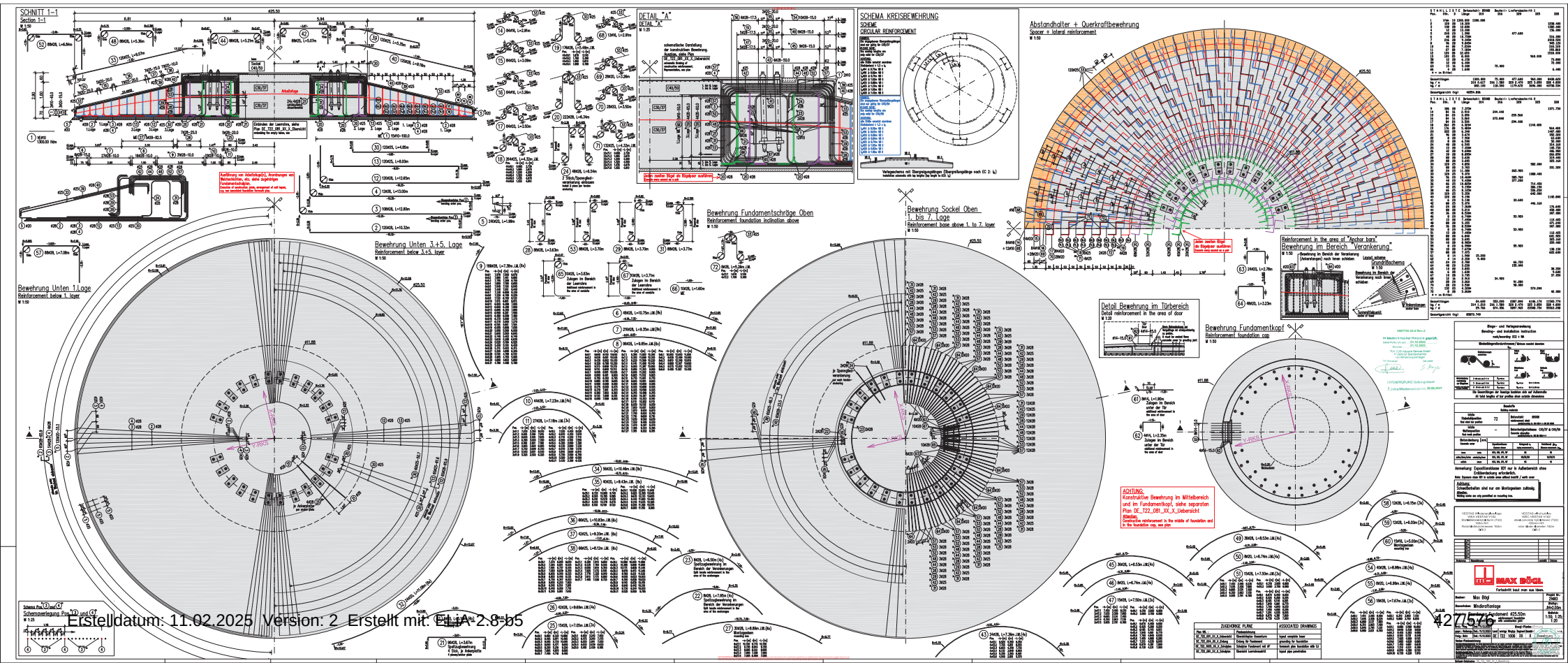
Bauherr:	Max Bögl		Projekt Nr.: 21683
Bauvorhaben:	Windkraftanlage wind turbine generator		Blattgr.: 1.194.84m
Bauteile:	Schalplan Fundament ø25,50m mit Arbeitsfuge formwork plan foundation with construction joint		Maßstäbe: 1:50; 1:25; 1:10
erst.: Reg.	Dat.: 11.12.2023	Bogl–Planbezeichnung	
gepr.: Reitenp.	Dat.: 11.12.2023	Land	Lauf–Nr. 0 Blatt–Segment Bereich
freig.: Betz	Dat.: 11.12.2023	DE	T22 X Schalplan 0

Vestas–Planbezeichnung

Das Bögl Urheberrecht: An diesen (Bögl) Inhalten ist ein Urheberrecht entstanden und existiert. Jede Verwertung, die nicht ausdrücklich vom Urheber zugelassen ist, ist eine Urheberrechtsverletzung. Dies gilt insbesondere für die Vervielfältigung, für die Bearbeitung, für die Verbreitung, für die Einspeicherung und Verarbeitung in elektronischen Systemen. Das Urheberrecht besteht auch nach Beendigung des Vertrages. Das Urheberrecht besteht auch nach Beendigung des Vertrages. Die Inhalte dürfen nicht ohne unsere ausdrückliche Genehmigung vervielfältigt, verbreitet oder öffentlich wiedergegeben werden. Sie dürfen nicht an Dritte weitergegeben werden. Sie dürfen nicht für Wettbewerbszwecke verwendet werden. Sie dürfen nicht für Wettbewerbszwecke verwendet werden. Sie dürfen nicht für Wettbewerbszwecke verwendet werden. Sie dürfen nicht für Wettbewerbszwecke verwendet werden.

Softcad–Dateiname: DE_T22_1005_XX_X_Schalplan

Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: ELiA-2.8-b5


SCHNITT 1-1
Section 1-1
DETAIL "A"
DETAIL "A"
SCHEMA KREISBEWEHRUNG
SCHEME
CIRCULAR REINFORCEMENT
Abstandhalter + Querkraftbewehrung
Spacer + lateral reinforcement
Bewehrung Fundamentschräge Oben
Reinforcement foundation inclination above
Bewehrung Sockel Oben
1. bis 7. Lage
Reinforcement base above 1. to 7. layer
Bewehrung Unten 1.Lage
Reinforcement below 1. layer
Bewehrung Unten 3.+5. Lage
Reinforcement below 3.+5. layer
Reinforcement in the area of "Anchor bars"
Bewehrung im Bereich "Verankerung"
Detail Bewehrung im Türbereich
Detail reinforcement in the area of door
Bewehrung Fundamentkopf
Reinforcement foundation cap
ACHTUNG:
Konstruktive Bewehrung im Mittelbereich und im Fundamentkopf, siehe separaten Plan DE_T22_081_XX_X_Uebersicht
Attention:
Constructive reinforcement in the middle of foundation and in the foundation cap, see plan
Schema Pos. 70 und 71
Schemaverlegung Pos. 70 und 71
ZUGEHÖRIGE PLÄNE
ASSOCIATED DRAWINGS
Max Bögl
Windkraftanlage
Fundamentkopf ø25.50m
Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: CLIA 2.8-b5
42/576

RESTRICTED

PRÜFAMT FÜR STANDSICHERHEIT FÜR DIE
BAUTECHNISCHE PRÜFUNG VON WINDENERGIEANLAGEN

Industrie Service

Mehr Wert.
Mehr Vertrauen.

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Prüfbericht für eine Typenprüfung

Datum: 21.12.2023

Prüfnummer: 3667703-12-d Rev. 1

Objekt: **Prüfung der Standsicherheit – Hybridturm HA2A90A** (**T22**)
Windenergieanlage Vestas V162-6.8/7.2 MW,
169 m Nabenhöhe
Windzone S, Erdbebenzone 3
Lebensdauer: 25 Jahre

Prüfgrundlage: DIBt-Richtlinie 2012

Hersteller Windenergieanlage:
Vestas Wind Systems A/S
Hedeager 42
8200 Aarhus N
Dänemark

Konstruktion und Berechnung Betonteil:
Max Bögl Wind AG
Max-Bögl-Straße 1
92369 Sengenthal

Konstruktion und Berechnung Stahlteil:
Max Bögl Wind AG
Max-Bögl-Straße 1
92369 Sengenthal

Auftraggeber:
Max Bögl Wind AG
Max-Bögl-Straße 1
92369 Sengenthal

Gültig bis: 30.08.2027

Unsere Zeichen:
IS-ESW-MUC/CRE

Dokument:
3667703-12-d_Rev1_Bögl_V162_T22_HH169 m_25a

Das Dokument besteht aus 15 Seiten.
Seite 1 von 15

Die auszugsweise Wiedergabe des Dokumentes und die Verwendung zu Werbezwecken bedürfen der schriftlichen Genehmigung der TÜV SÜD Industrie Service GmbH.

Die Prüfergebnisse beziehen sich ausschließlich auf die untersuchten Prüfgegenstände.

Sitz: München
Amtsgericht München HRB 96 869
USt-IdNr. DE129484218
Informationen gemäß § 2 Abs. 1 DL-InfoV unter www.tuvsud.com/impressum

Aufsichtsrat:
Reiner Block (Vors.)
Geschäftsführer:
Ferdinand Neuwieser (Sprecher),
Thomas Kainz, Simon Kellerer

Telefon: +49 89 5791-3146
Telefax: +49 89 5791-2956
www.tuvsud.com/de-is

TÜV SÜD Industrie Service GmbH
Prüfamt für Standsicherheit für die bautechnische Prüfung von Windenergieanlagen
Westendstraße 199
80686 München
Deutschland

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

Restricted - 2024-09-24 11:14 UTC - This document is the property of Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Revision	Datum	Änderungen
0	31.08.2022	Erstfassung
1	21.12.2023	Dokumente [9] und [11] ergänzt. Dokumente [1] bis [4], [6], [7], [12], [24], [26] bis [31] aktualisiert. Zeichnungen [A1], [A4], [A5], [A9] aktualisiert.

Inhaltsverzeichnis

1. Unterlagen 3
1.1. Geprüfte Unterlagen....3
1.2. Eingesehene Unterlagen....3
2. Prüfgrundlage 5
3. Beschreibung 7
3.1. Maße:....7
3.2. Baustoffe:....7
3.3. Lastannahmen: 8
4. Prüfumfang 8
5. Prüfbemerkungen....9
6. Prüfergebnis....12
Anhang 1: Verzeichnis geprüfter Pläne 15

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

1. Unterlagen

1.1. Geprüfte Unterlagen

Folgende Dokumente, sofern nicht anders angegeben erstellt von Max Bögl Wind AG, wurden zur Prüfung vorgelegt:

[1] „Statische Berechnung, Max Bögl Hybridturm T22, Bauteil: Spannbetonturm“, Dokument Nr. D00282004, Rev. 03, Datum 2023-12-18

[2] „Statische Berechnung der Bauzustände, Max Bögl Hybridturm T22“, Dokument Nr. D00282005, Rev. 01, Datum 2023-12-14

[3] „Spannanweisung der Ankerstäbe, Max Bögl Hybridturm T22“, Dokument Nr. D00282006, Rev. 03, Datum 2023-12-14

[4] „Spannanweisung der Spannglieder, Max Bögl Hybridturm T22“, Dokument Nr. D00282007, Rev. 02, Datum 2023-12-14

[5] „Statische Berechnung, Max Bögl Hybridturm T22, Bauteil: Stahlturm“, Dokument Nr. D00282009, Rev. 01, Datum 2022-08-09

[6] „Anforderungen an das Fundamentdesign, Max Bögl Hybridturm T22“, Dokument Nr. D00282001, Rev. 03, Datum 2023-12-18

[7] „Tower Top Flange ULS and FLS Strength Check for CHT Tower V162 6.8MW und 7.2 MW“, erstellt von Vestas, Dokument Nr. 0131-1200, Ver. 01, Datum 2023-11-21

[8] Pläne gemäß Planliste in Anhang 1

[9] „Lastvergleich / Überprüfung der Turm- und Fundamentstatik aufgrund neuer Lasten „0121-5839_V05“ für den Max Bögl Hybridturm Turmtyp T22“, Dokument Nr. D00445763, Rev. 02, Datum 2023-12-14

1.2. Eingesehene Unterlagen

Folgende Dokumente wurden im Rahmen der Prüfung zusätzlich zur Information herangezogen:

Lasten:

[10] „Combine Tower loads – HA2A90A, EV162-6.8/7.2 MW, EnVentus, WZ2GK2(S), HH169 m, 50/60 Hz, GS“, erstellt von Vestas, Dokument Nr. 0121-5839, Ver. 01, Datum 2022-04-29

[11] „Combine Tower loads – HA2A90A, EV162-6.8/7.2 MW, EnVentus, WZ2GK2(S), HH169 m, 50/60 Hz, GS“, erstellt von Vestas, Dokument Nr. 0121-5839, Ver. 05, Datum 2023-11-23

[12] „Gutachtliche Stellungnahme für Lastannahmen zur Turmberechnung der Vestas Turbinen Vestas EnVentus V162-6.8 / 7.2 MW mit 169 m Nabenhöhe, Windzone S, 25 Jahre Entwurfslebensdauer“, erstellt von DNV GL Energy Renewables Certification, Dokument Nr. L-08867-A052-0B, Rev. 2, Datum 2023-12-11

Betonturm:

[13] „Spezifikation für den Max Bögl Hybridturm“, erstellt von Max Bögl Wind AG, Projekt Nr. 21683, Rev. i, Datum 2021-06-23

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

[14] „Prüfbericht Spezifikation – Max Bögl Hybridturm“, erstellt von TÜV SÜD Industrie Service GmbH,
Dokument Nr. 3149390-1-d, Rev. 2, Datum 2021-11-26

[15] „Ausführungsbeschreibung zu den Planungsgrundlagen, Ansatz einer reduzierten Turmschiefstellung von 200mm“,
Projekt Nr. 21683, Rev. a, Datum 2018-05-03

[16] Allgemeine Bauartgenehmigung „SUSPA Draht EX für Windenergieanlagen“ erstellt vom Deutschen Institut für Bautechnik,
Zulassungsnr. Z-13.3-141, vom 16.04.2021, Geltungsdauer bis 25.03.2026

[17] Allgemeine Bauartgenehmigung „Anwendungsregeln für das Spannverfahren SUSPA-Draht Ex nach ETA-07/0186“, erstellt vom Deutschen Institut für Bautechnik,
Zulassungsnr. Z-13.73-70186, vom 25.03.2021, Geltungsdauer bis 25.03.2026

[18] European Technical Assessment „SUSPA – Wire EX, External post-tensioning kit for prestressing of structures with 30 to 84 prestressing steel wires”, erstellt vom Österreichischen Institut für Bautechnik,
Dokument Nr. ETA-07/0186, vom 16.11.2020

[19] Allgemeine Bauartgenehmigung „Anwendungsregeln für das Spannverfahren SUSPA-Draht Ex nach ETA-20/0810“, erstellt vom Deutschen Institut für Bautechnik,
Zulassungsnr. Z-13.73-200810, vom 25.03.2021, Geltungsdauer bis 25.03.2026

[20] European Technical Assessment „Wire EX Wind, External post-tensioning kit for prestressing of structures with 30 to 84 prestressing steel wires”, erstellt vom Österreichischen Institut für Bautechnik,
Dokument Nr. ETA-20/0810, vom 16.11.2020

[21] Allgemeine bauaufsichtliche Zulassung „Hochfeste Betone der Max Bögl GmbH & Co. KG“, erstellt vom Deutschen Institut für Bautechnik,
Zulassungsnr. Z-3.51-2036, vom 24.01.2019, Geltungsdauer bis 15.02.2024

[22] Allgemeine bauaufsichtliche Zulassung „Geschweißte Bewehrungselemente aus Betonstahl B500B für erhöhte dynamische Beanspruchung, Nenndurchmesser: 10.0 und 12.0 mm“, erstellt vom Deutschen Institut für Bautechnik,
Zulassungs-Nr. Z-1.3-284, vom 29.05.2019, Geltungsdauer bis 01.06.2024

[23] „Statische Berechnung für den Max Bögl Hybridturm RT2.0, Bauteil: Spannglied-verankerung“, erstellt von Max Bögl Wind AG,
Projekt Nr. 21683, Rev. i, Datum 2021-03-02

[24] „Gutachtliche Stellungnahme Hybridtürme für Windenergieanlagen – Bauteile für Spann-gliedverankerung 3.0 – Statischer Nachweis der Bauteile für die untere Spanngliedverankerung von Hybridtürmen für Windenergieanlagen gemäß DIBt Richtlinie Fassung Oktober 2015”, erstellt von TÜV NORD CERT GmbH,
Dokument Nr. 8118409048-6 D, Rev. 2, vom 2022-03-22

[25] „Gutachterliche Stellungnahme zum Vorspannen von Ankerbolzen großer Nenndurchmesser in Hybridtürmen von Windenergieanlagen“, erstellt von Univ.-Prof. Dr.-Ing. Peter Schaumann,
keine Dokument Nr., Datum 2017-12-15

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Stahlturm:

[26] Zeichnung „FLANGE,L,3725 mm,3416 mm, 450 mm,3478 mm, S420NL EN 10025-3 (FORGED)“, erstellt von Vestas,
Zeichnung Nr. 29266351, Ver. 4, Datum 2023-08-04

[27] Zeichnung „FLANGE,L,3725 mm,3416 mm, 450 mm,3478 mm, S420NL EN 10025-3 (WELDED)“, erstellt von Vestas,
Zeichnung Nr. 29266593, Ver. 4, Datum 2023-08-04

[28] Zeichnung „FLANGE,L,3725 mm,3416 mm, 450 mm,3478 mm, S355NL EN 10025-3 (FORGED)“, erstellt von Vestas,
Zeichnung Nr. 29266594, Ver. 4, Datum 2023-08-04

[29] Zeichnung „FLANGE,L,3725 mm,3416 mm, 450 mm,3478 mm, S355NL EN 10025-3 (WELDED)“, erstellt von Vestas,
Zeichnung Nr. 29266595, Ver. 4, Datum 2023-08-04

[30] „Tower Top Flange – EnVentus Mk1BC Robust Version FE analysis - Fatigue/Extreme Loads Assessment“, erstellt von Vestas,
Dokument Nr. 0122-6133, Ver. 04, Datum 2023-09-14

[31] „Nachweis Turmkopfflansch für die EnVentus Mk1-Plattform“, erstellt von DNV Energy Systems Renewables Certification,
Dokument Nr. LTR-04971-20220825-01, Rev. 3, Datum 2023-09-29

[32] “Klassifizierung eines Kerbfalls auf Basis des Strukturspannungskonzeptes Stahlturmschale mit angeschweißten Butzen“, erstellt von Max Bögl Wind AG,
keine Dokument Nr., Rev. c, Datum 2020-03-04

[33] “Gutachtliche Stellungnahme Bewertung der Konstruktion - Stahlrohrturm Strukturmechanische Bestimmung von Kerbfallgruppen für Anschweißbuchsen”, erstellt von TÜV SÜD Industrie Service GmbH,
Dokument Nr. 3170193-1-d, Rev. 1, Datum 2020-03-20

2. Prüfgrundlage

Die Prüfung der Unterlagen erfolgte gemäß folgender Richtlinie:

/1/ „Richtlinie für Windenergieanlagen“, herausgegeben vom Deutschen Institut für Bautechnik (DIBt), Ausgabe Oktober 2012, korrigierte Fassung März 2015

Zur Prüfung wurden zusätzlich folgende Normen und Richtlinien herangezogen:

/2/ DIN EN 1991-1-1:2010 „Eurocode 1: Einwirkungen auf Tragwerke – Teil 1-1: Allgemeine Einwirkungen auf Tragwerke – Wichten, Eigengewicht und Nutzlasten im Hochbau; Deutsche Fassung EN 1991-1-1:2002 + AC:2009“ mit nationalem Anhang
DIN EN 1991-1-1/NA:2010 + DIN EN 1991-1-1/NA/A1:2015

/3/ DIN EN 1991-1-4:2010 „Eurocode 1: Einwirkungen auf Tragwerke – Teil 1-4: Allgemeine Einwirkungen – Windlasten; Deutsche Fassung EN 1991-1-4:2005 + A1:2010 + AC:2010“, mit nationalem Anhang DIN EN 1991-1-4/NA:2010

/4/ DIN EN 1992-1-1:2011 „Eurocode 2: Bemessung und Konstruktion von Stahlbeton- und Spannbetonbauwerken –Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau; Deutsche Fassung EN 1992-1-1:2004 + AC:2010“ + DIN EN 1992-1-1/A1:2015, mit nationalem Anhang DIN EN 1992-1-1/NA:2013 + DIN EN 1992-1-1/NA/A1:2015

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

/5/ DIN EN 1993-1-1:2010 „Eurocode 3: Bemessung und Konstruktion von Stahlbauten – Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau; Deutsche Fassung EN 1993-1-1:2005 + AC:2009“ + DIN EN 1993-1-1/A1:2014, mit nationalem Anhang DIN EN 1993-1-1/NA:2015

/6/ DIN EN 1993-1-6:2010 „Eurocode 3: Bemessung und Konstruktion von Stahlbauten – Teil 1-6: Festigkeit und Stabilität von Schalen; Deutsche Fassung EN 1993-1-6:2007 + AC:2009“, mit nationalem Anhang DIN EN 1993-1-6/NA:2010

/7/ DIN EN 1993-1-8:2010 „Eurocode 3: Bemessung und Konstruktion von Stahlbauten – Teil 1-8: Bemessung von Anschlüssen; Deutsche Fassung EN 1993-1-8:2005 + AC:2009“, mit nationalem Anhang DIN EN 1993-1-8/NA:2010

/8/ DIN EN 1993-1-9:2010 „Eurocode 3: Bemessung und Konstruktion von Stahlbauten – Teil 1-9: Ermüdung; Deutsche Fassung EN 1993-1-9:2005 + AC:2009“, mit nationalem Anhang DIN EN 1993-1-9/NA:2010

/9/ DIN EN 1993-1-10:2010 „Eurocode 3: Bemessung und Konstruktion von Stahlbauten – Teil 1-10: Stahlsortenauswahl im Hinblick auf Bruchzähigkeit und Eigenschaften in Dickenrichtung; Deutsche Fassung EN 1993-1-10:2005 + AC:2009“, mit nationalem Anhang DIN EN 1993-1-10/NA:2010

/10/ DIN EN 1998-1:2010 „Eurocode 8: Auslegung von Bauwerken gegen Erdbeben – Teil 1: Grundlagen, Erdbebeneinwirkungen und Regeln für Hochbauten; Deutsche Fassung EN 1998-1:2004 + AC:2009“, mit nationalem Anhang DIN EN 1998-1/NA:2011

/11/ DIN 4149:2005 „Bauten in deutschen Erdbebengebieten – Lastannahmen, Bemessung und Ausführung üblicher Hochbauten“

/12/ DIN EN 1090-2:2018 „Ausführung von Stahltragwerken und Aluminiumtragwerken – Teil 2: Technische Regeln für die Ausführung von Stahltragwerken; Deutsche Fassung EN 1090-2:2018“

/13/ DIN EN 14399-4:2015 „Hochfeste vorspannbare Garnituren für Schraubverbindungen im Metallbau – Teil 4: System HV – Garnituren aus Sechskantschrauben und -muttern; Deutsche Fassung EN 14399-4:2015“

/14/ DASt – Richtlinie 021:2013 “Schraubenverbindungen aus feuerverzinkten Garnituren M 39 bis M 72 entsprechend DIN EN 14399-4, DIN EN 14399-6“

/15/ DIN EN ISO 898-1:2013 „Mechanische Eigenschaften von Verbindungselementen aus Kohlenstoffstahl und legiertem Stahl – Teil 1: Schrauben mit festgelegten Festigkeitsklassen – Regelgewinde und Feingewinde (ISO 898-1:2013); Deutsche Fassung EN ISO 898-1:2013”

/16/ Deutscher Ausschuss für Stahlbeton Heft 439: „Ermüdungsfestigkeit von Stahlbeton- und Spannbetonbauteilen mit Erläuterungen zu den Nachweisen gemäß CEB/FIP Model Code 1990“, Ausgabe 1994

/17/ Deutscher Ausschuss für Stahlbeton Heft 600: „Erläuterungen zu DIN EN 1992-1-1 und DIN EN 1992-1-1/NA (Eurocode 2)“, Ausgabe 2012

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

3. Beschreibung

Der Turm T22 der Windenergieanlage Vestas V162-6.8/7.2 MW besteht aus einem aus Fertigteilen zusammengesetzten, konischen Stahlbetonturm mit Stahlrohraufsatz. Der Betonteil besteht aus 33 Segmenten und einem einteiligen Adapterring, der Stahlrohraufsatz aus 3 Sektionen.

Die konischen Betonfertigteilelemente haben einen kreisringförmigen Querschnitt und werden aus Drittelschalen zusammengesetzt. Die horizontalen Fugen zwischen den Betonfertigteilen werden planmäßig trocken ausgeführt. In den horizontalen Fugen zwischen Segmenten S01 und S21 werden jeweils 6 Dübel zur Übertragung von Schubkräften angeordnet. Die Fuge am Turmfuß wird mit Verguss hergestellt. Die vertikalen Fugen der Teilsegmente werden trocken ohne Verbund ausgeführt. Am oberen Ende der Vertikalfuge befindet sich eine Kontaktfläche zur Übertragung von Druckkräften, oben und unten werden Schraubelemente angeordnet.

Der Betonschaft wird mit externen, im Inneren des Turms liegenden Spanngliedern vorgespannt. Die Spannglieder laufen vom obersten Segment des Betonturms bis zur Verankerung im Fundament, die als Ankerstangenkonstruktion mit Ankerplatte ausgeführt ist.

Die Verbindung zwischen der unteren Stahlsektion und dem obersten Betonelement wird als L-förmige Ringflanschverbindung mit vorgespannten Ankerstäben ausgeführt.

Die Sektionen des Stahlrohraufsatzes sind durch innenliegende Ringflansche mittels vorgespannter Schraubenverbindungen untereinander verbunden. Die einzelnen Teilsegmente sind durch Stumpfnähte miteinander verschweißt.

3.1. Maße:

Nabenhöhe:	169 m
Gesamtlänge Turm:	163,85 m
Außendurchmesser Turmwandung am Turmfuß:	9,148 m
Außendurchmesser Turmkopfflansch:	3,665 m

Weitere Angaben können den Zeichnungen [8] entnommen werden.

3.2. Baustoffe:

Betonteil:

Betonfertigteile	C100/115 mit Expositionsklassen XC4, XF1, WF gemäß DIN EN 1992-1-1 /4/ und [21]
	C90/105 mit Expositionsklassen XC4, XF1, WF gemäß DIN EN 1992-1-1 /4/ und [21]
	C80/95 mit Expositionsklassen XC4, XF1, WF gemäß DIN EN 1992-1-1 /4/ und [21]
	Für alle Segmente wird selbstverdichtender Beton gemäß DIN EN 206-9 und abZ [21] eingesetzt.
Vergussmörtel	≥ C70/85 gemäß DIN EN 1992-1-1 /4/
Betonstahl	B500B gemäß DIN EN 1992-1-1 /4/ und [22]
Spannsystem	24 Spannglieder System SUSPA Draht EX-84, 84 Spannstahldrähte St 1570/1770 mit 38,5 mm² Nennquerschnitt gemäß [16] und [17] in Verbindung mit [18] bzw. [19] in Verbindung mit [20]

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Schrauben in vertikaler Fuge	M24-8.8 gemäß DIN EN ISO 4014
Dübel in horizontaler Fuge	S235 JR+AR gemäß DIN EN 10025 und [13]
Gewindebolzen (Adapter)	M64-10.9 gemäß DIN EN ISO 898-1 /15/
Ankerring (Adapter)	S355 J2 gemäß DIN EN 10025
Lastverteilplatte (Adapter)	S355 J2 gemäß DIN EN 10025
Stahlteil:	
Turmwand	S355 J2+N gemäß DIN EN 10025
Ringflansche	S355 NL gemäß DIN EN 10025 mit Z15 Güte gemäß DIN EN 10164 für aus Blech hergestellte Flansche, die senkrecht zur Walzebene beansprucht werden
Turmfußflansch	S355 J2+N gemäß DIN EN 10025 mit Z15 Güte gemäß DIN EN 10164 für aus Blech hergestellte Flansche, die senkrecht zur Walzebene beansprucht werden
Schraubengarnituren	M42-10.9 gemäß DASt-Richtlinie 021 /14/ M48-10.9 gemäß DASt-Richtlinie 021 /14/

3.3. Lastannahmen:

Die dimensionierenden Lasten für die Prüfung des Turms der oben genannten Windenergieanlage sind in [10] für die Grenzzustände der Tragfähigkeit und der Gebrauchstauglichkeit angegeben. Diese Lasten wurden mit der Revision 0 der gutachtlichen Stellungnahme [12] bestätigt und werden als richtig vorausgesetzt. Die angesetzte Entwurfslebensdauer der Windenergieanlage beträgt 25 Jahre gemäß [12].

Mit Dokument [11] wurden neue Lasten eingeführt und durch eine neue Revision des Lastgutachtens [12] bestätigt. In [9] wurde gezeigt, dass das Turmdesign auch für diese neuen Lasten gültig ist.

Einwirkungen aus Erdbeben sind gemäß Dokument [12] auf Basis der DIN EN 1998-1 /10/ für alle Erdbebenzonen sowie Baugrund- und Untergrundklassen in Deutschland abgedeckt. Hiermit sind auch alle Erdbebenzonen sowie Baugrund- und Untergrundklassen nach DIN 4149 /11/ in Deutschland abgedeckt.

Eigengewichte wurden gemäß DIN EN 1991-1-1 /2/ und nach Herstellerangaben berücksichtigt.

Turmkopfmasse: 324 t

4. Prüfumfang

Dieser Prüfbericht für eine Typenprüfung umfasst die Prüfung hinsichtlich der Standsicherheit des in Abschnitt 3 beschriebenen Hybridturms auf Basis der in Abschnitt 2 genannten Prüfgrundlagen.

Für eine vollständige Typenprüfung sind alle in Dokument /1/, Kapitel 3 im Abschnitt I gelisteten gutachtlichen Stellungnahmen sowie ein zusammenfassender Prüfbescheid zur Typenprüfung erforderlich. Diese können bis spätestens zu Baubeginn der ersten Anlage nachgereicht werden.

Weitere Prüfungen wie die Überprüfung der Bauausführung, der Standorteignung, des Fundaments, des Blitzschutz-/Erdungskonzepts und der Turmeinbauten sind nicht Gegenstand dieses Berichtes.

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Abweichungen von den geprüften Unterlagen und Prüfgrundlagen bezüglich Konstruktion, Lasten, Randbedingungen, Ausführung und Anlagensteuerung, die Einfluss auf die Standsicherheit haben, sind durch diesen Bericht nicht abgedeckt und erfordern eine Überarbeitung der Berechnung und eine erneute Prüfung.

Es wird davon ausgegangen, dass Hersteller und Betreiber ihren Verpflichtungen zur Gewährleistung des sicheren Betriebes der Anlage nachkommen und über im Betrieb festgestellte, auslegungsrelevante Auffälligkeiten wie z.B. Schwingungsphänomene berichten und gegebenenfalls veranlassen, dass entsprechende Untersuchungen durchgeführt und neue Berechnungen zur Prüfung vorgelegt werden.

5. Prüfbemerkungen

Die vorgelegten Nachweise wurden durch eigene Vergleichsrechnungen überprüft. Auf Basis der eingereichten Unterlagen und unserer Vergleichsrechnungen können ausreichende Sicherheiten bestätigt werden. Die Zeichnungen wurden auf Übereinstimmung mit den Annahmen der Berechnungen sowie den Vorgaben der in Abschnitt 2 genannten Prüfgrundlagen geprüft.

Schnittstellen:

Die Berechnung des Turmkopfflansches mit dem Nachweis der Schweißverbindung in seinem Einflussbereich und seines Radius gemäß Zeichnungen [26] bis [29] wurden in [7] anhand von Spannungskonzentrationsfaktoren aus [30] durchgeführt. Dokument [30] wurde mit [31] bestätigt.

Die Nachweise der Lasteinleitung in den Vergussmörtel am Turmfuß werden mit diesem Prüfbericht bestätigt.

Die Nachweise der oberen und unteren Ankerplatten sowie der Ankerstangen der Spanngliedverankerung im Fundament wurden in Dokument [23] durchgeführt und mit [24] bestätigt. Ergänzend wurde in [1] ein detaillierter Ermüdungsnachweis der Ankerstangen gemäß Punkt 5.4.4 von [24] geführt. Mit diesem Prüfbericht wird bestätigt, dass die Randbedingungen der Nachweise in [23] für den vorliegenden Turm eingehalten sind.

Die Nachweise der Einbauteile für die Befestigung der Podeste und Einbauten sind nicht Bestandteil dieser Prüfung.

Eigenfrequenzen:

Die in [1] berechnete erste Eigenfrequenz liegt innerhalb des im Lastgutachten [12] angegebenen Gültigkeitsbereichs (0,183 Hz bis 0,206 Hz). Die dynamische Rotationsfedersteifigkeit aus der Interaktion von Fundament und Baugrund muss mindestens $k_{\varphi,dyn}$ = 200 GNm/rad betragen.

Die Eigenfrequenz liegt im Bereich der möglichen Erregerfrequenzen der Anlage. Daher ist eine betriebliche Schwingungsüberwachung vorzusehen, die mit dem Betriebs- und Sicherheitssystem der Anlage verbunden ist, siehe Auflage 2.

Imperfektionen:

Die Lasten aus [10] enthalten lediglich Effekte aus Theorie II. Ordnung. Zusätzliche Effekte aus einer Turmschiefstellung, von Differenzsetzungen des Fundaments von 3 mm/m sowie aus einer zusätzlichen Schiefstellung infolge der Berücksichtigung einer statischen Bodendrehfeder von $k_{\varphi,stat}$ = 40 GNm/rad wurden in [1] berücksichtigt.

Abweichend von /1/ wurden für die Turmschiefstellung statt 5 mm/m lediglich 200 mm an der Oberkante des Adapters angesetzt. In Dokument [15] wird das Vorgehen zur Ermittlung der Turmschiefstellung dargestellt.

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

Aufgrund der verschärften Toleranzgrenzen in Herstellung und Montage gemäß [15] und der rechnerischen Berücksichtigung der einseitigen Sonneneinstrahlung in [1] kann diese Abweichung akzeptiert werden.

Bauzustände, Querschwingungen:

Die Standsicherheit des Turms vor dem Vorspannen der Spannglieder wurde in [2] nachgewiesen. Nachweise wirbelerregter Querschwingungen wurden für verschiedene Errichtungszustände gemäß nachstehender Tabelle in [2] geführt. Die zeitliche Beschränkung gilt für den Fall, dass die angegebenen maximalen Windgeschwindigkeiten überschritten werden. Weitere hiervon abweichende Bau- und Montagezustände sowie Transportzustände sind nicht Gegenstand dieser Prüfung, siehe Auflage 5.

Bauzustand / vorübergehender Zustand	**Gesamte maximale Dauer oder Windgeschwindigkeit**	
Vorgespannter Betonturm ohne Stahlsektionen	1 Jahr	Die maximale Windgeschwindigkeit darf einen 10 Minuten-Mittelwert von 16,4 m/s nicht überschreiten
Vorgespannter Betonturm mit 1. Stahlsektion	90 Tage	Die maximale Windgeschwindigkeit darf einen 10 Minuten-Mittelwert von 12,0 m/s nicht überschreiten
Vorgespannter Betonturm mit 2. Stahlsektion	90 Tage	Die maximale Windgeschwindigkeit darf einen 10 Minuten-Mittelwert von 10,0 m/s nicht überschreiten
Vollständiger Turm (alle Stahlsektionen) ohne Gondel	90 Tage	Die maximale Windgeschwindigkeit darf einen 10 Minuten-Mittelwert von 7,1 m/s nicht überschreiten
Vollständiger Turm (alle Stahlsektionen) und Gondel ohne Rotor	90 Tage	Die maximale Windgeschwindigkeit darf einen 10 Minuten-Mittelwert von 4,0 m/s nicht überschreiten
Stillstandszeiten der fertiggestellten Anlage	456 Tage über die Lebensdauer	

Kerbfallklassen:

Für die Berechnung des Turmes in [5] wurden die Kerbfallkategorien, sofern nicht anders angegeben gemäß DIN EN 1993-1-9 /8/ Bild 7.1, folgendermaßen angesetzt:

Lage gemäß Zeichnung [A9]	**Kerbfallkategorie / Anforderung**
Zusätzlich an der Turmwand befestigte Teile	
Kerbfallklassen gemäß [32] und [33]. Die für jedes Turmblech zulässige Butzengröße der Anschweißteile und die zugehörigen Kerbfallklassen sind auf der Turmzeichnung [8] ([A9]) definiert.	
Rundnähte (wenn zutreffend auf beiden Seiten des genannten Bleches)	
Stumpfnaht zum Turmkopfflansch	KFK 90
Alle anderen Rundnähte	KFK 90

Ein Schwellenwert der Ermüdungsfestigkeit wurde nicht angesetzt.

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Ermüdung:

Für die Nachweise des Grenzzustandes der Ermüdung wurde das Alter der Betonfertigteile vor Beginn der zyklischen Belastung folgendermaßen angesetzt:

Position	Beginn der zyklischen Belastung t_0	Beiwert für die Betonfestigkeit bei Erstbelastung $\beta_{cc}(t_0)$
Adapter	90 Tage	1,09
S01 - S13	82 Tage	1,09
S14 - C33	28 Tage	1,00

Abweichend von den Angaben in /4/ wird der Bemessungswert der Ermüdungsfestigkeit $f_{cd,fat}$ für hochfeste Betone gemäß [21] angesetzt.

Abweichend von den Angaben in /4/ wird der Bemessungswert der Ermüdungsfestigkeit $\Delta\sigma_{Rsk}$ für geschweißte Bewehrungselemente gemäß [22] angesetzt.

Der charakteristische Wert der aufnehmbaren Spannungsschwingbreite $\Delta\sigma_{Rsk}$ ($N^* = 10^6$ Lastzyklen) für die Spannglieder im Bereich der Umlenkstellen wurde abweichend von der abG [16] mit 45 Mpa angesetzt, s. auch Auflage 17.

Stahlsortenauswahl:

Die Stahlsortenauswahl nach DIN EN 1993-1-10 /9/ wurde in [5] für eine Bezugstemperatur T_{Ed} = -30°C durchgeführt.

Betondeckung:

In Anlehnung an DIN EN 1992-1-1 /4/, NDP zu 4.4.1.3 (3) wurde das Vorhaltemaß der Betondeckung um 5 mm abgemindert.

Teilsicherheitsbeiwert Betonfestigkeit:

Für die Nachweise der Betonfertigteile wurde in Anlehnung an DIN EN 1992-1-1 /4/, Abschnitt A.2.3 ein reduzierter Teilsicherheitsbeiwert von $\gamma_{c,\,red}$ = 1,35 angesetzt.

Ausführungsvarianten:

Bezüglich der Ankerschrauben im Adapterelement sind 2 Varianten möglich:

a) Mit Decordynbeschichtung gemäß [A7]
b) Mit Schrumpfschlauch gemäß [A8]

Änderungen Einbauteile:

Die Ergänzung und Änderung von Erdungsfestpunkten und Einbauteilen für Turmeinbauten im Betonteil haben in der Regel keinen Einfluss auf die Standsicherheit des Turmes.

Lastvergleich:

In [11] wurden neue Lasten eingeführt und durch eine neue Revision des Lastgutachtens [12] bestätigt. In [9] werden die neuen Lasten mit denen aus [10] verglichen und weitestgehend gezeigt, dass die Nachweise in [1] und [5] gültig bleiben. Andernfalls wurde in [9] durch erneute Nachweisführung gezeigt, dass Turm und Fundament auch für die Lasten in [11] standsicher sind. Die Nachweise in [9] werden mit diesem Bericht bestätigt.

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Änderungen in der letzten Revision dieses Prüfberichts:

In [11] wurden neue Lasten eingeführt und mit Lastvergleich [9] für diesen Turm bestätigt. Dokument [6] wurde aufgrund der neuen Lasten überarbeitet.

In den Zeichnungen [A1], [A4] und [A5] wurde das außenliegende Mantelblech des Adapters konstruktiv verlängert und im Bereich der äußeren Betondeckung des Adapters eine konstruktive Zusatzbewehrung angeordnet. Die Zeichnung [A9] enthält redaktionelle Änderungen.

In der neuen Revision der Turmstatik [1] wurde der Bemessungswert der Ermüdungsfestigkeit $f_{cd,fat}$ für Fertigteilelemente mit einem Versprödungsfaktor von 0,9 gemäß abZ [21] angesetzt. Auflage 17 aus der vorherigen Revision dieses Prüfberichts entfällt.

Die Berechnung [7] des Turmkopfflansches mit dem Nachweis der Schweißverbindung in seinem Einflussbereich und seines Radius wurde aufgrund der neuen Lasten in [11], revidierter Turmkopfflanschzeichnungen [26] bis [29] und der angepassten Berechnung [30] überarbeitet. Dokumente [26] bis [30] wurden in [31] bestätigt.

Dokumente [2] bis [4] enthalten redaktionelle Änderungen.

6. Prüfergebnis

Die Berechnung und die zugehörigen Konstruktionszeichnungen für den Hybridturm entsprechen den in Abschnitt 2 genannten Normen und Richtlinien und sind im Wesentlichen vollständig und richtig.

Die Anforderungen an die Standsicherheit des Turmtragwerkes sind erfüllt, vorausgesetzt, die nachstehenden Auflagen sowie alle Auflagen und Bemerkungen der zugehörigen Prüfberichte und Gutachten werden beachtet bzw. vollzogen.

Der Turm der Windenergieanlage ist für Standorte entsprechend den Lastannahmen in [10] geeignet.

Die Prüfung der technischen Unterlagen für den Turm ist hiermit abgeschlossen.

Auflagen

Allgemein

1. Sollten Schwingungsphänomene festgestellt werden, die in den Lastannahmen in [10] nicht berücksichtigt wurden, so sind entsprechende Untersuchungen durchzuführen und gegebenenfalls neue Berechnungen zur Prüfung vorzulegen.
2. Die Anlage ist mit einer betrieblichen Schwingungsüberwachung auszurüsten, die in der Lage sein muss, auftretende Schwingungen entsprechend den Annahmen im Lastdokument [10] zu begrenzen.
3. Die in Abschnitt 5 angegebenen Mindestwerte der Steifigkeiten aus dem Zusammenwirken von Fundament und Baugrund dürfen nicht unterschritten werden.
4. Es ist für jede Anlage sicherzustellen, dass der Bereich der zulässigen Eigenfrequenzen gemäß Abschnitt 5 eingehalten wird.
5. Bauzustände und Stillstandszeiten der Anlage sind gemäß den Angaben in Abschnitt 5 zeitlich zu beschränken. Falls die zulässigen Zeiten überschritten werden oder die Gondel zu einem späteren Zeitpunkt vom Turm genommen wird, so sind geeignete Maßnahmen zur Verhinderung von wirbelerregten Querschwingungen zu treffen.

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Stahlsektionen

6. Der Korrosionsschutz der Turmaußenseite (Turminnenseite) ist für eine Korrosivitätskategorie C4 (C3) nach DIN EN ISO 12944 auszuführen. Bei Aufstellung in Industrienähe mit hoher Feuchte und aggressiver Atmosphäre oder Meeresnähe mit hoher Salzbelastung ist für die Turmaußenseite eine Korrosivitätskategorie C5 erforderlich. Für die Schutzdauer ist die Klasse „hoch“ gemäß DIN EN ISO 12944-5 anzusetzen, dies entspricht einer angestrebten Zeitspanne von mindestens 15 Jahren bis zur ersten planmäßigen Instandsetzungsmaßnahme aus Korrosionsschutzgründen.
7. Sämtliche in Dickenrichtung belasteten Bauteile (z.B. Flansche und Zargen) müssen hinsichtlich der Dopplungsfreiheit nach EN 10160, Qualitätsklasse S1 und E1, oder einem äquivalenten Standard ultraschallgeprüft sein.
8. Der Stahlrohrturm darf nur von Herstellern mit einer Qualifizierung gemäß DIN EN 1090-1 für mindestens Ausführungsklasse EXC3 gefertigt werden.
9. Die Fertigung des Stahlrohrturmes muss den Anforderungen der DIN EN 1090-2 Ausführungsklasse EXC3 entsprechen.
10. Die Anschlusspunkte aller zusätzlich an die Turmwand angeschweißten Teile (z.B. Besteigeeinrichtungen) müssen den auf der Zeichnung [8] [A9] angegebenen Kerbfallklassen entsprechen.
11. Die Schweißnähte des Turmes müssen den Anforderungen der Kerbfallklassen gemäß Abschnitt 5 entsprechen.
12. Die Prüfung der Schraubverbindung am Turmkopfflansch (Turm zur Maschine) ist in die Prüfung der Maschine einzubeziehen.

Betonteil

13. Infolge der Reduzierung des Vorhaltemaßes der Betondeckung der Fertigteilsegmente ist eine erhöhte Qualitätskontrolle gemäß DIN EN 1992-1-1/NA, 4.4.1.3 (3) bei der Herstellung erforderlich.
14. Aufgrund der Reduktion des Teilsicherheitsbeiwerts des Betons auf $\gamma_{c,\,red}$ = 1,35 sind gemäß DIN EN 1992-1-1 /4/, A.2.3 Maßnahmen zur erhöhten Qualitätssicherung erforderlich. Die Maßnahmen sind vom Hersteller in Abstimmung mit der zuständigen Überwachungsstelle festzulegen und zu dokumentieren.
15. Die Bestimmungen der allgemeinen bauaufsichtlichen Zulassungen für die Spannverfahren [16] bis [20] sowie für die Hochfestbetone [21] und geschweißten Bewehrungselemente [22] in der hier spezifizierten Fassung sind zu beachten.
16. Zum Zeitpunkt der Herstellung des Turmes ist eine gültige Version der zitierten Zulassungen [16] bis [22] vorzulegen und gegebenenfalls die Gleichwertigkeit mit der hier zitierten Version nachzuweisen.
17. Die gewählten Ansätze für die Ermüdungsfestigkeit der Spannglieder sind mit einer aktualisierten abG [16] zu bestätigen. Die aktualisierte abG [16] oder ein entsprechender bautechnischer Nachweis (Typengenehmigung) ist unaufgefordert vorzulegen und muss vor Inbetriebnahme des ersten Turms der hier genannten Anlage vorliegen. Falls der allgemeine Anwendbarkeitsnachweis noch nicht rechtzeitig erteilt sein sollte, ist für den verwendeten Ansatz eine vorhabenbezogene Bauartgenehmigung als Anwendbarkeitsnachweis vorzulegen. Dieser Nachweis kann bei der jeweils zuständigen Obersten Baubehörde beantragt werden.

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

18. Der Zeitpunkt des Erreichens der erforderlichen Festigkeit des Vergussmörtels für das Vorspannen ist zu bestimmen und durch fachgerecht, unter Berücksichtigung der standortspezifischen Umgebungsbedingungen gelagerte Proben zu überprüfen und zu dokumentieren. Die Druckfestigkeit des Vergussmörtels muss zum Zeitpunkt des Vorspannes ≥ 30 N/mm² betragen.
19. Für das Vorspannen der Spannglieder ist die Spannanweisung [4] heranzuziehen. Über das Spannen der Spannglieder ist ein Spannprotokoll zu führen.
20. Für das Vorspannen der Ankerschrauben ist die Spannanweisung [3] heranzuziehen. Es ist bei beiden Vorspannstufen eine Qualitätskontrolle des Anziehvorgangs nach DIN EN 1090-2 /10/, 12.5.2 durchzuführen, um eine stichprobenartige Überprüfung des erzielten Vorspanniveaus sicherzustellen.
21. Bis zum Beginn der Ermüdungsbeanspruchung müssen die Fertigteilsegmente das Mindestalter gemäß Abschnitt 5 aufweisen. Der dabei rechnerisch angesetzte Wert für die Nacherhärtung des Betons gemäß Abschnitt 5 kann alternativ auch messtechnisch nachgewiesen werden.
22. Der rechnerisch angesetzte E-Modul des Betons im Adapter zwischen 45.000 N/mm² und 53.000 N/mm² ist sicherzustellen.

Prüfintervalle

23. Die planmäßige Vorspannung der Schraubverbindungen ist nach Inbetriebnahme gemäß den Vorgaben der DIBt-Richtlinie /1/ (Abschnitt 13.1 Anmerkung 1) erneut zu kontrollieren und ggf. nachzuspannen. Wenn die 2. Vorspannstufe der Ankerschrauben des Adapters innerhalb dieses Zeitraums aufgebracht wird, kann die zuvor genannte Prüfung dieser Ankerschrauben hierdurch ersetzt werden.
24. Die Anforderungen an die wiederkehrenden Prüfungen gemäß der DIBt-Richtlinie /1/ sind zu beachten.

Für die Verlängerung der Typenprüfung sind die Zeichnungen und die Berechnungen zu einer erneuten Überprüfung hinsichtlich geänderter Vorschriften oder Richtlinien vorzulegen.

TÜV SÜD Industrie Service GmbH
Prüfamt für Standsicherheit für die
bautechnische Prüfung von Windenergieanlagen

Der Bearbeiter

C. Reuter

Der Leiter

i.V. S. Mayer

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

VESTAS PROPRIETARY NOTICE

RESTRICTED

Industrie Service

2024-09-24 11:14 UTC - diana.fernandes-haack@pne-ag.com - Diana Fernandes Haack

Anhang 1: Verzeichnis geprüfter Pläne

Betonteil (erstellt von Max Bögl)

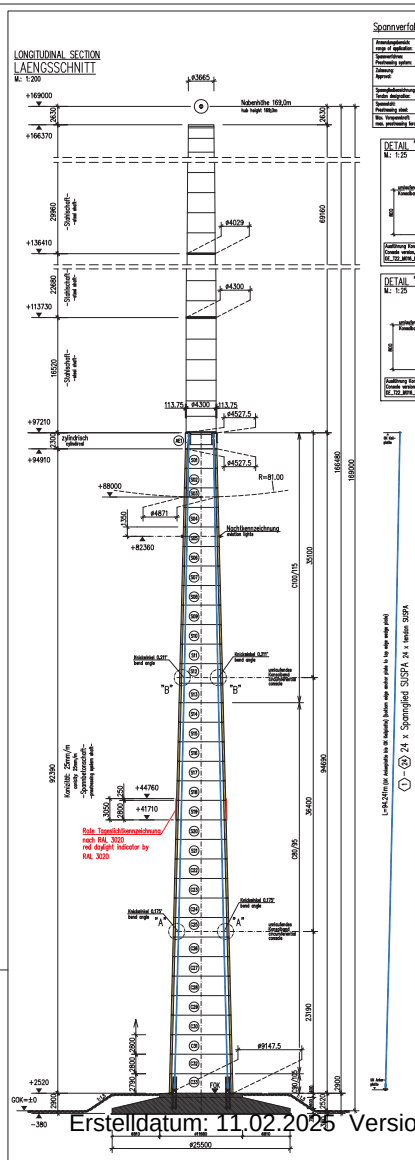
Nr.	Planbezeichnung	Ind.	Titel	Datum
[A1]	DE-T22-001-XX-X-Uebersicht	b	Uebersichtsplan Gesamtturm, NH = 169.0 m, Spannglieds. "SUSPA“	2023-08-30
[A2]	DE-T22-095-XX-X-Schalplan	-	Schalplan Rohteile C– und S–Ringe	2022-07-06
[A3]	DE-T22-096-XX-X-Bewehrung	-	Bewehrungsplan Rohteile C- und S-Ringe (3-teilig)	2022-07-06
[A4]	DE-T22-AE1-K1-X-Schalplan	b	Schalplan Uebergangsstueck AE1 (SUSPA)	2023-08-30
[A5]	DE-T22-AE1-K1-X-Bewehrung	c	Bewehrung Uebergangsstueck AE1 (SUSPA)	2023-12-12
[A6]	DE-T22-M008 Montageplan	-	Fugendetailplan	2022-07-06
[A7]	XX-XXX-M64-HV-1-Schalplan	c	Gewindestange fuer Uebergangsstueck mit Decordynbe-schichtung T0177772	2021-01-25
[A8]	XX-XXX-M64-HV-2-Schalplan	b	Gewindestange fuer Uebergangsstueck mit Schrumpf-schlauch T0177773	2021-01-25

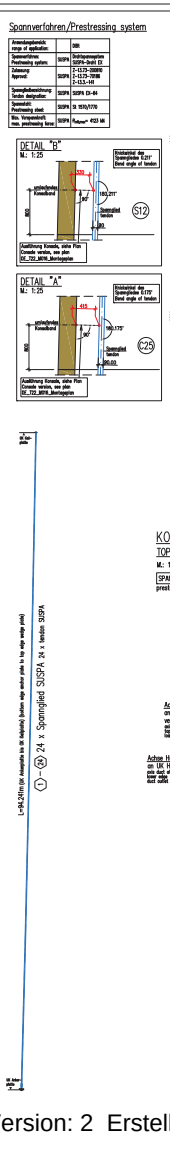
Stahlteil (erstellt von Max Bögl)

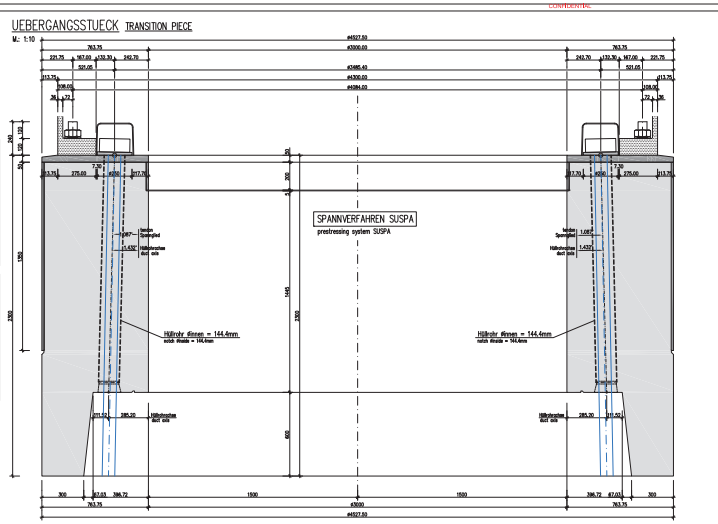
Nr.	Planbezeichnung	Ind.	Titel	Datum
[A9]	DE-T22-022-XX-X-Uebersicht	e	Übersichtsplan Stahlturm 169m NH	2023-11-17

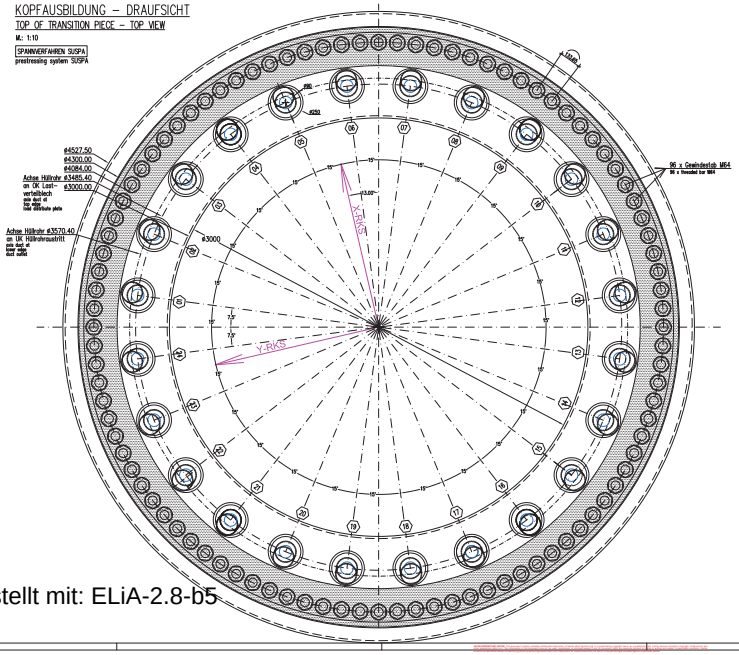
T05 0131-8548 Ver 01 - Approved- Exported from DMS: 2024-05-02 by INVOL

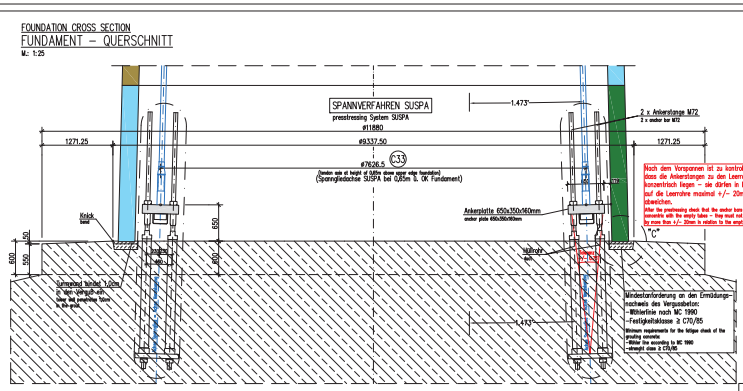
VESTAS PROPRIETARY NOTICE

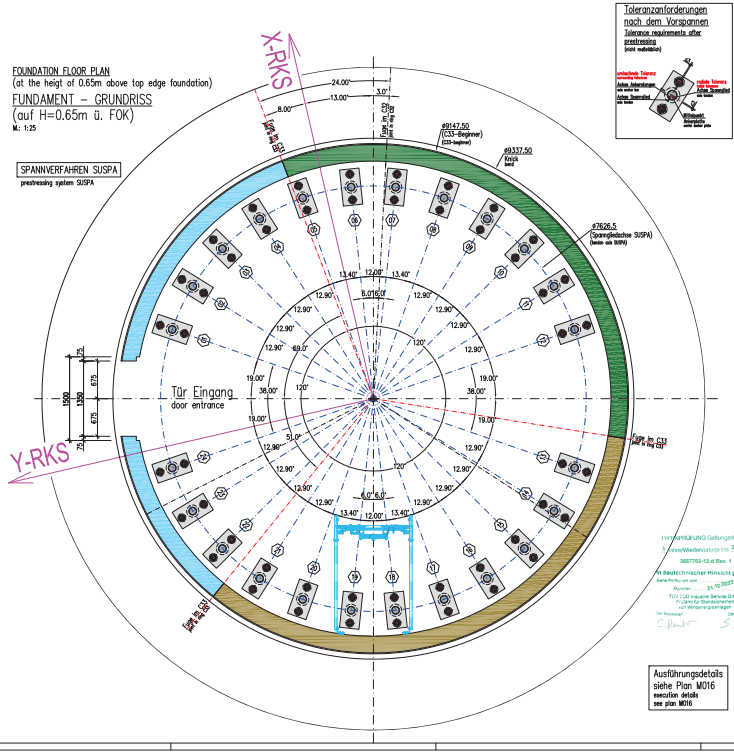


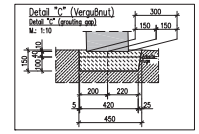


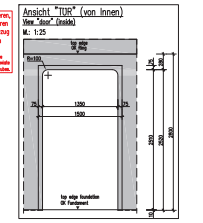


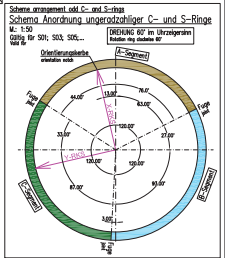


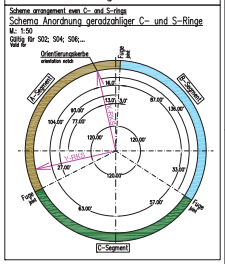










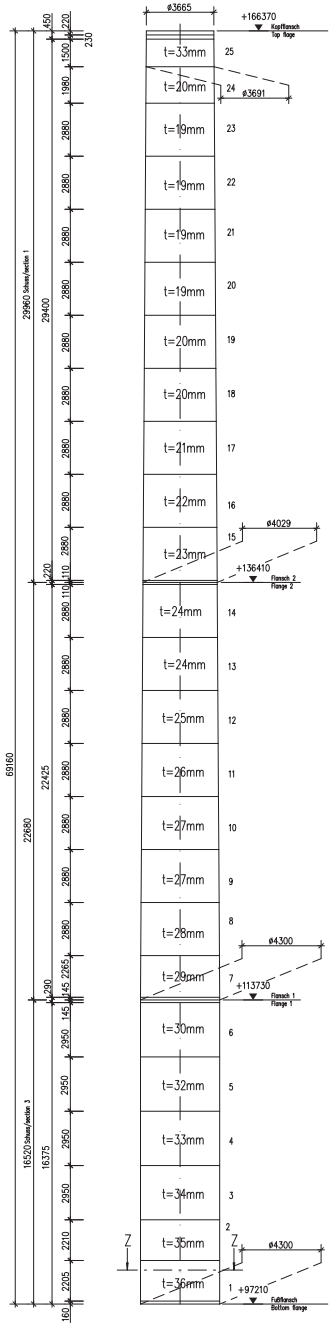


CONFIDENTIAL

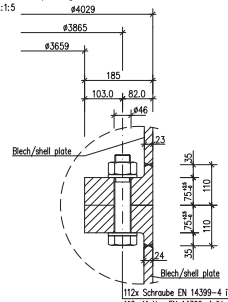
Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: ELiA-2.8-b5

CONFIDENTIAL

Längsschnitt
M.: 1:100

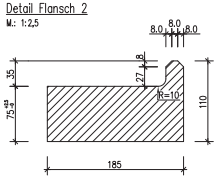


Flansch 2/Flange 2
M.: 1:5

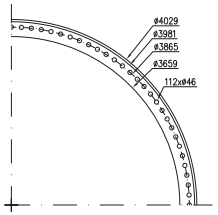


112x Schraube EN 14399-4 iVm. DASt-RIi 021 M42x220-10.9-tZn-HV
112x Mutter EN 14399-4 iVm. DASt-RIi 021 M42-10-tZn-HV
224x Scheibe EN 14399-6 iVm. DASt-RIi 021 42-tZn-HV
Fp,c=-710kN

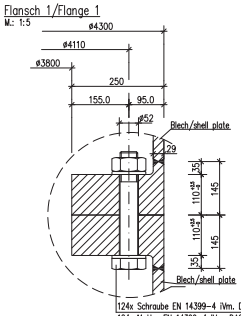
Detail Flansch 2
M.: 1:2,5



Draufsicht Flansch 2/Top view 2
M.: 1:20

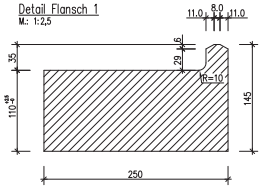


Flansch 1/Flange 1
M.: 1:5

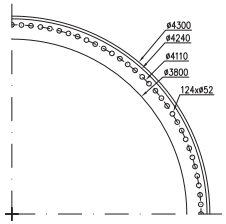


124x Schraube EN 14399-4 iVm. DASt-RIi 021 M48x290-10.9-tZn-HV
124x Mutter EN 14399-4 iVm. DASt-RIi 021 M48-10-tZn-HV
248x Scheibe EN 14399-6 iVm. DASt-RIi 021 48-tZn-HV
Fp,c=-930KN

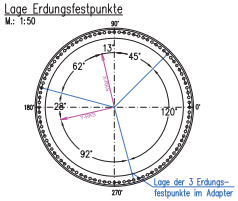
Detail Flansch 1
M.: 1:2,5



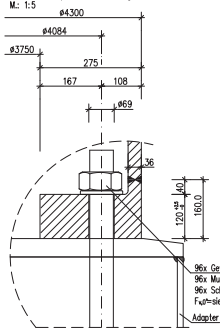
Draufsicht Flansch 1/Top view 1
M.: 1:20



Lage Erdungsfestpunkte
M.: 1:50

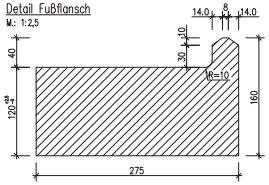


Fußflansch/bottom flange
M.: 1:5

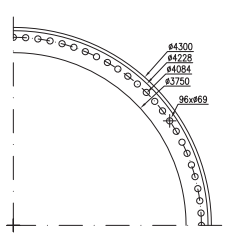


96x Gewindestange
96x Muttern EN 14399-4 iVm. DASt-RIi 021 M64-10.9-flZnncl 1000h-HV, Toleranz 6H
96x Scheiben EN 14399-6 iVm. DASt-RIi 021 64-flZnncl 1000h-HV
F_{vM}=siehe Dokument "Spannanweisung der Ankerstangen im Adapter"

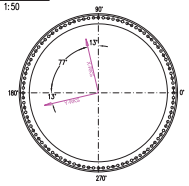
Detail Fußflansch
M.: 1:2,5



Draufsicht Fußflansch/ Top view bottom flange
M.: 1:20



Schnitt Z-Z
M.: 1:50

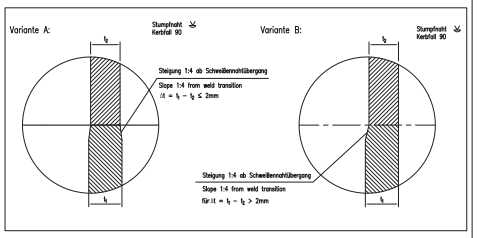


Kerbfallklasse / zulässige Butzen

Seg.	Höhe [m]	Schuss [#]	t [mm]	orl. KFK Stahlturm	KFK - Butzen 30/M6	30/M10	30/M16	40/M16	40/M20	Können die Butzen verwendet werden? 30/M6	30/M10	30/M16	40/M16	40/M20
Kopfsegment	1,500	25	33	KF86	88	88	89	87	88	nein	nein	ja	nein	nein
	1,980	24	20	KF88	89	89	91	88	89	ja	ja	ja	ja	ja
	2,880	23	19	KF87	88	88	90	87	88	ja	ja	ja	ja	ja
	2,880	22	19	KF87	88	88	90	87	88	ja	ja	ja	ja	ja
	2,880	21	19	KF88	88	88	90	87	88	ja	ja	ja	nein	ja
	2,880	20	19	KF89	88	88	90	87	88	nein	nein	ja	nein	nein
	2,880	19	20	KF87	89	89	91	88	89	ja	ja	ja	ja	ja
	2,880	18	20	KF90	89	89	91	88	89	nein	nein	ja	nein	nein
	2,880	17	21	KF89	89	89	91	88	89	ja	ja	ja	nein	ja
	2,880	16	22	KF88	89	90	92	88	90	ja	ja	ja	ja	ja
	2,880	15	23	KF87	89	90	92	89	90	ja	ja	ja	ja	ja
Mittelsegment	2,880	14	24	KF87	89	91	93	89	91	ja	ja	ja	ja	ja
	2,880	13	24	KF89	89	91	93	89	91	ja	ja	ja	ja	ja
	2,880	12	25	KF88	89	91	93	89	91	ja	ja	ja	ja	ja
	2,880	11	26	KF88	89	91	92	89	91	ja	ja	ja	ja	ja
	2,880	10	27	KF88	89	90	92	89	90	ja	ja	ja	ja	ja
	2,880	9	27	KF90	89	90	92	89	90	nein	ja	ja	nein	ja
	2,880	8	28	KF89	89	90	91	88	90	ja	ja	ja	nein	ja
	2,265	7	29	KF89	89	89	91	88	89	ja	ja	ja	nein	ja
Fußsegment	2,950	6	30	KF90	89	89	90	88	89	nein	nein	ja	nein	nein
	2,950	5	32	KF88	88	89	90	88	88	ja	ja	ja	ja	ja
	2,950	4	33	KF89	88	88	89	87	88	nein	nein	ja	nein	nein
	2,950	3	34	KF89	87	88	89	87	87	nein	nein	ja	nein	nein
	2,210	2	35	KF89	87	88	89	87	87	nein	nein	ja	nein	nein
	2,205	1	36	KF89	87	88	89	87	87	nein	nein	ja	nein	nein

Materialien/Materials		
Bauteil/ Component	Material	zusätzliche Anforderungen/ additional Requirements
Turmbleche Tower Shell Plates	DIN EN 10025-2 – S355J2+N	warm gewalzt, normalisiert (oder normalisierend gewalzt) hot rolled, normalized (or normalizing rolled)
Flansche Flanges	DIN EN 10025-3 – S355NL DIN EN 10164 – Z15	Es sind nur nahtlos gewalzte oder aus Stabstahl gebogene Flansche zulässig. Seamless Rolled (forged) or from steelbars bended Flanges are permitted only.

Temperature range		
Version	Temperatur Bereich für Normal Operation Temperature range for normal operation	Temperatur Bereich für Transport/Lagerung/Stillstand Temperature range for transport/storage/standstill (structural)
– Standard version (NC)	(–30°C to +50°C) Umgebungstemperatur/ambient temperature	(–30°C to +50°C) Umgebungstemperatur/ambient temperature



Kopfflansch gemäß VESTAS Zeichnung: 29266351; 29266593; 29266594; 29266595
Top flange acc. so VESTAS drawing:

Schweißnähte: Allgemein Längs-, Quernähte und tragende Anbauteile gem. DIN EN 1993-1-9.
Welds: generally longitudinal and circular weldings and structural components according to DIN EN 1993-1-9.

Mindest-Lichteabstand der Anbauteile zu den Längs- und Quernähten: 100mm.
Hauptlängsnähte der Stahlturmwand um min. 90° versetzen.
Mindest-Lichteabstand zwischen zwei Anschweißbolzen beträgt: 135mm.

Minimum clearance of the attachments to the longitudinal and transverse seams: 100mm.
Offset main longitudinal seams of the steel tower wall by min. 90°.
Minimum clearance between two weld-on studs is: 135mm.

Bezugstemperatur: T_{Ed} = –30°C
Lowest component temperature: T_{Ed} = –30°C

EG-Zertifikat EN 1090-2 EXC 3
EC-Certificate EN 1090-2 EXC 3

Stahlturmwand: – Unrundheit DIN EN 1993-1-6, Herrstelltoleranz-Qualitätsklasse B
Steel tower wall: – Ovality DIN EN 1993-1-6, manufacturing tolerance-quality class B

– Vorbeulen DIN EN 1993-1-6, Herrstelltoleranz-Qualitätsklasse B
– Buldge DIN EN 1993-1-6, manufacturing tolerance-quality class B

– Toleranzen für Grobbleche nach EN 10029 Toleranzklasse B
– Tolerances for steel plates according to EN 10029 tolerance class B

– Oberflächenbeschaffenheit nach DIN EN 10163-2 Klasse B2
– Surface finish according DIN EN 10163-2 class B2

Flanschtoleranzen gemäß DIBt-Richtlinie
Flange tolerances according to DIBt-guideline

– Ebenheitsabweichung über gesamten Umfang ≤ 2.0 mm
– Flatness deviation over circumference ≤ 2.0 mm

– Kurzwelligkeit ≤ 1.0 mm/30"
– Short waveness ≤ 1.0 mm/30"

– Neigungen α der Flanschaußenflächen zur Turmwand nach dem Vorspannen 0,0°–0,7°
– Taper α to the inside of the conection surface of each flange after pre-loading 0,0°–0,7°

– Neigung α der Flanschaußenflächen nach dem Vorspannen ≤ 2°
– Taper α of flange outer surface after pre loading ≤ 2°

Sichtkontrolle der Schweißnähte: 100%.
Visual inspection of welds: 100%.

Schweißnähte nach DIN EN ISO 5817 Bewertungsgruppe B.
Welds in accordance with DIN EN ISO 5817 level B.

Ultraschallkontrolle der Schweißnähte: Flanschnähte 100%, Stumpfnähte in Querrichtung 20%, sonstige Nähte 10%.
Ultrasonic inspection of welds: flange welds 100%, lateral butt welds 20%, other welds 10%.

Werkstoff: Abnahmeprüfzeugnis gem. DIN EN 10204 3.1.
Material: acceptance test certificate in accordance with DIN EN 10204 3.1.

Korrosionsschutz und Beschichtung: siehe separater Plan.
Corrosion protection and coating: see extra drawing.

Stahlturmmassen (kg)
Steel tower masses (kg)

	Sektionsgewicht Section weight	Bleche Shells	Oberer Flansch Top flange	Unterer Flansch Bottom flange
Topsektion Top section	63284	57909	3977	1398
Mittelsektion Middle section	64227	59971	1398	2857
Fußsektion Bottom section	62819	56535	2857	3427
Gesamtgewicht Total weight	190330	174415	15915	

VESTAS Windenergieanlage
WEA VESTAS V162
Stahl-Beton-Hybridturm (T22)
169m NH
Rotorblattdurchmesser 162m
DIBt 2

VESTAS wind turbine
WEC VESTAS V162
steel concrete hybridtower (T22)
169m HH
rotor blade diameter 162m
DIBt 2

TYPENPRÜFUNG Geltungsdauer
5 Jahre/Wiedervorlage bis 30.08.2027
3667703-12-d Rev. 1
in bautechnischer Hinsicht geprüft.
Siehe Prüfbericht vom 21.12.2023
München
TÜV SÜD Industrie Service GmbH
Prüfamt für Standsicherheit
von Windenergieanlagen
Der Prüfer / Der Leiter

Änderung:	Bezeichnung:	Name	Datum
A	Angabe Befestigungsmittel Fußflansch berichtigt	Moos.	17.11.2023
B	Normverweise Schrauben, Muttern, Scheiben & Toleranzen ang.	Moos.	05.06.2023
C	Zeichnungsnummern und Maßkette vom Letzten Blech ergänzt	Grdlbaj.	30.08.2022
D	Lochkreisdurchmesser Fußflansch angepasst	Moos.	25.08.2022
		Ers.	10.08.2022

MAX BÖGL
Fortschritt baut man aus Ideen.

Bauherr:	Max Bögl	Projekt Nr.:	21683
Bauvorhaben:	Windkraftanlage wind turbine generator	Blattgr.:	1.194-84m
Bauteile:	Übersichtsplan Stahlturm 169m NH layout steel tower 169m NH	Maßstab:	1:100

erst.: Reg.	Dat.: 08.07.2022	Boegl-Planbezeichnung							
gepr.: Von Oes.	Dat.: 11.07.2022	Land	Turmtyp	Rotortyp	Segment/Baustufe		Planart		Index
freig.: Betz	Dat.: 11.07.2022	DE	T22	022	XX	X	Uebersicht		e

"Vestas"-Planbezeichnung

Im Textfeld "Zugriffsrecht gemäß Vestas Plan-" ist die "Einstufungsstufe 1– 3" anzugeben

Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: ELiA-2.8-b5

TEK-01-84-0418 Ver 01 – Approved. Exported from DMS: 2024-04-18 by RKOL

16.1.5 Anlagenwartung

Der Wartungsvertrag zwischen Anlagenbetreiber und Anlagenhersteller wird erst bei Bestellung der Windkraftanlagen geschlossen und kann daher hier noch nicht zur Verfügung gestellt werden. Bei Bestellung der Windkraftanlagen wird mit dem Anlagenhersteller ein Wartungsvertrag abgeschlossen.

16.1.6 Zuwegung, Kabelverbindung, Kranstellfläche

Anlagen:

- #16-1-6-1_Mindestanforderung-an-Zuwegung-und-Kranstellflaechen_V172.pdf

PUBLIC

Dokument Nr.: 0040-4327 V13
01.05.2022

Anforderungen an Transportwege und Kranstellflächen

V90, V100, V110, V112, V117, V120, V126, V136, V150, V162, V172

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

Uncontrolled when printed. Document is valuable intellectual property of Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

PUBLIC

Anforderungen an Transportwege und Kranstellflächen

V90, V100, V110, V112, V117, V120, V126, V136, V150, V162, V172

Änderungsprotokoll

Version Nr..	Datum	Beschreibung der Änderung
00	2013-10-17	Erstfassung
01	2014-04-09	Änderung der Kurvenradien V117 und V126, Anlage 3 hinzugefügt
02	2014-08-19	Vervollständigung der Angaben zu den Kranstellflächen A1.1 bis A5.4
03	2014-11-19	Überarbeitung des Kapitels 2.3.4, hier: Mindestanforderung an Kurven. Klarstellungen zu den Kranstellflächen.
04	2015-09-10	Aktualisierung der Anlagentypen, Überarbeitung des Kapitels 2.3, Überarbeitung A1.1 bis A5.4
05	2016-02-05	Aktualisierung der Kurvenradien Kap. 2.3.4
06	2016-09-23	Aktualisierung der Anlagentypen, Überarbeitung der Kurvenradien, Überarbeitung der Kranstellflächen
07	2017-06-17	Aktualisierung der Anlagentypen, Überarbeitung der Kurvenradien, Überarbeitung der Kranstellflächen
08	2018-07-30	Komplette Überarbeitung
09	2018-11-12	Komplette Überarbeitung
10	2019-04-01	Ergänzung V100 / V110 / V150 5.6 MW / V162
11	2020-04-01	Ergänzung Hybridbetonturm (CHT) Ergänzung und Auslagerung der Dokumente: - 0092-8386 Anlage 2 Zeichnungen Kurvenradien - 0092-8388 Anlage 3 Zeichnungen Kranstellflächen - 0092-8389 Anlage 4 Projektspezifische Beispiele
12	2021-04-01	Textliche Ergänzung Baustelleneinrichtungsfläche Anforderung Anlieferung CHT Allgemeine graphische und textliche Überarbeitung Bodenanforderungen angepasst
13	2022-05-01	Ergänzung V172 in allen Dokumenten Anforderung Anlieferung CHT aktualisiert: Kurvenradius 0092-8386 Anlage 2: V162 / V172 Kurvenradien aktualisiert 0092-8388 Anlage 3: V172 ergänzt 0092-8389 Anlage 4: Umladeplatz aktualisiert und ergänzt

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

VESTAS PROPRIETARY NOTICE

PUBLIC

Inhaltsverzeichnis

1 Allgemeines 5

1.1 Vorbemerkungen 5

1.2 Verantwortliche Personen 5

1.3 Abstimmung mit Vestas 5

1.4 Weitere generelle Festlegungen 6

2 Anforderungen an Transportwege 7

2.1 Achslasten und Optimierungsmöglichkeiten 7

2.2 Definition von Kategorien 7

2.3 Anforderungen an die Planung 8

2.3.1 Baugrundgutachten und Baugrunderkundungen 8

2.3.2 Statische und konstruktive Planung 10

2.3.3 Übersicht über die geometrischen Anforderungen 12

2.3.4 Anforderungen an Kurven und Kreuzungen 15

2.3.5 Anforderungen an Ausweichbuchten und Wendebereiche 15

3 Anforderungen an die Kranstellflächen 17

3.1 Übersicht über die Fahrzeuge, Krane, Komponenten und Materialien 17

3.2 Belastungen und Belastungsbereiche 18

3.3 Anforderungen an die Planung (Länderspezifisch) 20

3.3.1 Baugrundgutachten und Baugrunderkundungen 20

3.3.2 Statische und konstruktive Planung 21

3.3.3 Geometrische Anforderungen 21

4 Anforderungen an die Bauausführung 22

4.1 Lieferung der Ankerkorbkonstruktion 23

4.2 Prüfung der Tragfähigkeit 23

4.3 Wartungs- und Kennzeichnungspflicht 25

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

VESTAS PROPRIETARY NOTICE

PUBLIC

5 Anforderungen an die Baustelleneinrichtungsflächen.....25

6 Sonstige Anforderungen und Hinweise 26

Anlagenverzeichnis

Anlage 1a: Darstellung der Baustelleneinrichtungsfläche (BE-Fläche) 27

Anlage 1b: Bestätigung der ordnungsgemäßen Ausführung der Arbeiten in statischer und konstruktiver Hinsicht 28

Anlage 2: Zeichnungen Kurvenradien (separates Dokument 0092-8386)

Anlage 3: Zeichnungen Kranstellflächen (separates Dokument 0092-8388)

Anlage 4: Projektspezifische Beispiele (separates Dokument 0092-8389)

Verwendete Abkürzungen:

LDST	Large Diameter Steel Tower (Stahlturm mit großem Durchmesser, geteilt)
CHT	Concrete Hybrid Tower (Beton-Hybridturm)
TST	Tubular Steel Tower (Stahlrohrturm)
HTST	High Tubular Steel Tower (Stahlrohrturm mit >6m Turmdurchmesser)
HH	Hub Height (Nabenhöhe)
DIBt	German Institute for Structual Engineering (Deutsches Institut für Bautechnik)
IEC	International Electrotechnical Commission (Internationale Elektrotechnische Kommission)

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

VESTAS PROPRIETARY NOTICE

1 Allgemeines

1.1 Vorbemerkungen

Das vorliegende Dokument 0040-4327 V13 mit dem Titel Anforderungen an Transportwege und Kranstellflächen gibt Auskunft über die von Seiten der verantwortlichen Fachplanern und Bauausführenden einzuhaltenden Anforderungen, Voraussetzungen und Vor-Ort-Bedingungen für die zur Lieferung, Lagerung und Installation von Windenergieanlagen der Baureihe V90 bis V172, erforderlichen Transportwege und Kranstellflächen innerhalb des Windparks.

Ziel ist es, durch Einhaltung der Anforderungen einen reibungslosen Ablauf hinsichtlich Logistik und Technik sowie Arbeitssicherheit zu gewährleisten.

Eine frühzeitige Berücksichtigung der Anforderungen in der Projektierungs- und Planungsphase wird empfohlen.

1.2 Verantwortliche Personen

Verantwortliche Personen in Bezug auf die Berücksichtigung der Anforderungen an Transportwege und Kranstellflächen in der Planung und Ausführung sind

- der/ die Baugrundsachverständige,
- der/ die Fachplaner/in für die statische und konstruktive Auslegung der Transportwege und Kranstellflächen,
- der/ die Sicherheits- und Gesundheitsschutzkoordinator/in (SiGeKo)

Die hier genannten verantwortlichen Personen agieren als Erfüllungsgehilfen im Auftrag des Bauherrn.

1.3 Abstimmung mit Vestas

Es wird ein Vorort Kick-off-Meeting mit allen Beteiligten empfohlen. Erfolgt keine Abstimmung mit Vestas wird von der Einhaltung aller Anforderungen ausgegangen.

HINWEIS: Die Nichteinhaltung der Anforderungen kann zu Behinderungen im Arbeitsablauf und somit zu Zusatzkosten z. B. durch Stillstandzeiten oder zusätzlichen Personal- und Geräteeinsatz führen.
Eine rechtzeitige Abstimmung der Planung sowie der Arbeiten vor Ort mit Vestas wird in jedem Fall empfohlen.

Gemäß abgestimmten Projektablaufplan (i.d.R. 14 Tage vor Beginn der Lieferung und somit einhergehenden Nutzung der Transportwege und Kranstellflächen durch Vestas) ist die Bescheinigung der ordnungsgemäßen Ausführung der Arbeiten in

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

statischer und konstruktiver Hinsicht gem. Anlage 1a als pdf-Dateien und 1-fach als Hardcopy zur Verfügung zu stellen.

Sollten projektbezogen begründete Abweichungen zu den Anforderungen erforderlich werden, ist in jedem Fall Vestas Projektmanager in die Planung miteinzubeziehen und eine schriftliche Zustimmung einzuholen.

Auf Anfrage sind dem Vestas-Projektmanagement folgende Dokumente als pdf-Dateien und 1-fach als Hardcopy zur Verfügung zu stellen:

- Baugrundgutachten gem. Kapitel 2.3.2 und 3.3.1
- Fachplanung in statischer und konstruktiver Hinsicht der Transportwege und Kranstellflächen gem. Kapitel 2.3, 3.3.2 und 3.3.3

1.4 Weitere generelle Festlegungen

Folgende generelle Festlegungen sollen gelten und sind bei der Planung und Ausführung zu berücksichtigen:

- Während der Lieferung, Lagerung und Installation der Windenergieanlagen sowie der Servicearbeiten vor Ort muss eine Zugänglichkeit für alle Gewerke zur gesamten Baustelle zu jeder Tages- und Nachtzeit gewährleistet sein, so dass die Arbeiten vollumfänglich ausgeführt werden können.

- Während der Lieferung, Lagerung und Installation der Windenergieanlagen vor Ort müssen die Sicherheits- und Gesundheitsschutzmaßnahmen zu jeder Tages- und Nachtzeit gewährleistet und eine bauherrenseitige Koordination und Überwachung der erforderlichen Maßnahmen gegeben sein.

- Baugruben und Böschungen in Arbeits- und Lagerbereichen sind bauseitig während des gesamten Anlieferungs-, Errichtungs- und Inbetriebnahme-zeitraums gem. geltenden gesetzlichen Bestimmungen gegen Absturz zu sichern.

- Während der Planung und Ausführung der Transportwege- und Kranstellflächen sind neben dem hier vorliegenden Dokument die national geltenden technischen Vorschriften, Normen und gesetzlichen Vorgaben gem. dem aktuellen Stand der Technik zu berücksichtigen, diese sind über die hier aufgezeigten VESTAS-Anforderungen hinausgehen, einzuhalten.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

PUBLIC

2 Anforderungen an Transportwege

Im vorliegenden Kapitel werden die Anforderungen an die Transportwege definiert. Kranstellflächen dienen ebenfalls, zumindest temporär, als Transportweg und werden hier auch als diese verstanden. Die darüber hinausgehenden Anforderungen für Kranstellflächen werden in Kapitel 3 beschrieben.

2.1 Achslasten und Optimierungsmöglichkeiten

Die Anforderungen an die Transportwege und Kranstellflächen werden in statischer Hinsicht maßgebend beeinflusst durch die auftretenden Belastungen aus den Transport- und Hebefahrzeugen. Die Standard-Achslast der Fahrzeuge beträgt $\leqslant$ 12 t.

Die Beschränkung der Achslast auf $\leqslant$ 12 t bedeutet z. T. ein umfangreiches Auf- und Abrüsten der Schwerlastfahrzeuge und -kräne an den Windenergiestandorten.
Um den damit verbundenen Zeitaufwand optimierend zu beeinflussen, kann ein Manövrieren der Schwerlastkrane zwischen den Windenergieanlagenstandorten in einem auf $\leqslant$ 21 t teilabgerüsteten Zustand der Schwerlastkrane in Absprache mit Vestas in Erwägung gezogen werden.

2.2 Definition von Kategorien

In den nationalen und internationalen Normen existiert bereits eine Einstufung der Ingenieuraufgaben / der Projekte gem. den Baugrundverhältnissen im Verhältnis zur Bauwerksart in Geotechnische Kategorien.
Im vorliegenden Dokument werden in Tabelle 1 und Tabelle 2 weitere Einstufungen der zu lösenden geotechnischen Ingenieuraufgaben in Abhängigkeit der vorherrschenden Baugrundverhältnisse und der genutzten Achslasten definiert und der Mindestumfang der Baugrunderkundungen empfohlen bzw. vorgegeben.

<u>Kategorie 1: Einfache Verhältnisse</u>
Eine Achslast der Transport- und Hebefahrzeuge von $\leqslant$ 12 t und $\leqslant$ 160 t Fahrzeuggesamtgewicht ist Mindestvoraussetzung für die Einstufung in die Kategorie K1.

Darüber hinaus ist mit einfachen Verhältnissen das Vorliegen von einheitlichen Baugrundverhältnissen im Bereich des Baufeldes gemeint. Die anstehenden, schichtwechselarmen Böden sind bis zur Einflusstiefe gut bis sehr gut tragfähig und die Grundwasserverhältnisse unbedeutend.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

VESTAS PROPRIETARY NOTICE

PUBLIC

Tabelle 1: Kategorien und Empfehlungen für einfache Verhältnisse

Einfache Verhältnisse	**Kategorie 1.1**	**Kategorie 1.2**	**Kategorie 1.3**
Achslast	≤ 12 t		
Baugrundeigenschaften	Mind. mitteldicht bis dicht gelagerte Sande	Annähernd halbfeste kohäsive Böden	Wechsellagerungen der Kategorie 1.1 und Kategorie 1.2
Grundwasser	Batman purge	≥ 2,5 cm unter GOK	Gem. K 1.1 und K 1.2
Geotechnische Untersuchungen	EMPFEHLUNG Gem. Kapitel 2.3.1		

Kategorie 2: Schwierige Verhältnisse

Zu einer Einstufung in schwierige Verhältnisse kommt es bei Ansatz einer Achslast von ⩽ 12 t, wenn uneinheitliche Baugrundverhältnisse im Bereich des Baufeldes vorliegen. Die in Wechsellagerung anstehenden Böden sind bis zur Einflusstiefe nicht tragfähig bis nur bedingt tragfähig, so dass umfassende geotechnische Nachweise und Maßnahmen erforderlich werden. Die wechselnden Grundwasserverhältnisse nehmen z. B. Einfluss auf die Konsistenz und somit auf die Tragfähigkeit sowie auf das Setzungsverhalten.

Tabelle 2: Kategorien und Erfordernisse für schwierige Verhältnisse

Schwierige Verhältnisse	**Kategorie 2.1**
Achslast	≤ 12 t (Minimum Transport)
Baugrund-eigenschaften	Locker gelagerte Sande, kohäsive Böden mit steifer oder geringer Konsistenz
Grundwasser	≥ 50 cm unter GOK
Geotechnische	ERFORDERNIS Gem. Kapitel 2.3.1

2.3 Anforderungen an die Planung

2.3.1 Baugrundgutachten und Baugrunderkundungen

Eine grundsätzliche Definition der Anforderungen an das Baugrundgutachten und die dazu erforderlichen Baugrunderkundungen für die Gründung der Windenergieanlagen ist in dem Dokument 0019-5727 gegeben.

Für die Planung der Transportwege empfiehlt es sich darüber hinaus, in den einfachen Fällen (Kategorie 1)

- je Streckenstrang (⩽ 650 m) eine indirekte Erkundung z. B. in Form einer Drucksondierung (CPT-E) oder glw. Bis in die Einflusstiefe der Lasten unter Geländehöhe abzuteufen.
- je Streckenstrang (⩽ 650 m) eine direkte Erkundung z. B. in Form einer Kleinrammbohrung oder glw. Bis in die Einflusstiefe der Lasten unter Geländehöhe abzuteufen, sofern sich abweichende Ergebnisse in den

Classification: Restricted

VESTAS PROPRIETARY NOTICE

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

PUBLIC

durchgeführten Drucksondierungen gegenüber den Hauptuntersuchungen im Bereich der Windenergieanlagen aufzeigen.
- je Bodenschicht- und/ oder Bodeneigenschaftswechsel oder Tiefenmeter mindestens eine Bodenprobe zu entnehmen.
- die Auswertung der gewonnen Bodenproben im Baugrundlabor zur Ermittlung der Bodenparameter (Rechenwerte) bzw. zur Bestätigung der in den Normen genannten Rechenwerte vorzunehmen.

Für die Planung der Transportwege wird gefordert, in den schwierigen Fällen (Kategorie 2)
- je Streckenstrang (≤ 650 m) eine indirekte Erkundung z. B. in Form einer Drucksondierung (CPT-E) oder glw. Bis in die Einflusstiefe der Lasten unter Geländehöhe abzuteufen.
- je Streckenstrang (≤ 650 m) eine direkte Erkundung z. B. in Form einer Kleinrammbohrung oder glw. Bis in die Einflusstiefe der Lasten unter Geländehöhe abzuteufen.
- je Bodenschicht- und/ oder Bodeneigenschaftswechsel oder Tiefenmeter mindestens eine Bodenprobe zu entnehmen.
- die Auswertung der gewonnen Bodenproben im Baugrundlabor zur Ermittlung der Bodenparameter (Rechenwerte) bzw. zur Bestätigung der in den Normen genannten Rechenwerte vorzunehmen.

Der erforderliche Umfang der Baugrunderkundungen richtet sich nach den geologischen Gegebenheiten vor Ort und liegt im Verantwortungsbereich des Baugrundsachverständigen.
Dieser hat in beiden Fällen die Anforderung zu erfüllen und im Rahmen seines Hauptgutachtens in einem Extrakapitel oder, je nach Umfang, in einem separaten Gutachten fachlich begründete Vorgaben für die Planung der Transportwege zu tätigen.

Folgende Informationen sind in Bezug auf die Planung und Ausführung der Transportwege und Kranstellflächen in dem Baugrundgutachten mindestens zu tätigen:
- Nennung der Bodenarten, Bodenschichtungen und Homogenbereiche
- Nennung der Bodenkenngrößen (Korngröße und Korngrößenverteilung, Kornform, Korngefüge und Beimengungen, Wassergehalt und Wasseraufnahmevermögen, Durchlässigkeit, Bodendichte, Bodenwichte, Porenanteil, Lagerungsdichte, Verdichtungsfähigkeit, Zustandsformen etc.)
- Nennung der Festigkeits- und Formänderungseigenschaften (Scherfestigkeit, Zusammendrückbarkeit, Bodendynamische Kennwerte etc.)
- Nennung der Bodenkenngrößen für bindige und nichtbindige Böden (hier: Rechenparameter)

Classification: Restricted

VESTAS PROPRIETARY NOTICE

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

PUBLIC

- Dimensionierung der Wege- und Kranstellflächenaufbaus (Querschnitte mit Materialangaben)
- Angabe zur Wiederverwendbarkeit des Bodenaushubs als Auffüllmaterial für Wege- und Kranstellflächenbau bzw. als Fundamentüberschüttung.

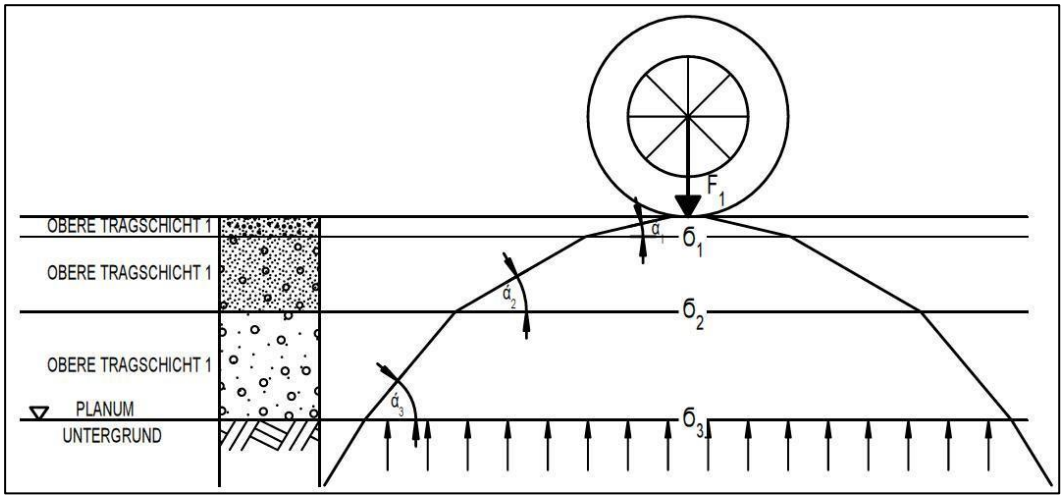
2.3.2 Statische und konstruktive Planung

Auf Basis des Baugrundgutachtens ist eine Planung der Transportwege in statischer und konstruktiver Hinsicht zu erarbeiten.

Folgende erdstatische Nachweise sind prüffähig zu führen:

- Nachweis der Grundbruchsicherheit und Einhaltung der zulässigen Schiefstellung (Setzungsberechnung)
- Nachweis der Spannungsverteilung unter Lasten (Sohlspannungsverteilung, Spannungsverteilung im Boden)
- Nachweis der Gleit- und Kippsicherheit
- Nachweis der Gelände- und Böschungsbruchsicherheit
- Nachweis des Wassereinflusses (Wasserdruck, hydraulischer Grundbruch, Veränderung der Bodenwichte, Frostempfindlichkeit)

Abbildung 1: Schematische Darstellung der Lastverteilung auf künstlichem Aufbau sowie den natürlich anstehenden Böden (Untergrund)



Die zeichnerische Darlegung der Planung ist in folgender Form zu erbringen:

- Lagepläne im Maßstab 1:1000 / 1:2000 / 1:5000
- Querschnittsprofile mit Angabe der Quergefälle im Maßstab 1:50 / 1:100
- Höhenpläne als Schnittdarstellung im Maßstab 1: 200 / 1:500 / 1:1000
- Detailpläne im Maßstab 1:10, 1:50 je nach Erfordernis

In die statische und konstruktive Planung der Transportwege ist die Nachweisführung und zeichnerische Darlegung der Maßnahmen für zu überfahrende Bauteile, wie z. B.

Classification: Restricted

VESTAS PROPRIETARY NOTICE
T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

Brücken und Durchlässe, Ver- und Entsorgungsleitungen, Schächten etc. zu integrieren.

Für das Überfahren von bestehenden Bauwerken sind im Allgemeinen Genehmigungen, denen u. a. eine statische Prüfung vorausgeht, erforderlich, die bauseits einzuholen sind.

Die Transportwege sind für den kompletten Zeitraum des Windparkprojektes (Aufbau- , Betriebs- und Rückbauphase) auszulegen.

Schwerlastfahrzeuge sind keine geländegängigen Fahrzeuge und für den Verkehr auf befestigten Straßen konstruiert und vorgesehen. Daher bestehen an die Transportwege besondere Anforderungen nicht nur in Bezug auf die Tragfähigkeit, sondern auch an die Gebrauchstauglichkeit.

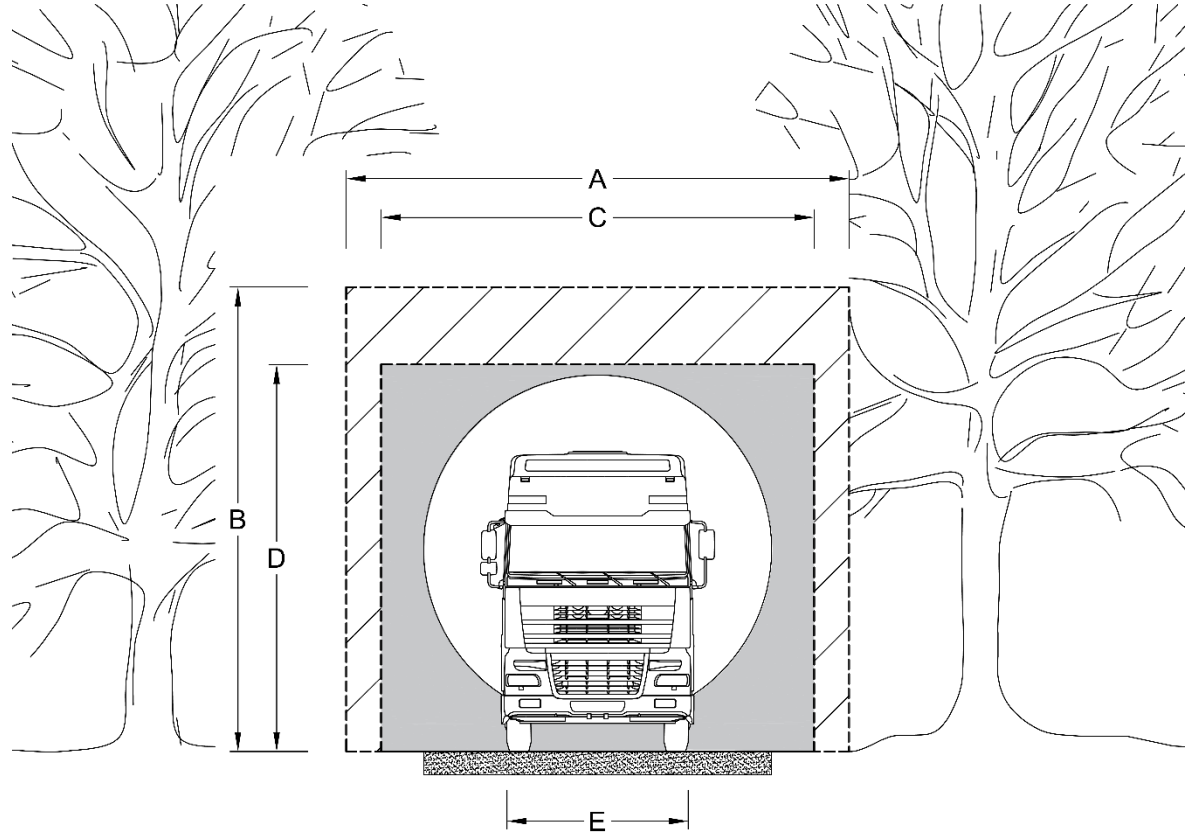
T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

PUBLIC

2.3.3 Übersicht über die geometrischen Anforderungen

Bei der Planung der Transportwege sind Mindestabmessungen einzuhalten, die in den folgenden Abschnitten dargelegt werden:

STANDARD-LICHTRAUMPROFIL		
	Durchfahrtsbreite (Kurven)	s. Kapitel 2.3.4.
A	Durchfahrtsbreite (Geraden)	6,00 m (TST) 6,00 m (CHT) 6,50 m (LDST(1)) 7,00 m (nur LDST V162 NH166) 7,50 m (HTST)
B	Durchfahrtshöhe	5,50 m 7,50 m (HTST)
C	Transportbreite	4,60 – 6,30 m
D	Transporthöhe	5,00-7,30 m
E	Spurbreite	3,00 m



Hybridturm: Abweichend zu den o.g. sind andere Werte während des *Bauabschnittes Fundament- und Betonturmbau* möglich.

A Durchfahrtsbreite 5,5m
B Durchfahrtshöhe 5,0m

Für die Anlagenerrichtung sind die oben genannten Tabellenwerte (Standard-Lichtraumprofil) zu verwenden.

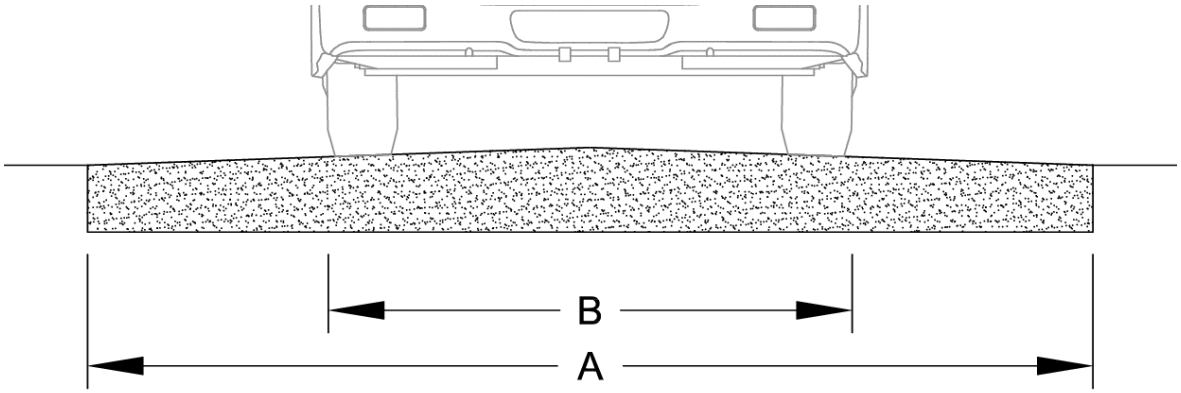
(1) Auswahl gemäß WEA-Typ Kapitel 7

Classification: Restricted

VESTAS PROPRIETARY NOTICE

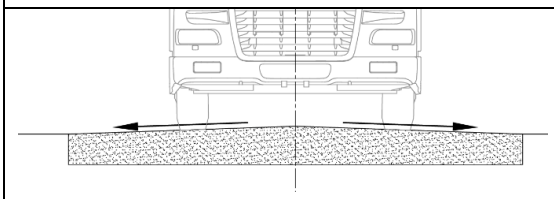
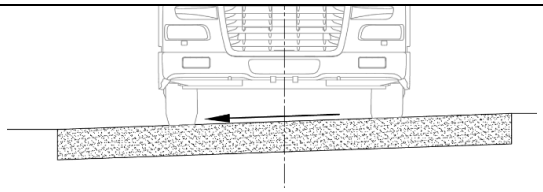
T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

FAHRBAHN TRAGFÄHIGE OBERFLÄCHE		
A	Breite tragfähige Fahrbahn (Geraden)	4,50 m
B	Fahrzeug Spurbreite (Geraden)	2,50 m – 3,00 m
	Breite tragfähige Fahrbahn (Kurven/-radien)	s. Kapitel 2.3.4.



Hybridturm: Abweichend zu den o.g. sind andere Werte während des *Bauabschnittes Fundament- und Betonturmbau* möglich.

A Breite tragfähige Fahrbahn (Geraden) 4,0m

GRENZWERTE VON QUERGEFÄLLEN	
Kurven	⩽ 3%
Geraden	⩽ 3%
	

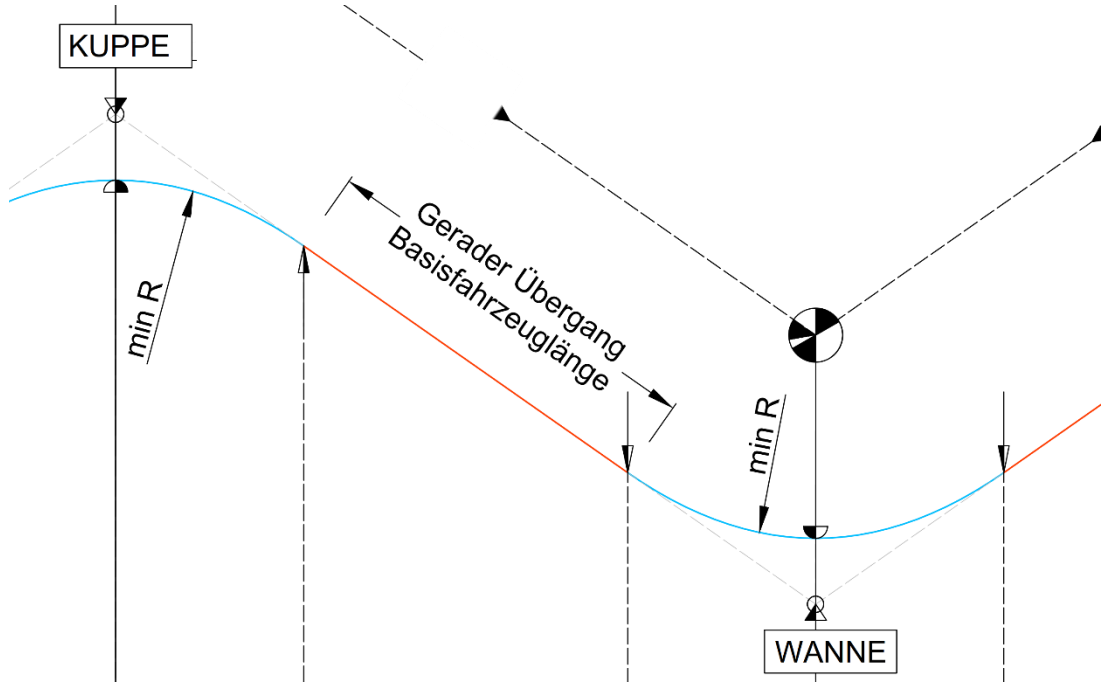
LÄNGSGEFÄLLE / MAXIMALWERTE BEI STEIGUNGEN / GEFÄLLE	
Fahrt vorwärts (Schichten ohne Bindemittel)	< 7%
Fahrt vorwärts (mit gebundener Deckschicht)	⩾ 7 % *(projektspezifische Bedingungen wie z.B. Zug- /Bremshilfe, Traktion, Kurvenradien und Straßenbreite u.a.)*
Fahrt rückwärts	⩽ 3%

Hybridturm: Ab einer Steigung von 7% müssen ggfs. Zusatzmaßnahmen getroffen werden, wie z.B. das Umladen auf eine Transporttechnik, die zusätzlich schlepp- und bremsbar ist. Dies ist im Detail mit Vestas und Max Bögl abzustimmen bzw. Festzulegen. Hierfür wird ein entsprechender Umladeplatz notwendig.
Ein notwendiges Rückwärtsfahren bei der Anlieferung der Betonturm-Komponenten ist zu vermeiden.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

BODENFREIHEIT		
Komponente	Minimum	Maximum
Turm	⩾ 15 cm	⩽ 80 cm
Rotorblätter	⩾ 40 cm	⩽ 80 cm

KUPPEN & WANNEN		
WEA-Typ	Minimumradius	Basisfahrzeuglänge
V90 / 100 / V110 / V112	400 m	60 m
V117 / V120	500 m	65 m
V126	500 m	70 m
V136	600 m	75 m
V150	600 m	80 m
V162	500 m	90 m (Nachläufer)
V172	500 m	95 m (Nachläufer)



Hybridturm: Abweichend zu den o.g. sind andere Werte während des Bauabschnittes Fundament- und Betonturmbau möglich. Minimumradius von 250 m und Basis-fahrzeuglänge von 25m.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

2.3.4 Anforderungen an Kurven und Kreuzungen

Die Planung von Kurven ist durch die Einhaltung von Mindestmaßen vorzunehmen. Diese sind gem. den in Anlage 2 (separates Dokument 0092-8386) stehenden Beispielen anzuwenden.

Anmerkungen:

- dargestellte Grafiken sind nicht maßstäblich
- Kurven sind für alle Komponenten gültig
- tragfähige Fahrbahnbreite vor Kurveneinfahrt: 4,50 m
- vor Einfahrt in eine Kurve und einem Übergang von Kuppe zu Wanne, muss mind. die entsprechende Basisfahrzeuglänge (s. Tabelle „Kuppen und Wannen“, Kap. 2.3.3 „Übersicht über die geometrischen Anforderungen“) zum gerade Positionieren des Transporterfahrzeuges vorhanden sein
- müssen Längen- und/ oder Kurvenausbauten auf Baustellen kleiner oder größer sein, sind diese projektspezifisch zu prüfen

Hybridturm: Abweichend zu den o.g. Werten sind andere Werte während des Bauabschnittes Fundament- und Betonturmbau möglich.

Innenradius der Fahrbahn	25,0 m
Breite der Fahrbahn	5,0 m
Überschwenkbereich innen	1,0 m
Steigungen in Kurven mit Seitenneigung sind zu vermeiden (projektspezifische Absprache)	(Richtwert ≤4%)

Besonderer Hinweis aus dem Kapitel 1.3:

Sollten projektbezogen begründete Abweichungen zu den Mindestanforderungen erforderlich werden, ist in jedem Fall Vestas in die Planung miteinzubeziehen und eine schriftliche Zustimmung einzuholen.

2.3.5 Anforderungen an Ausweichbuchten und Wendebereiche

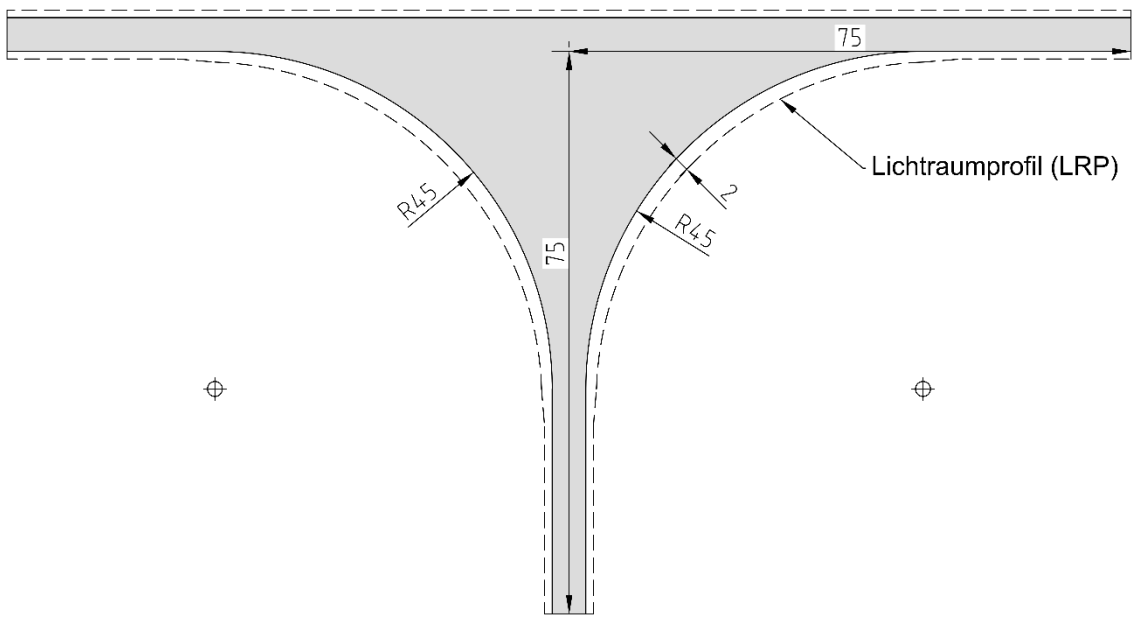
Bei nicht einsehbaren Streckenabschnitten und/oder Längen ⩾ 0,5 km und im Streckenabschnitt der Hauptzufahrt sind Ausweichbuchten für Massentransporte von 20 m (Länge) x 4,0 m (Zusatzfahrbahnbreite) anzulegen, um ein Vorbeifahren von entgegenkommendem Verkehr (ausgenommen sind Schwerlasttransporte), sowie insbesondere die freie Durchfahrt von Rettungsfahrzeugen zu gewährleisten.
Jeder Windpark muss über mindestens eine Wendemöglichkeit verfügen, die Lage wird projektspezifisch mit VESTAS abgestimmt. Die Radien des Wendebereiches betragen 2x R45 m zuzüglich 2 m Lichtraumprofil, dieser dient für alle Fahrzeuge exklusive der Rotorblätter.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

Sollte auf Grund der Anordnung der Kranstellfläche, oder der Anordnung der Blattlager an der Kranstellfläche ein Wenden der Fahrzeuge mit den Rotorblättern notwendig sein, sind die Radien der Kurvendarstellungen für den entsprechenden Anlagetyp zu wählen.

Beispieldarstellung eines Wendetrichters

WENDETRICHTER



Für Ausweichbuchten sowie alle Wendemöglichkeiten gelten die gleichen statischen und konstruktiven Anforderungen wie an die Transportwege.

Hybridturm: Abweichend zu den o.g. sind andere Werte während des Bauabschnittes Fundament- und Betonturmbau möglich.

In der Nähe der Kranstellfläche muss eine Ausweichbucht angelegt werden, damit es während der Montage nicht zu einer Behinderung zwischen zu- und abfahrenden Transportfahrzeugen kommt. An dieser Stelle muss die Straße auf einer Länge von 70 m eine Gesamtbreite von mindestens 8,0m haben.

Je nach Örtlichkeit können zusätzliche Wendemöglichkeiten von 2x R25m und Stichlänge 30m notwendig sein.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

PUBLIC

3 Anforderungen an die Kranstellflächen

Im vorliegenden Kapitel werden die weiterführenden Anforderungen an die Kranstellflächen definiert.

3.1 Übersicht über die Fahrzeuge, Krane, Komponenten und Materialien

Einen Überblick über die zum Einsatz kommenden Fahrzeuge, Krane, Komponenten und Materialien gibt die folgende Auflistung:

- Begleitfahrzeuge — ca. 3,5 t Gesamtgewicht
- ca. 55-65 LKW und Schwerlasttransporte — Achslast 12 t
- 2 Hilfskrane, 1 Vormontagekran, min. 1 Großkran — Achslast 12 t
- ca. 66 Fahrzeuge für Betonfertigteile pro CHT
- Stahlturmteile — 42 t bis 95 t
- Maschinenhaus, Nabe, Getriebe — 35 t bis 105 t
- 3 Rotorblätter — 12-27 t
- Werkzeugcontainer
- Baustelleneinrichtung

Hinweis: Anlagenspezifisch abweichend.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

VESTAS PROPRIETARY NOTICE

PUBLIC

3.2 Belastungen und Belastungsbereiche

Für die Kranstellflächen gelten die in Kapitel 2.1 definierten Belastungen und Anforderungen gleichlautend. Jedoch gelten für die verschiedenen Teilflächen/ Teilbereiche der Kranstellflächen verschiedene Belastungsstufen und Anforderungsprofile.
Es wird von vollflächiger Nutzung der beschriebenen Teilflächen ausgegangen. Die gegebenenfalls notwendigen lastfreien Bereiche sind zu berechnen und zu ergänzen.

Tabelle 3: Bezeichnung, Belastung und Anforderungen an die Kranstell(teil)flächen

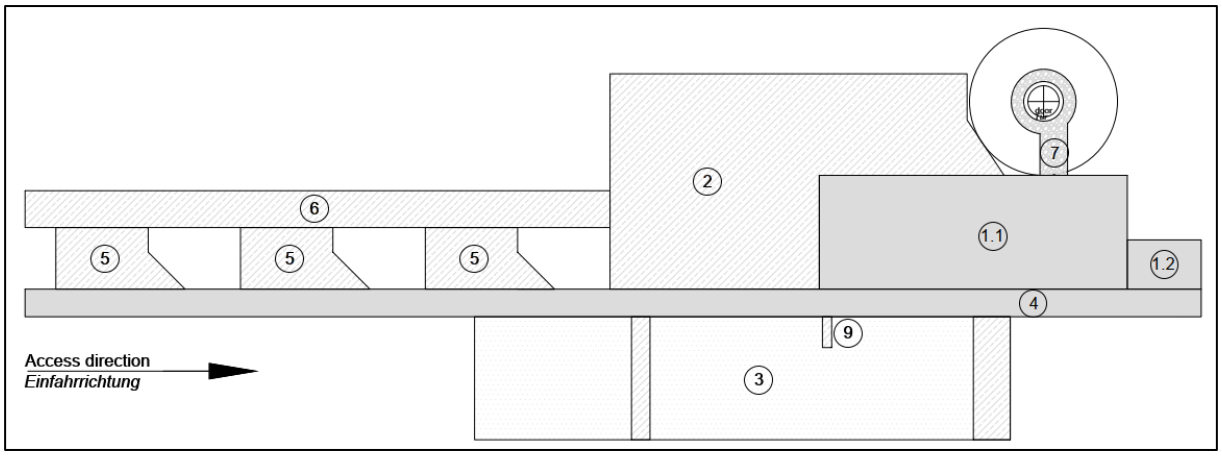
Nr.	Teilflächen-bezeichnung	Verwendung	Achslast (t) gebrauchs-tauglich	Anforderungen/ Beschaffenheit
1	Kranstellfläche	Montagekran		0% Gefälle, Flächenlast: 260 kN/m² für NH ≤152m 350- 400(2) kN/m² für NH >152m, dauerhaft ausgebaut, Krantyp z.B. LG1750/ LR11000
2	Montagefläche	Montage	12	0 % Gefälle; temporär ausgebaut, zum Teil Wiederherstellung im Servicefall notwendig
3	Lagerfläche	Rotorblatt-lagerung	6 (nur Blatt-ablage-streifen)	eben und frei von Hindernissen, Ablagestreifen 30 cm angehoben, höhengleich zueinander, in alle Richtungen neigungsfrei, temporär ausgebaut
4	Transportweg	Transport	12	vgl. Kapitel 2, dauerhaft ausgebaut
5	Hilfskranfläche	Hilfskran	12	<2 % Gefälle, temporär ausgebaut, Wiederherstellung im Servicefall notwendig
6	Rüstfläche	Rüsten	12	<2 % Gefälle vom Kranmittelpunkt, temporär ausgebaut, Wiederherstellung im Servicefall notwendig
7	Turmsockelumfahrung und Zufahrt	Arbeitsbereich	6	dauerhaft ausgebaut
8	Ballast- und Hilfskranfläche	Ballastieren des Großkranes	12	eben und frei von Hindernissen, temporär ausgebaut, Wiederherstellung im Servicefall notwendig
9	Turmlager	Lagerfläche	12	temporär ausgebaut
10	Werkzeuglager	Lagerfläche	12	<2 % Gefälle, temporär ausgebaut

(2) Standortspezifische Berechnung empfohlen.

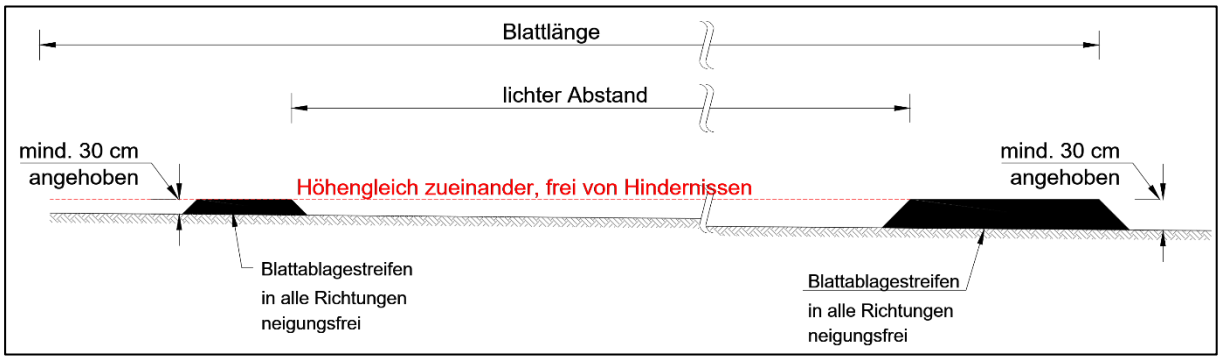
Classification: Restricted

VESTAS PROPRIETARY NOTICE
T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

Prinzipdarstellung einer Kranstellfläche



Prinzipdarstellung der Blattablagefläche



T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

3.3 Anforderungen an die Planung (Länderspezifisch)

3.3.1 Baugrundgutachten und Baugrunderkundungen

WEA-Kranstellflächen sind wie Gründungsflächen von Bauwerken der Geotechnischen Kategorie GK 3 zu erkunden und zu untersuchen.
Der geotechnische Sachverständige hat geeignete Erkundungsmaßnahmen zu planen, auszuführen und auszuwerten sowie Hinweise zum Wegeaufbau und zur Stabilisierung der Kranstellflächen (z.B. Mächtigkeit des Tragschichtaufbaus, ggf. Angaben zum Einsatz von Geokunststoffen oder hydraulischen Bindemitteln) in seinem geotechnischen Bericht zu geben.
Hierbei ist zu beachten, dass auf der gesamten Kranstellfläche, inklusive der an die Kranstellfläche angrenzenden Baugruben-Arbeitsraumverfüllung des WEA-Fundamentes, die von VESTAS angegebene Bodenpressung aufgenommen und schadlos abgetragen werden kann.

Neben den Angaben in Kapitel 2.3.1 wird für die Planung der Kranstellflächen im Bereich der Fläche 1 ergänzend gefordert sowie im Bereich der Flächen 2 bis 3, 5 und 8 ergänzend empfohlen:

- mindestens je zwei indirekte Erkundungen z.B. in Form von elektrischen Drucksondierungen (CPT) gemäß DIN EN ISO 22476-1 oder glw. bis in die Einflusstiefe der Lasten unter Geländehöhe abzuteufen.
- je eine direkte Erkundung z. B. in Form einer Kleinrammbohrung oder glw. bis in die Einflusstiefe der Lasten unter Geländehöhe abzuteufen, sofern sich abweichende Ergebnisse in den durchgeführten Drucksondierungen gegenüber den Hauptuntersuchungen im Bereich der Windenergieanlagen aufzeigen.
- je Bodenschicht- und/ oder Bodeneigenschaftswechsel oder Tiefenmeter mindestens eine Bodenprobe zu entnehmen.
- die Auswertung der gewonnenen Bodenproben im Baugrundlabor zur Ermittlung der Bodenparameter (Rechenwerte) bzw. zur Bestätigung der in den Normen genannten Rechenwerte vorzunehmen.
- ein rechnerischer Nachweis der Grundbruchsicherheit (gegen Durchstanzen der Kranpratzen) gemäß DIN 4017 ist vom geotechnischen Sachverständigen zu führen.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

3.3.2 Statische und konstruktive Planung

Neben den in Kapitel 2.3.2 definierten Anforderungen sind ergänzend die Nachweise für eine Flächenlast von 260 kN/m² bzw. 400 kN/m² zu führen.

Ergänzend gilt noch ein besonderer Hinweis auf die möglichen Überschneidungen der Lastauswirkungsbereiche der Kranstellflächen mit denen des Fundamentes. Die Überschneidungen der Lastauswirkungsbereiche sind in der Planung statisch sowie konstruktiv zu berücksichtigen.

3.3.3 Geometrische Anforderungen

Neben den in Kapitel 2.3.3 bis 2.3.5 definierten Anforderungen sind ergänzend die in den jeweiligen Zeichnungen vermerkten geometrischen Werte einzuhalten.

Die zeichnerischen Darstellungen in der aktuellen Anlage 3 stellen die jeweiligen Maße der zur Verfügung zu stellenden tragfähigen Nutzungsoberflächen ohne evtl. lastfreie Bereiche, Drainagegräben etc. dar.

Bei einer Planung von in den Typenprüfungen abweichenden Höhendifferenzen zwischen Fundamentoberkante und Geländeoberfläche ist eine gesonderte Absprache mit Vestas zu führen und schriftlich festzuhalten. Bei gegenüber der Typenprüfung erhöhten oder niedrigeren Fundamenten kann es durch ggf. notwendige abweichende Kranaufbauten und erweiterten Maschinen-/ Zeitaufwand zu Mehrkosten kommen. Ein höher, oder niedriger liegendes Fundament darf durch notwendige Böschungskanten nicht die Maße der tragfähigen Kranstellfläche verringern. Entsprechend notwendige Sicherheitsabstände zu belastbaren Kanten sind in der Planung zu berücksichtigen.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

PUBLIC

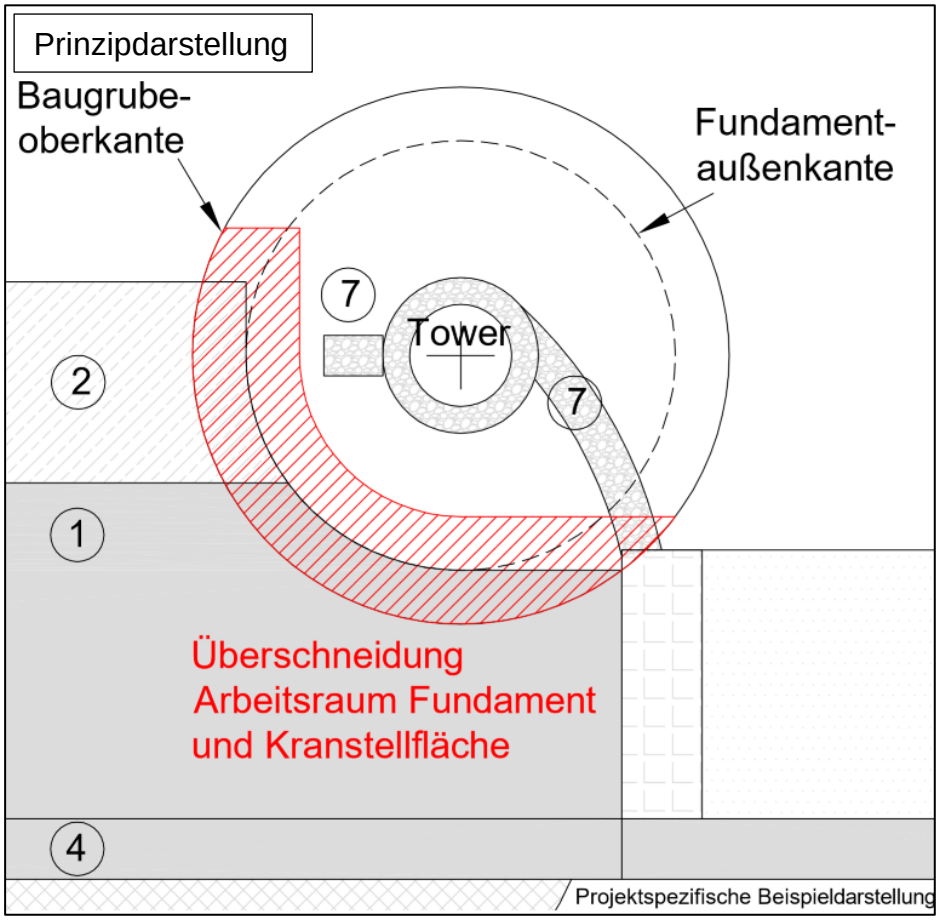
4 Anforderungen an die Bauausführung

Die Arbeiten sind durch eine Fachbauleitung zu überwachen. Baustellenprotokolle sind zu führen. Abnahmen und Anweisungen der Fachingenieure (verantwortliche Personen gem. Kapitel 1.2) sind zu protokollieren und neben den Baustellenprotokollen, den Lieferscheinen etc. in der Bauakte zu archivieren.

Alle Arbeiten sind durch einen Sicherheits- und Gesundheitsschutzkoordinator zu beaufsichtigen.

Der Arbeitsraum des Fundamentbaus greift bei einigen Fundamenten in den Bereich der Kranstellfläche. Wird die Kranstellfläche vor Ausführung der Fundamentarbeiten vollständig fertig gestellt, kommt es beim Aushub im Randbereich zu Überschneidung und Zerstörung der Kranstellfläche. Diese wäre nachträglich wiederherzustellen. Aus diesem Grund ist bei der Ausführung der Arbeiten für die Kranstellfläche der Übergangsbereich zum Fundament (Arbeitsraum) zurückzustellen, bis das Fundament betoniert und der Arbeitsraum verfüllt und verdichtet ist. So lässt sich ausschließen, dass es zu zusätzlichen Aufwendungen und Mehrkosten kommt.

Abbildung 2: Überschneidung Arbeitsraum Fundament und Kranstellfläche



T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

VESTAS PROPRIETARY NOTICE

4.1 Lieferung der Ankerkorbkonstruktion

Mit dem Beginn der Lieferleistung durch Vestas ist die Lieferung der Ankerkorbkonstruktion zwecks Einbaus in das Fundament zu verstehen. Es wird daher gem. Kapitel 1.3 von einer Fertigstellung der Transportwege und Kranstellflächen gemäß Projektablaufplan (i.d.R. mind. 14 Tage vor Beginn der Lieferleistung) ausgegangen.

Sollte eine vorzeitige Lieferung vor Fertigstellung der Transportwege und Kranstellflächen gewollt sein, sind Ersatzflächen zur Zwischenlagerung bereitzustellen. Für die Ersatzflächen ist eine Tragfähigkeit von 12t Achslast sicherzustellen und gelten somit die Vorgaben gem. Kapitel 2 und Kapitel 3 gleichlautend. Die benötigten Abmessungen richten sich nach dem Umfang der Lieferung, so dass in jedem Fall eine Absprache mit Vestas erfolgen muss.

4.2 Prüfung der Tragfähigkeit

Zur Prüfung der Tragfähigkeiten sind vor Ort baubegleitend Verdichtungsnachweise in Form von

- flächendeckenden, dynamischen Verdichtungskontrollen z.B. mit dem leichten Fallgewichtsgerät gemäß der Technischen Prüfvorschrift für Boden und Fels im Straßenbau (TP BF-StB), Teil B 8.3 oder / und
- statischen Plattendruckversuchen durchzuführen, und zwar
    - 2 Stück auf der Kran(teil)fläche Nr. 1,
    - 1 Stück auf der Kran(teil)fläche Nr. 8,
    - je 2 Stück auf den Kran(teil)flächen Nr. 2 und 5,
    - 1 Stück je km-Transportweg mit 12 t Achslast

Der Verdichtungserfolg ist letztendlich durch den Nachweis eines Verdichtungsgrades von $D_{Pr} \geqslant 100\%$ zu bestätigen.

Anforderungen an	**Verformungs-modul E_{v2}**	**Verhältnis-wert E_{v2}/E_{v1}**	**D_{Pr}**
Transportwege mit max. 12t-Achslast	≥ 80 MN/m²	≤ 2,3	≥ 100 %
Kranstellflächen	≥ 120 MN/m²	≤ 2,3	≥ 100 %

Die maximale zulässige Spurrinnentiefe der Transportwege soll auf unter 5 cm begrenzt werden. Dabei sind Bodenfreiheit, Kuppen und Wannen jederzeit zu gewährleisten.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

Das Feinanteil von Baustoffgemischen für Schottertragschichten darf 5% nicht übersteigen.

Hinweise: Je größer das Verformungsmodul ist, desto steifer ist der Baugrund. Je kleiner der Verhältniswert ist, desto besser ist die Verdichtung des Baugrundes. Der bestmögliche Verhältniswert ist 1.
Erfahrungsgemäß müssen die natürlich anstehenden Böden bereits ein Verformungsmodul von $E_{v2} \geqslant 45$ MN/m² erreichen, um die o. g. Werte letztendlich bei einem fachgerechten Aufbau von ca. 60 cm erreichen zu können. Kann dieser Wert auf dem natürlichen Baugrund nicht erreicht werden, ist dieser bis in größere Tiefen zu verbessern. Maßnahmen sind z. B. die Erhöhung der Tragschichtdicke, Stabilisierung mit hydraulischen Bindemitteln, Verlegen von Geokunststoffen und Geovlies etc.

Bei mächtigeren Aufbauten bzw. Bodenverbesserungsmaßnahmen als die Wirkungstiefe der Plattendruckversuche bzw. die Einflusstiefe der Belastungen, ist dementsprechend der Aufbau lagenweise zu prüfen, oder sind prüfende Baugrunderkundungen in Form von Drucksondierungen oder gleichwertig auszuführen.

Der letztendlich erforderliche Umfang der Prüfungen richtet sich nach den geologischen Gegebenheiten sowie den geplanten Maßnahmen vor Ort und liegt im Verantwortungsbereich des Baugrundsachverständigen.

Zur Bestätigung der Mindesttragfähigkeiten ist Vestas spätestens 14 Tage vor Beginn der Lieferung die Bescheinigung der ordnungsgemäßen Ausführung der Arbeiten in statischer und konstruktiver Hinsicht gem. Anlage 1b zu übergeben (siehe hierzu auch Kapitel 1.3).

Auf Anfrage sind dem Vestas-Projektmanagement die entsprechenden Aufzeichnungen und Ergebnisse der Messungen vorzulegen.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

PUBLIC

4.3 Wartungs- und Kennzeichnungspflicht

Die Wartung der Transportwege und Kranstellflächen muss während der Lieferung, Lagerung und Installation der Windenergieanlagen sowie allen Servicezeiten gewährleistet sein. Die Wartung umfasst

- Alle erforderlichen Maßnahmen zur Sicherung und ggf. Wiederherstellung der statischen und konstruktiven Anforderungen,
- insbesondere die Beseitigung von Schlaglöchern, Aufwölbungen, Spurrillen etc. vor Lieferung der Großkomponenten,
- die Vermeidung von Staub und Schmutz durch Beregnung der Flächen,
- die ordnungsgemäße Entwässerung der Flächen,
- den Winterdienst,
- die Kennzeichnung der schneebedeckten Flächen durch Signalpfosten.

5 Anforderungen an die Baustelleneinrichtungsflächen

Für die befestigte Baustelleneinrichtungsfläche 30m x 40m, <2%-Gefälle, gelten die in Kapitel 2.1 definierten Belastungen und Anforderungen gleichlautend. Ab 12 Windenergieanlagen wird eine vergrößerte Baustelleneinrichtungsfläche benötigt. Dies ist mit dem Vestas Projektteam abzustimmen. Die Park-, Rangier- und Ladeflächen sind für eine Achslast von 12t auszulegen. Die diesen Bereich umschließende sonstige Baustelleneinrichtungsfläche ist als Lager- und Abstellfläche (z. B. von Containereinrichtungen etc.) vorzusehen und muss eben sowie frei von Hindernissen sein.

Baustelleneinrichtungsflächen müssen außerhalb des Gefahrenbereiches mit einem Radius von min. 200 m um die jeweiligen Windenergieanlagen positioniert sein.

Die erforderlichen Abmessungen sind der Anlage 1a zu entnehmen.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

VESTAS PROPRIETARY NOTICE

6 Sonstige Anforderungen und Hinweise

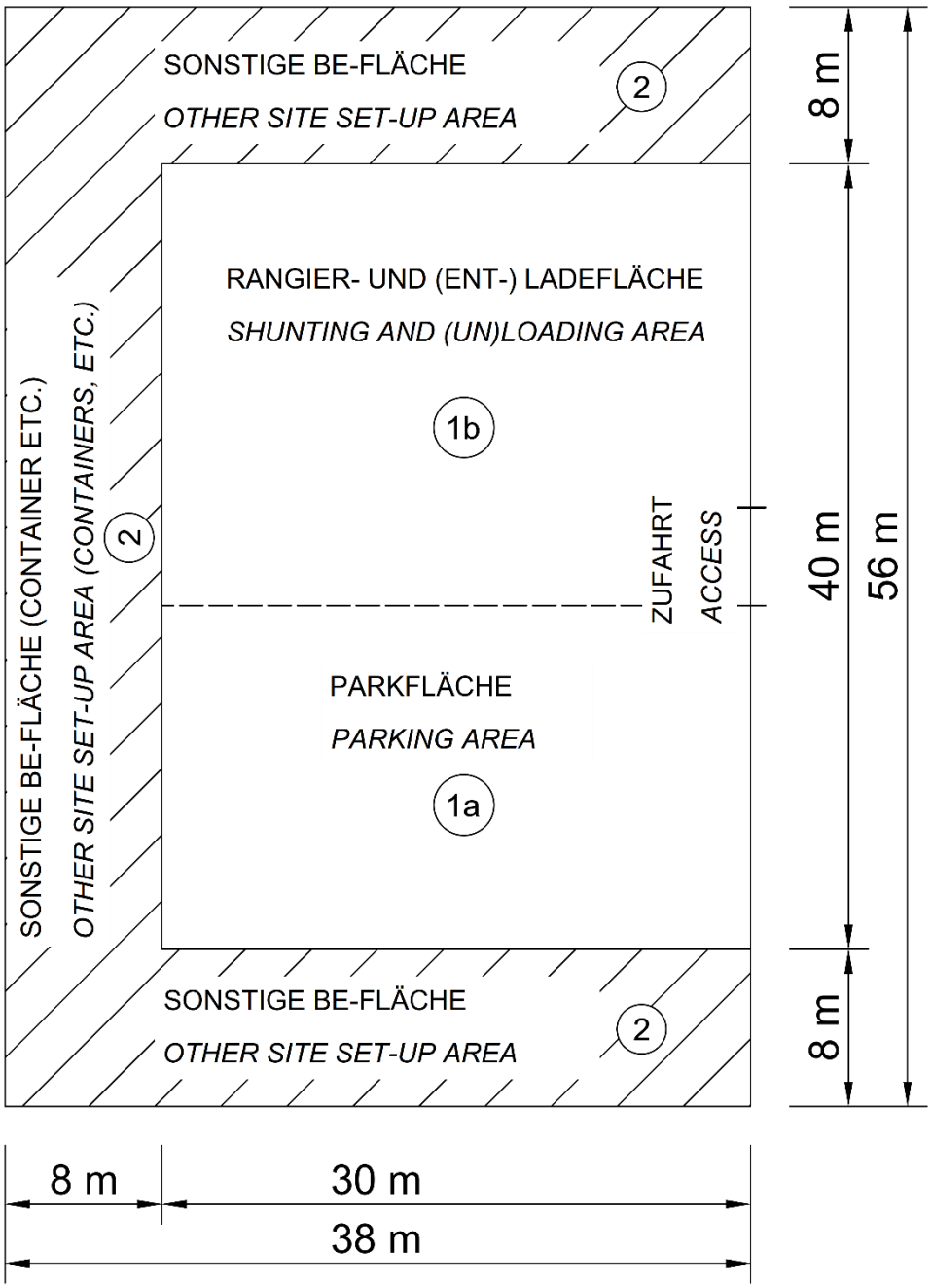
Folgende sonstige Anforderungen und Hinweise werden formuliert:

- Für das Personal sind ausreichend Parkflächen für das sichere Abstellen der Fahrzeuge vorzusehen.
- Das Tragen von Sicherheitskleidung ist Pflicht. Schutzhelm, Sicherheitsschuhe, Arbeitshandschuhe, Arbeitskleidung und Schutzbrille sind vor Arbeitsbeginn anzulegen. Die Anweisungen des Sicherheits- und Gesundheitsschutzkoordinators sowie des verantwortlichen Baustellenpersonals ist Folge zu leisten. Verstöße können zum Verweis von der Baustelle führen.
- Aufgrund des Arbeitens mit schweren Materialien und Gerätschaften besteht erhöhtes Unfallrisiko insbesondere durch deren mögliches Kippen und Niederfall.
- Das vorliegende Dokument wurde nach bestem Wissen und Gewissen ohne Anspruch auf Vollständigkeit durch die Vestas Deutschland GmbH, Kapstadtring 7, 22297 Hamburg verfasst.

Hinweise und Verbesserungsvorschläge sind erwünscht, um insbesondere die Arbeitssicherheit weiter zu erhöhen und den Ablauf der Projekte zu optimieren. Vorschläge und Anmerkungen richten Sie bitte an den zuständigen Projektleiter.

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

Anlage 1a: Darstellung der Baustelleneinrichtungsfläche (BE-Fläche)



1 PARK-, RANGIER- UND LAGERFLÄCHE
PARKING, SHUNTING AND (UN)LOADING AREA *1200 m²*

2 SONSTIGE BE-FLÄCHE
OTHER SITE SET-UP AREA 928 m²

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

Anlage 1b: Bestätigung der ordnungsgemäßen Ausführung der Arbeiten in statischer und konstruktiver Hinsicht

Transportwege und Kranstell(teil)flächen

1. Bestätigung

Hiermit wird die ordnungsgemäße Ausführung der Arbeiten in statischer und konstruktiver Hinsicht sowie die Einhaltung der Anforderungen gem. Dokument 0040-4327 V13 – Anforderungen an Transportwege und Kranstellflächen für das Projekt …… bestätigt.

Auf Anfrage können dem Vestas-Projektmanagement die entsprechenden Aufzeichnungen und Ergebnisse der Messungen binnen 5 Tagen vorgelegt werden.

2. Transportwege

(…) alle

(....) Streckenabschnitte: 1. ……

2. ……

3. ……

3. Kranstell(teil)flächen

(…) alle

(...) Kranstellfläche
WEA: …… Teilfläche(n):……
WEA: …… Teilfläche(n):……
WEA: …… Teilfläche(n):……

4. Verantwortliche Personen / Unterschriften

Für die Richtigkeit der Angaben Bauherr:

T05 0040-4327 Ver 13 - Approved- Exported from DMS: 2022-05-03 by INVOL

16.1.7 Kennzeichnung von Luftfahrthindernissen

Anlagen:

- #16-1-7-1_Formblatt_Windkraftanlage-WEA06.pdf
- #16-1-7-2_Formblatt_Windkraftanlage-WEA07.pdf
- #16-1-7-3_Tages--und-Nachtkennzeichnung.pdf
- #16-1-7-4_Notbeleuchtung-an-WEA---Allgemeine-Spezifikation.pdf
- #16-1-7-5_Allgemeine-Spezifikation-Gefahrenfeuer-OeRGA-USV-SPS60.pdf
- #16-1-7-6_Allg.-Spezifikation-Gef.feuer-Sichtweitenmessgeraet-OeRGA-SWS-200-N-AC.pdf
- #16-1-7-7_Allg.-Spezifikation-Gef.feuer-Turm-KIT-SET-AL-TOeW-1-4-L92-AVV-ES.pdf
- #16-1-7-8_Allg.-Spezifikation-Gef.feuer-OeRGA-AL-L240-GFW-IRG-G-BR.pdf
- #16-1-7-9_Allg.-Spezifikation-Gef.feuer-OeRGA-L240-GFW-IRG-G-BR-10M.pdf

Thüringer Landesverwaltungsamt
Referat 540
Jorge-Semprún-Platz 4
99423 Weimar

E-Mail: luft540@tlvwa.thueringen.de

Bitte beachten Sie folgende Hinweise:
- Antrag vollständig ausgefüllt und mit Originalunterschrift einscannen
- je Anlage ein Formblatt
- Lageplan mit Standort beifügen
- ggf. weitere erforderliche Angaben als Anlage beifügen

Antrag auf luftverkehrsrechtliche Zustimmung — Windkraftanlage

1. Antragsteller / Kostenschuldner

Name /Firma:	Windpark Gebstedt GmbH & Co. KG
Straße und Haus-Nr.:	Otto-Hahn-Str. 12-16
PLZ:	25813
Ort:	Husum
Telefon:	04841 8944 - 224
E-Mail:	04841 8944 - 225

2. Angaben zur Windkraftanlage

Bezeichnung: WEA06

Standort

Ort:	Apolda
Gemarkung:	Zottelstedt
Flur:	4
Flurstück:	337/2
Nabenhöhe (m über Grund):	169,00
Rotorradius (m):	162,00
Rotordurchmesser (m):	81,00
Anlagenhöhe (m):	331,00
Geländehöhe am Standort (m üNHN):	223,90
Gesamthöhe (Gelände+Anlage in (m):	554,90

Beachtung:
Bei der Eingabe von Dezimalwerten (max. zweistellig) ist ein Punkt als Trennungszeichen zu verwenden.

3. Koordinaten:

Breite (Nord)						Länge (Ost)					
51	Grad	4	Min	10.3368	Sek.	11	Grad	28	Min	40.7028	Sek.

4. vorhandene Angaben zum Bauvorhaben

Genehmigung: Az

Datum

Stempel / Unterschrift

Thüringer Landesverwaltungsamt
Referat 540
Jorge-Semprún-Platz 4
99423 Weimar

E-Mail: luft540@tlvwa.thueringen.de

Bitte beachten Sie folgende Hinweise:
- Antrag vollständig ausgefüllt und mit Originalunterschrift einscannen
- je Anlage ein Formblatt
- Lageplan mit Standort beifügen
- ggf. weitere erforderliche Angaben als Anlage beifügen

Antrag auf luftverkehrsrechtliche Zustimmung **Windkraftanlage**

1. Antragsteller / Kostenschuldner

Name /Firma:	Windpark Gebstedt GmbH & Co. KG
Straße und Haus-Nr.:	Otto-Hahn-Str. 12-16
PLZ:	25813
Ort:	Husum
Telefon:	04841 8944 - 224
E-Mail:	04841 8944 - 225

2. Angaben zur Windkraftanlage

Bezeichnung: WEA07

Standort

Ort:	Apolda
Gemarkung:	Zottelstedt
Flur:	4
Flurstück:	376

Nabenhöhe (m über Grund):	169,00
Rotorradius (m):	162,00
Rotordurchmesser (m):	81,00
Anlagenhöhe (m):	331,00
Geländehöhe am Standort (m üNHN):	220,60
Gesamthöhe (Gelände+Anlage in (m):	551,60

Beachtung:
Bei der Eingabe von Dezimalwerten (max. zweistellig) ist ein Punkt als Trennungszeichen zu verwenden.

3. Koordinaten:

Breite (Nord)					Länge (Ost)				
51	Grad	4	Min	5.1708	Sek.	11	Grad	29	Min	12.03	Sek.

4. vorhandene Angaben zum Bauvorhaben

Genehmigung: Az

Datum

Stempel / Unterschrift

PUBLIC

Vestas

T05

DOKUMENT:
0049-8134.V23

BESCHREIBUNG:
Gefahrenfeuer in Deutschland gemäß AVV-Kennzeichnung (2020)

Tages- und Nachtkennzeichnung von Vestas Windenergieanlagen in Deutschland

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Classification: Public
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com
Erstelldatum: 11.02.2025 Version: 2 Erstellt mit: ELiA 2.8-b5
The content of this document is the property of Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Versionshistorie

VERSION:	DATUM:	ÄNDERUNG: :
00	17/12/2014	Erstfassung MASEP
01	13/01/2015	Korrigierte Turmkennzeichnung
02	14/01/2015	Korrigierte CoolerTop-Kennzeichnung, Sichtweitenmessgerät und USV
03	03/08/2015	Neue Türme hinzugefügt und an neue AVV (vom 10.07.2015) angepasst
04	31/08/2015	V136 hinzugefügt, V126 Turmbefeuerung korrigiert
05	18/12/2015	Tageskennzeichnung von Maschinenhäusern an Windenergieanlagen <150 m korrigiert, neue Maschinenhauskennzeichnung
06	01/02/2016	Redaktionelle Änderungen, aktualisierte Turmbefeuerungen V126 & V136
07	10/11/2016	166m Turm zu der V126 und V136 zugefügt
08	23/06/2017	V126 MK3B HTq, V136 MK3E, und V150 zugefügt
09	23/02/2018	V150-4.2MW 145mNH zugefügt
10	15/01/2019	V150-5.6 und V162-5.6MW zugefügt
11	31.07.2019	V162-5.6 auf 166m – Turmbefeuerung wegen Turmflansch verlegt
12	06.09.2019	Kap. 2.5: Dargestellter Wert Abstand Blattspitze zu Turmzentrum der V150 nicht korrekt – gilt nicht für beide V150 Varianten. Alle dargestellten Dimensionen zum Abstand Blattspitze zu Turmzentrum in Kapitel 5 entfernt. [4] in Kap. 2 ergänzt um 0067-0753
13	28.11.2019	CHT Betonfarbe und 169m NH Anpassungen gemacht
14	21.04.2020	V136-4.2MW auf 82m hinzugefügt, AVV 2020 Anpassungen
15	16.06.2020	V136-3.45/3.6/4.0/4.2MW auf 149m Nabenhöhe korrigiert, AVV Link korrigiert
16	06.10.2020	V162-5.6MW wurde für NH 119m und 169m auf 6.0MW erweitert
17	26.10.2020	Aufnahme V150-5.6MW 105 m Nabenhöhe
18	26.02.2021	Aufnahme V150-6.0MW für 105m, 125m, 148m und 166m; Referenzdokumente zur Befeuerung angepasst
19	10.08.2021	V162-5.6/6.0MW wurde für NH 119m und 169m auf 6.2MW erweitert
20	20.01.2022	V150-5.6/6.0MW für 169m wurde 6.0MW zugefügt
21	25.02.2022	V162-7.2MW hinzugefügt, Referenzdokumente zur Befeuerung angepasst
22	28.04.2022	V172-7.2MW hinzugefügt
23	29.11.2022	Marginale Korrekturen an den Zeichnungen der folgenden Anlagen: - V136-4.0/4.2MW NH112 - V150-4.0/4.2MW NH145 - V150-5.6/6.0MW NH105 - V150-4.0/4.2/5.6/6.0MW NH125 - V162-5.6MW NH148 - V162-6.8/7.2MW NH169 V172-7.2MW NH199 hinzugefügt

QMS 00091 VER 00

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

Inhaltsverzeichnis

1. GESETZLICHE GRUNDLAGE FÜR KENNZEICHNUNGSANFORDERUNGEN 4
1.1. GELTUNGSBEREICH 4
1.2. ANFORDERUNGEN AN DIE TAGESKENNZEICHNUNG 4
1.3. BESTANDTEILE DER NACHTKENNZEICHNUNG 5
1.3.1. MASCHINENHAUSBEFEUERUNG 5
1.3.2. TURMBEFEUERUNG 6
1.3.3. ZUSATZEINRICHTUNGEN 6
1.3.4. NACHTKENNZEICHNUNG VON VESTAS WINDENERGIEANLAGEN 6
2. ANLAGENKENNZEICHNUNGEN – STANDARD NACH AVV 7
2.1. V112-3.3MW UND 3.45MW 7
2.1.1. 94M NABENHÖHE (150M SPITZENHÖHE) 7
2.1.2. 119M NABENHÖHE (175M SPITZENHÖHE) 8
2.1.3. 140M NABENHÖHE (196M SPITZENHÖHE) 9
2.2. V117-3.3MW UND 3.45MW 10
2.2.1. 91,5M NABENHÖHE (150M SPITZENHÖHE) 10
2.2.2. 116,5M NABENHÖHE (175M SPITZENHÖHE) 11
2.2.3. 141,5M NABENHÖHE (200M SPITZENHÖHE) 12
2.3. V126-3.3MW, 3.45MW UND 3.6MW 13
2.3.1. 87M NABENHÖHE (150M SPITZENHÖHE) 13
2.3.2. 117M NABENHÖHE (180M SPITZENHÖHE) 14
2.3.3. 137M NABENHÖHE (200M SPITZENHÖHE) 15
2.3.4. 149M NABENHÖHE (212M SPITZENHÖHE) 16
2.3.5. 166M NABENHÖHE (229M SPITZENHÖHE) 17
2.4. V136-3.45 / 3.6 / 4.0 / 4.2MW 18
2.4.1. 82M NABENHÖHE (150M SPITZENHÖHE) 18
2.4.2. 112M NABENHÖHE (180M SPITZENHÖHE) 19
2.4.3. 132M NABENHÖHE (200M SPITZENHÖHE) 20
2.4.4. 149M NABENHÖHE (217M SPITZENHÖHE) 21
2.4.5. 166M NABENHÖHE (234M SPITZENHÖHE) 22
2.5. V150-4.0 / 4.2MW -5.6 / 6.0MW 23
2.5.1. 105M NABENHÖHE (180M SPITZENHÖHE) 23
2.5.2. 125M NABENHÖHE* (200M SPITZENHÖHE) 24
2.5.3. 145M NABENHÖHE (220M SPITZENHÖHE) 25
2.5.4. 148M NABENHÖHE (223M SPITZENHÖHE) 26
2.5.5. 166/169M NABENHÖHE (241/244M SPITZENHÖHE) 27
2.6. V162-5.6 / 6.0 / 6.2MW 28
2.6.1. 119M NABENHÖHE (200M SPITZENHÖHE) 28
2.6.2. 148M NABENHÖHE (229M SPITZENHÖHE) 29

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.6.3. 166M/169M NABENHÖHE (247/250M SPITZENHÖHE) 30
2.7. V162-7.2MW 31
2.7.1. 119M NABENHÖHE (200M SPITZENHÖHE) 31
2.7.2. 169M NABENHÖHE (250M SPITZENHÖHE) 32
2.8. V172-7.2MW 33
2.8.1. 164M NABENHÖHE (250M SPITZENHÖHE) 33
2.8.2. 175M NABENHÖHE (261M SPITZENHÖHE) 34
3. VERWEISE 36

1. Gesetzliche Grundlage für Kennzeichnungsanforderungen

Die Allgemeine Verwaltungsvorschrift zur Kennzeichnung von Luftfahrthindernissen (im Folgenden „die AVV“) [1] regelt die Anforderungen der Hinderniskennzeichnung an in Deutschland errichteten Windenergieanlagen. Das vorliegende Dokument erläutert die zur Erfüllung der Anforderungen der AVV in der aktuellen, im Staatsanzeiger im April 2020 veröffentlichten Fassung erforderliche Standardkonfiguration der von Vestas gelieferten Windenergieanlagen. Im Zuge des Antragsverfahrens für eine immissionsschutzrechtliche Genehmigung kann die örtliche Luftfahrtbehörde nach eigenem Ermessen den Wunsch nach zusätzlichen Kennzeichnungen äußern, um dadurch die Luftverkehrssicherheit in der Region verantwortlich zu gewährleisten. Sie kann bei Errichtung an Standorten mit geringem Gefährdungspotenzial auch einer eingeschränkten Kennzeichnung aus ästhetischen Gründen zustimmen (z.B. Blockbefeuerung). In Einzelfällen können also von Vestas Abweichungen von den hier gezeigten Standardkennzeichnungen gefordert werden.

1.1. Geltungsbereich

Die AVV beschreibt in ihrer aktuellen Fassung die erforderliche Kennzeichnung von Bauwerken innerhalb von Flugplatzbereichen, von Bauwerken mit einer Höhe von mehr als 150 m in dicht besiedelten Gebieten außerhalb von Flugplatzbereichen sowie von Bauwerken mit einer Höhe von mehr als 100 m in weniger dicht besiedelten Gebieten außerhalb von Flugplatzbereichen. In der Regel fallen Windenergieanlagen nur in die letzte Kategorie. Daher sind die in diesem Dokument beschriebenen Kennzeichnungen so konfiguriert, dass sie den Anforderungen an diese Kategorie entsprechen. Sofern keine abweichenden Einzelfallregelungen vorliegen, sind alle Windenergieanlagen innerhalb eines Windparks mit diesen Kennzeichnungen zu liefern. Das vorliegende Dokument bezieht sich auf Onshore-Anlagen. Für Windparks im Küstenvorfeld können daher zusätzliche Vorschriften gelten.

1.2. Anforderungen an die Tageskennzeichnung

Die für Windenergieanlagen geltenden Tageskennzeichnungen werden in den Kapiteln 2 und 4 der AVV behandelt. Als Hauptanforderung gilt die Sichtbarkeit der Windenergieanlage aus der Luft durch einen rot/weißen Anstrich. Bei Kennzeichnung durch weiß-rote Streifen sind die folgenden Kombinationen zulässig: vgl. AVV Teil 2 – Technische Spezifikationen Punkt 4 sowie Teil 4 – Windenergieanlagen, Abschnitt 2 – Tageskennzeichnung Punkt 14.

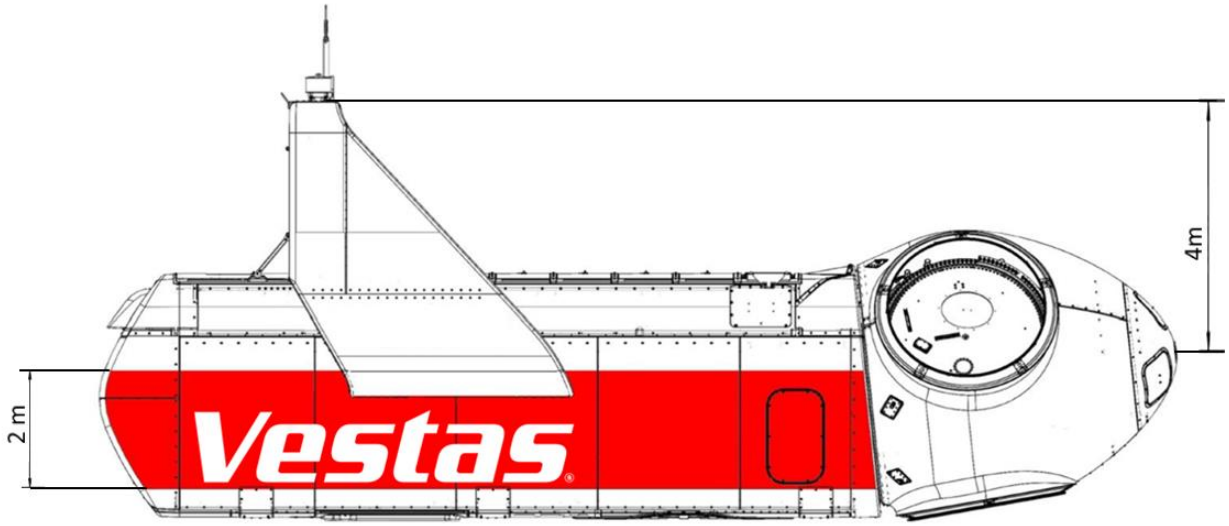
Stahltürme, Maschinenhäuser und Rotorblätter von Vestas Windenergieanlagen sind mit RAL 7035 angestrichen. Betonsegmente bei Hybridtürmen werden in der Standardkonfiguration ohne Anstrich in

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

Beton-Grau ausgeliefert, der Farbton von Beton ähnelt mit dem Farbton RAL 7035, weshalb ein zusätzlicher Anstrich nicht notwendig ist. Optional kann ein Anstrich in RAL 7035 angeboten werden. Daher werden die roten Streifen am Turm, am Maschinenhaus sowie auf den Rotorblättern in RAL 3020 ausgeführt. Dies sind die im vorliegenden Dokument dargestellten Konfigurationen. Die folgende Abbildung zeigt die Maschinenhaus-Kennzeichnung. Wie in der AVV angefordert, läuft der rote Streifen mit einer Höhe von mindestens 2m um das Maschinenhaus herum. Grafische Elemente beanspruchen maximal ein Drittel der Fläche der jeweiligen Maschinenhausseite.



Beispiel des Streifens in RAL 3020 auf einem Maschinenhaus. Die Maschinenhäuser sowie CoolerTop Einheiten von anderen MK-Versionen können im Form Abweichen, jedoch gilt das Konzept des kontinuierlichen, mindestens 2m hohen roten Streifens sowie des Vestas Logos für alle Varianten.

1.3. Bestandteile der Nachtkennzeichnung

Die Nachtkennzeichnung von Windenergieanlagen bis zu einer Gesamthöhe von 315m ist gemäß Teil 4 – Windenergieanlagen, Abschnitt 3 Nachtkennzeichnung der AVV auszuführen. Die Nachtkennzeichnung der Windenergieanlagen ist durch das spezielle deutsche „Feuer W, rot“ oder „Feuer W, rot ES“ zu erfolgen. Nach Ziffer 16.4 ist zusätzlich eine Infrarotkennzeichnung gemäß Anhang 3 der AVV auf dem Maschinenhausdach vorzusehen.

1.3.1. Maschinenhausbefeuerung

Die Lampen müssen paarweise auf dem Dach des Maschinenhauses angebracht werden, um zu gewährleisten, dass jederzeit mindestens ein Feuer aus jeder Richtung sichtbar ist. Die Bauwerksspitze darf bis einschließlich 315m betragen. Die Blinkfolge wird in der AVV festgelegt.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

1.3.2. Turmbefeuerung

Gemäß AVV müssen Windenergieanlagen mit einer maximalen Spitzenhöhe von mehr als 150 m mit einer zusätzlichen Hindernisbefeuerungsebenen am Turm ausgestattet werden, wobei aus jeder Richtung mindestens zwei Hindernisfeuer sichtbar sein müssen. Diese ist auf halber Höhe zwischen Gondelbefeuerung und Geländeoberkante anzubringen und darf technisch bedingt davon abweichen.

1.3.3. Zusatzeinrichtungen

Eine bestimmte Reduzierung der Lichtstärken der Tagesbefeuerung (Gefahrenfeuer und Feuer W, rot) abhängig von den Messungen eines zertifizierten Sichtweitenmessgerätes ist zulässig.

Einem Ausfall der Hindernisbefeuerung ist durch Installation einer Notstromversorgung mit ausreichender Kapazität zur Überbrückung der Stromversorgung von mind. 16h vorzubeugen. Die Aktivierung der Notstromversorgung darf nicht später als 2 Minuten nach dem Stromausfall erfolgen. Fehler in diesem Ablauf, die einen Ausfall der Befeuerung verursachen, müssen eine entsprechende Meldung an den Anlagenbetreiber auslösen, sodass dieser die NOTAM-Zentrale unverzüglich telefonisch benachrichtigen kann. Ist eine Behebung innerhalb von zwei Wochen nicht möglich, so ist die NOTAM-Zentrale nach zwei Wochen erneut zu informieren.

1.3.4. Nachtkennzeichnung von Vestas Windenergieanlagen

Vestas Windenergieanlagen werden in Deutschland standardmäßig mit zwei blinkenden Feuern W, rot, in Kombination mit einer Infrarotbefeuerung auf dem CoolerTop (ca. 4 m über der Nabenhöhe) geliefert. Die allgemeine Spezifikation für diese Komponenten findet sich in [2]. Eine Tageskennzeichnung mittels Weißblitz ist nicht vorgesehen.

Eine zusätzliche Befeuerung des Turms mit einer Reihe von vier Hindernisfeuern, die um den Turmumfang in rechten Winkeln zueinander angeordnet sind, ist gemäß den folgenden Zeichnungen installiert. Technisch bedingt kann zu marginalen Abweichungen der Höhe der Turmbefeuerungsebene kommen. Die Spezifikation für diese Komponenten findet sich in [3].

Optional ist auf Wunsch ein Sichtweitenmessgerät gemäß Spezifikation in [4] und/oder eine Unterbrechungsfreie Stromversorgung (USV) gemäß Spezifikation in [5] von Vestas erhältlich, um den Störeinfluss der Befeuerung zu reduzieren bzw. um der Forderung der AVV nach einer Notversorgung der Befeuerung während eines Netzausfalls nachzukommen.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

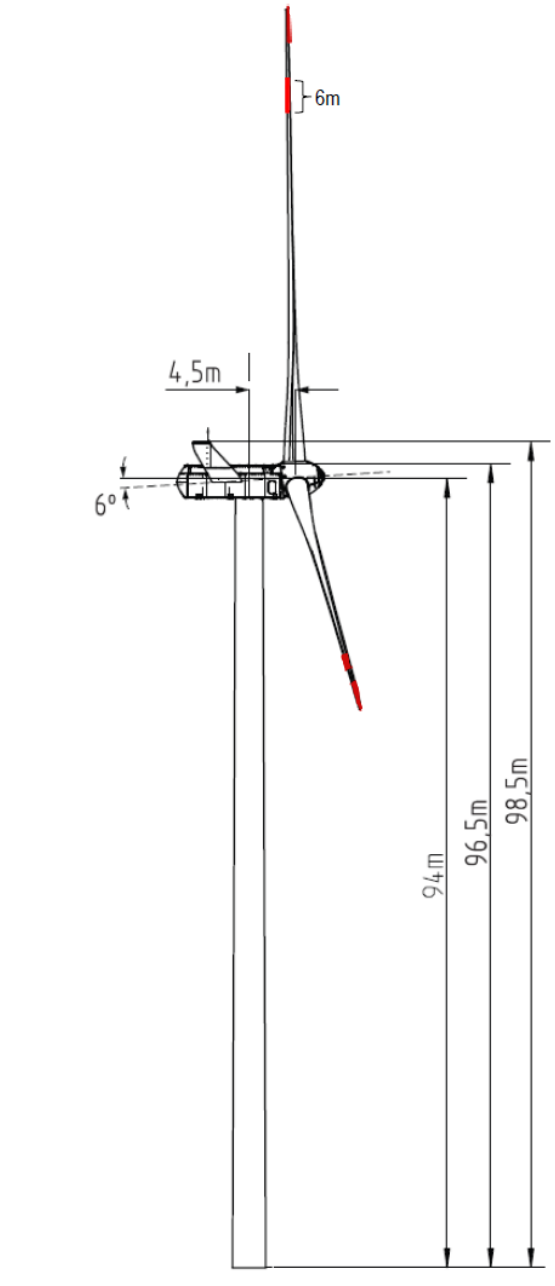
VESTAS PROPRIETARY NOTICE

2. Anlagenkennzeichnungen – Standard nach AVV

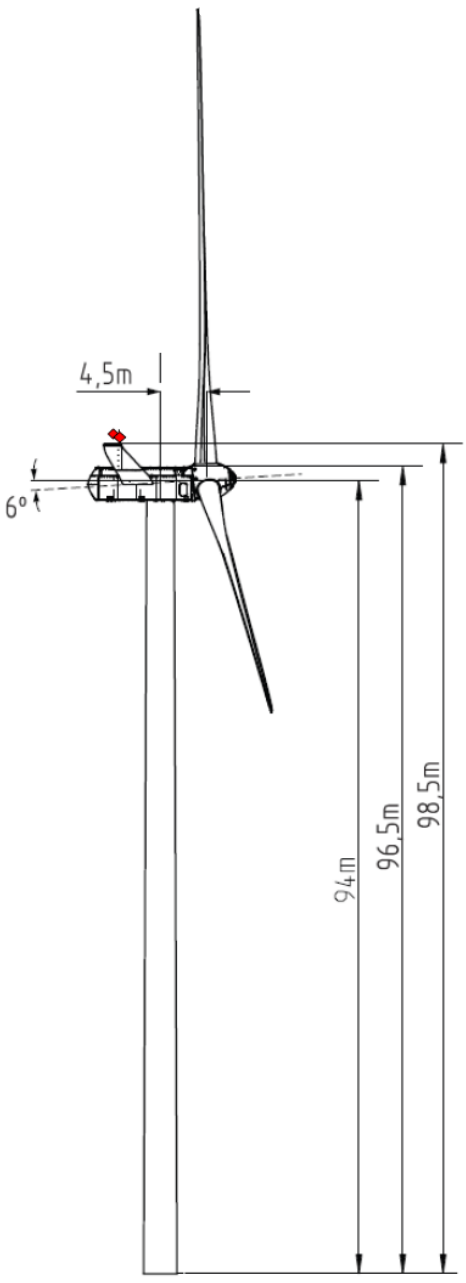
Die Grafiken auf den folgenden Seiten zeigen die standardmäßig konfigurierten Tages- und Nachtkennzeichnungen an Vestas-Produkten aus dem aktuellen deutschen Lieferprogramm.

2.1. V112-3.3MW und 3.45MW

2.1.1. 94m Nabenhöhe (150m Spitzenhöhe)



Tageskennzeichnung der V112-3.0MW, 3.3MW und 3.45MW mit 94 m Nabenhöhe



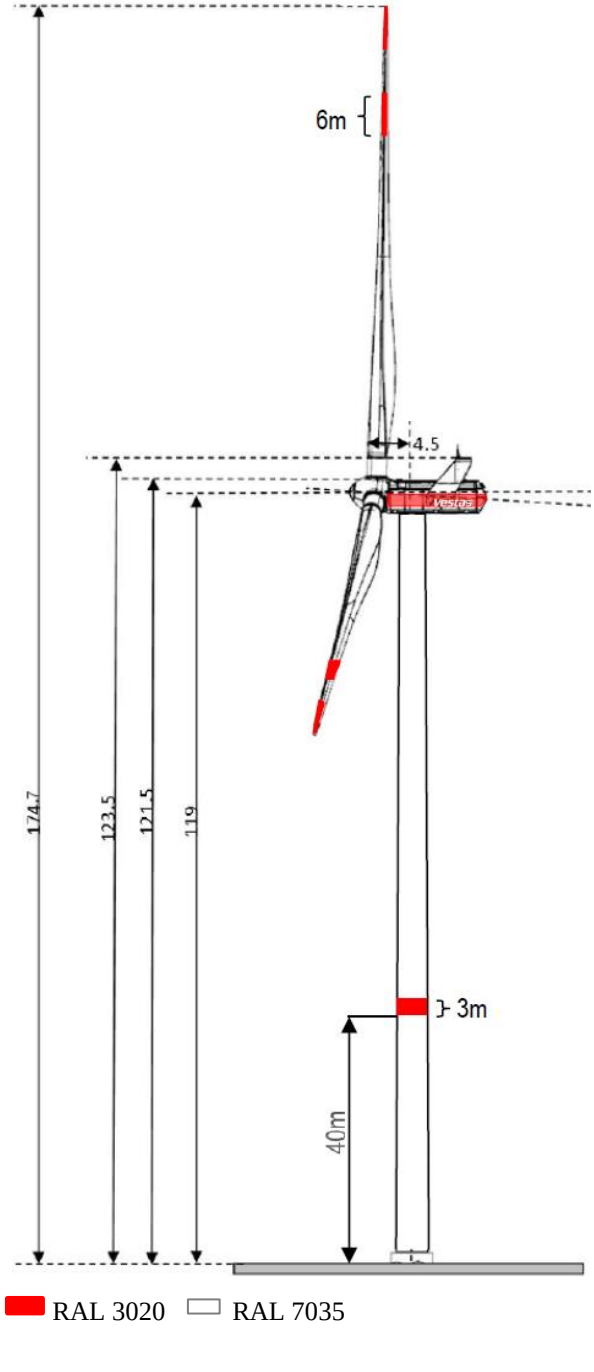
Nachtkennzeichnung der V112-3.0MW, 3.3MW und 3.45MW mit 94 m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

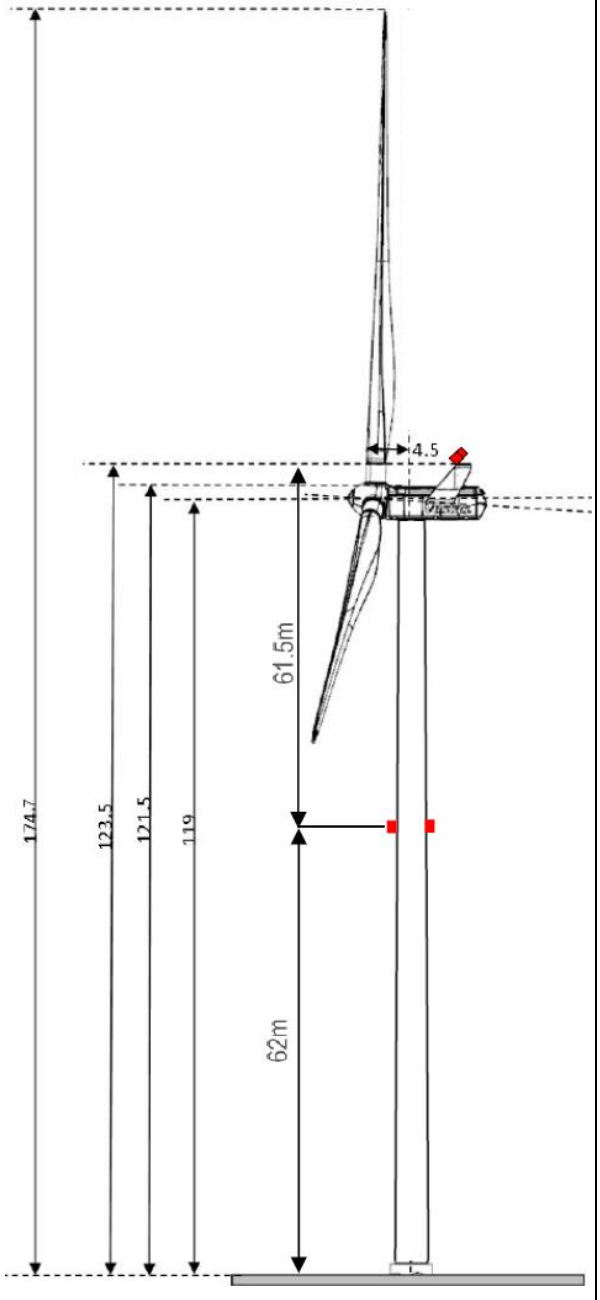
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.1.2. 119m Nabenhöhe (175m Spitzenhöhe)



Tageskennzeichnung der V112-3.0MW, 3.3MW und 3.45MW mit 119 m Nabenhöhe



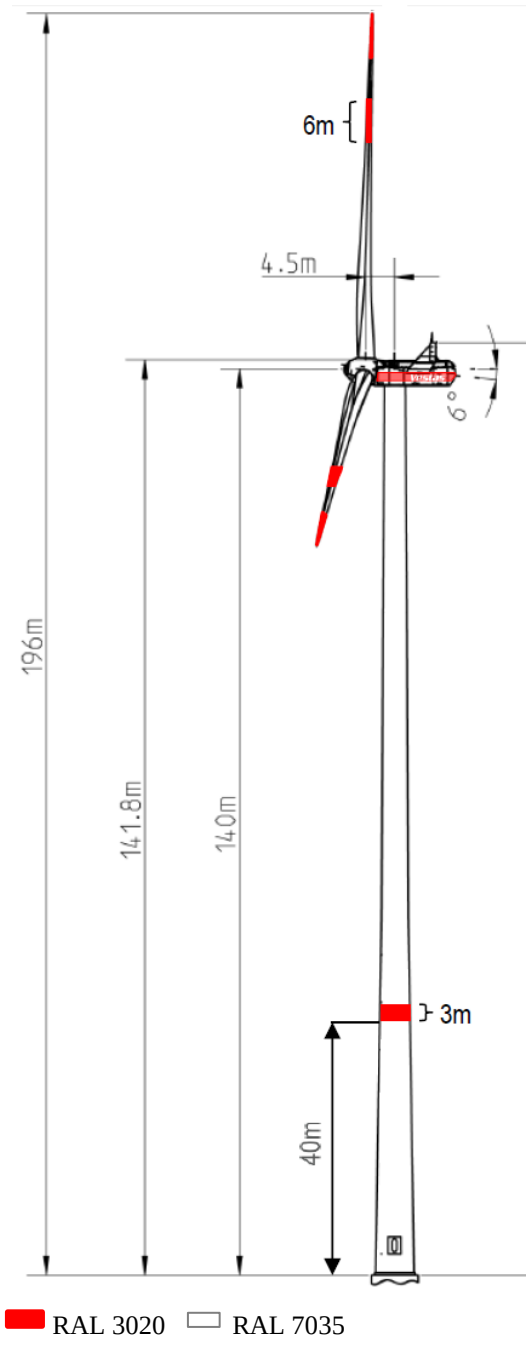
Nachtkennzeichnung der V112-3.0MW, 3.3MW und 3.45MW mit 119 m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

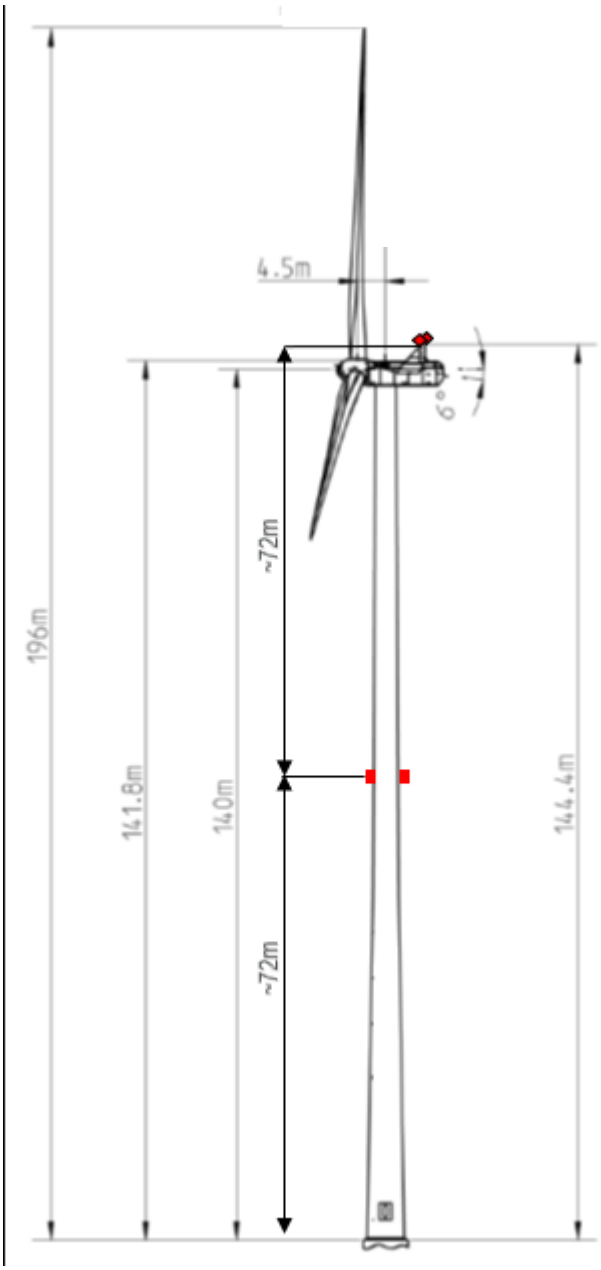
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.1.3. 140m Nabenhöhe (196m Spitzenhöhe)



Tageskennzeichnung der V112-3.0MW, 3.3MW und 3.45MW mit 140 m Nabenhöhe



Nachtkennzeichnung der V112-3.0MW, 3.3MW und 3.45MW mit 140 m Nabenhöhe

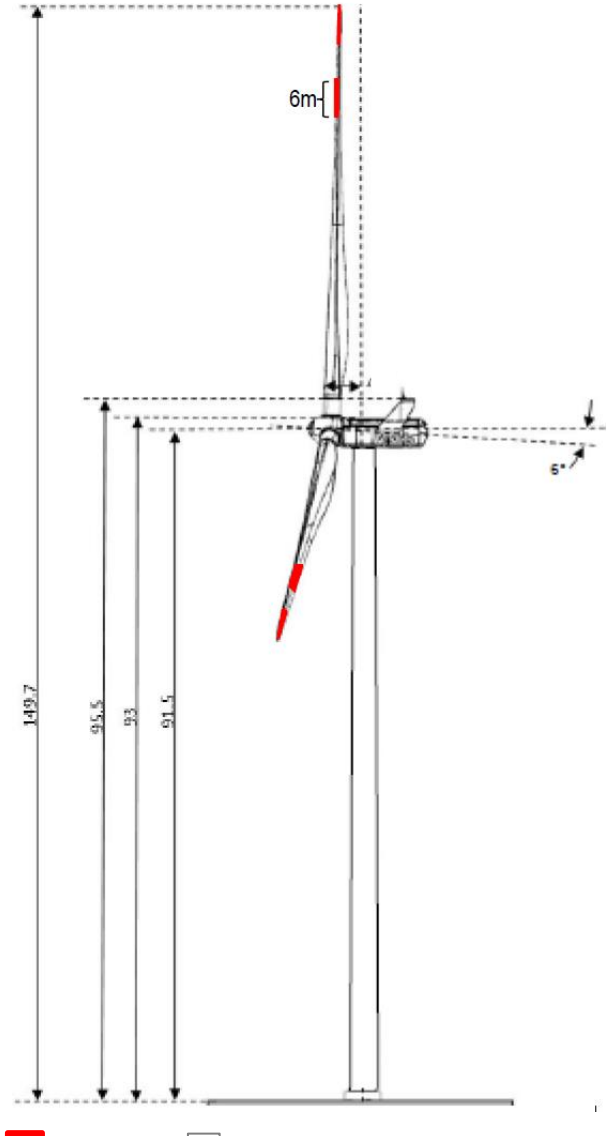
T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

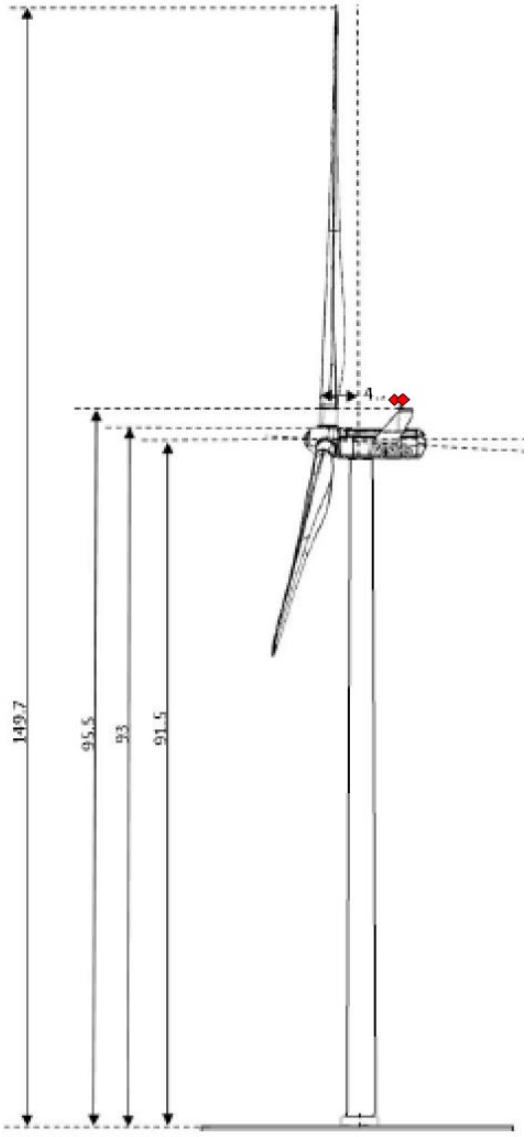
VESTAS PROPRIETARY NOTICE

2.2. V117-3.3MW und 3.45MW

2.2.1. 91,5m Nabenhöhe (150m Spitzenhöhe)



Tageskennzeichnung der V117-3.3 / 3.45 MW mit 91,5 m Nabenhöhe



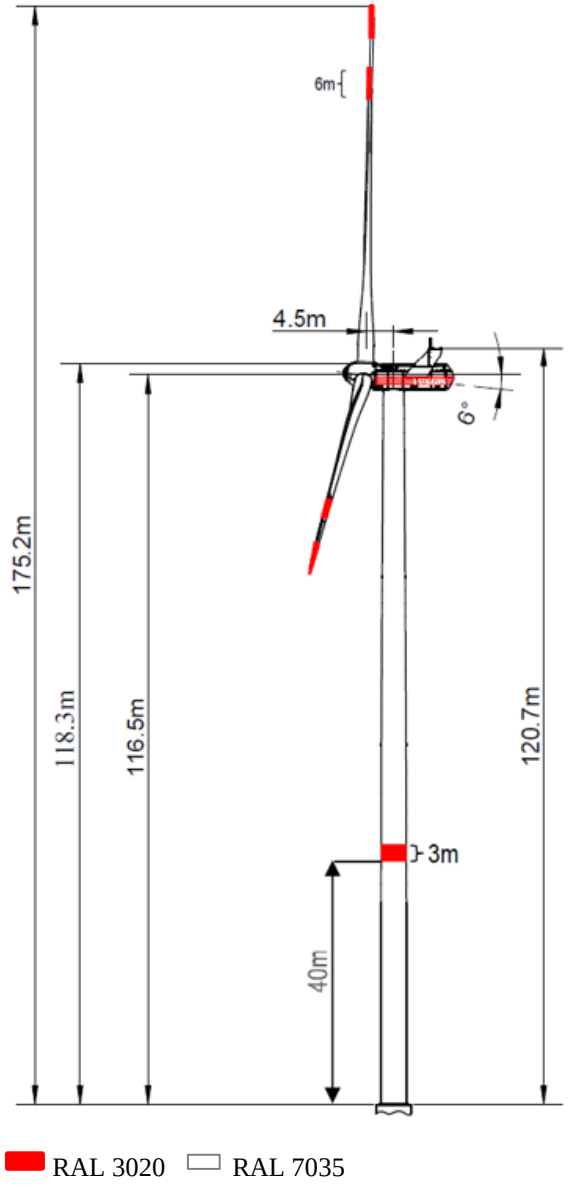
Nachtkennzeichnung der V117-3.3 / 3.45 MW mit 91,5 m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

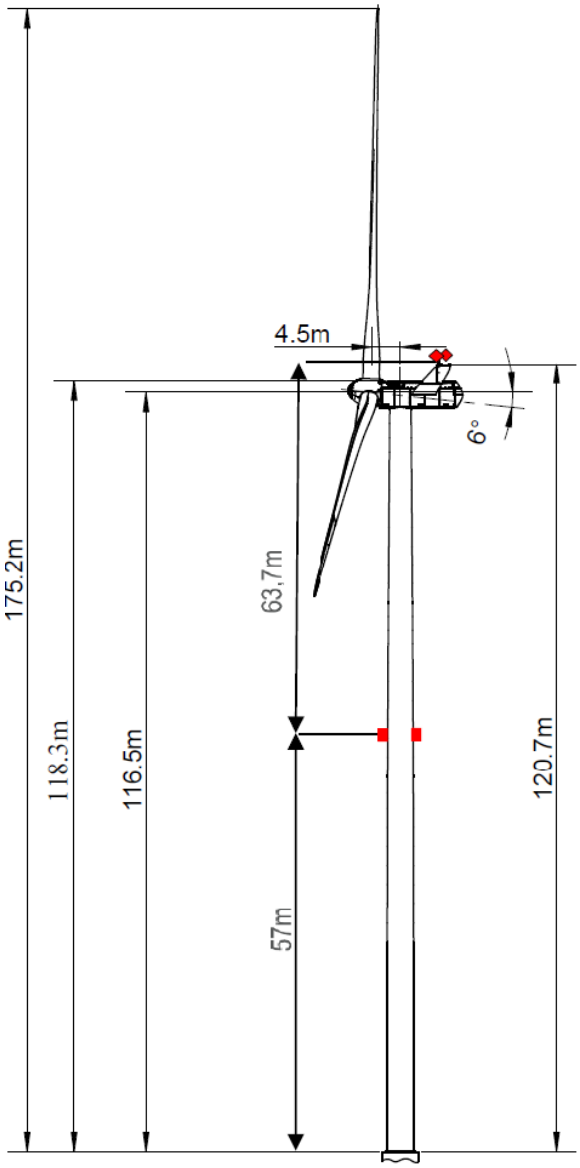
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.2.2. 116,5m Nabenhöhe (175m Spitzenhöhe)



Tageskennzeichnung der V117-3.3 / 3.45 MW mit 116,5 m Nabenhöhe



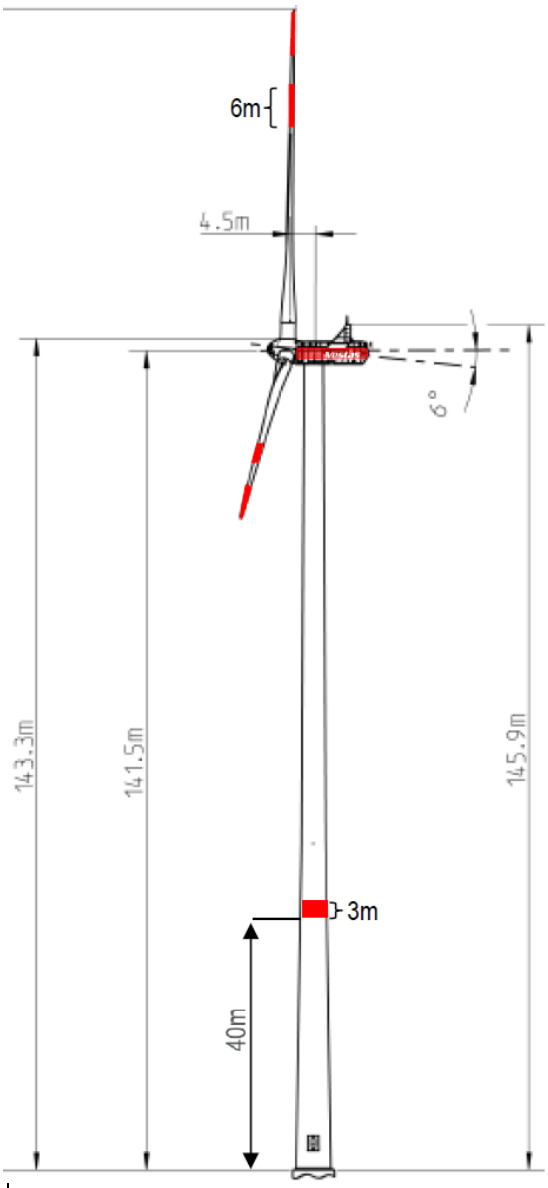
Nachtkennzeichnung der V117-3.3 / 3.45 MW mit 116,5 m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

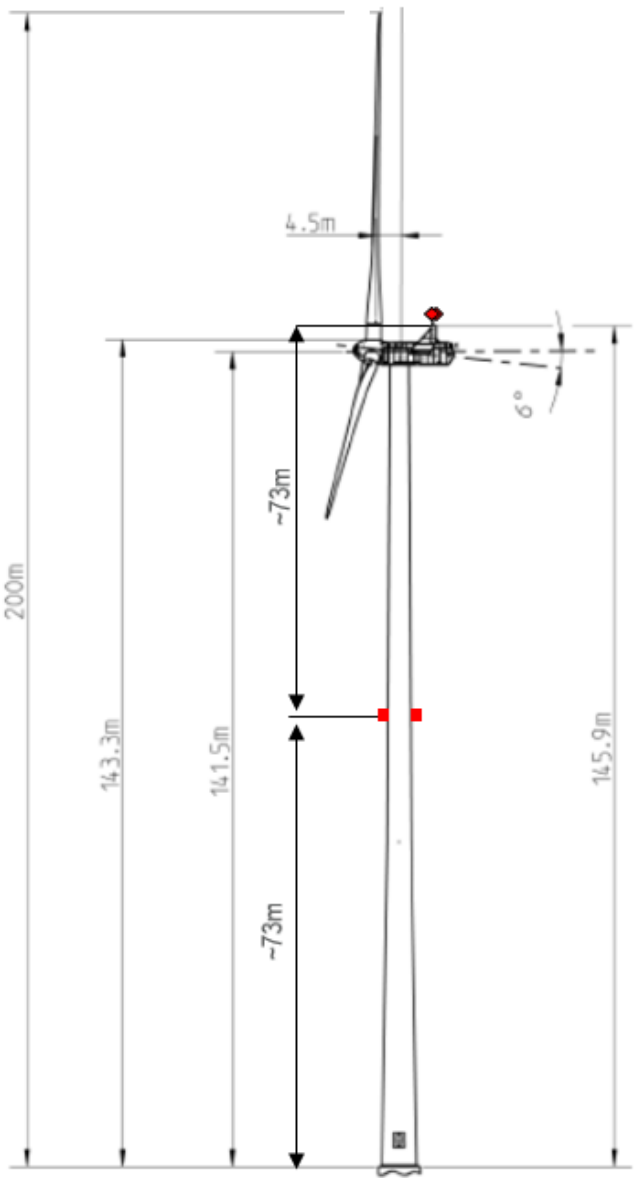
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.2.3. 141,5m Nabenhöhe (200m Spitzenhöhe)



Tageskennzeichnung der V117-3.3 / 3.45 MW mit 141,5 m Nabenhöhe



Nachtkennzeichnung der V117-3.3 / 3.45 MW mit 141,5 m Nabenhöhe

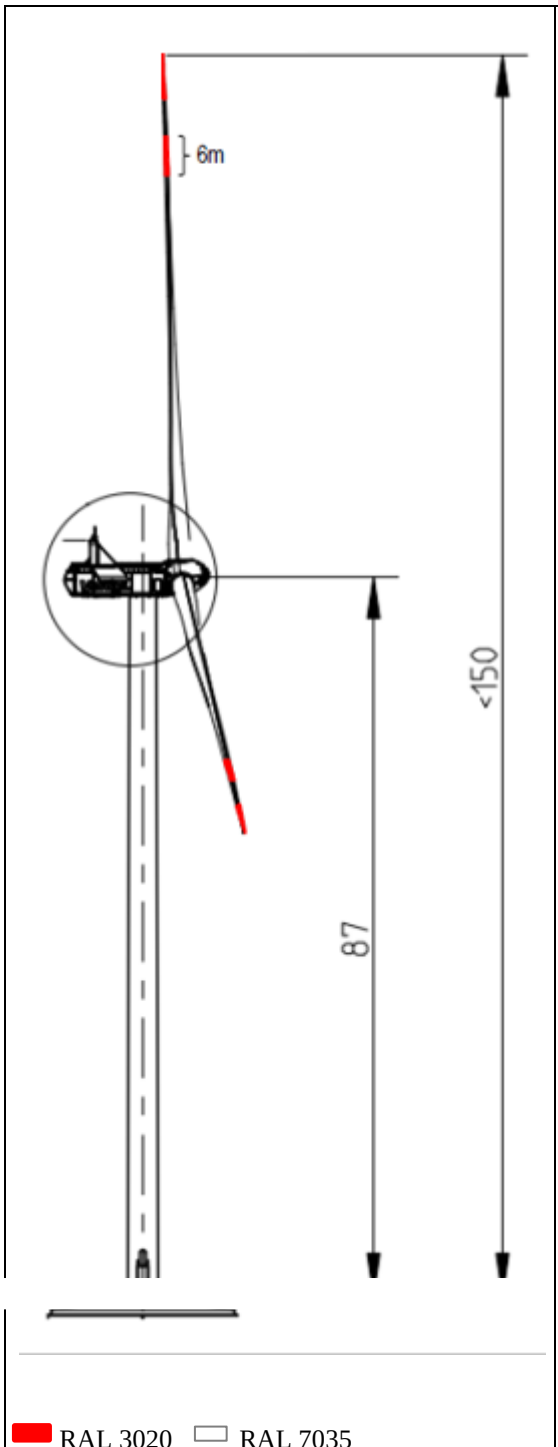
T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

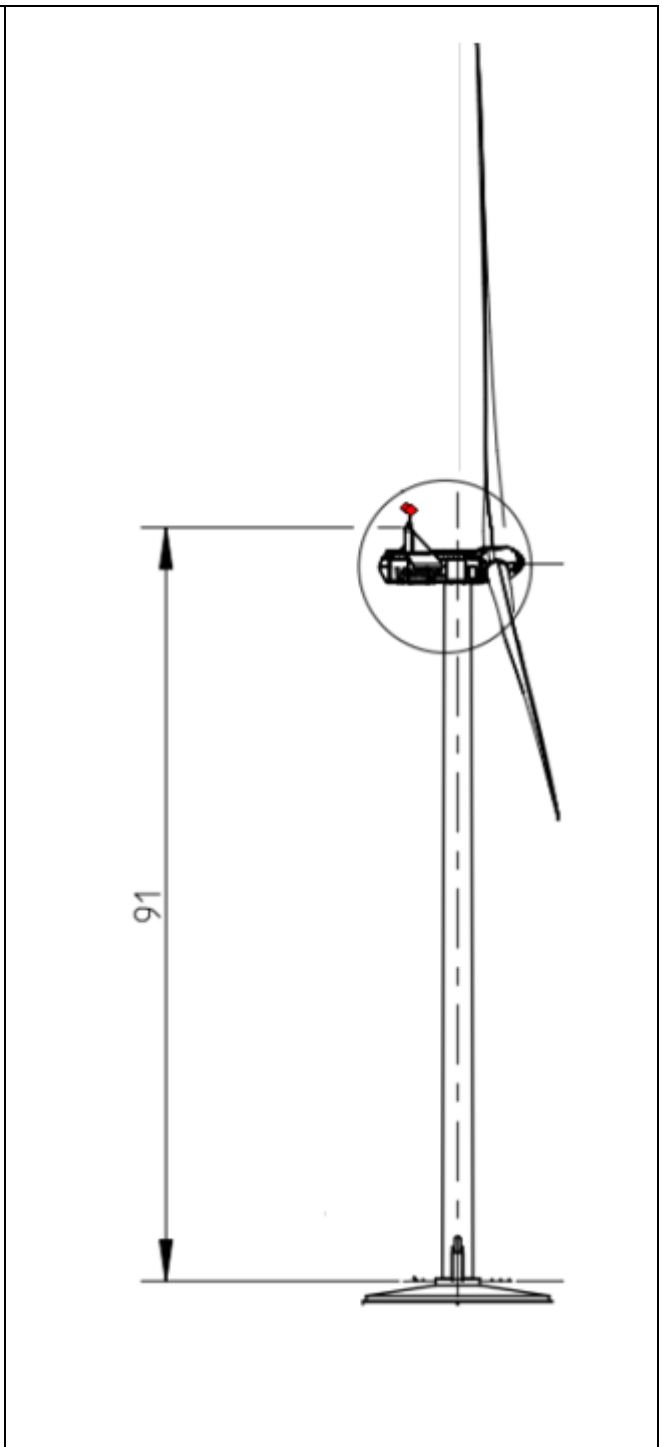
VESTAS PROPRIETARY NOTICE

2.3. V126-3.3MW, 3.45MW und 3.6MW

2.3.1. 87m Nabenhöhe (150m Spitzenhöhe)



Tageskennzeichnung der V126-3.45 / 3.6 MW mit 87m Nabenhöhe. Nabenhöhe nicht bei der V126-3.3/3.45 (MK3A) verfügbar.



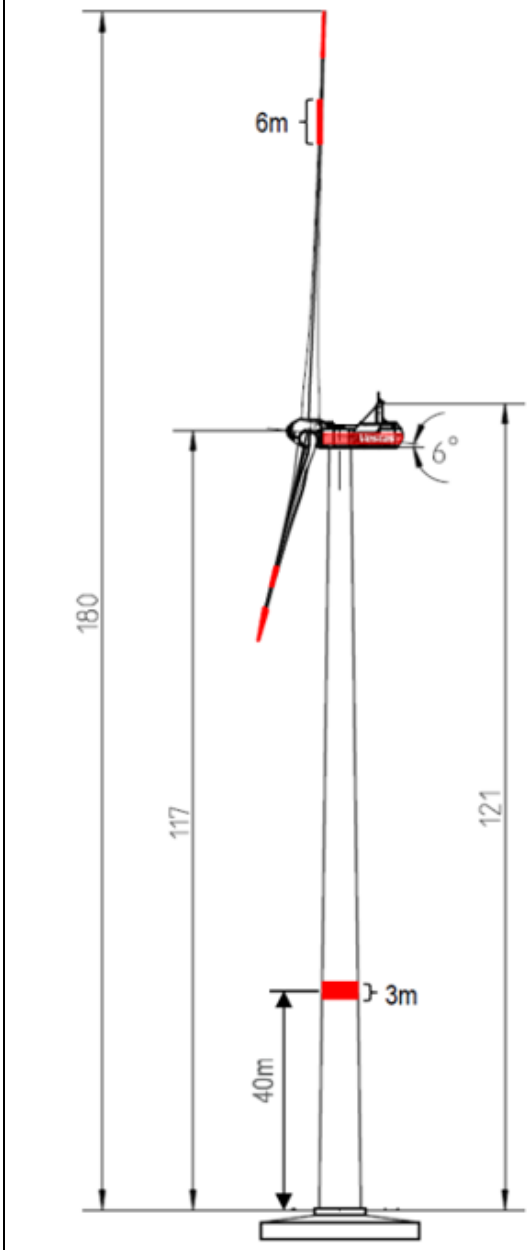
Nachtkennzeichnung der V126-3.45 / 3.6 MW mit 87m Nabenhöhe. Nabenhöhe nicht bei der V126-3.3/3.45 (MK3A) verfügbar.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

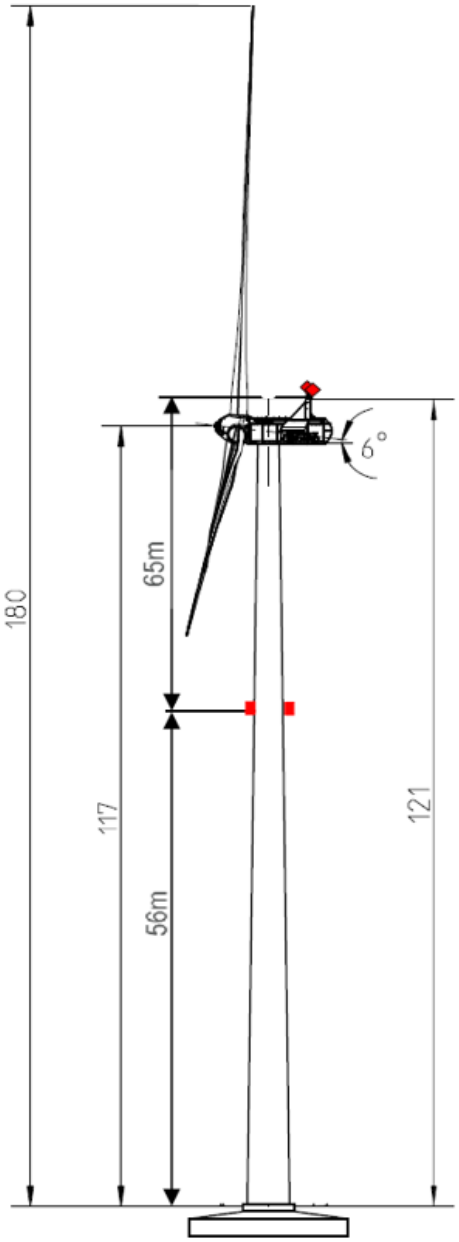
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.3.2. 117m Nabenhöhe (180m Spitzenhöhe)



Tageskennzeichnung der V126-3.3 / 3.45 MW mit 117 m Nabenhöhe.



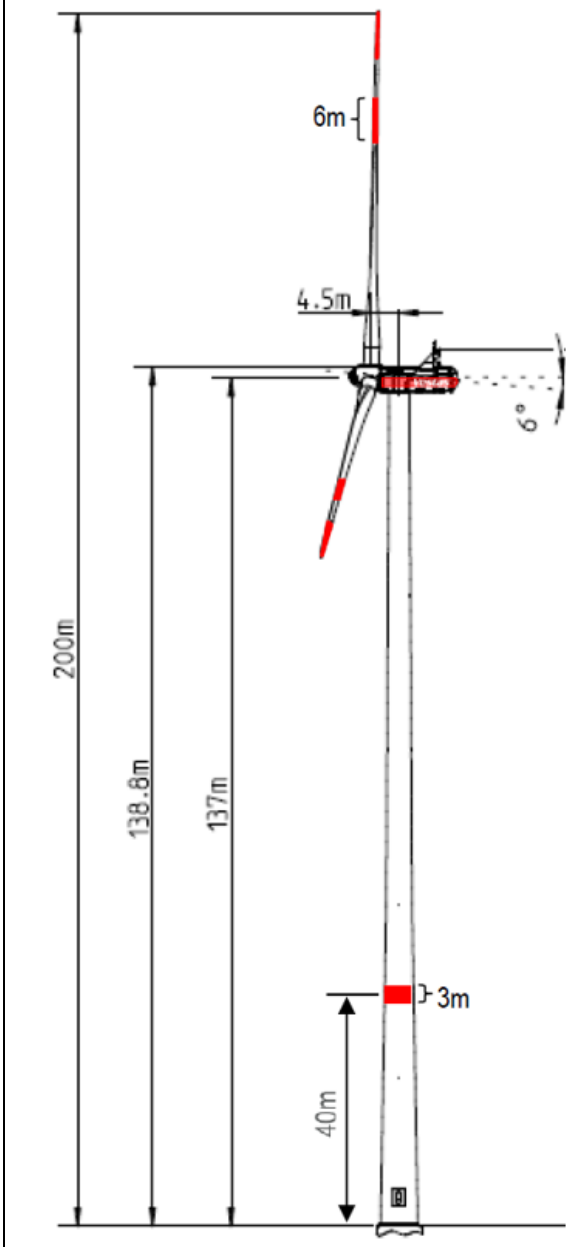
Nachtkennzeichnung der V126-3.3 / 3.45 MW mit 117 m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

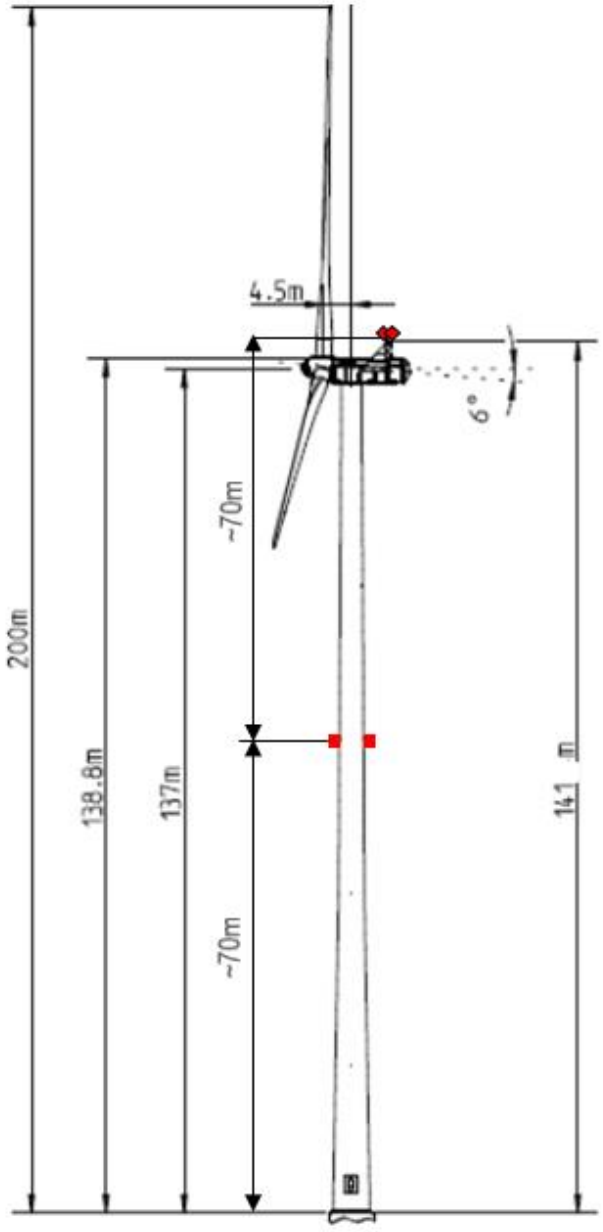
VESTAS PROPRIETARY NOTICE

2.3.3. 137m Nabenhöhe (200m Spitzenhöhe)



RAL 3020 RAL 7035

Tageskennzeichnung der V126-3.3 / 3.45 MW mit 137 m Nabenhöhe



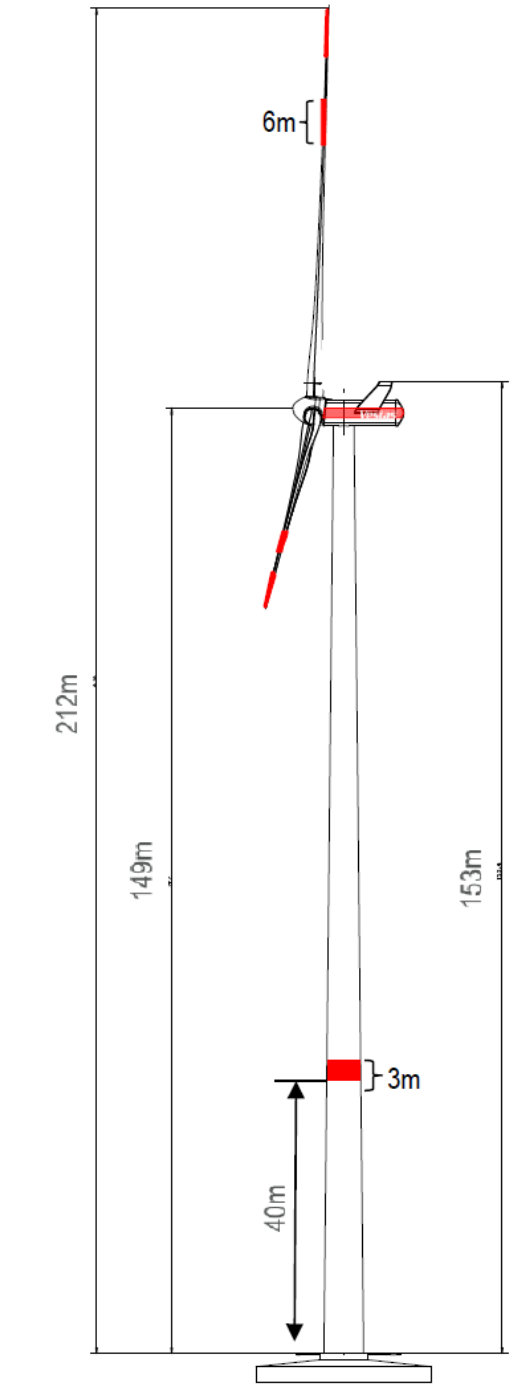
Nachtkennzeichnung der V126-3.3 / 3.45 MW mit 137 m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

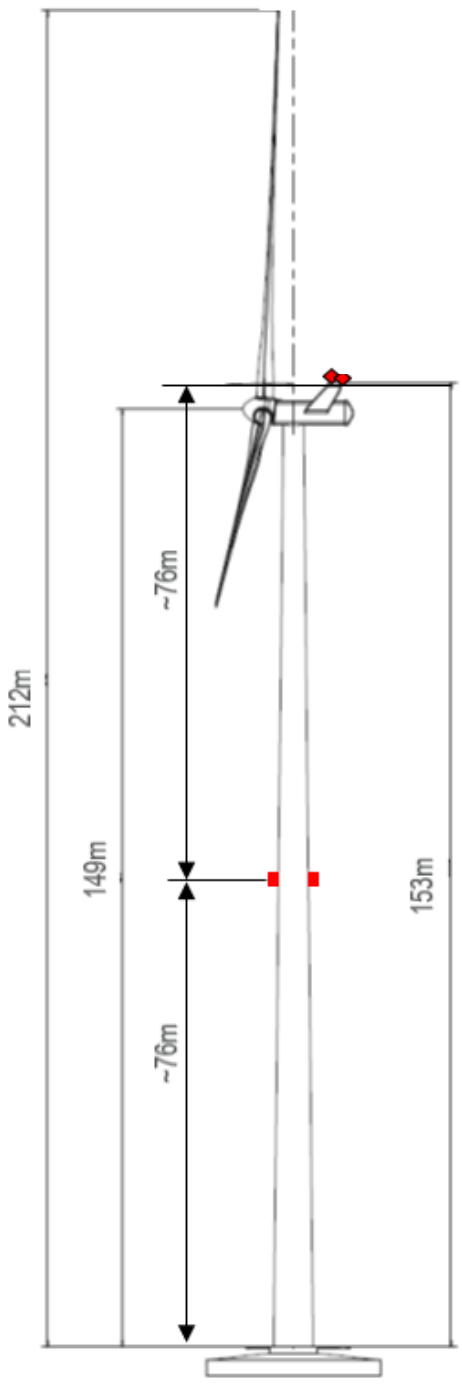
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.3.4. 149m Nabenhöhe (212m Spitzenhöhe)



Tageskennzeichnung der V126-3.3 / 3.45 MW mit 149 m Nabenhöhe



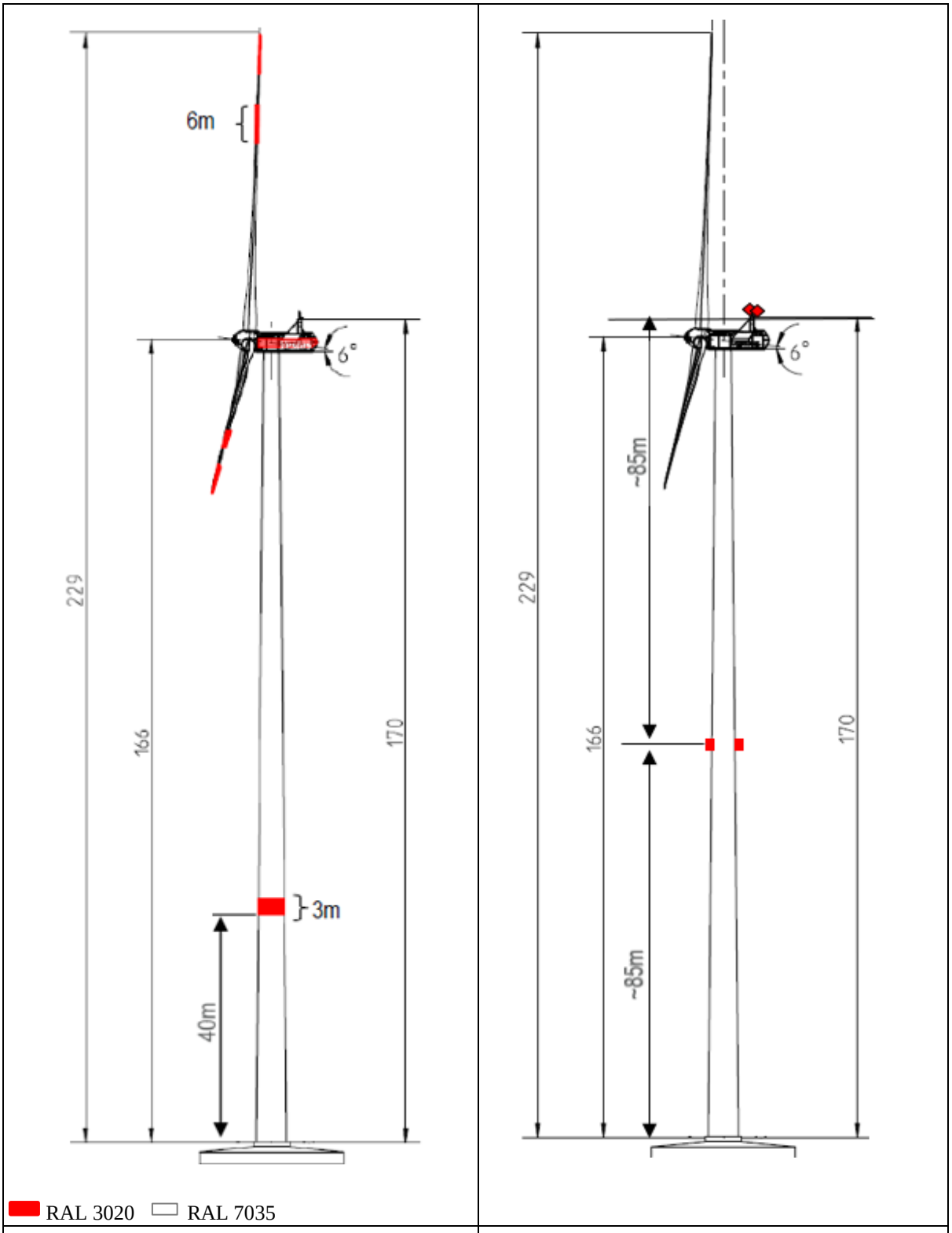
Nachtkennzeichnung der V126-3.3 / 3.45MW mit 149 m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.3.5. 166m Nabenhöhe (229m Spitzenhöhe)



Tageskennzeichnung der V126-3.3 / 3.45 MW mit 166 m Nabenhöhe	Nachtkennzeichnung der V126-3.3 / 3.45MW mit 166 m Nabenhöhe

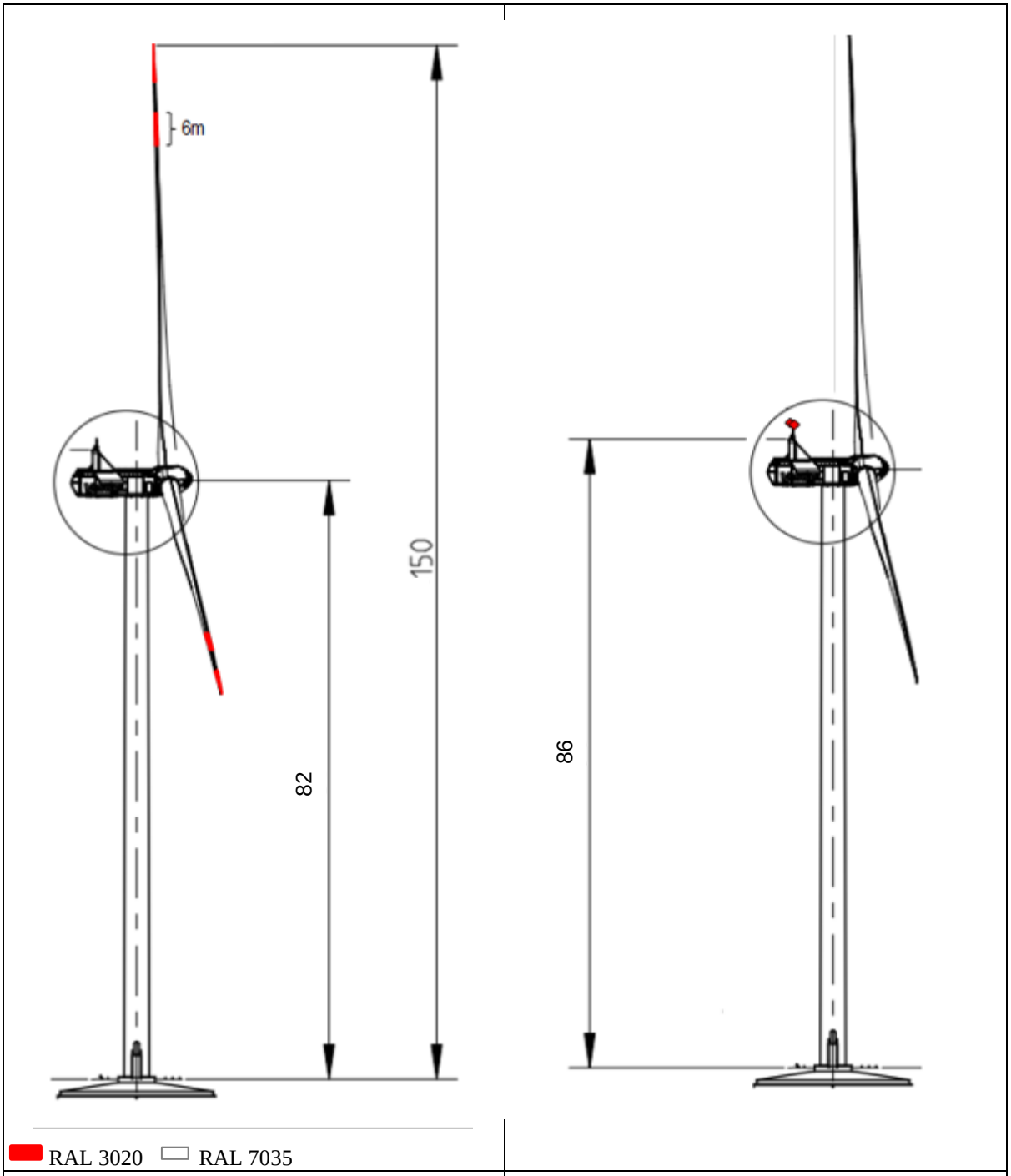
T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.4. V136-3.45 / 3.6 / 4.0 / 4.2MW

2.4.1. 82m Nabenhöhe (150m Spitzenhöhe)



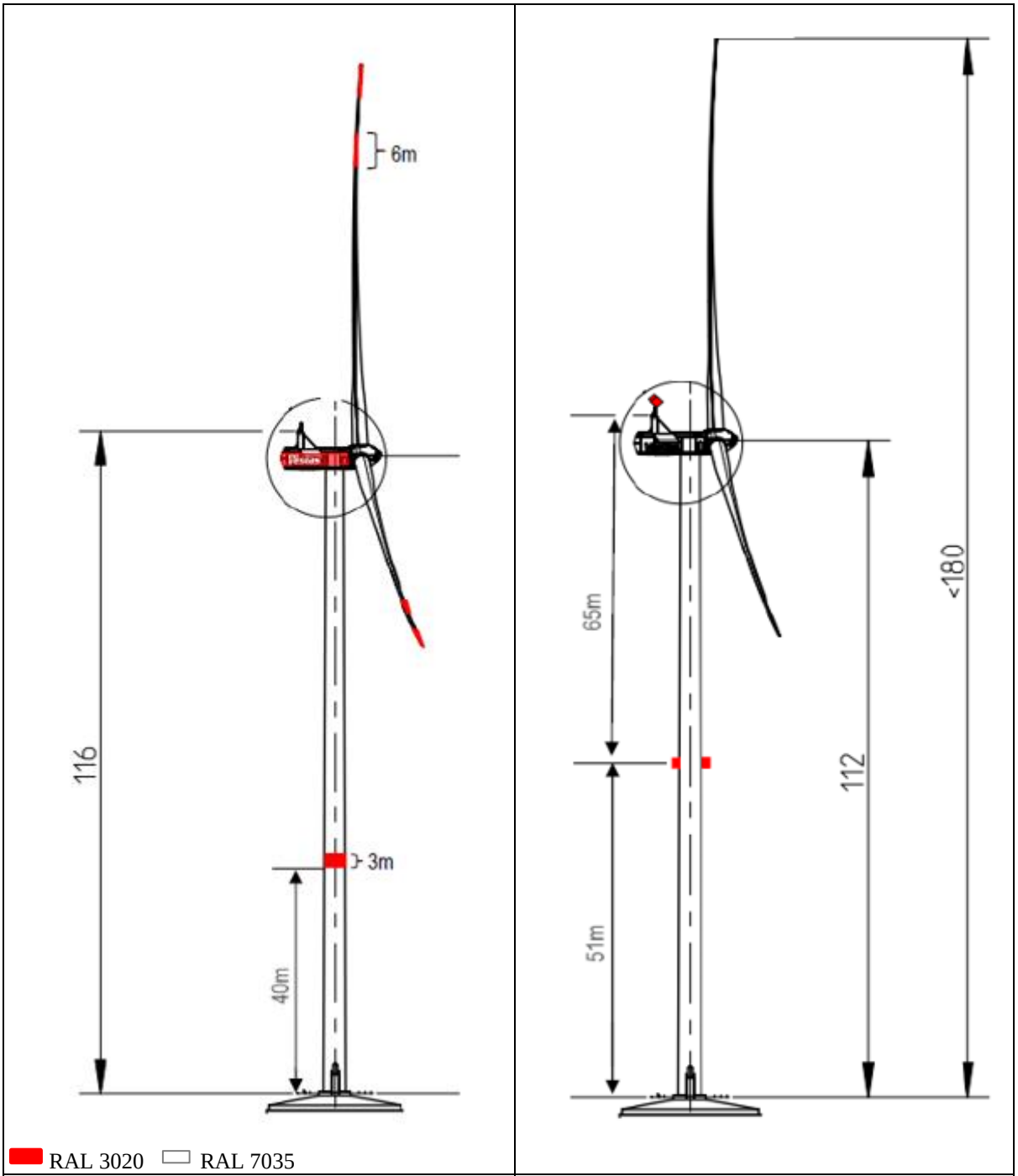
Tageskennzeichnung der V136-4.0/4.2 MW mit 82m Nabenhöhe. Nabenhöhe nicht bei der V136-3.3/3.45 (MK3B) verfügbar.	Nachtkennzeichnung der V136-4.0/4.2 MW mit 82m Nabenhöhe. Nabenhöhe nicht bei der V136-3.3/3.45 (MK3B) verfügbar.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.4.2. 112m Nabenhöhe (180m Spitzenhöhe)



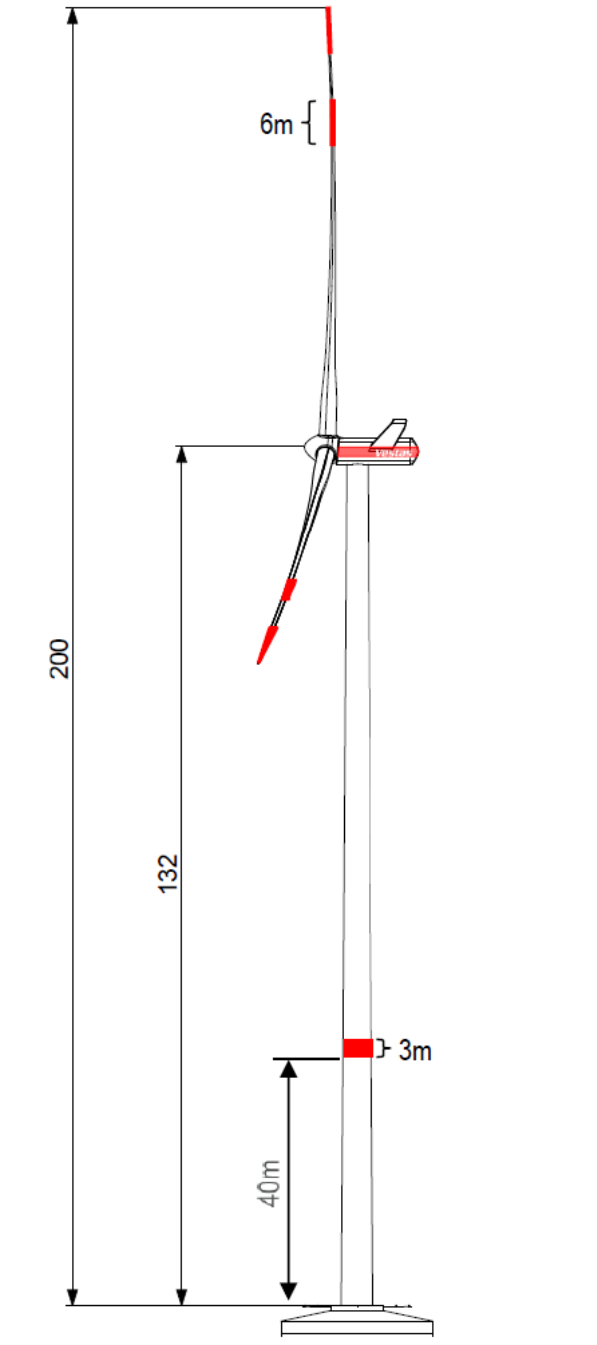
Tageskennzeichnung der V136-4.0/4.2 MW mit 112m Nabenhöhe. Nabenhöhe nicht bei der V136-3.3/3.45 (MK3B) verfügbar.	Nachtkennzeichnung der V136-4.0/4.2 MW mit 112m Nabenhöhe. Nabenhöhe nicht bei der V136-3.3/3.45 (MK3B) verfügbar.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

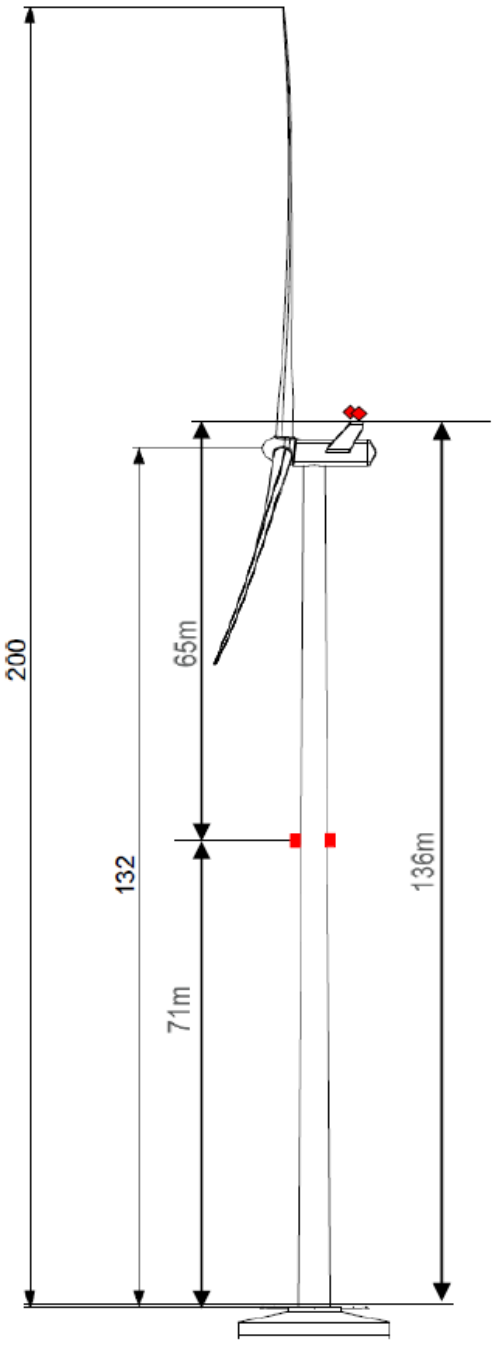
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.4.3. 132m Nabenhöhe (200m Spitzenhöhe)



Tageskennzeichnung der V136-3.45/3.60 MW mit 132 m Nabenhöhe. Nabenhöhe nicht bei der V136-4.0/4.2 (MK3E) verfügbar.



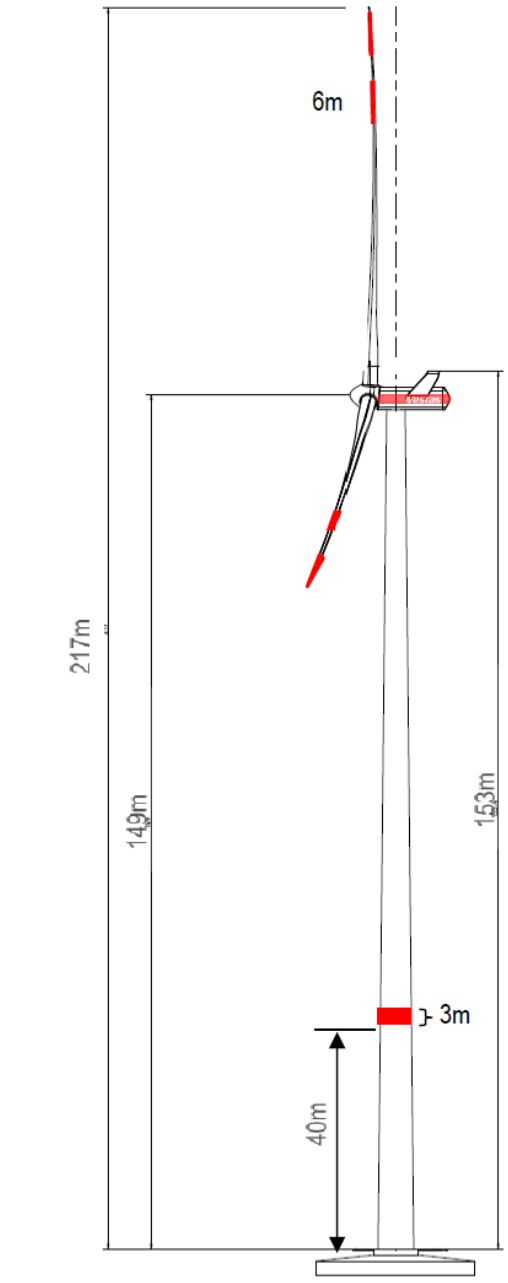
Nachtkennzeichnung der V136-3.45/3.60 MW mit 132 m Nabenhöhe. Nabenhöhe nicht bei der V136-4.0/4.2 (MK3E) verfügbar.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

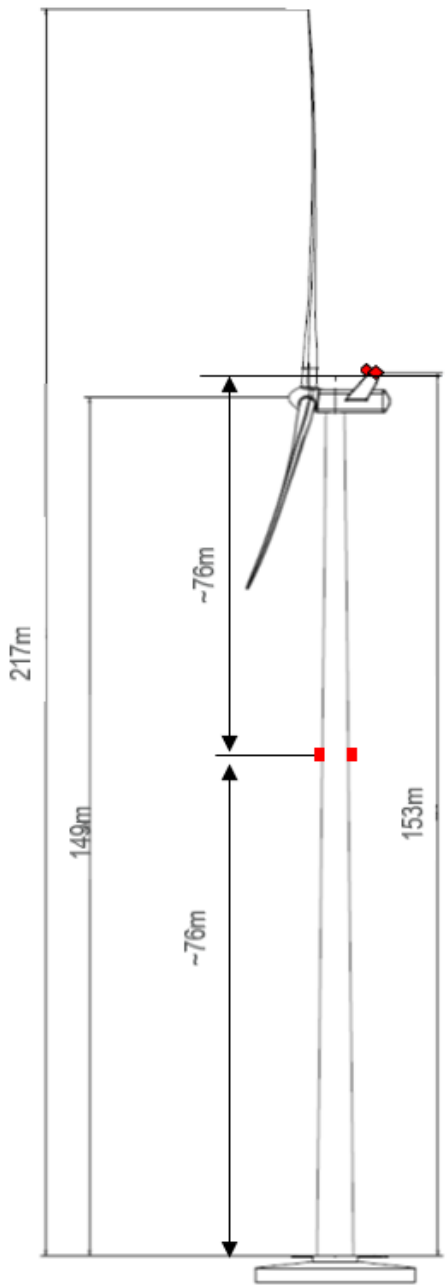
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.4.4. 149m Nabenhöhe (217m Spitzenhöhe)



Tageskennzeichnung der V136-3.45/3.6/4.0/4.2 MW mit 149 m Nabenhöhe



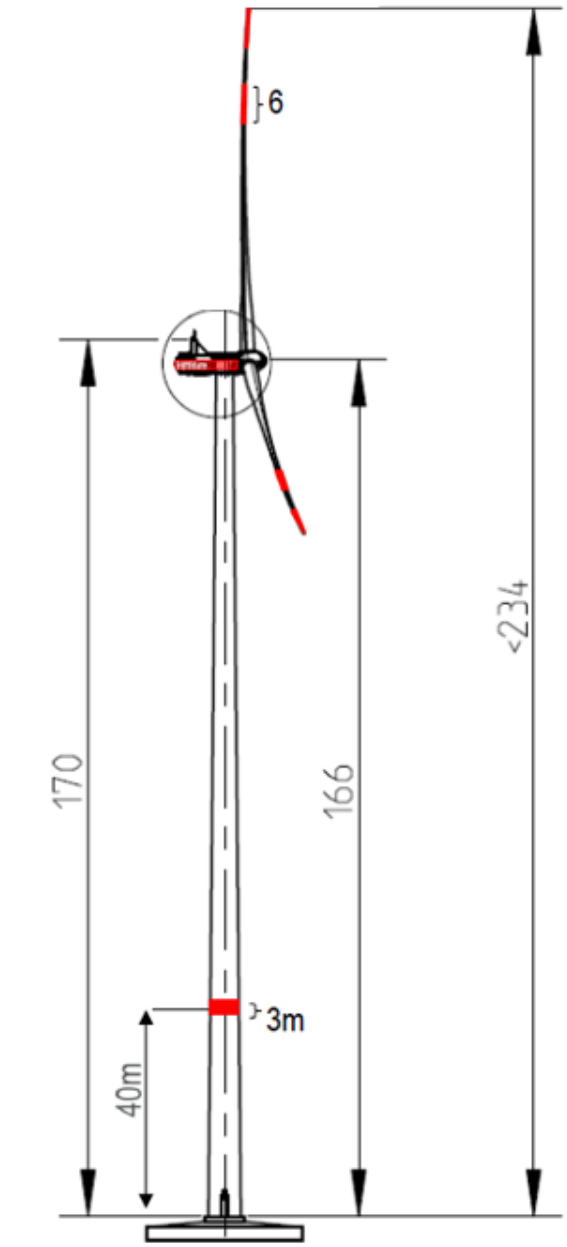
Nachtkennzeichnung der V136-3.45/3.6/4.0/4.2 MW mit 149 m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

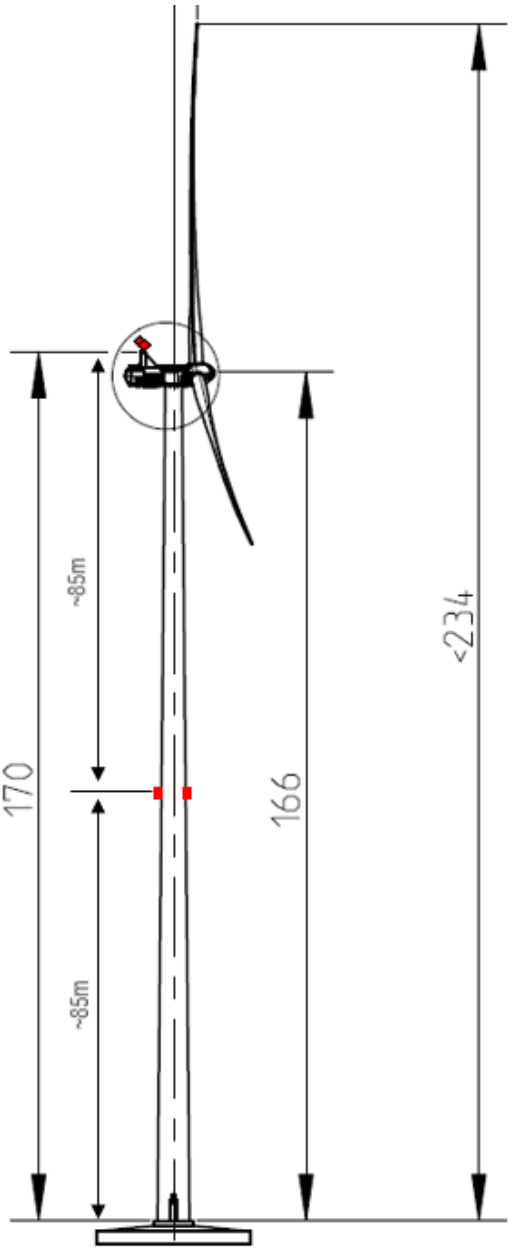
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.4.5. 166m Nabenhöhe (234m Spitzenhöhe)



Tageskennzeichnung der V136-3.45/3.60/4.0/4.2 MW mit 166 m Nabenhöhe



Nachtkennzeichnung der V136-3.45/3.60/4.0/4.2 MW mit 166 m Nabenhöhe

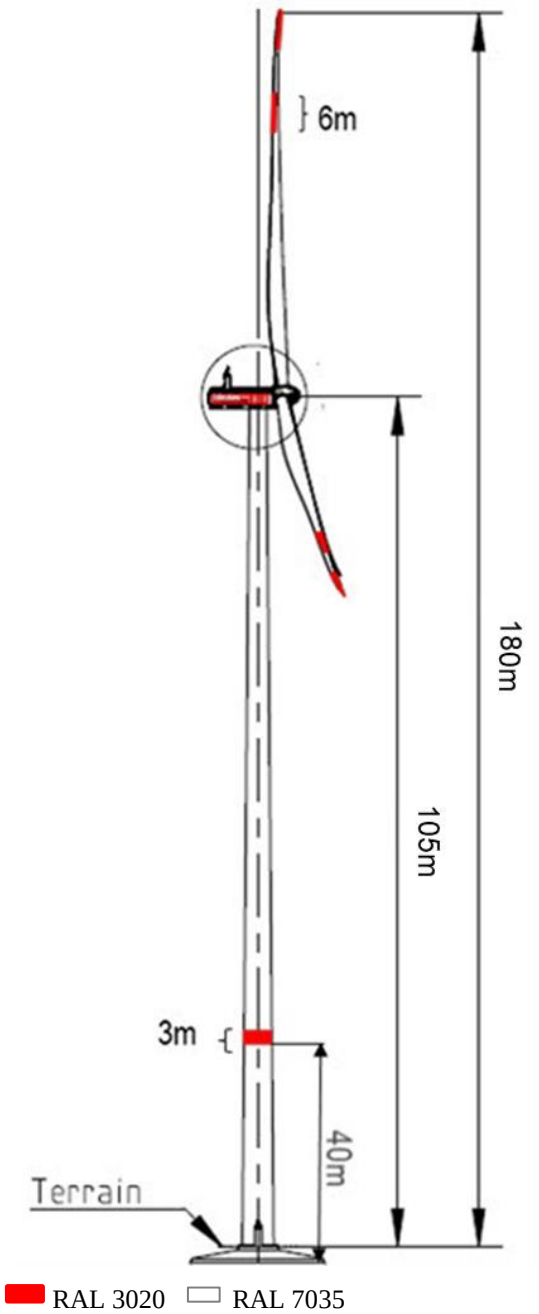
T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

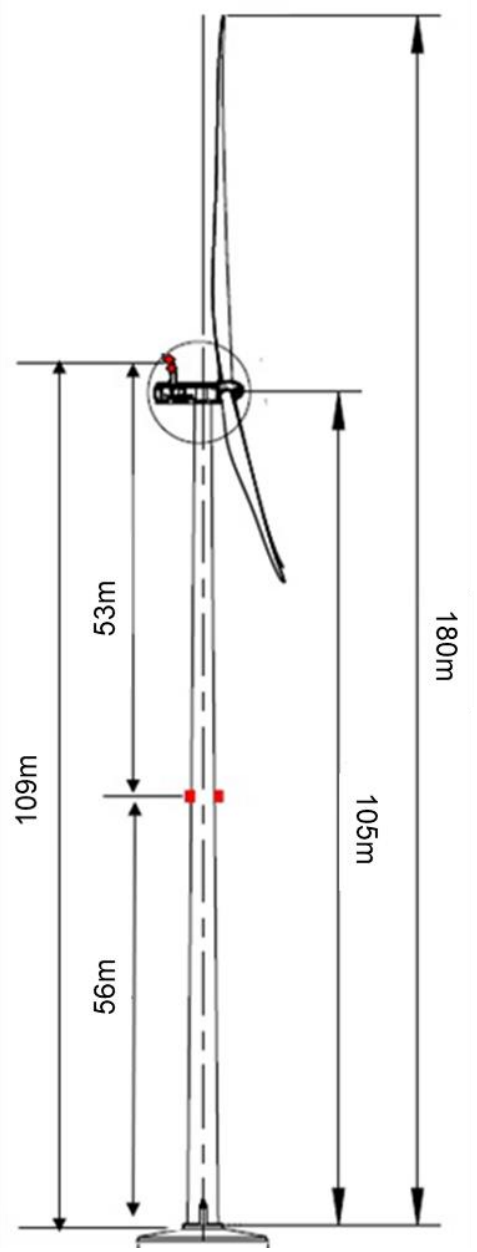
VESTAS PROPRIETARY NOTICE

2.5. V150-4.0 / 4.2MW -5.6 / 6.0MW

2.5.1. 105m Nabenhöhe (180m Spitzenhöhe)



Tageskennzeichnung der V150-5.6 / 6.0 MW mit 105m Nabenhöhe



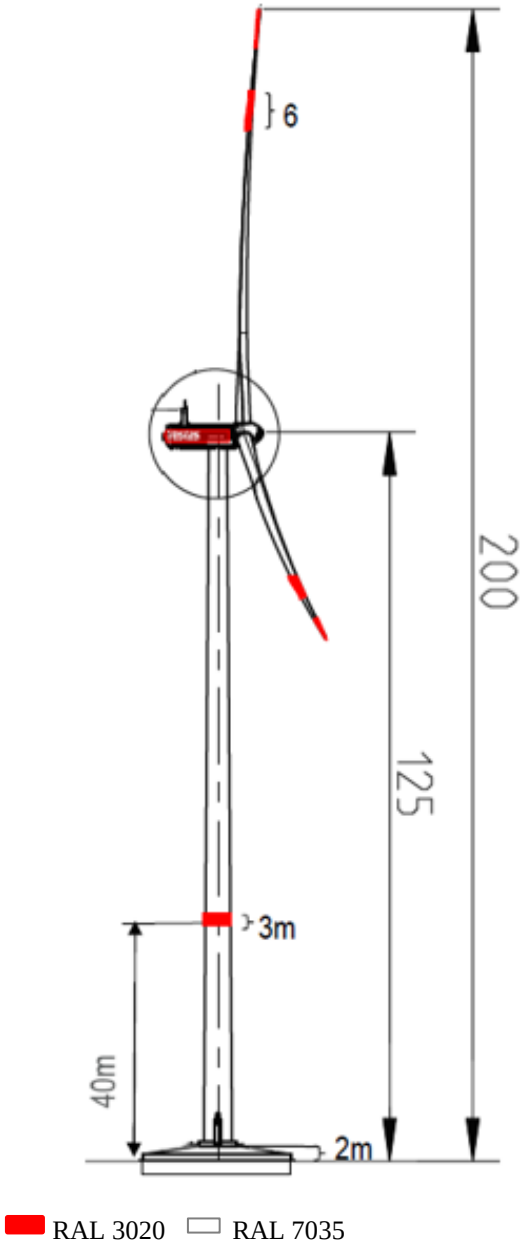
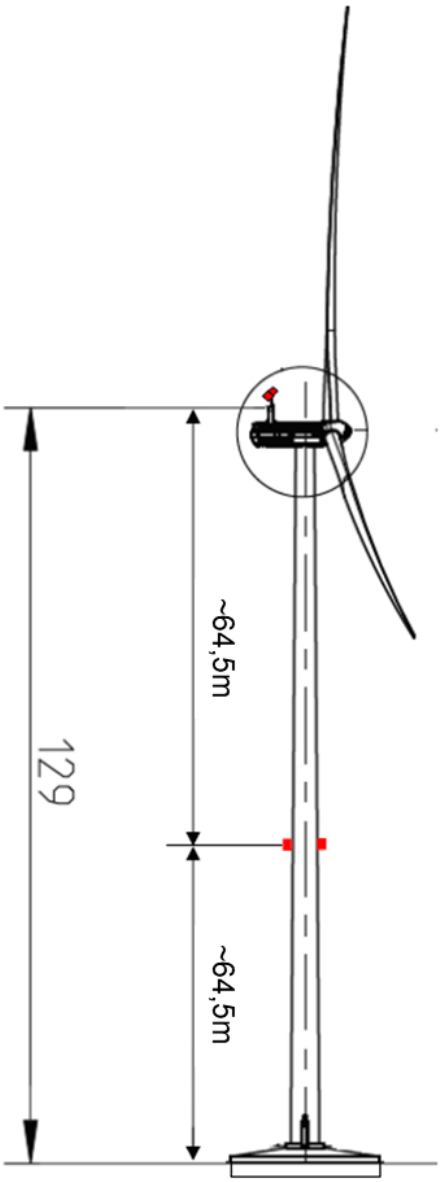
Nachtkennzeichnung der V150-5.6 / 6.0 MW mit 105m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.5.2. 125m Nabenhöhe* (200m Spitzenhöhe)

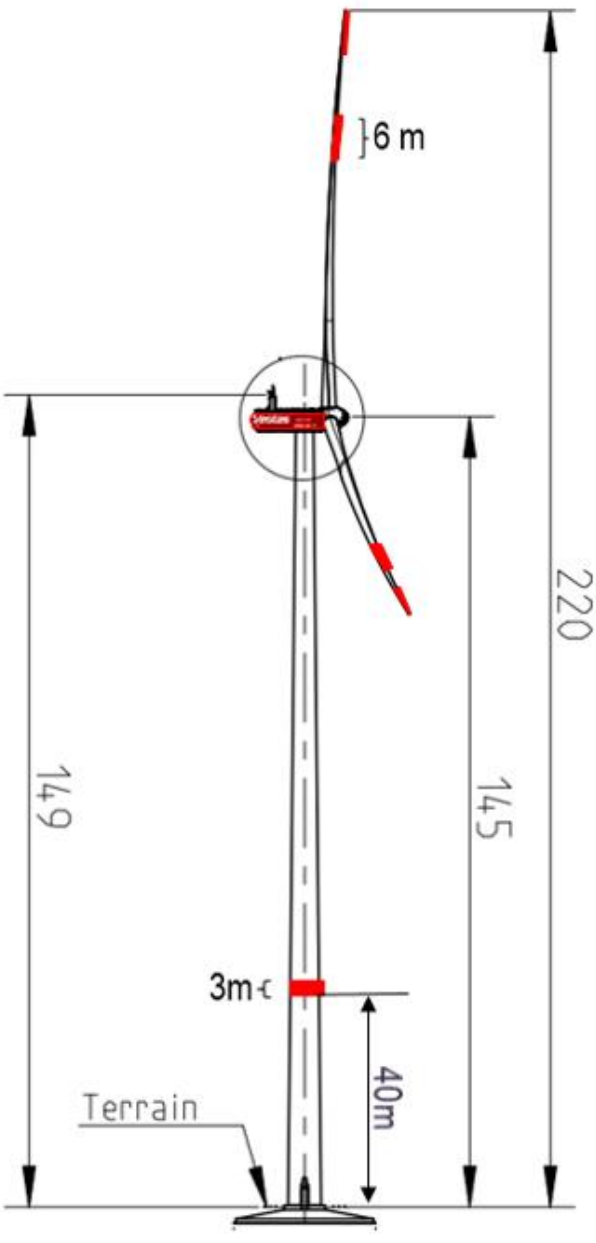
	
Tageskennzeichnung der V150-4.0 / 4.2 / 5.6 / 6.0 MW mit 125m Nabenhöhe Bei der 4.0/4.2MW (MK3E) Variante handelt es sich um einen 123m Turm mit einer 2 m hohen Fundamenterhöhung	Nachtkennzeichnung der V150-4.0 / 4.2 / 5.6 / 6.0 MW mit 125m Nabenhöhe Bei der 4.0/4.2MW (MK3E) Variante handelt es sich um einen 123m Turm mit einer 2 m hohen Fundamenterhöhung

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

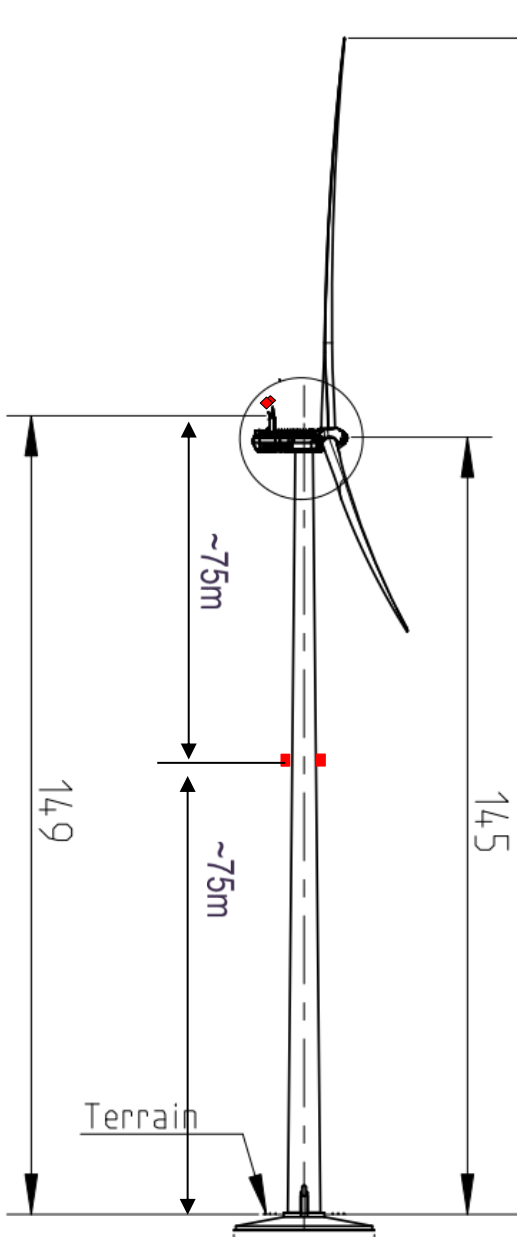
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.5.3. 145m Nabenhöhe (220m Spitzenhöhe)



Tagesmarkierung für V150-4.0 / 4.2 MW auf 145m Nabenhöhe. Nabenhöhe nicht bei der V150-5.6/6.0 MW verfügbar.



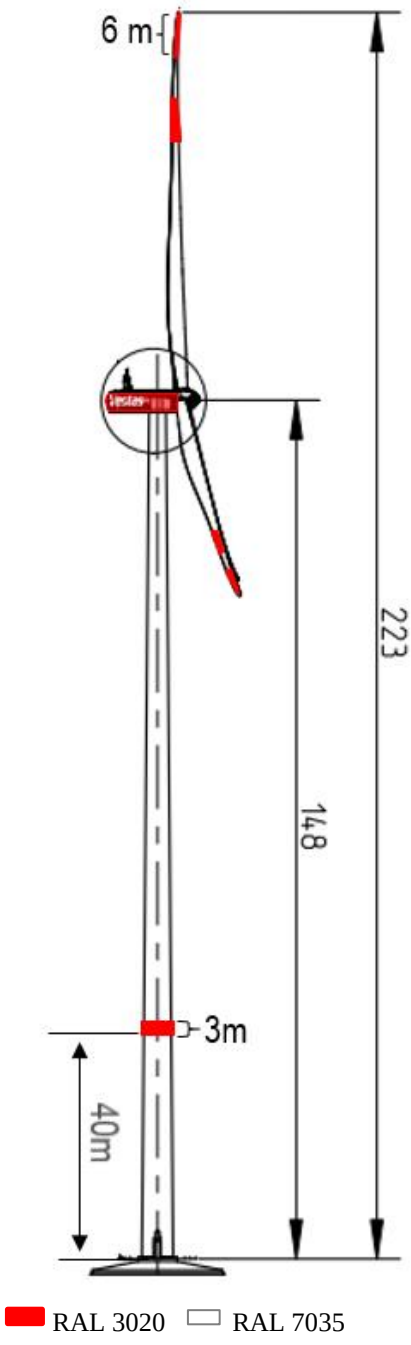
Nachtmarkierung für V150-4.0 / 4.2 MW auf 145m Nabenhöhe. Nabenhöhe nicht bei der V150-5.6/6.0 MW verfügbar.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

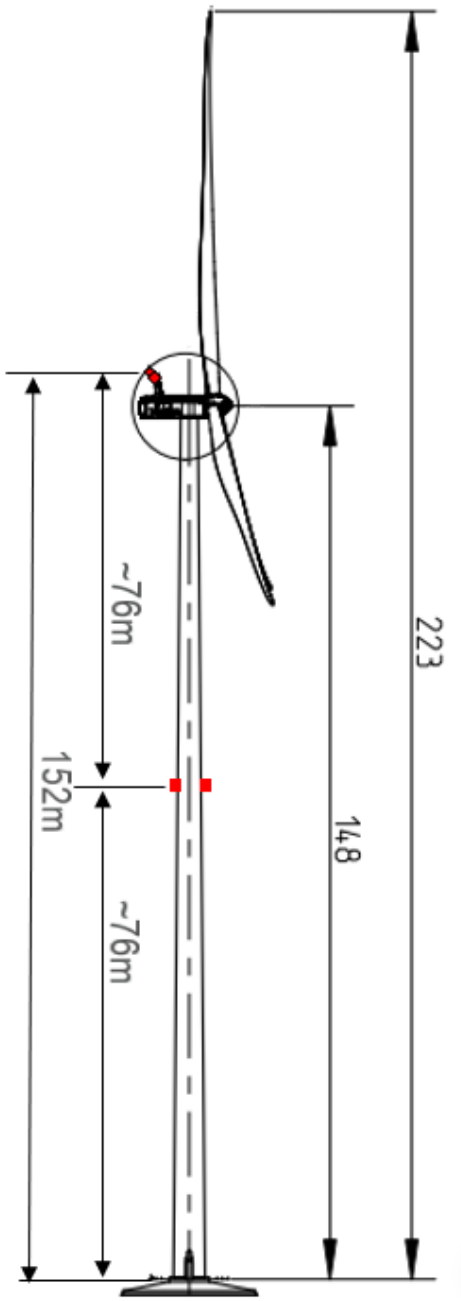
Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.5.4. 148m Nabenhöhe (223m Spitzenhöhe)



Tagesmarkierung für V150-5.6 /6.0 MW auf 148m Nabenhöhe. Nabenhöhe nicht bei der V150-4.0 / 4.2 MW (MK3E) verfügbar.



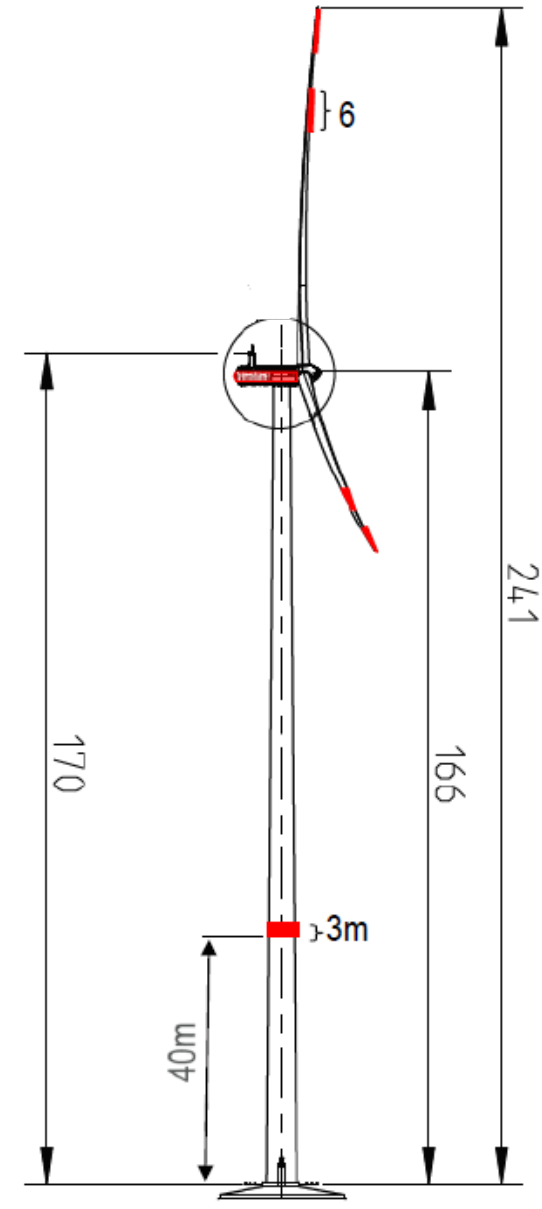
Nachtmarkierung für V150-5.6 / 6.0 MW auf 148m Nabenhöhe. Nabenhöhe nicht bei der V150-4.0 / 4.2 MW (MK3E) verfügbar.

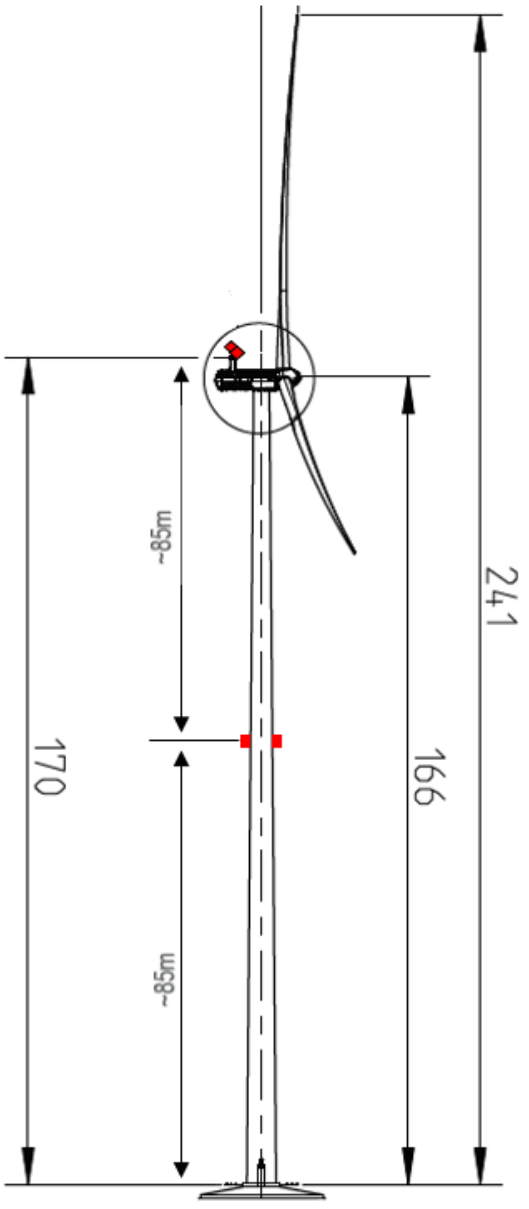
T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.5.5. 166/169m Nabenhöhe (241/244m Spitzenhöhe)





RAL 3020 RAL 7035

Tageskennzeichnung der V150- 4.0 / 4.2 / 5.6 / 6.0 MW mit 166m Nabenhöhe	Nachtkennzeichnung der V150-4.0 / 4.2 / 5.6 /6.0 MW mit 166m Nabenhöhe

*Die gleichen Zeichnungen gelten für eine Ausführung V150- 4.0 / 4.2 / 5.6 / 6.0 MW mit 169m Nabenhöhe.

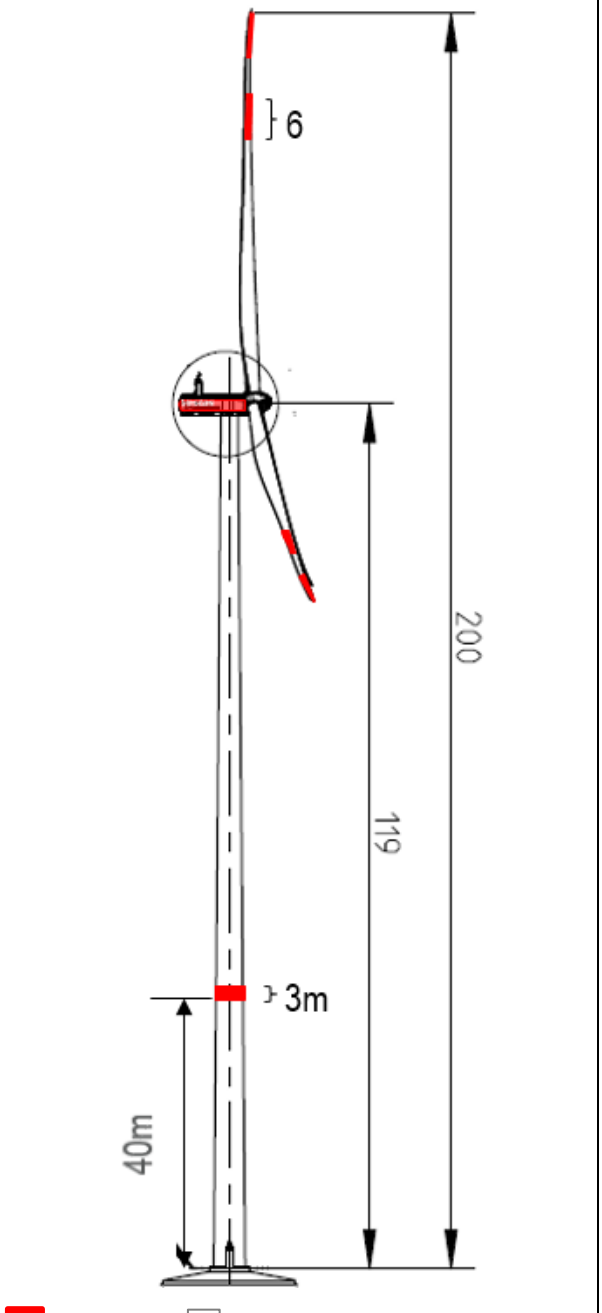
T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

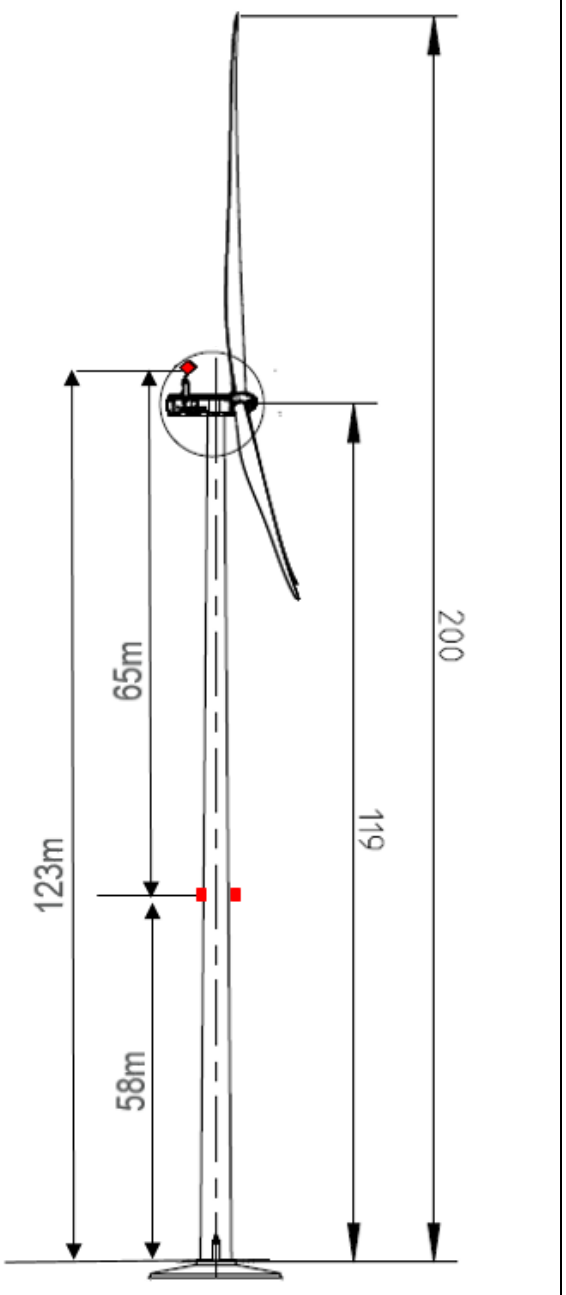
VESTAS PROPRIETARY NOTICE

2.6. V162-5.6 / 6.0 / 6.2MW

2.6.1. 119m Nabenhöhe (200m Spitzenhöhe)



Tageskennzeichnung für die V162-5.6 / 6.0 /6.2 MW auf 119m Nabenhöhe*



Nachtkennzeichnung für die V162-5.6 / 6.0 /6.2 MW auf 119m Nabenhöhe*

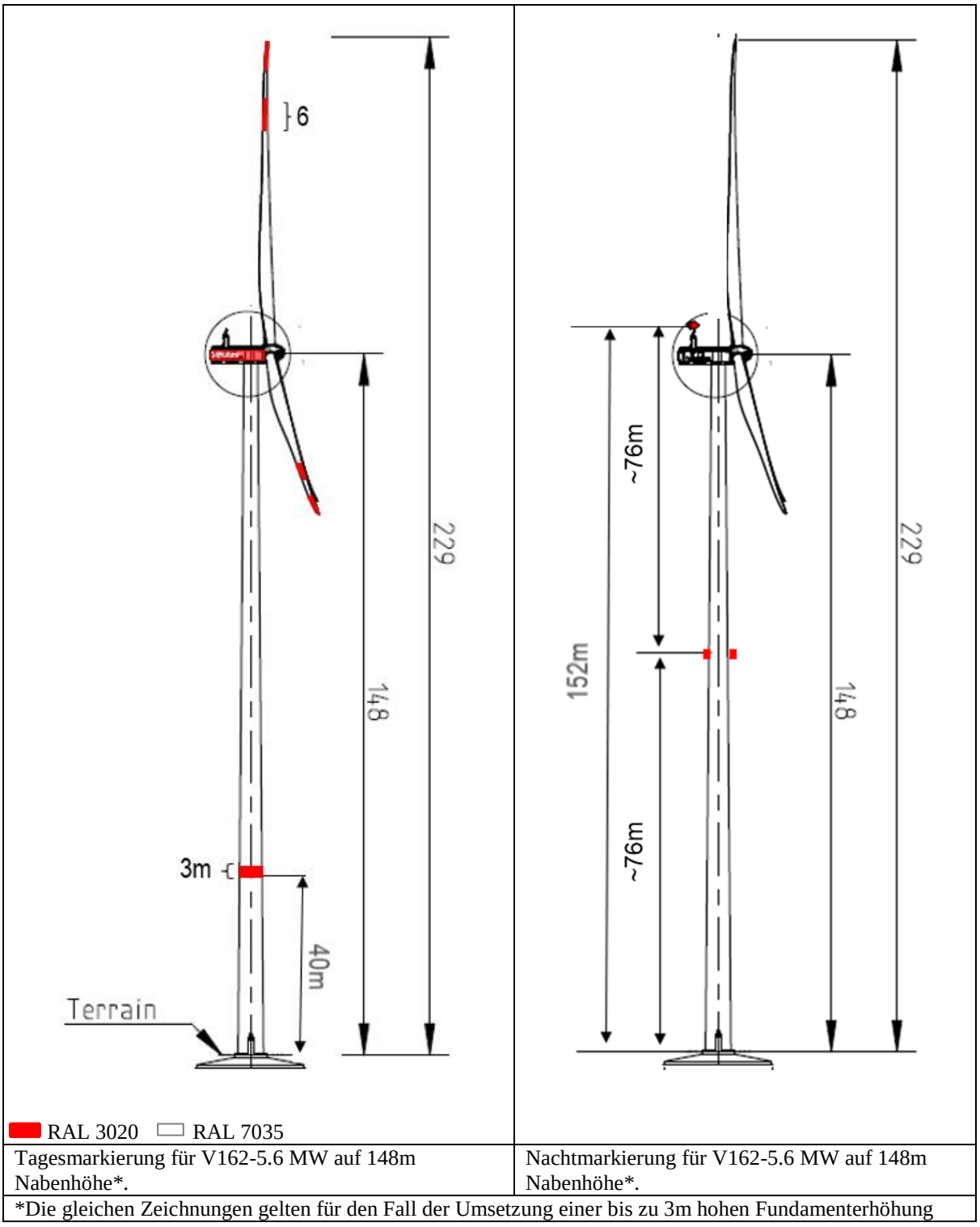
*Die gleichen Zeichnungen gelten für den Fall der Umsetzung einer bis zu 3m hohen Fundamenterhöhung.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.6.2. 148m Nabenhöhe (229m Spitzenhöhe)



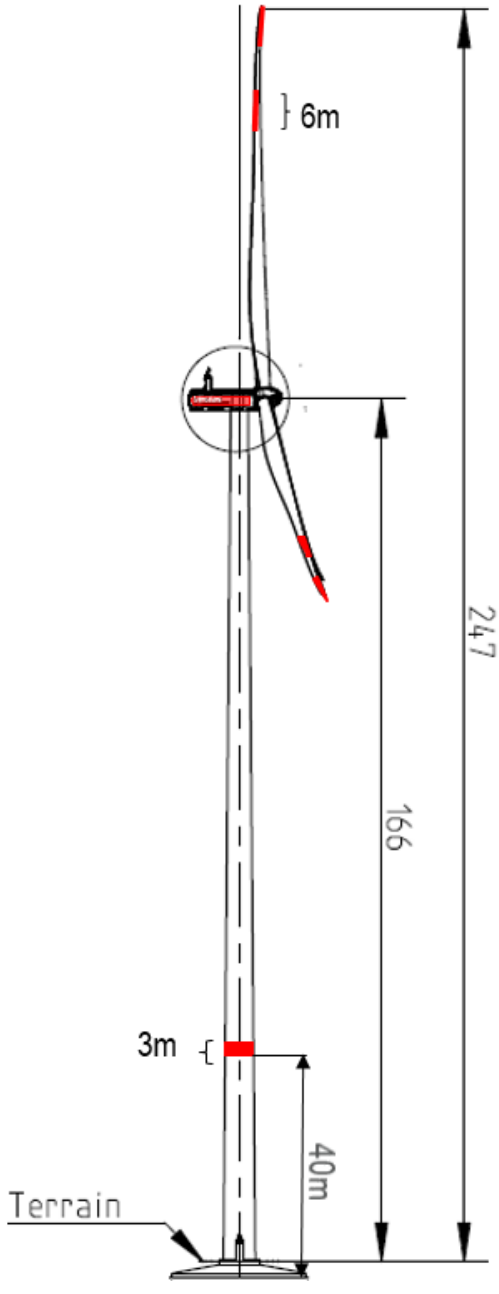
Tagesmarkierung für V162-5.6 MW auf 148m Nabenhöhe*.	Nachtmarkierung für V162-5.6 MW auf 148m Nabenhöhe*.
*Die gleichen Zeichnungen gelten für den Fall der Umsetzung einer bis zu 3m hohen Fundamenterhöhung	

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

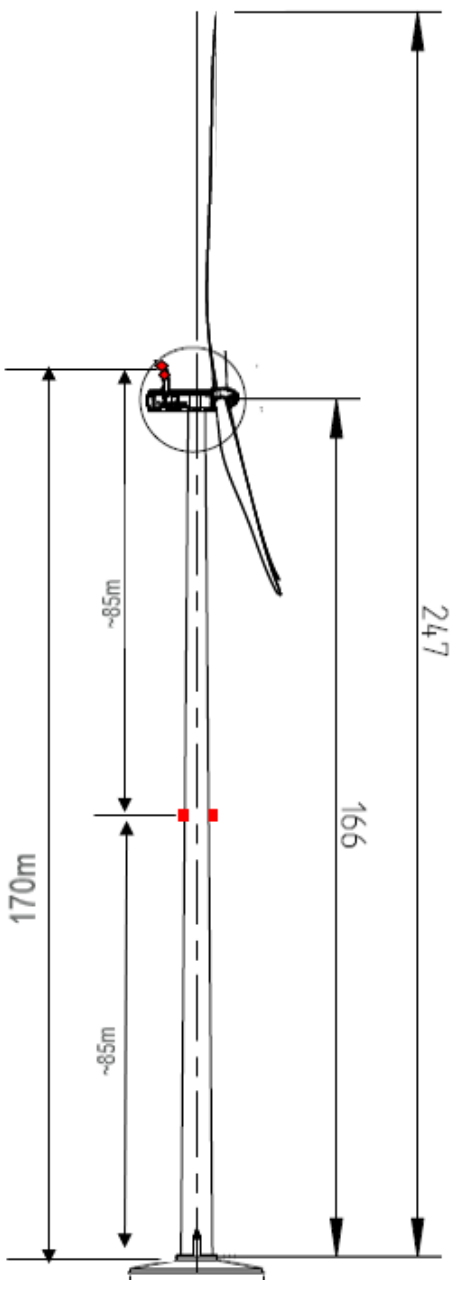
VESTAS PROPRIETARY NOTICE

2.6.3. 166m/169m Nabenhöhe (247/250m Spitzenhöhe)



RAL 3020 RAL 7035

Tagesmarkierung für V162-5.6 / 6.0 / 6.2 MW auf 166m Nabenhöhe*.



Nachtmarkierung für V162-5.6 / 6.0 / 6.2 MW auf 166m Nabenhöhe*.

*Die gleichen Zeichnungen gelten für eine AusführungV162-5.6 / 6.0 / 6.2MW mit 169m Nabenhöhe.

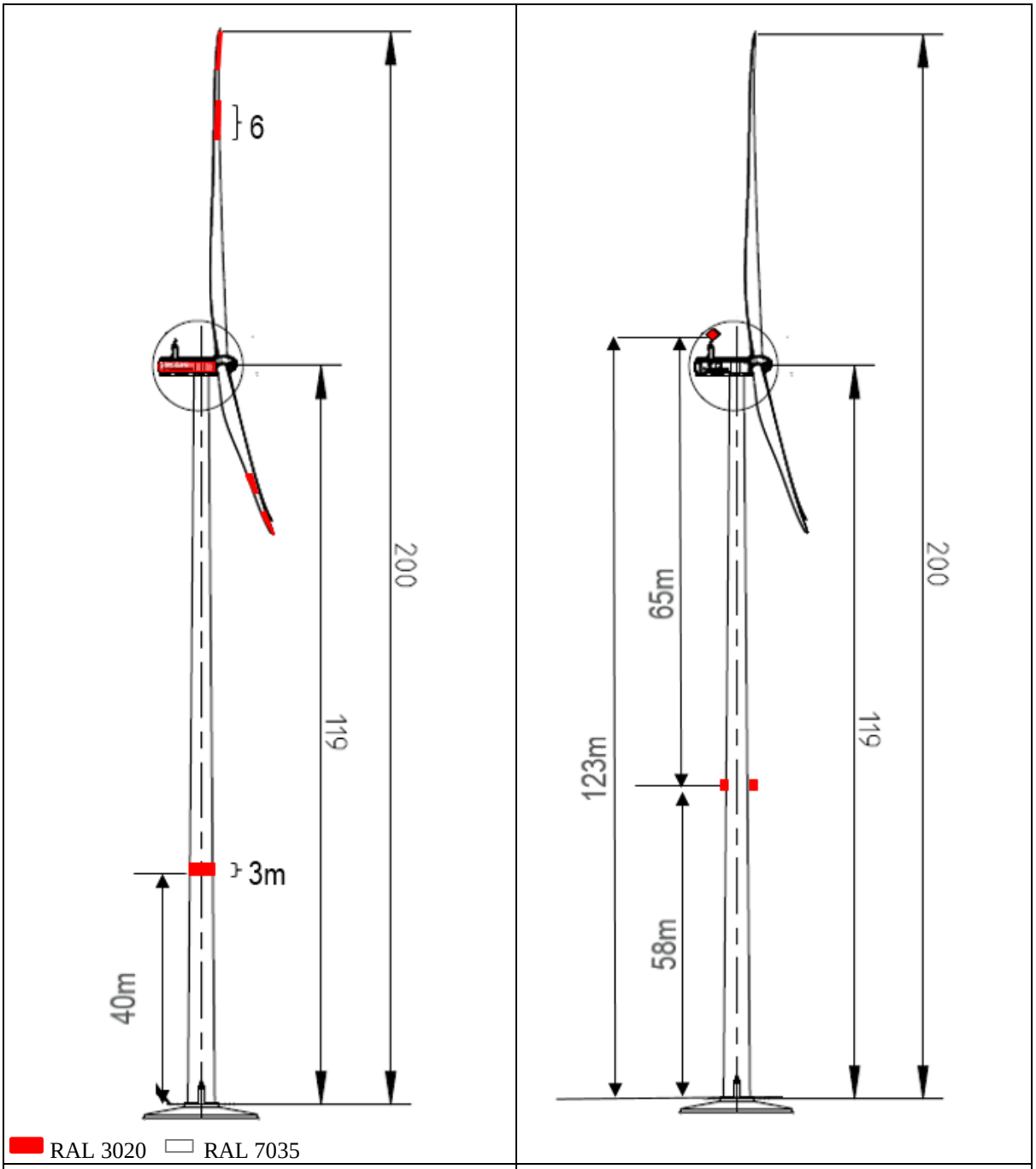
T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.7. V162-7.2MW

2.7.1. 119m Nabenhöhe (200m Spitzenhöhe)



Tageskennzeichnung für die V162-6.8 / 7.2 MW auf 119m Nabenhöhe*	Nachtkennzeichnung für die V162-6.8 / 7.2 MW auf 119m Nabenhöhe*

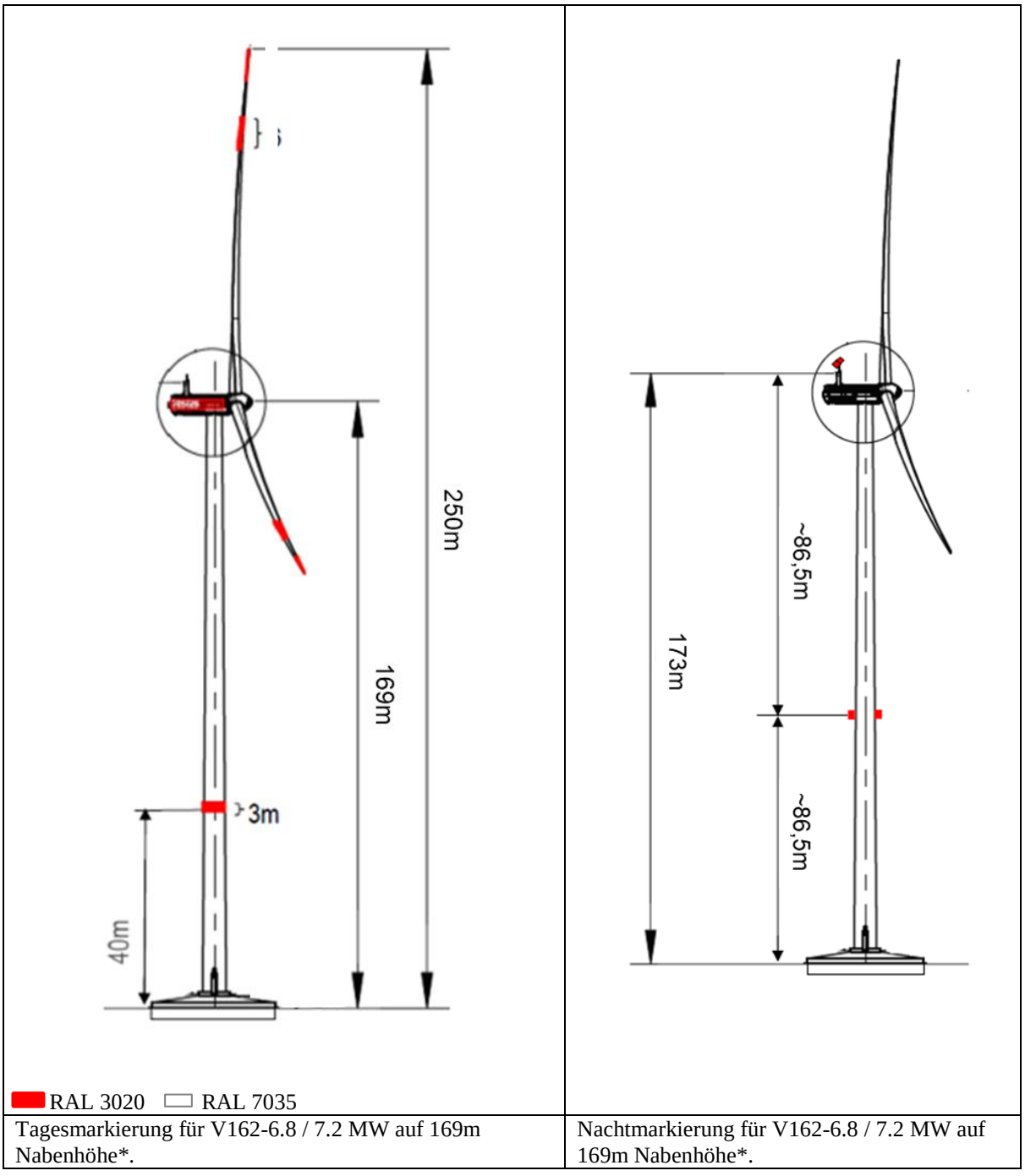
*Die gleichen Zeichnungen gelten für den Fall der Umsetzung einer bis zu 3m hohen Fundamenterhöhung.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

2.7.2. 169m Nabenhöhe (250m Spitzenhöhe)



Tagesmarkierung für V162-6.8 / 7.2 MW auf 169m Nabenhöhe*.

Nachtmarkierung für V162-6.8 / 7.2 MW auf 169m Nabenhöhe*.

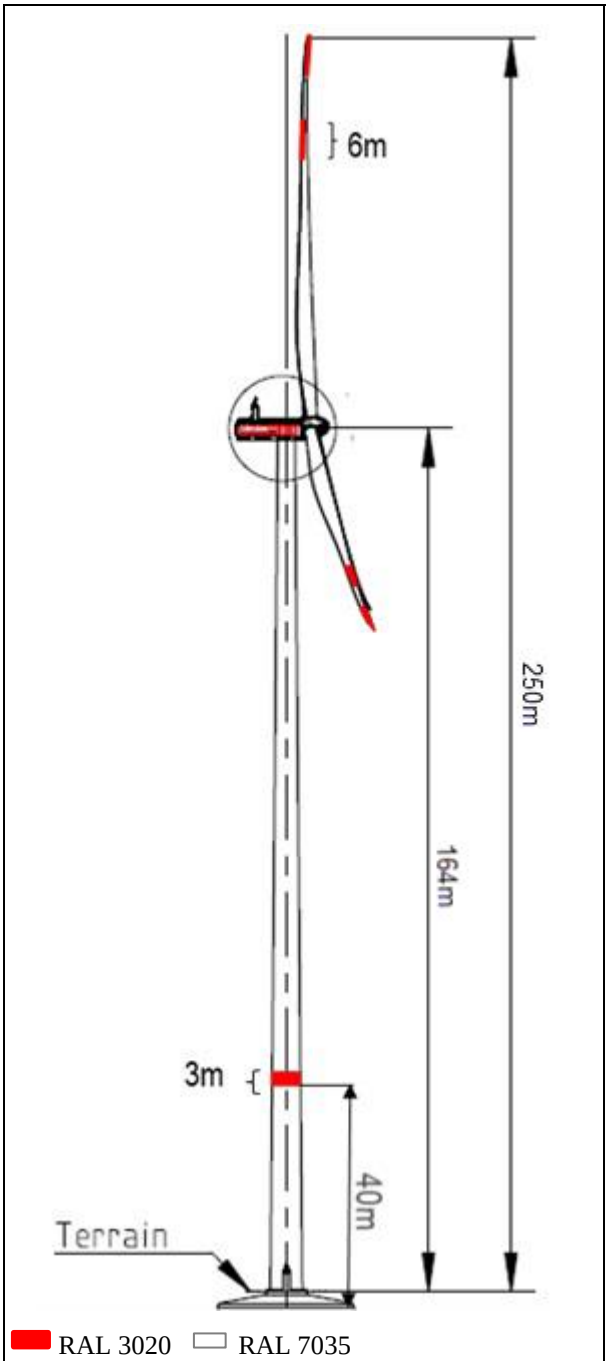
T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

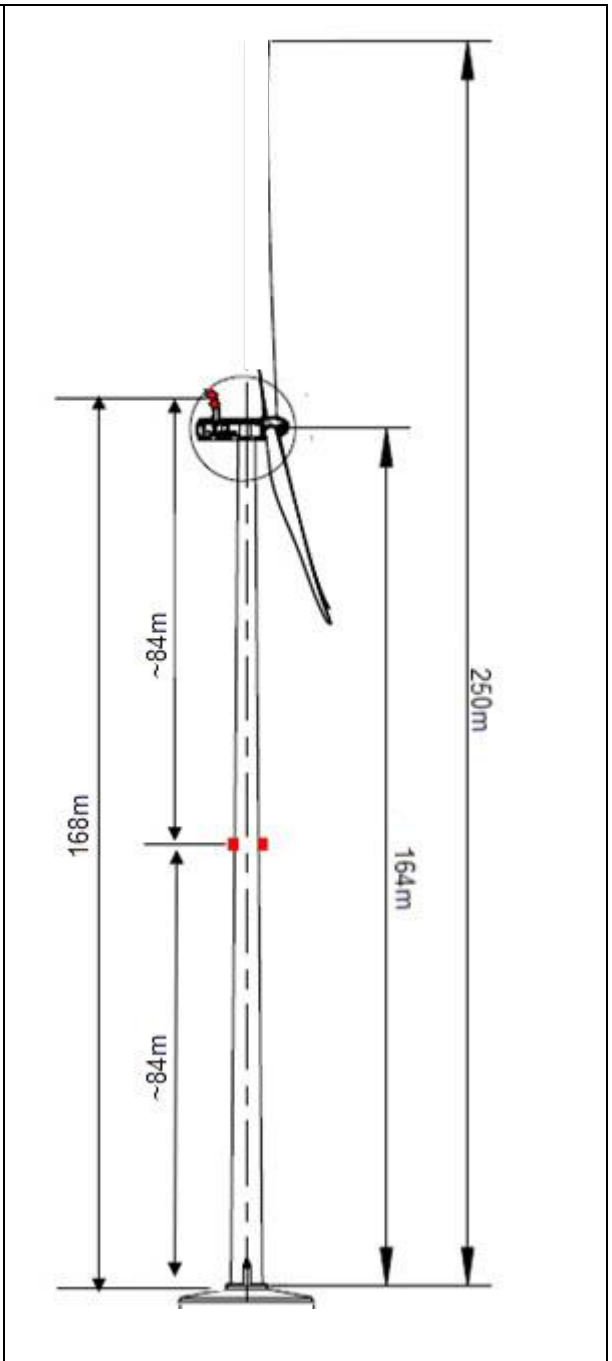
VESTAS PROPRIETARY NOTICE

2.8. V172-7.2MW

2.8.1. 164m Nabenhöhe (250m Spitzenhöhe)



Tageskennzeichnung für die V172-7.2 MW auf 164m Nabenhöhe



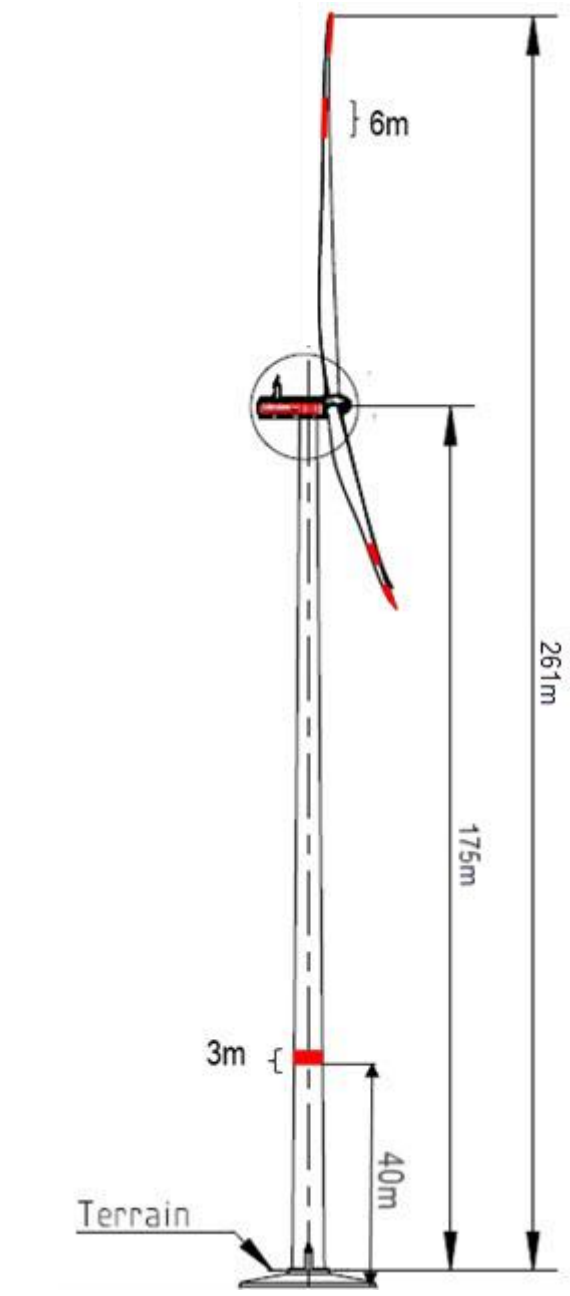
Nachtkennzeichnung für die V172-7.2 MW auf 164m Nabenhöhe

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

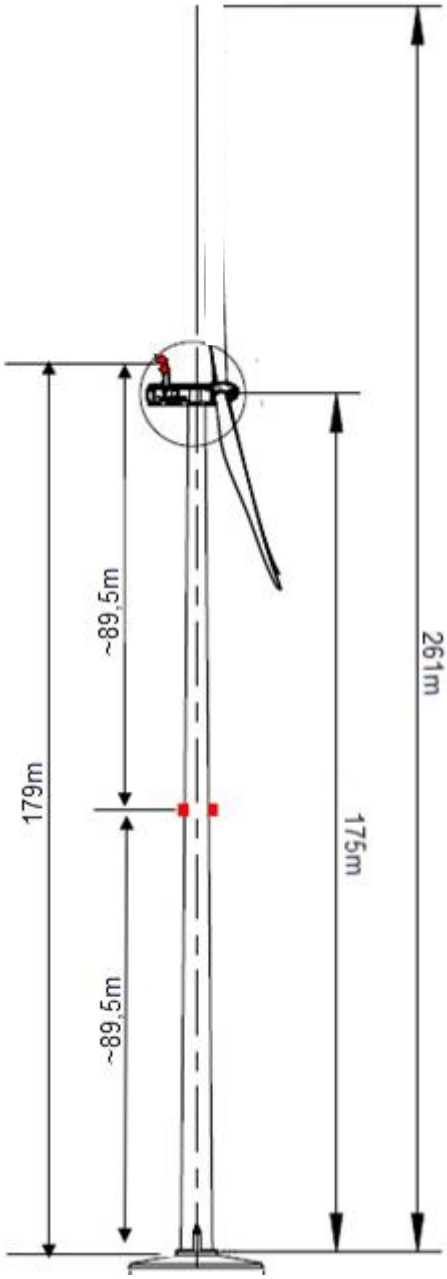
VESTAS PROPRIETARY NOTICE

2.8.2. 175m Nabenhöhe (261m Spitzenhöhe)



RAL 3020 RAL 7035

Tagesmarkierung für V172-7.2 MW auf 175m Nabenhöhe.



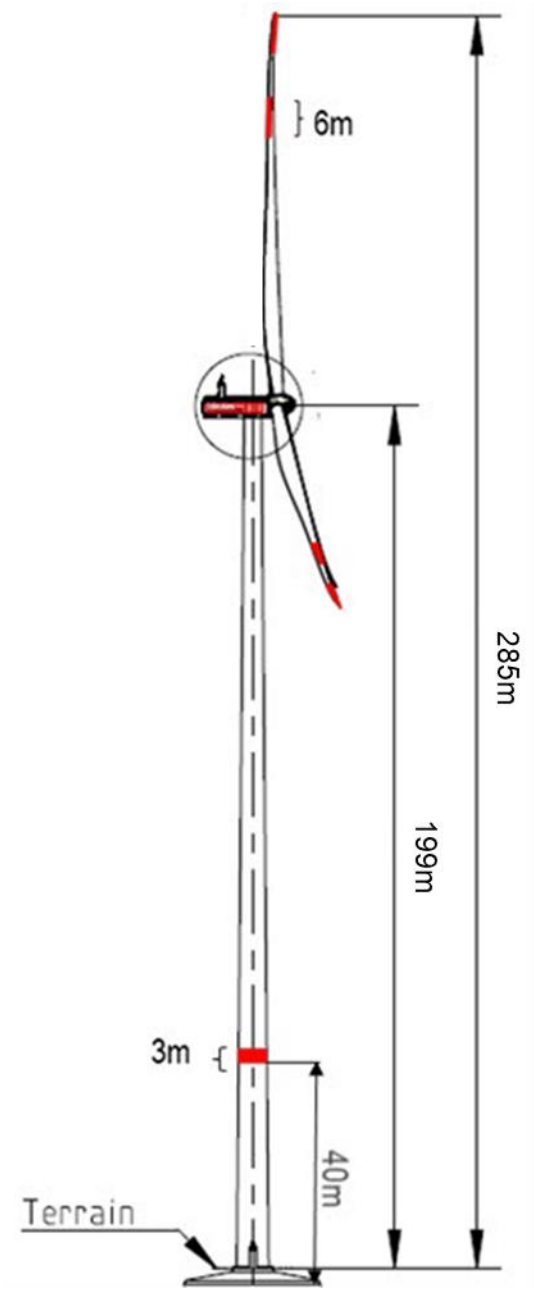
Nachtmarkierung für V172-7.2 MW auf 175m Nabenhöhe.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

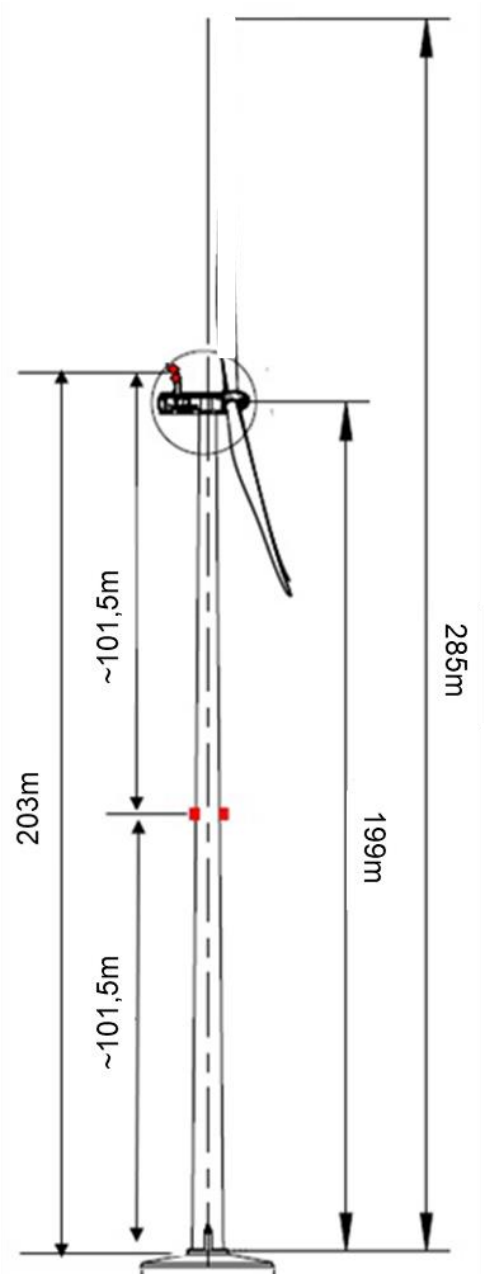
VESTAS PROPRIETARY NOTICE

2.8.3. 199m Nabenhöhe (285m Spitzenhöhe)



RAL 3020 RAL 7035

Tagesmarkierung für V172-7.2 MW auf 199m Nabenhöhe.



Nachtmarkierung für V172-7.2 MW auf 199m Nabenhöhe.

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

3. Verweise

[1] Allgemeine Verwaltungsvorschrift zur Kennzeichnung von Luftfahrthindernissen

Link Banz AT 30.04.2020 B4

Aufgerufen: Mai 2020

[2] 0097-1016 / 0092-1230 / 0101-2404 / 0097-6802 Vestas-Spezifikation für Feuer W, rot und Feuer W, rot ES in Kombination mit einer Infrarotbefeuerung (Maschinenhausbefeuerung)

[3] 0082-3013 Vestas-Spezifikationen für Turmbefeuerung

[4] 0055-7838 Vestas-Spezifikation für Sichtweitenmessgerät

[5] 0040-8699 Vestas-Spezifikation für USV

QMS 00091 VER 00

T05 0049-8134 Ver 23 - Approved- Exported from DMS: 2022-12-09 by INVOL

Classification: Public

Copyright © - Vestas Wind Systems A/S, Alsvej 21, 8940 Randers SV, Danemark, www.vestas.com

VESTAS PROPRIETARY NOTICE

Restricted
Dokument Nr.: 0040-0154 V04
2018-08-02

Notbeleuchtung an Vestas Windenergieanlagen

Allgemeine Spezifikation

T05 0040-0154 Ver 04 - Approved - Exported from DMS: 2018-08-21 by INVOL

Vestas Restricted. Vestas Document. This document is the property of Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret, and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Inhalt

1 Allgemeines..... 3
2 Technische Beschreibung 3

Dies Dokument ist gültig für den Vertriebsbereich von Vestas Central Europe.

T05 0040-0154 Ver 04 - Approved - Exported from DMS: 2018-08-21 by INVOL

VESTAS PROPRIETARY NOTICE

1 Allgemeines

VESTAS-Windenergieanlagen werden mit einer Notbeleuchtung geliefert.

Dadurch wird sichergestellt, dass im Falle eines Stromausfalles (z.B. Netzfehler) die vorhandene Beleuchtung in Turm und Maschinenhaus weiterhin funktioniert.

Sollten sich in dieser Zeit z.B. Servicemonteure in der WEA aufhalten, wird dadurch auch bei Spannungslosigkeit ein gefahrloser Ab- oder Aufstieg im Turm gewährleistet.

2 Technische Beschreibung

Zur technischen Realisierung werden der Turm und das Maschinenhaus mit Feuchtraumwannenleuchten ausgestattet. Bei einem Ausfall der Versorgungsspannung wird **unverzüglich** auf die USV umgeschaltet, sodass das Leuchtmittel mit Spannung versorgt wird.

Die Beleuchtung liefert mindestens 10 Lux auf den Fluchtwegen im Turm und im Maschinenhaus. Die Notbeleuchtung erreicht gemäß EN 50172 innerhalb von 5 Sekunden 50% und innerhalb von 60 Sekunden 100% der erforderlichen Lichtintensität.

Die Überbrückungszeit beträgt mindestens 30 Minuten.

Die Wiederaufladezeit, bei konstantem Strom, beträgt maximal 24 Stunden.

T05 0040-0154 Ver 04 - Approved - Exported from DMS: 2018-08-21 by INVOL

VESTAS PROPRIETARY NOTICE

Restricted
Dokument-Nr.: 0040-8699.V07
2021-03-08

Allgemeine Spezifikation Gefahrenfeuer

ORGA USV SPS60



2MW	V90-1.8/2.0 MW Mk 8–9	V90-3.0 MW Mk 1–9
	V100-1.8/2.0/2.2 MW Mk 10	V110-1.8/2.0/2.2 MW Mk 10
	V116-2.0 MW Mk 11B	V120-2.0/2.2 MW Mk 11C
3MW	V105-3.3/3.45 MW Mk 2–3	V112-3.3/3.45 MW Mk 2–3*
	V117-3.3/3.45 MW Mk 2–3*	V126-3.3/3.45 MW Mk 2–3*
	V126-3.45/3.6 MW Mk 3**	V136-3.45/3.60 MW Mk 3
4MW	V117-4.0/4.2 MW Mk 3E	V136-4.0/4.2 MW Mk 3E
	V150-4.0/4.2 MW Mk 3E	
EnVentus	V150-5.6MW	V150-6.0MW
	V162-5.6MW	V162-6.0MW

* für Deutschland ist hier die 3MW Anlagenplattform in der Ausführung Backwards-Compatible (BWC) eingeschlossen
** beschreibt die Version HTq in der Plattform

T05 0040-8699 Ver 07 - Approved- Exported from DMS: 2021-03-19 by INVOL

Document Owner: 2021-03-19 Uncontrolled when downloaded or printed. This document is subject to version control in Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Version Nr.	Datum	Beschreibung der Änderungen
04	2018-04-10	Tabelle der Windenergieanlagentypen aktualisiert
05	2020-02-22	Aktualisiert mit Datentabelle Aktualisiert mit neuen Beispielen für die theoretische Laufzeit-und Berechnungswerkzeug
06	2020-05-08	Aktualisierter Anhang A mit aktualisierten Lösungen für die deutsche AVV '2020-Regelung
07	2021-03-08	Ergänzung und Anpassung der tabellarischen Auflistung der Windenergieanlagentypen

Inhaltsverzeichnis

1 Referenzen ... 3
2 Abkürzungen und technische Begriffe ... 3
3 Einleitung ... 3
4 Allgemeine Beschreibung ... 4
4.1 Daten zur Gefahrenfeuer-USV ... 4
4.2 Funktion ... 4
4.3 Montagevorschriften ... 5
5 Abmessung ... 5
6 USV-Laufzeit ... 6
7 Hardware ... 6
8 Prüfung und Bescheinigung ... 7
9 Anhang A: Theoretische Laufzeit ... 8

T05 0040-8699 Ver 07 - Approved- Exported from DMS: 2021-03-19 by INVOL

1 Referenzen

Nummer	Dateiname
0073-1976	Zeitberechnungswerkzeug für die USV-Option des Luftfahrthilfesystems (AAS)

Tabelle 1-1: Referenzen

2 Abkürzungen und technische Begriffe

Abkürzung	Erklärung
SCADA	Supervisory Control and Data Acquisition (System zur Prozesssteuerung und Datenerfassung)
USV	Unterbrechungsfreie Stromversorgung
WEA	Windenergieanlagen

Tabelle 2-1: Abkürzungen und technische Begriffe

3 Einleitung

Dieses Dokument beschreibt die USV-Option für Gefahrenfeuer (Aviation Light Optional UPS) für Vestas-WEA. Die durch Vestas gelieferte USV-Option für Gefahrenfeuer ist vollständig in das elektrische System der WEA integriert.

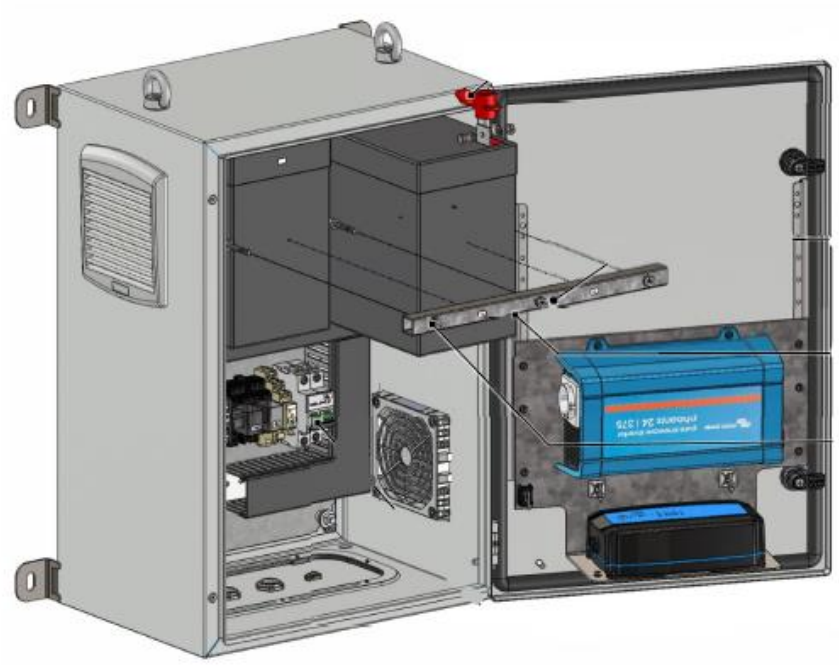


Abbildung 1 – USV-Option für Gefahrenfeuer

T05 0040-8699 Ver 07 - Approved- Exported from DMS: 2021-03-19 by INVOL

4 Allgemeine Beschreibung

Die USV-Option für Gefahrenfeuer versorgt das Luftfahrthilfesystem bei einem Stromausfall mit Strom.

Die USV-Option für Gefahrenfeuer wird durch den Hersteller von Flugbefeurerungssystemen ORGA bereitgestellt. Die USV ist eine unabhängige Einheit. Für sie bestehen keinerlei Anwendungseinschränkungen hinsichtlich der Hersteller. Die Einheit kann herstellerunabhängig mit den meisten Systemen zusammenarbeiten.

4.1 Daten zur Gefahrenfeuer-USV

Parameter	Wert
Artikelnummer von Vestas	29060846
Vestas Typenbezeichnung	Batterie-Hilfssystem
Typenbezeichnung Lieferant	Batterie-Hilfssystem SPS60
USV-Kapazität	60 Ah bei 20 °C
Batteriespannung	24 V_{DC}
Eingangsspannung	180–256 V_{AC}
Eingangsfrequenz	50–60 Hz
Ausgangsspannung	230 VAC +/- 3 %
Ausgangsfrequenz	50 Hz +/- 1 %
Ausgangsleistung	375 VA – 300 W/260 W
Betriebstemperaturbereich	-20 °C bis +40 °C
Umweltschutzklasse	IP54
Abmessungen in mm (L x B x H)	600 x 400 x 300
Gewicht	72 kg

Tabelle 4-1: Technische Daten

4.2 Funktion

Die USV-Option für Gefahrenfeuer versorgt das Luftfahrthilfesystem bei einem Stromausfall mit Strom. Bei installierter USV-Option für Gefahrenfeuer wird das Luftfahrthilfesystem kontinuierlich durch den USV-Schrank mit Strom versorgt. Ein Schaltgerät in der USV-Einheit schaltet bei einem Netzausfall von netzgestützter auf batteriegestützte Stromversorgung um. Die Schaltzeit von der Netzstromversorgung auf Batterieversorgung beträgt 1,5 s.

Die Laufzeit der Reservestromversorgung hängt von der Batteriekapazität und der Konfiguration des Luftfahrthilfesystems ab. Die USV-Option für Gefahrenfeuer ist eine Hilfseinheit, die integriert werden muss, wenn die erforderliche Reserveversorgungslaufzeit des Luftfahrthilfesystems 15 min. übersteigt.

T05 0040-8699 Ver 07 - Approved- Exported from DMS: 2021-03-19 by INVOL

Classification: Restricted
VESTAS PROPRIETARY NOTICE

4.3 Montagevorschriften

Die USV-Option für Gefahrenfeuer wird mit allen erforderlichen Montage- und Installationselementen ausgeliefert. Die USV-Option für Gefahrenfeuer wird mit Magneten am Turm befestigt.

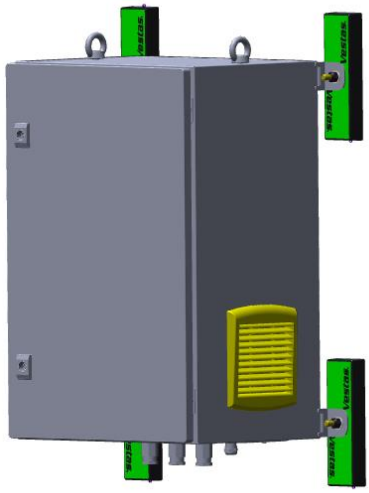


Abbildung 1 – USV-Option für Gefahrenfeuer – Anbringung

5 Abmessung

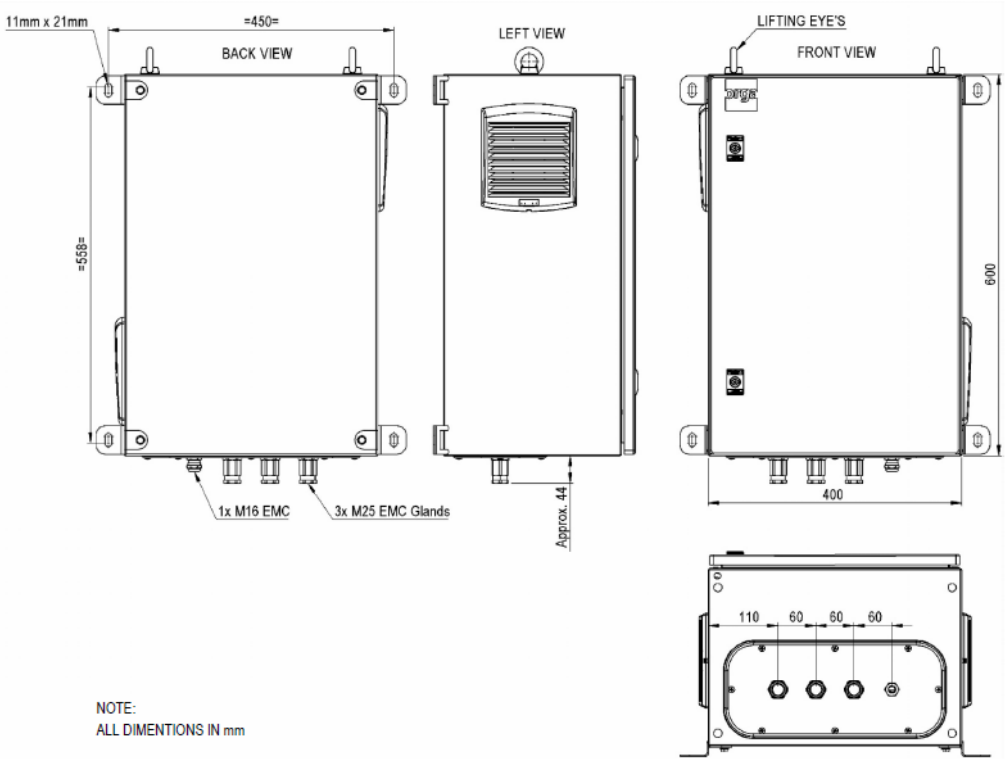


Abbildung 3 – USV-Option für Gefahrenfeuer – Abmessungen

T05 0040-8699 Ver 07 - Approved- Exported from DMS: 2021-03-19 by INVOL

6 USV-Laufzeit

Die Laufzeiten der USV werden als maximale theoretische Laufzeiten berechnet, ausgehend von vollständig geladenen Akkus in gutem Zustand bei einer optimalen Temperatur von 15–35 °C.

Laufzeiten für ausgewählte Konfigurationen sind in Kapitel 9 angegeben.

Die theoretische Laufzeit muss für jede Konfiguration berechnet werden, damit die Laufzeitwerte so genau wie möglich sind. Vestas verfügt über ein Werkzeug zur Berechnung der theoretischen Laufzeit für verschiedene Lösungen mit der USV-Option für Gefahrenfeuer, die Bestandteil der Produktpalette sind. Hierbei handelt es sich um das Zeitberechnungswerkzeug für die USV-Option des Luftfahrthilfesystems (AAS) (Optional UPS Time Calculation Tool) mit der Dokumenten-Management-System-Nummer: 0073-1976.

Die berechnete Reservelaufzeit ist ein theoretischer Wert. Bei Unklarheiten oder Fragen hinsichtlich der berechneten theoretischen Laufzeit im Vergleich zur erforderlichen Reservelaufzeit wenden Sie sich bitte an Ihren Ansprechpartner bei Vestas.

7 Hardware

Die USV besteht aus mehreren Batterien, einem Ladegerät und einem Wechselrichter. Diese Komponenten sind im Schaltschrank der USV-Option für Gefahrenfeuer integriert.

T05 0040-8699 Ver 07 - Approved- Exported from DMS: 2021-03-19 by INVOL

Classification: Restricted
VESTAS PROPRIETARY NOTICE

8 Prüfung und Bescheinigung

EU-Declaration of Conformity

Orga BV
Strickliedeweg 13
3125 AT Schiedam
The Netherlands

Postal address
P.O. Box 3046
3101 EA Schiedam
The Netherlands

+31 (0)10 208 5555
+31 (0)10 437 8445

info@orga.nl
www.orga.nl

Wij, Orga BV, verklaren geheel onder eigen verantwoordelijkheid dat het product
We, Orga BV, declare under sole responsibility that the product

BATTERY BACKUP SYSTEM type SPS60

waarop deze verklaring betrekking heeft, in overeenstemming is met de volgende norm(en) en andere normatie(f)(ve) document(en):
to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

NEN-EN-IEC 61000-6-2 : 2005
NEN-EN-IEC 61000-6-3 : 2007/ A1: 2011/ C11: 2012
NEN-EN-IEC 61439-1 : 2011

In overeenstemming met de volgende (bepaling(en) (indien van toepassing):
Following the provisions of directive(s) (if applicable):

EMC-RICHTLIJN: 2014/30/EU
EMC-DIRECTIVE: 2014/30/EU

LAAGSPANNINGS-RICHTLIJN: 2014/35/EU
LOW VOLTAGE DIRECTIVE: 2014/35/EU

Schiedam, 07/08/2019

P. Voorwald-Slijder
Compliance Manager

CE

T05 0040-8699 Ver 07 - Approved- Exported from DMS: 2021-03-19 by INVOL

9 Anhang A: Theoretische Laufzeit

Nachstehend einige Beispiele unterschiedlicher Gefahrenfeuerkonfigurationen, deren theoretische Laufzeit (Reservelaufzeit in Stunden) berechnet wurde. Um zu gewährleisten, dass die Reservelaufzeit für die ausgewählte Gefahrenfeuerkonfiguration so zutreffend wie möglich ist, müssen bei jeder Berechnung das Werkzeug und die tatsächlichen Artikelnummern verwendet werden. Zeitberechnungswerkzeug für die USV-Option des Luftfahrthilfesystems (AAS) mit der Dokumenten-Management-System-Nummer: 0073-1976.

KONFIGURATION mit Akku SPS60 (60 Ah) Artikel 29060846				
Menge	**Artikelnummern * (unterschiedliche Nummern aufgrund abweichender Plattformen)**	**Artikelbezeichnung**	**Beschreibung**	**Backup-Zeit in Stunden**
1	29053375, 29152737,	L550-63B-G	**1 Maschinenhausbeleuchtung rot (2000 cd, „Blinkmodus“ Nacht)**	50
1	106671	OVP-S30	**Inklusive Steuerung**	
2	29053375, 29152737,	L550-63B-G	**2 Maschinenhausbeleuchtungen rot (2000 cd, „Blinkmodus“ Nacht)**	31
1	29057115	CIP400	**Inklusive Steuerung**	
1	29052778, 29152725,	L550-63A/63B-G	**1 Maschinenhausbeleuchtung rot/weiß (20.000 cd weiß Tag/2000 cd rot Nacht)**	33
1	106671	OVP-S30	**Inklusive Steuerung**	
2	29052778, 29152725,	L550-63A/63B-G	**2 Maschinenhausbeleuchtungen rot/weiß (20.000 cd weiß Tag/2000 cd rot Nacht)**	18
1	29057115	CIP400	**Inklusive Steuerung**	
2	29197892, 29197879,	L240-GFW-IRG-G-BR	**2 Maschinenhausbeleuchtungen mit geringer Intensität, rot (Feuer W. + IR Nacht)**	53
1	29057116	CIP400-O-MV		
1	29127389	Kit Set AL Tow 1-4-L92-AVV-ES	**einschl. Regler** **1 Reihe, 4 Leuchten Turmbeleuchtung (10 cd Turmbeleuchtung)**	

T05 0040-8699 Ver 07 - Approved- Exported from DMS: 2021-03-19 by INVOL

KONFIGURATION mit Akku SPS60 (60 Ah) Artikel 29060846				
Menge	**Artikelnummern * (unterschiedliche Nummern aufgrund abweichender Plattformen)**	**Artikelbezeichnung**		
2	29197893, 29197891,	L550-GFW-ES-IRG-G	**2 Maschinenhausbeleuchtungen rot (Feuer W. ES + IR Nacht)** **einschl. Regler** **1 Reihe, 4 Leuchten Turmbeleuchtung, (10 cd Turmbeleuchtung)**	40
1	29057116	CIP400-O-MV		
1	29127389	Kit Set AL Tow 1-4-L92-AVV-ES		
2	29199127	L550-63Adt/ L240-GFW-IRG-G	**2 zweifarbige Lichtlösungen (20 000 cd weiß Tag/Feuer W Nacht)** **einschl. Regler** **1 Reihe, 4 Leuchten Turmbeleuchtung,**	18
1	29057116	CIP400-O-MV		
1	29127389	Kit Set AL TOW 1-4-L92-AVV-ES		
2	29199122	L550-63Ad/ L550-GFW-ES-IRG-G	**2 zweifarbige Lichtlösungen (20 000 cd weiß Tag/Feuer W ES Nacht)** **einschl. Regler** **1 Reihe, 4 Leuchten Turmbeleuchtung,**	16
1	29057116	CIP400-O-MV		
1	29127389	Kit Set AL TOW 1-4-L92-AVV-ES		
2	29016790, 29152745,	L500-63B2/63C2-IRF	**2 Maschinenhausbeleuchtungen weiß und zweifarbig weiß/rot (50.000 cd weiß Tag/10000 weiß/rot Dämmerung/Nacht)** **einschl. Regler** **2 Reihen, 4 Leuchten Turmbeleuchtung inkl. Infrarot (10 cd Turmbeleuchtung + IR)**	10
1	29057115	CIP400		
1	29127382	KIT SET AL TOW 2-4-L92-62A-IRF		

Artikelnummer: Aufgrund der unterschiedlichen Plattformen kann eine Beleuchtung unterschiedliche Artikelnummern haben, je nach Plattform, zu der die Leuchte passt. Abweichende Artikelnummern aufgrund dieser Unterschiedlichkeit deuten nicht die Anzahl der in der Berechnung verwendeten Leuchten hin. Die in der Berechnung verwendete Anzahl Leuchten steht in der Spalte „Menge“.

T05 0040-8699 Ver 07 - Approved- Exported from DMS: 2021-03-19 by INVOL

Eingeschränkte Weitergabe
Dokumentennr.: 0055-7838 V05
27.04.2022

Allgemeine Spezifikation Gefahrenfeuer

ORGA SWS 200-N-AC



Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com

Uncontrolled when printed. Document is only valid for the day of printing. Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

Version Nr.	Datum	Beschreibung der Änderungen
05	27.04.2022	Neue Normen und Zertifikate hinzugefügt

Inhaltsverzeichnis

1 Abkürzungen und technische Begriffe ... 3
2 Einführung ... 3
3 Allgemeine Beschreibung ... 3
3.1 Daten des Gefahrenfeuers ... 3
3.2 Montage des Sichtweitensensors (SWS200-N-AC) ... 4
3.3 Betriebsstrategie ... 4
3.4 Hauptfunktionen ... 5
4 Blitzschutz ... 5
4.1 Kabel ... 5
5 Abmessung ... 6
5.1 Maßstabsgetreue Zeichnung ... 6
5.2 Systemübersicht ... 8
6 Zertifikate und Prüfberichte ... 11

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

1 Abkürzungen und technische Begriffe

Abkürzung	Erklärung
EMV	Elektromagnetische Verträglichkeit
OVP	Überspannungsschutz

Tabelle1:1 Abkürzungsverzeichnis

Laufzeit	Erklärung
Keiner	

Tabelle 1 2: Erklärung von Fachbegriffen

2 Einführung

In diesem Dokument wird der Wetter-Sichtweitensensor (SWS200-N-AC), der speziell für den Einsatz mit der Steuerung CIP400-O-MV oder CIP402-22-R des Gefahrenfeuersystems (ORGA) entwickelt wurde, beschrieben.

3 Allgemeine Beschreibung

Der Sichtweitensensor (SWS200-N-AC) für das Gefahrenfeuer (ORGA) passt die Betriebshelligkeit des Gefahrenfeuers (ORGA) an die aktuell vorherrschenden Sichtbedingungen an.

3.1 Daten des Gefahrenfeuers

Parameter	Wert
Artikelnummer von Vestas	29058870 / 29152729
Vestas-Typenbezeichnung	Sichtweitenmessgerät SWS-200-N-AC
Typenbezeichnung Lieferant	SWS200-N-AC
Entspricht	RoHS und WEEE
Eingangsspannung	120 - 240 VAC
Eingangsfrequenz	50–60 Hz
Energieverbrauch	11 W (bei Enteisung +39 W)
Betriebstemperaturbereich (°C)	-40 °C bis +60 °C
Umweltschutzklasse	IP66
Betriebsfeuchte	0 – 100 % rF
EMV-Übereinstimmung	Mit EN 61326-1997, 1998, 2001
Messbereich (wählbar)	2-10-20-32-50 km
Messfehler	Weniger als 10 % bei 2 km
Misst die Sichtbarkeit	Meteorologische Reichweite: Nebel
Misst auch	Dunst, Rauch, Sand, Nieselregen, Regen, Schnee

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com

VESTAS PROPRIETARY NOTICE

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

Parameter	Wert
Niederschlagserkennungsauflösung	Regen: 0,015 mm/h Schnee: 0,0015 mm/h
Maximale Regenstärke	250 mm/h
Abmessungen in mm (L x B x H)	811 x 270 x 375
Gewicht (kg)	5 kg ohne Kabel

Tabelle 3-1: Technische Daten

3.2 Montage des Sichtweitensensors (SWS200-N-AC)

Der Sichtweitensensor (SWS200-N-AC) ist oben auf dem Maschinenhaus montiert, und die erweiterte Systemsteuerung CIP400-O-MV oder CIP402-22 ist für seine Steuerung erforderlich.



Abbildung 3-1: Sichtweitensensor (SWS 200-N-AC)

3.3 Betriebsstrategie

Der Sichtweitensensor (SWS200-N-AC) misst die in der Luft enthaltenen Partikel. Es besteht eine positive Korrelation zwischen der Partikelanzahl und der Signalstärke des Empfängers. Die tatsächliche lokale Sichtweite wird an die Steuerung des Gefahrenfeuers (ORGA) übermittelt und die Lichtstärke wird dann entsprechend angepasst. Siehe Tabelle 3-2 auf Seite 4.

Die Steuerung CIP400-O-MV oder CIP402-22-R ist für den Sichtweitensensor (SWS200-N-AC) erforderlich, um die Betriebshelligkeit des Gefahrenfeuers an die gegenwärtig herrschenden Sichtbedingungen anzupassen.

Sichtweite [km]	Lichtstärke [%]
<5	100
5–10	30
>10	10

Tabelle 3-2: Lichtintensitätsstufen

Der Sichtweitensensor (SWS200-N-AC) nutzt das Prinzip der Vorwärtsstreuung und misst die Sichtverhältnisse am Standort der Windenergieanlage. Siehe Abbildung 3 2 auf Seite 5.

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com

VESTAS PROPRIETARY NOTICE

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

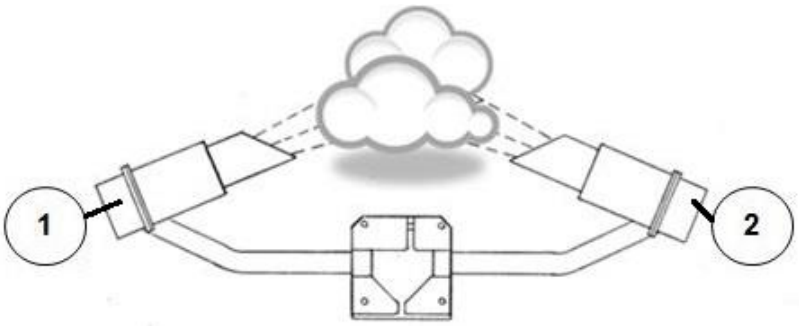


Abbildung 3 2:*Sender und Empfänger*

1 Sender **2** Empfänger

3.4 Hauptfunktionen

Die Hauptmerkmale des Sichtweitensensors (SWS200-N-AC) sind:

- Kompakter Wetter-Sichtweitensensor (SWS200-N-AC), der speziell für den Einsatz mit der Steuerung CIP400-O-MV oder CIP402-22-R des Gefahrenfeuersystems (ORGA) entwickelt wurde.
- Einstellbare Betriebshelligkeit des Gefahrenfeuers
- Wählbarer Messbereich
- Erweiterte Selbsttest- und Wartungsinformationen

4 Blitzschutz

Zusätzlich zu den strengen Testnormen und dem eingebauten OVP erfüllt oder übertrifft das Gefahrenfeuer (ORGA) die gängigen Industrienormen hinsichtlich EMV und Blitzschutz.

4.1 Kabel

Der Sichtweitensensor (SWS200-N-AC) verfügt über ein (1) Kabel, das sowohl als Netz- als auch als Datenkabel dient.

- Standardlänge: 15 m
- Abmessungen: 14,5 mm
- Maximaler Biegeradius: 116 mm

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com

VESTAS PROPRIETARY NOTICE

5 Abmessung

5.1 Maßstabsgetreue Zeichnung

Für die Abmessungen des Sichtweitensensors (SWS200-N-AC) siehe Abbildung 5-1, Seite 6, und Abbildung 5 2, Seite 7.

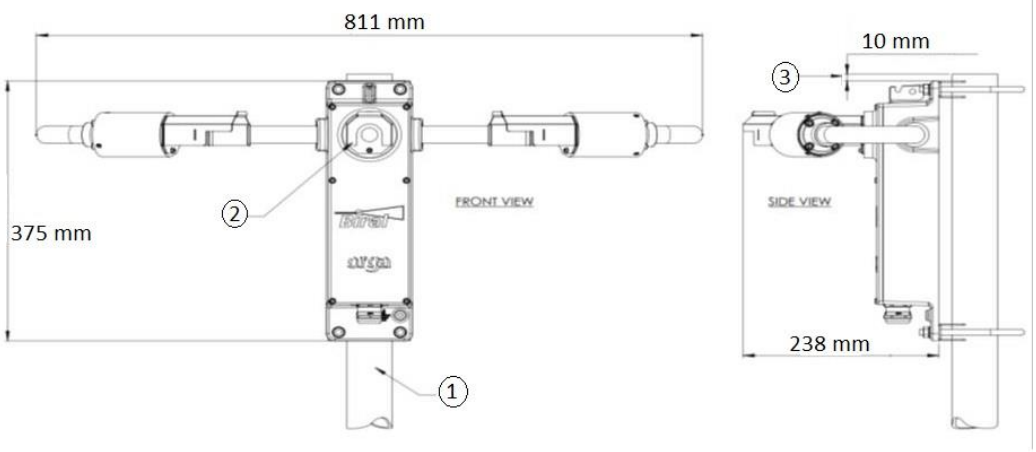


Abbildung 5-1*: Abmessungen des Sichtweitensensors (SWS200-N-AC)*

1 Im Lieferumfang enthalten: Montagemast, Außendurchm.: min. 40 mm, max. 63,5 mm

2 Montierter Streukopf

3 Max. Abstand zwischen Mastspitze und Sensorkopf

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com

VESTAS PROPRIETARY NOTICE

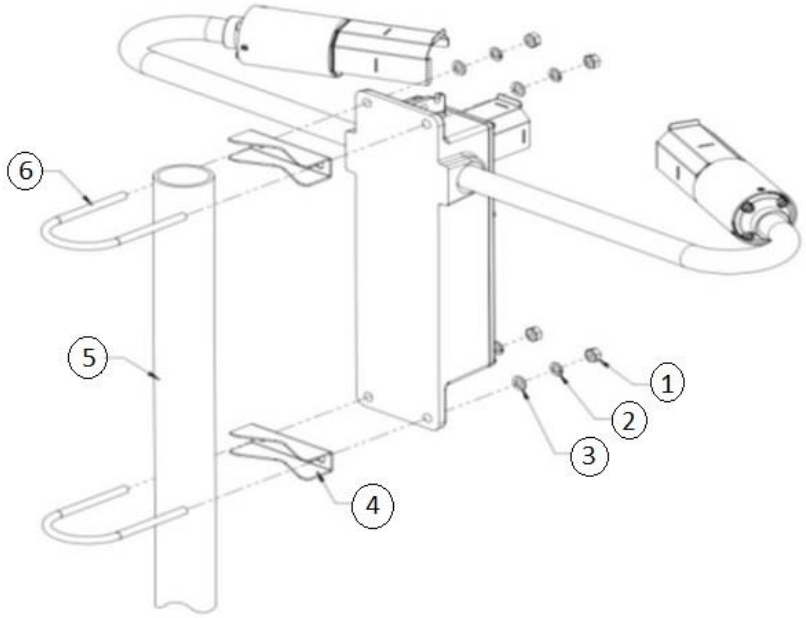


Abbildung 5 2:*Komponenten des Sichtweitensensors (SWS200-N-AC)*

1	4 x M8 Schraubenmutter	**2**	4 x M8 Spannscheibe
3	4 x M8 Unterlegscheibe	**4**	2 x Sättel (Sättel müssen befestigt werden)
5	Montagemast	**6**	2 x U-Schrauben

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com

VESTAS PROPRIETARY NOTICE

5.2 Systemübersicht

Für eine Übersicht über das System CIP400 siehe Abbildung 5-3 und Abbildung 5-4.

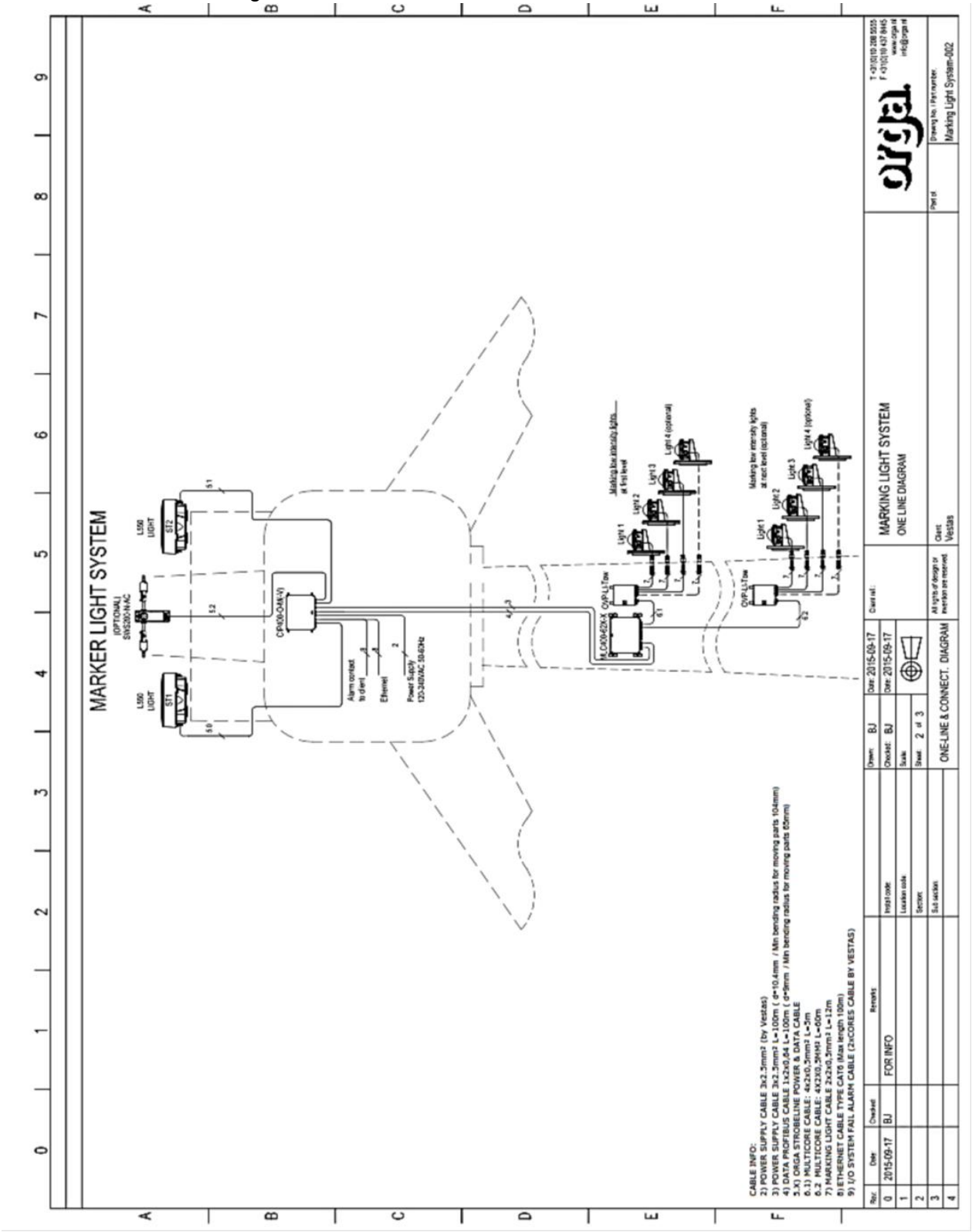


Abbildung 5-3: Markierungsleuchtensystem, Einzelleitungsdiagramm

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com
VESTAS PROPRIETARY NOTICE

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

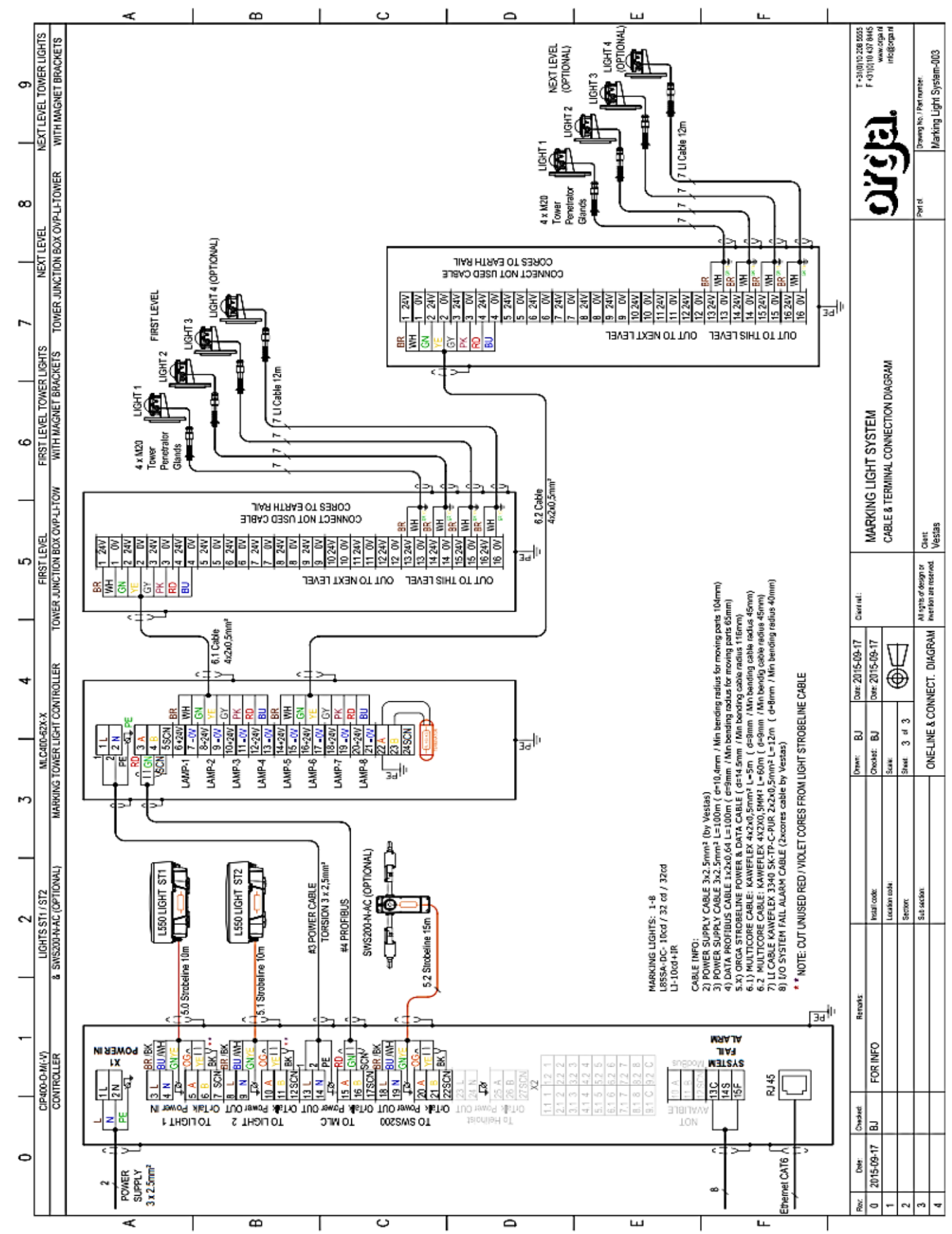


Abbildung 5-4: Markierungsleuchtensystem, Kabel- und Klemmen-Anschlussdiagramm

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com

VESTAS PROPRIETARY NOTICE

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Siehe Abbildung 5-5: Systemübersicht CIP402-22-R

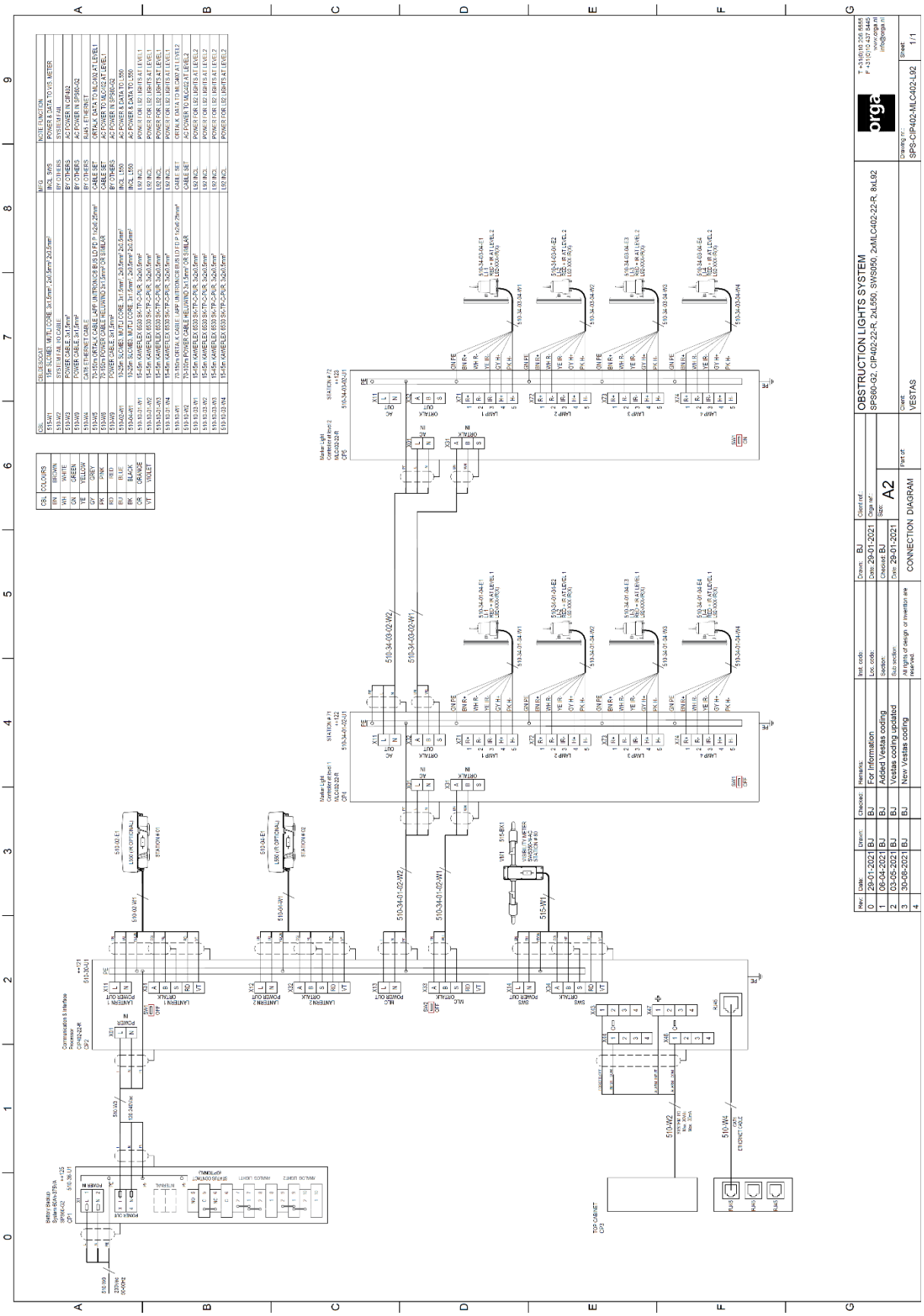


Abbildung 5-5: Markierungsleuchtensystem, Kabel- und Klemmen-Anschlussdiagramm System CIP402-22-R

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

6 Zertifikate und Prüfberichte

Nicht harmonisierte Normen.

orga

EU-Declaration of Conformity

Orga BV
Strickledeweg 13
3125 AT Schiedam
The Netherlands

Postal address
P.O. Box 3046
3101 EA Schiedam
The Netherlands

+31 (0)10 208 5555
+31 (0)10 437 8445

info@orga.nl
www.orga.nl

Wij, Orga BV, verklaren geheel onder eigen verantwoordelijkheid dat het product
We, Orga BV, declare under sole responsibility that the product

VISIBILITY SENSOR type SWSxxx-N-AC

waarop deze verklaring betrekking heeft, in overeenstemming is met de volgende norm(en) en andere normatie(f)(ve) document(en):
to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

NEN-EN-IEC 61000-6-2 : 2019
NEN-EN-IEC 61000-6-4 : 2007
IEC 61000-6-4 : 2018
NEN-EN-IEC 61439-1: 2011

In overeenstemming met de volgende (bepaling(en) (indien van toepassing):
Following the provisions of directive(s) (if applicable):

EMC-RICHTLIJN: 2014/30/EU
EMC-DIRECTIVE: 2014/30/EU

LAAGSPANNINGS-RICHTLIJN: 2014/35/EU
LOW VOLTAGE DIRECTIVE 2014/35/EU

Schiedam, 30/07/2019

P. Voorwald-Snijder
Compliance Manager

CE

EG085 SWSxxx-N-AC_R02

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com
VESTAS PROPRIETARY NOTICE

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

Harmonisierte Normen.

EU-Declaration of Conformity

Deze conformiteitsverklaring wordt afgegeven onder volledige verantwoordelijkheid van de fabrikant Orga B.V..
This declaration of conformity is issued under the sole responsibility of the manufacturer Orga B.V..

Voorwerp van de verklaring:
Object of the declaration:

VISIBILITY SENSOR type SWSxxx-N-AC

Het hierboven beschreven voorwerp van de verklaring is in overeenstemming met de desbetreffende harmonisatiewetgeving van de Unie:
The object of the declaration described above is in conformity with the relevant Union harmonisation legislation:

EMC-RICHTLIJN: 2014/30/EU
EMC-DIRECTIVE: 2014/30/EU

LOW VOLTAGE DIRECTIVE: 2014/35/EU
LOW VOLTAGE DIRECTIVE 2014/35/EU

Relevante geharmoniseerde norm(en) en andere normatieve documenten:
Relevant harmonised standard(s) or other normative document(s):

EN 61000-6-2 : 2005 + AC : 2005
EN 61000-6-4 : 2007 + A1 : 2011
EN 61439-1 : 2011

Schiedam, 22/11/2021

P. Voorwald-Snijder
Compliance Manager

EG058 SWSxxx-NA-C_R05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com

VESTAS PROPRIETARY NOTICE



Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Deutscher Wetterdienst - Frahmredder 95 22393 Hamburg

Bristol Industrial & Research Associates Ltd,
PO Box 2, Portishead,
Bristol
BS20 7JB
United Kingdom

Measuring Systems Division (TI 23)

Contact Person:
Dr. Bernd Mergardt
Telephone:
+49 (0)69 8062 6500
E-Mail:
bernd.mergardt@dwd.de

Reference Number:
TI23b
Fax:
+49 (0)69 8061-6507

Hamburg - Sasel, 12 October 2018

Dear Sir or Madam,

With reference to your enquiry regarding the period of validity of the DWD approval certificates for visibility sensors on obstacles to air navigation, we hereby confirm that our certificates of approval for the BIRAL visibility sensors SWS 050, SWS 100, SWS 200 and VPF 700/710 used on obstacles to air navigation are still valid.
The validity will expire with immediate effect if a new hard- or software is employed that changes the specifications of a sensor to such an extent that its properties no longer meet the requirements set out by the Deutscher Wetterdienst (DWD) and prescribed by the German federal legislative bodies.

You will find a list of these requirements and relevant information enclosed to this letter.

Yours sincerely

Deutscher Wetterdienst
Wetter und Klima aus einer Hand
Messsysteme, TI 23
Postfach 30 11 90, 20304 Hamburg

Dr. Bernd Mergardt
Head of Division TI23

Deutscher Wetterdienst (German Meteorological Service)
Measuring Systems Division TI23

Frahmredder 95
D-22393 Hamburg
Tel.: +49 (0)69 8062 6500
Fax: +49 (0)69 8062 6507

E-mail: bernd.mergardt@dwd.de
http://www.dwd.de

www.dwd.de
Dienstgebäude: Frankfurter Str. 135 - 63067 Offenbach am Main, Tel. 069 / 8062 - 0
Kontoverbindung: Bundeskasse Trier - Deutsche Bundesbank, Filiale Saarbrücken - Kto-Nr.: 59001020 - BLZ: 590 000 00
Der Deutsche Wetterdienst ist eine teilrechtsfähige Anstalt des öffentlichen Rechts im Geschäftsbereich des Bundesministeriums für Verkehr, Bau und Stadtentwicklung.
Das Qualitätsmanagement des DWD ist zertifiziert nach DIN ISO 9001:2015 (Reg.-Nr. 10700813 ZER-QMS)

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com

VESTAS PROPRIETARY NOTICE

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

DWD

Information Sheet

Acceptance of Visual Range Sensors according to the "General Administrative Regulation for the Marking and Lighting of Obstacles to Air Navigation" of the Federal Republic of Germany, Printed Matter 506/04 of 16 June 2004

For automatic determination of the visual range, internationally commonly known as "Meteorological Optical Range (MOR)" at its weather stations, the Deutscher Wetterdienst (DWD) uses measuring devices that operate using the forward scatter method. These devices have to meet a fixed range of requirements specified in an official catalogue.
These requirements take account of national and international definitions and recommendations and are in line with the latest standards of measuring technology.

List of references:

- WMO No. 8, 1996, Geneva, Guide to Meteorological Instruments and Methods of Observations
- VDI 3786 Blatt 6, Beuth Verlag, Berlin 1983, Meteorologische Messungen für Fragen der Luftreinhaltung; Trübung der bodennahen Atmosphäre, Normsichtweite (Meteorological Measurements of Air Pollution, Turbidity of Ground-Level Atmosphere, Standard Visibility)
- DWD, Offenbach 1998, Vorschriften und Betriebsunterlagen, Band 3 (Regulations and Documents of Operation, Volume 3)

If, by inspection of the technical documents for a visual range sensor, the DWD finds that a device is basically suitable for determining the visual range according to the General Administrative Regulation for the Marking and Lighting of Obstacles to Air Navigation, the device will be officially accepted for such use. Examination of documents (User Manual, Maintenance and Installation Manual, collected data, etc.) will be carried out following an informal request to the DWD.

Acceptance by the DWD solely refers to the fact that the device with the properties specified by the manufacturer is appropriate for the given use. The DWD will not make any laboratory or field tests nor carry out any regular inspections. The manufacturer is responsible for ensuring that the device complies with the properties specified whereas it is the users' responsibility to obey the manufacturer's instructions for operation and maintenance.

The DWD excludes any liability for damages that may possibly result from using the device.

Zertifikat seit 2011 audit berufundfamilie

www.dwd.de
Dienstgebäude: Frankfurter Str. 135 - 63067 Offenbach am Main, Tel. 069 / 8062 - 0
Kontoverbindung: Bundeskasse Trier - Deutsche Bundesbank, Filiale Saarbrücken - Kto-Nr.: 59001020 - BLZ: 590 000 00
Der Deutsche Wetterdienst ist eine teilrechtsfähige Anstalt des öffentlichen Rechts im Geschäftsbereich des Bundesministeriums für Verkehr, Bau und Stadtentwicklung.
Das Qualitätsmanagement des DWD ist zertifiziert nach DIN ISO 9001:2015 (Reg.-Nr. 10700813 ZER-QMS)

Vestas Wind Systems A/S · Hedeager 42 · 8200 Aarhus N · Dänemark · www.vestas.com
VESTAS PROPRIETARY NOTICE

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Appendix 1: Quotations from the Administrative Regulations:

Printed Matter 506/04 of 16 June 2004
"General Administrative Regulation for the Marking and Lighting of Obstacles to Air Navigation""

Printed Matter 214/15 of 20 May 2015
"General Administrative Regulation amending the General Administrative Regulation for the Marking and Lighting of Obstacles to Air Navigation"

14.2 If the visual range is more than 5000 m, the nominal luminous intensity may be reduced to 30%, and if the visual range is more than 10 km, it may be reduced to 10%. The visual range shall be determined in accordance with Annex 2.

17.4 If the visual range is more than 5000 m, the nominal luminous intensity of the hazard beacons may be reduced to 30%, and if the visual range is more than 10 km it may be reduced to 10%. The visual range shall be determined in accordance with Annex 2.

Annex 2 Visual range measurement

Pursuant to the German standard DIN 5037 Page 2, the visual range shall be determined as meteorological visual range by means of a device certified by the Deutscher Wetterdienst (DWD). In the case of wind turbine blocks/wind parks in sea areas, the visual range instruments have to be installed along the outer edges and at the corners of the block/wind park.
The distance between a wind turbine with visual range measuring device and wind turbines without visual range measuring device shall not be more than 1500 m. The visual range measuring devices shall be installed close to the generator housing. The least favourable value of all measuring devices shall be used for the entire block/wind park. If one of the measuring devices fails, all beacon lights shall be operated at full power (100%). The data concerning the functioning and the results of the visual range measuring devices shall be recorded continuously. The records shall be retained for a minimum of four weeks.

The functioning of the lighting controls shall be examined by an independent institution before the lighting system is put into service. The examination protocol shall be submitted to the authorising authority.

www.dwd.de
Dienstgebäude: Frankfurter Str. 135 - 63067 Offenbach am Main, Tel. 069 / 8062 - 0
Kontoverbindung: Bundeskasse Trier - Deutsche Bundesbank, Filiale Saarbrücken - Kto-Nr.: 59001020 - BLZ: 590 000 00
Der Deutsche Wetterdienst ist eine teilrechtsfähige Anstalt des öffentlichen Rechts im Geschäftsbereich des Bundesministeriums für Verkehr, Bau und Stadtentwicklung.
Das Qualitätsmanagement des DWD ist zertifiziert nach DIN ISO 9001:2015 (Reg.-Nr. 10700813 ZER-QMS)

VESTAS PROPRIETARY NOTICE

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0055-7838 VER 05

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Appendix 3: Requirements to be met by a visual range sensor (specimen)

Manufacturer: Company XYZ
Type of device: ABC Sensor
Version number: Hardware x.xx, Software y.yy, (Date of manufacture)

	Minimum requirement	Specified	Met? (yes/no)
Measuring principle	Forward scatter		
Measuring range	50m to 20km		
Resolution	< Measurement uncertainty>		
Measurement uncertainty **range < 500m** **range 500-5000m** **range > 5000m**	 ± 50m ± 10% ± 20%		
Outdoor temperature range	-30°C to +50°C		
Outdoor humidity range	0 to 100 % RH		
IP protection class	min. IP54		
Report and output interval	adjustable		
Protection against interference of extraneous light (sunlight, artificial light, ground albedo)	existent		
Measures against snow and ice accretion on the optical devices	existent		
Maintenance interval	≥ 6 Months		
Self-testing (transmitter, light source, receiver, electronics, condition of window)	existent		
Compensation of performance reduction and pollution	existent		
Output of status reports	existent		
Temporal averaging	adjustable		
Adjustable time range	<60sec at 90% of sudden change		
CE identification	existent		

www.dwd.de
Dienstgebäude: Frankfurter Str. 135 - 63067 Offenbach am Main, Tel. 069 / 8062 - 0
Kontoverbindung: Bundeskasse Trier - Deutsche Bundesbank, Filiale Saarbrücken - Kto-Nr.: 59001020 - BLZ: 590 000 00
Der Deutsche Wetterdienst ist eine teilrechtsfähige Anstalt des öffentlichen Rechts im Geschäftsbereich des Bundesministeriums für Verkehr, Bau und Stadtentwicklung.
Das Qualitätsmanagement des DWD ist zertifiziert nach DIN ISO 9001:2015 (Reg.-Nr. 10700813 ZER-QMS)

VESTAS PROPRIETARY NOTICE

T05 0055-7838 Ver 05 - Approved- Exported from DMS: 2022-11-04 by INVOL

Eingeschränkte Weitergabe
Dokumentennr.: 0082-3013 V03
13.10.2021

Allgemeine Spezifikation

Gefahrenfeuer – Turm

KIT SET AL TOW 1-4-L92-AVV-ES



Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

Document owned by Vestas and/or its suppliers, subsuppliers or customers. This document contains valuable confidential information of Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Version Nr.	Datum	Beschreibung der Änderungen
03	13.10.2021	EU-Konformitätserklärung für L92 hinzugefügt

Inhaltsverzeichnis

1 Haftungsausschluss ... 3
2 Abkürzungen und Fachbegriffe ... 3
3 Abkürzungen und Fachbegriffe ... 3
4 Allgemeine Beschreibung ... 4
4.1 Komponentenübersicht ... 4
4.2 Kabel ... 5
4.3 Daten des Turm-Gefahrenfeuers ... 6
4.4 Alarm ... 6
4.5 Hauptfunktionen ... 6
5 Blitzschutz ... 6
6 Abmessung ... 7
6.1 Maßstabsgetreue Zeichnung ... 8
7 Zertifikate und Prüfberichte ... 9

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

1 Haftungsausschluss

- © 2017 Vestas Wind Systems A/S. Dieses Dokument wurde von Vestas Wind Systems A/S und/oder einer der Tochtergesellschaften des Unternehmens erstellt und enthält urheberrechtlich geschütztes Material, Markenzeichen und andere geschützte Informationen. Alle Rechte vorbehalten. Das Dokument darf ohne vorherige schriftliche Erlaubnis durch Vestas Wind Systems A/S weder als Ganzes noch in Teilen reproduziert oder in irgendeiner Weise oder Form (grafisch, elektronisch oder mechanisch, einschließlich Fotokopien, Bandaufzeichnungen oder mittels Datenspeicherungs- und Datenzugriffssystemen) vervielfältigt werden. Die Nutzung dieses Dokuments über den ausdrücklich von Vestas Wind Systems A/S gestatteten Umfang hinaus ist untersagt. Marken-, Urheberrechts- oder sonstige Vermerke im Dokument dürfen nicht geändert oder entfernt werden.
- Die allgemeinen Beschreibungen in diesem Dokument gelten für die aktuelle Version der Windenergieanlagen der 2- und 3/4-MW-Plattform. Bei neueren Versionen der Windenergieanlagen der 2- und 3/4-MW-Plattform, die ggf. zukünftig hergestellt werden, gilt u. U. eine andere allgemeine Beschreibung. Falls Vestas eine neuere Version der 2- und 3/4-MW-Plattform-Windenergieanlagen liefern sollte, wird das Unternehmen hierzu eine aktualisierte allgemeine Beschreibung vorlegen.
- Die vorliegende „Allgemeine Spezifikation“ stellt kein Verkaufsangebot dar. Sie beinhaltet keine Garantie oder Zusage und auch keine Prüfung der Leistungskurve bestimmter Optionen.

2 Abkürzungen und Fachbegriffe

Abkürzung	Erklärung
EMV	Elektromagnetische Verträglichkeit
GPS	Global Positioning System (Globales Positionierungssystem)
OVP	Überspannungsschutz
SCADA	System zur Prozesssteuerung und Datenerfassung
IR	Infrarot

Tabelle 2 1: Abkürzungen

3 Abkürzungen und Fachbegriffe

Dieses Dokument beschreibt die Optionen für Turm-Gefahrenfeuer bei Vestas-Windenergieanlagen. Die von Vestas gelieferten Turm-Gefahrenfeuer sind vollständig in die Elektrik und das SCADA-Überwachungssystem integrierte mechanische Montageoptionen.

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

4 Allgemeine Beschreibung

Das Turm-Gefahrenfeuersystem verfügt über folgende Komponenten:

- Steuereinheit (MLC400)
- Anschlusskasten OVP-LI-TOW (Überspannungsschutzeinheit)
- Turmbeleuchtung (L92-xxx)
- Kabel für den Anschluss aller Elemente
- Mit Magneten befestigte Montagehalterungen

Die Turmbeleuchtung (L92) ist ein konstant leuchtendes Gefahrenfeuer mit geringer Lichtstärke. Die Turmbeleuchtungen (L92) sind rund um den Turm auf Halterungen montiert, welche mittels Magneten befestigt sind.

Die Steuereinheit (MLC400) wird mit einer 230-V-Wechselstromversorgung von der CIP400-Einheit betrieben. Die Steuereinheit (MLC400) besitzt einen integrierten Transformator. Der integrierte Transformator hat eine 230-V-Wechselstrom-Primärversorgung und eine 24-V-Gleichstrom-Sekundärversorgung. Die Turmbeleuchtung (L92) wird mit 24 V Gleichspannung versorgt.

4.1 Komponentenübersicht



Abbildung 4-1

Steuerung MLC400 für Markierungsleuchten, bis zu vier Stück

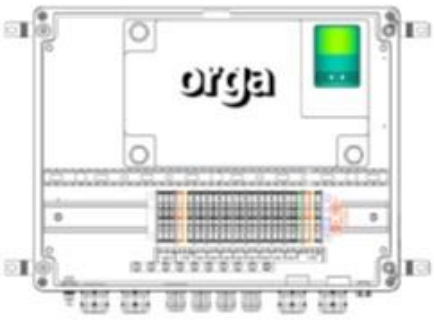


Abbildung 4-2

Interne Ansicht der Steuereinheit (MLC400)

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03



Abbildung 4-3:
Anschlusskasten OVP-LI-TOW (mit Überspannungsschutz) für Turmbeleuchtungen (L92)

Für jede Ebene ist ein Anschlusskasten OVP-LI-TOW erforderlich.

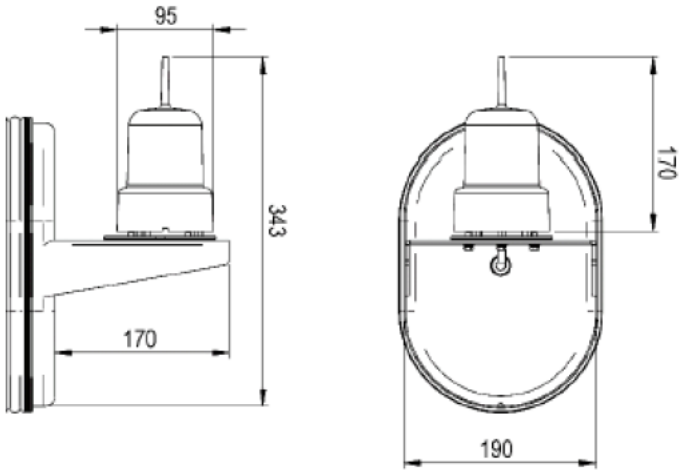


Abbildung 4-4: Turmbeleuchtung (L92)

4.2 Kabel

- Stromkabel von CIP zu MLC: 3 x 2,5 mm^2.
- Der Querschnitt der Profibus-Datenkabel von CIP zu MLC beträgt 2 x 0,25 mm^2.

VESTAS PROPRIETARY NOTICE

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

- Stromkabel von MLC zu einer Turmbeleuchtung (L92): 2 x 2 x 0,5 mm^2.
- Stromkabel vom Anschlusskasten OVP-LI-TOW zur Turmbeleuchtung (L92) 2 x 2 x 0,5 mm.

4.3 Daten des Turm-Gefahrenfeuers

Parameter	Wert für Einzelleuchte
Artikelnummer von Vestas	29127389
Typ	KIT SET AL TOW 1-4-L92-AVV-ES
Standard	ICAO, AVV
Betriebsspannung	24 VDC
Energieverbrauch sichtbares Licht	3 W pro Leuchte
Energieverbrauch MLC400	3 W
Intensität Rotes Licht	10 cd
Horizontale Lichtverteilung	>180°
Überspannungsschutzklasse	IEC 61643-1
Betriebstemperaturbereich	-40 °C bis +55 °C
Umweltschutzklasse	IP66
Blinkt ein Mal pro Minute	Leuchtet kontinuierlich
Farbe	Rot

Tabelle 4 1: Technische Daten

4.4 Alarm

Das Turm-Gefahrenfeuer erhält über einen Profibus-Anschluss ein Alarmsignal, das in der CIP400-Einheit erkannt und verwendet werden kann.

4.5 Hauptfunktionen

- Eine Turm-Gefahrenfeuer-Ebene besteht aus vier Turmbeleuchtungen (L92) von geringer Intensität und mit Halterungen auf jeder Ebene.
- Strom und alarmgeschirmte Kabel.
- Über die Turmbeleuchtung gesteuerte Integration mit der CIP400-Einheit.
- In das Bedienfeld integrierter Überspannungsschutz.

5 Blitzschutz

Das Gefahrenfeuersystem erfüllt mindestens die gängigen Industrienormen hinsichtlich EMV und Blitzschutz. Neben den hohen Prüfnormen verfügt die Einheit über einen eingebauten Überspannungsschutz.

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

6 Abmessung

Abmessungen L92:

- Die Länge (L) des Gefahrenfeuers beträgt 92 mm.
- Die Breite (B) des Gefahrenfeuers beträgt 95 mm.
- Die Höhe (H) des Gefahrenfeuers beträgt 170 mm.

Abmessungen des MLC400: Siehe Abbildung 6-1, S. 7.

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

6.1 Maßstabsgetreue Zeichnung

Abbildung 4-4 auf S. 5 zeigt das maßstabsgetreue Bild der Turmbeleuchtung (L92).

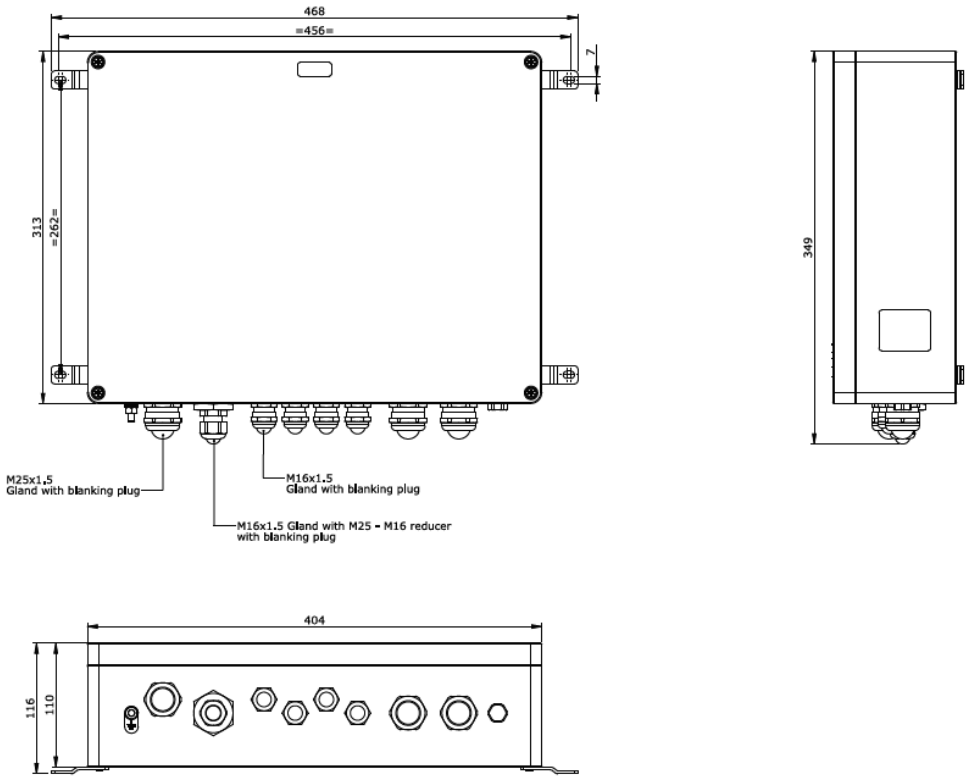


Abbildung 6-1:

Steuerung MLC400
für Markierungsleuchten, bis zu vier Stück

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

7 Zertifikate und Prüfberichte

Dieses Dokument wurde in Übereinstimmung mit den Anforderungen des ICAO-



EU-Declaration of Conformity

Orga BV
Strickledeweg 13
3125 AT Schiedam
The Netherlands

Postal address
P.O. Box 3046
3101 EA Schiedam
The Netherlands

+31 (0)10 208 5555
+31 (0)10 437 8445

info@orga.nl
www.orga.nl

Wij, Orga BV, verklaren geheel onder eigen verantwoordelijkheid dat het product
We, Orga BV, declare under sole responsibility that the product

MARKER LIGHT CONTROLLER type MLC400

waarop deze verklaring betrekking heeft, in overeenstemming is met de volgende norm(en) en andere normatie(f)(ve) document(en):
to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

NEN-EN-IEC 61000-6-2 : 2019
NEN-EN-IEC 61000-6-4 : 2019
NEN-EN-IEC 61439-1 : 2011
NEN-EN-IEC 61439-2 : 2011
NEN-EN 50581 : 2012

In overeenstemming met de volgende (bepaling(en) (indien van toepassing):
Following the provisions of directive(s) (if applicable):

EMC-RICHTLIJN: 2014/30/EU
EMC-DIRECTIVE: 2014/30/EU

LAAGSPANNINGS-RICHTLIJN: 2014/35/EU
LOW VOLTAGE DIRECTIVE: 2014/35/EU

RoHS-RICHTLIJN: 2011/65/EU
RoHS-DIRECTIVE: 2011/65/EU

Schiedam, 10/09/2019

P. Vogrwald-Snijder
Compliance Manager

CE

EG047 MLC400_R05

Standards erstellt.

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

EU-Declaration of Conformity

Orga BV
Strickledeweg 13
3125 AT Schiedam
The Netherlands

Postal address
P.O. Box 3046
3101 EA Schiedam
The Netherlands

+31 (0)10 208 5555
+31 (0)10 437 8445

info@orga.nl
www.orga.nl

Wij, Orga BV, verklaren geheel onder eigen verantwoordelijkheid dat het product
We, Orga BV, declare under sole responsibility that the product

AERONAUTICAL OBSTRUCTION LIGHT type L92-XXX-E

waarop deze verklaring betrekking heeft, in overeenstemming is met de volgende norm(en) en andere normatie(f)(ve) document(en):
to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

NEN-EN-IEC 61000-6-2 : 2019
NEN-EN-IEC 61000-6-4 : 2019
NEN-EN-IEC 60598-1 : 2021
NEN-EN 50581 : 2012

In overeenstemming met de volgende (bepaling(en) (indien van toepassing):
Following the provisions of directive(s) (if applicable):

EMC-RICHTLIJN: 2014/30/EU
EMC-DIRECTIVE: 2014/30/EU

LAAGSPANNINGS-RICHTLIJN: 2014/35/EU
LOW VOLTAGE DIRECTIVE: 2014/35/EU

RoHS Richtlijn: 2011/65/EG
ROHS DIRECTIVE: 2011/65/EC

Schiedam, 28/07/2021

P. Voorwald-Snijder
Compliance Manager

CE

EG045L92_R05

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0082-3013 VER 03

WASSERSTRAßEN- UND SCHIFFFAHRTSVERWALTUNG DES BUNDES
Fachstelle der WSV für Verkehrstechniken

WSV.de

Zertifikat
nach Nr. 28 der Allgemeinen Verwaltungsvorschrift zur Kennzeichnung von Luftfahrthindernissen (AVV Kennzeichnung) zur Vorlage bei der zuständigen Genehmigungsbehörde nach dem Luftverkehrsgesetz

Art des Feuers	Hindernisfeuer / Hindernisfeuer ES
	Low Intensity Type A
Hersteller	**Orga BV**
	Strickledeweg 13
	NL-3125 AT Schiedam
Typenbezeichnung	**L92-AVV-ES-E**
	L92-AVV-ES

Aufgrund der technischen Überprüfung durch die Fachstelle der Wasserstraßen- und Schifffahrtsverwaltung für Verkehrstechniken vom 03.05.2017 wird festgestellt, dass das vorgestellte Produktmuster des oben bezeichneten Leuchtentyps den lichttechnischen Anforderungen gemäß AVV Kennzeichnung in der Fassung vom 26. August 2015 (BAnz AT 01.09.2015 B4, vom 01.09.2015) und den Standards und Empfehlungen des Anhangs 14 Band I Tabelle 6.1 und 6.3, Ausgabe 6, vom Juli 2013, des Chicagoer Abkommens entspricht. Die Ergebnisse der lichttechnischen Prüfung sind im Prüfbericht LS198, vom 09.05.2017 dokumentiert.

Der Leuchtentyp darf, vorbehaltlich einer Änderung der genannten Anforderungen und unter Einhaltung eventueller Vorgaben auf Grund des Prüfprotokolls, zur Kennzeichnung von Luftfahrthindernissen verwendet werden.

Koblenz, den 26.06.2017

FACHSTELLE DER WSV FÜR VERKEHRSTECHNIKEN BEIM WSA KOBLENZ

(Strenge)

VESTAS PROPRIETARY NOTICE

T05 0082-3013 Ver 03 - Approved- Exported from DMS: 2021-12-21 by INVOL

Eingeschränkte Weitergabe
Dokumentennr.: 0092-1230 V03
24.01.2023

Allgemeine Spezifikation Gefahrenfeuer

ORGA AL L240-GFW-IRG-G-BR

Feuer W, Rot Intensität, Rot blinkend/Infrarot blinkend



Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL

Document owner: Vestas Wind Systems A/S. This document is the property of Vestas Wind Systems A/S. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Version Nr.	Datum	Beschreibung der Änderungen
03	24.01.2023	Zertifikat hinzufügen.

Inhaltsverzeichnis

1 Haftungsausschluss ... 3
2 Abkürzungen und Fachbegriffe ... 3
3 Einführung ... 3
4 Allgemeine Beschreibung ... 4
4.1 Daten des Gefahrenfeuers ... 4
4.2 Steuerung ... 5
4.2.1 Überspannungsschutz(OVP)-Schaltschrank ... 5
4.2.2 Erweiterter Schaltschrank ... 5
4.3 GPS und Fotozelle ... 5
4.3.1 GPS ... 5
4.3.2 Fotozelle ... 5
4.4 Notstromversorgung ... 6
5 Blitzschutz ... 6
6 Maße ... 6
7 Erklärungen und Zertifikate ... 7

Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

1 Haftungsausschluss

- © 2017 Vestas Wind Systems A/S. Dieses Dokument wurde von Vestas Wind Systems A/S und/oder einer der Tochtergesellschaften des Unternehmens erstellt und enthält urheberrechtlich geschütztes Material, Markenzeichen und andere geschützte Informationen. Alle Rechte vorbehalten. Das Dokument darf ohne vorherige schriftliche Erlaubnis durch Vestas Wind Systems A/S weder als Ganzes noch in Teilen reproduziert oder in irgendeiner Weise oder Form (grafisch, elektronisch oder mechanisch, einschließlich Fotokopien, Bandaufzeichnungen oder mittels Datenspeicherungs- und Datenzugriffssystemen) vervielfältigt werden. Die Nutzung dieses Dokuments über den ausdrücklich von Vestas Wind Systems A/S gestatteten Umfang hinaus ist untersagt. Marken-, Urheberrechts- oder sonstige Vermerke im Dokument dürfen nicht geändert oder entfernt werden.
- Die vorliegende „Allgemeine Spezifikation“ stellt kein Verkaufsangebot dar. Sie beinhaltet keine Garantie oder Zusage und auch keine Prüfung der Leistungskurve bestimmter Optionen.

2 Abkürzungen und Fachbegriffe

Abkürzung	Erklärung
EMV	Elektromagnetische Verträglichkeit
GPS	Global Positioning System (Globales Positionierungssystem)
OVP	Überspannungsschutz
SCADA	Supervisory Control and Data Acquisition (System zur Prozesssteuerung und Datenerfassung)
USV	Unterbrechungsfreie Stromversorgung
IR	Infrarot
AVV	Allgemeine Verwaltungsvorschrift zur Kennzeichnung von Luftfahrthindernissen
CIP	Communication and Interface Processor (Kommunikations- und Schnittstellenprozessor)

Tabelle 2-1: Abkürzungen

3 Einführung

Dieses Dokument beschreibt die Konfiguration der Gefahrenfeuer bei Vestas Windenergieanlagen. Die von Vestas gelieferten Gefahrenfeuer sind vollständig in die Elektrik und das SCADA-Überwachungssystem integrierte mechanische Montageoptionen.

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL



Abbildung 3-1: Gefahrenfeuer ORGA L240-GFW-IRG-G-BR.

4 Allgemeine Beschreibung

Das bzw. die Gefahrenfeuer sind oben auf dem Maschinenhaus an einer bzw. mehreren Halterung(en) montiert und werden durch die Steuerung der Hinderniskennzeichnung mit Strom versorgt und gesteuert. Daten des Gefahrenfeuers

4.1 Daten des Gefahrenfeuers

Parameter	Wert
Typenbezeichnung Lieferant	L240-GFW-IRG-G-BR
Standard	AVV 2020
Leuchtkraft – Tag	Entf.
Leuchtkraft – Dämmerung	Entf.
Leuchtkraft – Nacht	„Feuer W“ + IR
Farbe – Tag	Entf.
Farbe – Dämmerung	Entf.
Farbe – Nacht	Rot und IR
Blinkverhalten – Tag	Entf.
Blinkverhalten – Dämmerung	Entf.
Blinkverhalten – Nacht	Rot – W-rot-Zyklus; IR – 60 B/min
Vertikale Lichtverteilung (min)	gemäß AVV 2020
Horizontale Lichtverteilung	360°
Intensität IR-Licht	gemäß AVV 2020
IR-Wellenlänge	~850 nm
Leuchtmitteltyp	LED
Eingangsspannung	120 bis 240 VAC
Eingangsfrequenz	50 bis 60 Hz
Energieverbrauch ohne Heizung	1 W Tag/1 W Dämmerung/12 W Nacht
Überspannungsschutz	Klasse III nach IEC 61643-1:
Betriebstemperaturbereich	-40 bis +55 °C
Umweltschutzklasse	IP66

Tabelle 4-1: Technische Daten

Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

4.2 Steuerung

4.2.1 Überspannungsschutz(OVP)-Schaltschrank

Der OVP-Schaltschrank wird verwendet, wenn ein oder zwei Gefahrenfeuer an einer Windenergieanlage erforderlich sind und kein externes Eingangssteuerungssignal benötigt wird. Der OVP-Schaltschrank stellt den Überspannungsschutz für die Wechselstrom-Versorgungsspannung und die Klemmen bereit. Darüber hinaus dient der OVP-Schaltschrank als Schnittstelle für Leistungsstrom und Alarmsignale zwischen der WEA und dem Gefahrenfeuer. Wenn der OVP-Schaltschrank in Betrieb ist, funktioniert die Leuchte als autonome Einheit, die über eine in sie integrierte Steuerung reguliert wird.

4.2.2 Erweiterter Schaltschrank

Der erweiterte Schaltschrank CIP400/402 von Orga wird verwendet, wenn verschiedene Eingangssignale und erweiterte Funktionen des Luftfahrthilfesystems benötigt werden. Die Steuerung CIP400/402 ist mit denselben Klemmen und OVP-Einrichtungen ausgestattet, die auch im OVP-Schaltschrank vorhanden sind. Die Steuerung bietet folgende Funktionen:

- Zeitgleicher Betrieb beider Gefahrenfeuer (Modusänderung Tag/Dämmerung/ Nacht)
- Verarbeitung des Messsignals vom Sichtweitensensor,
- Verarbeitung der externen Steuersignale vom SCADA mithilfe des Ethernet-Anschlusses,
- Verarbeitung von digitalen Signalen der Radar- bzw. Transpondergeräte anderer Hersteller
- Steuerung der Turm-Gefahrenfeuer.

Der erweiterte Schaltschrank CIP400/402 übermittelt die Informationen über den Zustand mithilfe der internen Software der Windenergieanlage.

Das SCADA-System kann so konfiguriert werden, dass die Betriebsstatusmeldungen erfasst werden(aufgelistet in einem TPS-Anhang).

4.3 GPS und Fotozelle

4.3.1 GPS

Das Gefahrenfeuer ist mit einem GPS-Blinkpositionsgeber ausgestattet (nur die Versionen mit „G“ im Artikelnamen, wie beispielsweise: L550-864/865-30/40-**G**), der die Daten des GPS-Satellitensystemsignals verwendet. Alle Gefahrenfeuer blinken, aufeinander abgestimmt, gleichzeitig.

4.3.2 Fotozelle

Die Konfigurationen verfügen über eine integrierte Fotozelle. Diese leitet einen Messwert für die Umgebungslichtintensität an die Steuerung des Luftfahrtsystems weiter, damit die Gefahrenfeuer zwischen Tag-, Dämmerungs- und Nachtmodus umschalten können.

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL

VESTAS PROPRIETARY NOTICE

4.4 Notstromversorgung

Eine USV-Notstromversorgung für das Gefahrenfeuer ist eine Option, die je nach landes- bzw.standortspezifischen Anforderungen gewählt werden kann. Die gewünschte Dauer USV-Notstromversorgung hängt von den landesspezifischen Anforderungen ab.

5 Blitzschutz

Das Gefahrenfeuersystem erfüllt mindestens die gängigen Industrienormen hinsichtlich EMV und Blitzschutz. Zusätzlich zur Einhaltung der strengen Prüfnormen verfügt die Einheit über einen eingebauten Überspannungsschutz.

6 Maße

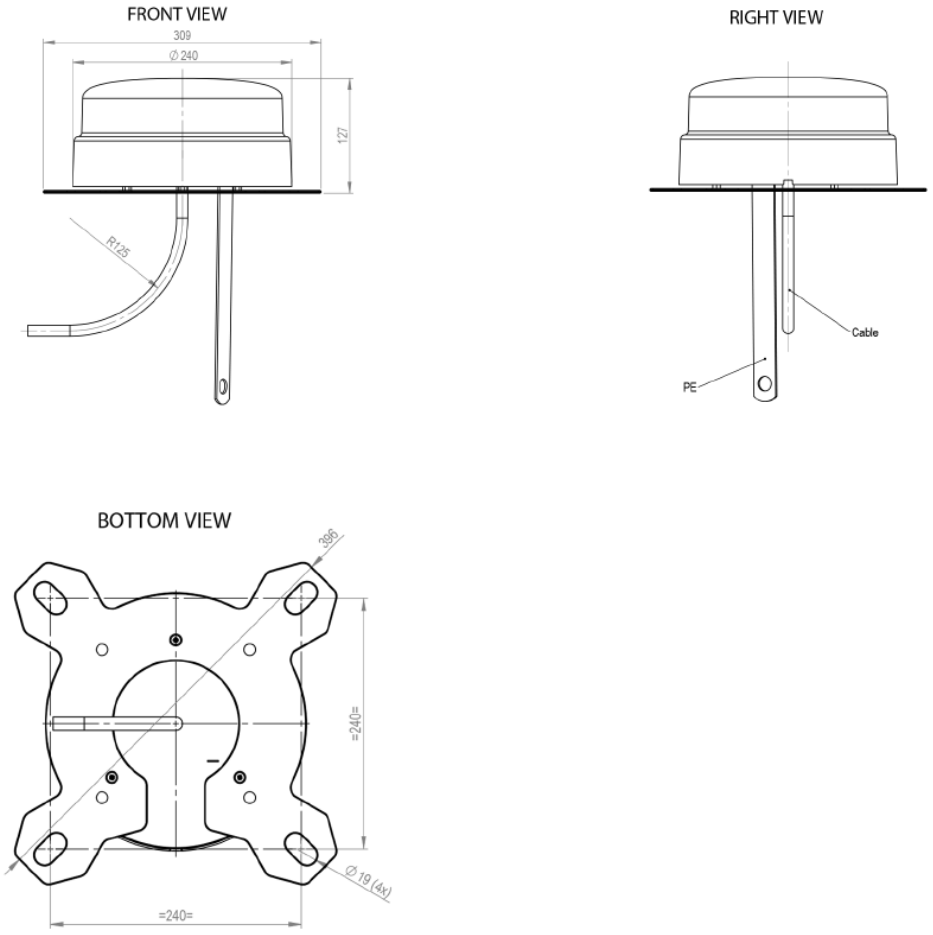


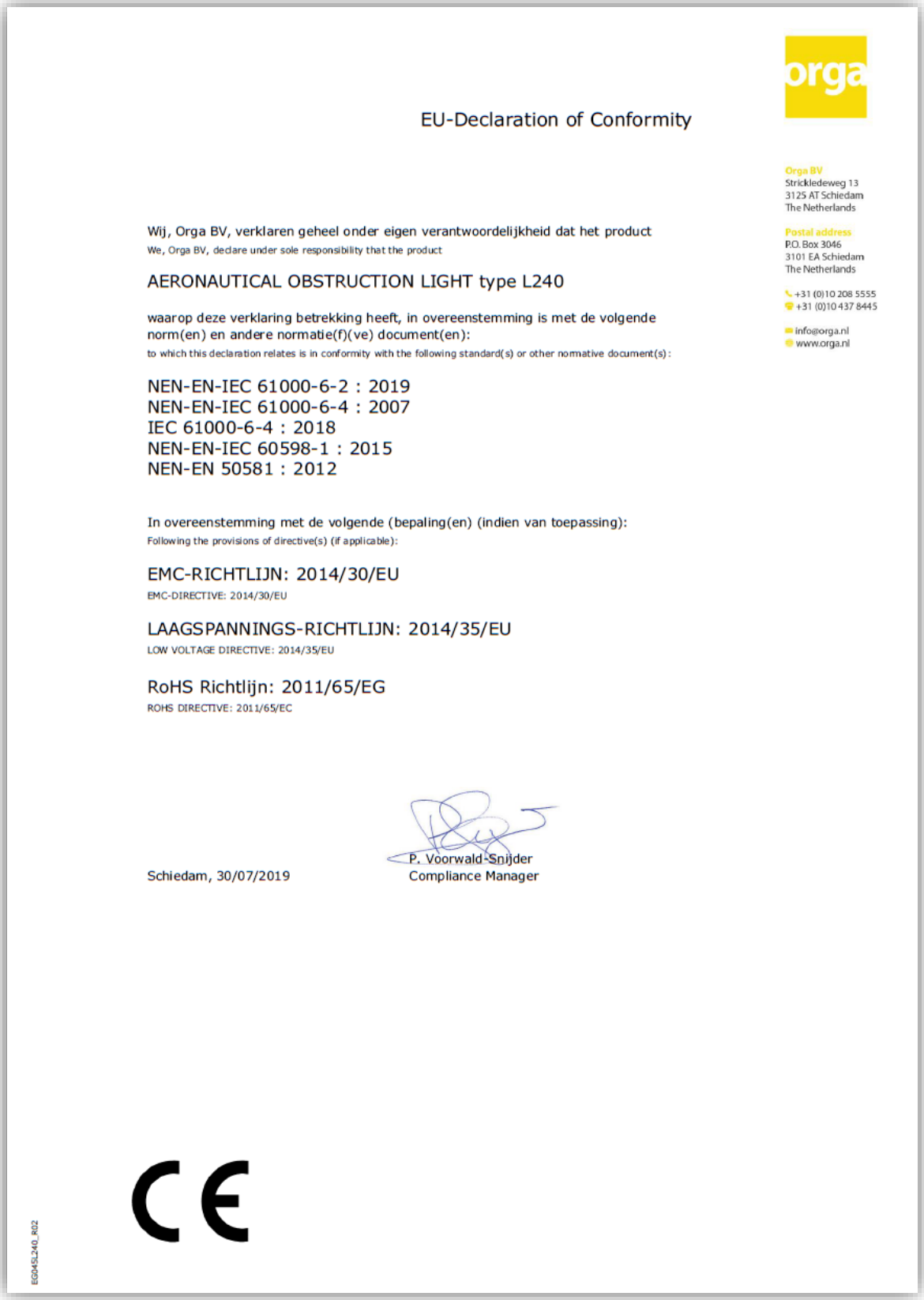
Abbildung 6-1: Abmessungen – Gefahrenfeuer L240-GFW-IRG-G-BR.

Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL

7 Erklärungen und Zertifikate

Die Bauart des Gefahrenfeuers erfüllt die Vorgaben der folgenden Normen:



EU-Declaration of Conformity

Orga BV
Strickledeweg 13
3125 AT Schiedam
The Netherlands

Postal address
P.O. Box 3046
3101 EA Schiedam
The Netherlands

+31 (0)10 208 5555
+31 (0)10 437 8445

info@orga.nl
www.orga.nl

Wij, Orga BV, verklaren geheel onder eigen verantwoordelijkheid dat het product
We, Orga BV, declare under sole responsibility that the product

AERONAUTICAL OBSTRUCTION LIGHT type L240

waarop deze verklaring betrekking heeft, in overeenstemming is met de volgende norm(en) en andere normatie(f)(ve) document(en):
to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

NEN-EN-IEC 61000-6-2 : 2019
NEN-EN-IEC 61000-6-4 : 2007
IEC 61000-6-4 : 2018
NEN-EN-IEC 60598-1 : 2015
NEN-EN 50581 : 2012

In overeenstemming met de volgende (bepaling(en) (indien van toepassing):
Following the provisions of directive(s) (if applicable):

EMC-RICHTLIJN: 2014/30/EU
EMC-DIRECTIVE: 2014/30/EU

LAAGSPANNINGS-RICHTLIJN: 2014/35/EU
LOW VOLTAGE DIRECTIVE: 2014/35/EU

RoHS Richtlijn: 2011/65/EG
ROHS DIRECTIVE: 2011/65/EC

Schiedam, 30/07/2019

P. Voorwald-Snijder
Compliance Manager

CE

EG045L240_R02

Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL

Manufacturer's Declaration

Date
10-06-2020

Orga Aviation BV
Strickledeweg 13
3125 AT Schiedam
The Netherlands

Postal address
P.O. Box 353
3100 AJ Schiedam
The Netherlands

+31 (0)10 208 5511
+31 (0)10 462 6853

info@orga.nl
www.orga.nl

Order no.	**Client**
NA	NA
Our reference	**Your reference**
NA	NA

To whom it may concern,

Based on internal measurements at Orga we herewith declare the following Orga products are in compliance with the German Allgemeine Verwaltungsvorschrift zur Kennzeichnung von Luftfahrthindernissen dated 24-04-2020:

- L240-GFW-IRG-G, L550-GFW-IRG-G and L550-GFW-ES-IRG-G; Feuer W, rot according to anhang 2 and Feuern zur Infrarotkennzeichnung according to anhang 3
- L240-IRG-G; Feuern zur Infrarotkennzeichnung according to anhang 3

Both of these products are in the process of certification by Fachstelle der WSV für Verkehrstechniken.

Orga Representative,

Jan-Willem Deé
Technical Product Coordinator

Orga Aviation BV is part of Orga Holding Group.

Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL

Manufacturer's Declaration

Orga Aviation BV
Strickledeweg 13
3125 AT Schiedam
The Netherlands

Postal address
P.O. Box 353
3100 AJ Schiedam
The Netherlands

+31 (0)10 208 5511
+31 (0)10 462 6853

info@orga.nl
www.orga.nl

Date
05-10-2021

Subject
German day/night switching point

We herewith confirm that obstacle light systems consisting of the light types as mentioned in this document comply to the *Allgemeine Verwaltungsvorschrift zur Kennzeichnung von Luftfahrthindernissen* and therefore are provided with a photocell which will switch on the lights between 50 and 150 Lux as required as required in this *Allgemeine Verwaltungsvorschrift zur Kennzeichnung von Luftfahrthindernissen*.

Products:
L550-GFW-xxx
L240-GFW-xxx
L92-AVV-xxx

Orga Representative,

Jan-Willem Dee
Technical Product Coordinator

Orga Aviation BV is part of
Orga Holding Group.

Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL

WASSERSTRAßEN- UND SCHIFFFAHRTSVERWALTUNG DES BUNDES
Fachstelle der WSV für Verkehrstechniken

WSV.de

Zertifikat
nach Nr. 22 der Allgemeinen Verwaltungsvorschrift zur Kennzeichnung von Luftfahrthindernissen (AVV Kennzeichnung) zur Vorlage bei der zuständigen Genehmigungsbehörde nach dem Luftverkehrsgesetz

Art des Feuers	Feuer W, rot IR-Feuer
Hersteller	**ORGA BV** **Strickledeweg 13** **3125 AT Schiedam (Niederlande)**
Typenbezeichnung	**L240-GFW-IRG-G**

Aufgrund der technischen Überprüfung durch die Fachstelle der Wasserstraßen- und Schifffahrtsverwaltung für Verkehrstechniken vom 30.07.2020 wird festgestellt, dass das vorgestellte Produktmuster des oben bezeichneten Leuchtentyps den lichttechnischen und/oder radiometrischen Anforderungen gemäß AVV Kennzeichnung in der Fassung vom 24. April 2020 (BAnz AT 30.04.2020 B4 vom 30.04.2020) entspricht. Die Ergebnisse der Prüfung sind im Prüfbericht LS227, vom 27.08.2020 dokumentiert.

Der Leuchtentyp darf, vorbehaltlich einer Änderung der genannten Anforderungen und unter Einhaltung eventueller Vorgaben auf Grund des Prüfprotokolls, zur Kennzeichnung von Luftfahrthindernissen verwendet werden.

Koblenz, den 27.08.2020

FACHSTELLE DER WSV FÜR VERKEHRSTECHNIKEN · BEIM WSA MOSEL-SAAR-LAHN · 110

(Polschinski)

Übersetzung der Originalbetriebsanleitung: T05 0092-1230 VER 03

T05 0092-1230 Ver 03 - Approved- Exported from DMS: 2023-02-13 by INVOL

Restricted
Dokument Nr.: 0097-1016 V01
21.9.2020

Allgemeine Spezifikation Gefahrenfeuer

ORGA AL L240-GFW-IRG-G-BR 10M

Feuer W, Rot Intensität, Rot blinkend/Infrarot blinkend



V105-3.45 MW Mk 3A
V105-3.45/3.6 MW Mk 3A
V112-3.45 MW Mk 3A
V112-3.45/3.6 MW Mk 3A
V117-3.45 MW Mk 3A
V117-3.45/3.6 MW Mk 3A
V117-4.0/4.2 MW Mk 3E
V126-3.45 MW Mk 3A
V126-3.45/3.6 MW Mk 3B
V136-3.45/3.6 MW Mk 3B
V136-4.0/4.2 MW Mk 3E
V150-4.0/4.2 MW Mk 3E

Übersetzung der Originalbetriebsanleitung: T05 0092-1258 VER 01

T05 0097-1016 Ver 01 - Approved- Exported from DMS: 2020-12-11 by INVOL

Vestas Wind Systems A/S. This document is Vestas property and contains Vestas' confidential information. It is protected by copyright law as an unpublished work. Vestas reserves all patent, copyright, trade secret and other proprietary rights to it. The information in this document may not be used, reproduced, or disclosed except if and to the extent rights are expressly granted by Vestas in writing and subject to applicable conditions. Vestas disclaims all warranties except as expressly granted by written agreement and is not responsible for unauthorized uses, for which it may pursue legal remedies against responsible parties.

Übersetzung der Originalbetriebsanleitung: T05 0092-1258 VER 01

Inhaltsverzeichnis

1 Abkürzungen und technische Begriffe ... 3
2 Einführung ... 3
3 Allgemeine Beschreibung ... 4
3.1 Daten des Gefahrenfeuers ... 4
3.2 Halterung ... 5
3.3 Steuerung ... 5
3.3.1 Überspannungsschutz(OVP)-Schaltschrank ... 5
3.3.2 Erweiterter Schaltschrank (Orga CIP400) ... 5
3.4 GPS und Fotozelle ... 5
3.4.1 GPS ... 5
3.4.2 Fotozelle ... 6
3.5 Notstromversorgung ... 6
4 Blitzschutz ... 6
5 Maße ... 7
6 Erklärungen und Zertifikate ... 8

T05 0097-1016 Ver 01 - Approved- Exported from DMS: 2020-12-11 by INVOL

VESTAS PROPRIETARY NOTICE

Übersetzung der Originalbetriebsanleitung: T05 0092-1258 VER 01

1 Abkürzungen und technische Begriffe

Abkürzung	Erklärung
AC	Alternating Current (Wechselstrom)
EMV	Elektromagnetische Verträglichkeit
GPS	Global Positioning System (Globales Positionierungssystem)
OVP	Überspannungsschutz
SCADA	Supervisory Control and Data Acquisition (System zur Prozesssteuerung und Datenerfassung)
USV	Unterbrechungsfreie Stromversorgung

Tabelle 1-1: Abkürzungen

Begriff	Erklärung
Keine	

Tabelle 1-2: Begriffserklärung

2 Einführung

Dieses Dokument beschreibt die Gefahrenfeueroption für Vestas-Windenergieanlagen. Die von Vestas gelieferten Gefahrenfeuer sind vollständig in die Elektrik und das SCADA-Überwachungssystem integrierte mechanische Montageoptionen.



Abbildung 2-1: Gefahrenfeuer AL L240-GFW-IRG-G-BR 10M

T05 0097-1016 Ver 01 - Approved- Exported from DMS: 2020-12-11 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0092-1258 VER 01

3 Allgemeine Beschreibung

Das bzw. die Gefahrenfeuer sind oben auf dem Maschinenhaus an einer bzw. mehreren Halterung(en) montiert und werden durch die Steuerung der Hinderniskennzeichnung mit Strom versorgt und gesteuert.

3.1 Daten des Gefahrenfeuers

Parameter	Wert
Vestas-Artikelnummer	29197892
Vestas-Typenbezeichnung	AL L240-GFW-IRG-G-BR 10M
Typenbezeichnung Lieferant	L240-GFW-IRG-G-BR
Standard	Deutsche AVV 2020
Leuchtkraft – Tag	Entf.
Leuchtkraft – Dämmerung	Entf.
Leuchtkraft – Nacht	„Feuer W“ + IR
Farbe – Tag	Entf.
Farbe – Dämmerung	Entf.
Farbe – Nacht	Rot und IR
Blinkverhalten – Tag	Entf.
Blinkverhalten – Dämmerung	Entf.
Blinkverhalten – Nacht	Rot – W-rot-Zyklus; IR – 60 B/min
Vertikale Lichtverteilung (min)	nach deutscher AVV 2020
Horizontale Lichtverteilung	360°
Intensität IR-Licht	nach deutscher AVV 2020
IR-Wellenlänge	~850 nm
Leuchtmitteltyp	LED
Eingangsspannung	120 – 240 VAC
Eingangsfrequenz	50 - 60 Hz
Energieverbrauch ohne Heizung	1/1/12 W (Tag/Dämmerung/Nacht)
Überspannungsschutz	Klasse III nach IEC 61643-1:
Betriebstemperaturbereich (°C)	-40 °C bis +55 °C
Umweltschutzklasse	IP66
Abmessungen in mm (L x B x H)	309 x 309 x 127
Gewicht (kg)	3 kg (5,6 kg mit Kabel)

Tabelle 3-1: Technische Daten

T05 0097-1016 Ver 01 - Approved- Exported from DMS: 2020-12-11 by INVOL

3.2 Halterung

Das Gefahrenfeuer wird mit einer oder mehreren Stützhalterungen oben auf dem Maschinenhaus montiert. Die Halterungen für Gefahrenfeuer wurden speziell für WEA geprüft und entwickelt. Korrekte Erdung/Masse im Hinblick auf EMV und Blitze sowie Windlasten und Gewicht wurden berücksichtigt. Die Halterungen sind im Lieferumfang enthalten.

3.3 Steuerung

3.3.1 Überspannungsschutz(OVP)-Schaltschrank

Der OVP-Schaltschrank wird verwendet, wenn ein oder zwei Gefahrenfeuer an einer Windenergieanlage erforderlich sind und kein externes Eingangssteuerungssignal benötigt wird. Der OVP-Schaltschrank stellt den Überspannungsschutz für die Wechselstrom-Versorgungsspannung sowie Klemmen, die als Schnittstellen zwischen der WEA und dem Gefahrenfeuer für Leistungsstrom und Alarmsignale dienen, zur Verfügung. Die Betriebssteuerung des Gefahrenfeuers übernimmt die im Gehäuse des Gefahrenfeuers integrierte Steuerung.

3.3.2 Erweiterter Schaltschrank (Orga CIP400)

Anstelle der in den Gefahrenfeuern eingebauten Steuerung kommt eine erweiterte Steuerung der Hinderniskennzeichnug vom Typ ORGA CIP400 zum Einsatz, wenn ein oder mehrere externe Eingangssignale erforderlich sind. Ein erweiterter Schaltschrank vom Typ ORGA CIP400 ist mit denselben Klemmen und OVP-Einrichtungen ausgestattet, die auch im OVP-Schaltschrank vorhanden sind. Außerdem verfügt er über eine Zusatzsteuerung mit weiteren Funktionen. Die Funktionen der Zusatzsteuerung sind Folgende:

- Implementiert den Sichtweitensensor
- Verarbeitet die externen Steuersignale vom SCADA-System über das Ethernet-Verbindungskabel zum Ethernet-Schalter der Windenergieanlage
- Fügt die Turmfeuer hinzu

Der erweiterte Schaltschrank übermittelt die Informationen über den Zustand mithilfe der internen Software der Windenergieanlage.

Das SCADA-System kann so konfiguriert werden, dass die Betriebsstatusmeldungen erfasst werden.

3.4 GPS und Fotozelle

3.4.1 GPS

Das Gefahrenfeuer ist mit einem in das Produkt integrierten GPS-Blinkpositionsgeber ausgestattet (nur die Version -G). Der Blinkpositionsgeber verwendet die Daten des GPS-Satellitensystemsignals. Alle Gefahrenfeuer blinken, aufeinander abgestimmt, gleichzeitig.

Übersetzung der Originalbetriebsanleitung: T05 0092-1258 VER 01

T05 0097-1016 Ver 01 - Approved- Exported from DMS: 2020-12-11 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0092-1258 VER 01

3.4.2 Fotozelle

Das AL L240-GFW-IRG-BR 10M verfügt über eine integrierte Fotozelle. Sie leitet einen Messwert der Umgebungslichtintensität an die Steuerung der Hinderniskennzeichnung weiter, damit das Gefahrenfeuer zwischen Tag-, Dämmerungs- und Nachtmodus umgeschaltet werden kann.

3.5 Notstromversorgung

Die USV-Notstromversorgung für das Gefahrenfeuer ist eine Option, die vom Standort und von landesspezifischen Anforderungen abhängt. Die gewünschte Dauer USV-Notstromversorgung hängt von den landesspezifischen Anforderungen ab.

4 Blitzschutz

Das Gefahrenfeuersystem erfüllt mindestens die gängigen Industrienormen hinsichtlich EMV und Blitzschutz. Zusätzlich zur Einhaltung der strengen Prüfnormen verfügt die Einheit über einen eingebauten Überspannungsschutz.

T05 0097-1016 Ver 01 - Approved- Exported from DMS: 2020-12-11 by INVOL

5 Maße

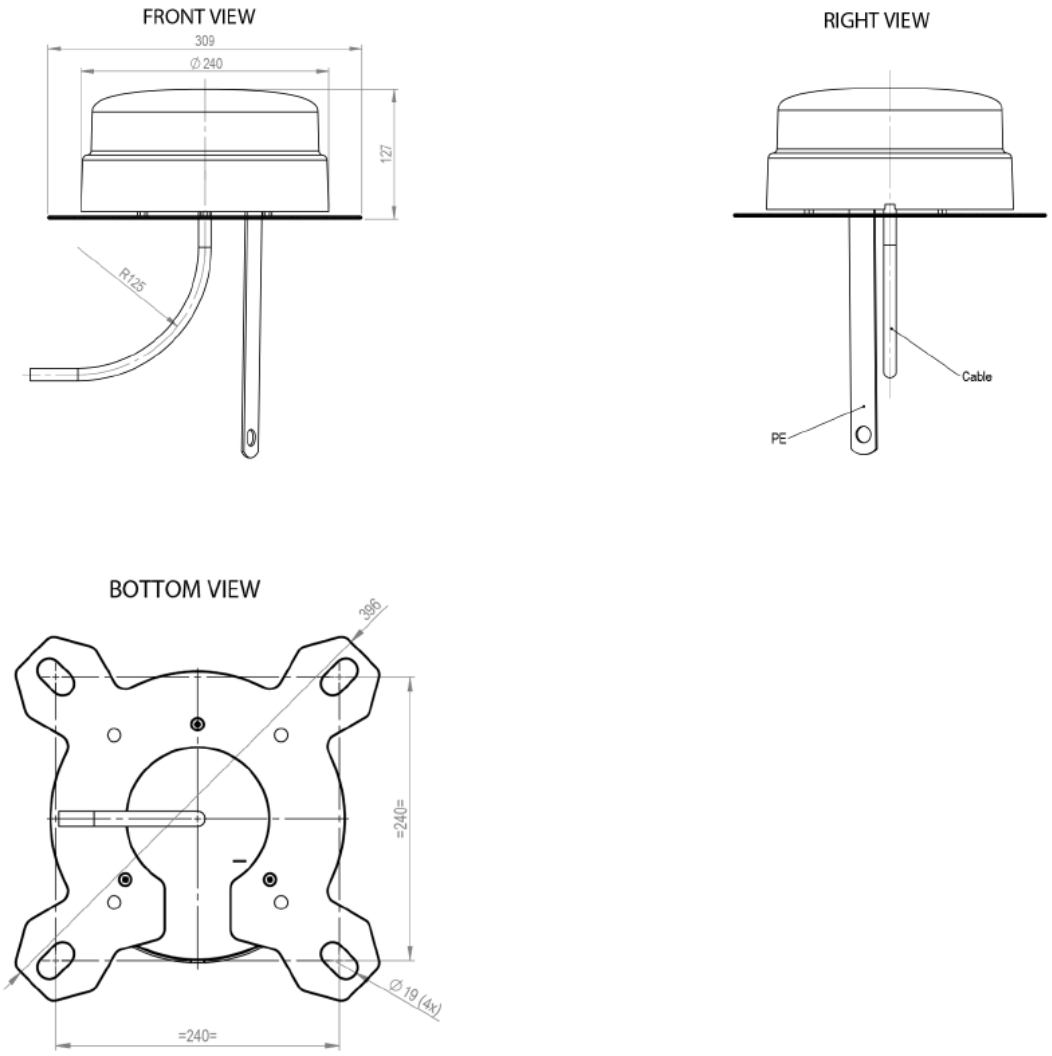


Abbildung 5: Gefahrenfeuer – Maße

Übersetzung der Originalbetriebsanleitung: T05 0092-1258 VER 01

T05 0097-1016 Ver 01 - Approved- Exported from DMS: 2020-12-11 by INVOL

6 Erklärungen und Zertifikate

WASSERSTRAßEN- UND SCHIFFFAHRTSVERWALTUNG DES BUNDES
Fachstelle der WSV für Verkehrstechniken

WSV.de

Zertifikat
nach Nr. 22 der Allgemeinen Verwaltungsvorschrift
zur Kennzeichnung von Luftfahrthindernissen (AVV Kennzeichnung) zur Vorlage
bei der zuständigen Genehmigungsbehörde nach dem Luftverkehrsgesetz

Art des Feuers	Feuer W, rot
	IR-Feuer
Hersteller	**ORGA BV**
	Strickledeweg 13
	3125 AT Schiedam (Niederlande)
Typenbezeichnung	**L240-GFW-IRG-G**

Aufgrund der technischen Überprüfung durch die Fachstelle der Wasserstraßen- und Schifffahrtsverwaltung für Verkehrstechniken vom 30.07.2020 wird festgestellt, dass das vorgestellte Produktmuster des oben bezeichneten Leuchtentyps den lichttechnischen und/oder radiometrischen Anforderungen gemäß AVV Kennzeichnung in der Fassung vom 24. April 2020 (BAnz AT 30.04.2020 B4 vom 30.04.2020) entspricht. Die Ergebnisse der Prüfung sind im Prüfbericht LS227, vom 27.08.2020 dokumentiert.

Der Leuchtentyp darf, vorbehaltlich einer Änderung der genannten Anforderungen und unter Einhaltung eventueller Vorgaben auf Grund des Prüfprotokolls, zur Kennzeichnung von Luftfahrthindernissen verwendet werden.

Koblenz, den 27.08.2020

FACHSTELLE DER WSF FÜR VERKEHRSTECHNIKEN · BEIM WSA MOSEL-SAAR-LAHN · 110

(Polschinski)

Übersetzung der Originalbetriebsanleitung: T05 0092-1258 VER 01

T05 0097-1016 Ver 01 - Approved- Exported from DMS: 2020-12-11 by INVOL

Übersetzung der Originalbetriebsanleitung: T05 0092-1258 VER 01

EU-Declaration of Conformity

Orga BV
Strickledeweg 13
3125 AT Schiedam
The Netherlands

Postal address
P.O. Box 3046
3101 EA Schiedam
The Netherlands

+31 (0)10 208 5555
+31 (0)10 437 8445

info@orga.nl
www.orga.nl

Wij, Orga BV, verklaren geheel onder eigen verantwoordelijkheid dat het product
We, Orga BV, declare under sole responsibility that the product

AERONAUTICAL OBSTRUCTION LIGHT type L240

waarop deze verklaring betrekking heeft, in overeenstemming is met de volgende norm(en) en andere normatie(f)(ve) document(en):
to which this declaration relates is in conformity with the following standard(s) or other normative document(s):

NEN-EN-IEC 61000-6-2 : 2019
NEN-EN-IEC 61000-6-4 : 2007
IEC 61000-6-4 : 2018
NEN-EN-IEC 60598-1 : 2015
NEN-EN 50581 : 2012

In overeenstemming met de volgende (bepaling(en) (indien van toepassing):
Following the provisions of directive(s) (if applicable):

EMC-RICHTLIJN: 2014/30/EU
EMC-DIRECTIVE: 2014/30/EU

LAAGSPANNINGS-RICHTLIJN: 2014/35/EU
LOW VOLTAGE DIRECTIVE: 2014/35/EU

RoHS Richtlijn: 2011/65/EG
ROHS DIRECTIVE: 2011/65/EC

Schiedam, 30/07/2019

P. Voorwald-Snijder
Compliance Manager

CE

EG045L240_R02

T05 0097-1016 Ver 01 - Approved- Exported from DMS: 2020-12-11 by INVOL

16.1.8 Abstände / Erschließung (pro Anlage aus 16.1.1 ein Formblatt 16.1.8)

Anlagebezeichnung aus Fbl. 16.1.1	WEA06

Anlagentyp	Antragsteller	ETRS 89/UTM Koordinaten	Ostwert	Nordwert
Vestas V162-7.2MW 169m NH	Windpark Gebstedt GmbH & Co. KG		32673607	5660479

Anlagenstandort

Gemeinde	Gemarkung	Flur	Flurstück	Grundstückeigentümer Name, Vorname	Zustimmung
Apolda	Zottelstedt	4	337/2		

Abstand nach LBauO

Apolda	Zottelstedt	4	337/1	[redacted]	☒
Apolda	Zottelstedt	4	338/1		☒

Erschließung

Apolda	Zottelstedt	4	341		☒
Apolda	Zottelstedt	4	745		☒
Apolda	Zottelstedt	4	744		☒
Apolda	Zottelstedt	4	340/1		☒
Apolda	Zottelstedt	4	338/1		☒
Apolda	Zottelstedt	4	337/1		☒

Gewässerquerung

					☐

Rückzubauende Anlage (Repowering)

1.

Anlagentyp		ETRS 89/UTM Koordinaten				Genehmigung				Zustimmung
Betreiber		Ostwert		Nordwert		Datum		AZ.:		
Gemeinde		Gemarkung		Flur		Flurstücke				☐

16.1.8 Abstände / Erschließung (pro Anlage aus 16.1.1 ein Formblatt 16.1.8)

Anlagebezeichnung aus Fbl. 16.1.1	WEA07			
Anlagentyp	Antragsteller	ETRS 89/UTM Koordinaten	Ostwert	Nordwert
Vestas V162-7.2MW 169m NH	Windpark Gebstedt GmbH & Co. KG		32674222	5660340

Anlagenstandort

Gemeinde	Gemarkung	Flur	Flurstück	Grundstückeigentümer Name, Vorname	Zustimmung
Apolda	Zottelstedt	4	376		

Abstand nach LBauO

Apolda	Zottelstedt	4	374	[redacted]	☒

Erschließung

Apolda	Zottelstedt	4	374	[redacted]	☒

Gewässerquerung

					☐

Rückzubauende Anlage (Repowering)

1.

Anlagentyp		ETRS 89/UTM Koordinaten				Genehmigung				Zustimmung
Betreiber		Ostwert		Nordwert		Datum		AZ.:		
Gemeinde		Gemarkung		Flur		Flurstücke				☐

16.1.9 Daten der beantragten Anlage / Daten der Anlagen im Windpark

Betriebsinterne Bezeichnung der Anlage	Bezeichnung des Windparks/ Konzentrations-zone	WEA-Hersteller	WEA-Typ	Serie/ Seriennummer	Narbenhöhe (m)	Rotordurch-messer (m)	Gesamthöhe (m)	Leistung (MW)	BNK-Funktionsart
1	2	3	4	5	6	7	8	9	10
2 Windenergieanlagen WEA06 und WEA07 im Windpark Willerstedt Gebstedt - Vestas EnVentus V162-7.2MW 169m NH	W9 - Willerstedt bis Zottelstedt								
WEA06	W9 - Willerstedt bis Zottelstedt	Vestas	EnVentus V162-7.2MW		169	162	250	7,2	Transponder
WEA07	W9 - Willerstedt bis Zottelstedt	Vestas	EnVentus V162-7.2MW		169	162	250	7,2	Transponder

16.1.10 Oktav-Schallleistungspegel (SLP) der beantragten Anlage / der Anlagen im Windpark

Betriebsinterne Bezeichnung der Anlage	Betriebs-modus	Rotor-umdrehung (1/min)	63 Hz (db [A])	125 Hz (db [A])	250 Hz (db [A])	500 Hz (db [A])	1000 Hz (db [A])	2000 Hz (db [A])	4000 Hz (db [A])	8000 Hz (db [A])	Gesamtschall-leistungspegel (db [A])
1	2	3	4	5	6	7	8	9	10	11	12
2 Windenergieanlagen WEA06 und WEA07 im Windpark Willerstedt Gebstedt - Vestas EnVentus V162-7.2MW 169m NH											
WEA06	tags	9,6	88,5	96,4	99,8	100,2	98,7	94,2	86,6	75,9	105,5
WEA06	nachts	9,6	88,5	96,4	99,8	100,2	98,7	94,2	86,6	75,9	105,5
WEA07	tags	9,6	88,5	96,4	99,8	100,2	98,7	94,2	86,6	75,9	105,5
WEA07	nachts	9,6	88,5	96,4	99,8	100,2	98,7	94,2	86,6	75,9	