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November 14, 2013
File: 195600539

Daniel Courtemanch
Maine Department of Environmental Protection
17 State House Station
Augusta, Maine 04333-0017

Reference: DEP L-25973-24-A-N / L-25973-B-N Modifications and Supporting Information: MDEP Combined Site Law/NRPA Application, Bingham Wind Project

Dear Dan,

Enclosed is supplemental information associated with the Bingham project applications, DEP L-25973-24-A-N and L-25973-B-N.

The applicants, Blue Sky West, LLC and Blue Sky West II, LLC, have worked to address questions and comments from various agencies during the review process. We have included a summary of the substantive modifications here for your reference.

Forms

- Site Location of Development Permit Application Form
    - #18: Project Description Replacement Text– Construction of 62 turbines generating up to **206** MW of electricity.
- Natural Resource Protection Act Application Form
    - #16 Activity Description Replacement Text – Construction of 62 turbines generating up to **206** MW of electricity.

Exhibit 1

- Three access road plan and profile drawing sheets have been revised to show the replacement of proposed rock sandwiches with pipe arch culverts. These changes were made at the request of Maine Department of Inland Fisheries and Wildlife (MDIFW) biologists and do not change wetland impacts. Figure A, Typical Pipe Arch Culvert detail and the revised drawings are included with this letter.
    - Sheet DWG C-S1.10– Crane Road 3 – Station 208+00
    - Sheet DWG C-N1.10 – Crane Road 11 – Station 833+50

Reference: DEP L-25973-24-A-N / L-25973-B-N Modifications and Supporting Information: MDEP Combined Site Law/NRPA Application, Bingham Wind Project

- Sheet DWG C-N1.27 –Crane Road 18– Station 1407+00

- The Typical "Swamp Mat" Temporary Bridge detail as shown on the Access Road Details sheet DET-03 has been revised to include geo-textile covering of the primary bridge decking with a second mat or other suitable material placed on top of the geo-textile.

Exhibit 2

- A new detail sheet, V-Style Clearing Deer Wintering Areas STR#1–#6, was developed to depict V-style clearing at Deer Wintering Areas (DWA) #084031 and #084033. This new detail sheet was provided in an **e-mail dated August 29, 2013** and has been included again with this letter. The August 29, 2013 e-mail and a letter response dated October 18, 2013 include details regarding the use of H-frame poles and V-style clearing at specified DWAs that will result in clearing only at the poles located within these DWAs [**Refer to** Bingham Wind Project, Response to Environmental Project Review Comments from Maine Department of Inland Fisheries and Wildlife dated October 18, 2013]. These modifications were in response to requests by MDIFW biologists.

    - Design modifications within DWAs:
        - DWA #084031 – H-frames and V-notch around poles and 16 foot access roads
        - DWA #084033 – V-notch around poles and 16 foot access roads

- The locations of two structures were moved and three other structures were eliminated to address local permitting requirements and/or to accommodate reductions in wildlife habitat impacts. These include:

    - Sheet 1: Structure 1 was moved a small distance to the west to accommodate a required setback from Route 150

    - Sheet 4: Elimination of Structures 41, 43, and 45

    - Sheets 7 and 8: Structure 100 was relocated a short distance to the south, closer to the intersection of Crow Hill Road and Welts Road

Section 1

- Section 1.1 Project Summary Replacement Text

    - The project includes 62 turbines (63 potential turbine locations are being permitted) in Bingham, Kingsbury Plantation, and Mayfield Township capable of generating up to **206** megawatts (MW) of electricity.

    - **Three** turbine models are being evaluated for the civil and electrical design described in this permit application: (1) up to 62 Siemens SWT-3.0-113 turbines with a maximum height of 149 meters (489 feet); (2) up to 62 Vestas V112 3.0 MW turbines with a maximum height

Reference: DEP L-25973-24-A-N / L-25973-B-N Modifications and Supporting Information: MDEP Combined Site Law/NRPA Application, Bingham Wind Project

of 150 meters (492 feet); and **(3) up to 62 Vestas V112-3.3 MW turbines with a maximum height of 150 meters (492 feet)**.

- Section 1.3 Environmental Studies Replacement Text
    - Targeted Roaring Brook mayfly (*Epeorus frisoni*), northern bog lemming (*Synaptomys borealis*), and northern spring salamander (*Gyrinophilus porphyriticus*) surveys in the fall (2010) and summer/fall (2011 **and 2013**);
- Table 1.1 updated for the following environmental resources to include the results of the 2013 northern spring salamander surveys. This change applies throughout the permit application sections including Section 7, Table 7.1 and Table 7.3.

Table 1.1. Summary of Environmental Impacts from Bingham Wind Project	
Environmental Resource	**Project Impact**
Northern Spring Salamander Habitat	No direct stream impact, but clearing within the associated stream buffer of **8** streams **where** northern spring salamanders **were documented**. [**Original text**: No direct stream impact, but clearing within the associated stream buffer of 24 streams that provided potential habitat for northern spring salamanders.]

Section 1A Replacement Text

- Section 1A.1 Project Description – The project includes 62 turbines (63 potential turbine locations are being permitted) in Bingham, Kingsbury Plantation, and Mayfield Township capable of generating up to **206** megawatts (MW) of electricity.
- Section 1A.4.3 Turbine Location Analysis – ~~Five of the 35 streams have habitat potentially suitable for northern spring salamanders.~~ Northern spring salamander were documented within **three** of the project area streams, and one other surveyed stream provides good potential habitat for this species; however, no direct in-stream work is proposed within the project area. No disturbance is proposed within 250 feet of ~~the~~ stream S21 where northern spring salamander was documented. **There will be some clearing within 250 feet of streams S23 and S25 for construction of the aboveground collector line** [**Refer to** September 24, 2013 memo for results of 2013 northern spring salamander surveys].

Reference: DEP L-25973-24-A-N / L-25973-B-N Modifications and Supporting Information: MDEP Combined Site Law/NRPA Application, Bingham Wind Project

Section 2

- **Refer to** supplemental TRI information provided on or about May 10, 2013.

Section 5

- A supplemental sound evaluation was completed to address a third possible turbine model: Vestas V112-3.3 MW turbine. Based upon this analysis, the predicted sound levels for all turbine types are below the MDEP nighttime limit of 42 dBA at all protected locations in the vicinity of the project where no easements are required or have been obtained. In addition, the sound level predictions indicate that project will also meet the applicable 51 dBA limit at receptor B1. **Refer to** Bodwell EnviroAcoustics LLC memo dated November 13, 2013, which is included with this letter.

Section 7

- Section 7.1 Project Area Context Replacement Text – The project includes 62 turbines (63 potential turbine locations are being permitted) in Bingham, Kingsbury Plantation, and Mayfield Township capable of generating up to **206** megawatts (MW) of electricity.

- Section 7.2 Agency Consultation and Data Collection Replacement Text – Northern Spring Salamander (*Gyrinophilus porphyriticus*) Surveys (Fall 2010, Summer/Fall 2011 **and Summer/Fall 2013**) [**Refer to** September 17, 2013 and September 24, 2013 memos for results of 2013 northern spring salamander surveys and August 21, 2013 Supplemental Northern Spring Salamander Stream Guidance Analysis].

- Section 7.8 Wildlife Habitat Replacement Text – During project specific field surveys, Stantec documented **nine** streams within the project area where northern spring salamanders were observed or where surveys identified high quality habitat for the species. Northern spring salamander was documented in **eight streams**. ~~In addition, 6 streams along the aboveground portion of the electrical collector corridor and 17 streams along the generator lead corridor were identified as potential habitat for this species.~~ No direct in-stream work is proposed within the project area; however, clearing within the vegetated buffer of **each** of these streams will occur for one access road, for the aboveground portion of the electrical collector line, and for the electrical generator lead corridor [**Refer to** September 17, 2013 and September 24, 2013 memos for results of 2013 northern spring salamander surveys and August 21, 2013 Supplemental Northern Spring Salamander Stream Guidance Analysis].

- Section 7.9 Summary: Potential Impact and Design Considerations – **Refer to** Exhibit 2 discussion above for design modifications to reduce clearing impacts within DWAs #084031 and #084033.

- Section 7.10 Compensation Revised Approach – In the April 2013 permit application, the Applicants proposed to compensate for unavoidable wetland impacts through the purchase and subsequent preservation of land that would be managed for wildlife. In June 2013, the US Environmental Protection Agency reviewed this proposed preservation and determined that the value of the wetlands to be protected was insufficient and that there was a lack of demonstrated

Reference: DEP L-25973-24-A-N / L-25973-B-N Modifications and Supporting Information: MDEP Combined Site Law/NRPA Application, Bingham Wind Project

threat of development. Similar feedback regarding the ecological value of the parcel was received from MDIFW biologists in September 2013. Based upon agency comments and the challenges of finding an adequate preservation parcel in this rural area, the Applicants are providing compensation in accordance with 38 MRSA Section 480-Z and the In Lieu Fee (IFL) program to mitigate for unavoidable wetland and habitat impacts. The attached Bingham Wind Project ILF Calculation Table demonstrates how this fee payment was determined. Based on the total project impacts and as set forth in the attached table, the ILF amount is $1,127,261.85. In the event that resource impacts are reduced in the course of final design, the ILF amount will be reduced accordingly.

- Section 7.11 Post-Construction Mortality Monitoring – **Refer to** revised submission dated September 26, 2013.

- Section 7.12 Curtailment – **Refer to** the attachment to the Bingham Wind Project, Response to Environmental Project Review Comments from MDIFW dated October 18, 2013.

- Exhibit 7D-1, Exhibit 7D-2, Exhibit 7D-3 – Note that the inclusion of a third possible turbine model, Vestas V112-3.3 MW, does not alter the results of pre-construction surveys since this turbine model falls with the height parameters used to analyze survey data.

Section 10

- At a meeting held on July 11, 2013 with the MDIFW, the Applicants agreed to place a minimum 100-foot buffer on all streams, both perennial and intermittent, within the project area. The five streams along the generator lead and two streams along the aboveground collector line where project surveys documented the presence of northern spring salamander will receive a 250-foot buffer [**Refer to** Bingham Wind Project, Response to Preliminary Review Comments from MDIFW Fisheries Division dated September 18, 2013]. This change will apply to Table 10.1 and as appropriate throughout Section 10.

Section 19

- Table 19.1 updated to reflect removal of one utility pole from the mapped flood zone along Gales Brook in Parkman.

Reference: DEP L-25973-24-A-N / L-25973-B-N Modifications and Supporting Information: MDEP Combined Site Law/NRPA Application, Bingham Wind Project

Stream/Wetland	Town	Type of Impact	Approximate Crossing Length (feet)	Amount of Clearing (acres)	Amount of Fill (square feet)	Structures within Mapped Flood Zone	Figure Number
Gales Brook	Parkman	Generator Lead and Access Road	6' across stream 965' across flood zone for Generator Lead, 1,185' across flood zone for Access Road	**3.1**	20,430	**2** utility poles (#44, #46)	19-3

Section 27

- The following additional certificates and specifications related to the Vestas V112 3.0 MW turbine and the Vestas V112-3.3 MW are included with this letter. Note that the safety certificate for the Vestas V112-3.3 MW will be available in 2014.
    - Fire Safety of Vestas V112-3.0 MW [dated June 3, 2013]
    - General Specifications V112-3.0 MW 50/60 Hz [dated August 19, 2013]
    - V112-3.3 MW HH94 IEC IIA Tower Drawing [dated September 9, 2013]
    - Tower Foundation Design Basis –V112-3.3 MW HH94 IEC IIA [dated April 9, 2013]
    - General Specifications V112-3.3 MW 50/60 Hz [dated April 4, 2013]

Section 30

- The addition of a third possible turbine model, Vestas V112-3.3 MW, did not change the Visual Impact Assessment included in the original permit application because the height of this turbine is equal to that of the Vestas V112 3.0 MW turbine. **Refer to** Landworks memo dated November 7, 2013, which is included with this letter.
- The increase in pole height to reduce clearing within DWAs #084031 and#084033 will not substantially change the view of the proposed line from the Piscataquis River. **Refer to** Landworks memo dated October 28, 2013, which is included with this letter.

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Regards,

STANTEC CONSULTING SERVICES INC.

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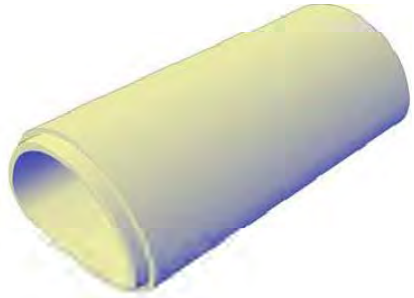
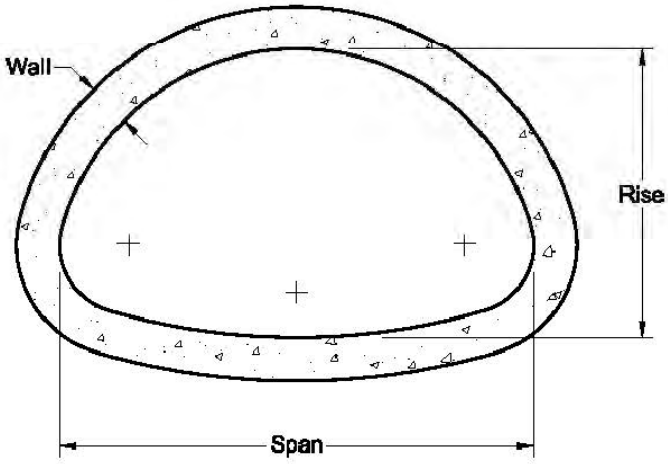
Senior Project Scientist
Phone: (207) 729-1199 x153
Fax: (207) 729-2715
dale.knapp@stantec.com

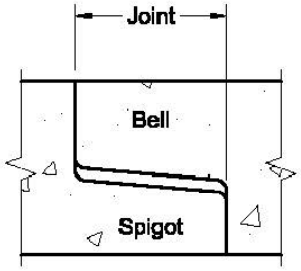
Attachment: Figure A, Typical Pipe Arch Culvert
Sheet DWG C-S1.10– Crane Road 3 – Station 208+00
Sheet DWG C-N1.10 – Crane Road 11 – Station 833+50
Sheet DWG C-N1.27 –Crane Road 18– Station 1407+00
Access Road Details sheet DET-03
V Style Clearing Deer Wintering AreasSTR#1–#6
Bingham Wind Project 115kV Generator Lead Design, Map 1
Bingham Wind Project 115kV Generator Lead Design, Map 4
Bingham Wind Project 115kV Generator Lead Design, Map 7
Bingham Wind Project 115kV Generator Lead Design, Map 8
Bodwell EnviroAcoustics LLC November 13, 2013 memo
Bingham Wind Project ILF Calculation Table
Fire Safety of Vestas V112-3.0 MW
General Specifications V112-3.0 MW 50/60 Hz
V112-3.3 MW HH94 IEC IIA Tower Drawing
Tower Foundation Design Basis –V112-3.3 MW HH94 IEC IIA
General Specifications V112-3.3 MW 50/60 Hz
Landworks November 7, 2013 memo
Landworks October 28, 2013 memo

c. Josh Bagnato, First Wind





Transverse Section



Joint Detail

Approximate Equivalent Round Size	Rise × Span	Wall	Joint	Flow Area	Weight
15"	11" × 18"	3"	2¼"	1.09 ft²	180 lb/ft
18"	13½" × 22"	3⅛"	2¼"	1.65 ft²	225 lb/ft
24"	18" × 28½"	3½"	2¾"	2.79 ft²	320 lb/ft
30"	22½" × 36¼"	3½"	3"	4.42 ft²	395 lb/ft
36"	26⅝" × 43¾"	4"	3½"	6.29 ft²	535 lb/ft
42"	31⅝" × 51⅛"	4½"	3½"	8.66 ft²	705 lb/ft
48"	36" × 58½"	5"	3½"	11.40 ft²	895 lb/ft
54"	40" × 65"	5½"	5"	14.07 ft²	1090 lb/ft
60"	45" × 73"	6"	5"	17.79 ft²	1330 lb/ft

BINGHAM WIND PROJECT

TYPICAL PIPE ARCH CULVERT

ENGINEERS FST Since 1914
FAY, SPOFFORD & THORNDIKE, INC.
ENGINEERS · PLANNERS · SCIENTISTS
778 MAIN ST, SUITE 8, SOUTH PORTLAND, ME 04106

DRAWN:	SJB	DATE:	NOV. 2013	FIGURE
DESIGNED:	SJB	SCALE:	NTS	A
CHECKED:	SJB	JOB NO.	3048	
FILE NAME:	3048-DET			

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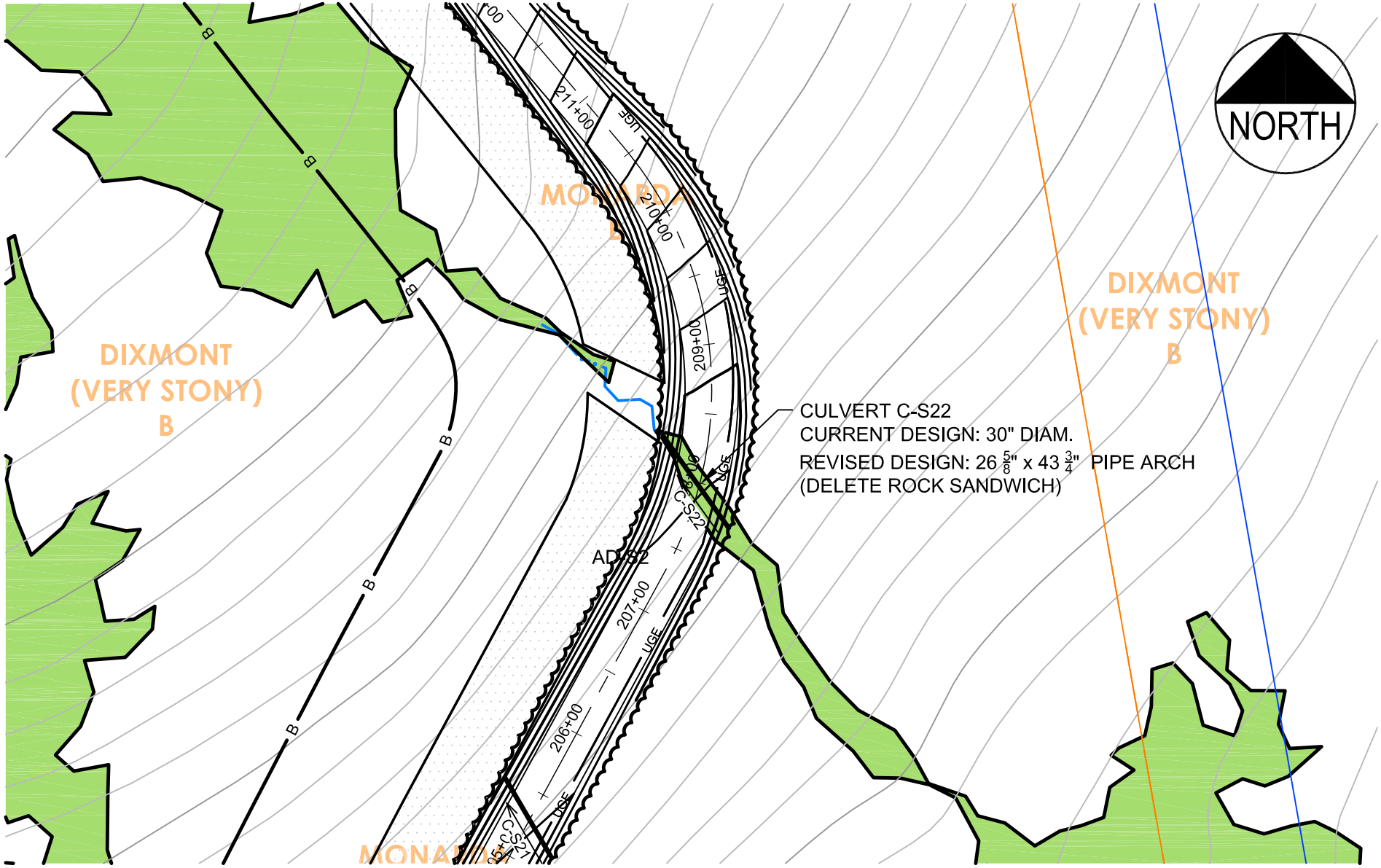

DWG C-S1.10 - CRANE ROAD 3 - STATION 208+00

FAY, SPOFFORD & THORNDIKE, INC. ENGINEERS · PLANNERS · SCIENTISTS 778 MAIN ST, SUITE 8, SOUTH PORTLAND, ME 04106	BINGHAM WIND PROJECT	CULVERT UPGRADES	DRAWN: SJB · DATE: NOV. 2013 DESIGNED: SJB · SCALE: 1"=100' CHECKED: SJB · JOB NO. 3048 FILE NAME: 3048-PROF ROAD

FIGURE 1

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DWG C-N1.10 - CRANE ROAD 11 - STATION 833+50

ENGINEERS FST Since 1914 **FAY, SPOFFORD & THORNDIKE, INC.** ENGINEERS · PLANNERS · SCIENTISTS 778 MAIN ST, SUITE 8, SOUTH PORTLAND, ME 04106	BINGHAM WIND PROJECT	CULVERT UPGRADES	DRAWN: SJB / DATE: NOV. 2013 DESIGNED: SJB / SCALE: 1"=100' CHECKED: SJB / JOB NO. 3048 FILE NAME: 3048-PROF ROAD NORTH	FIGURE 2

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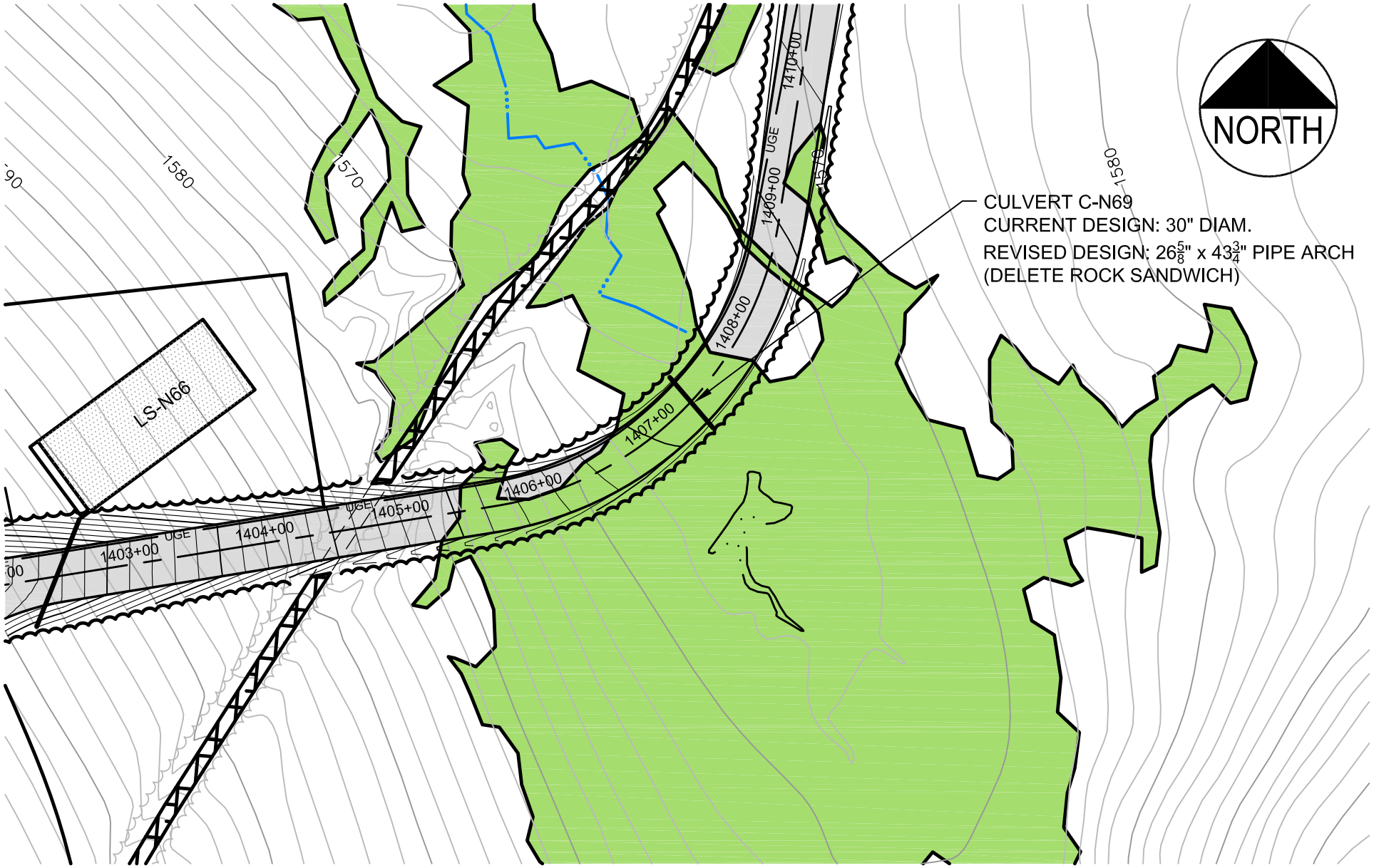

DWG C-N1.27 - CRANE ROAD 18 - STATION 1407+00

ENGINEERS FST Since 1914
FAY, SPOFFORD & THORNDIKE, INC.
ENGINEERS · PLANNERS · SCIENTISTS
778 MAIN ST, SUITE 8, SOUTH PORTLAND, ME 04106

BINGHAM WIND PROJECT

CULVERT UPGRADES

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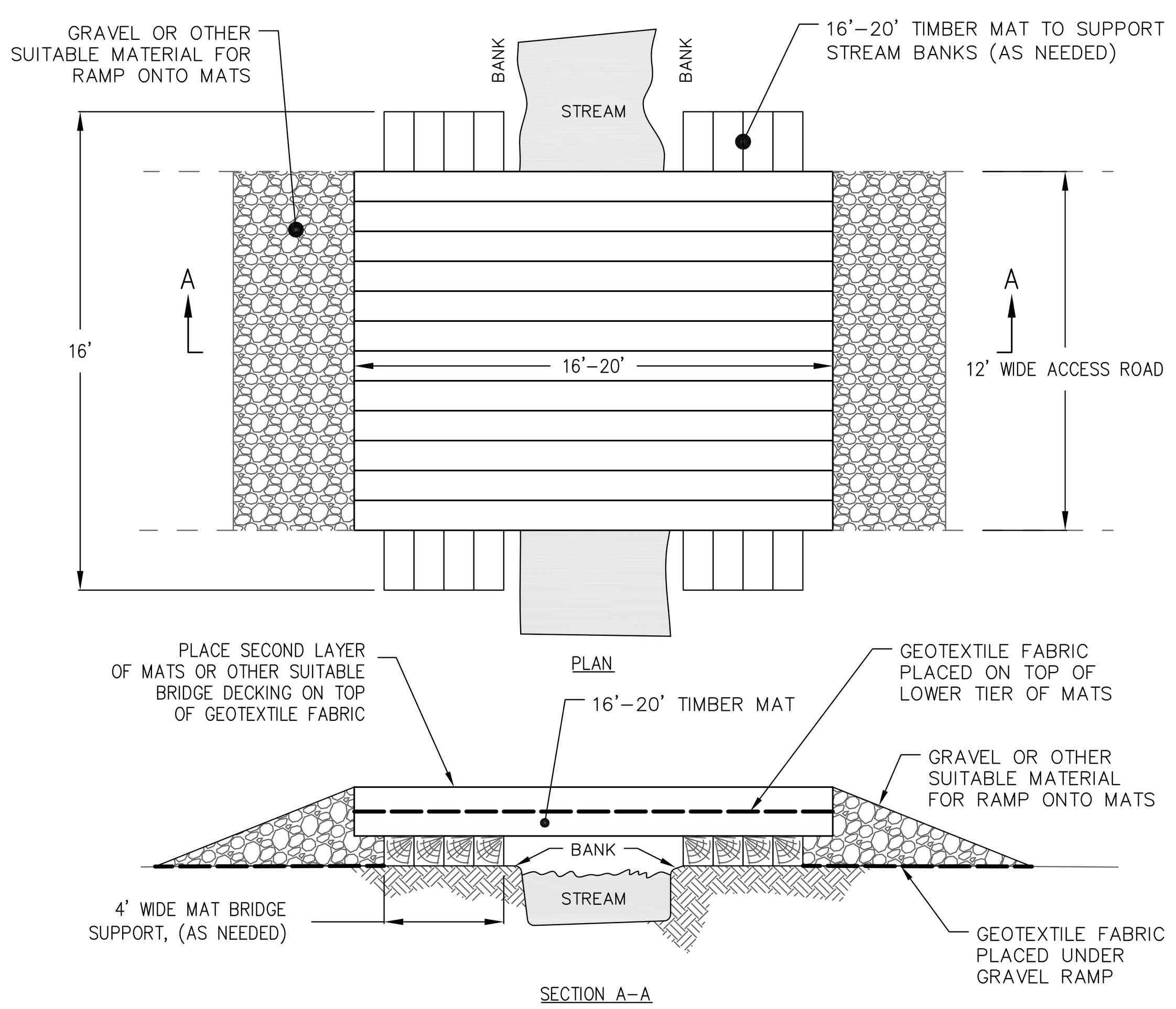
CHECKED:	SJB	JOB NO.	3048
FILE NAME:	3048-PROF ROAD NORTH		

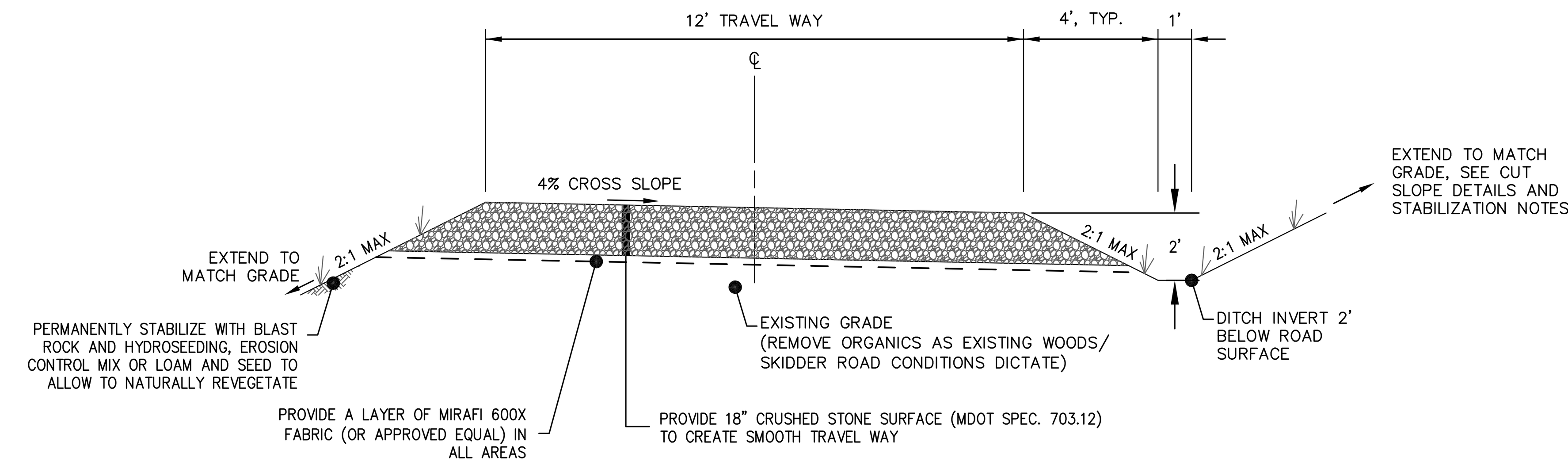
FIGURE 3



NOTES

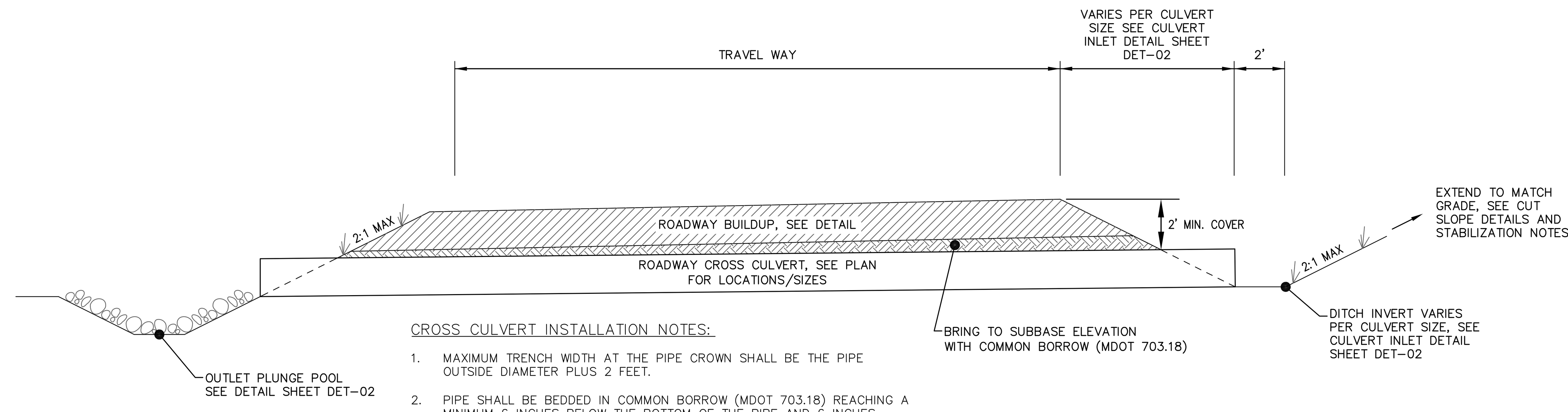
1. DEPLOY EROSION CONTROLS AS NEEDED TO MINIMIZE EROSION.
2. MATS SHALL BE POSITIONED TO RETAIN THE NATURAL STREAM CHARACTERISTICS.
3. PROVIDE BOTTOM LAYER OF MATS TO SERVE AS PRIMARY BRIDGE DECKING. PLACE GEOTEXTILE FABRIC ON TOP OF MATS TO PREVENT SEDIMENT TRANSPORT THROUGH THE MATS INTO THE WATER RESOURCE. PLACE SECOND LAYER OF MATS (OR OTHER SUITABLE BRIDGE DECK) ON TOP OF GEOTEXTILE FABRIC TO SECURE FABRIC AND PROVIDE A SUITABLE TRAVEL WAY.
4. POSITION MATS TO CROSS STREAMS AT RIGHT ANGLES TO THE CHANNEL AT A LOCATION WITH FIRM BANKS AND LEVEL APPROACHES AS SITE CONDITIONS DICTATE.
5. MATS LAID PERPENDICULAR TO THE STREAM CAN BE SUBSTITUTED WITH PRE-FABRICATED BRIDGE STRUCTURES AS SPAN LENGTHS DICTATE OR AT THE PREFERENCE OF THE CONTRACTOR.
6. EXTEND STRINGERS AT LEAST TWO FEET ONTO FIRM BANKS OR SEVERAL FEET INTO THE UPLAND EDGE OF A WETLAND.
7. PLACE MATS AND STONE RAMP ON TOP OF GEOTEXTILE FABRIC AND PROVIDE A SMOOTH TRANSITION FOR EQUIPMENT TRAVEL FROM THE ADJACENT GROUND.
8. INSTALL ROUGH STONE AREAS AT BOTH ENDS OF THE BRIDGE TO PROMOTE CLEANING OF VEHICLE TIRES.
9. TEMPORARY BRIDGES WILL BE REMOVED AS SOON AS THEY ARE NO LONGER REQUIRED FOR PROJECT ACCESS.
10. PERFORM ROUTINE INSPECTION AND MAINTENANCE TO INCLUDE:
   - 10.1. REMOVAL OF ACCUMULATED SOIL MATERIAL FROM BRIDGE DECK AND RAMPS.
   - 10.2. SPREAD REMOVED SOIL MATERIAL AT A STABILIZED UPLAND LOCATION AS DIRECTED BY THE ENVIRONMENTAL INSPECTOR (EI).
   - 10.3. INSPECT STREAM BANKS FOR STABILITY.
   - 10.4. INSPECT FOR SIGNS OF MATERIAL BEING DEPOSITED INTO THE WATER RESOURCE.
   - 10.5. REPLACE TIMBERS OR BRIDGE DECKING IN POOR CONDITION AS SOON AS DETERIORATION IS OBSERVED.
   - 10.6. ENVIRONMENTAL INSPECTOR (IE) TO BE RESPONSIBLE FOR REGULAR INSPECTIONS AND WILL MAINTAIN A LOG OF CHANGES, MAINTENANCE, AND IMPROVEMENTS BEING PERFORMED.

TYPICAL "SWAMP MAT" TEMPORARY BRIDGE
NOT TO SCALE



NOTE 12' TRANSMISSION LINE ACCESS ROAD IS SUPERELEVATED AT ALL LOCATIONS. SEE ACCESS ROAD PLANS FOR SUPERELEVATION DIRECTION TABLES.

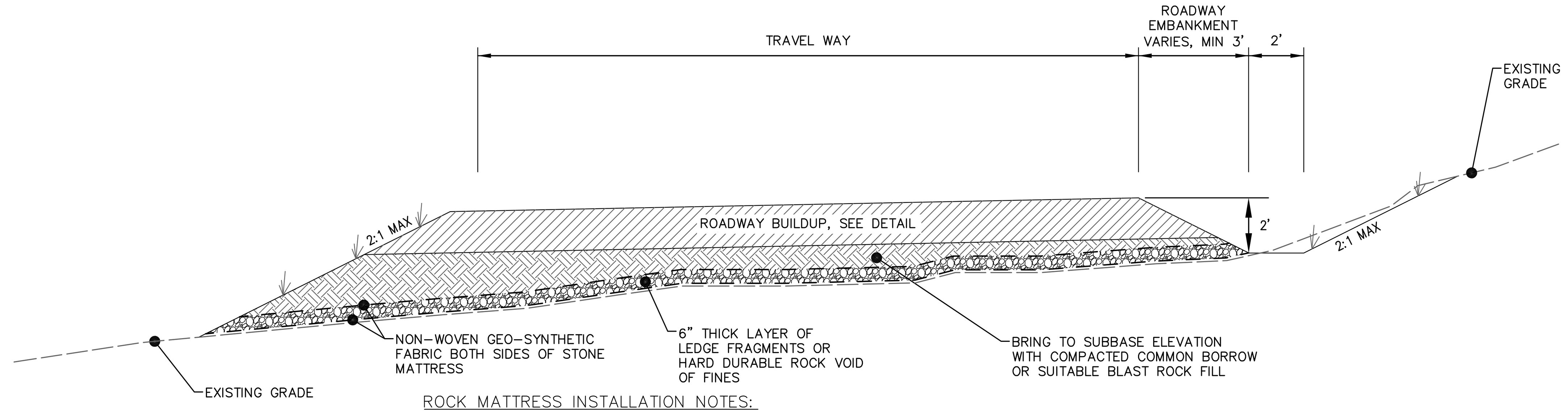
12' TRANSMISSION LINE ACCESS ROAD CROSS-SECTION DETAIL
NOT TO SCALE



CROSS CULVERT INSTALLATION NOTES:

1. MAXIMUM TRENCH WIDTH AT THE PIPE CROWN SHALL BE THE PIPE OUTSIDE DIAMETER PLUS 2 FEET.
2. PIPE SHALL BE BEDDED IN COMMON BORROW (MDOT 703.18) REACHING A MINIMUM 6 INCHES BELOW THE BOTTOM OF THE PIPE AND 6 INCHES ABOVE THE TOP OF THE PIPE.
3. ALL ROAD CULVERTS TO BE HDPE, DOUBLE WALL, SMOOTH INTERIOR BORE, OUTSIDE CORRUGATED, ADS N-12 ST IB OR EQUAL, SIZE VARIES PER PLAN.
4. ANY CULVERT INSTALLED ON THE PROJECT SHALL HAVE THE APPROPRIATE INLET AND OUTLET PROTECTION INSTALLED WITHIN 7 DAYS FOR CULVERTS IN NON-CRITICAL AREAS AND WITHIN 48 HOURS OR PRIOR TO ANY STORM EVENT, WHICHEVER OCCURS FIRST, FOR CULVERTS IN CRITICAL AREAS. A CRITICAL AREA IS ANY AREA WITHIN 75 FEET OF A WETLAND, RIVER/STREAM/BROOK, SHORELINE, OR VERNAL POOL.

TYPICAL ROADWAY CROSS CULVERT DETAIL
NOT TO SCALE



ROCK MATTRESS INSTALLATION NOTES:

1. ROCK MATTRESS TO BE USED AS APPROPRIATE IN AREAS WHERE SIGNIFICANT UNANTICIPATED GROUNDWATER SEEPS ARE ENCOUNTERED DURING CONSTRUCTION.

TYPICAL ROCK MATTRESS DRAINAGE DETAIL
NOT TO SCALE

ROADWAY CROSS SECTION NOTES:

1. VERTICAL ROADWAY GEOMETRY FOR REFERENCE PURPOSES ONLY AND TO CONFIRM DRAINAGE PATTERNS. FINAL FINISHED GRADE ELEVATION AND VERTICAL CURVE GEOMETRY TO BE DETERMINED AS FIELD CONDITIONS DICTATE.
2. ROADWAY GRAVEL TO EXTEND TO EDGE OF THE DITCH/FILL SLOPE.
3. ALL ROADWAY MATERIALS TO BE PLACED IN 2 FOOT MAXIMUM LIFTS COMPACTED TO 95%
4. IN AREAS OF EXISTING VEGETATION/ORGAINIC MATERIAL, ROAD AREA SHALL BE GRUBBED TO A DEPTH SUFFICIENT TO REMOVE ALL ORGANICS (2 FEET MAXIMUM). BRING TO SUBGRADE WITH COMMON BORROW OR SUITABLE BLAST ROCK FILL.
5. GEOTEXTILE FABRIC TO BE PLACED BENEATH ROAD SUBBASE IN ALL AREAS.
6. LIMIT ROADWAY CLEARING TO THE EXTENT PRACTICABLE. TYPICALLY, CLEARING SHOULD BE LIMITED TO 10' FROM THE BOTTOM OF FILL SLOPES AND 5' FROM THE TOP OF CUT SLOPES.
7. IN AREAS WHERE EXISTING ROADS ARE BEING IMPROVED, RE-CONSTRUCTED, OR WIDENED, THE ADEQUACY OF EXISTING ROADWAY BASE AND SURFACE MATERIALS TO BE REUSED SHALL BE AS DETERMINED OR AGREED TO BY ENGINEER OR OTHER AUTHORIZED OWNER'S REPRESENTATIVE. IF EXISTING MATERIAL IS FOUND TO BE INADEQUATE OR OF INSUFFICIENT DEPTH, EXISTING ROADWAY MATERIALS ARE TO BE REMOVED, REPLACED, AND IMPROVED TO MEET THE SPECIFICATION OF THE ROADWAY DETAILS AS SHOWN ON THIS SHEET.
8. ROADSIDE SWALES ARE TO BE FINISHED PER THE DETAILS ON SHEET DET-01. AS INDICATED, SWALES ARE TO BE GRASS LINED FOR ROAD SLOPES OF 6% OR LESS. SWALES WITH SLOPES GREATER THAN 6% ARE TO BE FINISHED PER THE STONE LINED SWALE DETAIL.

NO.	REVISIONS:	APPD:	DATE:
0	ISSUED FOR REVIEW	TMH	03/20/13
1	MAINE DEP SUBMITTAL	TMH	03/29/13
2	RESPONSE TO ME DEP COMMENTS	NRP	07/03/13
3	REVISED TEMPORARY MAT BRIDGE DETAIL	NRP	10/29/13

SGC ENGINEERING, LLC
• Civil Design & Survey Engineering
• Environmental & Regulatory Permitting
• Electrical Power Systems Engineering
SERVING OUR CLIENTS IN THE U.S.A. & CANADA

SGC Project:	Date:	Scale:	Drawn:	Design:	Appd:
782001	03-20-2013		NRP	NRP	TMH

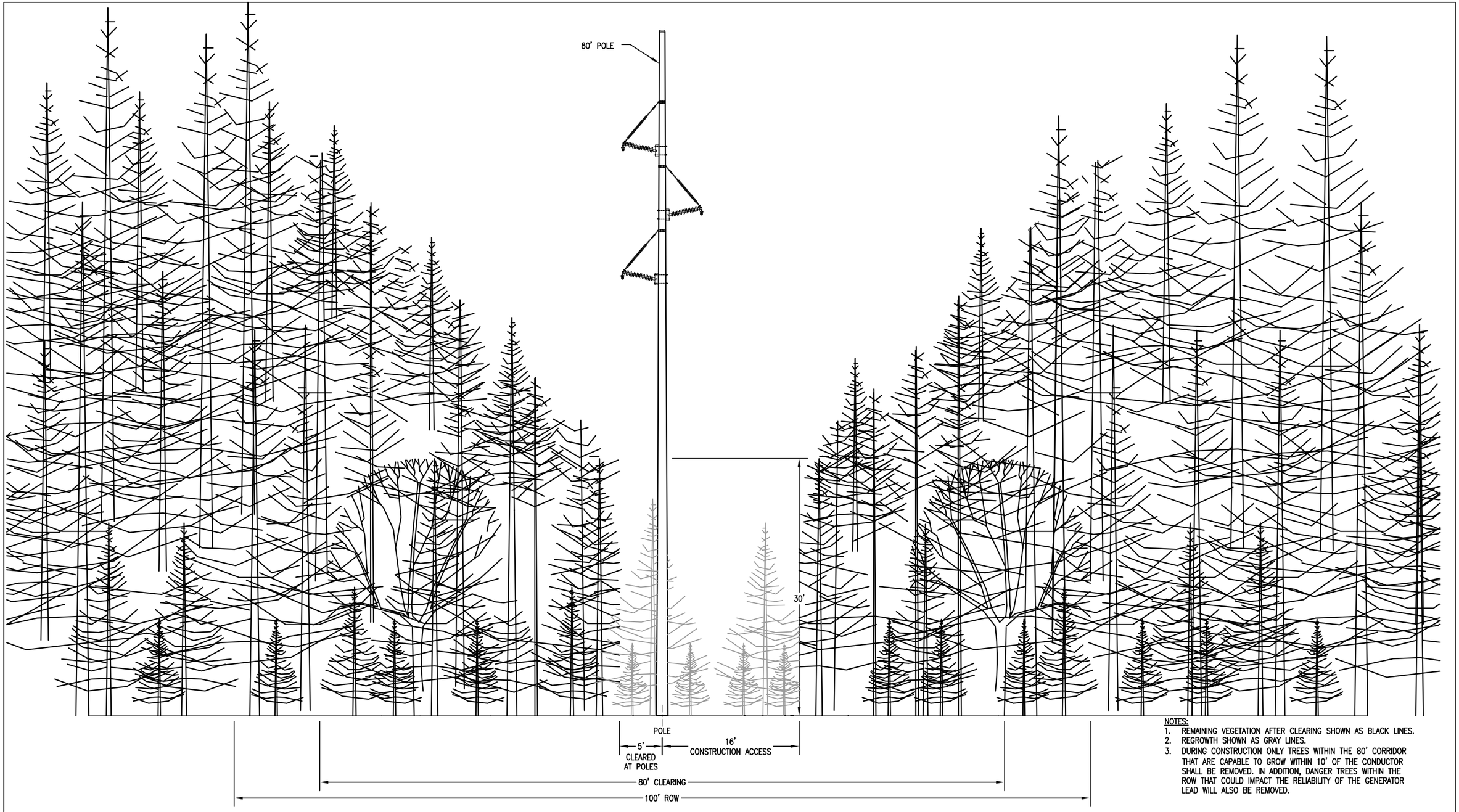
Title: ACCESS ROAD DETAILS
ROADWAY DETAILS

Project: 115kV GENERATOR LEAD
MAYFIELD TWP TO PARKMAN, MAINE

Applicant: BLUE SKY WEST II, LLC
c/o First Wind Energy, LLC
129 Middle Street, 3rd Floor, Portland, ME 04101

firstwind
CLEAN ENERGY. MADE HERE.

DWG. DET-03



NOTES:
1. REMAINING VEGETATION AFTER CLEARING SHOWN AS BLACK LINES.
2. REGROWTH SHOWN AS GRAY LINES.
3. DURING CONSTRUCTION ONLY TREES WITHIN THE 80' CORRIDOR THAT ARE CAPABLE TO GROW WITHIN 10' OF THE CONDUCTOR SHALL BE REMOVED. IN ADDITION, DANGER TREES WITHIN THE ROW THAT COULD IMPACT THE RELIABILITY OF THE GENERATOR LEAD WILL ALSO BE REMOVED.

SGC Engineering, LLC
a part of Senergy

firstwind
CLEAN ENERGY. MADE HERE.

ISSUED FOR REVIEW

DATE:	SCALE:	DRAWN:	DESIGN:	APPD:
AUGUST 14, 2013	N.T.S.	SJF	DLH	TMH

NO.	REVISION	APPD:	DATE:
A	ISSUED FOR REVIEW	TMH	8/14/13

TITLE:
V STYLE CLEARING
DEER WINTERING AREA STR#1–#6

PROJECT:
BINGHAM WIND PROJECT
SOMERSET COUNTY, MAINE

CLIENT:
BLUE SKY WEST II, LLC
129 MIDDLE ST., 3RD FLOOR, PORTLAND, ME 04101

SGC PROJECT NUMBER
782001

DRAWING NUMBER
782–13–1325

REVISION
A

SHEET NUMBER
1 OF 1

REV	DESCRIPTION	DATE
0.	ISSUE FOR DEP PERMIT	04/12/2013
1.	UPDATED STRUCTURES: 100,101	05/23/2013
2.	UPDATED STRUCTURES:42,44,46	06/21/2013
3.	UPDATED STRUCTURE:1	06/27/2013

- Generator Lead Structures (SGC: 06-27-2013)
- Bingham Layout (First Wind: 01-16-2013)
- Generator Lead (SGC: 05-23-2013)
- Generator Lead Clearing Limits/ROW (SGC: 05-23-2013)
- Generator Lead Guy/Anchor (SGC: 06-27-2013)
- Section 216 Corridor (Plisga and Day: 09-27-2012)
- Existing Access Road - No Permit Required (SGC: 03-27-2013)
- Access Road Included in MDEP SLODA Permit (SGC: 03-27-2013)
- Mountain Top Roads (DeLuca Hoffman: 02-27-2013)
- #210 Generator Lead Structure Labels
- 16-45 Parcel Labels
- AR210 Access Road Labels

- MDEP Streams (Stantec: 03-15-2013)
- LUPC Streams (Stantec: 03-15-2013)
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- Railroads (ESRI Street Map)
- Minor Roads (MEGIS: 03-14-2012)
- US or State HWY (MEGIS: 03-14-2012)

PURPOSE:
Genlead design review.

DATA SOURCE:
Data sources are identified in the legend next to the feature layer that was provided.

Bingham Wind Project
115kV Generator Lead - Design

BLUE SKY WEST II, LLC.
c/o First Wind Energy, LLC
129 Middle Street, 3rd Floor
Portland, ME 04101

prepared for: firstwind℠ CLEAN ENERGY. MADE HERE.

SGC Engineering, LLC
a part of Senergy

PROJECT: 782001

MAP 1 OF 21

JUNE 27, 2013

1 " = 300 '

0 300 600 Feet

EXHIBIT 2

2-11
GRANT,DANIEL M.

2-11-1
CHICK, FREDERICK C.

3-2-1
PRIDE, JAYNE M.

3-5
PROVOST, MARK

15-72
DAVIS, GORDON E.

15-73
DAVIS, GORDON FORMERLY DAVIS, MILAN O.

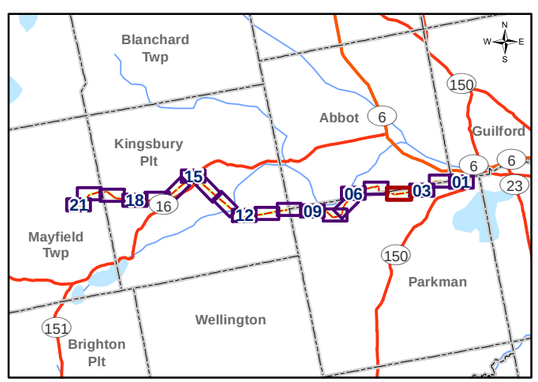
15-21
TOOLEY, JACK

15-22-1
DAVIS, MILAN O.

AR230

AR221-C

REV	DESCRIPTION	DATE
0.	ISSUE FOR DEP PERMIT	04/12/2013
1.	UPDATED STRUCTURES: 100,101	05/23/2013
2.	UPDATED STRUCTURES:42,44,46	06/21/2013
3.	UPDATED STRUCTURE:1	06/27/2013
4.	UPDATED STRUCTURES:42,44,46	07/22/2013



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PURPOSE:
Genlead design review.

DATA SOURCE:
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Bingham Wind Project
115kV Generator Lead - Design

BLUE SKY WEST II, LLC.
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Portland, ME 04101

prepared for: firstwind
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PROJECT: 782001

MAP 4 OF 21

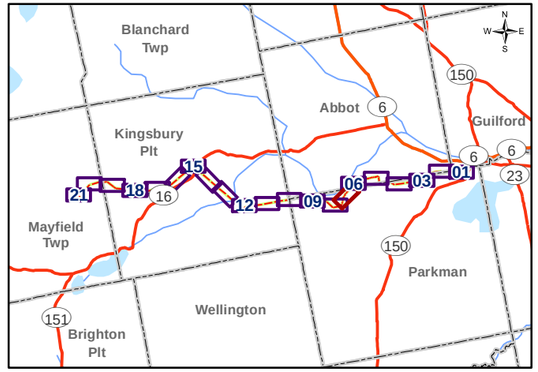
JULY 22, 2013

1 " = 300 '

0 300 600 Feet

EXHIBIT 2

REV	DESCRIPTION	DATE
0.	ISSUE FOR DEP PERMIT	04/12/2013
1.	UPDATED STRUCTURES: 100,101	05/23/2013



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Bingham Wind Project

115kV Generator Lead - Design

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PROJECT: 782001

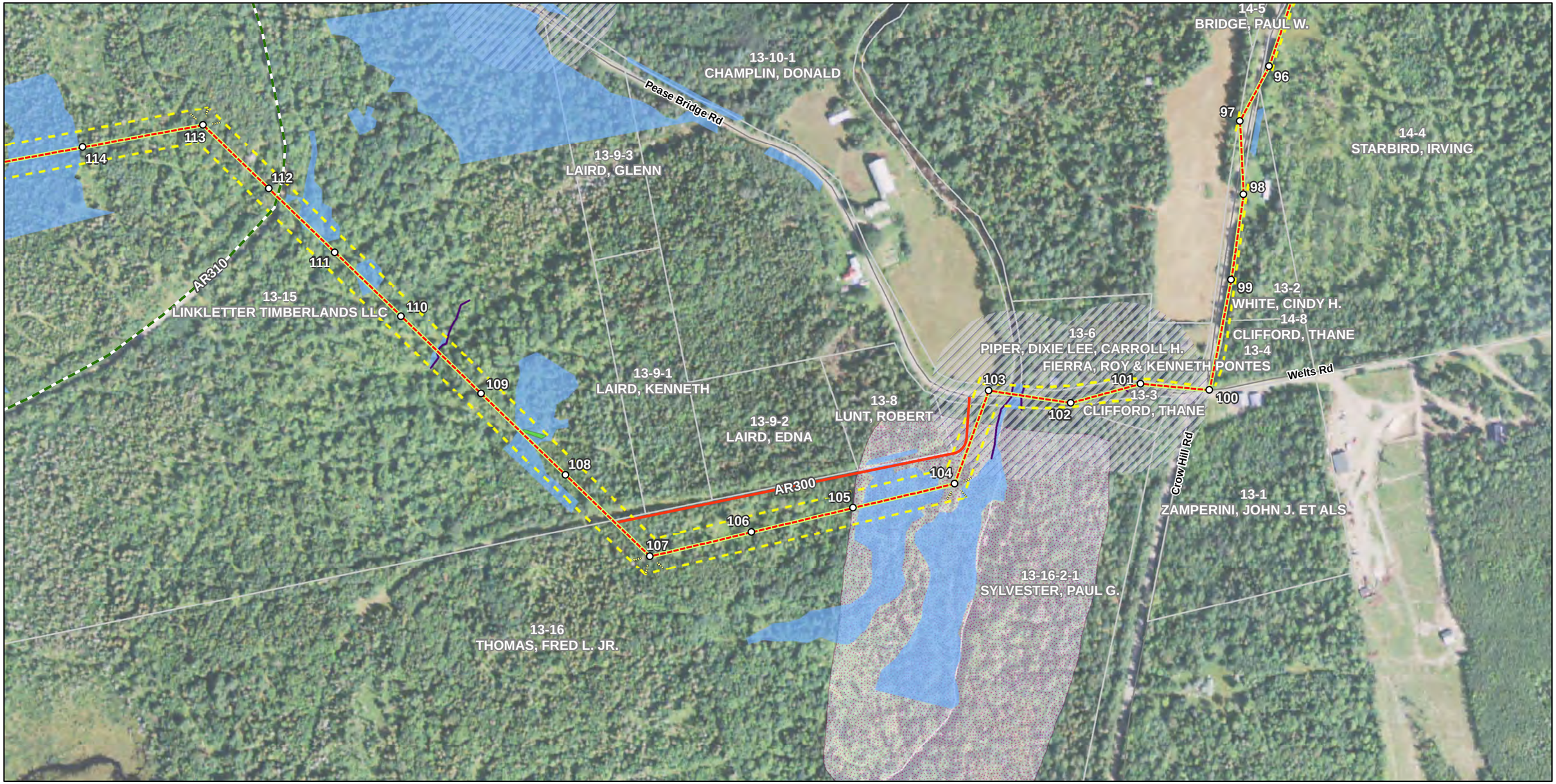
MAP 7 OF 21

MAY 23, 2013

1 " = 300 '

0 300 600 Feet

EXHIBIT 2



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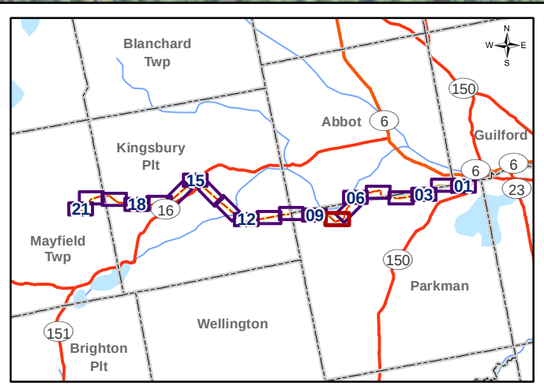

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Genlead design review.
DATA SOURCE:
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Bingham Wind Project
115kV Generator Lead - Design

prepared for:

BLUE SKY WEST II, LLC.
c/o First Wind Energy, LLC
129 Middle Street, 3rd Floor
Portland, ME 04101

firstwind℠
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SGC Engineering, LLC
a part of Senergy

PROJECT: 782001

N
W E
S

MAP
8
OF 21

MAY 23, 2013

1 " = 300 '

0 300 600 Feet

EXHIBIT
2

Bodwell EnviroAcoustics LLC

Josh Bagnato
Environmental Permitting and Compliance Manager
First Wind

November 13, 2013

RE Bingham Wind Project
Supplement to Sound Level Assessment
Evaluation of Vestas V112-3.3 MW Turbine

Dear Josh,

Bodwell EnviroAcoustics LLC (BEA) evaluated sound levels associated with construction and operation of the proposed Bingham Wind Project. The results were presented in a Sound Level Assessment report dated April 2013 which provides analysis of predicted sound levels from operation of Vestas V112-3.075 and Siemens ST-113-3.0 wind turbines and demonstrates that the project will comply with applicable Maine Department of Environmental (DEP) noise standards for wind energy developments. This report was submitted as part of the DEP Application for the Bingham Project. This Supplement extends the original Sound Level Assessment by BEA to evaluate sound levels from a third turbine model: Vestas V112-3.3 MW. Refer to the original Sound Level Assessment from April 2013 for a full description of the Bingham Wind Project and applicable noise regulations.

Vestas Wind Systems provided a Sou*nd Level Performance Standard and Testing Procedure* that warranted the sound power level (LwA) of the originally proposed Vestas V112-3.075 WTG IEC Class II turbine. The warranted LwA of the V112-3.075MW turbine at full routine operation is 106.5 dBA with an uncertainty of ±2.0 dBA. Vestas also warrants that this V112–3.075MW Class II turbine will not produce a tonal sound, as defined by Maine DEP Chapter 375.10, during operation in any mode. The *Sound Level Testing Procedure* referenced by the Vestas warranty is IEC 61400-11, Ed.2, 2002 - *Wind turbines- Part 11: Acoustic noise measurement techniques*. IEC 61400-11 establishes detailed procedures for measurement of wind turbine sound and calculation methods for determining the sound power level of a wind turbine as a point source for the stated purpose of conducting community assessments of sound levels resulting from wind turbine operation.

Vestas has also provided a *Sound Level Performance Standard and Testing Procedure* for the V112 –3.3 MW WTG IEC Class 2A and other technical information for this additional proposed turbine model. The warranted LwA of Vestas V112-3.3MW WTG IEC Class 2A turbine is 106.5 dBA with an uncertainty of ±2.0 dBA, which is identical to the V112-3.075MW turbine. Further, Vestas also warrants that the V112–

3.3 MW IEC Class 2A turbines will not produce a tonal sound, as defined by Maine DEP Chapter 375.10, during operation in any mode. Exhibit 1 of this Supplement provides the *Sound Level Performance Standard and Testing Procedure* for the proposed additional V112-3.3MW turbine.

The April 2013 Sound Level Assessment by BEA describes the acoustic propagation model used to calculate predicted sound levels from full simultaneous operation of all proposed wind turbines for Bingham Wind. The predictive sound model uses octave band sound power levels for the V112-3.075MW turbine ranging from 31.5 to 8,000 Hz as provided by Vestas. BEA selected the octave band sound levels for the 10-meter wind speed yielding the highest sound level predictions at nearby protected locations. The hub height of the additional proposed V112-3.3MW turbine will be 94 meters, the same as the originally proposed V112-3.075MW turbine. Information from Vestas indicates that these two turbines have nearly the same operating characteristics and physical architecture, and more importantly, the turbine blades and rotational speed range are the same.

Based on technical and sound warranty information from Vestas, the V112-3.3MW octave band sound levels are expected to be nearly identical to octave bands for the V112-3.075 MW turbine used in the Bingham predictive sound model. Further, the additional proposed V112-3.3MW turbine is not expected to impact the analysis of short duration repetitive or tonal sounds presented in the original Sound Level Assessment for Bingham Wind.

As presented in the April 2013 Sound Level Assessment, sound levels were calculated for specific community receptor points to evaluate compliance with relevant or applicable sound limits. "Receptor points" are the protected locations in each direction from Bingham Wind with the greatest potential to exceed the Maine DEP sound level limits. A summary of predicted sound levels at the receptor points for full daytime and nighttime operation of Bingham Wind is provided in Table 1 for both proposed Vestas V112 turbine models and for the Siemens SWT-113 turbine. Distances to the nearest proposed turbine and the applicable nighttime sound level limit are also shown for each receptor point.

The calculated sound levels in Table 1 are the same as shown in Table 6-1 of the original Sound Level Assessment dated April 2013. The only revision to Table 6-1 is the addition of the Vestas V112-3.3 MW turbine as shown in Table 1 presented herein.

Receptor Point	Description and Approximate Distance to Nearest Wind Turbine		Predicted Hourly Sound Level and Nighttime Limit, dBA		
	Description	Distance (ft)	V112-3.3MW or 3.075MW	SWT-113	Sound Limit
B1	Protected Location with Easement Limit - Kingsbury PLT	1,410	49.1	49.1	51
B2	Protected Location – Kingsbury PLT	6,250	39.1	39.6	42
B3	Protected Location – Mayfield TWP	6,860	34.8	35.4	42
B4	Protected Location – Mayfield TWP	6,640	37.2	37.3	42
B5	Protected Location – Mayfield TWP	6,975	37.6	37.8	42
B6	Protected Location – Bingham	4,675	34.6	34.8	42

Table 1. Predicted Sound Levels from Wind Turbine Operations at Receptor Points (Source: Table 6-1 of Bingham Wind Sound Level Assessment, Bodwell EnviroAcoustics LLC, April 2013.)

At all protected locations in the vicinity of the project where no easements are required or have been obtained, the predicted sound levels for all turbine types are below the Maine DEP nighttime limit of 42 dBA. In addition, the sound level predictions indicate that Bingham Wind will also meet the applicable 51 dBA limit at receptor B1. In all cases, the predicted sound levels indicate that when operating any of the proposed turbines at full sound output, Bingham Wind will comply with the applicable Maine DEP sound level limits. For additional details and information, including evaluation of tonal and short duration repetitive sounds, refer to the original Sound Level Assessment by BEA dated April 2013.

Please contact me should you have any questions or need additional information concerning the findings of this Supplement.

Respectfully,

R. Scott Bodwell, P.E.
Principal

Bodwell EnviroAcoustics LLC
55 Ocean Drive
Brunswick, Maine 04011

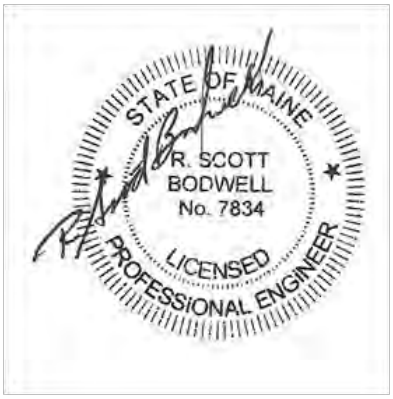

EXHIBIT 1: VESTAS V112 – 3.3 MW SOUND LEVEL PERFORMANCE STANDARD

Sound Level Performance Standard and Testing Procedure

Warranted Sound Power Level V112 – 3.3 MW WTG

When measured in accordance with these testing procedures the **V112 – 3.3 MW WTG IEC Class 2A** warranted maximum Sound Level Performance Standard is as follows;

Mode 0 Operation: Lwa = 106.5 dB(A).

This warranted sound level is subject to a tolerance for measurement uncertainties of the greater of (i) the actual measurement uncertainty determined in accordance with the Sound Level Test Standard and (ii) ± 2dB(A). If the measured sound power level is at or below the warranted sound power level plus the uncertainty, the standard has been met.

Supplier also warrants that the sound generated by any Wind Turbine shall not produce a Tonal Sound during operation in Mode 0 when measured in accordance with the Sound Level Test Standard and on the linear scale for one-third octave bands with center frequencies ranging from 20 to 12,500 Hz. A Tonal Sound is defined to exist if the one-third (1/3) octave band sound pressure level in the band, including the tone, exceeds the arithmetic average of the sound pressure levels of the two (2) contiguous one-third (1/3) octave bands by five (5) dB for center frequencies between five hundred (500) Hz and ten thousand (10,000) Hz, by eight (8) dB for center frequencies between one hundred and sixty (160) Hz and four hundred (400) Hz, or by fifteen (15) dB for center frequencies twenty-five (25) Hz between one hundred and twenty-five (125) Hz.

"Sound Level Test Standard" means the test protocol as defined in IEC 61400-11-ed2:2002.

Bingham Wind Project In Lieu Fee Calculation Table

			Piscataquis	Somerset	Piscataquis	Somerset	Piscataquis	Somerset		
	ILF Multiplier	Percent Reduction	Sq Ft	Sq Ft	Acres	Acres	ILF Amount $3.08+$0.03	ILF Amount $3.64+$0.04		
Permanent Wetland Fill (Poles and T-Line Access Roads	1	no reductions allowed	25,994	32,515	0.60	0.75	$ 80,841.34	$ 119,655.20	@100%	$ 200,496.54
Temporary Wetland Fill, PSS/PEM	1	standard reduction, in place for <18 mos.	38,485	0	0.88	0.00	$ 119,688.35	$ -	@5%	$ 5,984.42
Temporary Wetland Fill, PFO converted to PSS/PEM	1	standard reduction, habitat conversion	229,665	7,297	5.27	0.17	$ 714,258.15	$ 26,852.96	@15%	$ 111,166.67
Fill in Vernal Pool	2	no reductions allowed	0	0	0.00	0.00	$ -	$ -	@100%	$ -
Fill in and/or removal of forest in natural SVP Buffer (>=25%)	2	no reductions allowed	0	0	0.00	0.00	$ -	$ -	@20%	$ -
Clearing of upland forest or PSS within 100' of stream bank	1	standard reduction with BMPs	10,933	8,028	0.25	0.18	$ 34,001.63	$ 29,543.04	@10%	$ 6,354.47
Clearing of PFO	1	reductions applicable to widening only	1,134,294	163,322	26.04	3.75	$ 3,527,654.34	$ 601,024.96	@15%	$ 619,301.90
IWWH Impact: Wetland	2	reductions applicable to widening only	78,309	0	1.80	0.00	$ 487,081.98	$ -	@37.5%	$ 182,655.74
IWWH Impact: Upland	2	standard reduction, habitat fragmentation	57,872	0	1.33	0.00	$ 3,472.32	$ -	@37.5%	$ 1,302.12
										$1,127,261.85

June 3, 2013

Neil Kiely
179 Lincoln St, Suite 500
Boston, MA 02111

RE: Fire Safety of Vestas V112-3.0 MW

Mr. Kiely,

Thank you for your recent inquiry about the risk of fire associated with the Vestas V112-3.0 MW wind turbine generator (WTG). I understand that you will be providing this information to the Maine Department of Environmental Protection (DEP) in connection with the permitting for the Bowers Wind Project in Maine.

First, as you know, safety is Vestas' number one priority. Vestas takes the risk of fires very seriously. As described below, the V112-3.0 MW turbine is designed to minimize this risk.

Lightning Strike

The V112-3.0 MW is designed according to lightning protection level 1 of the International Electrotechnical Commission (IEC) 62305 standard; the highest protection level, corresponding to safe conduction of lightning strikes up to 200 kA; this is the recommended level according to the Confederation of Fire Protection Associations in Europe (CFPA E) document "Wind turbines fire protection guideline" (section 5.1.1). The lightning protection system of the V112-3.0 MW is a proven design, refined over many previous turbine models, incorporating design best practices to ensure safe operation for the duration of the turbine's life. During the turbine design phase Vestas validated the performance of the lightning protection system according to all applicable IEC test standards in state-of-the-art facilities in Europe. This provided verification that the system is designed to transfer lightning strikes safely to ground, no matter where the turbine has been struck. The lightning protection system extends from the tips of the blades, around the entire nacelle, the tower, and into the foundation earthing system. This comprehensive approach to lightning protection is recommended by the CFPA E (section 5.1.1).

Vestas' extensive experience designing safe lightning protection systems for wind turbines, and the laboratory validation work on the V112-3.0 MW, has resulted in an extremely reliable lightning protection system. Vestas has installed over 600 units of the V112-3.0 MW turbine globally (including 91 turbines in New York and Vermont) since 2010 with no recorded lightning damage to-date.

Electrical Installations

The safety focus at Vestas means electrical safety is a major design focus for all Vestas wind turbines, including the V112-3.0 MW. Proper design and manufacture of electrical systems is essential for protection of personnel and minimizing risk of fires.

One source of potential fires in wind turbines is the high-voltage transformer, which in many turbines are oil-filled and hence flammable. The Vestas V112-3.0 MW eliminates this oil-based risk by using dry transformers that are air cooled and physically separated from other components in the nacelle. This minimizes the risk of an electrical arc and fire, and is the preferred configuration of the National Fire Protection Association (NFPA) code 850 (section 5.1.5.1).

Vestas turbines utilize a Condition Monitoring System (CMS) to monitor hundreds of signals throughout the turbine, including temperature, current, and voltage measurements, to ensure that the turbine is operating completely within

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Tel: +1 503 327 2000, Fax: +1 503 327 2001, vestas-americas@vestas.com, www.vestas.com

normal bounds. The turbine is designed to safely de-rate or shut down if any parameter exceeds pre-set thresholds. Such use of CMS systems is recommended by the CFPA E (sections 4, 5.1.2, and 5.1.6).

In the case of an electrical arc incident, arc detectors are positioned to instantaneously detect the arc, safely shut down the turbine, and open the main switchgear. This system acts independently of the control system, and removes the energy source for the fire before it has a chance to ignite. The shutdown causes the blades to automatically pitch to an aerodynamically neutral position using stored hydraulic energy, causing the rotor to come to a complete stop within seconds, without requiring use of a mechanical disc brake. This is in accordance with CFPA E (section 5.1.2) and NFPA (section 10.5.1.3) recommendations.

There is also an ionization smoke detector located inside the nacelle as recommended by the CFPA E (section 5.2.1). The smoke detector acts independently from the turbine controller and automatically shuts down the turbine and opens the main switchgear of the turbine using the same procedures as the arc detectors.

Manufacturing quality is essential for ensuring the effectiveness of the turbine's electrical safety systems. Vestas uses state-of-the-art quality systems in its manufacturing facilities, and cascades many of these requirements to sub-suppliers, to ensure that product quality enhances fire safety. Sophisticated systems ensure that bolted connections are at the correct torque value, cable connections are secure, and the entire turbine functions properly before leaving the manufacturing facilities. Each turbine undergoes full-scale testing both in the factory and at the site before it is released for operation. Such quality systems are recommended by the CFPA E to ensure safe operation of wind turbines for their service life (section 5.4).

Hot Surfaces

Hot surfaces are kept to a minimum in the V112-3.0 MW. In order to bring the rotor to a safe stop, no matter what the wind conditions, the hydraulic pitch system is used, not the mechanical disc brake. This method of operation is reliable and proven across more than 20 years of Vestas wind turbine designs. Each blade of the wind turbine has its own pitch actuator, and in case of problems with the pitch system, only two blades are required to bring the rotor to a complete stop.

The mechanical disc brake in the V112-3.0 MW is only used for service activities (stopping rotation of the rotor so that the rotor lock pins can be installed) or when a technician physically presses the emergency stop button. Even during an emergency stop, the mechanical disc brake is only applied at low rotational speeds to decrease the amount of heat build-up, and the brake is automatically released after approximately 30 minutes so that brake friction doesn't cause excessive heat. The disc brake is covered for safety, according to the recommendations of the CFPA E (section 3.3.3)

Work Involving Fire Hazards

Welding, burning, grinding, and other work involving heat sources are not part of the standard maintenance plan of the turbine. Such work typically takes place in the factory during the manufacturing process, or in workshops in the case of component repair.

In the rare instance that "hot work" is required to be performed in the turbine (hot work in the turbine is avoided if possible) Vestas' work instructions include numerous requirements to ensure that personnel and equipment are safe. Precautions include ensuring the work area is free of any flammable materials, sufficient ventilation, fire blankets, ensuring that extinguishers are on hand, and clean-up and inspection of the work place after the job is finished. Technicians must complete appropriate documentation and obtain permits from site management before engaging in any hot work. Limitation and regulation of hot work is recommended by the CFPA E (section 5.1.5) and NFPA (section 16.3(5)).

Combustible Materials

The V112-3.0 MW is designed to minimize the use of flammable materials in the turbine, however for practical reasons this cannot be completely avoided. Oil is used in the hydraulic pitch system and to lubricate the gearbox; so the turbine continuously monitors oil pressures and oil levels to ensure that there are no leaks. If a leak is detected the turbine is automatically shut down and technicians need to visit the turbine and repair the issue before it can be re-started.

Materials that are not essential to the operation of the turbine are not left in the machine, including cleaning solvents, rags, papers, garbage, etc. This keeps the amount of flammable materials in the turbine to a minimum, as recommended by the CFPA E (section 5.1.3 and 5.1.4). Smoking is not allowed in Vestas wind turbines, in accordance with CFPA E recommendations (section 5.1.7).

Fire Fighting

Technicians have a standard safety kit that they bring when working on the turbines (in addition to their standard personal protective equipment including safety boots, safety glasses, gloves, fall arrest equipment, etc.). This includes a first aid kit, 5-6 kg CO_2 fire extinguisher, and emergency descent device. Fire blankets are required if any hot work is to be performed. These items are stored at the site office, not the turbine, because it is easier to maintain and inspect them on the ground than during turbine visits, which may be as long as 1 year apart (fire extinguishers receive monthly inspections).

Technicians receive training and regular refresher courses on the proper usage of these items in the case of emergency situations, as the CFPA E recommends (section 5.1.8). Prior to each turbine visit technicians are required to check that fire extinguishers are in good condition and are not late on inspections, otherwise work cannot proceed.

Maintenance

The V112-3.0 MW turbine is designed with much more working space than other wind turbine models to ensure that technicians have enough open space to safely maintain, repair, and replace equipment as needed – an increase of 60% versus previous Vestas turbine models. In addition to fluorescent lighting along the entire height of the tower, and throughout the nacelle, skylights provide additional lighting during daytime hours. This allows technicians to properly see their work, ensure high quality, and clean up when the work is done; aspects that have been recognized by the CFPA E as important to fire safety (section 3.3.7)

While working on the turbine, technicians keep fire safety in mind at all times. Before performing any work on the turbine, technicians prepare a thorough Pre-Task Planning Worksheet and Job Hazard Assessment to describe the activities that are planned to take place in the turbine and the potential hazards associated with these tasks, including confined space and risk of fire assessments.

During annual service visits, technicians inspect and maintain a variety of components in the turbine that ensures safe operation. For example, electrical connections are inspected and re-tightened, oil filters are replaced, the disc brake is inspected, arc detectors are tested and cleaned, the transformer is inspected and cleaned, etc. These maintenance activities are considered by the CFPA E to be important steps that mitigate the risk of fires (section 5.1.6). Technicians are qualified to perform this work after attending regular and extensive training sessions at our North American training center in Portland, Oregon as well as on the job training and certification activities.

Conclusion

Vestas takes fire safety very seriously, which is shown in the design of the V112-3.0 MW wind turbine. Every aspect of the turbine from layout, to electrical design, to maintenance requirements have been developed to ensure years of

safe and trouble-free operation. This wind turbine is an excellent fit for the Bowers Wind Project and is designed to safely provide years of clean energy to the residents of Maine.

Kind regards,

Galvin Clancey
Technical Specialist
Vestas-American Wind Technology, Inc.

Restricted
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General Specification

V112-3.0 MW 50/60 Hz

Vestas Wind Systems A/S · Hedeager 44 · 8200 Aarhus N · Denmark · www.vestas.com

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1 General Description

The Vestas V112-3.0 MW wind turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V112-3.0 MW turbine has a rotor diameter of 112 m and a rated output power of 3.075 MW. The turbine utilises the OptiTip® concept and a power system based on a permanent magnet generator and full-scale converter. With these features, the wind turbine is able to operate the rotor at variable speed and thereby maintaining the power output at or near rated power even in high wind speed. At low wind speed, the OptiTip® concept and the power system work together to maximise the power output by operating at the optimal rotor speed and pitch angle.

2 Mechanical Design

2.1 Rotor

The V112-3.0 MW is equipped with a 112-meter rotor consisting of three blades and a hub. The blades are controlled by the microprocessor pitch control system OptiTip®. Based on the prevailing wind conditions, the blades are continuously positioned to optimise the pitch angle.

Rotor	
Diameter	112 m
Swept Area	9852 m^2
Speed, Dynamic Operation Range	6.2-17.7
Rotational Direction	Clockwise (front view)
Orientation	Upwind
Tilt	6°
Blade Coning	4°
Number of Blades	3
Aerodynamic Brakes	Full feathering

Table 2-1: Rotor data

2.2 Blades

The blades are made of carbon and fibreglass and consist of two airfoil shells bonded to a supporting beam.

Blades	
Type Description	Airfoil shells bonded to supporting beam
Blade Length	54.65 m
Material	Fibreglass reinforced epoxy and carbon fibres
Blade Connection	Steel roots inserted

Blades	
Airfoils	High-lift profile
Maximum Chord	4.0 m

Table 2-2: Blades data

2.3 Blade Bearing

The blade bearings are double-row four-point contact ball bearings.

Blade Bearing	
Lubrication	Grease

Table 2-3: Blade bearing data

2.4 Pitch System

The turbine is equipped with a pitch system for each blade and a distributor block, all located in the hub. Each pitch system is connected to the distributor block with flexible hoses. The distributor block is connected to the pipes of the hydraulic rotating transfer unit in the hub by means of three hoses (pressure line, return line and drain line).

Each pitch system consists of a hydraulic cylinder mounted to the hub and a piston rod mounted to the blade via a torque arm shaft. Valves facilitating operation of the pitch cylinder are installed on a pitch block bolted directly onto the cylinder.

Pitch System	
Type	Hydraulic
Number	1 per blade
Range	-9° to 90°

Table 2-4: Pitch system data

Hydraulic System	
Main Pump	Two redundant internal-gear oil pumps
Pressure	260 bar
Filtration	3 µm (absolute)

Table 2-5: Hydraulic system data

2.5 Hub

The hub supports the three blades and transfers the reaction forces to the main bearing and the torque to the gearbox. The hub structure also supports blade bearings and pitch cylinder.

Hub	
Type	Cast ball shell hub
Material	Cast iron

Table 2-6: Hub data

2.6 Main Shaft

The main shaft transfers the reaction forces to the main bearing and the torque to the gearbox.

Main Shaft	
Type Description	Hollow shaft
Material	Cast iron

Table 2-7: Main shaft data

2.7 Main Bearing Housing

The main bearing housing covers the main bearing and is the first connection point for the drive train system to the bedplate.

Main Bearing Housing	
Material	Cast iron

Table 2-8: Main bearing housing data

2.8 Main Bearing

The main bearing carries all thrust loads.

Main Bearing	
Type	Double-row spherical roller bearing
Lubrication	Automatic grease lubrication

Table 2-9: Main bearing data

2.9 Gearbox

The main gear converts the low-speed rotation of the rotor to high-speed generator rotation.

The disc brake is mounted on the high-speed shaft. The gearbox lubrication system is a pressure-fed system.

Gearbox	
Type	Planetary stages + one helical stage
Gear House Material	Cast
Mechanical Power	3300 kW
Lubrication System	Pressure oil lubrication
Backup Lubrication System	Oil sump filled from external gravity tank
Total Gear Oil Volume	1000-1200
Oil Cleanliness Codes	ISO 4406-/15/12
Shaft Seals	Labyrinth

Table 2-10: Gearbox data

2.10 Generator Bearings

The bearings are grease lubricated and grease is supplied continuously from an automatic lubrication unit.

2.11 High-Speed Shaft Coupling

The coupling transmits the torque of the gearbox high-speed output shaft to the generator input shaft.

The coupling consists of two 4-link laminate packages and a fibreglass intermediate tube with two metal flanges. The coupling is fitted to two-armed hubs on the brake disc and the generator hub.

2.12 Yaw System

The yaw system is an active system based on a robust pre-tensioned plain yaw-bearing concept with PETP as friction material.

The yaw gears have a torque limiter.

Yaw System	
Type	Plain bearing system
Material	Forged yaw ring heat-treated. Plain bearings PETP
Yawing Speed (50 Hz)	0.46°/sec.
Yawing Speed (60 Hz)	0.6°/sec.

Table 2-11: Yaw system data

Yaw Gear	
Type	Multiple stages geared
Ratio Total	944:1
Rotational Speed at Full Load	1.4 rpm at output shaft

Table 2-12: Yaw gear data

2.13 Crane

The nacelle houses the internal safe working load (SWL) service crane. The crane is a single system hoist.

Crane	
Lifting Capacity	Maximum 800 kg

Table 2-13: Crane data

2.14 Towers

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. The towers are designed with the majority of internal welded connections replaced by magnet supports to create a predominantly smooth-walled tower. Magnets provide load support in a horizontal direction and internals, such as platforms, ladders, etc., are supported vertically (that is in the gravitational direction) by a mechanical connection. The smooth tower design reduces the required steel thickness, rendering the tower lighter compared to one with all internals welded to the tower shells.

The hub heights listed include a distance from the foundation section to the ground level of approximately 0.2 m depending on the thickness of the bottom flange and a distance from the tower top flange to the centre of the hub of 2.2 m.

Towers	
Type	Cylindrical/conical tubular
Hub Heights	84 m/94 m/119 m/140 m
Hub Heights (North America)	84 m
Material	Steel (some site specific variants can be concrete or hybrid)

Table 2-14: Tower structure data

2.15 Nacelle Bedplate and Cover

The nacelle cover is made of fibreglass. Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel. The roof section is equipped with wind sensors and skylights. The skylights can be opened from both inside the nacelle to access the roof and from outside to access the nacelle. Access from the tower to the nacelle is through the yaw system.

The nacelle bedplate is in two parts and consists of a cast iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train and transmits forces from the rotor to the tower through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw gears are bolted to the front nacelle bedplate.

The crane girders are attached to the top structure. The lower beams of the girder structure are connected at the rear end. The rear part of the bedplate serves as the foundation for controller panels, the cooling system and transformer. The nacelle cover is mounted on the nacelle bedplate.

Type Description	Material
Nacelle Cover	GRP
Bedplate Front	Cast iron
Bedplate Rear	Girder structure

Table 2-15: Nacelle bedplate and cover data

2.16 Thermal Conditioning System

The thermal conditioning system consists of a few robust components:

- The Vestas CoolerTop® located on top of the rear end of the nacelle. The CoolerTop® is a free flow cooler, thus ensuring that there are no electrical components in the thermal conditioning system located outside the nacelle.
- The Liquid Cooling System, which serves the gearbox, hydraulic systems, generator and converter is driven by an electrical pumping system.
- The transformer forced air cooling comprised of an electrical fan.
- The nacelle forced air cooling comprises of electrical fans.

2.16.1 Generator and Converter Cooling

The generator and converter cooling systems operate in parallel. A dynamic flow valve mounted in the generator cooling circuit divides the cooling liquid flow. The cooling liquid removes heat from the generator and converter unit using a free-air flow radiator placed on the top of the nacelle. In addition to the generator, converter unit and radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

2.16.2 Gearbox and Hydraulic Cooling

The gearbox and hydraulic cooling systems are coupled in parallel. A dynamic flow valve mounted in the gearbox cooling circuit divides the cooling flow. The cooling liquid removes heat from the gearbox and the hydraulic power unit through heat exchangers and a free-air flow radiator placed on the top of the nacelle. In addition to the heat exchangers and the radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

2.16.3 Transformer Cooling

The transformer is equipped with forced-air cooling. The ventilator system consists of a central fan, located below the service floor and an air duct leading the air to locations beneath and between the high voltage and low voltage windings of the transformer.

2.16.4 Nacelle Cooling

Hot air generated by mechanical and electrical equipment is removed from the nacelle by a fan system located in the nacelle.

3 Electrical Design

3.1 Generator

The generator is a three-phase synchronous generator with a permanent magnet rotor that is connected to the grid through a full-scale converter.

The generator housing is built with a cylindrical jacket and channels. The channels circulate cooling liquid around the generator internal stator housing.

Generator	
Type	Synchronous with permanent magnets
Frequency [f_N]	0- 200 Hz
Voltage, Stator [U_{NS}]	3 x 710 V (at rated speed)
Number of Poles	12
Winding Type	Form with VPI (Vacuum Pressurized Impregnation)
Winding Connection	Star
Rated rpm	1450 - 1540 rpm
Overspeed Limit Acc. to IEC (2 minutes)	2400 rpm
Generator Bearing	Hybrid/ceramic
Temperature Sensors, Stator	3 PT100 sensors placed at hot spots and 3 as back-up
Temperature Sensors, Bearings	1 per bearing
Insulation Class	F or H
Enclosure	IP54

Table 3-1: Generator data

3.2 Converter

The converter is a full-scale converter system controlling both the generator and the power quality delivered to the grid.

The converter consists of multiple converter units operating in parallel with a common controller.

The converter controls conversion of variable frequency power from the generator into fixed frequency AC power with desired active and reactive power levels (and other grid connection parameters) suitable for the grid. The converter is located in the nacelle and has a grid side voltage rating of 650 V. The generator side voltage rating is up to 710 V dependent on generator speed.

Converter	
Rated Grid Voltage	650 V

Table 3-2: Converter data

3.3 HV Transformer

The step-up transformer is located in a separate, locked room in the back of the nacelle.

The transformer is a three-phase, two-winding, dry-type transformer which is self-extinguishing. The windings are delta-connected on the high-voltage side unless otherwise specified.

3.3.1 IEC 50Hz/60Hz Version

For 50 Hz regions, the transformer is as default designed according to IEC standards. However, on special request, a 60 Hz transformer based on IEC standards can also be delivered.

Transformer	
Type description	Dry-type cast resin transformer
Basic layout	3 phase, 2 winding transformer
Applied standards	IEC 60076-11, IEC 60076-16, Cenelec HD 637:S1.
Cooling method	AF
Rated power	3450 kVA
Nominal voltage, turbine side	
U_m 1.1kV	0.650 kV
Nominal voltage, grid side	
U_m 12.0kV	10.0-11.0 kV
U_m 24.0kV	11.1-22.0 kV
U_m 36.0kV	22.1-33.0 kV
U_m 41.5kV	33.1-35.0 kV
Insulation level AC / LI / LIC	
U_m 1.1kV	3^1 / - / - kV
U_m 12.0kV	28^1 / 75 / 75 kV
U_m 24.0kV	50^1 / 125 / 125 kV
U_m 36.0kV	70^1 / 170 / 170 kV

U_m 41.5kV	80[1] / 170 / 170 kV
Off-circuit tap changer	±2 x 2.5 %
Frequency	50 Hz / 60 Hz
Vector group	Dyn5 / YNyn0
No-load loss [2]	5.3 kW
Load loss @ rated power HV, 120°C [2]	25.2 kW
No-load reactive power [3]	16kVAr
Full load reactive power [3]	300kVAr
Positive sequence short-circuit impedance @ rated power, 120°C [4]	8.0 %
Positive sequence short-circuit resistance@ rated power, 120°C[3]	0.7 %
Zero sequence short-circuit impedance@ rated power, 120°C[3]	7.8 %
Zero sequence short-circuit resistance@ rated power, 120°C[3]	0.7 %
Inrush peak current [3]	
Dyn5	6-9 x $\hat{I}_n$
YNyn0	8-12 x $\hat{I}_n$
Half crest time [3]	~ 0.7 s
Sound power level	≤ 80 dB(A)
Average temperature rise @ 1000m	≤80 K
Max altitude [5]	2000 m
Insulation class	155 (F)
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1
Corrosion class	C4
Weight	≤8500 kg
Temperature monitoring	PT100 sensors in LV windings and core
Overvoltage protection	Surge arresters on HV terminals
Temporary earthing	3 x Ø20 mm earthing ball points

Table 3-3: Transformer data for IEC 50 Hz/60 Hz version

NOTE

[1] @1000m. According to IEC 60076-11, AC test voltage is altitude dependent.
[2] Based on an average of measured values during qualification tests across voltages and manufacturers.
[3] Based on an average of calculated values across voltages and manufacturers.
[4] Subjected to standard IEC tolerances.
[5] Maximum hub height altitude will depend on site location.

3.3.2 IEEE 60 Hz Version

For 60 Hz regions the transformer is as default designed mainly according to IEEE standards but on areas not covered by IEEE standards, the design is also based on parts of the IEC standards.

Transformer	
Type description	Dry-type cast resin transformer
Basic layout	3 phase, 2 winding transformer
Applied standards	UL 1562, CSA C22.2 No. 47, IEEE C57.12, IEC 60076-11, IEC 60076-16, Cenelec HD 637:S1
Cooling method	AFA
Rated power	3450 kVA
Nominal voltage, turbine side	
N_{LL} 1.2 kV	0.650 kV
Nominal voltage, grid side	
N_{LL} 15.0 kV	10.0-15.0 kV
N_{LL} 25.0 kV	15.1-25.0 kV
N_{LL} 34.5 kV	25.1-34.5 kV
Insulation level AC / LI & LIC	
N_{LL} 1.2 kV	4[1] / +10 kV
N_{LL} 15.0 kV	34[1] / +95 kV
N_{LL} 25.0 kV	50[1] / +125 kV
N_{LL} 34.5 kV	70[1] / (+150 & -170) or +170 kV
Off-circuit tap changer	±2 x 2.5 %
Frequency	60 Hz
Vector group	Dyn5 / YNyn0
No-load loss [2]	5.3 kW
Load loss @ rated power HV, 120°C [2]	25.2 kW
No-load reactive power [3]	16 kVAr
Full load reactive power [3]	300 kVAr
Positive sequence short-circuit impedance @ rated power, 120°C [4]	8.0 %
Positive sequence short-circuit resistance @ rated power, 120°C [3]	0.7 %
Zero sequence short-circuit impedance @ rated power, 120°C [3]	7.8 %
Zero sequence short-circuit resistance @ rated power, 120°C [3]	0.7 %
Inrush peak current [3]	
Dyn5	6-9 x $\hat{I}_n$
YNyn0	8-12 x $\hat{I}_n$
Half crest time [3]	~ 0.7 s
Sound power level	≤ 80 dB(A)
Average temperature rise @ 1000m	≤ 80 K
Max altitude [5]	2000 m
Insulation class	150°C
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1

Corrosion class	C4
Weight	≤ 8500 kg
Temperature monitoring	PT100 sensors in LV windings and core
Overvoltage protection	Surge arresters on HV terminals
Temporary earthing	3 x Ø20 mm earthing ball points

Table 3-4: Transformer data for IEEE 60 Hz version

NOTE

[1] @1000m. According to IEEE C57.12, AC test voltage is altitude dependent.
[2] Based on an average of measured values during qualification tests across voltages and manufacturers.
[3] Based on an average of calculated values across voltages and manufacturers.
[4] Subjected to standard IEEE C57.12 tolerances.
[5] Maximum hub height altitude will depend on site location.

3.4 HV Cables

The high-voltage cable runs from the transformer in the nacelle down the tower to the switchgear located at the bottom of the tower. The high-voltage cable is a four-core, rubber-insulated, halogen-free, high-voltage cable.

HV Cables	
High-Voltage Cable Insulation Compound	Improved ethylene-propylene (EP) based material-EPR or high modulus or hard grade ethylene-propylene rubber-HEPR
Conductor Cross Section	3 x 70 / 70 mm^2
Maximum Voltage	24 kV for 10-22 kV rated voltage 42 kV for 22.1-35 kV rated voltage

Table 3-5: HV cables data

3.5 HV Switchgear

The high-voltage switchgear is located in the bottom of the tower.

HV Switchgear			
Type	Gas insulated SF6		
Nominal Frequency	50/60 Hz		
Nominal Rated Voltage	10–22 kV	22.1–33 kV	33.1–35 kV
Maximum Voltage	24 kV	36 kV	40.5 kV
Maximum Short Circuit Current (1 second)	20 kA	25 kA	25 kA

Table 3-6: HV switchgear data

3.6 AUX System

The AUX system is supplied from a separate 650/400 V transformer located in the nacelle. All motors, pumps, fans and heaters are supplied from this system.

All 230 V consumers are supplied from a 400/230 V transformer located in the tower base.

Power Sockets	
Single Phase (Nacelle and Tower Platforms)	230 V (16 A)/110 V (16 A)/ 2 x 55 V (16 A)
Three Phase (Nacelle and Tower Base)	3 x 400 V (16 A)

Table 3-7: AUX system data

3.7 Wind Sensors

The turbine is either equipped with two ultrasonic wind sensors or one ultrasonic wind sensor and one mechanical wind vane and anemometer. The sensors have built-in heaters to minimise interference from ice and snow. The wind sensors are redundant, and the turbine is able to operate with one sensor only.

3.8 Vestas Multi Processor (VMP) Controller

The turbine is controlled and monitored by the VMP6000 control system.

VMP6000 is a multiprocessor control system comprised of four main processors (ground, nacelle, hub and converter) interconnected by an optically based 2.5 Mbit ArcNet network.

In addition to the four main processors, the VMP6000 consists of a number of distributed I/O modules interconnected by a 500 kbit CAN network.

I/O modules are connected to CAN interface modules by a serial digital bus, CTBus.

The VMP6000 controller serves the following main functions:

- Monitoring and supervision of overall operation
- Synchronizing of the generator to the grid during connection sequence
- Operating the wind turbine during various fault situations
- Automatic yawing of the nacelle
- OptiTip® - blade pitch control
- Reactive power control and variable speed operation
- Noise emission control
- Monitoring of ambient conditions
- Monitoring of the grid
- Monitoring of the smoke detection system

3.9 Uninterruptible Power Supply (UPS)

The UPS is equipped with an AC/DC, DC/AC converter (double conversions) and battery cells placed in the same cabinet as the converter. During grid outage, the UPS will supply specific components with 230 V AC.

The backup time for the UPS system is proportional to the power consumption. Actual backup time may vary.

UPS						
Battery Type	Valve-Regulated Lead Acid (VRLA)					
Rated Battery Voltage	2 x 8 x 12 V (192 V)					
Converter Type	Double conversion					
Converter Input	230 V +/-20%					
Rated Output Voltage	230 Vac					
Backup Time**	**Aviation Lights**		**0 hr.**	**1 hr.**	**8 hrs.**	**>8 hrs.**
	Control System*	**15 min.**	1 EXB	1 EXB	3 EXB	4 EXB (max. 630min.)
		1 hr.	1 EXB	3 EXB	4 EXB	N/A.
		2 hrs.	2 EXB	3 EXB	4 EXB	N/A.
		3 hrs.	3 EXB	4 EXB	N/A.	N/A.
		>3 hrs.	4 EXB (max. 230min.)	N/A.	N/A.	N/A.
Re-charging Time	80%		Approximately 3 hours			
	100%		Approximately 8 hours			

Table 3-8: UPS data

N/A. = desired back-up time not possible

EXB = extra battery pack.

**The control system includes: the turbine controller (System 6000), switchgear functions, and remote control system. Internal lights are fed by separate built-in batteries.*

NOTE ** For alternative backup times, consult Vestas.

4 Turbine Protection Systems

4.1 Braking Concept

The main brake on the turbine is aerodynamic. Braking the turbine is done by full feathering the three blades (individually turning each blade). Each blade has a hydraulic accumulator to supply power for turning the blade. Braking of the turbine is further supported by a braking resistor that is connected to the permanent magnet generator during shut down. This ensures that torque is maintained in, for example, grid loss situations.

In addition, there is a mechanical disc brake on the high-speed shaft of the gearbox with a dedicated hydraulic system. The mechanical brake is only used as a parking brake and when activating the emergency stop buttons.

4.2 Short Circuit Protections

Breakers	**Breaker for Aux. Power.** **T4L 250A TMD 4P** **690 V**	**Breaker for Converter Modules** **T7M1200L PR332/P LSIG 1000 A 3P** **690 V**
Breaking Capacity, Icu, Ics	70 kA@690 V	50 kA @690 V
Making Capacity, Icm	154 kA@690 V	105 kA @690 V

Table 4-1: Short circuit protection data

4.3 Overspeed Protection

The generator rpm and the main shaft rpm are registered by inductive sensors and calculated by the wind turbine controller to protect against overspeed and rotating errors.

In addition, the turbine is equipped with a safety PLC, an independent computer module that measures the rotor rpm. In case of an overspeed situation, the safety PLC activates the emergency feathered position (full feathering) of the three blades independently of the turbine controller.

Overspeed Protection	
Sensors Type	Inductive
Trip Level	17.66 (rotor rpm)/2000 (generator rpm)

Table 4-3: Overspeed protection data

4.4 Lightning Protection of Blades, Nacelle, Hub and Tower

The Lightning Protection System (LPS) helps protect the wind turbine against the physical damage caused by lightning strikes. The LPS consists of five main parts:

- Lightning receptors
- Down-conducting system (a system to conduct the lightning current down through the wind turbine to help avoid or minimise damage to the LPS itself or other parts of the wind turbine)
- Protection against over-voltage and over-current
- Shielding against magnetic and electrical fields
- Earthing system

Lightning Protection Design Parameters			Protection Level I
Current Peak Value	i_{max}	[kA]	200
Impulse Charge	$Q_{impulse}$	[C]	100
Long Duration Charge	Q_{long}	[C]	200
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/Ω]	10
Average Steepness	di/dt	[kA/μs]	200

Table 4-4: Lightning protection design parameters

NOTE The Lightning Protection System is designed according to IEC standards (see section 7 Approvals and Design Codes, p. 23).

4.5 EMC System

The turbine and related equipment fulfils the EU Electromagnetic Compatibility (EMC) legislation:

- DIRECTIVE 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC

4.6 Earthing

The Vestas Earthing System consists of a number of individual earthing electrodes interconnected as one joint earthing system.

The Vestas Earthing System includes the TN-system and the Lightning Protection System for each wind turbine. It works as an earthing system for the medium voltage distribution system within the wind farm.

The Vestas Earthing System is adapted for the different types of turbine foundations. A separate set of documents describe the earthing system in detail, depending on the type of foundation.

In terms of lightning protection of the wind turbine, Vestas has no separate requirements for a certain minimum resistance to remote earth (measured in ohms) for this system. The earthing for the lightning protection system is based on the design and construction of the Vestas Earthing System.

A primary part of the Vestas Earthing System is the main earth bonding bar placed where all cables enter the wind turbine. All earthing electrodes are connected to this main earth bonding bar. Additionally, equipotential connections are made to all cables entering or leaving the wind turbine.

Requirements in the Vestas Earthing System specifications and work descriptions are minimum requirements from Vestas and IEC. Local and national requirements, as well as project requirements, may require additional measures.

4.7 Corrosion Protection

Classification of corrosion protection is according to ISO 12944-2.

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5	Minimum C3
Hub	C5	C3
Tower	C4	C3

Table 4-5: Corrosion protection data for nacelle, hub and tower

5 Safety

The safety specifications in this section provide limited general information about the safety features of the turbine and are not a substitute for Buyer and its agents taking all appropriate safety precautions, including but not limited to (a) complying with all applicable safety, operation, maintenance, and service agreements, instructions, and requirements, (b) complying with all safety-related laws, regulations, and ordinances, and (c) conducting all appropriate safety training and education.

5.1 Access

Access to the turbine from the outside is through the bottom of the tower. The door is equipped with a lock. Access to the top platform in the tower is by a ladder or service lift. Access to the nacelle from the top platform is by ladder. Access to the transformer room in the nacelle is controlled with a lock. Unauthorised access to electrical switchboards and power panels in the turbine is prohibited according to IEC 60204-1 2006.

5.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch, from the spinner by opening the nose cone, or from the roof of the nacelle. Rescue equipment is placed in the nacelle.

The hatch in the roof can be opened from both the inside and outside.

Escape from the service lift is by ladder.

An emergency response plan, placed in the turbine, describes evacuation and escape routes.

5.3 Rooms/Working Areas

The tower and nacelle are equipped with power sockets for electrical tools for service and maintenance of the turbine.

5.4 Floors, Platforms, Standing and Working Places

All floors have anti-slip surfaces.

There is one floor per tower section.

Rest platforms are provided at intervals of 9 metres along the tower ladder between platforms.

Foot supports are placed in the turbine for maintenance and service purposes.

5.5 Service Lift

The V112-3.0 MW turbine can be delivered with a service lift as an option.

5.6 Climbing Facilities

A ladder with a fall arrest system (rigid rail) is mounted through the tower.

There are anchor points in the tower, nacelle and hub, and on the roof for attaching fall arrest equipment (full-body harness).

Over the crane hatch there is an anchor point for the emergency descent equipment.

Anchor points are coloured yellow and are calculated and tested to 22.2 kN.

5.7 Moving Parts, Guards and Blocking Devices

All moving parts in the nacelle are shielded.

The turbine is equipped with a rotor lock to prevent the rotor and drive train from rotating.

Blocking the pitch of the cylinder can be done with mechanical tools in the hub.

5.8 Lights

The turbine is equipped with lights in the tower, nacelle, transformer room and hub.

There is emergency light in case of the loss of electrical power.

5.9 Emergency Stop

There are emergency stop buttons in the nacelle, hub and bottom of the tower.

5.10 Power Disconnection

The turbine is equipped with breakers to allow for disconnection from all power sources during inspection or maintenance. The switches are marked with signs and are located in the nacelle and bottom of the tower.

5.11 Fire Protection/First Aid

A handheld 5-6 kg CO_2 fire extinguisher, first aid kit and fire blanket are required to be located in the nacelle during service and maintenance.

- A handheld 5-6 kg CO_2 fire extinguisher is required only during service and maintenance activities, unless a permanently mounted fire extinguisher located in the nacelle is mandatorily required by authorities.
- First aid kits are required only during service and maintenance activities.
- Fire blankets are required only during non-electrical hot work activities.

5.12 Warning Signs

Warning signs placed inside or on the turbine must be reviewed before operating or servicing the turbine.

5.13 Manuals and Warnings

The Vestas Corporate OH&S Manual and manuals for operation, maintenance and service of the turbine provide additional safety rules and information for operating, servicing or maintaining the turbine.

6 Environment

6.1 Chemicals

Chemicals used in the turbine are evaluated according to the Vestas Wind Systems A/S Environmental System certified according to ISO 14001:2004. The following chemicals are used in the turbine:

- Anti-freeze to help prevent the cooling system from freezing
- Gear oil for lubricating the gearbox
- Hydraulic oil to pitch the blades and operate the brake
- Grease to lubricate bearings
- Various cleaning agents and chemicals for maintenance of the turbine

7 Approvals and Design Codes

7.1 Type Approvals

The standard turbine is type certified according to the certification standards listed below:

Certification	Wind Class	Hub Height
IEC61400-22	IEC IIA	84 m / 94 m
	IEC IIIA	119 m / 140 m
DIBt Anlage 2.7/10	DIBt II	94 m / 119 m / 140 m
	DIBt III	94 m / 119 m

Table 7-1: Type approvals data

7.2 Design Codes – Structural Design

The turbine design has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes	
Nacelle and Hub	IEC 61400-1 Edition 3 EN 50308
Tower	IEC 61400-1 Edition 3 Eurocode 3
Blades	DNV-OS-J102 IEC 1024-1 IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) IEC WT 01 IEC DEFU R25 ISO 2813 DS/EN ISO 12944-2
Gearbox	ISO 81400-4
Generator	IEC 60034
Transformer	IEC 60076-11, IEC 60076-16, CENELEC HD637 S1
Lightning Protection	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006 IEC/TR 61400-24:2002
Rotating Electrical Machines	IEC 34
Safety of Machinery, Safety-related Parts of Control Systems	IEC 13849-1
Safety of Machinery – Electrical Equipment of Machines	IEC 60204-1

Table 7-2: Design codes

8 Colours

8.1 Nacelle Colour

Colour of Vestas Nacelles	
Standard Nacelle Colour	RAL 7035 (light grey)
Standard Logo	Vestas

Table 8-1: Colour, nacelle

8.2 Tower Colour

Colour of Vestas Tower Section		
	External:	**Internal:**
Standard Tower Colour	RAL 7035 (light grey)	RAL 9001 (cream white)

Table 8-2: Colour, tower

8.3 Blades Colour

Blades Colour	
Standard Blade Colour	RAL 7035 (light grey)
Tip-End Colour Variants	RAL 2009 (traffic orange), RAL 3020 (traffic red)
Gloss	< 30% DS/EN ISO 2813

Table 8-3: Colour, blades

9 Operational Envelope and Performance Guidelines

Actual climate and site conditions have many variables and should be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section do not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

9.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters	
Wind Climate	**IEC IIA**
Ambient Temperature Interval (Standard Temperature Turbine)	-40° to +50°C
Extreme Wind Speed (10 Minute Average)	42.5 m/s
Survival Wind Speed (3 Second Gust)	59.5 m/s

Table 9-1: Extreme design parameters

Average Design Parameters	
Wind Climate	**IEC IIA**
Wind Speed	8.5 m/s
A-Factor	9.59 m/s
Form Factor, c	2.0
Turbulence Intensity According to IEC 61400-1, Including Wind Farm Turbulence (@15 m/s – 90% quartile)	18%
Wind Shear	0.20
Inflow Angle (vertical)	8°

Table 9-2: Average design parameters

9.1.1 Complex Terrain

Classification of complex terrain according to IEC 61400-1:2005 Chapter 11.2.

For sites classified as complex, appropriate measures are to be included in site assessment.

Positioning of each turbine must be verified via the Vestas Site Check programme.

9.1.2 Altitude

The turbine is designed for use at altitudes up to 1000 m above sea level as standard and can, as an option, be designed for use at altitude up to 2000 m above sea level.

9.1.3 Wind Power Plant Layout

Turbine spacing is to be evaluated site-specifically. Spacing, in any case, must not be below three rotor diameters (3D).

NOTE As evaluation of climate and site conditions is complex, consult Vestas for every project. If conditions exceed the above parameters, Vestas must be consulted.

9.2 Operational Envelope – Temperature and Wind

Values refer to hub height and are determined by the sensors and control system of the turbine.

Operational Envelope – Temperature and Wind	
Ambient Temperature Interval (Standard Turbine)	-20° to +40°C
Ambient Temperature Interval (Low Temperature Turbine)	-30° to +40°C
Cut-In	3 m/s
Cut-Out (10 Minute Exponential Average)	25 m/s
Re-Cut In (10 Minute Exponential Average)	23 m/s

Table 9-3: Operational envelope – temperature and wind

NOTE At ambient temperatures above +40°C, the turbine will maintain derated production, within the component capacity as seen in Figure 9-1, p. 27.

The wind turbine will stop producing power when ambient temperature is above 45°C. For the low and high temperature options of the wind turbine, consult Vestas.

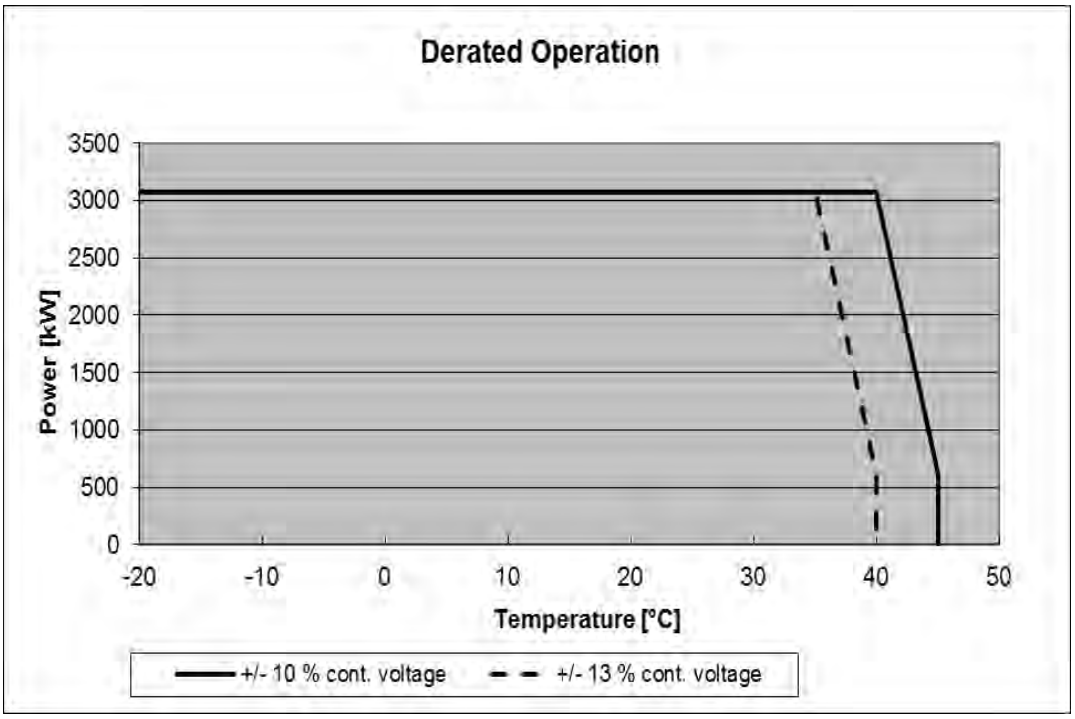


Figure 9-1: Derated operation

9.3 Operational Envelope – Grid Connection

Operational Envelope – Grid Connection		
Nominal Phase Voltage	[U_{NP}]	650 V
Nominal Frequency	[f_N]	50/60 Hz
Maximum Steady State Voltage Jump	±2% (from turbine) ±4% (from grid)	
Maximum Frequency Gradient	±4 Hz/sec.	
Maximum Negative Sequence Voltage	3% (connection) 2% (operation)	
Minimum Required Short Circuit Ratio at Turbine HV Connection	5.0	
Maximum Short Circuit Current Contribution	1.05 p.u. (continuous) 1.45 p.u. (peak)	

Table 9-4: Operational envelope – grid connection

The generator and the converter will be disconnected if*:

Protection Settings	
Voltage Above 110% of Nominal for 3600 Seconds**	715 V
Voltage Above 121% of Nominal for 2 Seconds	787 V
Voltage Above 136% of Nominal for 0.150 Seconds	884 V
Voltage Below 90% of Nominal for 60 Seconds**	585 V
Voltage Below 80% of Nominal for 10 Seconds	520 V
Frequency is Above 106% of Nominal for 0.2 Seconds	53/63.6 Hz
Frequency is Below 94% of Nominal for 0.2 Seconds	47/56.4 Hz

Table 9-5: Generator and converter disconnecting values

NOTE

* Over the turbine lifetime, grid drop-outs are to occur at an average of no more than 50 times a year.

** The turbine may be configured for continuous operation @ +/- 13 % voltage. Reactive power capability and acceptable ambient temperature are limited for these widened settings (See section 9.2 and 9.4)

9.4 Operational Envelope – Reactive Power Capability

The turbine has a reactive power capability as illustrated:

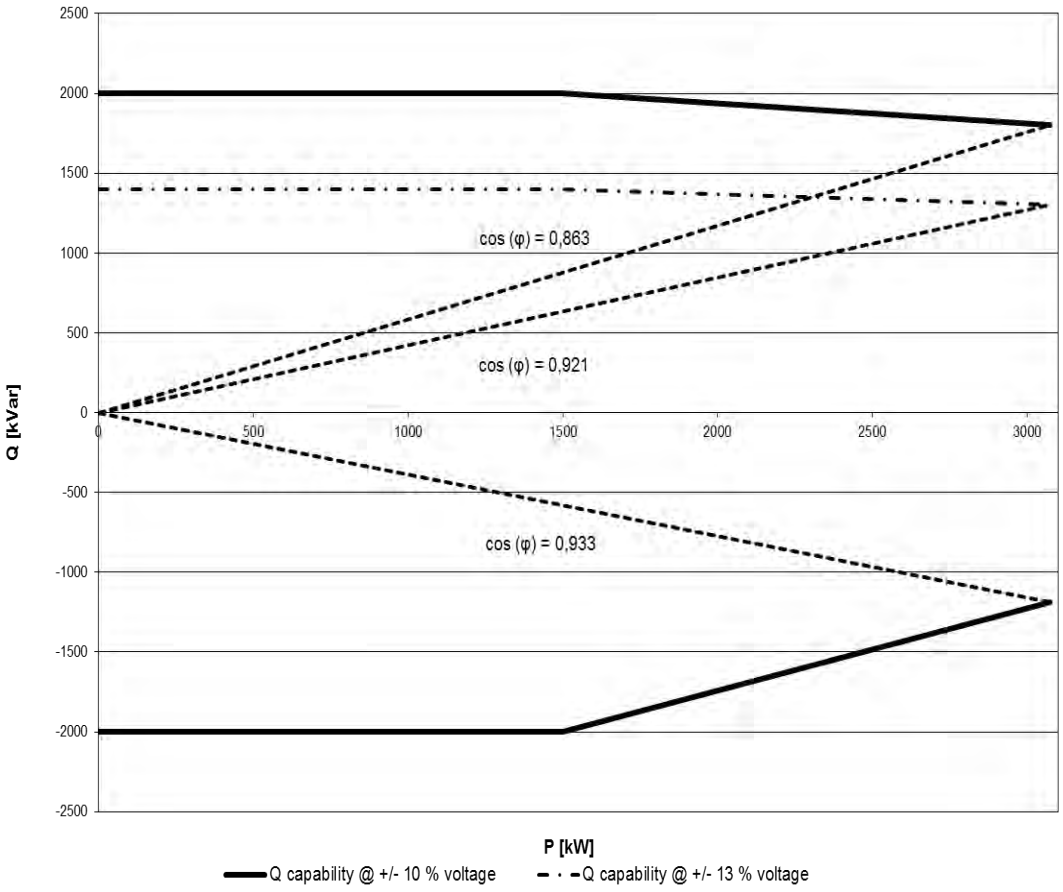


Figure 9-2: Reactive power capability

Reactive power capability at full load on high voltage side of the HV transformer is approximately: cosφ = 0.90/0.90 capacitive/inductive @ +/- 10 % voltage and cosφ = 0.95/0.90 capacitive/inductive @ +/- 13 % voltage.

Reactive power is produced by the full-scale converter. Traditional capacitors are, therefore, not used in the turbine.

The turbine is able to maintain the reactive power capability at low wind with no active power production.

9.5 Performance – Fault Ride Through

The turbine is equipped with a full-scale converter to gain better control of the wind turbine during grid faults. The turbine control system continues to run during grid faults.

The turbine is designed to stay connected during grid disturbances within the voltage tolerance curve as illustrated:

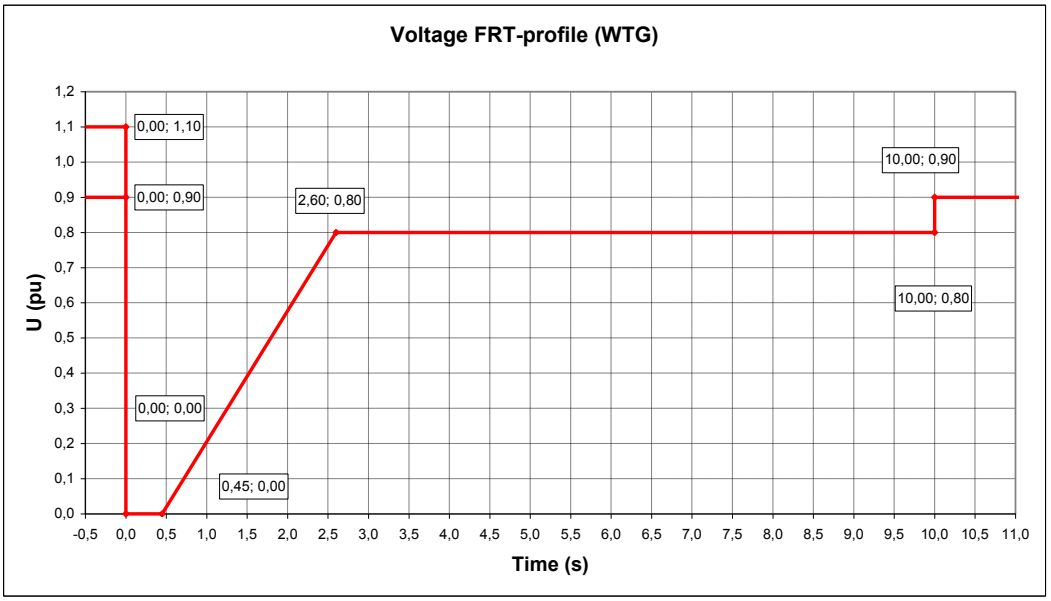


Figure 9-3: Low voltage tolerance curve for symmetrical and asymmetrical faults, where U represents voltage as measured on the grid.

For grid disturbances outside the protection curve in Figure 9-3, p. 30 the turbine will be disconnected from the grid.

Power Recovery Time	
Power Recovery to 90% of Pre-Fault Level	Maximum 0.1 seconds

Table 9-6: Power recovery time

9.6 Performance – Reactive Current Contribution

The reactive current contribution depends on whether the fault applied to the turbine is symmetrical or asymmetrical.

9.6.1 Symmetrical Reactive Current Contribution

During symmetrical voltage dips, the wind farm will inject reactive current to support the grid voltage. The reactive current injected is a function of the measured grid voltage.

The default value gives a reactive current part of 1 pu of the rated active current at the high voltage side of the HV transformer. Figure 9-4, p. 31 indicates the reactive current contribution as a function of the voltage. The reactive current contribution is independent from the actual wind conditions and pre-fault power level.

As seen in Figure 9-4, p. 31, the default current injection slope is 2% reactive current increase per 1% voltage decrease. The slope can be parameterized between 0 and 10 to adapt to site specific requirements.

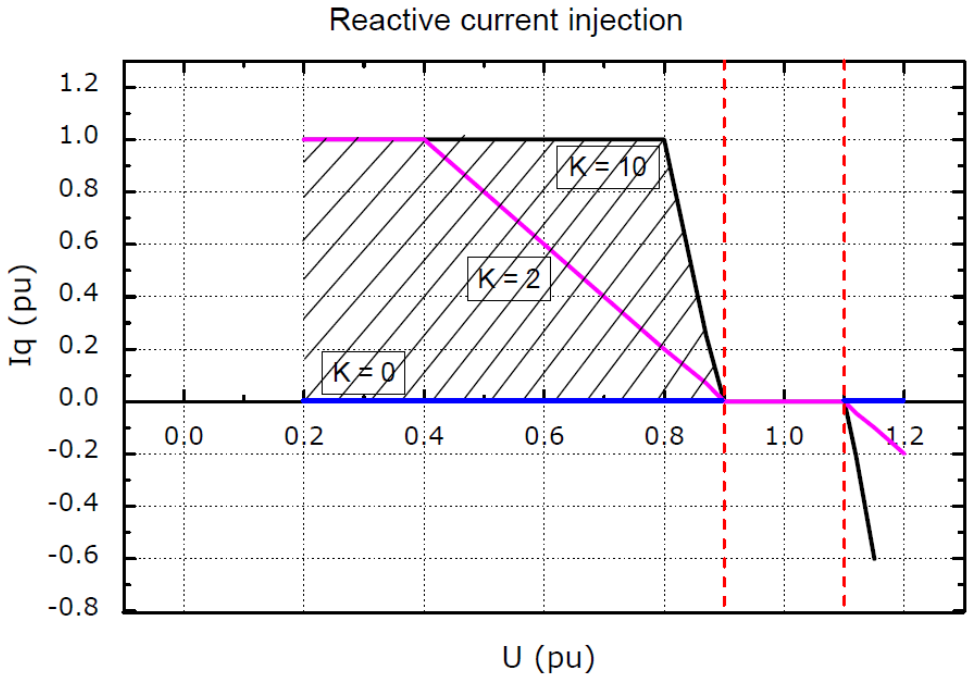


Figure 9-4: Reactive current injection

9.6.2 Asymmetrical Reactive Current Contribution

The injected current is based on the measured positive sequence voltage and the used K-factor. During asymmetrical voltage dips, the reactive current injection is limited to approximate 0.4 pu to limit the potential voltage increase on the healthy phases.

9.7 Performance – Multiple Voltage Dips

The turbine is designed to handle re-closure events and multiple voltage dips within a short period of time due to the fact that voltage dips are not evenly distributed during the year. For example, the turbine is designed to handle 10 voltage dips of duration of 200 ms, down to 20% voltage, within 30 minutes.

9.8 Performance – Active and Reactive Power Control

The turbine is designed for control of active and reactive power via the VestasOnline® SCADA system.

Maximum Ramp Rates for External Control	
Active Power	0.1 pu/sec (300 kW/sec)
Reactive Power	20 pu/sec (60 MVAr/sec)

Table 9-7: Active/reactive power ramp rates

To support grid stability the turbine is capable to stay connected to the grid at active power references down to 10 % of nominal power for the turbine. For active power references below 10 % the turbine may disconnect from the grid.

9.9 Performance – Voltage Control

The turbine is designed for integration with VestasOnline® voltage control by utilising the turbine reactive power capability.

9.10 Performance – Frequency Control

The turbine can be configured to perform frequency control by decreasing the output power as a linear function of the grid frequency (over frequency).

Dead band and slope for the frequency control function are configurable.

9.11 Main Contributors to Own Consumption

The consumption of electrical power by the wind turbine is defined as the power used by the wind turbine when it is not providing energy to the grid. This is defined in the control system as Production Generator 0 (zero).The following components have the largest influence on the own consumption of the wind turbine (the average own consumption depends on the actual conditions, the climate, the wind turbine output, the cut-off hours, etc.):

Main contributors to Own Consumption	
Hydraulic Motor	2 x 15 kW (master/slave)
Yaw Motors	Maximum 18 kW in total
Water Heating	10 kW
Water Pumps	2.2 + 5.5 kW
Oil Heating	7.9 kW
Oil Pump for Gearbox Lubrication	10 kW
Controller Including Heating Elements for the Hydraulics and all Controllers	Approximately 3 kW
HV Transformer No-load Loss	See section 3.3 HV Transformer, p. 13

Table 9-8: Main contributors to own consumption data

9.12 Operational Envelope – Conditions for Power Curve and Ct Values (at Hub Height)

See section 12 Appendices, p. 36 for power curves and C_t values.

Conditions for Power Curve and C_t Values (at Hub Height)	
Wind Shear	0.00-0.30 (10 minute average)
Turbulence Intensity	6-12% (10 minute average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No
Leading Edge	No damage
Terrain	IEC 61400-12-1

Conditions for Power Curve and C_t Values (at Hub Height)	
Inflow Angle (Vertical)	0 ±2°
Grid Frequency	Nominal Frequency ±0.5 Hz

Table 9-9: Conditions for power curve and C_t values

9.13 Noise Modes

The noise modes mentioned in section 12 Appendices, p. 36 are available for the hub heights listed in table tower structure data in section 2.14 Towers, p. 10, except for noise mode 6 with is not available for hub height 119 m.

10 Drawings

10.1 Structural Design – Illustration of Outer Dimensions

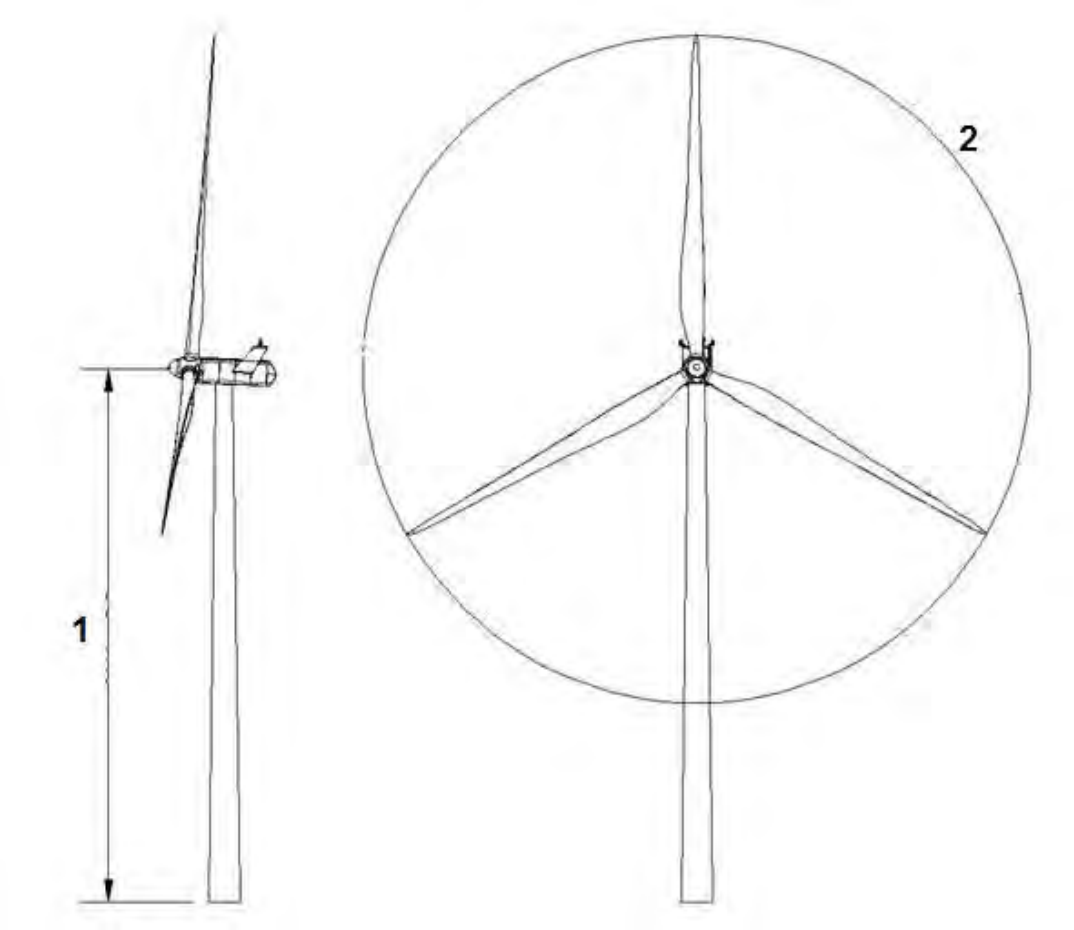


Figure 10-1: Illustration of outer dimensions – structure

1 Hub height 84/94/119/140

2 Diameter: 112 m

10.2 Structural Design – Side View Drawing

Figure 10-2: Side-view drawing

11 General Reservations, Notes and Disclaimers

-
- The general specifications described in this document apply to the current version of the V112-3.0 MW wind turbine. Updated versions of the V112-3.0 MW wind turbine, which may be manufactured in the future, may differ from these general specifications. In the event that Vestas supplies an updated version of the V112-3.0 MW wind turbine, Vestas will provide an updated general specification applicable to the updated version.
- Vestas recommends that the grid be as close to nominal as possible with limited variation in frequency and voltage.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- All listed start/stop parameters (e.g. wind speeds and temperatures) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.

- The earthing system must comply with the minimum requirements from Vestas, and be in accordance with local and national requirements and codes of standards.
- This document, General Specification, is not an offer for sale, and does not contain any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method). Any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method) must be agreed to separately in writing between recipient and Vestas.

12 Appendices

12.1 Mode 0

12.1.1 Power Curves, Noise Mode 0

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**26**	11	12	13	15	16	17	19	20	22	23	25	27	29
3.5	**73**	45	48	50	53	55	58	60	63	65	68	70	75	78
4	**133**	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	**207**	150	155	161	166	171	176	181	187	192	197	202	213	218
5	**302**	223	230	237	244	251	259	266	273	280	287	294	309	316
5.5	**416**	312	321	331	340	350	359	369	378	388	397	407	426	435
6	**554**	418	431	443	455	468	480	493	505	517	530	542	567	579
6.5	**717**	544	560	576	591	607	623	638	654	670	686	701	733	749
7	**907**	691	711	730	750	769	789	809	828	848	867	887	926	946
7.5	**1126**	860	884	908	932	956	981	1005	1029	1053	1077	1102	1150	1174
8	**1375**	1053	1082	1112	1141	1170	1200	1229	1258	1287	1316	1346	1404	1433
8.5	**1652**	1270	1305	1340	1375	1410	1445	1480	1514	1549	1583	1618	1687	1721
9	**1958**	1510	1551	1592	1633	1674	1715	1755	1796	1837	1877	1917	1997	2037
9.5	**2282**	1774	1821	1868	1915	1963	2009	2055	2101	2148	2192	2237	2325	2368
10	**2585**	2044	2097	2149	2202	2254	2303	2353	2402	2451	2496	2541	2625	2666
10.5	**2821**	2314	2368	2423	2478	2532	2578	2624	2670	2716	2751	2786	2849	2877
11	**2997**	2571	2624	2678	2731	2784	2821	2858	2895	2932	2953	2975	3010	3023
11.5	**3050**	2790	2830	2870	2910	2950	2969	2988	3007	3027	3034	3042	3054	3059
12	**3067**	2943	2965	2987	3009	3030	3037	3044	3051	3059	3061	3064	3069	3071
12.5	**3074**	3024	3033	3042	3050	3059	3062	3065	3067	3070	3071	3073	3074	3075
13	**3075**	3055	3059	3063	3066	3070	3071	3072	3073	3074	3075	3075	3075	3075
13.5	**3075**	3070	3071	3072	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075
14	**3075**	3074	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
14.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-1: Power curve, noise mode 0

12.1.2 C_t Values, Noise Mode 0

Air density kg/m^3														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.901**	0.903	0.902	0.902	0.902	0.902	0.902	0.902	0.901	0.901	0.901	0.901	0.900	0.900
3.5	**0.847**	0.849	0.849	0.848	0.848	0.848	0.848	0.848	0.848	0.848	0.847	0.847	0.847	0.847
4	**0.821**	0.822	0.822	0.822	0.822	0.821	0.821	0.821	0.821	0.821	0.821	0.821	0.820	0.820
4.5	**0.815**	0.817	0.817	0.816	0.816	0.816	0.816	0.816	0.816	0.815	0.815	0.815	0.815	0.814
5	**0.812**	0.815	0.815	0.814	0.814	0.814	0.814	0.813	0.813	0.813	0.813	0.813	0.812	0.812
5.5	**0.808**	0.810	0.810	0.810	0.810	0.810	0.809	0.809	0.809	0.809	0.808	0.808	0.807	0.807
6	**0.805**	0.809	0.808	0.808	0.807	0.807	0.807	0.806	0.806	0.806	0.805	0.805	0.804	0.804
6.5	**0.801**	0.806	0.806	0.805	0.805	0.804	0.804	0.803	0.803	0.802	0.802	0.802	0.801	0.800
7	**0.798**	0.804	0.803	0.803	0.802	0.802	0.801	0.801	0.800	0.800	0.799	0.799	0.798	0.797
7.5	**0.795**	0.802	0.801	0.801	0.800	0.800	0.799	0.798	0.798	0.797	0.796	0.796	0.794	0.794
8	**0.794**	0.803	0.802	0.801	0.800	0.800	0.799	0.798	0.797	0.797	0.796	0.795	0.794	0.793
8.5	**0.795**	0.804	0.803	0.803	0.802	0.801	0.800	0.799	0.798	0.798	0.797	0.796	0.794	0.793
9	**0.786**	0.796	0.795	0.794	0.794	0.793	0.792	0.791	0.790	0.789	0.788	0.787	0.785	0.784
9.5	**0.760**	0.772	0.771	0.771	0.770	0.769	0.768	0.767	0.766	0.765	0.763	0.761	0.758	0.755
10	**0.713**	0.734	0.733	0.732	0.731	0.730	0.728	0.726	0.725	0.723	0.720	0.717	0.708	0.703
10.5	**0.642**	0.687	0.685	0.684	0.682	0.681	0.677	0.673	0.670	0.666	0.658	0.650	0.633	0.624
11	**0.564**	0.639	0.636	0.633	0.631	0.628	0.620	0.613	0.605	0.598	0.587	0.575	0.552	0.539
11.5	**0.478**	0.588	0.582	0.575	0.569	0.562	0.551	0.539	0.528	0.516	0.503	0.491	0.466	0.454
12	**0.407**	0.534	0.523	0.513	0.502	0.491	0.479	0.466	0.453	0.440	0.429	0.418	0.398	0.388
12.5	**0.352**	0.475	0.462	0.450	0.437	0.424	0.413	0.402	0.391	0.379	0.370	0.361	0.344	0.335
13	**0.307**	0.416	0.404	0.392	0.380	0.368	0.359	0.349	0.340	0.330	0.322	0.315	0.300	0.293
13.5	**0.270**	0.366	0.355	0.344	0.334	0.323	0.315	0.307	0.299	0.290	0.284	0.277	0.265	0.259
14	**0.240**	0.322	0.313	0.303	0.294	0.285	0.278	0.271	0.264	0.257	0.252	0.246	0.235	0.230
14.5	**0.215**	0.285	0.277	0.269	0.262	0.254	0.248	0.242	0.236	0.230	0.225	0.220	0.210	0.206
15	**0.193**	0.254	0.247	0.240	0.234	0.227	0.222	0.216	0.211	0.206	0.201	0.197	0.189	0.185
15.5	**0.174**	0.228	0.222	0.216	0.210	0.204	0.200	0.195	0.190	0.186	0.182	0.178	0.171	0.167
16	**0.158**	0.206	0.201	0.195	0.190	0.185	0.181	0.177	0.172	0.168	0.165	0.161	0.155	0.152
16.5	**0.144**	0.187	0.182	0.177	0.173	0.168	0.164	0.161	0.157	0.153	0.150	0.147	0.141	0.138
17	**0.132**	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.129	0.127
17.5	**0.121**	0.155	0.152	0.148	0.144	0.140	0.137	0.134	0.131	0.128	0.126	0.123	0.118	0.116
18	**0.111**	0.143	0.139	0.136	0.132	0.129	0.126	0.123	0.121	0.118	0.116	0.113	0.109	0.107
18.5	**0.102**	0.131	0.128	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.105	0.101	0.099
19	**0.095**	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.103	0.101	0.099	0.097	0.094	0.092
19.5	**0.088**	0.113	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.087	0.085
20	**0.082**	0.105	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.084	0.081	0.079
20.5	**0.077**	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.075	0.074
21	**0.072**	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.073	0.070	0.069
21.5	**0.067**	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.069	0.066	0.065
22	**0.063**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.062	0.061
22.5	**0.059**	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.062	0.060	0.058	0.057
23	**0.056**	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054
23.5	**0.053**	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052	0.051	0.049	0.048
24.5	**0.047**	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.045
25	**0.044**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043

Table 12-2: C_t values, noise mode 0

12.1.3 Noise Curve, Noise Mode 0

Sound Power Level at Hub Height, Noise Mode 0				
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**			
Hub Height	**84 m**	**94 m**	**119 m**	**140 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.5 4.2	94.5 4.3	94.8 4.5	95.0 4.6
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.2 5.6	97.5 5.7	98.0 5.9	98.4 6.1
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.8 7.0	101.2 7.2	101.9 7.4	102.4 7.6
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.3 8.4	104.5 8.6	105.0 8.9	105.3 9.2
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.0 9.8	106.5 10.0	106.5 10.4	106.5 10.7
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 11.2	106.5 11.4	106.5 11.9	106.5 12.2
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 12.7	106.5 12.9	106.5 13.4	106.5 13.7
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 14.1	106.5 14.3	106.5 14.9	106.5 15.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 15.5	106.5 15.7	106.5 16.3	106.5 16.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 16.9	106.5 17.2	106.5 17.8	106.5 18.3
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 18.3	106.5 18.6	106.5 19.3	106.5 19.8

Table 12-3: Noise curve, noise mode 0

12.2 Mode 1

12.2.1 Power Curves, Noise Mode 1

	Air density [kg/m^3]													
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**26**	11	12	13	15	16	17	19	20	21	23	24	27	29
3.5	**73**	45	48	50	53	55	58	60	63	65	68	70	75	78
4	**131**	91	94	98	102	105	109	113	116	120	124	127	135	138
4.5	**202**	146	152	157	162	167	172	177	182	187	192	197	207	212
5	**291**	215	222	229	236	243	250	257	264	271	277	284	298	305
5.5	**402**	301	310	320	329	338	347	356	365	375	384	393	411	420
6	**538**	406	418	430	442	454	466	478	490	502	514	526	550	562
6.5	**698**	531	546	561	576	592	607	622	637	653	668	683	714	729
7	**885**	675	694	713	732	751	771	790	809	828	847	866	904	923
7.5	**1099**	841	864	888	911	935	958	982	1005	1029	1052	1076	1123	1146
8	**1345**	1031	1060	1089	1117	1146	1174	1203	1231	1260	1288	1317	1373	1402
8.5	**1621**	1247	1281	1316	1350	1384	1418	1452	1486	1520	1554	1587	1655	1689
9	**1924**	1485	1525	1565	1605	1645	1685	1725	1765	1805	1844	1884	1963	2002
9.5	**2246**	1741	1787	1834	1880	1927	1973	2019	2065	2111	2156	2201	2289	2333
10	**2551**	1995	2047	2100	2153	2205	2256	2307	2358	2409	2456	2503	2593	2636
10.5	**2793**	2240	2297	2354	2412	2469	2521	2572	2624	2676	2715	2754	2824	2855
11	**2974**	2464	2524	2585	2645	2706	2752	2797	2843	2889	2917	2945	2991	3008
11.5	**3039**	2672	2726	2780	2834	2888	2917	2946	2975	3005	3016	3028	3045	3051
12	**3062**	2844	2882	2920	2959	2997	3010	3023	3036	3049	3053	3058	3065	3067
12.5	**3072**	2962	2983	3003	3024	3045	3050	3055	3060	3065	3067	3070	3073	3074
13	**3075**	3026	3035	3045	3054	3064	3066	3068	3070	3073	3073	3074	3075	3075
13.5	**3075**	3055	3059	3064	3068	3073	3073	3074	3074	3075	3075	3075	3075	3075
14	**3075**	3069	3070	3072	3073	3075	3075	3075	3075	3075	3075	3075	3075	3075
14.5	**3075**	3073	3074	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-4: Power curve, noise mode 1

12.2.2 C_t Values, Noise Mode 1

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.892**	0.894	0.894	0.894	0.893	0.893	0.893	0.893	0.893	0.893	0.892	0.892	0.892	0.892
3.5	**0.819**	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.819	0.819	0.819	0.819	0.819	0.819
4	**0.765**	0.767	0.767	0.767	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.766	0.765	0.765
4.5	**0.731**	0.732	0.732	0.732	0.732	0.732	0.732	0.732	0.731	0.731	0.731	0.731	0.731	0.730
5	**0.715**	0.717	0.717	0.717	0.717	0.717	0.716	0.716	0.716	0.716	0.716	0.716	0.715	0.715
5.5	**0.712**	0.714	0.714	0.714	0.714	0.713	0.713	0.713	0.713	0.713	0.713	0.712	0.712	0.712
6	**0.718**	0.720	0.720	0.720	0.720	0.720	0.720	0.719	0.719	0.719	0.719	0.718	0.718	0.718
6.5	**0.723**	0.727	0.726	0.726	0.726	0.725	0.725	0.725	0.724	0.724	0.724	0.723	0.723	0.722
7	**0.726**	0.730	0.730	0.729	0.729	0.729	0.728	0.728	0.727	0.727	0.727	0.726	0.725	0.725
7.5	**0.727**	0.732	0.732	0.731	0.731	0.730	0.730	0.729	0.729	0.728	0.728	0.727	0.726	0.726
8	**0.731**	0.737	0.737	0.736	0.736	0.735	0.735	0.734	0.733	0.733	0.732	0.732	0.730	0.730
8.5	**0.736**	0.743	0.743	0.742	0.742	0.741	0.740	0.740	0.739	0.738	0.738	0.737	0.736	0.735
9	**0.737**	0.745	0.744	0.744	0.743	0.742	0.742	0.741	0.740	0.739	0.739	0.738	0.736	0.735
9.5	**0.725**	0.736	0.735	0.734	0.734	0.733	0.732	0.731	0.730	0.729	0.728	0.726	0.723	0.721
10	**0.693**	0.711	0.711	0.710	0.709	0.708	0.706	0.705	0.703	0.702	0.699	0.696	0.688	0.683
10.5	**0.632**	0.675	0.673	0.672	0.671	0.669	0.666	0.662	0.658	0.655	0.647	0.640	0.623	0.614
11	**0.560**	0.632	0.629	0.627	0.624	0.621	0.614	0.606	0.599	0.592	0.581	0.570	0.547	0.535
11.5	**0.476**	0.585	0.578	0.572	0.565	0.559	0.547	0.536	0.525	0.514	0.501	0.489	0.464	0.453
12	**0.407**	0.532	0.522	0.511	0.500	0.490	0.477	0.465	0.452	0.440	0.429	0.418	0.397	0.387
12.5	**0.351**	0.474	0.462	0.449	0.436	0.424	0.413	0.401	0.390	0.379	0.370	0.361	0.343	0.335
13	**0.307**	0.416	0.404	0.392	0.380	0.368	0.359	0.349	0.340	0.330	0.322	0.315	0.300	0.293
13.5	**0.270**	0.366	0.355	0.344	0.334	0.323	0.315	0.307	0.299	0.290	0.284	0.277	0.265	0.259
14	**0.240**	0.322	0.313	0.303	0.294	0.285	0.278	0.271	0.264	0.257	0.252	0.246	0.235	0.230
14.5	**0.215**	0.285	0.277	0.269	0.262	0.254	0.248	0.242	0.236	0.230	0.225	0.220	0.210	0.206
15	**0.193**	0.254	0.247	0.240	0.234	0.227	0.222	0.216	0.211	0.206	0.201	0.197	0.189	0.185
15.5	**0.174**	0.228	0.222	0.216	0.210	0.204	0.200	0.195	0.190	0.186	0.182	0.178	0.171	0.167
16	**0.158**	0.206	0.201	0.195	0.190	0.185	0.181	0.177	0.172	0.168	0.165	0.161	0.155	0.152
16.5	**0.144**	0.187	0.182	0.177	0.173	0.168	0.164	0.161	0.157	0.153	0.150	0.147	0.141	0.138
17	**0.132**	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.129	0.127
17.5	**0.121**	0.155	0.152	0.148	0.144	0.140	0.137	0.134	0.131	0.128	0.126	0.123	0.118	0.116
18	**0.111**	0.143	0.139	0.136	0.132	0.129	0.126	0.123	0.121	0.118	0.116	0.113	0.109	0.107
18.5	**0.102**	0.131	0.128	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.105	0.101	0.099
19	**0.095**	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.103	0.101	0.099	0.097	0.094	0.092
19.5	**0.088**	0.113	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.087	0.085
20	**0.082**	0.105	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.084	0.081	0.079
20.5	**0.077**	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.075	0.074
21	**0.072**	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.073	0.070	0.069
21.5	**0.067**	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.069	0.066	0.065
22	**0.063**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.062	0.061
22.5	**0.059**	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.062	0.060	0.058	0.057
23	**0.056**	0.070	0.069	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054
23.5	**0.053**	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052	0.051	0.049	0.048
24.5	**0.047**	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.045
25	**0.044**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043

Table 12-5: C_t values, noise mode 1

12.2.3 Noise Curve, Noise Mode 1

Sound Power Level at Hub Height, Noise Mode 1				
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**			
Hub Height	**84 m**	**94 m**	**119 m**	**140**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.2 4.2	94.3 4.3	94.4 4.5	94.5 4.6
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	96.2 5.6	96.5 5.7	97.0 5.9	97.4 6.1
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	99.8 7.0	100.2 7.2	100.9 7.4	101.4 7.6
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.3 8.4	103.6 8.6	104.3 8.9	104.7 9.2
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.9 9.8	106.5 10.0	106.5 10.4	106.5 10.7
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 11.2	106.5 11.4	106.5 11.9	106.5 12.2
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 12.7	106.5 12.9	106.5 13.4	106.5 13.7
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 14.1	106.5 14.3	106.5 14.9	106.5 15.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 15.5	106.5 15.7	106.5 16.3	106.5 16.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 16.9	106.5 17.2	106.5 17.8	106.5 18.3
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 18.3	106.5 18.6	106.5 19.3	106.5 19.8

Table 12-6: Noise curve, noise mode 1

12.3 Mode 2

12.3.1 Power Curves

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**26**	11	12	13	15	16	17	19	20	21	23	24	27	29
3.5	**73**	45	48	50	53	55	58	60	63	65	68	70	75	78
4	**133**	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	**207**	150	155	161	166	171	176	181	187	192	197	202	212	218
5	**301**	223	230	237	244	251	258	266	273	280	287	294	308	315
5.5	**416**	311	321	330	340	349	359	368	378	387	397	406	425	435
6	**553**	417	430	442	454	467	479	491	504	516	528	541	565	578
6.5	**715**	543	559	574	590	605	621	637	652	668	684	699	731	746
7	**903**	689	708	728	747	767	786	806	825	845	864	884	923	943
7.5	**1121**	856	880	904	928	952	976	1001	1025	1049	1073	1097	1145	1169
8	**1365**	1045	1075	1104	1133	1162	1191	1220	1249	1278	1307	1336	1393	1422
8.5	**1631**	1255	1289	1324	1358	1392	1427	1461	1495	1529	1563	1597	1665	1699
9	**1910**	1475	1515	1555	1595	1635	1674	1714	1753	1793	1832	1871	1949	1988
9.5	**2191**	1699	1744	1790	1835	1880	1925	1970	2014	2059	2103	2147	2234	2277
10	**2447**	1908	1958	2008	2059	2109	2158	2207	2256	2306	2353	2400	2492	2536
10.5	**2668**	2102	2156	2211	2265	2320	2372	2424	2476	2529	2575	2621	2705	2742
11	**2829**	2279	2337	2395	2453	2512	2562	2612	2663	2713	2752	2790	2857	2885
11.5	**2932**	2441	2499	2557	2615	2673	2717	2761	2805	2849	2876	2904	2949	2965
12	**2996**	2596	2650	2703	2756	2809	2843	2877	2911	2945	2962	2979	3004	3013
12.5	**3034**	2745	2789	2833	2877	2921	2943	2964	2986	3008	3016	3025	3038	3043
13	**3056**	2879	2909	2939	2969	2999	3010	3021	3032	3043	3047	3052	3058	3060
13.5	**3067**	2966	2984	3002	3020	3038	3044	3050	3056	3062	3064	3065	3068	3069
14	**3072**	3026	3034	3043	3052	3061	3063	3066	3068	3070	3071	3071	3072	3073
14.5	**3074**	3057	3060	3064	3067	3071	3071	3072	3073	3074	3074	3074	3074	3074
15	**3075**	3069	3070	3071	3073	3074	3074	3074	3074	3075	3074	3074	3075	3075
15.5	**3075**	3074	3074	3074	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075
16	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-7: Power curve, noise mode 2

12.3.2 C_t Values, Noise Mode 2

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.899**	0.901	0.901	0.900	0.900	0.900	0.900	0.900	0.899	0.899	0.899	0.899	0.898	0.898
3.5	**0.845**	0.847	0.847	0.847	0.846	0.846	0.846	0.846	0.846	0.846	0.846	0.845	0.845	0.845
4	**0.816**	0.818	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.816	0.816	0.816	0.816
4.5	**0.805**	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.805	0.805	0.805
5	**0.801**	0.804	0.804	0.804	0.803	0.803	0.803	0.802	0.802	0.802	0.802	0.801	0.801	0.801
5.5	**0.798**	0.802	0.801	0.801	0.801	0.800	0.800	0.800	0.800	0.799	0.799	0.799	0.798	0.798
6	**0.796**	0.799	0.799	0.798	0.798	0.798	0.798	0.797	0.797	0.797	0.796	0.796	0.795	0.795
6.5	**0.790**	0.795	0.794	0.794	0.794	0.793	0.793	0.792	0.792	0.792	0.791	0.790	0.789	0.788
7	**0.783**	0.790	0.789	0.788	0.787	0.787	0.786	0.786	0.785	0.785	0.784	0.784	0.783	0.783
7.5	**0.776**	0.782	0.782	0.781	0.781	0.780	0.780	0.779	0.779	0.778	0.777	0.777	0.775	0.775
8	**0.765**	0.772	0.771	0.771	0.770	0.769	0.769	0.768	0.767	0.767	0.766	0.765	0.764	0.763
8.5	**0.749**	0.756	0.756	0.755	0.754	0.754	0.753	0.752	0.752	0.751	0.750	0.749	0.748	0.747
9	**0.721**	0.729	0.728	0.728	0.727	0.726	0.726	0.725	0.724	0.723	0.723	0.722	0.720	0.720
9.5	**0.682**	0.691	0.690	0.689	0.689	0.688	0.687	0.687	0.686	0.685	0.684	0.683	0.681	0.680
10	**0.633**	0.643	0.642	0.641	0.641	0.640	0.639	0.638	0.638	0.637	0.635	0.634	0.630	0.628
10.5	**0.575**	0.591	0.590	0.590	0.589	0.589	0.587	0.586	0.585	0.584	0.581	0.578	0.571	0.566
11	**0.511**	0.541	0.540	0.539	0.538	0.537	0.535	0.532	0.529	0.527	0.521	0.516	0.504	0.497
11.5	**0.448**	0.492	0.491	0.489	0.487	0.486	0.481	0.477	0.473	0.469	0.462	0.455	0.440	0.432
12	**0.392**	0.451	0.448	0.444	0.441	0.438	0.433	0.427	0.421	0.415	0.408	0.400	0.385	0.377
12.5	**0.345**	0.414	0.409	0.405	0.400	0.395	0.388	0.381	0.374	0.367	0.360	0.352	0.337	0.330
13	**0.304**	0.381	0.375	0.368	0.362	0.355	0.348	0.340	0.332	0.325	0.318	0.311	0.297	0.291
13.5	**0.269**	0.346	0.339	0.332	0.324	0.317	0.310	0.303	0.296	0.288	0.282	0.276	0.264	0.258
14	**0.240**	0.313	0.306	0.298	0.291	0.283	0.277	0.270	0.263	0.257	0.251	0.245	0.235	0.230
14.5	**0.215**	0.282	0.275	0.268	0.260	0.253	0.247	0.241	0.235	0.229	0.224	0.220	0.210	0.206
15	**0.193**	0.253	0.246	0.240	0.233	0.227	0.222	0.216	0.211	0.206	0.201	0.197	0.189	0.185
15.5	**0.174**	0.228	0.222	0.216	0.210	0.204	0.200	0.195	0.190	0.186	0.182	0.178	0.171	0.167
16	**0.158**	0.206	0.201	0.195	0.190	0.185	0.181	0.177	0.172	0.168	0.165	0.161	0.155	0.152
16.5	**0.144**	0.187	0.182	0.177	0.173	0.168	0.164	0.161	0.157	0.153	0.150	0.147	0.141	0.138
17	**0.132**	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.129	0.127
17.5	**0.121**	0.155	0.152	0.148	0.144	0.140	0.137	0.134	0.131	0.128	0.126	0.123	0.118	0.116
18	**0.111**	0.143	0.139	0.136	0.132	0.129	0.126	0.123	0.121	0.118	0.116	0.113	0.109	0.107
18.5	**0.102**	0.131	0.128	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.105	0.101	0.099
19	**0.095**	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.103	0.101	0.099	0.097	0.094	0.092
19.5	**0.088**	0.113	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.087	0.085
20	**0.082**	0.105	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.084	0.081	0.079
20.5	**0.077**	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.075	0.074
21	**0.072**	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.073	0.070	0.069
21.5	**0.067**	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.069	0.066	0.065
22	**0.063**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.062	0.061
22.5	**0.059**	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.062	0.060	0.058	0.057
23	**0.056**	0.070	0.069	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054
23.5	**0.053**	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052	0.051	0.049	0.048
24.5	**0.047**	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.045
25	**0.044**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043

Table 12-8: C_t values, noise mode 2

12.3.3 Noise Curve, Noise Mode 2

Sound Power Level at Hub Height, Noise Mode 2				
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**			
Hub Height	**84 m**	**94 m**	**119 m**	**140 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.4 4.2	94.5 4.3	94.8 4.5	95.0 4.6
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.2 5.6	97.5 5.7	98.0 5.9	98.4 6.1
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.8 7.0	101.2 7.2	101.9 7.4	102.4 7.6
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.7 8.4	103.8 8.6	104.1 8.9	104.2 9.2
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.5 9.8	104.5 10.0	104.5 10.4	104.5 10.7
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.5 11.2	104.5 11.4	104.5 11.9	104.5 12.2
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.5 12.7	104.5 12.9	104.5 13.4	104.5 13.7
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.5 14.1	104.5 14.3	104.5 14.9	104.5 15.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.5 15.5	104.5 15.7	104.5 16.3	104.5 16.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.5 16.9	104.5 17.2	104.5 17.8	104.5 18.3
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.5 18.3	104.5 18.6	104.5 19.3	104.5 19.8

Table 12-9: Noise curve, noise mode 2

12.4 Mode 3

12.4.1 Power Curves, Noise Mode 3

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**26**	11	12	13	15	16	17	19	20	21	23	24	27	29
3.5	**73**	45	48	50	53	55	58	60	63	65	68	70	75	78
4	**133**	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	**207**	150	155	161	166	171	176	181	187	192	197	202	212	218
5	**301**	223	230	237	244	251	258	266	273	280	287	294	308	315
5.5	**416**	311	321	330	340	349	359	368	378	387	397	406	425	435
6	**553**	417	430	442	454	467	479	491	504	516	528	541	565	578
6.5	**715**	543	559	574	590	605	621	637	652	668	684	699	731	746
7	**904**	689	708	728	747	767	786	806	825	845	864	884	923	943
7.5	**1121**	857	881	905	929	953	977	1001	1025	1049	1073	1097	1145	1169
8	**1367**	1048	1077	1106	1135	1165	1194	1223	1252	1281	1309	1338	1396	1425
8.5	**1640**	1261	1296	1331	1365	1400	1434	1469	1503	1537	1571	1606	1674	1708
9	**1932**	1492	1532	1573	1613	1653	1693	1733	1773	1813	1853	1893	1972	2011
9.5	**2238**	1736	1782	1828	1874	1920	1966	2012	2058	2103	2148	2193	2281	2326
10	**2524**	1972	2024	2076	2128	2179	2230	2280	2330	2381	2429	2476	2569	2614
10.5	**2764**	2201	2257	2314	2370	2427	2479	2531	2583	2635	2678	2721	2798	2832
11	**2946**	2418	2477	2537	2597	2657	2704	2752	2799	2847	2880	2913	2967	2990
11.5	**3025**	2620	2675	2730	2785	2840	2874	2908	2942	2976	2992	3009	3034	3043
12	**3057**	2798	2840	2882	2923	2965	2983	3001	3019	3037	3044	3050	3061	3065
12.5	**3069**	2933	2958	2982	3007	3032	3039	3046	3054	3061	3064	3067	3071	3073
13	**3074**	3015	3026	3037	3048	3059	3062	3065	3068	3071	3072	3073	3074	3075
13.5	**3075**	3048	3053	3059	3065	3071	3072	3073	3074	3075	3075	3075	3075	3075
14	**3075**	3067	3069	3070	3072	3074	3074	3075	3075	3075	3075	3075	3075	3075
14.5	**3075**	3073	3073	3074	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075
15	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-10: Power curve, noise mode 3

12.4.2 C_t Values, Noise Mode 3

Air density kg/m^3														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.899**	0.901	0.901	0.900	0.900	0.900	0.900	0.900	0.899	0.899	0.899	0.899	0.898	0.898
3.5	**0.845**	0.847	0.847	0.847	0.846	0.846	0.846	0.846	0.846	0.846	0.846	0.845	0.845	0.845
4	**0.816**	0.818	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.816	0.816	0.816	0.816
4.5	**0.805**	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.805	0.805	0.805
5	**0.801**	0.804	0.804	0.804	0.803	0.803	0.803	0.802	0.802	0.802	0.802	0.801	0.801	0.801
5.5	**0.798**	0.802	0.801	0.801	0.801	0.800	0.800	0.800	0.800	0.799	0.799	0.799	0.798	0.798
6	**0.796**	0.799	0.799	0.798	0.798	0.798	0.798	0.797	0.797	0.797	0.796	0.796	0.795	0.795
6.5	**0.790**	0.795	0.794	0.794	0.794	0.793	0.793	0.792	0.792	0.792	0.791	0.790	0.789	0.788
7	**0.784**	0.790	0.789	0.788	0.788	0.787	0.787	0.786	0.786	0.785	0.785	0.784	0.783	0.783
7.5	**0.778**	0.784	0.783	0.783	0.782	0.782	0.781	0.781	0.780	0.780	0.779	0.778	0.777	0.776
8	**0.770**	0.777	0.776	0.776	0.775	0.775	0.774	0.773	0.773	0.772	0.771	0.770	0.769	0.768
8.5	**0.759**	0.767	0.766	0.766	0.765	0.764	0.763	0.763	0.762	0.761	0.760	0.760	0.758	0.757
9	**0.739**	0.748	0.747	0.747	0.746	0.745	0.744	0.744	0.743	0.742	0.741	0.740	0.739	0.738
9.5	**0.710**	0.720	0.719	0.718	0.717	0.717	0.716	0.715	0.714	0.713	0.712	0.711	0.709	0.707
10	**0.667**	0.681	0.680	0.679	0.679	0.678	0.677	0.675	0.674	0.673	0.671	0.669	0.664	0.662
10.5	**0.610**	0.637	0.636	0.635	0.634	0.633	0.631	0.629	0.627	0.624	0.620	0.615	0.604	0.597
11	**0.544**	0.593	0.592	0.590	0.588	0.587	0.582	0.577	0.572	0.568	0.560	0.552	0.535	0.525
11.5	**0.470**	0.549	0.545	0.541	0.537	0.533	0.525	0.517	0.509	0.501	0.491	0.480	0.460	0.449
12	**0.405**	0.506	0.498	0.491	0.484	0.476	0.466	0.456	0.445	0.435	0.425	0.415	0.395	0.386
12.5	**0.351**	0.460	0.449	0.439	0.429	0.419	0.408	0.398	0.388	0.377	0.368	0.360	0.343	0.335
13	**0.307**	0.411	0.400	0.388	0.377	0.366	0.357	0.348	0.339	0.329	0.322	0.314	0.300	0.293
13.5	**0.270**	0.363	0.353	0.343	0.333	0.323	0.314	0.306	0.298	0.290	0.284	0.277	0.265	0.259
14	**0.240**	0.321	0.312	0.303	0.294	0.285	0.278	0.271	0.264	0.257	0.252	0.246	0.235	0.230
14.5	**0.215**	0.285	0.277	0.269	0.261	0.254	0.248	0.242	0.236	0.230	0.225	0.220	0.210	0.206
15	**0.193**	0.254	0.247	0.240	0.234	0.227	0.222	0.216	0.211	0.206	0.201	0.197	0.189	0.185
15.5	**0.174**	0.228	0.222	0.216	0.210	0.204	0.200	0.195	0.190	0.186	0.182	0.178	0.171	0.167
16	**0.158**	0.206	0.201	0.195	0.190	0.185	0.181	0.177	0.172	0.168	0.165	0.161	0.155	0.152
16.5	**0.144**	0.187	0.182	0.177	0.173	0.168	0.164	0.161	0.157	0.153	0.150	0.147	0.141	0.138
17	**0.132**	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.129	0.127
17.5	**0.121**	0.155	0.152	0.148	0.144	0.140	0.137	0.134	0.131	0.128	0.126	0.123	0.118	0.116
18	**0.111**	0.143	0.139	0.136	0.132	0.129	0.126	0.123	0.121	0.118	0.116	0.113	0.109	0.107
18.5	**0.102**	0.131	0.128	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.105	0.101	0.099
19	**0.095**	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.103	0.101	0.099	0.097	0.094	0.092
19.5	**0.088**	0.113	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.087	0.085
20	**0.082**	0.105	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.084	0.081	0.079
20.5	**0.077**	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.075	0.074
21	**0.072**	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.073	0.070	0.069
21.5	**0.067**	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.069	0.066	0.065
22	**0.063**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.062	0.061
22.5	**0.059**	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.062	0.060	0.058	0.057
23	**0.056**	0.070	0.069	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054
23.5	**0.053**	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052	0.051	0.049	0.048
24.5	**0.047**	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.045
25	**0.044**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043

Table 12-11: C_t values, noise mode 3

12.4.3 Noise Curve, Noise Mode 3

Sound Power Level at Hub Height, Noise Mode 3				
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Maximum turbulence at 10 metre height: 16% Inflow angle (vertical): 0 ±2° Air density: 1.225 kg/m^3**			
Hub Height	**84 m**	**94 m**	**119 m**	**140 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.4 4.2	94.5 4.3	94.8 4.5	95.0 4.6
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.2 5.6	97.5 5.7	98.0 5.9	98.4 6.1
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.8 7.0	101.2 7.2	101.9 7.4	102.4 7.6
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.3 8.4	104.5 8.6	104.8 8.9	105.0 9.2
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.3 9.8	105.4 10.0	105.5 10.4	105.5 10.7
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 11.2	105.5 11.4	105.5 11.9	105.5 12.2
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 12.7	105.5 12.9	105.5 13.4	105.5 13.7
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 14.1	105.5 14.3	105.5 14.9	105.5 15.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 15.5	105.5 15.7	105.5 16.3	105.5 16.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 16.9	105.5 17.2	105.5 17.8	105.5 18.3
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 18.3	105.5 18.6	105.5 19.3	105.5 19.8

Table 12-12: Noise curve, noise mode 3

12.5 Mode 4

12.5.1 Power Curves, Noise Mode 4

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**26**	10	12	13	14	16	17	19	20	21	23	24	27	29
3.5	**72**	44	47	49	52	54	57	59	62	64	67	69	74	77
4	**127**	88	91	95	99	102	106	109	113	117	120	124	131	135
4.5	**192**	139	143	148	153	158	163	168	173	177	182	187	197	201
5	**272**	201	207	214	220	227	233	240	246	253	259	266	279	285
5.5	**375**	281	289	298	307	315	324	332	341	350	358	367	384	393
6	**507**	383	394	406	417	428	440	451	462	473	485	496	519	530
6.5	**667**	506	521	535	550	565	579	594	608	623	638	652	681	696
7	**851**	649	667	686	704	722	741	759	778	796	815	833	870	888
7.5	**1059**	810	833	856	878	901	924	946	969	991	1014	1036	1082	1104
8	**1294**	993	1020	1047	1075	1102	1130	1157	1184	1212	1239	1266	1321	1348
8.5	**1556**	1199	1231	1264	1297	1330	1362	1395	1427	1460	1492	1524	1588	1621
9	**1851**	1431	1469	1508	1546	1585	1623	1661	1700	1738	1776	1813	1889	1927
9.5	**2172**	1685	1730	1775	1819	1864	1909	1953	1997	2042	2085	2128	2214	2257
10	**2479**	1937	1988	2039	2090	2141	2190	2239	2289	2338	2385	2432	2522	2566
10.5	**2737**	2179	2234	2290	2346	2402	2454	2505	2557	2609	2651	2694	2771	2805
11	**2929**	2401	2460	2519	2578	2638	2685	2733	2780	2828	2861	2895	2952	2975
11.5	**3019**	2610	2664	2719	2773	2828	2862	2897	2932	2966	2984	3001	3028	3037
12	**3054**	2793	2834	2876	2918	2960	2978	2996	3015	3033	3040	3047	3058	3061
12.5	**3068**	2931	2955	2980	3004	3029	3037	3044	3052	3060	3062	3065	3069	3071
13	**3074**	3014	3025	3035	3046	3057	3060	3064	3067	3070	3071	3072	3074	3074
13.5	**3075**	3048	3053	3059	3065	3070	3071	3073	3074	3075	3075	3075	3075	3075
14	**3075**	3067	3069	3070	3072	3074	3074	3075	3075	3075	3075	3075	3075	3075
14.5	**3075**	3073	3073	3074	3074	3075	3075	3075	3075	3075	3075	3075	3075	3075
15	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
15.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
16.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
17.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
18.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
19.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
20.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
21.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-13: Power curve, noise mode 4

12.5.2 C_t Values, Noise Mode 4

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.862**	0.864	0.864	0.864	0.864	0.863	0.863	0.863	0.863	0.863	0.862	0.862	0.862	0.862
3.5	**0.779**	0.781	0.781	0.781	0.781	0.781	0.780	0.780	0.780	0.779	0.779	0.779	0.779	0.779
4	**0.714**	0.716	0.716	0.716	0.716	0.716	0.715	0.715	0.715	0.715	0.715	0.715	0.714	0.714
4.5	**0.662**	0.663	0.663	0.663	0.662	0.662	0.662	0.662	0.662	0.662	0.662	0.662	0.661	0.661
5	**0.635**	0.636	0.636	0.636	0.636	0.635	0.635	0.635	0.635	0.635	0.635	0.635	0.634	0.634
5.5	**0.630**	0.631	0.631	0.631	0.631	0.631	0.631	0.631	0.631	0.630	0.630	0.630	0.630	0.630
6	**0.643**	0.645	0.645	0.645	0.644	0.644	0.644	0.644	0.644	0.644	0.644	0.644	0.643	0.643
6.5	**0.658**	0.660	0.660	0.660	0.659	0.659	0.659	0.659	0.659	0.658	0.658	0.658	0.657	0.657
7	**0.666**	0.670	0.669	0.669	0.669	0.668	0.668	0.668	0.667	0.667	0.667	0.666	0.666	0.666
7.5	**0.667**	0.672	0.671	0.671	0.671	0.670	0.670	0.670	0.669	0.669	0.668	0.668	0.667	0.667
8	**0.666**	0.671	0.671	0.670	0.670	0.669	0.669	0.668	0.668	0.667	0.667	0.666	0.666	0.665
8.5	**0.664**	0.669	0.669	0.668	0.668	0.667	0.667	0.666	0.666	0.665	0.665	0.664	0.663	0.663
9	**0.665**	0.672	0.671	0.670	0.670	0.669	0.669	0.668	0.667	0.667	0.666	0.666	0.664	0.664
9.5	**0.661**	0.670	0.669	0.668	0.668	0.667	0.666	0.666	0.665	0.664	0.663	0.662	0.660	0.659
10	**0.641**	0.653	0.653	0.652	0.651	0.651	0.650	0.648	0.647	0.646	0.644	0.643	0.638	0.635
10.5	**0.598**	0.624	0.623	0.622	0.621	0.620	0.618	0.616	0.614	0.612	0.607	0.602	0.591	0.585
11	**0.539**	0.587	0.586	0.584	0.582	0.580	0.576	0.571	0.566	0.562	0.554	0.547	0.530	0.521
11.5	**0.469**	0.547	0.542	0.538	0.534	0.530	0.522	0.514	0.506	0.499	0.489	0.479	0.458	0.448
12	**0.404**	0.504	0.497	0.490	0.482	0.475	0.465	0.455	0.444	0.434	0.424	0.414	0.395	0.386
12.5	**0.350**	0.459	0.449	0.439	0.428	0.418	0.408	0.398	0.387	0.377	0.368	0.359	0.343	0.335
13	**0.307**	0.410	0.399	0.388	0.377	0.366	0.357	0.348	0.339	0.329	0.322	0.314	0.300	0.293
13.5	**0.270**	0.363	0.353	0.343	0.333	0.322	0.314	0.306	0.298	0.290	0.284	0.277	0.265	0.259
14	**0.240**	0.321	0.312	0.303	0.294	0.285	0.278	0.271	0.264	0.257	0.252	0.246	0.235	0.230
14.5	**0.215**	0.285	0.277	0.269	0.261	0.254	0.248	0.242	0.236	0.230	0.225	0.220	0.210	0.206
15	**0.193**	0.254	0.247	0.240	0.234	0.227	0.222	0.216	0.211	0.206	0.201	0.197	0.189	0.185
15.5	**0.174**	0.228	0.222	0.216	0.210	0.204	0.200	0.195	0.190	0.186	0.182	0.178	0.171	0.167
16	**0.158**	0.206	0.201	0.195	0.190	0.185	0.181	0.177	0.172	0.168	0.165	0.161	0.155	0.152
16.5	**0.144**	0.187	0.182	0.177	0.173	0.168	0.164	0.161	0.157	0.153	0.150	0.147	0.141	0.138
17	**0.132**	0.170	0.166	0.162	0.158	0.154	0.150	0.147	0.143	0.140	0.137	0.134	0.129	0.127
17.5	**0.121**	0.155	0.152	0.148	0.144	0.140	0.137	0.134	0.131	0.128	0.126	0.123	0.118	0.116
18	**0.111**	0.143	0.139	0.136	0.132	0.129	0.126	0.123	0.121	0.118	0.116	0.113	0.109	0.107
18.5	**0.102**	0.131	0.128	0.125	0.122	0.119	0.116	0.114	0.111	0.109	0.107	0.105	0.101	0.099
19	**0.095**	0.122	0.119	0.116	0.113	0.110	0.108	0.106	0.103	0.101	0.099	0.097	0.094	0.092
19.5	**0.088**	0.113	0.110	0.108	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.087	0.085
20	**0.082**	0.105	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.084	0.081	0.079
20.5	**0.077**	0.097	0.095	0.093	0.091	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.075	0.074
21	**0.072**	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.073	0.070	0.069
21.5	**0.067**	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.069	0.066	0.065
22	**0.063**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.062	0.061
22.5	**0.059**	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.062	0.060	0.058	0.057
23	**0.056**	0.070	0.069	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054
23.5	**0.053**	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052	0.051	0.049	0.048
24.5	**0.047**	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.045
25	**0.044**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043

Table 12-14: C_t values, noise mode 4

12.5.3 Noise Curve, Noise Mode 4

Sound Power Level at Hub Height, Noise Mode 4				
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**			
Hub Height	**84 m**	**94 m**	**119 m**	**140 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.1 4.2	94.1 4.3	94.1 4.5	94.2 4.6
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	95.3 5.6	95.5 5.7	96.0 5.9	96.4 6.1
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	98.8 7.0	99.1 7.2	99.8 7.4	100.3 7.6
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.2 8.4	102.6 8.6	103.3 8.9	103.7 9.2
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.1 9.8	105.4 10.0	105.5 10.4	105.5 10.7
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 11.2	105.5 11.4	105.5 11.9	105.5 12.2
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 12.7	105.5 12.9	105.5 13.4	105.5 13.7
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 14.1	105.5 14.3	105.5 14.9	105.5 15.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 15.5	105.5 15.7	105.5 16.3	105.5 16.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 16.9	105.5 17.2	105.5 17.8	105.5 18.3
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.5 18.3	105.5 18.6	105.5 19.3	105.5 19.8

Table 12-15: Noise curve, noise mode 4

12.6 Mode 5

12.6.1 Power Curves, Noise Mode 5

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**26**	11	12	13	15	16	17	19	20	21	23	24	27	29
3.5	**73**	45	48	50	53	55	58	60	63	65	68	70	75	78
4	**133**	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	**207**	150	155	161	166	171	176	181	187	192	197	202	212	218
5	**301**	223	230	237	244	251	258	266	273	280	287	294	308	315
5.5	**416**	311	321	330	340	349	359	368	378	387	397	406	425	435
6	**553**	417	430	442	454	467	479	491	504	516	528	541	565	578
6.5	**715**	543	558	574	590	605	621	637	652	668	684	699	731	746
7	**902**	687	707	726	746	765	785	804	824	843	863	882	921	941
7.5	**1112**	850	874	897	921	945	969	993	1016	1040	1064	1088	1136	1159
8	**1340**	1027	1055	1084	1112	1141	1169	1198	1226	1255	1283	1311	1368	1396
8.5	**1573**	1210	1243	1277	1310	1343	1376	1409	1442	1475	1508	1540	1606	1639
9	**1800**	1390	1427	1464	1502	1540	1577	1614	1651	1689	1726	1763	1836	1873
9.5	**2015**	1560	1602	1644	1686	1727	1769	1810	1851	1893	1934	1974	2055	2095
10	**2211**	1719	1764	1809	1855	1901	1945	1990	2035	2080	2124	2167	2252	2294
10.5	**2385**	1866	1915	1964	2013	2062	2110	2157	2205	2253	2297	2341	2424	2462
11	**2520**	2000	2052	2104	2156	2208	2256	2304	2352	2401	2440	2480	2551	2582
11.5	**2617**	2116	2170	2223	2277	2331	2377	2423	2469	2516	2549	2583	2640	2663
12	**2681**	2214	2268	2321	2375	2429	2472	2514	2557	2600	2627	2654	2698	2716
12.5	**2728**	2300	2353	2405	2458	2511	2548	2586	2624	2661	2683	2706	2742	2756
13	**2770**	2390	2440	2489	2538	2588	2620	2652	2684	2716	2734	2752	2781	2791
13.5	**2811**	2498	2542	2587	2631	2676	2700	2725	2750	2776	2787	2799	2817	2824
14	**2833**	2606	2640	2674	2708	2742	2759	2776	2793	2810	2818	2826	2838	2842
14.5	**2848**	2697	2721	2745	2768	2792	2803	2814	2825	2835	2840	2844	2850	2852
15	**2855**	2766	2781	2796	2811	2827	2832	2838	2844	2850	2852	2853	2856	2857
15.5	**2860**	2816	2824	2832	2840	2849	2851	2853	2855	2858	2858	2859	2860	2861
16	**2862**	2844	2847	2851	2854	2858	2859	2859	2860	2861	2861	2862	2862	2862
16.5	**2863**	2856	2857	2858	2860	2861	2861	2862	2862	2862	2862	2863	2863	2863
17	**2863**	2860	2861	2861	2862	2863	2863	2863	2863	2863	2863	2863	2863	2863
17.5	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
18	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
18.5	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
19	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
19.5	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
20	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
20.5	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
21	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
21.5	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
22	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
22.5	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
23	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
23.5	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
24	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
24.5	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863
25	**2863**	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863	2863

Table 12-16: Power curve, noise mode 5

12.6.2 C_t Values, Noise Mode 5

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.899**	0.901	0.901	0.900	0.900	0.900	0.900	0.900	0.899	0.899	0.899	0.899	0.898	0.898
3.5	**0.845**	0.847	0.847	0.847	0.846	0.846	0.846	0.846	0.846	0.846	0.846	0.845	0.845	0.845
4	**0.816**	0.818	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.816	0.816	0.816	0.816
4.5	**0.805**	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.805	0.805	0.805
5	**0.801**	0.804	0.804	0.804	0.803	0.803	0.803	0.802	0.802	0.802	0.802	0.801	0.801	0.801
5.5	**0.798**	0.802	0.801	0.801	0.801	0.800	0.800	0.800	0.800	0.799	0.799	0.799	0.798	0.798
6	**0.796**	0.799	0.799	0.798	0.798	0.798	0.797	0.797	0.797	0.796	0.796	0.796	0.795	0.795
6.5	**0.790**	0.795	0.794	0.794	0.794	0.793	0.793	0.792	0.792	0.791	0.791	0.791	0.790	0.789
7	**0.780**	0.785	0.784	0.784	0.783	0.783	0.782	0.782	0.781	0.781	0.780	0.780	0.779	0.779
7.5	**0.762**	0.767	0.767	0.766	0.766	0.765	0.765	0.764	0.764	0.763	0.763	0.762	0.761	0.761
8	**0.733**	0.739	0.738	0.738	0.737	0.737	0.736	0.736	0.735	0.735	0.734	0.734	0.732	0.732
8.5	**0.693**	0.699	0.698	0.698	0.697	0.697	0.696	0.696	0.695	0.695	0.694	0.693	0.692	0.692
9	**0.645**	0.650	0.650	0.649	0.649	0.648	0.648	0.647	0.647	0.646	0.646	0.645	0.644	0.644
9.5	**0.594**	0.600	0.599	0.599	0.598	0.598	0.597	0.597	0.597	0.596	0.596	0.595	0.594	0.593
10	**0.543**	0.549	0.549	0.548	0.548	0.548	0.547	0.547	0.546	0.546	0.545	0.544	0.542	0.541
10.5	**0.493**	0.501	0.501	0.501	0.500	0.500	0.499	0.499	0.498	0.498	0.496	0.495	0.490	0.487
11	**0.441**	0.457	0.457	0.456	0.456	0.455	0.454	0.453	0.452	0.450	0.447	0.444	0.436	0.431
11.5	**0.390**	0.413	0.413	0.412	0.411	0.411	0.409	0.407	0.404	0.402	0.398	0.394	0.384	0.379
12	**0.344**	0.372	0.371	0.370	0.369	0.368	0.366	0.363	0.360	0.358	0.353	0.348	0.338	0.333
12.5	**0.304**	0.336	0.335	0.333	0.332	0.331	0.328	0.324	0.321	0.318	0.314	0.309	0.299	0.294
13	**0.271**	0.306	0.304	0.303	0.301	0.299	0.295	0.292	0.288	0.285	0.280	0.276	0.267	0.262
13.5	**0.244**	0.283	0.281	0.278	0.276	0.273	0.269	0.265	0.262	0.258	0.253	0.249	0.239	0.235
14	**0.219**	0.263	0.260	0.256	0.253	0.250	0.245	0.241	0.237	0.232	0.228	0.224	0.215	0.211
14.5	**0.197**	0.244	0.240	0.236	0.232	0.228	0.223	0.219	0.214	0.210	0.206	0.202	0.194	0.190
15	**0.178**	0.225	0.221	0.216	0.212	0.207	0.203	0.198	0.194	0.190	0.186	0.182	0.174	0.171
15.5	**0.161**	0.207	0.203	0.198	0.193	0.189	0.184	0.180	0.176	0.172	0.168	0.165	0.158	0.155
16	**0.146**	0.190	0.185	0.181	0.176	0.171	0.168	0.164	0.160	0.156	0.153	0.150	0.144	0.141
16.5	**0.134**	0.173	0.169	0.165	0.160	0.156	0.153	0.149	0.146	0.142	0.139	0.136	0.131	0.128
17	**0.122**	0.158	0.154	0.150	0.147	0.143	0.140	0.136	0.133	0.130	0.128	0.125	0.120	0.118
17.5	**0.112**	0.145	0.141	0.138	0.134	0.130	0.128	0.125	0.122	0.119	0.117	0.114	0.110	0.108
18	**0.103**	0.133	0.130	0.126	0.123	0.120	0.117	0.115	0.112	0.110	0.107	0.105	0.101	0.099
18.5	**0.095**	0.122	0.119	0.116	0.113	0.111	0.108	0.106	0.103	0.101	0.099	0.097	0.093	0.092
19	**0.089**	0.113	0.111	0.108	0.105	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.087	0.085
19.5	**0.082**	0.105	0.103	0.100	0.098	0.095	0.093	0.091	0.089	0.087	0.086	0.084	0.081	0.079
20	**0.076**	0.098	0.095	0.093	0.091	0.088	0.087	0.085	0.083	0.081	0.080	0.078	0.075	0.074
20.5	**0.071**	0.091	0.089	0.087	0.084	0.082	0.081	0.079	0.077	0.076	0.074	0.073	0.070	0.069
21	**0.067**	0.085	0.083	0.081	0.079	0.077	0.075	0.074	0.072	0.071	0.069	0.068	0.065	0.064
21.5	**0.063**	0.079	0.077	0.076	0.074	0.072	0.071	0.069	0.068	0.066	0.065	0.064	0.061	0.060
22	**0.059**	0.074	0.073	0.071	0.069	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.058	0.057
22.5	**0.055**	0.070	0.068	0.066	0.065	0.063	0.062	0.061	0.060	0.058	0.057	0.056	0.054	0.053
23	**0.052**	0.065	0.064	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.051	0.050
23.5	**0.049**	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.048	0.047
24	**0.046**	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.045	0.045
24.5	**0.044**	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043	0.042
25	**0.041**	0.052	0.051	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.042	0.041	0.040

Table 12-17: C_t values, noise mode 5

12.6.3 Noise Curve, Noise Mode 5

Sound Power Level at Hub Height, Noise Mode 5				
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**			
Hub Height	**84 m**	**94 m**	**119 m**	**140 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.4 4.2	94.5 4.3	94.8 4.5	95.0 4.6
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.2 5.6	97.5 5.7	98.0 5.9	98.4 6.1
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.8 7.0	101.0 7.2	101.3 7.4	101.6 7.6
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.5 8.4	102.5 8.6	102.5 8.9	102.5 9.2
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.5 9.8	102.5 10.0	102.5 10.4	102.5 10.7
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.5 11.2	102.5 11.4	102.5 11.9	102.5 12.2
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.5 12.7	102.5 12.9	102.5 13.4	102.5 13.7
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.5 14.1	102.5 14.3	102.5 14.9	102.5 15.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.5 15.5	102.5 15.7	102.5 16.3	102.5 16.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.5 16.9	102.5 17.2	102.5 17.8	102.5 18.3
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.5 18.3	102.5 18.6	102.5 19.3	102.5 19.8

Table 12-18: Noise curve, noise mode 5

12.7 Mode 6

12.7.1 Power Curves, Noise Mode 6

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**26**	11	12	13	15	16	17	19	20	21	23	24	27	29
3.5	**73**	45	48	50	53	55	58	60	63	65	68	70	75	78
4	**133**	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	**207**	150	155	161	166	171	176	181	187	192	197	202	212	218
5	**301**	223	230	237	244	251	258	266	273	280	287	294	308	315
5.5	**416**	311	321	330	340	349	359	368	378	387	397	406	425	435
6	**553**	417	430	442	454	467	479	491	504	516	528	541	565	578
6.5	**714**	541	557	573	588	604	620	635	651	667	682	698	729	745
7	**897**	683	703	722	742	761	780	800	819	839	858	877	916	936
7.5	**1094**	836	860	883	906	930	953	977	1000	1023	1047	1070	1117	1140
8	**1291**	990	1017	1045	1072	1100	1127	1154	1182	1209	1237	1264	1318	1346
8.5	**1478**	1137	1168	1199	1230	1261	1292	1323	1354	1386	1416	1447	1509	1539
9	**1652**	1273	1308	1343	1377	1412	1446	1481	1515	1549	1583	1617	1685	1719
9.5	**1816**	1404	1441	1479	1517	1555	1592	1630	1667	1705	1742	1779	1853	1890
10	**1969**	1525	1566	1607	1647	1688	1729	1769	1809	1850	1889	1929	2007	2045
10.5	**2109**	1642	1685	1729	1772	1816	1859	1902	1944	1987	2028	2068	2145	2182
11	**2222**	1751	1797	1844	1890	1936	1980	2023	2067	2110	2147	2184	2252	2283
11.5	**2310**	1860	1908	1957	2005	2053	2094	2136	2177	2218	2249	2279	2333	2355
12	**2369**	1967	2014	2062	2109	2157	2192	2228	2264	2300	2323	2346	2383	2397
12.5	**2404**	2069	2113	2158	2202	2246	2274	2302	2330	2358	2373	2389	2412	2420
13	**2427**	2164	2202	2240	2278	2315	2336	2357	2378	2399	2408	2417	2431	2436
13.5	**2446**	2250	2280	2311	2341	2372	2386	2400	2414	2428	2434	2440	2448	2450
14	**2468**	2330	2353	2376	2399	2422	2431	2440	2449	2459	2462	2465	2469	2470
14.5	**2493**	2401	2418	2434	2451	2468	2473	2479	2484	2490	2491	2492	2494	2494
15	**2528**	2459	2472	2485	2498	2511	2515	2518	2522	2526	2526	2527	2529	2529
15.5	**2565**	2522	2530	2539	2547	2556	2558	2560	2562	2564	2564	2565	2565	2566
16	**2601**	2577	2582	2587	2592	2597	2598	2599	2600	2601	2601	2601	2601	2602
16.5	**2636**	2622	2625	2628	2631	2633	2634	2634	2635	2635	2635	2635	2635	2636
17	**2666**	2659	2660	2662	2663	2665	2665	2665	2665	2666	2665	2665	2665	2666
17.5	**2694**	2692	2692	2693	2693	2694	2694	2694	2694	2694	2694	2694	2694	2694
18	**2714**	2713	2713	2714	2714	2714	2714	2714	2714	2714	2714	2714	2714	2714
18.5	**2729**	2729	2729	2729	2729	2729	2729	2729	2729	2729	2729	2729	2729	2729
19	**2737**	2737	2737	2737	2737	2737	2737	2737	2737	2737	2737	2737	2737	2737
19.5	**2744**	2744	2744	2744	2744	2744	2744	2744	2744	2744	2744	2744	2744	2744
20	**2749**	2749	2749	2749	2749	2749	2749	2749	2749	2749	2749	2749	2749	2749
20.5	**2752**	2752	2752	2752	2752	2752	2752	2752	2752	2752	2752	2752	2752	2752
21	**2754**	2754	2754	2754	2754	2754	2754	2754	2754	2754	2754	2754	2754	2754
21.5	**2755**	2755	2755	2755	2755	2755	2755	2755	2755	2755	2755	2755	2755	2755
22	**2756**	2756	2756	2756	2756	2756	2756	2756	2756	2756	2756	2756	2756	2756
22.5	**2756**	2756	2756	2756	2756	2756	2756	2756	2756	2756	2756	2756	2756	2756
23	**2757**	2757	2756	2756	2756	2757	2756	2756	2756	2757	2756	2756	2756	2757
23.5	**2757**	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757
24	**2757**	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757
24.5	**2757**	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757
25	**2757**	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757	2757

Table 12-19: Power curve, noise mode 6

12.7.2 C_t Values, Noise Mode 6

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.899**	0.901	0.901	0.900	0.900	0.900	0.900	0.900	0.899	0.899	0.899	0.899	0.898	0.898
3.5	**0.845**	0.847	0.847	0.847	0.846	0.846	0.846	0.846	0.846	0.846	0.846	0.845	0.845	0.845
4	**0.816**	0.818	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.816	0.816	0.816	0.816
4.5	**0.805**	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.805	0.805	0.805
5	**0.801**	0.804	0.804	0.804	0.803	0.803	0.803	0.802	0.802	0.802	0.802	0.801	0.801	0.801
5.5	**0.800**	0.803	0.803	0.802	0.802	0.802	0.801	0.801	0.801	0.801	0.801	0.800	0.800	0.800
6	**0.798**	0.802	0.801	0.801	0.801	0.800	0.800	0.800	0.799	0.799	0.799	0.798	0.798	0.797
6.5	**0.792**	0.796	0.796	0.796	0.795	0.795	0.794	0.794	0.794	0.793	0.793	0.793	0.792	0.791
7	**0.773**	0.778	0.777	0.777	0.776	0.776	0.776	0.775	0.775	0.775	0.774	0.774	0.773	0.772
7.5	**0.735**	0.739	0.739	0.739	0.738	0.738	0.737	0.737	0.737	0.736	0.736	0.735	0.734	0.734
8	**0.683**	0.687	0.687	0.687	0.686	0.686	0.686	0.685	0.685	0.684	0.684	0.683	0.683	0.682
8.5	**0.625**	0.629	0.628	0.628	0.628	0.627	0.627	0.626	0.626	0.626	0.625	0.625	0.624	0.624
9	**0.568**	0.571	0.571	0.571	0.570	0.570	0.570	0.569	0.569	0.569	0.568	0.568	0.567	0.567
9.5	**0.516**	0.519	0.519	0.519	0.519	0.518	0.518	0.518	0.517	0.517	0.517	0.516	0.516	0.515
10	**0.470**	0.473	0.473	0.473	0.473	0.472	0.472	0.472	0.471	0.471	0.471	0.470	0.469	0.468
10.5	**0.427**	0.433	0.432	0.432	0.432	0.432	0.431	0.431	0.431	0.430	0.429	0.428	0.425	0.423
11	**0.385**	0.397	0.397	0.397	0.396	0.396	0.395	0.394	0.393	0.392	0.390	0.388	0.382	0.378
11.5	**0.344**	0.365	0.365	0.364	0.364	0.363	0.361	0.359	0.358	0.356	0.352	0.348	0.339	0.335
12	**0.305**	0.337	0.336	0.334	0.333	0.332	0.329	0.326	0.323	0.319	0.315	0.310	0.300	0.295
12.5	**0.270**	0.311	0.309	0.307	0.304	0.302	0.298	0.294	0.290	0.285	0.280	0.275	0.265	0.259
13	**0.239**	0.287	0.283	0.280	0.277	0.274	0.269	0.264	0.260	0.255	0.250	0.244	0.234	0.229
13.5	**0.213**	0.263	0.259	0.255	0.252	0.248	0.243	0.238	0.233	0.228	0.223	0.218	0.209	0.204
14	**0.192**	0.242	0.238	0.233	0.229	0.224	0.220	0.215	0.210	0.205	0.201	0.196	0.188	0.183
14.5	**0.173**	0.223	0.218	0.213	0.209	0.204	0.199	0.195	0.190	0.186	0.181	0.177	0.170	0.166
15	**0.158**	0.204	0.199	0.195	0.190	0.186	0.181	0.177	0.173	0.169	0.165	0.162	0.155	0.151
15.5	**0.145**	0.188	0.184	0.179	0.175	0.170	0.166	0.162	0.159	0.155	0.151	0.148	0.142	0.139
16	**0.133**	0.173	0.169	0.165	0.161	0.156	0.153	0.149	0.146	0.142	0.139	0.136	0.130	0.128
16.5	**0.123**	0.160	0.156	0.152	0.148	0.144	0.141	0.138	0.134	0.131	0.128	0.126	0.121	0.118
17	**0.114**	0.148	0.144	0.140	0.137	0.133	0.130	0.127	0.124	0.121	0.119	0.116	0.112	0.109
17.5	**0.105**	0.136	0.133	0.130	0.126	0.123	0.120	0.118	0.115	0.112	0.110	0.108	0.103	0.101
18	**0.098**	0.126	0.123	0.120	0.117	0.114	0.111	0.109	0.106	0.104	0.102	0.100	0.096	0.094
18.5	**0.091**	0.117	0.114	0.111	0.108	0.106	0.103	0.101	0.099	0.096	0.095	0.093	0.089	0.087
19	**0.085**	0.109	0.106	0.103	0.101	0.098	0.096	0.094	0.092	0.090	0.088	0.086	0.083	0.081
19.5	**0.079**	0.101	0.099	0.096	0.094	0.091	0.089	0.087	0.086	0.084	0.082	0.080	0.077	0.076
20	**0.073**	0.094	0.092	0.089	0.087	0.085	0.083	0.081	0.080	0.078	0.076	0.075	0.072	0.071
20.5	**0.069**	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.074	0.073	0.071	0.070	0.067	0.066
21	**0.064**	0.082	0.080	0.078	0.076	0.074	0.073	0.071	0.069	0.068	0.067	0.065	0.063	0.062
21.5	**0.060**	0.076	0.075	0.073	0.071	0.069	0.068	0.067	0.065	0.064	0.063	0.061	0.059	0.058
22	**0.056**	0.072	0.070	0.068	0.067	0.065	0.064	0.062	0.061	0.060	0.059	0.058	0.055	0.055
22.5	**0.053**	0.067	0.066	0.064	0.063	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.052	0.051
23	**0.050**	0.063	0.061	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.048
23.5	**0.047**	0.059	0.058	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.045
24	**0.044**	0.056	0.055	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043
24.5	**0.042**	0.053	0.052	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.043	0.041	0.041
25	**0.040**	0.050	0.049	0.048	0.047	0.045	0.045	0.044	0.043	0.042	0.041	0.040	0.039	0.038

Table 12-20: C_t values, noise mode 6

12.7.3 Noise Curve, Noise Mode 6

Sound Power Level at Hub Height, Noise Mode 6			
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**		
Hub Height	**84 m**	**94 m**	**140 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.4 4.2	94.5 4.3	95.0 4.6
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.2 5.6	97.5 5.7	98.4 6.1
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.4 7.0	100.4 7.2	100.7 7.6
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	101.0 8.4	101.0 8.6	101.0 9.2
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	101.0 9.8	101.0 10.0	101.0 10.7
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	101.0 11.2	101.0 11.4	101.0 12.2
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	101.0 12.7	101.0 12.9	101.0 13.7
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	101.0 14.1	101.0 14.3	101.0 15.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	101.0 15.5	101.0 15.7	101.0 16.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	101.0 16.9	101.0 17.2	101.0 18.3
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	101.0 18.3	101.0 18.6	101.0 19.8

Table 12-21: Noise curve, noise mode 6

12.8 Mode 7

12.8.1 Power Curves, Noise Mode 7

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**26**	11	12	13	15	16	17	19	20	21	23	24	27	29
3.5	**73**	45	48	50	53	55	58	60	63	65	68	70	75	78
4	**133**	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	**207**	150	155	161	166	171	176	181	187	192	197	202	212	218
5	**301**	223	230	237	244	251	258	266	273	280	287	294	308	315
5.5	**416**	311	321	330	340	349	359	368	378	387	397	406	425	435
6	**553**	417	430	442	454	467	479	491	504	516	528	541	565	578
6.5	**714**	542	558	574	589	605	620	636	652	667	683	699	730	746
7	**898**	685	704	723	743	762	782	801	820	840	859	878	917	937
7.5	**1097**	839	863	886	910	933	957	980	1003	1027	1050	1074	1120	1144
8	**1305**	1001	1029	1057	1084	1112	1140	1167	1195	1223	1250	1278	1332	1360
8.5	**1520**	1171	1203	1235	1267	1299	1330	1362	1394	1426	1457	1489	1552	1583
9	**1750**	1352	1389	1425	1462	1498	1534	1571	1607	1643	1679	1715	1786	1821
9.5	**1999**	1551	1592	1633	1674	1716	1757	1797	1838	1879	1919	1959	2038	2078
10	**2246**	1754	1801	1847	1893	1939	1984	2029	2074	2119	2161	2203	2286	2327
10.5	**2477**	1963	2013	2064	2114	2164	2211	2258	2304	2351	2393	2435	2512	2547
11	**2669**	2162	2216	2270	2324	2378	2424	2470	2517	2564	2599	2634	2695	2721
11.5	**2783**	2361	2414	2467	2519	2572	2609	2646	2683	2721	2741	2762	2794	2805
12	**2830**	2537	2582	2627	2672	2717	2739	2761	2784	2806	2814	2822	2834	2838
12.5	**2851**	2677	2708	2739	2771	2802	2812	2822	2832	2842	2845	2848	2853	2855
13	**2865**	2772	2790	2808	2826	2844	2848	2852	2856	2861	2862	2863	2865	2866
13.5	**2878**	2828	2839	2849	2860	2870	2872	2874	2875	2877	2877	2878	2878	2878
14	**2895**	2873	2878	2883	2888	2893	2893	2894	2894	2895	2895	2895	2895	2895
14.5	**2915**	2908	2910	2911	2913	2915	2915	2915	2915	2915	2915	2915	2915	2915
15	**2944**	2941	2942	2942	2943	2944	2944	2944	2944	2944	2944	2944	2944	2944
15.5	**2971**	2970	2970	2970	2971	2971	2971	2971	2971	2971	2971	2971	2971	2971
16	**2995**	2995	2995	2995	2995	2995	2995	2995	2995	2995	2995	2995	2995	2995
16.5	**3017**	3017	3017	3017	3017	3017	3017	3017	3017	3017	3017	3017	3017	3017
17	**3034**	3034	3034	3034	3034	3034	3034	3034	3034	3034	3034	3034	3034	3034
17.5	**3052**	3052	3052	3052	3052	3052	3052	3052	3052	3052	3052	3052	3052	3052
18	**3061**	3061	3061	3061	3061	3061	3061	3061	3061	3061	3061	3061	3061	3061
18.5	**3067**	3067	3067	3067	3067	3067	3067	3067	3067	3067	3067	3067	3067	3067
19	**3069**	3069	3069	3069	3069	3069	3069	3069	3069	3069	3069	3069	3069	3069
19.5	**3071**	3071	3071	3071	3071	3071	3071	3071	3071	3071	3071	3071	3071	3071
20	**3073**	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073	3073
20.5	**3074**	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074	3074
21	**3075**	3075	3074	3074	3074	3075	3074	3074	3074	3075	3074	3074	3074	3075
21.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
22.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
23.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
24.5	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075
25	**3075**	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075	3075

Table 12-22: Power curve, noise mode 7

12.8.2 C_t Values, Noise Mode 7

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.899**	0.901	0.901	0.900	0.900	0.900	0.900	0.900	0.899	0.899	0.899	0.899	0.898	0.898
3.5	**0.845**	0.847	0.847	0.847	0.846	0.846	0.846	0.846	0.846	0.846	0.846	0.845	0.845	0.845
4	**0.816**	0.818	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.816	0.816	0.816	0.816
4.5	**0.805**	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.805	0.805	0.805
5	**0.801**	0.804	0.804	0.804	0.803	0.803	0.803	0.802	0.802	0.802	0.802	0.801	0.801	0.801
5.5	**0.798**	0.802	0.801	0.801	0.801	0.800	0.800	0.800	0.800	0.799	0.799	0.799	0.798	0.798
6	**0.795**	0.799	0.798	0.798	0.798	0.797	0.797	0.797	0.796	0.796	0.796	0.796	0.795	0.795
6.5	**0.784**	0.789	0.789	0.788	0.788	0.788	0.787	0.787	0.786	0.786	0.785	0.785	0.784	0.783
7	**0.763**	0.768	0.767	0.767	0.766	0.766	0.765	0.765	0.764	0.764	0.763	0.763	0.762	0.762
7.5	**0.726**	0.731	0.731	0.730	0.730	0.729	0.729	0.728	0.728	0.728	0.727	0.727	0.726	0.725
8	**0.681**	0.687	0.686	0.686	0.685	0.685	0.684	0.684	0.683	0.683	0.682	0.682	0.681	0.680
8.5	**0.637**	0.643	0.642	0.642	0.641	0.641	0.640	0.640	0.639	0.639	0.638	0.638	0.637	0.636
9	**0.601**	0.607	0.606	0.606	0.605	0.605	0.605	0.604	0.604	0.603	0.602	0.602	0.601	0.600
9.5	**0.573**	0.579	0.578	0.578	0.577	0.577	0.576	0.576	0.575	0.575	0.574	0.573	0.572	0.571
10	**0.544**	0.553	0.553	0.553	0.552	0.552	0.551	0.550	0.549	0.548	0.547	0.545	0.542	0.540
10.5	**0.511**	0.530	0.529	0.528	0.527	0.526	0.525	0.523	0.521	0.519	0.517	0.514	0.507	0.503
11	**0.473**	0.505	0.504	0.503	0.501	0.500	0.497	0.494	0.491	0.488	0.483	0.478	0.466	0.460
11.5	**0.422**	0.481	0.478	0.475	0.472	0.469	0.463	0.457	0.451	0.445	0.438	0.430	0.413	0.404
12	**0.368**	0.452	0.446	0.440	0.435	0.429	0.421	0.412	0.404	0.395	0.386	0.377	0.360	0.352
12.5	**0.322**	0.417	0.409	0.400	0.392	0.384	0.374	0.365	0.356	0.346	0.338	0.330	0.314	0.307
13	**0.283**	0.377	0.367	0.358	0.348	0.338	0.330	0.321	0.313	0.304	0.297	0.290	0.277	0.270
13.5	**0.251**	0.336	0.327	0.318	0.309	0.300	0.292	0.285	0.277	0.270	0.263	0.257	0.246	0.240
14	**0.224**	0.301	0.292	0.284	0.275	0.267	0.260	0.254	0.247	0.241	0.235	0.230	0.220	0.215
14.5	**0.202**	0.269	0.262	0.254	0.247	0.239	0.234	0.228	0.222	0.216	0.212	0.207	0.198	0.194
15	**0.184**	0.243	0.236	0.230	0.223	0.217	0.211	0.206	0.201	0.196	0.192	0.188	0.180	0.176
15.5	**0.168**	0.220	0.214	0.208	0.203	0.197	0.192	0.188	0.183	0.179	0.175	0.171	0.164	0.161
16	**0.153**	0.200	0.195	0.190	0.185	0.180	0.176	0.172	0.168	0.163	0.160	0.157	0.150	0.147
16.5	**0.141**	0.183	0.178	0.174	0.169	0.165	0.161	0.157	0.154	0.150	0.147	0.144	0.138	0.135
17	**0.130**	0.168	0.164	0.159	0.155	0.151	0.148	0.145	0.141	0.138	0.135	0.132	0.127	0.125
17.5	**0.119**	0.154	0.150	0.147	0.143	0.139	0.136	0.133	0.130	0.127	0.125	0.122	0.117	0.115
18	**0.110**	0.142	0.138	0.135	0.132	0.128	0.126	0.123	0.120	0.117	0.115	0.113	0.108	0.106
18.5	**0.102**	0.131	0.128	0.125	0.122	0.118	0.116	0.113	0.111	0.108	0.106	0.104	0.100	0.098
19	**0.095**	0.122	0.119	0.116	0.113	0.110	0.108	0.105	0.103	0.101	0.099	0.097	0.093	0.092
19.5	**0.088**	0.113	0.110	0.107	0.105	0.102	0.100	0.098	0.096	0.094	0.092	0.090	0.087	0.085
20	**0.082**	0.105	0.102	0.100	0.097	0.095	0.093	0.091	0.089	0.087	0.086	0.084	0.081	0.079
20.5	**0.077**	0.097	0.095	0.093	0.091	0.088	0.087	0.085	0.083	0.081	0.080	0.078	0.075	0.074
21	**0.072**	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.073	0.070	0.069
21.5	**0.067**	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.069	0.066	0.065
22	**0.063**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.062	0.061
22.5	**0.059**	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.062	0.060	0.058	0.057
23	**0.056**	0.070	0.069	0.067	0.065	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054
23.5	**0.053**	0.066	0.064	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24	**0.050**	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.052	0.051	0.049	0.048
24.5	**0.047**	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.045
25	**0.044**	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.043

Table 12-23: C_t values, noise mode 7

12.8.3 Noise Curve, Noise Mode 7

Sound Power Level at Hub Height, Noise Mode 7				
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**			
Hub Height	**84 m**	**94 m**	**119 m**	**140 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.5 4.2	94.5 4.3	94.7 4.5	95.0 4.6
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.3 5.6	97.5 5.7	98.1 5.9	98.4 6.1
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.9 7.0	101.2 7.2	101.9 7.4	101.3 7.6
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	101.9 8.4	102.0 8.6	102.2 8.9	102.4 9.2
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	102.9 9.8	103.0 10.0	103.3 10.4	103.5 10.7
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.9 11.2	104.0 11.4	104.0 11.9	104.0 12.2
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.0 12.7	105.0 12.9	105.0 13.4	105.0 13.7
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.0 14.1	105.0 14.3	105.0 14.9	105.0 15.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.0 15.5	105.0 15.7	105.0 16.3	105.0 16.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.0 16.9	105.0 17.2	105.0 17.8	105.0 18.3
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	105.0 18.3	105.0 18.6	105.0 19.3	105.0 19.8

Table 12-24: Noise curve, noise mode 7

12.9 Mode 8

12.9.1 Power Curves, Noise Mode 8

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**26**	11	12	13	15	16	17	19	20	21	23	24	27	29
3.5	**73**	45	48	50	53	55	58	60	63	65	68	70	75	78
4	**133**	92	95	99	103	107	110	114	118	121	125	129	136	140
4.5	**207**	150	155	161	166	171	176	181	187	192	197	202	212	218
5	**301**	223	230	237	244	251	258	266	273	280	287	294	308	315
5.5	**416**	311	321	330	340	349	359	368	378	387	397	406	425	435
6	**553**	417	430	442	454	467	479	491	504	516	528	541	565	578
6.5	**715**	543	559	574	590	606	621	637	653	668	684	700	731	747
7	**904**	689	708	728	747	767	786	806	825	845	864	884	923	943
7.5	**1119**	855	879	903	927	951	975	999	1023	1047	1071	1095	1143	1167
8	**1359**	1041	1070	1099	1128	1157	1186	1215	1244	1273	1301	1330	1388	1417
8.5	**1614**	1242	1276	1310	1344	1378	1412	1445	1479	1513	1547	1580	1648	1681
9	**1869**	1443	1482	1521	1560	1599	1638	1676	1715	1754	1792	1831	1907	1945
9.5	**2115**	1640	1683	1727	1770	1814	1857	1900	1944	1987	2029	2072	2156	2198
10	**2335**	1818	1866	1914	1962	2010	2057	2104	2151	2199	2244	2290	2379	2422
10.5	**2530**	1985	2037	2089	2140	2192	2242	2292	2342	2393	2438	2484	2570	2610
11	**2680**	2139	2194	2249	2304	2359	2409	2459	2509	2559	2599	2640	2711	2742
11.5	**2790**	2285	2341	2398	2454	2511	2557	2603	2649	2695	2726	2758	2811	2832
12	**2865**	2429	2483	2537	2591	2646	2684	2722	2761	2799	2821	2843	2877	2889
12.5	**2911**	2569	2617	2665	2713	2761	2789	2817	2845	2874	2886	2899	2918	2925
13	**2940**	2701	2739	2777	2815	2853	2870	2887	2903	2920	2926	2933	2943	2947
13.5	**2957**	2807	2832	2857	2882	2907	2917	2927	2937	2947	2950	2954	2958	2960
14	**2964**	2882	2896	2911	2926	2941	2946	2951	2955	2960	2962	2963	2965	2966
14.5	**2968**	2928	2935	2943	2951	2959	2961	2962	2964	2966	2967	2967	2968	2968
15	**2968**	2952	2955	2959	2962	2965	2966	2966	2967	2968	2968	2968	2968	2968
15.5	**2969**	2963	2964	2965	2967	2968	2968	2968	2969	2969	2969	2969	2969	2969
16	**2969**	2967	2967	2968	2968	2969	2969	2969	2969	2969	2969	2969	2969	2969
16.5	**2969**	2968	2968	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
17	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
17.5	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
18	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
18.5	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
19	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
19.5	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
20	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
20.5	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
21	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
21.5	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
22	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
22.5	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
23	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
23.5	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
24	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
24.5	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969
25	**2969**	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969	2969

Table 12-25: Power curve, noise mode 8

12.9.2 C_t Values, Noise Mode 8

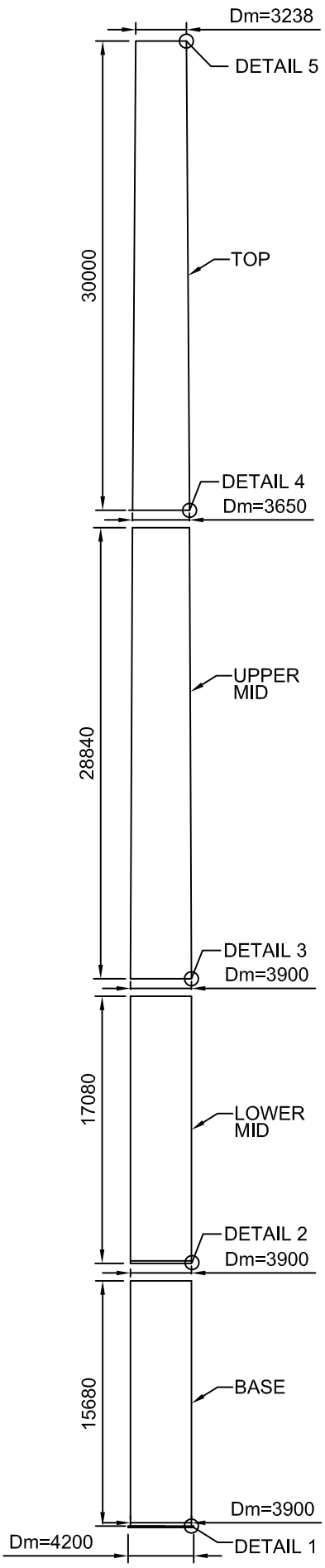
Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3	**0.899**	0.901	0.901	0.900	0.900	0.900	0.900	0.900	0.899	0.899	0.899	0.899	0.898	0.898
3.5	**0.845**	0.847	0.847	0.847	0.846	0.846	0.846	0.846	0.846	0.846	0.846	0.845	0.845	0.845
4	**0.816**	0.818	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.817	0.816	0.816	0.816	0.816
4.5	**0.805**	0.807	0.807	0.807	0.806	0.806	0.806	0.806	0.806	0.806	0.806	0.805	0.805	0.805
5	**0.801**	0.804	0.804	0.804	0.803	0.803	0.803	0.802	0.802	0.802	0.802	0.801	0.801	0.801
5.5	**0.798**	0.802	0.801	0.801	0.801	0.800	0.800	0.800	0.800	0.799	0.799	0.799	0.798	0.798
6	**0.796**	0.799	0.799	0.799	0.798	0.798	0.798	0.797	0.797	0.797	0.796	0.796	0.795	0.795
6.5	**0.792**	0.796	0.796	0.796	0.795	0.795	0.794	0.794	0.793	0.793	0.793	0.792	0.791	0.791
7	**0.787**	0.793	0.792	0.792	0.791	0.791	0.790	0.790	0.789	0.789	0.788	0.788	0.787	0.786
7.5	**0.780**	0.786	0.785	0.785	0.784	0.784	0.783	0.783	0.782	0.781	0.781	0.780	0.779	0.779
8	**0.762**	0.769	0.768	0.768	0.767	0.767	0.766	0.765	0.765	0.764	0.764	0.763	0.762	0.761
8.5	**0.732**	0.739	0.738	0.738	0.737	0.737	0.736	0.735	0.735	0.734	0.734	0.733	0.732	0.731
9	**0.690**	0.697	0.696	0.695	0.695	0.694	0.694	0.693	0.692	0.692	0.691	0.691	0.689	0.689
9.5	**0.640**	0.647	0.646	0.646	0.645	0.645	0.644	0.643	0.643	0.642	0.642	0.641	0.639	0.638
10	**0.586**	0.593	0.593	0.592	0.592	0.591	0.591	0.590	0.589	0.589	0.588	0.587	0.584	0.582
10.5	**0.531**	0.542	0.541	0.541	0.541	0.540	0.539	0.538	0.538	0.537	0.535	0.533	0.528	0.525
11	**0.474**	0.494	0.494	0.493	0.493	0.492	0.490	0.489	0.487	0.485	0.481	0.478	0.469	0.463
11.5	**0.420**	0.451	0.450	0.449	0.448	0.447	0.444	0.441	0.438	0.435	0.430	0.425	0.414	0.407
12	**0.371**	0.414	0.412	0.410	0.408	0.406	0.402	0.398	0.394	0.390	0.383	0.377	0.364	0.358
12.5	**0.328**	0.382	0.379	0.376	0.372	0.369	0.364	0.358	0.353	0.348	0.341	0.335	0.321	0.315
13	**0.290**	0.353	0.348	0.344	0.339	0.335	0.328	0.322	0.316	0.309	0.303	0.297	0.284	0.279
13.5	**0.258**	0.324	0.318	0.313	0.307	0.301	0.295	0.289	0.282	0.276	0.270	0.264	0.253	0.248
14	**0.230**	0.296	0.290	0.283	0.277	0.271	0.265	0.259	0.252	0.246	0.241	0.236	0.226	0.221
14.5	**0.206**	0.269	0.262	0.256	0.249	0.243	0.237	0.232	0.226	0.221	0.216	0.211	0.202	0.198
15	**0.185**	0.243	0.237	0.230	0.224	0.218	0.213	0.208	0.203	0.198	0.194	0.190	0.182	0.178
15.5	**0.168**	0.219	0.214	0.208	0.202	0.197	0.192	0.188	0.183	0.179	0.175	0.171	0.164	0.161
16	**0.152**	0.198	0.193	0.188	0.183	0.178	0.174	0.170	0.166	0.162	0.159	0.156	0.149	0.146
16.5	**0.139**	0.180	0.176	0.171	0.167	0.162	0.159	0.155	0.151	0.148	0.145	0.142	0.136	0.133
17	**0.127**	0.164	0.160	0.156	0.152	0.148	0.145	0.142	0.138	0.135	0.132	0.130	0.124	0.122
17.5	**0.116**	0.150	0.146	0.143	0.139	0.135	0.132	0.129	0.126	0.124	0.121	0.119	0.114	0.112
18	**0.107**	0.138	0.134	0.131	0.128	0.124	0.122	0.119	0.116	0.114	0.111	0.109	0.105	0.103
18.5	**0.099**	0.127	0.124	0.121	0.118	0.115	0.112	0.110	0.107	0.105	0.103	0.101	0.097	0.095
19	**0.092**	0.118	0.115	0.112	0.109	0.106	0.104	0.102	0.100	0.098	0.096	0.094	0.090	0.088
19.5	**0.085**	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.090	0.089	0.087	0.084	0.082
20	**0.079**	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.083	0.081	0.078	0.077
20.5	**0.074**	0.094	0.092	0.090	0.088	0.085	0.084	0.082	0.080	0.078	0.077	0.075	0.073	0.071
21	**0.069**	0.088	0.086	0.084	0.082	0.080	0.078	0.077	0.075	0.073	0.072	0.071	0.068	0.067
21.5	**0.065**	0.082	0.080	0.078	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.064	0.063
22	**0.061**	0.077	0.075	0.073	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.060	0.059
22.5	**0.057**	0.072	0.070	0.069	0.067	0.066	0.064	0.063	0.062	0.061	0.059	0.058	0.056	0.055
23	**0.054**	0.068	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.053	0.052
23.5	**0.051**	0.064	0.062	0.061	0.059	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.050	0.049
24	**0.048**	0.060	0.059	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.047	0.046
24.5	**0.045**	0.057	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044
25	**0.043**	0.054	0.052	0.051	0.050	0.049	0.048	0.047	0.046	0.045	0.044	0.044	0.042	0.041

Table 12-26: C_t values, noise mode 8

12.9.3 Noise Curve, Noise Mode 8

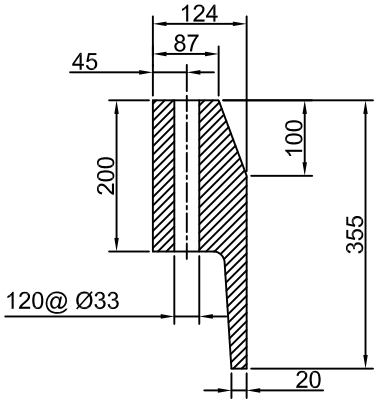
Sound Power Level at Hub Height, Noise Mode 8				
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**			
Hub Height	**84 m**	**94 m**	**119 m**	**140 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.4 4.2	94.5 4.3	94.8 4.5	95.0 4.6
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.2 5.6	97.5 5.7	98.0 5.9	98.4 6.1
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.8 7.0	101.1 7.2	101.7 7.4	102.1 7.6
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.2 8.4	103.3 8.6	103.5 8.9	103.5 9.2
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.5 9.8	103.5 10.0	103.5 10.4	103.5 10.7
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.5 11.2	103.5 11.4	103.5 11.9	103.5 12.2
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.5 12.7	103.5 12.9	103.5 13.4	103.5 13.7
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.5 14.1	103.5 14.3	103.5 14.9	103.5 15.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.5 15.5	103.5 15.7	103.5 16.3	103.5 16.8
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.5 16.9	103.5 17.2	103.5 17.8	103.5 18.3
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	103.5 18.3	103.5 18.6	103.5 19.3	103.5 19.8

Table 12-27: Noise curve, noise mode 8

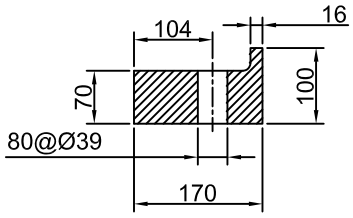


NOTES:

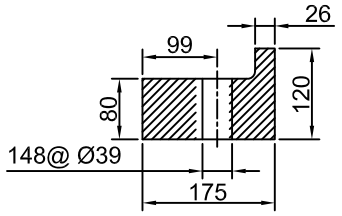
1. ALL DIMENSIONS IN [mm] UNLESS NOTED OTHERWISE
2. SHELL DIAMETERS INDICATED TO CENTER LINE OF STEEL PLATE SEGMENTS



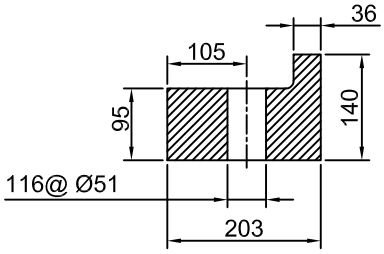
DETAIL 5-TOP FLANGE



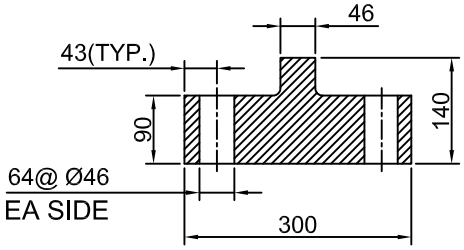
DETAIL 4-INTERMEDIATE FLANGE



DETAIL 3-INTERMEDIATE FLANGE



DETAIL 2-INTERMEDIATE FLANGE



DETAIL 1-BASE FLANGE

VESTAS
1417 NW EVERETT STREET
PORTLAND, OR 97209 +1 (503) 327-2000

DRAWING TITLE

V112-3.3MW HH94 IEC IIA
TOWER DRAWING

ORIGINAL DATE	DWG BY	CHK'D BY	APPROVAL REFERENCE	DWG NO.	VERSION
9/09/2013	CLHAA	TRTAY	0039-5891	0040-1566	00
REV DATE	REV BY	REV CHK'D BY	SCALE		SHEET
			N.T.S.		1 OF 1

Tower Foundation Design Basis
[V112-3.3MW HH94 IEC IIA]

TOWER FOUNDATION DESIGN BASIS
V112-3.3MW, 94-METER HUB HEIGHT IEC IIA

INTRODUCTION

This document contains information relevant to the structural design of the Tower Foundations for the Wind Turbines. This document assumes that model V112-3.3MW Wind Turbines will be installed on 94-meter hub height Towers at the Project Site locations set forth in the Contract.

FUNCTIONAL REQUIREMENTS

The following requirements shall be met for all tower foundations**:**

- Buyer shall design and construct the Tower Foundation to provide adequate serviceability, strength and stability for a design service life of not less than twenty (20) years.
- The maximum allowable permanent rotation of the Tower Foundation due to differential settlement is 0.17º.
- All Tower Foundations must be designed with a capped drainage system to allow for drainage of water/condensation out of the base of the Tower. The drain cap must be water-tight to prevent leaks of Hazardous Substances or other materials.
- The foundation anchor bolts shall be designed such that when the Tower is erected, the bolts extend above the Tower base flange (Figure 2) by at least twelve (12) inches but no more than fourteen (14) inches.
- The exposed portion of the anchor bolts above the Tower base flange shall have adequate corrosion protection (corrosion inhibiting grease and Griptight® anchor-bolt caps or equal).

DESIGN INPUTS

Buyer shall account for factors specific to the Project Site, such as proximity to bodies of water, topography, Soil and Subsurface Conditions, etc., in the Tower Foundation designs.

Supplier has not reviewed or taken into account any geotechnical or similar report for the Project Site in connection with the preparation of this document. Buyer is responsible for obtaining a geotechnical report from an independent third party with experience providing geotechnical reports for projects of a size and nature similar to the Project and otherwise in accordance with the BOP Requirements. The Tower Foundation must be designed based on the recommendations and conditions at the Project Site as described in the geotechnical report.

Typical design loads exerted on the Tower Foundation and applicable to Tower Drawing 0040-1566 are included as Figure 1. Design load combinations and load factors must be applied as required by Applicable Law.

Buyer shall use the base flange layout for design of the Tower Foundation attached to this document as Figure 2.

A typical conduit layout diagram is attached as Figure 3. This document is to serve as a guideline only and should be included in the foundation design drawings. The Buyer shall be responsible for coordination between the foundation engineer and collection system design.

A drawing for the Tower Foundation Template is attached as Figure 4. The tolerances for each dimension specified on the drawing must be within the limits set forth thereon. The Tower Foundation Template is intended for use during construction to align the anchor bolts. The bottom template ring is intended to form the grout trough after the ring is removed. Figure 5 shows the intended installation of the template rings. The Tower Foundation Template is not intended to be a permanent component of the Tower Foundation.

The turbine grounding (earthing) system must be incorporated into construction of the foundation. The information presented in the earthing wire installation drawings from the following documents must be included on the Foundation Construction Drawings. Only the information for the type of foundation(s) that will be used for the project shall be included in the Foundation Construction Drawings. If the Buyer intends to use a foundation system other than the types listed below, Buyer must notify Supplier and Supplier will provide grounding information suitable for the alternate foundation type.

Spread Footing Gravity Foundation – Vestas Document 964756

Patrick and Henderson (P&H) Tensionless Pier Foundation – Vestas Document 959020

Pile Anchor or Rock Anchor Foundation – Vestas Document 964772

DESIGN REQUIREMENTS

The Tower Foundation shall be designed to meet the requirements of all Applicable Laws, including international and local building codes, and this document. Buyer shall be responsible for determining whether any Applicable Laws relating to the design of the Tower Foundations have been enacted or issued by any Governmental Authority prior to and after the Effective Date. If Buyer determines that the Tower Foundation must comply with additional Applicable Laws after the Effective Date, Buyer shall design the Tower Foundation to meet the requirements of the Applicable Laws and shall notify Supplier of such Applicable Laws.

Figure 1 - Foundation Loads

CLASS T05

Vestas

DOCUMENT:
0037-7275 VER 00

DESCRIPTION:
Foundation loads

Foundation loads

V112-3.3 MW, Mk2A, IEC2A, 94 m US

Version History

VERSION:	DATE:	CHANGE:
00	2013.04.09	New document

Table of Contents

1. Introduction

This document presents the foundation loads from the V112-3.3 MW HH 94 US IEC2A load spectrum. The loads are simulated in accordance with IEC61400-1 Edition 3, ref. [1]. Additional tower & foundation interface requirements can be found in ref [3] and the tower used for calculating the loads can be found in ref [2].

Reference	Description	Doc No.
[1]	IEC61400-1 Edition 3	
[2]	Tower File	0037-6680.V00
[3]	Additional Tower & Foundation Interface Requirements	0001-3891.V01

Table 1-1 Reference to documents.

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 (0.008 m/m) is included with PLF 1.10 in below resultant moments.

Loads are given at height: 0.20m

Extreme resulting tower bottom moment according to ref [1] incl. own weight moment contribution due to 8mm/m tower out of vertical and second order effects. *unfavorable loads: PLF = 1.1, favorable loads: PLF = 0.9.

Mbt1: Resulting bending moment. SQRT(Mxt1^2 + Myt1^2) (also M_{res})
FndFr: Resulting shear force. SQRT(Fxt1^2 + Fyt1^2) (also F_{res})

Characteristic Extreme							
Lead	LC/Family	PLF	Type	Mbt1	Mzt1	FndFr	Fzt1
Sensor	[-]	[-]	[-]	[kNm]	[kNm]	[kN]	[kN]
Mbt1	62E50b07500(fam150)	1.10	Abs	**82780**	1409	995.9	-4468
Mzt1	21RPY18Vob00(fam48)	1.35	Abs	21730	**-5968**	268.0	-4437
FndFr	62E50b07500(fam150)	1.10	Abs	82670	1392	**998.0**	-4467
Fzt1	81P60015b00000(fam188)	1.50	Abs	8994	163.2	114.6	**-4589**

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

Characteristic Extreme							
Lead	LC/Family	PLF	Type	Mbt1	Mzt1	FndFr	Fzt1
Sensor	[-]	[-]	[-]	[kNm]	[kNm]	[kN]	[kN]
Mbt1	62E50b07500(fam150)	1.10	Abs	**82780**	1409	995.9	-4468
Mzt1	22OSFVo00(fam61)	1.10	Abs	19900	**-6131**	208.3	-4416
FndFr	62E50b07500(fam150)	1.10	Abs	82670	1392	**998.0**	-4467
Fzt1	71Id2bV150b00(fam168)	1.10	Abs	21240	1792	288.3	**-4740**

Table 3 Characteristic Extreme (excl. PLF). Load cases sorted without PLF.

Characteristic Extreme							
Lead	LC/Family	PLF	Type	Mbt1	Mzt1	FndFr	Fzt1
Sensor	[-]	[-]	[-]	[kNm]	[kNm]	[kN]	[kN]
Mbt1	62E50b07500(fam150)	1.10	Abs	**82780**	1409	995.9	-4468
Mzt1	22OSFVo00(fam61)	1.10	Abs	19900	**-6131**	208.3	-4416
FndFr	62E50b07500(fam150)	1.10	Abs	82670	1392	**998.0**	-4467
Fzt1	71Id2bV150b00(fam168)	1.10	Abs	21240	1792	288.3	**-4740**

Table 4 Characteristic Extreme (excl. PLF). Only load cases with PLF = 1.10.

Characteristic Extreme							
Lead	LC/Family	PLF	Type	Mbt1	Mzt1	FndFr	Fzt1
Sensor	[-]	[-]	[-]	[kNm]	[kNm]	[kN]	[kN]
Mbt1	32PREogVrm11(fam108)	1.35	Abs	**63500**	-384.3	659.8	-4550
Mzt1	21RPY18Vob00(fam48)	1.35	Abs	21730	**-5968**	268.0	-4437
FndFr	61E50a00800(fam132)	1.35	Abs	55670	-599.5	**716.6**	-4306
Fzt1	12IcVo00(fam25)	1.35	Abs	28450	1513	345.6	**-4649**

Table 5 Characteristic Extreme (excl. PLF). Only load cases with PLF = 1.35.

3. Serviceability loads

The serviceability loads are calculated as the 99% fraction of the load level during normal production.

Characteristic Extreme Serviceability Loads		
M_{res}	[kNm]	44061.75
M_z	[kNm]	-2045.11
F_{res}	[kN]	478.96
F_z	[kN]	-4575.72

Table 6 Quantile Ldd loads for Mres, Mz, Fres and Fz. PLF is not included.

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: 0.20m

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
Fy	[kN]	236.09	470.32	406.17
Mx	[kNm]	-22201.92	22334.33	23592.26
Mz	[kNm]	-85.15	5089.52	4811.96

Table 7 Fatigue loads for N=1E7 cycles.

Ref. [3] contains a description of how to combine ranges and mean values.

5. Stiffness of foundation

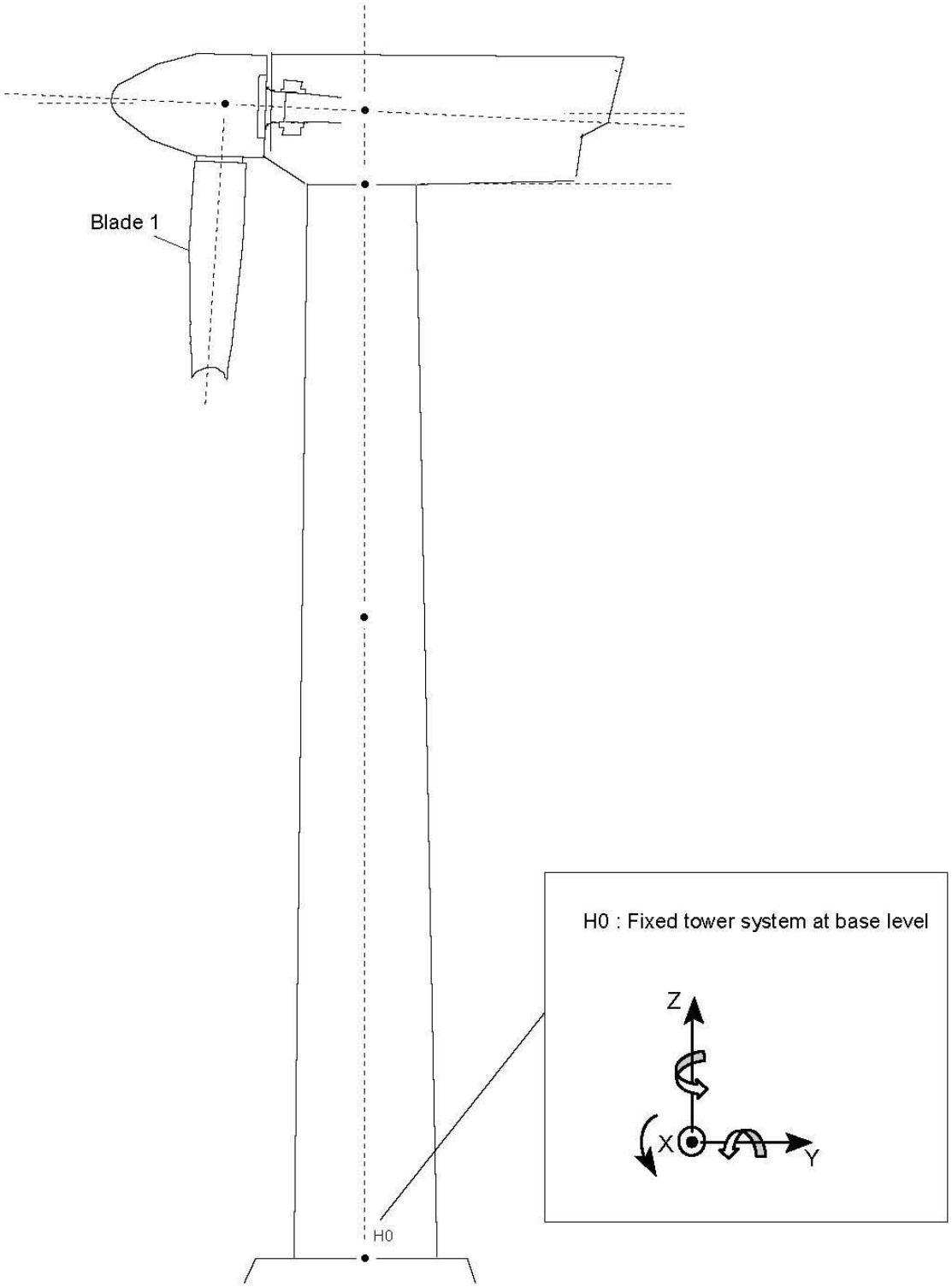
The nominal spring stiffness used for the load calculations is 104 GNm/rad resulting in a nominal tower frequency of 0.241 Hz. The spring stiffness of the foundation must be at least $C_{\varphi,dyn} \geq 62$ GNm/rad for the loads to be valid. The minimum lateral stiffness of the foundations is given in Table 5.1 as a function of the rotational stiffness.

Minimum Lateral Stiffness										
Rotational stiffness	[GNm/rad]	62.0	74.0	102.0	140.0	193.0	265.0	364.0	445.0	500.0
Lateral stiffness	[MN/m]	5000.0	54.7	22.4	15.3	12.9	11.2	10.6	10.0	10.0

Table 5.1 Minimum lateral stiffness.

The natural frequency of the tower must be within the frequency interval [0.237 Hz; 0.253 Hz]

Appendix A. Co-ordinate systems



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.

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
9.3454E+02	6.0000E+00	7.5105E+04	3.5000E+00	1.0050E+04	1.0417E+00
8.9716E+02	1.4708E+01	7.2101E+04	5.2500E+00	9.6476E+03	3.1555E+02
8.5977E+02	8.1917E+01	6.9096E+04	6.3208E+01	9.2456E+03	1.8600E+02
8.2239E+02	1.1900E+02	6.6092E+04	1.9621E+02	8.8436E+03	1.8691E+03
7.8501E+02	1.5456E+03	6.3088E+04	8.5626E+01	8.4416E+03	5.3028E+03
7.4763E+02	6.4298E+02	6.0084E+04	1.5342E+02	8.0396E+03	4.8017E+03
7.1025E+02	1.3611E+03	5.7080E+04	9.2003E+01	7.6377E+03	1.9112E+04
6.7287E+02	5.7728E+03	5.4075E+04	2.2942E+02	7.2357E+03	4.9656E+04
6.3548E+02	1.8120E+04	5.1071E+04	4.8598E+02	6.8337E+03	7.0339E+04
5.9810E+02	3.8920E+04	4.8067E+04	1.4577E+03	6.4317E+03	1.5157E+05
5.6072E+02	6.5946E+04	4.5063E+04	4.4308E+03	6.0297E+03	2.5244E+05
5.2334E+02	1.4802E+05	4.2059E+04	4.3391E+03	5.6278E+03	4.4320E+05
4.8596E+02	3.5637E+05	3.9055E+04	2.3152E+04	5.2258E+03	6.5335E+05
4.4858E+02	7.1685E+05	3.6050E+04	6.3642E+04	4.8238E+03	1.1026E+06
4.1120E+02	1.2945E+06	3.3046E+04	1.9167E+05	4.4218E+03	1.3603E+06
3.7381E+02	2.3796E+06	3.0042E+04	3.4326E+05	4.0198E+03	2.2738E+06
3.3643E+02	4.0920E+06	2.7038E+04	6.3011E+05	3.6178E+03	3.4335E+06
2.9905E+02	7.6565E+06	2.4034E+04	1.1426E+06	3.2159E+03	6.9651E+06
2.6167E+02	1.6093E+07	2.1029E+04	1.7920E+06	2.8139E+03	1.1898E+07
2.2429E+02	3.0768E+07	1.8025E+04	3.1754E+06	2.4119E+03	2.1605E+07
1.8691E+02	5.6212E+07	1.5021E+04	6.2701E+06	2.0099E+03	3.7450E+07
1.4953E+02	1.0003E+08	1.2017E+04	1.1121E+07	1.6079E+03	6.0328E+07
1.1214E+02	1.5798E+08	9.0126E+03	2.4907E+07	1.2059E+03	8.1564E+07
7.4763E+01	2.3593E+08	6.0084E+03	1.1558E+08	8.0396E+02	9.6776E+07
3.7381E+01	3.4639E+08	3.0042E+03	4.9962E+08	4.0198E+02	1.8249E+08

Table 8 Rainflow counting spectra.

Appendix C. Markov matrices

This appendix contains the Markov Matrices for the shear force, the bending moment and the torsional moment in the bottom of the tower.

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
5.6135E+02	1.1214E+02	1.2500E+00	2.5263E+04	3.0042E+03	3.5000E+00	3.0835E+03	2.0099E+02	1.0288E+03
5.1695E+02	3.7381E+01	6.3655E+03	2.3626E+04	3.0042E+03	3.5000E+00	2.8460E+03	1.0050E+03	3.8084E+03
4.9475E+02	2.2429E+02	5.0000E+00	2.3626E+04	1.5021E+03	7.8500E+01	2.8460E+03	0.0000E+00	6.6667E+01
4.9475E+02	1.4953E+02	6.3655E+03	2.3626E+04	0.0000E+00	7.0000E+00	2.6085E+03	1.8089E+03	1.0070E+03
4.9475E+02	1.3084E+02	1.8100E+02	2.1989E+04	3.0042E+03	3.5000E+00	2.6085E+03	1.0050E+03	3.0645E+03
4.9475E+02	1.1214E+02	2.2645E+04	2.1989E+04	1.5021E+03	2.5000E+00	2.6085E+03	4.0198E+02	4.4761E+02
4.9475E+02	7.4763E+01	5.3283E+02	2.1989E+04	0.0000E+00	1.7500E+01	2.6085E+03	2.0099E+02	3.5000E+00
4.9475E+02	5.6072E+01	4.1601E+04	2.0351E+04	3.0042E+03	1.3000E+01	2.6085E+03	0.0000E+00	5.1477E+03
4.9475E+02	3.7381E+01	1.8100E+02	2.0351E+04	1.5021E+03	1.7500E+01	2.3709E+03	3.8188E+03	1.8100E+02
4.9475E+02	1.8691E+01	3.9905E+03	2.0351E+04	0.0000E+00	1.4000E+01	2.3709E+03	6.0297E+02	4.4761E+02
4.9475E+02	0.0000E+00	1.6411E+04	1.8714E+04	3.0042E+03	1.0500E+01	2.3709E+03	2.0099E+02	1.1799E+04
4.7254E+02	2.2429E+02	2.0833E+00	1.8714E+04	1.5021E+03	2.4150E+02	2.3709E+03	0.0000E+00	3.9575E+04
4.7254E+02	2.0560E+02	1.0417E+00	1.8714E+04	0.0000E+00	3.1500E+01	2.1334E+03	2.8139E+03	3.5000E+00
4.7254E+02	1.8691E+02	2.5141E+02	1.7077E+04	6.0084E+03	2.5000E+00	2.1334E+03	1.4069E+03	1.7500E+00
4.7254E+02	1.6822E+02	6.3725E+03	1.7077E+04	4.5063E+03	8.5000E+00	2.1334E+03	1.2059E+03	9.5606E+03
4.7254E+02	1.4953E+02	1.0008E+04	1.7077E+04	3.0042E+03	7.0000E+00	2.1334E+03	1.0050E+03	1.7083E+02
4.7254E+02	1.3084E+02	5.5687E+04	1.7077E+04	1.5021E+03	1.1150E+02	2.1334E+03	6.0297E+02	2.2292E+04
4.7254E+02	1.1214E+02	4.4744E+04	1.7077E+04	0.0000E+00	1.8850E+02	2.1334E+03	4.0198E+02	5.8705E+03
4.7254E+02	9.3454E+01	5.0103E+04	1.5440E+04	4.5063E+03	3.5000E+00	2.1334E+03	2.0099E+02	1.9898E+04
4.7254E+02	7.4763E+01	6.4614E+04	1.5440E+04	3.0042E+03	1.1050E+02	2.1334E+03	0.0000E+00	6.5499E+04
4.7254E+02	5.6072E+01	9.9198E+04	1.5440E+04	1.5021E+03	2.0500E+02	1.8959E+03	3.2159E+03	4.1150E+03
4.7254E+02	3.7381E+01	7.9966E+04	1.5440E+04	0.0000E+00	2.1017E+02	1.8959E+03	2.6129E+03	3.9894E+03
4.7254E+02	1.8691E+01	1.1723E+05	1.3802E+04	4.5063E+03	6.0000E+00	1.8959E+03	2.2109E+03	2.0833E+00
4.7254E+02	0.0000E+00	6.4920E+04	1.3802E+04	3.0042E+03	2.7500E+01	1.8959E+03	2.0099E+03	4.1666E+00
4.5034E+02	2.9905E+02	6.3655E+03	1.3802E+04	1.5021E+03	6.5000E+01	1.8959E+03	1.8089E+03	1.9113E+04
4.5034E+02	2.8036E+02	1.6614E+04	1.3802E+04	0.0000E+00	2.9867E+02	1.8959E+03	1.6079E+03	3.5323E+03
4.5034E+02	2.6167E+02	2.6175E+04	1.2165E+04	3.6050E+04	1.7500E+00	1.8959E+03	1.4069E+03	3.5173E+04
4.5034E+02	2.4298E+02	2.8736E+04	1.2165E+04	3.3046E+04	1.7500E+00	1.8959E+03	1.2059E+03	1.1769E+04
4.5034E+02	2.2429E+02	2.2778E+04	1.2165E+04	7.5105E+03	3.5000E+00	1.8959E+03	1.0050E+03	2.0833E+00
4.5034E+02	2.0560E+02	4.4679E+04	1.2165E+04	6.0084E+03	2.5000E+00	1.8959E+03	8.0396E+02	1.6288E+04
4.5034E+02	1.8691E+02	6.7883E+04	1.2165E+04	4.5063E+03	1.2000E+01	1.8959E+03	6.0297E+02	2.1973E+04
4.5034E+02	1.6822E+02	2.1515E+05	1.2165E+04	3.0042E+03	1.3000E+01	1.8959E+03	4.0198E+02	3.9708E+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
4.5034E+02	1.4953E+02	2.9423E+05	1.2165E+04	1.5021E+03	3.4508E+02	1.8959E+03	2.0099E+02	1.6925E+05
4.5034E+02	1.3084E+02	3.1132E+05	1.2165E+04	0.0000E+00	1.3759E+04	1.8959E+03	0.0000E+00	1.7543E+05
4.5034E+02	1.1214E+02	4.9374E+05	1.0528E+04	3.7552E+04	1.7500E+00	1.6583E+03	3.8188E+03	2.0575E+03
4.5034E+02	9.3454E+01	5.3088E+05	1.0528E+04	2.7038E+04	1.7500E+00	1.6583E+03	3.6178E+03	1.2806E+04
4.5034E+02	7.4763E+01	6.8369E+05	1.0528E+04	1.0515E+04	3.5000E+00	1.6583E+03	3.0149E+03	4.8154E+03
4.5034E+02	5.6072E+01	7.0638E+05	1.0528E+04	7.5105E+03	7.0000E+00	1.6583E+03	2.8139E+03	6.3655E+03
4.5034E+02	3.7381E+01	7.3134E+05	1.0528E+04	6.0084E+03	1.0500E+01	1.6583E+03	2.6129E+03	4.5626E+03
4.5034E+02	1.8691E+01	6.4774E+05	1.0528E+04	4.5063E+03	7.0000E+00	1.6583E+03	2.4119E+03	9.5606E+03
4.5034E+02	0.0000E+00	6.4539E+05	1.0528E+04	3.0042E+03	3.2000E+01	1.6583E+03	2.2109E+03	2.2367E+04
4.2814E+02	3.3643E+02	3.8333E+00	1.0528E+04	1.5021E+03	1.5492E+02	1.6583E+03	2.0099E+03	9.5606E+03
4.2814E+02	3.1774E+02	2.2380E+02	1.0528E+04	0.0000E+00	7.3421E+03	1.6583E+03	1.8089E+03	3.8119E+03
4.2814E+02	2.9905E+02	5.4315E+04	8.8905E+03	3.9055E+04	1.7500E+00	1.6583E+03	1.6079E+03	3.9859E+04
4.2814E+02	2.8036E+02	8.3029E+04	8.8905E+03	3.1544E+04	1.7500E+00	1.6583E+03	1.4069E+03	3.0802E+04
4.2814E+02	2.6167E+02	1.1177E+05	8.8905E+03	3.0042E+04	7.0000E+00	1.6583E+03	1.2059E+03	4.1606E+04
4.2814E+02	2.4298E+02	9.6579E+04	8.8905E+03	2.7038E+04	7.0000E+00	1.6583E+03	1.0050E+03	1.0364E+05
4.2814E+02	2.2429E+02	2.4655E+05	8.8905E+03	2.2531E+04	7.0000E+00	1.6583E+03	8.0396E+02	2.6362E+04
4.2814E+02	2.0560E+02	4.3721E+05	8.8905E+03	2.1029E+04	1.7500E+00	1.6583E+03	6.0297E+02	4.5690E+04
4.2814E+02	1.8691E+02	8.6900E+05	8.8905E+03	1.9527E+04	3.5000E+00	1.6583E+03	4.0198E+02	1.0240E+05
4.2814E+02	1.6822E+02	1.1256E+06	8.8905E+03	1.8025E+04	3.5000E+00	1.6583E+03	2.0099E+02	2.9232E+05
4.2814E+02	1.4953E+02	1.7087E+06	8.8905E+03	1.6523E+04	3.5000E+00	1.6583E+03	0.0000E+00	4.8644E+05
4.2814E+02	1.3084E+02	2.2401E+06	8.8905E+03	1.5021E+04	3.5000E+00	1.4208E+03	4.6228E+03	1.0088E+03
4.2814E+02	1.1214E+02	2.9856E+06	8.8905E+03	1.3519E+04	3.5000E+00	1.4208E+03	3.6178E+03	3.5000E+00
4.2814E+02	9.3454E+01	4.0828E+06	8.8905E+03	1.0515E+04	7.8500E+01	1.4208E+03	3.4168E+03	2.0575E+03
4.2814E+02	7.4763E+01	4.0809E+06	8.8905E+03	9.0126E+03	1.0500E+01	1.4208E+03	3.0149E+03	4.0401E+04
4.2814E+02	5.6072E+01	4.0128E+06	8.8905E+03	7.5105E+03	3.5000E+00	1.4208E+03	2.8139E+03	4.0915E+04
4.2814E+02	3.7381E+01	3.7017E+06	8.8905E+03	4.5063E+03	1.4000E+01	1.4208E+03	2.6129E+03	8.4230E+03
4.2814E+02	1.8691E+01	3.1833E+06	8.8905E+03	3.0042E+03	4.8000E+01	1.4208E+03	2.4119E+03	2.2994E+04
4.2814E+02	0.0000E+00	1.8687E+06	8.8905E+03	1.5021E+03	3.8751E+02	1.4208E+03	2.2109E+03	4.0846E+04
4.0594E+02	4.1120E+02	7.9630E+03	8.8905E+03	0.0000E+00	2.3942E+04	1.4208E+03	2.0099E+03	8.9772E+04
4.0594E+02	3.9251E+02	2.3017E+04	7.2533E+03	3.6050E+04	7.0000E+00	1.4208E+03	1.8089E+03	8.3467E+04
4.0594E+02	3.7381E+02	9.5606E+03	7.2533E+03	3.4548E+04	3.9250E+01	1.4208E+03	1.6079E+03	1.2014E+05
4.0594E+02	3.5512E+02	4.3111E+04	7.2533E+03	3.3046E+04	5.2500E+00	1.4208E+03	1.4069E+03	2.4474E+05
4.0594E+02	3.3643E+02	6.7257E+04	7.2533E+03	3.0042E+04	1.0500E+01	1.4208E+03	1.2059E+03	1.5371E+05
4.0594E+02	3.1774E+02	7.2219E+04	7.2533E+03	2.8540E+04	5.2500E+00	1.4208E+03	1.0050E+03	1.5465E+05
4.0594E+02	2.9905E+02	1.3169E+05	7.2533E+03	2.7038E+04	8.9000E+01	1.4208E+03	8.0396E+02	2.0874E+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
4.0594E+02	2.8036E+02	1.6570E+05	7.2533E+03	2.5536E+04	4.6250E+01	1.4208E+03	6.0297E+02	1.7174E+05
4.0594E+02	2.6167E+02	5.5897E+05	7.2533E+03	2.4034E+04	3.5000E+00	1.4208E+03	4.0198E+02	3.0019E+05
4.0594E+02	2.4298E+02	8.0162E+05	7.2533E+03	2.2531E+04	7.0000E+00	1.4208E+03	2.0099E+02	7.1648E+05
4.0594E+02	2.2429E+02	1.5700E+06	7.2533E+03	2.1029E+04	3.5000E+00	1.4208E+03	0.0000E+00	1.1722E+06
4.0594E+02	2.0560E+02	2.0540E+06	7.2533E+03	1.9527E+04	4.2750E+01	1.1833E+03	5.0248E+03	1.7500E+00
4.0594E+02	1.8691E+02	2.9960E+06	7.2533E+03	1.8025E+04	7.8500E+01	1.1833E+03	4.4218E+03	2.5000E+00
4.0594E+02	1.6822E+02	3.8689E+06	7.2533E+03	1.6523E+04	1.0500E+01	1.1833E+03	4.2208E+03	4.8094E+02
4.0594E+02	1.4953E+02	5.4712E+06	7.2533E+03	1.5021E+04	1.0500E+01	1.1833E+03	4.0198E+03	4.2960E+03
4.0594E+02	1.3084E+02	7.5312E+06	7.2533E+03	1.3519E+04	1.5750E+01	1.1833E+03	3.8188E+03	1.8275E+02
4.0594E+02	1.1214E+02	8.3241E+06	7.2533E+03	1.2017E+04	1.0500E+01	1.1833E+03	3.6178E+03	4.6374E+03
4.0594E+02	9.3454E+01	9.8736E+06	7.2533E+03	9.0126E+03	1.0500E+01	1.1833E+03	3.4168E+03	1.1432E+04
4.0594E+02	7.4763E+01	1.0302E+07	7.2533E+03	7.5105E+03	2.2500E+01	1.1833E+03	3.2159E+03	3.3642E+04
4.0594E+02	5.6072E+01	9.5185E+06	7.2533E+03	6.0084E+03	7.0000E+00	1.1833E+03	3.0149E+03	3.3107E+04
4.0594E+02	3.7381E+01	8.4444E+06	7.2533E+03	4.5063E+03	1.3000E+01	1.1833E+03	2.8139E+03	5.3040E+04
4.0594E+02	1.8691E+01	6.0584E+06	7.2533E+03	3.0042E+03	2.1500E+01	1.1833E+03	2.6129E+03	4.4182E+04
4.0594E+02	0.0000E+00	4.3282E+06	7.2533E+03	1.5021E+03	5.2868E+02	1.1833E+03	2.4119E+03	1.0262E+05
3.8373E+02	5.6072E+02	1.2500E+00	7.2533E+03	0.0000E+00	2.8528E+04	1.1833E+03	2.2109E+03	1.0859E+05
3.8373E+02	5.2334E+02	3.1828E+03	5.6160E+03	4.2059E+04	1.7500E+00	1.1833E+03	2.0099E+03	1.7514E+05
3.8373E+02	5.0465E+02	3.1828E+03	5.6160E+03	4.0557E+04	1.7500E+00	1.1833E+03	1.8089E+03	1.5649E+05
3.8373E+02	4.4858E+02	1.4590E+04	5.6160E+03	3.7552E+04	3.5000E+00	1.1833E+03	1.6079E+03	4.2182E+05
3.8373E+02	4.2989E+02	2.8732E+04	5.6160E+03	3.6050E+04	1.7500E+00	1.1833E+03	1.4069E+03	4.6950E+05
3.8373E+02	4.1120E+02	2.7147E+04	5.6160E+03	3.4548E+04	3.5000E+00	1.1833E+03	1.2059E+03	4.6599E+05
3.8373E+02	3.9251E+02	7.3092E+04	5.6160E+03	3.3046E+04	3.5000E+00	1.1833E+03	1.0050E+03	5.1365E+05
3.8373E+02	3.7381E+02	6.9684E+04	5.6160E+03	3.1544E+04	7.0000E+00	1.1833E+03	8.0396E+02	4.2061E+05
3.8373E+02	3.5512E+02	1.7096E+05	5.6160E+03	3.0042E+04	5.2500E+00	1.1833E+03	6.0297E+02	4.7515E+05
3.8373E+02	3.3643E+02	2.3033E+05	5.6160E+03	2.8540E+04	1.2250E+01	1.1833E+03	4.0198E+02	7.5165E+05
3.8373E+02	3.1774E+02	3.3284E+05	5.6160E+03	2.7038E+04	4.2750E+01	1.1833E+03	2.0099E+02	1.7680E+06
3.8373E+02	2.9905E+02	5.1032E+05	5.6160E+03	2.5536E+04	1.2250E+01	1.1833E+03	0.0000E+00	2.7300E+06
3.8373E+02	2.8036E+02	1.0539E+06	5.6160E+03	2.4034E+04	1.2250E+01	9.4575E+02	8.2406E+03	1.0417E+00
3.8373E+02	2.6167E+02	1.2711E+06	5.6160E+03	2.2531E+04	3.3849E+03	9.4575E+02	5.0248E+03	2.5000E+00
3.8373E+02	2.4298E+02	2.2560E+06	5.6160E+03	2.1029E+04	1.5750E+01	9.4575E+02	4.6228E+03	4.8094E+02
3.8373E+02	2.2429E+02	2.7733E+06	5.6160E+03	1.9527E+04	1.0408E+02	9.4575E+02	4.4218E+03	5.0350E+02
3.8373E+02	2.0560E+02	3.6124E+06	5.6160E+03	1.8025E+04	7.0000E+00	9.4575E+02	4.2208E+03	2.6899E+03
3.8373E+02	1.8691E+02	4.8591E+06	5.6160E+03	1.6523E+04	4.1167E+01	9.4575E+02	4.0198E+03	3.8762E+03
3.8373E+02	1.6822E+02	6.7785E+06	5.6160E+03	1.5021E+04	5.5000E+01	9.4575E+02	3.8188E+03	8.2997E+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
3.8373E+02	1.4953E+02	8.6157E+06	5.6160E+03	1.3519E+04	5.5000E+01	9.4575E+02	3.6178E+03	2.4228E+04
3.8373E+02	1.3084E+02	1.0806E+07	5.6160E+03	1.2017E+04	8.2000E+01	9.4575E+02	3.4168E+03	2.6153E+04
3.8373E+02	1.1214E+02	1.2351E+07	5.6160E+03	1.0515E+04	2.2533E+02	9.4575E+02	3.2159E+03	4.1490E+04
3.8373E+02	9.3454E+01	1.3171E+07	5.6160E+03	9.0126E+03	2.1200E+02	9.4575E+02	3.0149E+03	1.2984E+05
3.8373E+02	7.4763E+01	1.3472E+07	5.6160E+03	7.5105E+03	8.5500E+01	9.4575E+02	2.8139E+03	8.2688E+04
3.8373E+02	5.6072E+01	1.3313E+07	5.6160E+03	6.0084E+03	6.8833E+01	9.4575E+02	2.6129E+03	1.2963E+05
3.8373E+02	3.7381E+01	1.0971E+07	5.6160E+03	4.5063E+03	1.5433E+02	9.4575E+02	2.4119E+03	2.1963E+05
3.8373E+02	1.8691E+01	8.8379E+06	5.6160E+03	3.0042E+03	1.9925E+02	9.4575E+02	2.2109E+03	3.5936E+05
3.8373E+02	0.0000E+00	5.0703E+06	5.6160E+03	1.5021E+03	7.6206E+02	9.4575E+02	2.0099E+03	6.6267E+05
3.6153E+02	5.2334E+02	3.1828E+03	5.6160E+03	0.0000E+00	4.2570E+04	9.4575E+02	1.8089E+03	6.0745E+05
3.6153E+02	5.0465E+02	3.1828E+03	3.9788E+03	3.6050E+04	1.7500E+00	9.4575E+02	1.6079E+03	1.0238E+06
3.6153E+02	4.8596E+02	2.4233E+04	3.9788E+03	3.1544E+04	5.2500E+00	9.4575E+02	1.4069E+03	1.0893E+06
3.6153E+02	4.6727E+02	4.7803E+03	3.9788E+03	3.0042E+04	1.7500E+00	9.4575E+02	1.2059E+03	1.1926E+06
3.6153E+02	4.4858E+02	2.8262E+04	3.9788E+03	2.8540E+04	8.7500E+00	9.4575E+02	1.0050E+03	1.2493E+06
3.6153E+02	4.2989E+02	4.9416E+04	3.9788E+03	2.7038E+04	1.4000E+01	9.4575E+02	8.0396E+02	1.1389E+06
3.6153E+02	4.1120E+02	5.8017E+04	3.9788E+03	2.5536E+04	5.2500E+00	9.4575E+02	6.0297E+02	1.0709E+06
3.6153E+02	3.9251E+02	9.5544E+04	3.9788E+03	2.4034E+04	1.4000E+01	9.4575E+02	4.0198E+02	1.6296E+06
3.6153E+02	3.7381E+02	1.3764E+05	3.9788E+03	2.2531E+04	1.2250E+01	9.4575E+02	2.0099E+02	3.5403E+06
3.6153E+02	3.5512E+02	2.3965E+05	3.9788E+03	2.1029E+04	1.0500E+01	9.4575E+02	0.0000E+00	5.3659E+06
3.6153E+02	3.3643E+02	2.2383E+05	3.9788E+03	1.9527E+04	4.9750E+01	7.0822E+02	7.2357E+03	3.7500E+01
3.6153E+02	3.1774E+02	4.3132E+05	3.9788E+03	1.8025E+04	3.3728E+03	7.0822E+02	6.0297E+03	2.0358E+03
3.6153E+02	2.9905E+02	5.2974E+05	3.9788E+03	1.6523E+04	3.3474E+03	7.0822E+02	5.6278E+03	1.8100E+02
3.6153E+02	2.8036E+02	6.3998E+05	3.9788E+03	1.5021E+04	3.9417E+01	7.0822E+02	5.4268E+03	1.8100E+02
3.6153E+02	2.6167E+02	1.1723E+06	3.9788E+03	1.3519E+04	3.2892E+02	7.0822E+02	5.0248E+03	1.8100E+02
3.6153E+02	2.4298E+02	1.5407E+06	3.9788E+03	1.2017E+04	1.6780E+04	7.0822E+02	4.8238E+03	2.2453E+03
3.6153E+02	2.2429E+02	2.2628E+06	3.9788E+03	1.0515E+04	1.0155E+04	7.0822E+02	4.6228E+03	3.6825E+02
3.6153E+02	2.0560E+02	3.0431E+06	3.9788E+03	9.0126E+03	3.8769E+03	7.0822E+02	4.4218E+03	2.7580E+03
3.6153E+02	1.8691E+02	4.3747E+06	3.9788E+03	7.5105E+03	4.9733E+02	7.0822E+02	4.2208E+03	8.9522E+02
3.6153E+02	1.6822E+02	5.5640E+06	3.9788E+03	6.0084E+03	2.3267E+02	7.0822E+02	4.0198E+03	2.3308E+03
3.6153E+02	1.4953E+02	6.9076E+06	3.9788E+03	4.5063E+03	1.5250E+04	7.0822E+02	3.8188E+03	5.6023E+03
3.6153E+02	1.3084E+02	9.1052E+06	3.9788E+03	3.0042E+03	1.2480E+04	7.0822E+02	3.6178E+03	4.5680E+04
3.6153E+02	1.1214E+02	1.0507E+07	3.9788E+03	1.5021E+03	7.9073E+02	7.0822E+02	3.4168E+03	6.7564E+04
3.6153E+02	9.3454E+01	1.1789E+07	3.9788E+03	0.0000E+00	1.0262E+05	7.0822E+02	3.2159E+03	1.1041E+05
3.6153E+02	7.4763E+01	1.2469E+07	2.3415E+03	3.4548E+04	3.5000E+00	7.0822E+02	3.0149E+03	2.0324E+05
3.6153E+02	5.6072E+01	1.1734E+07	2.3415E+03	3.1544E+04	1.7500E+00	7.0822E+02	2.8139E+03	2.8700E+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
3.6153E+02	3.7381E+01	1.0271E+07	2.3415E+03	3.0042E+04	1.7500E+00	7.0822E+02	2.6129E+03	4.5828E+05
3.6153E+02	1.8691E+01	7.5283E+06	2.3415E+03	2.8540E+04	3.3709E+03	7.0822E+02	2.4119E+03	6.2597E+05
3.6153E+02	0.0000E+00	5.0080E+06	2.3415E+03	2.7038E+04	1.7500E+00	7.0822E+02	2.2109E+03	7.1326E+05
3.3933E+02	6.1679E+02	1.2500E+00	2.3415E+03	2.5536E+04	3.5000E+00	7.0822E+02	2.0099E+03	8.9982E+05
3.3933E+02	5.6072E+02	1.9542E+03	2.3415E+03	2.4034E+04	1.0500E+01	7.0822E+02	1.8089E+03	1.2487E+06
3.3933E+02	5.4203E+02	1.9947E+03	2.3415E+03	2.2531E+04	7.0000E+00	7.0822E+02	1.6079E+03	1.5694E+06
3.3933E+02	5.2334E+02	6.3655E+03	2.3415E+03	2.1029E+04	3.7667E+01	7.0822E+02	1.4069E+03	2.2221E+06
3.3933E+02	5.0465E+02	5.2415E+03	2.3415E+03	1.9527E+04	3.4101E+03	7.0822E+02	1.2059E+03	2.2242E+06
3.3933E+02	4.8596E+02	1.9416E+04	2.3415E+03	1.8025E+04	1.0325E+02	7.0822E+02	1.0050E+03	2.5138E+06
3.3933E+02	4.6727E+02	4.9604E+04	2.3415E+03	1.6523E+04	3.9417E+01	7.0822E+02	8.0396E+02	2.7897E+06
3.3933E+02	4.4858E+02	1.9784E+04	2.3415E+03	1.5021E+04	2.6250E+01	7.0822E+02	6.0297E+02	2.4803E+06
3.3933E+02	4.2989E+02	8.1494E+04	2.3415E+03	1.3519E+04	1.5909E+03	7.0822E+02	4.0198E+02	3.4738E+06
3.3933E+02	4.1120E+02	1.0499E+05	2.3415E+03	1.2017E+04	6.9954E+03	7.0822E+02	2.0099E+02	6.8128E+06
3.3933E+02	3.9251E+02	1.0657E+05	2.3415E+03	1.0515E+04	1.5085E+04	7.0822E+02	0.0000E+00	1.0337E+07
3.3933E+02	3.7381E+02	1.4647E+05	2.3415E+03	9.0126E+03	2.1799E+04	4.7069E+02	7.6377E+03	1.2925E+02
3.3933E+02	3.5512E+02	1.2503E+05	2.3415E+03	7.5105E+03	2.8609E+04	4.7069E+02	7.0347E+03	2.5064E+03
3.3933E+02	3.3643E+02	2.7885E+05	2.3415E+03	6.0084E+03	3.8457E+03	4.7069E+02	6.8337E+03	1.0308E+03
3.3933E+02	3.1774E+02	2.9835E+05	2.3415E+03	4.5063E+03	1.6894E+04	4.7069E+02	6.6327E+03	1.6333E+02
3.3933E+02	2.9905E+02	4.1762E+05	2.3415E+03	3.0042E+03	1.4330E+04	4.7069E+02	6.2307E+03	1.6928E+03
3.3933E+02	2.8036E+02	4.7056E+05	2.3415E+03	1.5021E+03	5.4682E+04	4.7069E+02	6.0297E+03	2.0833E+00
3.3933E+02	2.6167E+02	6.7397E+05	2.3415E+03	0.0000E+00	4.0133E+05	4.7069E+02	5.8287E+03	5.0350E+02
3.3933E+02	2.4298E+02	9.5664E+05	7.0425E+02	4.8067E+04	1.2500E+00	4.7069E+02	5.6278E+03	6.9453E+03
3.3933E+02	2.2429E+02	1.4715E+06	7.0425E+02	4.0557E+04	1.2500E+00	4.7069E+02	5.4268E+03	2.1113E+04
3.3933E+02	2.0560E+02	2.0129E+06	7.0425E+02	3.4548E+04	1.2500E+00	4.7069E+02	5.2258E+03	8.3520E+03
3.3933E+02	1.8691E+02	2.8206E+06	7.0425E+02	3.0042E+04	1.2500E+00	4.7069E+02	5.0248E+03	1.8142E+04
3.3933E+02	1.6822E+02	4.0307E+06	7.0425E+02	2.8540E+04	3.5083E+01	4.7069E+02	4.8238E+03	1.8678E+03
3.3933E+02	1.4953E+02	4.9345E+06	7.0425E+02	2.7038E+04	3.2417E+01	4.7069E+02	4.6228E+03	2.8707E+04
3.3933E+02	1.3084E+02	6.5860E+06	7.0425E+02	2.5536E+04	7.0000E+00	4.7069E+02	4.4218E+03	7.2285E+03
3.3933E+02	1.1214E+02	8.2745E+06	7.0425E+02	2.4034E+04	3.4033E+03	4.7069E+02	4.2208E+03	3.0231E+04
3.3933E+02	9.3454E+01	8.7844E+06	7.0425E+02	2.2531E+04	3.5917E+01	4.7069E+02	4.0198E+03	4.6937E+04
3.3933E+02	7.4763E+01	9.3701E+06	7.0425E+02	2.1029E+04	6.6417E+01	4.7069E+02	3.8188E+03	5.5062E+04
3.3933E+02	5.6072E+01	8.8860E+06	7.0425E+02	1.9527E+04	8.0250E+01	4.7069E+02	3.6178E+03	7.3380E+04
3.3933E+02	3.7381E+01	7.9818E+06	7.0425E+02	1.8025E+04	2.5583E+02	4.7069E+02	3.4168E+03	9.3824E+04
3.3933E+02	1.8691E+01	6.3939E+06	7.0425E+02	1.6523E+04	1.4539E+04	4.7069E+02	3.2159E+03	2.8339E+05
3.3933E+02	0.0000E+00	4.2028E+06	7.0425E+02	1.5021E+04	2.0163E+04	4.7069E+02	3.0149E+03	3.9184E+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
3.1713E+02	6.9156E+02	2.2380E+02	7.0425E+02	1.3519E+04	3.2155E+04	4.7069E+02	2.8139E+03	4.1026E+05
3.1713E+02	6.7287E+02	9.0500E+01	7.0425E+02	1.2017E+04	9.6617E+04	4.7069E+02	2.6129E+03	6.0565E+05
3.1713E+02	6.5418E+02	1.0417E+00	7.0425E+02	1.0515E+04	1.4261E+05	4.7069E+02	2.4119E+03	6.2267E+05
3.1713E+02	6.3548E+02	2.0575E+03	7.0425E+02	9.0126E+03	1.5435E+05	4.7069E+02	2.2109E+03	1.0648E+06
3.1713E+02	6.1679E+02	1.9042E+03	7.0425E+02	7.5105E+03	1.0377E+05	4.7069E+02	2.0099E+03	1.3316E+06
3.1713E+02	5.9810E+02	5.0870E+03	7.0425E+02	6.0084E+03	9.7923E+04	4.7069E+02	1.8089E+03	2.0880E+06
3.1713E+02	5.7941E+02	2.5000E+00	7.0425E+02	4.5063E+03	2.5555E+05	4.7069E+02	1.6079E+03	2.5408E+06
3.1713E+02	5.6072E+02	5.0475E+02	7.0425E+02	3.0042E+03	7.2044E+05	4.7069E+02	1.4069E+03	3.2232E+06
3.1713E+02	5.4203E+02	8.8966E+03	7.0425E+02	1.5021E+03	1.0030E+06	4.7069E+02	1.2059E+03	3.9872E+06
3.1713E+02	5.2334E+02	6.2142E+03	7.0425E+02	0.0000E+00	2.9968E+07	4.7069E+02	1.0050E+03	4.7821E+06
3.1713E+02	5.0465E+02	2.0024E+04	-9.3300E+02	4.5063E+04	1.2500E+00	4.7069E+02	8.0396E+02	4.9914E+06
3.1713E+02	4.8596E+02	2.8998E+04	-9.3300E+02	4.3561E+04	1.2500E+00	4.7069E+02	6.0297E+02	4.8757E+06
3.1713E+02	4.6727E+02	4.1924E+04	-9.3300E+02	4.2059E+04	3.7500E+01	4.7069E+02	4.0198E+02	5.9956E+06
3.1713E+02	4.4858E+02	4.1500E+04	-9.3300E+02	4.0557E+04	1.2500E+00	4.7069E+02	2.0099E+02	1.1969E+07
3.1713E+02	4.2989E+02	7.4592E+04	-9.3300E+02	3.7552E+04	3.7500E+00	4.7069E+02	0.0000E+00	1.8142E+07
3.1713E+02	4.1120E+02	4.7504E+04	-9.3300E+02	3.6050E+04	1.2500E+00	2.3316E+02	8.8436E+03	9.0500E+01
3.1713E+02	3.9251E+02	9.1200E+04	-9.3300E+02	3.4548E+04	1.2500E+00	2.3316E+02	8.4416E+03	9.0500E+01
3.1713E+02	3.7381E+02	1.6260E+05	-9.3300E+02	3.3046E+04	2.5000E+00	2.3316E+02	8.2406E+03	9.0500E+01
3.1713E+02	3.5512E+02	1.7930E+05	-9.3300E+02	3.1544E+04	3.7500E+00	2.3316E+02	7.8387E+03	1.8308E+02
3.1713E+02	3.3643E+02	1.8623E+05	-9.3300E+02	2.8540E+04	3.7500E+00	2.3316E+02	7.6377E+03	1.0417E+00
3.1713E+02	3.1774E+02	2.5609E+05	-9.3300E+02	2.7038E+04	3.7500E+00	2.3316E+02	7.4367E+03	1.2536E+03
3.1713E+02	2.9905E+02	3.4808E+05	-9.3300E+02	2.5536E+04	3.0167E+01	2.3316E+02	7.2357E+03	2.2485E+02
3.1713E+02	2.8036E+02	5.0911E+05	-9.3300E+02	2.4034E+04	9.4953E+02	2.3316E+02	7.0347E+03	8.1665E+01
3.1713E+02	2.6167E+02	7.0667E+05	-9.3300E+02	2.2531E+04	9.4212E+02	2.3316E+02	6.6327E+03	1.9371E+03
3.1713E+02	2.4298E+02	1.0156E+06	-9.3300E+02	2.1029E+04	5.2233E+03	2.3316E+02	6.4317E+03	1.2500E+00
3.1713E+02	2.2429E+02	1.2223E+06	-9.3300E+02	1.9527E+04	1.8344E+03	2.3316E+02	6.2307E+03	6.1149E+03
3.1713E+02	2.0560E+02	1.9415E+06	-9.3300E+02	1.8025E+04	4.8205E+03	2.3316E+02	6.0297E+03	1.8088E+04
3.1713E+02	1.8691E+02	2.1785E+06	-9.3300E+02	1.6523E+04	2.3428E+04	2.3316E+02	5.8287E+03	8.3761E+03
3.1713E+02	1.6822E+02	2.9853E+06	-9.3300E+02	1.5021E+04	1.1699E+04	2.3316E+02	5.6278E+03	1.6953E+04
3.1713E+02	1.4953E+02	4.1543E+06	-9.3300E+02	1.3519E+04	1.4104E+04	2.3316E+02	5.4268E+03	2.5928E+04
3.1713E+02	1.3084E+02	5.1760E+06	-9.3300E+02	1.2017E+04	1.3360E+04	2.3316E+02	5.2258E+03	1.7840E+04
3.1713E+02	1.1214E+02	6.4484E+06	-9.3300E+02	1.0515E+04	4.2311E+04	2.3316E+02	5.0248E+03	3.9145E+04
3.1713E+02	9.3454E+01	7.3740E+06	-9.3300E+02	9.0126E+03	8.1475E+04	2.3316E+02	4.8238E+03	2.3115E+04
3.1713E+02	7.4763E+01	7.6932E+06	-9.3300E+02	7.5105E+03	1.0884E+05	2.3316E+02	4.6228E+03	5.2075E+04
3.1713E+02	5.6072E+01	8.2072E+06	-9.3300E+02	6.0084E+03	1.9106E+05	2.3316E+02	4.4218E+03	6.3100E+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
3.1713E+02	3.7381E+01	6.9436E+06	-9.3300E+02	4.5063E+03	2.6618E+05	2.3316E+02	4.2208E+03	9.1860E+04
3.1713E+02	1.8691E+01	6.0854E+06	-9.3300E+02	3.0042E+03	4.2407E+05	2.3316E+02	4.0198E+03	9.5044E+04
3.1713E+02	0.0000E+00	3.9099E+06	-9.3300E+02	1.5021E+03	3.8817E+05	2.3316E+02	3.8188E+03	1.5663E+05
2.9493E+02	8.5977E+02	1.2500E+00	-9.3300E+02	0.0000E+00	3.9210E+06	2.3316E+02	3.6178E+03	1.4476E+05
2.9493E+02	8.4108E+02	1.2500E+00	-2.5703E+03	4.9569E+04	1.2500E+00	2.3316E+02	3.4168E+03	2.5148E+05
2.9493E+02	7.8501E+02	5.0350E+02	-2.5703E+03	4.8067E+04	1.2500E+00	2.3316E+02	3.2159E+03	4.0617E+05
2.9493E+02	7.6632E+02	5.0558E+02	-2.5703E+03	4.0557E+04	1.2500E+00	2.3316E+02	3.0149E+03	4.2007E+05
2.9493E+02	6.9156E+02	9.3000E+01	-2.5703E+03	3.9055E+04	2.5000E+00	2.3316E+02	2.8139E+03	5.9359E+05
2.9493E+02	6.7287E+02	9.0500E+01	-2.5703E+03	3.7552E+04	2.5000E+00	2.3316E+02	2.6129E+03	9.0148E+05
2.9493E+02	6.5418E+02	9.0500E+01	-2.5703E+03	3.4548E+04	8.0000E+01	2.3316E+02	2.4119E+03	1.0988E+06
2.9493E+02	6.3548E+02	2.2836E+03	-2.5703E+03	3.3046E+04	1.2500E+00	2.3316E+02	2.2109E+03	1.4932E+06
2.9493E+02	6.1679E+02	3.0374E+03	-2.5703E+03	3.1544E+04	4.1250E+01	2.3316E+02	2.0099E+03	2.1247E+06
2.9493E+02	5.9810E+02	5.1181E+03	-2.5703E+03	3.0042E+04	2.5000E+00	2.3316E+02	1.8089E+03	2.7506E+06
2.9493E+02	5.7941E+02	2.1085E+03	-2.5703E+03	2.8540E+04	5.0000E+00	2.3316E+02	1.6079E+03	3.6954E+06
2.9493E+02	5.6072E+02	9.0486E+03	-2.5703E+03	2.7038E+04	4.7250E+01	2.3316E+02	1.4069E+03	4.6508E+06
2.9493E+02	5.4203E+02	3.5041E+03	-2.5703E+03	2.5536E+04	2.7546E+03	2.3316E+02	1.2059E+03	5.5566E+06
2.9493E+02	5.2334E+02	1.0690E+04	-2.5703E+03	2.4034E+04	2.0114E+03	2.3316E+02	1.0050E+03	6.7805E+06
2.9493E+02	5.0465E+02	1.1886E+04	-2.5703E+03	2.2531E+04	4.0000E+01	2.3316E+02	8.0396E+02	8.5368E+06
2.9493E+02	4.8596E+02	2.0283E+04	-2.5703E+03	2.1029E+04	1.2500E+01	2.3316E+02	6.0297E+02	8.4936E+06
2.9493E+02	4.6727E+02	2.3025E+04	-2.5703E+03	1.9527E+04	1.1519E+03	2.3316E+02	4.0198E+02	1.0932E+07
2.9493E+02	4.4858E+02	4.7024E+04	-2.5703E+03	1.8025E+04	1.5542E+02	2.3316E+02	2.0099E+02	1.9491E+07
2.9493E+02	4.2989E+02	6.3192E+04	-2.5703E+03	1.6523E+04	1.0051E+03	2.3316E+02	0.0000E+00	2.9750E+07
2.9493E+02	4.1120E+02	8.6077E+04	-2.5703E+03	1.5021E+04	4.3698E+03	-4.3702E+00	1.0050E+04	1.0417E+00
2.9493E+02	3.9251E+02	1.0331E+05	-2.5703E+03	1.3519E+04	5.8404E+03	-4.3702E+00	9.0446E+03	9.0500E+01
2.9493E+02	3.7381E+02	1.6065E+05	-2.5703E+03	1.2017E+04	7.6307E+03	-4.3702E+00	8.8436E+03	9.0500E+01
2.9493E+02	3.5512E+02	1.7549E+05	-2.5703E+03	1.0515E+04	1.9998E+04	-4.3702E+00	8.6426E+03	9.0500E+01
2.9493E+02	3.3643E+02	2.2993E+05	-2.5703E+03	9.0126E+03	2.7019E+04	-4.3702E+00	8.4416E+03	9.0500E+01
2.9493E+02	3.1774E+02	2.6838E+05	-2.5703E+03	7.5105E+03	1.3558E+05	-4.3702E+00	8.2406E+03	1.0300E+03
2.9493E+02	2.9905E+02	4.1357E+05	-2.5703E+03	6.0084E+03	3.4121E+05	-4.3702E+00	8.0396E+03	1.0288E+03
2.9493E+02	2.8036E+02	5.3766E+05	-2.5703E+03	4.5063E+03	7.9578E+05	-4.3702E+00	7.8387E+03	4.4761E+02
2.9493E+02	2.6167E+02	7.5069E+05	-2.5703E+03	3.0042E+03	1.2622E+06	-4.3702E+00	7.6377E+03	2.6127E+03
2.9493E+02	2.4298E+02	1.0663E+06	-2.5703E+03	1.5021E+03	1.0165E+06	-4.3702E+00	7.4367E+03	1.5669E+03
2.9493E+02	2.2429E+02	1.1481E+06	-2.5703E+03	0.0000E+00	9.1257E+06	-4.3702E+00	7.2357E+03	2.1263E+03
2.9493E+02	2.0560E+02	1.8167E+06	-4.2075E+03	6.1586E+04	1.2500E+00	-4.3702E+00	7.0347E+03	6.4063E+03
2.9493E+02	1.8691E+02	2.0313E+06	-4.2075E+03	5.5578E+04	1.2500E+00	-4.3702E+00	6.8337E+03	3.1853E+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
2.9493E+02	1.6822E+02	2.5754E+06	-4.2075E+03	5.2573E+04	1.2500E+00	-4.3702E+00	6.6327E+03	1.0369E+04
2.9493E+02	1.4953E+02	3.5602E+06	-4.2075E+03	4.2059E+04	1.2500E+00	-4.3702E+00	6.4317E+03	1.1106E+04
2.9493E+02	1.3084E+02	4.6553E+06	-4.2075E+03	3.9055E+04	5.0000E+00	-4.3702E+00	6.2307E+03	5.9215E+03
2.9493E+02	1.1214E+02	5.8735E+06	-4.2075E+03	3.7552E+04	1.2500E+00	-4.3702E+00	6.0297E+03	7.5011E+03
2.9493E+02	9.3454E+01	6.7345E+06	-4.2075E+03	3.6050E+04	3.7500E+00	-4.3702E+00	5.8287E+03	1.7196E+04
2.9493E+02	7.4763E+01	7.7527E+06	-4.2075E+03	3.4548E+04	7.5000E+00	-4.3702E+00	5.6278E+03	1.7649E+04
2.9493E+02	5.6072E+01	7.4177E+06	-4.2075E+03	3.3046E+04	7.8750E+01	-4.3702E+00	5.4268E+03	5.5332E+04
2.9493E+02	3.7381E+01	6.9357E+06	-4.2075E+03	3.1544E+04	1.9375E+02	-4.3702E+00	5.2258E+03	3.3308E+04
2.9493E+02	1.8691E+01	5.7645E+06	-4.2075E+03	3.0042E+04	1.5750E+02	-4.3702E+00	5.0248E+03	6.1899E+04
2.9493E+02	0.0000E+00	3.9025E+06	-4.2075E+03	2.8540E+04	1.6904E+03	-4.3702E+00	4.8238E+03	1.2390E+05
2.7272E+02	7.8501E+02	2.2380E+02	-4.2075E+03	2.7038E+04	4.6250E+01	-4.3702E+00	4.6228E+03	1.1778E+05
2.7272E+02	6.9156E+02	9.0500E+01	-4.2075E+03	2.5536E+04	2.5000E+01	-4.3702E+00	4.4218E+03	1.1738E+05
2.7272E+02	6.7287E+02	9.0830E+02	-4.2075E+03	2.4034E+04	9.7125E+02	-4.3702E+00	4.2208E+03	1.5177E+05
2.7272E+02	6.5418E+02	2.7254E+02	-4.2075E+03	2.2531E+04	4.3583E+02	-4.3702E+00	4.0198E+03	2.4597E+05
2.7272E+02	6.3548E+02	3.6200E+02	-4.2075E+03	2.1029E+04	1.9892E+03	-4.3702E+00	3.8188E+03	2.8229E+05
2.7272E+02	6.1679E+02	2.0058E+03	-4.2075E+03	1.9527E+04	5.4614E+03	-4.3702E+00	3.6178E+03	2.7112E+05
2.7272E+02	5.9810E+02	1.2970E+03	-4.2075E+03	1.8025E+04	1.9967E+03	-4.3702E+00	3.4168E+03	3.3538E+05
2.7272E+02	5.7941E+02	8.7802E+03	-4.2075E+03	1.6523E+04	5.9962E+03	-4.3702E+00	3.2159E+03	3.9377E+05
2.7272E+02	5.6072E+02	1.0396E+04	-4.2075E+03	1.5021E+04	3.3522E+03	-4.3702E+00	3.0149E+03	7.0248E+05
2.7272E+02	5.4203E+02	5.0650E+03	-4.2075E+03	1.3519E+04	1.2917E+04	-4.3702E+00	2.8139E+03	9.2802E+05
2.7272E+02	5.2334E+02	1.2607E+04	-4.2075E+03	1.2017E+04	1.6779E+04	-4.3702E+00	2.6129E+03	1.0154E+06
2.7272E+02	5.0465E+02	1.3466E+04	-4.2075E+03	1.0515E+04	2.1064E+04	-4.3702E+00	2.4119E+03	1.2620E+06
2.7272E+02	4.8596E+02	2.9142E+04	-4.2075E+03	9.0126E+03	3.2026E+04	-4.3702E+00	2.2109E+03	1.8288E+06
2.7272E+02	4.6727E+02	4.3683E+04	-4.2075E+03	7.5105E+03	1.0351E+05	-4.3702E+00	2.0099E+03	2.1523E+06
2.7272E+02	4.4858E+02	5.7854E+04	-4.2075E+03	6.0084E+03	3.7176E+05	-4.3702E+00	1.8089E+03	3.0652E+06
2.7272E+02	4.2989E+02	8.4729E+04	-4.2075E+03	4.5063E+03	1.0585E+06	-4.3702E+00	1.6079E+03	4.6566E+06
2.7272E+02	4.1120E+02	9.3760E+04	-4.2075E+03	3.0042E+03	1.8633E+06	-4.3702E+00	1.4069E+03	5.3320E+06
2.7272E+02	3.9251E+02	1.4991E+05	-4.2075E+03	1.5021E+03	1.9483E+06	-4.3702E+00	1.2059E+03	6.7674E+06
2.7272E+02	3.7381E+02	1.8222E+05	-4.2075E+03	0.0000E+00	1.5943E+07	-4.3702E+00	1.0050E+03	7.9256E+06
2.7272E+02	3.5512E+02	1.9662E+05	-5.8448E+03	6.6092E+04	1.7500E+00	-4.3702E+00	8.0396E+02	9.4009E+06
2.7272E+02	3.3643E+02	2.6763E+05	-5.8448E+03	6.3088E+04	1.2500E+00	-4.3702E+00	6.0297E+02	9.8852E+06
2.7272E+02	3.1774E+02	3.4676E+05	-5.8448E+03	5.4075E+04	4.2500E+00	-4.3702E+00	4.0198E+02	1.1680E+07
2.7272E+02	2.9905E+02	3.5283E+05	-5.8448E+03	4.3561E+04	3.7500E+00	-4.3702E+00	2.0099E+02	2.2924E+07
2.7272E+02	2.8036E+02	5.2383E+05	-5.8448E+03	4.2059E+04	1.2500E+00	-4.3702E+00	0.0000E+00	7.9183E+07
2.7272E+02	2.6167E+02	6.6487E+05	-5.8448E+03	4.0557E+04	2.5000E+00	-2.4190E+02	8.6426E+03	3.1535E+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
2.7272E+02	2.4298E+02	7.5185E+05	-5.8448E+03	3.6050E+04	3.7500E+00	-2.4190E+02	8.4416E+03	2.2917E+00
2.7272E+02	2.2429E+02	9.6240E+05	-5.8448E+03	3.4548E+04	6.2500E+00	-2.4190E+02	8.2406E+03	7.2119E+02
2.7272E+02	2.0560E+02	1.3862E+06	-5.8448E+03	3.3046E+04	8.7500E+00	-2.4190E+02	7.8387E+03	5.9608E+02
2.7272E+02	1.8691E+02	1.6278E+06	-5.8448E+03	3.1544E+04	8.5000E+01	-2.4190E+02	7.6377E+03	1.4346E+03
2.7272E+02	1.6822E+02	2.1940E+06	-5.8448E+03	3.0042E+04	1.1250E+01	-2.4190E+02	7.4367E+03	5.2371E+03
2.7272E+02	1.4953E+02	3.4758E+06	-5.8448E+03	2.8540E+04	2.3395E+02	-2.4190E+02	7.2357E+03	5.3934E+03
2.7272E+02	1.3084E+02	3.9653E+06	-5.8448E+03	2.7038E+04	4.2506E+02	-2.4190E+02	7.0347E+03	9.9845E+03
2.7272E+02	1.1214E+02	5.5753E+06	-5.8448E+03	2.5536E+04	5.3731E+02	-2.4190E+02	6.8337E+03	9.5166E+03
2.7272E+02	9.3454E+01	6.3460E+06	-5.8448E+03	2.4034E+04	1.1964E+03	-2.4190E+02	6.6327E+03	1.1709E+04
2.7272E+02	7.4763E+01	7.2665E+06	-5.8448E+03	2.2531E+04	2.0954E+03	-2.4190E+02	6.4317E+03	1.2446E+04
2.7272E+02	5.6072E+01	8.2237E+06	-5.8448E+03	2.1029E+04	2.7245E+03	-2.4190E+02	6.2307E+03	3.8714E+04
2.7272E+02	3.7381E+01	7.9388E+06	-5.8448E+03	1.9527E+04	3.5865E+03	-2.4190E+02	6.0297E+03	3.6769E+04
2.7272E+02	1.8691E+01	7.3921E+06	-5.8448E+03	1.8025E+04	3.1305E+03	-2.4190E+02	5.8287E+03	4.4227E+04
2.7272E+02	0.0000E+00	4.2796E+06	-5.8448E+03	1.6523E+04	7.9259E+03	-2.4190E+02	5.6278E+03	8.2367E+04
2.5052E+02	8.0370E+02	1.0417E+00	-5.8448E+03	1.5021E+04	2.0945E+04	-2.4190E+02	5.4268E+03	4.0952E+04
2.5052E+02	7.8501E+02	9.0500E+01	-5.8448E+03	1.3519E+04	1.5910E+04	-2.4190E+02	5.2258E+03	9.4086E+04
2.5052E+02	7.4763E+02	1.2800E+02	-5.8448E+03	1.2017E+04	1.7944E+04	-2.4190E+02	5.0248E+03	9.1145E+04
2.5052E+02	7.2894E+02	2.2839E+02	-5.8448E+03	1.0515E+04	2.6458E+04	-2.4190E+02	4.8238E+03	1.2698E+05
2.5052E+02	7.1025E+02	3.1430E+02	-5.8448E+03	9.0126E+03	6.6621E+04	-2.4190E+02	4.6228E+03	1.7355E+05
2.5052E+02	6.9156E+02	3.1535E+02	-5.8448E+03	7.5105E+03	1.5326E+05	-2.4190E+02	4.4218E+03	2.2315E+05
2.5052E+02	6.7287E+02	1.4764E+03	-5.8448E+03	6.0084E+03	4.9250E+05	-2.4190E+02	4.2208E+03	1.2434E+05
2.5052E+02	6.5418E+02	6.8985E+02	-5.8448E+03	4.5063E+03	1.4414E+06	-2.4190E+02	4.0198E+03	1.4161E+05
2.5052E+02	6.3548E+02	1.5853E+03	-5.8448E+03	3.0042E+03	2.9820E+06	-2.4190E+02	3.8188E+03	3.2963E+05
2.5052E+02	6.1679E+02	2.8431E+03	-5.8448E+03	1.5021E+03	2.8552E+06	-2.4190E+02	3.6178E+03	2.5981E+05
2.5052E+02	5.9810E+02	5.1254E+03	-5.8448E+03	0.0000E+00	2.0718E+07	-2.4190E+02	3.4168E+03	3.1160E+05
2.5052E+02	5.7941E+02	4.9658E+03	-7.4820E+03	7.5105E+04	1.7500E+00	-2.4190E+02	3.2159E+03	5.3077E+05
2.5052E+02	5.6072E+02	6.6999E+03	-7.4820E+03	7.2101E+04	3.5000E+00	-2.4190E+02	3.0149E+03	6.7764E+05
2.5052E+02	5.4203E+02	1.2045E+04	-7.4820E+03	6.7594E+04	1.7500E+00	-2.4190E+02	2.8139E+03	6.4032E+05
2.5052E+02	5.2334E+02	1.4176E+04	-7.4820E+03	6.4590E+04	1.7500E+00	-2.4190E+02	2.6129E+03	1.0238E+06
2.5052E+02	5.0465E+02	2.2756E+04	-7.4820E+03	6.3088E+04	3.5000E+00	-2.4190E+02	2.4119E+03	1.5002E+06
2.5052E+02	4.8596E+02	2.5624E+04	-7.4820E+03	5.8582E+04	3.0000E+00	-2.4190E+02	2.2109E+03	2.0597E+06
2.5052E+02	4.6727E+02	2.7906E+04	-7.4820E+03	5.7080E+04	4.7500E+00	-2.4190E+02	2.0099E+03	2.5383E+06
2.5052E+02	4.4858E+02	3.1509E+04	-7.4820E+03	5.4075E+04	1.2500E+00	-2.4190E+02	1.8089E+03	3.2884E+06
2.5052E+02	4.2989E+02	5.0934E+04	-7.4820E+03	4.8067E+04	4.2544E+00	-2.4190E+02	1.6079E+03	3.8453E+06
2.5052E+02	4.1120E+02	7.0164E+04	-7.4820E+03	4.3561E+04	1.7544E+00	-2.4190E+02	1.4069E+03	4.5827E+06

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
2.5052E+02	3.9251E+02	9.3130E+04	-7.4820E+03	3.9055E+04	1.7544E+00	-2.4190E+02	1.2059E+03	6.1609E+06
2.5052E+02	3.7381E+02	1.0971E+05	-7.4820E+03	3.7552E+04	1.2500E+00	-2.4190E+02	1.0050E+03	6.9772E+06
2.5052E+02	3.5512E+02	1.2823E+05	-7.4820E+03	3.6050E+04	1.7544E+00	-2.4190E+02	8.0396E+02	7.4533E+06
2.5052E+02	3.3643E+02	1.8432E+05	-7.4820E+03	3.4548E+04	3.0044E+00	-2.4190E+02	6.0297E+02	8.1835E+06
2.5052E+02	3.1774E+02	1.7987E+05	-7.4820E+03	3.3046E+04	1.2500E+00	-2.4190E+02	4.0198E+02	9.9708E+06
2.5052E+02	2.9905E+02	2.4044E+05	-7.4820E+03	3.1544E+04	6.2500E+00	-2.4190E+02	2.0099E+02	1.8482E+07
2.5052E+02	2.8036E+02	2.9280E+05	-7.4820E+03	3.0042E+04	7.5000E+00	-2.4190E+02	0.0000E+00	2.7995E+07
2.5052E+02	2.6167E+02	4.2196E+05	-7.4820E+03	2.8540E+04	1.3004E+01	-4.7943E+02	9.4466E+03	9.0500E+01
2.5052E+02	2.4298E+02	4.9905E+05	-7.4820E+03	2.7038E+04	5.5564E+01	-4.7943E+02	9.2456E+03	9.0500E+01
2.5052E+02	2.2429E+02	6.1855E+05	-7.4820E+03	2.5536E+04	3.3776E+02	-4.7943E+02	8.6426E+03	1.1749E+03
2.5052E+02	2.0560E+02	7.7043E+05	-7.4820E+03	2.4034E+04	1.8177E+03	-4.7943E+02	8.4416E+03	6.8450E+02
2.5052E+02	1.8691E+02	1.0529E+06	-7.4820E+03	2.2531E+04	1.3585E+03	-4.7943E+02	8.2406E+03	5.0350E+02
2.5052E+02	1.6822E+02	1.4335E+06	-7.4820E+03	2.1029E+04	3.5668E+03	-4.7943E+02	8.0396E+03	1.0417E+00
2.5052E+02	1.4953E+02	2.0596E+06	-7.4820E+03	1.9527E+04	8.3937E+03	-4.7943E+02	7.8387E+03	7.6525E+02
2.5052E+02	1.3084E+02	2.7539E+06	-7.4820E+03	1.8025E+04	2.1825E+03	-4.7943E+02	7.6377E+03	6.7630E+02
2.5052E+02	1.1214E+02	3.6088E+06	-7.4820E+03	1.6523E+04	2.9624E+04	-4.7943E+02	7.4367E+03	1.8204E+02
2.5052E+02	9.3454E+01	5.2031E+06	-7.4820E+03	1.5021E+04	3.2678E+04	-4.7943E+02	7.2357E+03	5.8285E+03
2.5052E+02	7.4763E+01	7.2036E+06	-7.4820E+03	1.3519E+04	2.1108E+04	-4.7943E+02	7.0347E+03	7.2699E+03
2.5052E+02	5.6072E+01	8.3731E+06	-7.4820E+03	1.2017E+04	3.4846E+04	-4.7943E+02	6.8337E+03	7.0014E+03
2.5052E+02	3.7381E+01	8.6589E+06	-7.4820E+03	1.0515E+04	7.6899E+03	-4.7943E+02	6.6327E+03	1.0562E+04
2.5052E+02	1.8691E+01	8.3656E+06	-7.4820E+03	9.0126E+03	4.3572E+04	-4.7943E+02	6.4317E+03	1.9500E+04
2.5052E+02	0.0000E+00	4.7300E+06	-7.4820E+03	7.5105E+03	1.0511E+05	-4.7943E+02	6.2307E+03	2.5648E+04
2.2832E+02	8.5977E+02	1.2500E+00	-7.4820E+03	6.0084E+03	4.1521E+05	-4.7943E+02	6.0297E+03	4.4473E+04
2.2832E+02	8.0370E+02	1.2500E+00	-7.4820E+03	4.5063E+03	1.3229E+06	-4.7943E+02	5.8287E+03	3.3577E+04
2.2832E+02	7.8501E+02	1.2500E+01	-7.4820E+03	3.0042E+03	3.4667E+06	-4.7943E+02	5.6278E+03	5.4364E+04
2.2832E+02	7.4763E+02	9.1542E+01	-7.4820E+03	1.5021E+03	3.8738E+06	-4.7943E+02	5.4268E+03	5.1794E+04
2.2832E+02	7.1025E+02	2.2380E+02	-7.4820E+03	0.0000E+00	2.4054E+07	-4.7943E+02	5.2258E+03	8.2327E+04
2.2832E+02	6.9156E+02	1.4583E+01	-9.1193E+03	7.5105E+04	1.7500E+00	-4.7943E+02	5.0248E+03	9.5772E+04
2.2832E+02	6.7287E+02	9.4386E+02	-9.1193E+03	7.0599E+04	1.7500E+00	-4.7943E+02	4.8238E+03	1.0771E+05
2.2832E+02	6.5418E+02	3.1339E+02	-9.1193E+03	6.9096E+04	1.7500E+00	-4.7943E+02	4.6228E+03	1.4698E+05
2.2832E+02	6.3548E+02	1.7758E+02	-9.1193E+03	6.7594E+04	4.1000E+01	-4.7943E+02	4.4218E+03	1.0690E+05
2.2832E+02	6.1679E+02	1.4840E+03	-9.1193E+03	6.6092E+04	1.0000E+01	-4.7943E+02	4.2208E+03	1.7283E+05
2.2832E+02	5.9810E+02	2.2765E+03	-9.1193E+03	6.4590E+04	1.7500E+00	-4.7943E+02	4.0198E+03	1.0908E+05
2.2832E+02	5.7941E+02	1.3422E+03	-9.1193E+03	6.1586E+04	1.7500E+00	-4.7943E+02	3.8188E+03	2.4975E+05
2.2832E+02	5.6072E+02	2.0922E+03	-9.1193E+03	5.8582E+04	1.7500E+00	-4.7943E+02	3.6178E+03	2.9912E+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
2.2832E+02	5.4203E+02	2.5295E+03	-9.1193E+03	5.5578E+04	1.2500E+00	-4.7943E+02	3.4168E+03	3.6673E+05
2.2832E+02	5.2334E+02	3.1227E+03	-9.1193E+03	5.4075E+04	1.7500E+00	-4.7943E+02	3.2159E+03	4.1319E+05
2.2832E+02	5.0465E+02	7.2031E+03	-9.1193E+03	5.2573E+04	2.5000E+00	-4.7943E+02	3.0149E+03	6.0571E+05
2.2832E+02	4.8596E+02	4.7381E+03	-9.1193E+03	5.1071E+04	2.6316E+00	-4.7943E+02	2.8139E+03	7.8913E+05
2.2832E+02	4.6727E+02	1.2100E+04	-9.1193E+03	4.9569E+04	6.0088E+00	-4.7943E+02	2.6129E+03	8.5221E+05
2.2832E+02	4.4858E+02	1.3507E+04	-9.1193E+03	4.8067E+04	3.0044E+00	-4.7943E+02	2.4119E+03	1.2678E+06
2.2832E+02	4.2989E+02	2.0745E+04	-9.1193E+03	4.5063E+04	1.2500E+00	-4.7943E+02	2.2109E+03	1.6593E+06
2.2832E+02	4.1120E+02	1.6030E+04	-9.1193E+03	3.9055E+04	1.2500E+00	-4.7943E+02	2.0099E+03	2.2346E+06
2.2832E+02	3.9251E+02	2.9009E+04	-9.1193E+03	3.7552E+04	3.7500E+00	-4.7943E+02	1.8089E+03	2.5892E+06
2.2832E+02	3.7381E+02	3.1791E+04	-9.1193E+03	3.6050E+04	1.3283E+01	-4.7943E+02	1.6079E+03	3.4138E+06
2.2832E+02	3.5512E+02	6.1460E+04	-9.1193E+03	3.4548E+04	1.1667E+01	-4.7943E+02	1.4069E+03	4.1093E+06
2.2832E+02	3.3643E+02	6.8118E+04	-9.1193E+03	3.3046E+04	5.5764E+00	-4.7943E+02	1.2059E+03	4.7752E+06
2.2832E+02	3.1774E+02	9.5893E+04	-9.1193E+03	3.1544E+04	3.5088E+00	-4.7943E+02	1.0050E+03	4.6120E+06
2.2832E+02	2.9905E+02	1.1030E+05	-9.1193E+03	3.0042E+04	1.4486E+01	-4.7943E+02	8.0396E+02	5.6132E+06
2.2832E+02	2.8036E+02	1.0773E+05	-9.1193E+03	2.8540E+04	3.0702E+01	-4.7943E+02	6.0297E+02	5.4318E+06
2.2832E+02	2.6167E+02	1.5630E+05	-9.1193E+03	2.7038E+04	5.5504E+01	-4.7943E+02	4.0198E+02	6.7169E+06
2.2832E+02	2.4298E+02	2.5103E+05	-9.1193E+03	2.5536E+04	2.8806E+02	-4.7943E+02	2.0099E+02	1.2845E+07
2.2832E+02	2.2429E+02	2.7600E+05	-9.1193E+03	2.4034E+04	2.0251E+02	-4.7943E+02	0.0000E+00	1.8993E+07
2.2832E+02	2.0560E+02	3.9796E+05	-9.1193E+03	2.2531E+04	3.3596E+02	-7.1696E+02	8.8436E+03	1.0417E+00
2.2832E+02	1.8691E+02	5.2389E+05	-9.1193E+03	2.1029E+04	3.4703E+02	-7.1696E+02	8.6426E+03	9.2583E+01
2.2832E+02	1.6822E+02	7.4886E+05	-9.1193E+03	1.9527E+04	6.5255E+03	-7.1696E+02	8.2406E+03	2.0862E+03
2.2832E+02	1.4953E+02	9.5027E+05	-9.1193E+03	1.8025E+04	1.3105E+04	-7.1696E+02	8.0396E+03	1.2925E+03
2.2832E+02	1.3084E+02	1.6686E+06	-9.1193E+03	1.6523E+04	1.3869E+04	-7.1696E+02	7.8387E+03	4.4367E+02
2.2832E+02	1.1214E+02	2.4026E+06	-9.1193E+03	1.5021E+04	1.2779E+03	-7.1696E+02	7.6377E+03	2.8215E+03
2.2832E+02	9.3454E+01	4.1248E+06	-9.1193E+03	1.3519E+04	1.4401E+04	-7.1696E+02	7.4367E+03	2.3002E+03
2.2832E+02	7.4763E+01	5.9246E+06	-9.1193E+03	1.2017E+04	2.6116E+04	-7.1696E+02	7.2357E+03	1.8225E+02
2.2832E+02	5.6072E+01	8.3399E+06	-9.1193E+03	1.0515E+04	2.6514E+04	-7.1696E+02	7.0347E+03	6.8002E+03
2.2832E+02	3.7381E+01	9.8342E+06	-9.1193E+03	9.0126E+03	1.5735E+04	-7.1696E+02	6.8337E+03	4.3989E+03
2.2832E+02	1.8691E+01	9.2039E+06	-9.1193E+03	7.5105E+03	7.6961E+04	-7.1696E+02	6.6327E+03	8.1108E+03
2.2832E+02	0.0000E+00	5.1124E+06	-9.1193E+03	6.0084E+03	1.6047E+05	-7.1696E+02	6.4317E+03	5.0925E+03
2.0612E+02	7.8501E+02	1.0417E+00	-9.1193E+03	4.5063E+03	8.9081E+05	-7.1696E+02	6.2307E+03	1.5514E+04
2.0612E+02	7.6632E+02	1.0417E+00	-9.1193E+03	3.0042E+03	2.8910E+06	-7.1696E+02	6.0297E+03	1.8208E+04
2.0612E+02	7.4763E+02	3.8542E+01	-9.1193E+03	1.5021E+03	4.1957E+06	-7.1696E+02	5.8287E+03	1.5688E+04
2.0612E+02	7.2894E+02	1.0550E+02	-9.1193E+03	0.0000E+00	2.1324E+07	-7.1696E+02	5.6278E+03	2.4904E+04
2.0612E+02	7.1025E+02	1.8958E+01	-1.0757E+04	6.9096E+04	1.7500E+00	-7.1696E+02	5.4268E+03	3.0388E+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
2.0612E+02	6.7287E+02	6.8517E+02	-1.0757E+04	6.7594E+04	9.9585E+00	-7.1696E+02	5.2258E+03	3.3231E+04
2.0612E+02	6.5418E+02	9.1542E+01	-1.0757E+04	6.6092E+04	1.0458E+01	-7.1696E+02	5.0248E+03	4.4708E+04
2.0612E+02	6.3548E+02	2.2839E+02	-1.0757E+04	6.4590E+04	4.7500E+00	-7.1696E+02	4.8238E+03	3.7502E+04
2.0612E+02	6.1679E+02	1.2508E+02	-1.0757E+04	6.3088E+04	4.7500E+00	-7.1696E+02	4.6228E+03	8.6386E+04
2.0612E+02	5.9810E+02	1.1238E+03	-1.0757E+04	6.1586E+04	3.5000E+00	-7.1696E+02	4.4218E+03	6.8948E+04
2.0612E+02	5.7941E+02	8.9154E+02	-1.0757E+04	6.0084E+04	3.8750E+01	-7.1696E+02	4.2208E+03	7.8833E+04
2.0612E+02	5.6072E+02	6.0233E+02	-1.0757E+04	5.7080E+04	3.8772E+00	-7.1696E+02	4.0198E+03	1.2213E+05
2.0612E+02	5.4203E+02	5.0859E+02	-1.0757E+04	5.4075E+04	1.2500E+00	-7.1696E+02	3.8188E+03	1.6718E+05
2.0612E+02	5.2334E+02	6.7358E+02	-1.0757E+04	5.1071E+04	1.7544E+00	-7.1696E+02	3.6178E+03	1.7511E+05
2.0612E+02	5.0465E+02	5.9400E+02	-1.0757E+04	4.8067E+04	3.0044E+00	-7.1696E+02	3.4168E+03	2.1293E+05
2.0612E+02	4.8596E+02	5.7855E+02	-1.0757E+04	4.6565E+04	3.7500E+00	-7.1696E+02	3.2159E+03	3.2961E+05
2.0612E+02	4.6727E+02	1.7142E+02	-1.0757E+04	4.5063E+04	2.6316E+00	-7.1696E+02	3.0149E+03	4.2039E+05
2.0612E+02	4.4858E+02	2.6020E+03	-1.0757E+04	4.2059E+04	1.2500E+01	-7.1696E+02	2.8139E+03	4.7930E+05
2.0612E+02	4.2989E+02	4.8612E+03	-1.0757E+04	4.0557E+04	2.6316E+00	-7.1696E+02	2.6129E+03	8.7359E+05
2.0612E+02	4.1120E+02	1.0794E+04	-1.0757E+04	3.9055E+04	1.7544E+00	-7.1696E+02	2.4119E+03	1.0025E+06
2.0612E+02	3.9251E+02	5.3053E+03	-1.0757E+04	3.7552E+04	2.4812E+01	-7.1696E+02	2.2109E+03	1.1211E+06
2.0612E+02	3.7381E+02	5.6906E+03	-1.0757E+04	3.6050E+04	3.5088E+00	-7.1696E+02	2.0099E+03	1.7596E+06
2.0612E+02	3.5512E+02	2.7129E+04	-1.0757E+04	3.4548E+04	2.9699E+01	-7.1696E+02	1.8089E+03	1.9377E+06
2.0612E+02	3.3643E+02	1.0292E+04	-1.0757E+04	3.3046E+04	1.0589E+01	-7.1696E+02	1.6079E+03	2.4875E+06
2.0612E+02	3.1774E+02	3.4180E+04	-1.0757E+04	3.1544E+04	1.0039E+02	-7.1696E+02	1.4069E+03	2.8299E+06
2.0612E+02	2.9905E+02	1.9439E+04	-1.0757E+04	3.0042E+04	2.8321E+01	-7.1696E+02	1.2059E+03	2.6383E+06
2.0612E+02	2.8036E+02	3.6378E+04	-1.0757E+04	2.8540E+04	6.7669E+00	-7.1696E+02	1.0050E+03	3.5173E+06
2.0612E+02	2.6167E+02	6.1963E+04	-1.0757E+04	2.7038E+04	5.0502E+01	-7.1696E+02	8.0396E+02	3.2760E+06
2.0612E+02	2.4298E+02	8.9506E+04	-1.0757E+04	2.5536E+04	2.6896E+01	-7.1696E+02	6.0297E+02	3.4702E+06
2.0612E+02	2.2429E+02	1.0923E+05	-1.0757E+04	2.4034E+04	7.8432E+01	-7.1696E+02	4.0198E+02	4.7058E+06
2.0612E+02	2.0560E+02	1.7388E+05	-1.0757E+04	2.2531E+04	6.5289E+01	-7.1696E+02	2.0099E+02	9.1322E+06
2.0612E+02	1.8691E+02	2.3209E+05	-1.0757E+04	2.1029E+04	2.1804E+02	-7.1696E+02	0.0000E+00	1.2224E+07
2.0612E+02	1.6822E+02	3.4466E+05	-1.0757E+04	1.9527E+04	2.8346E+02	-9.5449E+02	9.4466E+03	2.2380E+02
2.0612E+02	1.4953E+02	5.3503E+05	-1.0757E+04	1.8025E+04	3.2870E+02	-9.5449E+02	7.8387E+03	3.7500E+01
2.0612E+02	1.3084E+02	9.5391E+05	-1.0757E+04	1.6523E+04	2.0620E+02	-9.5449E+02	7.6377E+03	7.2835E+02
2.0612E+02	1.1214E+02	1.4931E+06	-1.0757E+04	1.5021E+04	1.4738E+04	-9.5449E+02	7.4367E+03	8.4790E+01
2.0612E+02	9.3454E+01	2.9306E+06	-1.0757E+04	1.3519E+04	6.7458E+03	-9.5449E+02	7.2357E+03	1.9454E+02
2.0612E+02	7.4763E+01	4.8072E+06	-1.0757E+04	1.2017E+04	5.7084E+02	-9.5449E+02	7.0347E+03	2.0745E+03
2.0612E+02	5.6072E+01	6.7592E+06	-1.0757E+04	1.0515E+04	7.5264E+03	-9.5449E+02	6.8337E+03	2.0833E+00
2.0612E+02	3.7381E+01	8.9246E+06	-1.0757E+04	9.0126E+03	6.8413E+03	-9.5449E+02	6.6327E+03	1.0083E+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
2.0612E+02	1.8691E+01	9.7850E+06	-1.0757E+04	7.5105E+03	2.9041E+04	-9.5449E+02	6.4317E+03	3.2561E+03
2.0612E+02	0.0000E+00	6.0447E+06	-1.0757E+04	6.0084E+03	1.2459E+05	-9.5449E+02	6.2307E+03	5.9214E+03
1.8391E+02	9.1585E+02	1.2500E+00	-1.0757E+04	4.5063E+03	9.4272E+05	-9.5449E+02	6.0297E+03	3.3843E+03
1.8391E+02	8.4108E+02	1.2500E+00	-1.0757E+04	3.0042E+03	2.9157E+06	-9.5449E+02	5.8287E+03	1.4517E+03
1.8391E+02	7.8501E+02	3.0000E+00	-1.0757E+04	1.5021E+03	6.4264E+06	-9.5449E+02	5.6278E+03	4.0029E+03
1.8391E+02	7.6632E+02	4.0500E+01	-1.0757E+04	0.0000E+00	2.1181E+07	-9.5449E+02	5.4268E+03	6.7736E+03
1.8391E+02	7.4763E+02	3.8772E+00	-1.2394E+04	6.9096E+04	1.7500E+00	-9.5449E+02	5.2258E+03	1.5916E+04
1.8391E+02	7.2894E+02	6.9629E+00	-1.2394E+04	6.7594E+04	5.2500E+00	-9.5449E+02	5.0248E+03	1.5183E+04
1.8391E+02	7.1025E+02	5.2085E+00	-1.2394E+04	6.6092E+04	4.1000E+01	-9.5449E+02	4.8238E+03	1.3993E+04
1.8391E+02	6.7287E+02	6.7917E+01	-1.2394E+04	6.4590E+04	8.0250E+01	-9.5449E+02	4.6228E+03	3.3724E+04
1.8391E+02	6.5418E+02	5.2085E+00	-1.2394E+04	6.3088E+04	3.9250E+01	-9.5449E+02	4.4218E+03	3.3337E+04
1.8391E+02	6.1679E+02	5.2085E+00	-1.2394E+04	6.1586E+04	4.7500E+00	-9.5449E+02	4.2208E+03	4.3221E+04
1.8391E+02	5.9810E+02	2.6130E+02	-1.2394E+04	6.0084E+04	3.8772E+00	-9.5449E+02	4.0198E+03	6.7182E+04
1.8391E+02	5.7941E+02	5.1913E+02	-1.2394E+04	5.8582E+04	2.1272E+00	-9.5449E+02	3.8188E+03	6.1718E+04
1.8391E+02	5.6072E+02	2.6316E+00	-1.2394E+04	5.5578E+04	6.4585E+00	-9.5449E+02	3.6178E+03	9.0274E+04
1.8391E+02	5.2334E+02	1.8484E+02	-1.2394E+04	5.4075E+04	3.0000E+00	-9.5449E+02	3.4168E+03	1.4269E+05
1.8391E+02	5.0465E+02	2.0833E+00	-1.2394E+04	4.8067E+04	4.0000E+01	-9.5449E+02	3.2159E+03	1.5367E+05
1.8391E+02	4.8596E+02	8.0043E+00	-1.2394E+04	4.6565E+04	3.8816E+00	-9.5449E+02	3.0149E+03	2.6047E+05
1.8391E+02	4.6727E+02	3.4430E+01	-1.2394E+04	4.3561E+04	2.6316E+00	-9.5449E+02	2.8139E+03	4.5740E+05
1.8391E+02	4.4858E+02	4.5889E+02	-1.2394E+04	4.2059E+04	2.5000E+00	-9.5449E+02	2.6129E+03	4.7980E+05
1.8391E+02	4.2989E+02	4.5249E+02	-1.2394E+04	3.9055E+04	1.7544E+00	-9.5449E+02	2.4119E+03	6.5717E+05
1.8391E+02	4.1120E+02	4.5145E+02	-1.2394E+04	3.7552E+04	2.6316E+00	-9.5449E+02	2.2109E+03	1.0389E+06
1.8391E+02	3.9251E+02	1.8996E+02	-1.2394E+04	3.4548E+04	3.5088E+00	-9.5449E+02	2.0099E+03	1.0388E+06
1.8391E+02	3.7381E+02	8.0451E+02	-1.2394E+04	3.3046E+04	2.0833E+00	-9.5449E+02	1.8089E+03	1.5095E+06
1.8391E+02	3.5512E+02	1.1141E+04	-1.2394E+04	3.1544E+04	3.6341E+01	-9.5449E+02	1.6079E+03	1.5851E+06
1.8391E+02	3.3643E+02	3.2419E+03	-1.2394E+04	3.0042E+04	5.8897E+00	-9.5449E+02	1.4069E+03	1.9787E+06
1.8391E+02	3.1774E+02	1.4547E+04	-1.2394E+04	2.8540E+04	1.7375E+02	-9.5449E+02	1.2059E+03	2.1134E+06
1.8391E+02	2.9905E+02	2.4647E+04	-1.2394E+04	2.7038E+04	1.7528E+01	-9.5449E+02	1.0050E+03	2.0521E+06
1.8391E+02	2.8036E+02	2.4573E+04	-1.2394E+04	2.5536E+04	1.0934E+01	-9.5449E+02	8.0396E+02	2.0904E+06
1.8391E+02	2.6167E+02	3.6440E+04	-1.2394E+04	2.4034E+04	1.7130E+02	-9.5449E+02	6.0297E+02	2.1882E+06
1.8391E+02	2.4298E+02	3.8363E+04	-1.2394E+04	2.2531E+04	5.3319E+02	-9.5449E+02	4.0198E+02	2.7111E+06
1.8391E+02	2.2429E+02	8.3224E+04	-1.2394E+04	2.1029E+04	2.4311E+01	-9.5449E+02	2.0099E+02	5.3874E+06
1.8391E+02	2.0560E+02	9.1108E+04	-1.2394E+04	1.9527E+04	1.7306E+02	-9.5449E+02	0.0000E+00	7.3991E+06
1.8391E+02	1.8691E+02	9.8394E+04	-1.2394E+04	1.8025E+04	3.9431E+02	-1.1920E+03	7.8387E+03	1.2500E+00
1.8391E+02	1.6822E+02	1.7550E+05	-1.2394E+04	1.6523E+04	1.0088E+01	-1.1920E+03	7.4367E+03	7.6250E+01

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
1.8391E+02	1.4953E+02	2.1084E+05	-1.2394E+04	1.5021E+04	5.4774E+02	-1.1920E+03	7.2357E+03	1.4300E+02
1.8391E+02	1.3084E+02	3.5303E+05	-1.2394E+04	1.3519E+04	1.7514E+02	-1.1920E+03	7.0347E+03	8.1665E+01
1.8391E+02	1.1214E+02	6.1362E+05	-1.2394E+04	1.2017E+04	1.5342E+04	-1.1920E+03	6.6327E+03	1.1125E+03
1.8391E+02	9.3454E+01	1.9404E+06	-1.2394E+04	1.0515E+04	2.6896E+01	-1.1920E+03	6.4317E+03	1.7217E+02
1.8391E+02	7.4763E+01	3.6579E+06	-1.2394E+04	9.0126E+03	4.5870E+02	-1.1920E+03	6.2307E+03	4.4761E+02
1.8391E+02	5.6072E+01	6.0009E+06	-1.2394E+04	7.5105E+03	8.5387E+03	-1.1920E+03	6.0297E+03	4.5061E+02
1.8391E+02	3.7381E+01	8.6301E+06	-1.2394E+04	6.0084E+03	1.2624E+05	-1.1920E+03	5.8287E+03	4.0835E+02
1.8391E+02	1.8691E+01	1.1453E+07	-1.2394E+04	4.5063E+03	7.0630E+05	-1.1920E+03	5.4268E+03	1.2005E+03
1.8391E+02	0.0000E+00	5.8019E+06	-1.2394E+04	3.0042E+03	3.1004E+06	-1.1920E+03	5.2258E+03	6.1219E+02
1.6171E+02	8.7846E+02	1.2500E+00	-1.2394E+04	1.5021E+03	7.4415E+06	-1.1920E+03	5.0248E+03	9.0022E+02
1.6171E+02	8.5977E+02	1.7500E+00	-1.2394E+04	0.0000E+00	1.8690E+07	-1.1920E+03	4.8238E+03	9.6773E+03
1.6171E+02	8.4108E+02	5.2085E+00	-1.4031E+04	6.6092E+04	1.7500E+00	-1.1920E+03	4.6228E+03	6.8803E+03
1.6171E+02	8.2239E+02	4.7500E+00	-1.4031E+04	6.4590E+04	1.7500E+00	-1.1920E+03	4.4218E+03	1.1858E+04
1.6171E+02	8.0370E+02	4.5708E+01	-1.4031E+04	6.3088E+04	1.0417E+01	-1.1920E+03	4.2208E+03	8.7898E+03
1.6171E+02	7.8501E+02	4.2250E+01	-1.4031E+04	6.1586E+04	5.2500E+00	-1.1920E+03	4.0198E+03	3.5008E+04
1.6171E+02	7.6632E+02	1.9125E+01	-1.4031E+04	6.0084E+04	5.2500E+00	-1.1920E+03	3.8188E+03	3.9928E+04
1.6171E+02	7.4763E+02	7.0000E+00	-1.4031E+04	5.8582E+04	4.9000E+01	-1.1920E+03	3.6178E+03	3.9724E+04
1.6171E+02	7.2894E+02	3.5000E+00	-1.4031E+04	5.7080E+04	8.7085E+00	-1.1920E+03	3.4168E+03	8.0230E+04
1.6171E+02	7.1025E+02	3.9584E+01	-1.4031E+04	5.5578E+04	6.4585E+00	-1.1920E+03	3.2159E+03	9.3059E+04
1.6171E+02	6.9156E+02	5.5000E+00	-1.4031E+04	5.4075E+04	1.2500E+00	-1.1920E+03	3.0149E+03	1.3106E+05
1.6171E+02	6.7287E+02	3.3333E+01	-1.4031E+04	5.2573E+04	5.2085E+00	-1.1920E+03	2.8139E+03	2.2186E+05
1.6171E+02	6.5418E+02	2.2917E+00	-1.4031E+04	5.1071E+04	1.2500E+00	-1.1920E+03	2.6129E+03	1.8467E+05
1.6171E+02	6.1679E+02	5.2085E+00	-1.4031E+04	4.9569E+04	1.2500E+00	-1.1920E+03	2.4119E+03	4.5732E+05
1.6171E+02	5.9810E+02	1.7544E+00	-1.4031E+04	4.8067E+04	1.2500E+00	-1.1920E+03	2.2109E+03	4.5723E+05
1.6171E+02	5.7941E+02	2.0833E+00	-1.4031E+04	4.6565E+04	2.5000E+00	-1.1920E+03	2.0099E+03	7.1950E+05
1.6171E+02	5.6072E+02	3.5088E+00	-1.4031E+04	4.5063E+04	1.5132E+01	-1.1920E+03	1.8089E+03	9.2998E+05
1.6171E+02	5.4203E+02	3.8377E+00	-1.4031E+04	4.0557E+04	1.2500E+00	-1.1920E+03	1.6079E+03	9.7300E+05
1.6171E+02	5.2334E+02	4.8794E+00	-1.4031E+04	3.9055E+04	1.7544E+00	-1.1920E+03	1.4069E+03	1.0564E+06
1.6171E+02	5.0465E+02	1.7544E+00	-1.4031E+04	3.6050E+04	4.8794E+00	-1.1920E+03	1.2059E+03	1.1616E+06
1.6171E+02	4.8596E+02	1.8312E+01	-1.4031E+04	3.4548E+04	2.0833E+00	-1.1920E+03	1.0050E+03	1.1565E+06
1.6171E+02	4.6727E+02	8.5965E+00	-1.4031E+04	3.1544E+04	2.0833E+00	-1.1920E+03	8.0396E+02	8.9193E+05
1.6171E+02	4.4858E+02	1.2672E+01	-1.4031E+04	3.0042E+04	1.7544E+00	-1.1920E+03	6.0297E+02	1.1845E+06
1.6171E+02	4.2989E+02	1.0269E+02	-1.4031E+04	2.8540E+04	4.1666E+00	-1.1920E+03	4.0198E+02	1.5313E+06
1.6171E+02	4.1120E+02	8.8448E+01	-1.4031E+04	2.7038E+04	3.8377E+00	-1.1920E+03	2.0099E+02	3.0872E+06
1.6171E+02	3.9251E+02	5.1204E+01	-1.4031E+04	2.5536E+04	1.5946E+01	-1.1920E+03	0.0000E+00	4.6292E+06

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
1.6171E+02	3.7381E+02	3.8706E+01	-1.4031E+04	2.2531E+04	8.0043E+00	-1.4296E+03	8.8436E+03	1.2500E+01
1.6171E+02	3.5512E+02	2.3340E+03	-1.4031E+04	2.1029E+04	8.0043E+00	-1.4296E+03	8.4416E+03	1.2500E+00
1.6171E+02	3.3643E+02	1.7626E+03	-1.4031E+04	1.9527E+04	8.0202E+03	-1.4296E+03	8.0396E+03	2.5000E+00
1.6171E+02	3.1774E+02	2.3147E+03	-1.4031E+04	1.8025E+04	4.9591E+02	-1.4296E+03	7.8387E+03	1.2500E+00
1.6171E+02	2.9905E+02	1.1354E+04	-1.4031E+04	1.6523E+04	4.2689E+02	-1.4296E+03	7.4367E+03	1.2500E+00
1.6171E+02	2.8036E+02	3.6606E+03	-1.4031E+04	1.5021E+04	1.5698E+04	-1.4296E+03	6.6327E+03	1.2500E+00
1.6171E+02	2.6167E+02	6.7969E+03	-1.4031E+04	1.3519E+04	1.7931E+02	-1.4296E+03	6.2307E+03	1.2500E+00
1.6171E+02	2.4298E+02	1.1166E+04	-1.4031E+04	1.2017E+04	5.0624E+02	-1.4296E+03	5.8287E+03	9.1750E+01
1.6171E+02	2.2429E+02	4.9015E+04	-1.4031E+04	1.0515E+04	2.3207E+04	-1.4296E+03	5.2258E+03	1.8100E+02
1.6171E+02	2.0560E+02	4.2924E+04	-1.4031E+04	9.0126E+03	1.6195E+04	-1.4296E+03	5.0248E+03	5.8333E+00
1.6171E+02	1.8691E+02	5.9571E+04	-1.4031E+04	7.5105E+03	5.0028E+04	-1.4296E+03	4.8238E+03	5.4504E+02
1.6171E+02	1.6822E+02	5.0855E+04	-1.4031E+04	6.0084E+03	8.0909E+04	-1.4296E+03	4.6228E+03	4.1550E+03
1.6171E+02	1.4953E+02	5.3619E+04	-1.4031E+04	4.5063E+03	3.9478E+05	-1.4296E+03	4.4218E+03	5.0051E+03
1.6171E+02	1.3084E+02	1.7142E+05	-1.4031E+04	3.0042E+03	2.0942E+06	-1.4296E+03	4.2208E+03	1.1010E+04
1.6171E+02	1.1214E+02	4.6750E+05	-1.4031E+04	1.5021E+03	6.5266E+06	-1.4296E+03	4.0198E+03	1.8336E+04
1.6171E+02	9.3454E+01	1.2089E+06	-1.4031E+04	0.0000E+00	1.2270E+07	-1.4296E+03	3.8188E+03	4.2472E+03
1.6171E+02	7.4763E+01	2.5475E+06	-1.5668E+04	6.6092E+04	3.9250E+01	-1.4296E+03	3.6178E+03	2.5279E+04
1.6171E+02	5.6072E+01	5.3214E+06	-1.5668E+04	6.4590E+04	1.7500E+00	-1.4296E+03	3.4168E+03	2.4404E+04
1.6171E+02	3.7381E+01	7.4418E+06	-1.5668E+04	6.3088E+04	8.7085E+00	-1.4296E+03	3.2159E+03	2.3089E+04
1.6171E+02	1.8691E+01	1.1132E+07	-1.5668E+04	6.0084E+04	6.9585E+00	-1.4296E+03	3.0149E+03	6.7054E+04
1.6171E+02	0.0000E+00	5.3570E+06	-1.5668E+04	5.8582E+04	5.2085E+00	-1.4296E+03	2.8139E+03	7.9230E+04
1.3951E+02	8.7846E+02	9.9585E+00	-1.5668E+04	5.7080E+04	8.2085E+00	-1.4296E+03	2.6129E+03	7.4949E+04
1.3951E+02	8.4108E+02	4.8750E+01	-1.5668E+04	5.4075E+04	3.7500E+01	-1.4296E+03	2.4119E+03	2.2600E+05
1.3951E+02	8.2239E+02	5.2500E+00	-1.5668E+04	5.2573E+04	6.4585E+00	-1.4296E+03	2.2109E+03	2.9720E+05
1.3951E+02	8.0370E+02	5.2500E+00	-1.5668E+04	5.1071E+04	1.7544E+00	-1.4296E+03	2.0099E+03	4.0514E+05
1.3951E+02	7.8501E+02	4.5708E+01	-1.5668E+04	4.9569E+04	3.7500E+01	-1.4296E+03	1.8089E+03	5.0980E+05
1.3951E+02	7.6632E+02	4.4500E+01	-1.5668E+04	4.8067E+04	2.5000E+00	-1.4296E+03	1.6079E+03	5.4027E+05
1.3951E+02	7.4763E+02	3.0000E+00	-1.5668E+04	4.6565E+04	8.3792E+01	-1.4296E+03	1.4069E+03	7.3290E+05
1.3951E+02	7.2894E+02	5.2085E+00	-1.5668E+04	4.0557E+04	2.7961E+00	-1.4296E+03	1.2059E+03	5.9335E+05
1.3951E+02	7.1025E+02	7.2500E+00	-1.5668E+04	3.9055E+04	2.5000E+00	-1.4296E+03	1.0050E+03	5.0354E+05
1.3951E+02	6.9156E+02	1.2500E+00	-1.5668E+04	3.6050E+04	3.1250E+00	-1.4296E+03	8.0396E+02	4.3645E+05
1.3951E+02	6.7287E+02	1.2500E+00	-1.5668E+04	3.3046E+04	2.0833E+00	-1.4296E+03	6.0297E+02	7.2650E+05
1.3951E+02	6.3548E+02	2.1272E+00	-1.5668E+04	3.1544E+04	2.8125E+01	-1.4296E+03	4.0198E+02	7.9462E+05
1.3951E+02	6.1679E+02	1.7544E+00	-1.5668E+04	3.0042E+04	2.0833E+00	-1.4296E+03	2.0099E+02	1.9038E+06
1.3951E+02	5.9810E+02	1.7544E+00	-1.5668E+04	2.8540E+04	7.6625E+03	-1.4296E+03	0.0000E+00	2.6504E+06

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
1.3951E+02	5.6072E+02	1.4254E+01	-1.5668E+04	2.7038E+04	1.7544E+00	-1.6671E+03	9.4466E+03	1.2500E+00
1.3951E+02	5.4203E+02	1.2500E+00	-1.5668E+04	2.5536E+04	1.5327E+04	-1.6671E+03	9.2456E+03	1.2500E+00
1.3951E+02	5.2334E+02	1.6250E+01	-1.5668E+04	2.4034E+04	1.7166E+02	-1.6671E+03	9.0446E+03	1.2500E+00
1.3951E+02	5.0465E+02	1.7362E+01	-1.5668E+04	2.2531E+04	7.8338E+03	-1.6671E+03	8.8436E+03	1.2500E+00
1.3951E+02	4.8596E+02	1.1529E+01	-1.5668E+04	2.1029E+04	1.6333E+02	-1.6671E+03	7.6377E+03	1.2500E+00
1.3951E+02	4.6727E+02	3.0044E+00	-1.5668E+04	1.9527E+04	7.6667E+03	-1.6671E+03	7.4367E+03	1.2500E+00
1.3951E+02	4.4858E+02	3.8816E+00	-1.5668E+04	1.8025E+04	1.6925E+02	-1.6671E+03	7.2357E+03	9.0500E+01
1.3951E+02	4.2989E+02	1.8234E+02	-1.5668E+04	1.6523E+04	3.8886E+04	-1.6671E+03	7.0347E+03	2.2917E+00
1.3951E+02	4.1120E+02	4.2544E+00	-1.5668E+04	1.5021E+04	3.0660E+04	-1.6671E+03	6.6327E+03	2.2380E+02
1.3951E+02	3.9251E+02	3.4934E+02	-1.5668E+04	1.3519E+04	3.8484E+04	-1.6671E+03	5.6278E+03	2.2505E+02
1.3951E+02	3.7381E+02	5.4166E+00	-1.5668E+04	1.2017E+04	4.5834E+00	-1.6671E+03	5.4268E+03	4.5833E+00
1.3951E+02	3.5512E+02	1.9042E+02	-1.5668E+04	1.0515E+04	7.8300E+03	-1.6671E+03	5.2258E+03	3.8750E+01
1.3951E+02	3.3643E+02	2.8948E+02	-1.5668E+04	9.0126E+03	1.7285E+04	-1.6671E+03	5.0248E+03	1.8350E+02
1.3951E+02	3.1774E+02	4.3729E+02	-1.5668E+04	7.5105E+03	3.0592E+04	-1.6671E+03	4.8238E+03	1.0083E+03
1.3951E+02	2.9905E+02	4.4239E+02	-1.5668E+04	6.0084E+03	1.9035E+05	-1.6671E+03	4.6228E+03	3.7500E+00
1.3951E+02	2.8036E+02	5.3582E+03	-1.5668E+04	4.5063E+03	6.8302E+05	-1.6671E+03	4.4218E+03	1.4801E+03
1.3951E+02	2.6167E+02	3.2115E+03	-1.5668E+04	3.0042E+03	2.7367E+06	-1.6671E+03	4.2208E+03	6.1594E+02
1.3951E+02	2.4298E+02	1.1053E+04	-1.5668E+04	1.5021E+03	8.1723E+06	-1.6671E+03	4.0198E+03	1.0217E+04
1.3951E+02	2.2429E+02	7.1392E+03	-1.5668E+04	0.0000E+00	1.2444E+07	-1.6671E+03	3.8188E+03	7.7762E+03
1.3951E+02	2.0560E+02	1.6476E+04	-1.7306E+04	6.0084E+04	3.7500E+01	-1.6671E+03	3.6178E+03	8.2601E+03
1.3951E+02	1.8691E+02	1.6817E+04	-1.7306E+04	5.7080E+04	5.2085E+00	-1.6671E+03	3.4168E+03	2.5024E+04
1.3951E+02	1.6822E+02	3.4291E+04	-1.7306E+04	5.5578E+04	3.3333E+01	-1.6671E+03	3.2159E+03	2.1859E+04
1.3951E+02	1.4953E+02	6.1778E+04	-1.7306E+04	5.2573E+04	6.6667E+01	-1.6671E+03	3.0149E+03	1.8517E+04
1.3951E+02	1.3084E+02	8.9377E+04	-1.7306E+04	5.1071E+04	4.6875E+01	-1.6671E+03	2.8139E+03	2.8237E+04
1.3951E+02	1.1214E+02	1.5891E+05	-1.7306E+04	4.9569E+04	8.2707E+01	-1.6671E+03	2.6129E+03	7.7600E+04
1.3951E+02	9.3454E+01	9.4006E+05	-1.7306E+04	4.8067E+04	8.6874E+01	-1.6671E+03	2.4119E+03	2.7728E+04
1.3951E+02	7.4763E+01	2.7428E+06	-1.7306E+04	4.6565E+04	2.0833E+00	-1.6671E+03	2.2109E+03	1.0378E+05
1.3951E+02	5.6072E+01	5.1142E+06	-1.7306E+04	4.5063E+04	1.3750E+01	-1.6671E+03	2.0099E+03	1.5398E+05
1.3951E+02	3.7381E+01	8.8057E+06	-1.7306E+04	4.3561E+04	1.0417E+00	-1.6671E+03	1.8089E+03	1.4395E+05
1.3951E+02	1.8691E+01	1.5186E+07	-1.7306E+04	4.2059E+04	8.1665E+01	-1.6671E+03	1.6079E+03	2.8463E+05
1.3951E+02	0.0000E+00	8.7656E+06	-1.7306E+04	4.0557E+04	1.0417E+00	-1.6671E+03	1.4069E+03	2.3289E+05
1.1731E+02	8.5977E+02	9.9585E+00	-1.7306E+04	3.9055E+04	2.0833E+00	-1.6671E+03	1.2059E+03	2.3052E+05
1.1731E+02	8.4108E+02	3.5000E+00	-1.7306E+04	3.6050E+04	1.7544E+00	-1.6671E+03	1.0050E+03	2.9364E+05
1.1731E+02	8.2239E+02	1.7500E+00	-1.7306E+04	3.1544E+04	7.6625E+03	-1.6671E+03	8.0396E+02	1.9432E+05
1.1731E+02	8.0370E+02	3.5000E+00	-1.7306E+04	2.8540E+04	2.6050E+02	-1.6671E+03	6.0297E+02	2.3492E+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
1.1731E+02	7.8501E+02	1.7500E+00	-1.7306E+04	2.7038E+04	7.6646E+03	-1.6671E+03	4.0198E+02	3.8927E+05
1.1731E+02	7.6632E+02	6.5000E+00	-1.7306E+04	2.5536E+04	7.6635E+03	-1.6671E+03	2.0099E+02	9.7682E+05
1.1731E+02	7.2894E+02	1.3708E+01	-1.7306E+04	2.4034E+04	3.3416E+02	-1.6671E+03	0.0000E+00	1.7112E+06
1.1731E+02	6.7287E+02	1.2500E+00	-1.7306E+04	2.2531E+04	7.6625E+03	-1.9046E+03	8.4416E+03	1.2500E+00
1.1731E+02	6.5418E+02	1.2500E+00	-1.7306E+04	2.1029E+04	1.6666E+02	-1.9046E+03	7.4367E+03	1.2500E+00
1.1731E+02	5.9810E+02	1.2500E+00	-1.7306E+04	1.9527E+04	1.7166E+02	-1.9046E+03	6.8337E+03	1.2500E+00
1.1731E+02	5.7941E+02	3.0044E+00	-1.7306E+04	1.8025E+04	2.4896E+04	-1.9046E+03	6.6327E+03	2.5000E+00
1.1731E+02	5.6072E+02	1.2500E+01	-1.7306E+04	1.6523E+04	8.0131E+03	-1.9046E+03	6.0297E+03	2.5000E+00
1.1731E+02	5.4203E+02	1.2500E+00	-1.7306E+04	1.5021E+04	3.3333E+00	-1.9046E+03	5.6278E+03	1.2500E+00
1.1731E+02	5.2334E+02	1.2500E+00	-1.7306E+04	1.3519E+04	7.9411E+02	-1.9046E+03	5.4268E+03	1.9304E+03
1.1731E+02	5.0465E+02	4.2544E+00	-1.7306E+04	1.2017E+04	1.0799E+03	-1.9046E+03	5.2258E+03	3.7500E+00
1.1731E+02	4.6727E+02	1.7544E+00	-1.7306E+04	1.0515E+04	2.1410E+04	-1.9046E+03	5.0248E+03	1.2500E+00
1.1731E+02	4.4858E+02	4.5833E+00	-1.7306E+04	9.0126E+03	3.5911E+03	-1.9046E+03	4.8238E+03	3.7500E+00
1.1731E+02	4.2989E+02	8.4210E+00	-1.7306E+04	7.5105E+03	2.1923E+04	-1.9046E+03	4.4218E+03	2.7917E+00
1.1731E+02	4.1120E+02	1.2500E+00	-1.7306E+04	6.0084E+03	1.8527E+05	-1.9046E+03	4.2208E+03	1.0088E+03
1.1731E+02	3.9251E+02	2.6529E+01	-1.7306E+04	4.5063E+03	8.5167E+05	-1.9046E+03	4.0198E+03	8.1136E+02
1.1731E+02	3.7381E+02	3.1784E+02	-1.7306E+04	3.0042E+03	3.2300E+06	-1.9046E+03	3.8188E+03	6.7500E+00
1.1731E+02	3.5512E+02	1.4325E+02	-1.7306E+04	1.5021E+03	9.1766E+06	-1.9046E+03	3.6178E+03	1.3715E+03
1.1731E+02	3.3643E+02	1.5348E+02	-1.7306E+04	0.0000E+00	1.3470E+07	-1.9046E+03	3.4168E+03	1.1004E+03
1.1731E+02	3.1774E+02	8.4509E+02	-1.8943E+04	5.7080E+04	1.2500E+01	-1.9046E+03	3.2159E+03	4.4401E+03
1.1731E+02	2.9905E+02	1.4187E+03	-1.8943E+04	5.1071E+04	6.2501E+00	-1.9046E+03	3.0149E+03	1.0444E+04
1.1731E+02	2.8036E+02	3.3087E+03	-1.8943E+04	4.9569E+04	3.3333E+01	-1.9046E+03	2.8139E+03	3.2025E+04
1.1731E+02	2.6167E+02	3.6785E+03	-1.8943E+04	4.8067E+04	1.7217E+02	-1.9046E+03	2.6129E+03	1.2988E+04
1.1731E+02	2.4298E+02	1.1590E+04	-1.8943E+04	4.6565E+04	3.1250E+00	-1.9046E+03	2.4119E+03	3.4219E+04
1.1731E+02	2.2429E+02	9.7125E+03	-1.8943E+04	4.5063E+04	7.2918E+00	-1.9046E+03	2.2109E+03	5.4930E+04
1.1731E+02	2.0560E+02	2.3655E+04	-1.8943E+04	4.3561E+04	2.0833E+00	-1.9046E+03	2.0099E+03	9.9458E+04
1.1731E+02	1.8691E+02	2.9084E+04	-1.8943E+04	4.2059E+04	3.1250E+00	-1.9046E+03	1.8089E+03	6.8573E+04
1.1731E+02	1.6822E+02	3.0606E+04	-1.8943E+04	4.0557E+04	9.3625E+01	-1.9046E+03	1.6079E+03	6.9561E+04
1.1731E+02	1.4953E+02	2.7108E+04	-1.8943E+04	3.9055E+04	2.4708E+02	-1.9046E+03	1.4069E+03	8.3498E+04
1.1731E+02	1.3084E+02	4.0313E+04	-1.8943E+04	3.6050E+04	2.2797E+02	-1.9046E+03	1.2059E+03	1.8681E+05
1.1731E+02	1.1214E+02	1.7297E+05	-1.8943E+04	3.4548E+04	3.5417E+00	-1.9046E+03	1.0050E+03	5.3576E+04
1.1731E+02	9.3454E+01	6.3589E+05	-1.8943E+04	3.3046E+04	7.8308E+03	-1.9046E+03	8.0396E+02	9.9193E+04
1.1731E+02	7.4763E+01	2.0826E+06	-1.8943E+04	3.1544E+04	5.2283E+02	-1.9046E+03	6.0297E+02	7.1903E+04
1.1731E+02	5.6072E+01	4.3939E+06	-1.8943E+04	3.0042E+04	7.9174E+03	-1.9046E+03	4.0198E+02	2.1238E+05
1.1731E+02	3.7381E+01	8.8069E+06	-1.8943E+04	2.8540E+04	1.1198E+03	-1.9046E+03	2.0099E+02	3.7141E+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
1.1731E+02	1.8691E+01	1.9880E+07	-1.8943E+04	2.7038E+04	1.1014E+03	-1.9046E+03	0.0000E+00	8.8238E+05
1.1731E+02	0.0000E+00	1.3243E+07	-1.8943E+04	2.5536E+04	8.0821E+03	-2.1421E+03	9.2456E+03	1.2500E+00
9.5105E+01	9.3454E+02	1.7500E+00	-1.8943E+04	2.4034E+04	1.6752E+04	-2.1421E+03	7.2357E+03	2.2380E+02
9.5105E+01	9.1585E+02	1.2500E+00	-1.8943E+04	2.2531E+04	1.8167E+03	-2.1421E+03	6.4317E+03	2.5000E+00
9.5105E+01	8.4108E+02	3.5000E+00	-1.8943E+04	2.1029E+04	1.8948E+04	-2.1421E+03	6.2307E+03	1.2500E+00
9.5105E+01	8.2239E+02	4.2750E+01	-1.8943E+04	1.9527E+04	1.9299E+03	-2.1421E+03	6.0297E+03	2.5000E+00
9.5105E+01	8.0370E+02	3.5000E+00	-1.8943E+04	1.8025E+04	2.1368E+04	-2.1421E+03	5.4268E+03	1.2500E+01
9.5105E+01	7.8501E+02	1.7500E+00	-1.8943E+04	1.6523E+04	7.3595E+03	-2.1421E+03	5.0248E+03	1.8350E+02
9.5105E+01	7.2894E+02	1.7500E+00	-1.8943E+04	1.5021E+04	2.1046E+04	-2.1421E+03	4.6228E+03	3.5417E+00
9.5105E+01	7.1025E+02	1.7500E+00	-1.8943E+04	1.3519E+04	3.5845E+03	-2.1421E+03	4.0198E+03	5.0000E+00
9.5105E+01	6.3548E+02	1.7500E+00	-1.8943E+04	1.2017E+04	1.3870E+04	-2.1421E+03	3.8188E+03	9.0500E+01
9.5105E+01	6.1679E+02	1.2500E+00	-1.8943E+04	1.0515E+04	2.4754E+04	-2.1421E+03	3.4168E+03	1.6402E+03
9.5105E+01	5.9810E+02	2.5000E+00	-1.8943E+04	9.0126E+03	4.2532E+04	-2.1421E+03	3.2159E+03	1.0787E+03
9.5105E+01	5.7941E+02	3.7500E+00	-1.8943E+04	7.5105E+03	6.8439E+04	-2.1421E+03	3.0149E+03	2.4687E+03
9.5105E+01	5.6072E+02	1.2500E+00	-1.8943E+04	6.0084E+03	3.1346E+05	-2.1421E+03	2.8139E+03	4.1702E+03
9.5105E+01	5.4203E+02	3.7500E+00	-1.8943E+04	4.5063E+03	1.2918E+06	-2.1421E+03	2.6129E+03	1.0445E+03
9.5105E+01	5.2334E+02	3.7500E+00	-1.8943E+04	3.0042E+03	4.0919E+06	-2.1421E+03	2.4119E+03	1.1837E+04
9.5105E+01	4.8596E+02	1.2917E+01	-1.8943E+04	1.5021E+03	1.0054E+07	-2.1421E+03	2.2109E+03	1.3538E+04
9.5105E+01	4.6727E+02	2.5417E+01	-1.8943E+04	0.0000E+00	1.3187E+07	-2.1421E+03	2.0099E+03	1.7060E+04
9.5105E+01	4.4858E+02	4.2500E+01	-2.0580E+04	6.1586E+04	1.2500E+00	-2.1421E+03	1.8089E+03	1.3671E+04
9.5105E+01	4.2989E+02	2.5000E+00	-2.0580E+04	5.4075E+04	5.2085E+00	-2.1421E+03	1.6079E+03	5.6596E+04
9.5105E+01	4.1120E+02	9.4167E+01	-2.0580E+04	5.2573E+04	9.0624E+01	-2.1421E+03	1.4069E+03	6.6217E+04
9.5105E+01	3.9251E+02	4.5969E+02	-2.0580E+04	5.1071E+04	8.5415E+01	-2.1421E+03	1.2059E+03	4.4505E+04
9.5105E+01	3.7381E+02	4.8750E+02	-2.0580E+04	4.9569E+04	1.7696E+02	-2.1421E+03	1.0050E+03	2.2188E+04
9.5105E+01	3.5512E+02	2.2270E+02	-2.0580E+04	4.8067E+04	9.0624E+01	-2.1421E+03	8.0396E+02	4.0077E+04
9.5105E+01	3.3643E+02	1.7916E+02	-2.0580E+04	4.6565E+04	1.8204E+02	-2.1421E+03	6.0297E+02	5.3317E+04
9.5105E+01	3.1774E+02	5.6898E+02	-2.0580E+04	4.5063E+04	1.9600E+02	-2.1421E+03	4.0198E+02	1.2336E+05
9.5105E+01	2.9905E+02	5.7364E+02	-2.0580E+04	4.3561E+04	1.3875E+02	-2.1421E+03	2.0099E+02	2.6498E+05
9.5105E+01	2.8036E+02	2.6858E+03	-2.0580E+04	4.2059E+04	4.0585E+02	-2.1421E+03	0.0000E+00	3.8086E+05
9.5105E+01	2.6167E+02	3.4442E+03	-2.0580E+04	4.0557E+04	1.8537E+02	-2.3797E+03	9.2456E+03	1.2500E+00
9.5105E+01	2.4298E+02	1.8470E+04	-2.0580E+04	3.9055E+04	1.1769E+03	-2.3797E+03	7.4367E+03	1.2500E+00
9.5105E+01	2.2429E+02	3.7773E+03	-2.0580E+04	3.7552E+04	2.1269E+03	-2.3797E+03	7.0347E+03	1.2500E+00
9.5105E+01	2.0560E+02	3.1411E+04	-2.0580E+04	3.6050E+04	1.7688E+03	-2.3797E+03	6.6327E+03	1.2500E+00
9.5105E+01	1.8691E+02	3.6184E+04	-2.0580E+04	3.4548E+04	9.0522E+02	-2.3797E+03	6.4317E+03	1.2500E+00
9.5105E+01	1.6822E+02	4.2645E+04	-2.0580E+04	3.3046E+04	2.7021E+03	-2.3797E+03	6.0297E+03	3.7500E+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
9.5105E+01	1.4953E+02	3.0651E+04	-2.0580E+04	3.1544E+04	3.0605E+03	-2.3797E+03	4.6228E+03	2.5000E+00
9.5105E+01	1.3084E+02	5.6976E+04	-2.0580E+04	3.0042E+04	6.2922E+03	-2.3797E+03	4.4218E+03	5.0000E+00
9.5105E+01	1.1214E+02	1.2710E+05	-2.0580E+04	2.8540E+04	8.4806E+03	-2.3797E+03	4.2208E+03	1.2500E+00
9.5105E+01	9.3454E+01	3.8811E+05	-2.0580E+04	2.7038E+04	1.8191E+04	-2.3797E+03	4.0198E+03	9.0500E+01
9.5105E+01	7.4763E+01	1.8592E+06	-2.0580E+04	2.5536E+04	6.2603E+03	-2.3797E+03	3.8188E+03	2.7500E+01
9.5105E+01	5.6072E+01	4.1013E+06	-2.0580E+04	2.4034E+04	1.3993E+04	-2.3797E+03	3.6178E+03	4.5261E+02
9.5105E+01	3.7381E+01	6.6149E+06	-2.0580E+04	2.2531E+04	2.0712E+04	-2.3797E+03	3.4168E+03	3.2480E+03
9.5105E+01	1.8691E+01	2.2444E+07	-2.0580E+04	2.1029E+04	2.2869E+04	-2.3797E+03	3.2159E+03	6.2861E+02
9.5105E+01	0.0000E+00	1.9606E+07	-2.0580E+04	1.9527E+04	2.6589E+04	-2.3797E+03	3.0149E+03	1.8450E+02
7.2903E+01	8.7846E+02	1.7500E+00	-2.0580E+04	1.8025E+04	2.5568E+04	-2.3797E+03	2.8139E+03	4.7511E+02
7.2903E+01	8.5977E+02	1.2500E+00	-2.0580E+04	1.6523E+04	2.1197E+04	-2.3797E+03	2.6129E+03	4.9200E+03
7.2903E+01	8.4108E+02	1.7500E+00	-2.0580E+04	1.5021E+04	4.2281E+04	-2.3797E+03	2.4119E+03	1.8700E+02
7.2903E+01	8.0370E+02	3.0000E+00	-2.0580E+04	1.3519E+04	3.8093E+04	-2.3797E+03	2.2109E+03	1.5833E+04
7.2903E+01	7.8501E+02	2.5000E+00	-2.0580E+04	1.2017E+04	3.5019E+04	-2.3797E+03	2.0099E+03	1.8223E+04
7.2903E+01	7.4763E+02	3.5000E+00	-2.0580E+04	1.0515E+04	7.7499E+04	-2.3797E+03	1.8089E+03	1.6456E+03
7.2903E+01	6.9156E+02	3.7500E+00	-2.0580E+04	9.0126E+03	8.6212E+04	-2.3797E+03	1.6079E+03	2.6944E+03
7.2903E+01	6.7287E+02	1.2500E+00	-2.0580E+04	7.5105E+03	2.0241E+05	-2.3797E+03	1.4069E+03	4.6343E+03
7.2903E+01	5.9810E+02	1.2500E+00	-2.0580E+04	6.0084E+03	6.7547E+05	-2.3797E+03	1.2059E+03	8.8196E+03
7.2903E+01	5.7941E+02	2.5000E+00	-2.0580E+04	4.5063E+03	1.7117E+06	-2.3797E+03	1.0050E+03	7.4647E+03
7.2903E+01	5.6072E+02	2.5000E+00	-2.0580E+04	3.0042E+03	5.7358E+06	-2.3797E+03	8.0396E+02	1.0722E+04
7.2903E+01	5.4203E+02	6.2500E+00	-2.0580E+04	1.5021E+03	1.3344E+07	-2.3797E+03	6.0297E+02	2.4977E+04
7.2903E+01	5.2334E+02	2.5000E+00	-2.0580E+04	0.0000E+00	1.2599E+07	-2.3797E+03	4.0198E+02	2.4501E+04
7.2903E+01	5.0465E+02	2.5000E+00	-2.2217E+04	5.1071E+04	1.0417E+00	-2.3797E+03	2.0099E+02	1.4111E+05
7.2903E+01	4.8596E+02	2.5000E+00	-2.2217E+04	4.8067E+04	2.6133E+02	-2.3797E+03	0.0000E+00	2.0456E+05
7.2903E+01	4.6727E+02	7.5000E+00	-2.2217E+04	4.6565E+04	1.0417E+01	-2.6172E+03	7.0347E+03	1.2500E+00
7.2903E+01	4.4858E+02	8.3333E+00	-2.2217E+04	4.5063E+04	6.3111E+02	-2.6172E+03	6.8337E+03	1.2500E+00
7.2903E+01	4.2989E+02	1.1250E+01	-2.2217E+04	4.3561E+04	9.2583E+01	-2.6172E+03	6.4317E+03	1.2500E+01
7.2903E+01	4.1120E+02	8.0833E+01	-2.2217E+04	4.2059E+04	4.0585E+02	-2.6172E+03	5.0248E+03	2.5000E+00
7.2903E+01	3.9251E+02	8.1250E+01	-2.2217E+04	4.0557E+04	1.4249E+03	-2.6172E+03	4.8238E+03	1.2500E+00
7.2903E+01	3.7381E+02	9.2083E+01	-2.2217E+04	3.9055E+04	2.3490E+03	-2.6172E+03	4.6228E+03	1.9042E+03
7.2903E+01	3.5512E+02	5.2958E+02	-2.2217E+04	3.7552E+04	4.6200E+03	-2.6172E+03	3.8188E+03	1.2500E+00
7.2903E+01	3.3643E+02	1.7208E+02	-2.2217E+04	3.6050E+04	2.2494E+03	-2.6172E+03	3.4168E+03	1.0417E+00
7.2903E+01	3.1774E+02	9.1042E+02	-2.2217E+04	3.4548E+04	6.0760E+03	-2.6172E+03	3.2159E+03	2.5000E+00
7.2903E+01	2.9905E+02	1.1568E+03	-2.2217E+04	3.3046E+04	1.6059E+04	-2.6172E+03	3.0149E+03	1.0338E+03
7.2903E+01	2.8036E+02	1.1642E+03	-2.2217E+04	3.1544E+04	1.1100E+04	-2.6172E+03	2.8139E+03	6.6466E+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
7.2903E+01	2.6167E+02	1.5994E+03	-2.2217E+04	3.0042E+04	8.5459E+03	-2.6172E+03	2.6129E+03	4.5261E+02
7.2903E+01	2.4298E+02	2.4192E+03	-2.2217E+04	2.8540E+04	1.8601E+04	-2.6172E+03	2.4119E+03	2.0575E+03
7.2903E+01	2.2429E+02	3.8075E+03	-2.2217E+04	2.7038E+04	1.8694E+04	-2.6172E+03	2.2109E+03	4.4969E+02
7.2903E+01	2.0560E+02	1.0421E+04	-2.2217E+04	2.5536E+04	3.3687E+04	-2.6172E+03	2.0099E+03	1.5288E+03
7.2903E+01	1.8691E+02	1.5797E+04	-2.2217E+04	2.4034E+04	3.5178E+04	-2.6172E+03	1.8089E+03	1.2190E+03
7.2903E+01	1.6822E+02	2.0870E+04	-2.2217E+04	2.2531E+04	4.8429E+04	-2.6172E+03	1.6079E+03	1.2992E+04
7.2903E+01	1.4953E+02	4.0616E+04	-2.2217E+04	2.1029E+04	6.2871E+04	-2.6172E+03	1.4069E+03	1.0111E+04
7.2903E+01	1.3084E+02	7.2930E+04	-2.2217E+04	1.9527E+04	9.4558E+04	-2.6172E+03	1.2059E+03	9.7958E+03
7.2903E+01	1.1214E+02	1.4794E+05	-2.2217E+04	1.8025E+04	8.5114E+04	-2.6172E+03	1.0050E+03	2.5658E+03
7.2903E+01	9.3454E+01	4.9666E+05	-2.2217E+04	1.6523E+04	9.2788E+04	-2.6172E+03	8.0396E+02	1.4467E+04
7.2903E+01	7.4763E+01	1.8259E+06	-2.2217E+04	1.5021E+04	1.1162E+05	-2.6172E+03	6.0297E+02	5.2055E+03
7.2903E+01	5.6072E+01	4.1070E+06	-2.2217E+04	1.3519E+04	1.3106E+05	-2.6172E+03	4.0198E+02	4.5565E+03
7.2903E+01	3.7381E+01	5.4588E+06	-2.2217E+04	1.2017E+04	1.2309E+05	-2.6172E+03	2.0099E+02	6.2111E+04
7.2903E+01	1.8691E+01	2.0777E+07	-2.2217E+04	1.0515E+04	1.6573E+05	-2.6172E+03	0.0000E+00	6.4923E+04
7.2903E+01	0.0000E+00	2.2473E+07	-2.2217E+04	9.0126E+03	1.8324E+05	-2.8547E+03	7.8387E+03	1.2500E+00
5.0700E+01	9.1585E+02	1.7500E+00	-2.2217E+04	7.5105E+03	2.7666E+05	-2.8547E+03	7.2357E+03	1.2500E+00
5.0700E+01	8.7846E+02	1.7500E+00	-2.2217E+04	6.0084E+03	7.7264E+05	-2.8547E+03	4.0198E+03	1.8350E+02
5.0700E+01	8.4108E+02	1.2500E+00	-2.2217E+04	4.5063E+03	2.3687E+06	-2.8547E+03	3.0149E+03	5.0000E+00
5.0700E+01	8.2239E+02	1.2500E+00	-2.2217E+04	3.0042E+03	6.2313E+06	-2.8547E+03	2.6129E+03	7.5000E+00
5.0700E+01	7.1025E+02	1.2500E+00	-2.2217E+04	1.5021E+03	1.3934E+07	-2.8547E+03	2.4119E+03	1.8100E+02
5.0700E+01	6.7287E+02	1.2500E+00	-2.2217E+04	0.0000E+00	1.2218E+07	-2.8547E+03	2.2109E+03	5.0000E+00
5.0700E+01	6.5418E+02	4.2500E+00	-2.3855E+04	4.8067E+04	2.2380E+02	-2.8547E+03	1.8089E+03	4.7511E+02
5.0700E+01	6.3548E+02	2.5000E+00	-2.3855E+04	4.6565E+04	2.2380E+02	-2.8547E+03	1.6079E+03	5.2500E+01
5.0700E+01	6.1679E+02	2.5000E+00	-2.3855E+04	4.5063E+04	7.2730E+02	-2.8547E+03	1.4069E+03	4.5261E+02
5.0700E+01	5.6072E+02	1.2500E+00	-2.3855E+04	4.2059E+04	5.3915E+02	-2.8547E+03	1.2059E+03	4.5461E+02
5.0700E+01	5.0465E+02	1.2500E+00	-2.3855E+04	4.0557E+04	8.1065E+02	-2.8547E+03	1.0050E+03	1.0355E+03
5.0700E+01	4.8596E+02	3.7500E+00	-2.3855E+04	3.9055E+04	1.3958E+03	-2.8547E+03	8.0396E+02	5.2960E+03
5.0700E+01	4.6727E+02	3.7500E+00	-2.3855E+04	3.7552E+04	1.4941E+03	-2.8547E+03	6.0297E+02	6.3111E+02
5.0700E+01	4.4858E+02	8.7500E+01	-2.3855E+04	3.6050E+04	3.9965E+03	-2.8547E+03	4.0198E+02	1.3034E+03
5.0700E+01	4.2989E+02	4.2500E+01	-2.3855E+04	3.4548E+04	4.5400E+03	-2.8547E+03	2.0099E+02	9.6045E+03
5.0700E+01	4.1120E+02	3.4583E+01	-2.3855E+04	3.3046E+04	7.0348E+03	-2.8547E+03	0.0000E+00	5.0715E+04
5.0700E+01	3.9251E+02	4.2500E+00	-2.3855E+04	3.1544E+04	1.1727E+04	-3.0923E+03	7.4367E+03	1.2500E+00
5.0700E+01	3.7381E+02	1.8750E+01	-2.3855E+04	3.0042E+04	1.3124E+04	-3.0923E+03	4.6228E+03	2.5000E+00
5.0700E+01	3.5512E+02	1.1750E+02	-2.3855E+04	2.8540E+04	2.9364E+04	-3.0923E+03	3.6178E+03	2.5000E+00
5.0700E+01	3.3643E+02	8.2500E+01	-2.3855E+04	2.7038E+04	4.2503E+04	-3.0923E+03	2.8139E+03	2.5000E+01

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
5.0700E+01	3.1774E+02	7.5000E+00	-2.3855E+04	2.5536E+04	5.0299E+04	-3.0923E+03	2.4119E+03	2.5000E+00
5.0700E+01	2.9905E+02	3.5833E+01	-2.3855E+04	2.4034E+04	5.1205E+04	-3.0923E+03	2.2109E+03	2.5000E+00
5.0700E+01	2.8036E+02	2.1167E+02	-2.3855E+04	2.2531E+04	6.8979E+04	-3.0923E+03	2.0099E+03	1.8833E+02
5.0700E+01	2.6167E+02	2.0390E+03	-2.3855E+04	2.1029E+04	1.1293E+05	-3.0923E+03	1.8089E+03	1.0000E+01
5.0700E+01	2.4298E+02	9.8125E+02	-2.3855E+04	1.9527E+04	1.1423E+05	-3.0923E+03	1.6079E+03	2.5000E+00
5.0700E+01	2.2429E+02	1.0187E+03	-2.3855E+04	1.8025E+04	1.4675E+05	-3.0923E+03	1.4069E+03	2.5000E+00
5.0700E+01	2.0560E+02	2.0112E+03	-2.3855E+04	1.6523E+04	1.4995E+05	-3.0923E+03	1.0050E+03	4.5011E+02
5.0700E+01	1.8691E+02	9.0915E+02	-2.3855E+04	1.5021E+04	1.8205E+05	-3.0923E+03	6.0297E+02	2.5301E+03
5.0700E+01	1.6822E+02	8.9036E+03	-2.3855E+04	1.3519E+04	2.4207E+05	-3.0923E+03	4.0198E+02	6.5825E+03
5.0700E+01	1.4953E+02	2.2201E+04	-2.3855E+04	1.2017E+04	2.4415E+05	-3.0923E+03	2.0099E+02	7.3333E+02
5.0700E+01	1.3084E+02	2.6731E+04	-2.3855E+04	1.0515E+04	2.6934E+05	-3.0923E+03	0.0000E+00	3.9473E+04
5.0700E+01	1.1214E+02	1.0431E+05	-2.3855E+04	9.0126E+03	3.2548E+05	-3.3298E+03	2.6129E+03	2.0833E+00
5.0700E+01	9.3454E+01	3.3995E+05	-2.3855E+04	7.5105E+03	5.5369E+05	-3.3298E+03	2.0099E+03	2.5000E+01
5.0700E+01	7.4763E+01	1.1565E+06	-2.3855E+04	6.0084E+03	1.2288E+06	-3.3298E+03	1.8089E+03	1.8100E+02
5.0700E+01	5.6072E+01	2.0681E+06	-2.3855E+04	4.5063E+03	3.3492E+06	-3.3298E+03	1.6079E+03	5.0000E+00
5.0700E+01	3.7381E+01	3.6504E+06	-2.3855E+04	3.0042E+03	7.8881E+06	-3.3298E+03	1.4069E+03	1.8100E+02
5.0700E+01	1.8691E+01	1.4401E+07	-2.3855E+04	1.5021E+03	1.5575E+07	-3.3298E+03	1.2059E+03	2.5000E+00
5.0700E+01	0.0000E+00	1.9591E+07	-2.3855E+04	0.0000E+00	1.1558E+07	-3.3298E+03	8.0396E+02	4.4761E+02
2.8498E+01	7.1025E+02	1.2500E+00	-2.5492E+04	5.2573E+04	1.2500E+00	-3.3298E+03	6.0297E+02	2.5000E+00
2.8498E+01	6.1679E+02	1.2500E+00	-2.5492E+04	4.6565E+04	5.1042E+01	-3.3298E+03	4.0198E+02	1.2622E+03
2.8498E+01	5.7941E+02	1.2500E+00	-2.5492E+04	4.3561E+04	6.8450E+02	-3.3298E+03	2.0099E+02	7.5924E+03
2.8498E+01	5.6072E+02	1.2500E+00	-2.5492E+04	4.0557E+04	3.1639E+02	-3.3298E+03	0.0000E+00	9.0147E+02
2.8498E+01	5.2334E+02	1.2500E+00	-2.5492E+04	3.9055E+04	6.7266E+02	-3.5673E+03	3.6178E+03	2.5000E+00
2.8498E+01	5.0465E+02	3.7500E+00	-2.5492E+04	3.7552E+04	4.1648E+03	-3.5673E+03	2.8139E+03	6.2500E+00
2.8498E+01	4.8596E+02	2.5000E+00	-2.5492E+04	3.6050E+04	2.6525E+03	-3.5673E+03	2.4119E+03	2.5000E+00
2.8498E+01	4.6727E+02	2.5000E+00	-2.5492E+04	3.4548E+04	3.2380E+03	-3.5673E+03	2.2109E+03	2.5000E+00
2.8498E+01	4.4858E+02	7.7500E+00	-2.5492E+04	3.3046E+04	2.7384E+03	-3.5673E+03	1.6079E+03	2.5000E+00
2.8498E+01	4.2989E+02	6.2500E+00	-2.5492E+04	3.1544E+04	5.3617E+03	-3.5673E+03	1.4069E+03	2.5000E+00
2.8498E+01	4.1120E+02	4.0083E+01	-2.5492E+04	3.0042E+04	1.4213E+04	-3.5673E+03	1.2059E+03	2.5000E+00
2.8498E+01	3.9251E+02	4.2500E+00	-2.5492E+04	2.8540E+04	1.6539E+04	-3.5673E+03	1.0050E+03	2.5000E+00
2.8498E+01	3.3643E+02	6.2500E+00	-2.5492E+04	2.7038E+04	4.0453E+04	-3.5673E+03	8.0396E+02	2.5000E+00
2.8498E+01	3.1774E+02	8.0000E+00	-2.5492E+04	2.5536E+04	3.1155E+04	-3.5673E+03	6.0297E+02	7.5000E+00
2.8498E+01	2.9905E+02	1.6250E+01	-2.5492E+04	2.4034E+04	3.5586E+04	-3.5673E+03	4.0198E+02	2.5000E+00
2.8498E+01	2.8036E+02	3.7076E+03	-2.5492E+04	2.2531E+04	8.6860E+04	-3.5673E+03	2.0099E+02	1.4592E+03
2.8498E+01	2.6167E+02	2.0595E+03	-2.5492E+04	2.1029E+04	7.9792E+04	-3.5673E+03	0.0000E+00	6.5295E+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
2.8498E+01	2.4298E+02	1.8730E+03	-2.5492E+04	1.9527E+04	1.0567E+05	-3.8049E+03	2.0099E+03	2.5000E+00
2.8498E+01	2.2429E+02	4.3348E+03	-2.5492E+04	1.8025E+04	1.5687E+05	-3.8049E+03	1.0050E+03	2.5000E+00
2.8498E+01	2.0560E+02	4.3530E+03	-2.5492E+04	1.6523E+04	2.3301E+05	-3.8049E+03	8.0396E+02	2.5000E+00
2.8498E+01	1.8691E+02	1.7811E+04	-2.5492E+04	1.5021E+04	2.3872E+05	-3.8049E+03	6.0297E+02	2.5000E+00
2.8498E+01	1.6822E+02	1.5169E+04	-2.5492E+04	1.3519E+04	2.8335E+05	-3.8049E+03	2.0099E+02	7.5000E+00
2.8498E+01	1.4953E+02	1.4217E+04	-2.5492E+04	1.2017E+04	3.9108E+05	-3.8049E+03	0.0000E+00	4.4761E+02
2.8498E+01	1.3084E+02	2.1670E+04	-2.5492E+04	1.0515E+04	3.8090E+05	-4.0424E+03	1.8089E+03	2.5000E+00
2.8498E+01	1.1214E+02	9.0119E+04	-2.5492E+04	9.0126E+03	4.8348E+05	-4.0424E+03	8.0396E+02	2.5000E+00
2.8498E+01	9.3454E+01	2.6530E+05	-2.5492E+04	7.5105E+03	6.1213E+05	-4.0424E+03	6.0297E+02	2.5000E+00
2.8498E+01	7.4763E+01	5.8609E+05	-2.5492E+04	6.0084E+03	1.6445E+06	-4.0424E+03	4.0198E+02	2.5000E+00
2.8498E+01	5.6072E+01	1.0606E+06	-2.5492E+04	4.5063E+03	3.7227E+06	-4.0424E+03	2.0099E+02	5.0000E+00
2.8498E+01	3.7381E+01	1.3277E+06	-2.5492E+04	3.0042E+03	9.2488E+06	-4.0424E+03	0.0000E+00	1.4571E+03
2.8498E+01	1.8691E+01	5.9988E+06	-2.5492E+04	1.5021E+03	1.5685E+07	-4.2799E+03	2.0099E+02	2.5000E+00
2.8498E+01	0.0000E+00	1.1287E+07	-2.5492E+04	0.0000E+00	1.0567E+07	-4.2799E+03	0.0000E+00	5.0000E+00
6.2959E+00	7.4763E+02	2.5000E+00	-2.7129E+04	4.3561E+04	2.5000E+00	-4.5175E+03	1.0050E+03	2.5000E+00
6.2959E+00	5.6072E+02	3.7500E+01	-2.7129E+04	3.7552E+04	1.0288E+03	-4.5175E+03	2.0099E+02	2.5000E+00
6.2959E+00	5.4203E+02	1.2500E+00	-2.7129E+04	3.6050E+04	4.2973E+03	-4.7550E+03	4.0198E+02	2.5000E+00
6.2959E+00	5.2334E+02	1.2500E+00	-2.7129E+04	3.4548E+04	1.3972E+04	-4.7550E+03	0.0000E+00	2.5000E+00
6.2959E+00	5.0465E+02	1.2500E+00	-2.7129E+04	3.3046E+04	2.4499E+04	-4.9925E+03	0.0000E+00	2.5000E+00
6.2959E+00	4.8596E+02	1.2500E+00	-2.7129E+04	3.1544E+04	1.2013E+04			
6.2959E+00	4.6727E+02	1.2500E+00	-2.7129E+04	3.0042E+04	1.0063E+04			
6.2959E+00	4.2989E+02	3.5000E+00	-2.7129E+04	2.8540E+04	1.4900E+04			
6.2959E+00	4.1120E+02	1.7500E+00	-2.7129E+04	2.7038E+04	2.1229E+04			
6.2959E+00	3.9251E+02	4.7500E+00	-2.7129E+04	2.5536E+04	3.2956E+04			
6.2959E+00	3.3643E+02	2.0833E+00	-2.7129E+04	2.4034E+04	4.9427E+04			
6.2959E+00	3.1774E+02	3.6833E+01	-2.7129E+04	2.2531E+04	4.7920E+04			
6.2959E+00	2.9905E+02	6.6500E+01	-2.7129E+04	2.1029E+04	7.9141E+04			
6.2959E+00	2.8036E+02	7.3417E+01	-2.7129E+04	1.9527E+04	1.2100E+05			
6.2959E+00	2.6167E+02	3.3745E+03	-2.7129E+04	1.8025E+04	9.1797E+04			
6.2959E+00	2.4298E+02	1.4092E+02	-2.7129E+04	1.6523E+04	1.6573E+05			
6.2959E+00	2.2429E+02	1.9300E+02	-2.7129E+04	1.5021E+04	2.0886E+05			
6.2959E+00	2.0560E+02	5.1023E+03	-2.7129E+04	1.3519E+04	3.1561E+05			
6.2959E+00	1.8691E+02	2.1778E+04	-2.7129E+04	1.2017E+04	3.6177E+05			
6.2959E+00	1.6822E+02	2.4138E+04	-2.7129E+04	1.0515E+04	4.7230E+05			
6.2959E+00	1.4953E+02	7.0604E+04	-2.7129E+04	9.0126E+03	4.7483E+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
6.2959E+00	1.3084E+02	1.2366E+05	-2.7129E+04	7.5105E+03	6.9772E+05			
6.2959E+00	1.1214E+02	1.9740E+05	-2.7129E+04	6.0084E+03	2.2613E+06			
6.2959E+00	9.3454E+01	2.2775E+05	-2.7129E+04	4.5063E+03	4.7223E+06			
6.2959E+00	7.4763E+01	2.0244E+05	-2.7129E+04	3.0042E+03	1.0345E+07			
6.2959E+00	5.6072E+01	3.0215E+05	-2.7129E+04	1.5021E+03	1.6431E+07			
6.2959E+00	3.7381E+01	8.1219E+05	-2.7129E+04	0.0000E+00	9.4037E+06			
6.2959E+00	1.8691E+01	2.3000E+06	-2.8766E+04	4.3561E+04	1.9042E+03			
6.2959E+00	0.0000E+00	6.4426E+07	-2.8766E+04	3.9055E+04	1.9042E+03			
-1.5906E+01	5.6072E+02	1.2500E+00	-2.8766E+04	3.4548E+04	4.8371E+03			
-1.5906E+01	5.2334E+02	1.2500E+00	-2.8766E+04	3.3046E+04	8.6238E+03			
-1.5906E+01	5.0465E+02	1.7500E+00	-2.8766E+04	3.1544E+04	3.5049E+04			
-1.5906E+01	4.8596E+02	1.7500E+00	-2.8766E+04	3.0042E+04	2.9126E+04			
-1.5906E+01	4.6727E+02	1.7500E+00	-2.8766E+04	2.8540E+04	3.8609E+04			
-1.5906E+01	4.4858E+02	3.5000E+00	-2.8766E+04	2.7038E+04	4.0131E+04			
-1.5906E+01	4.2989E+02	3.5000E+00	-2.8766E+04	2.5536E+04	3.2206E+04			
-1.5906E+01	3.9251E+02	8.7500E+00	-2.8766E+04	2.4034E+04	1.7598E+04			
-1.5906E+01	3.7381E+02	4.6333E+01	-2.8766E+04	2.2531E+04	6.7034E+04			
-1.5906E+01	3.5512E+02	8.7500E+00	-2.8766E+04	2.1029E+04	3.5480E+04			
-1.5906E+01	3.3643E+02	8.7500E+00	-2.8766E+04	1.9527E+04	8.7478E+04			
-1.5906E+01	3.1774E+02	3.3839E+03	-2.8766E+04	1.8025E+04	9.3685E+04			
-1.5906E+01	2.9905E+02	5.2500E+00	-2.8766E+04	1.6523E+04	1.9131E+05			
-1.5906E+01	2.8036E+02	9.5000E+00	-2.8766E+04	1.5021E+04	2.6798E+05			
-1.5906E+01	2.6167E+02	3.2750E+01	-2.8766E+04	1.3519E+04	2.6699E+05			
-1.5906E+01	2.4298E+02	8.5667E+01	-2.8766E+04	1.2017E+04	3.5784E+05			
-1.5906E+01	2.2429E+02	3.3989E+03	-2.8766E+04	1.0515E+04	3.7556E+05			
-1.5906E+01	2.0560E+02	1.7117E+02	-2.8766E+04	9.0126E+03	4.6862E+05			
-1.5906E+01	1.8691E+02	3.5783E+03	-2.8766E+04	7.5105E+03	9.5566E+05			
-1.5906E+01	1.6822E+02	1.2875E+02	-2.8766E+04	6.0084E+03	2.0168E+06			
-1.5906E+01	1.4953E+02	1.5092E+04	-2.8766E+04	4.5063E+03	4.6714E+06			
-1.5906E+01	1.3084E+02	7.2744E+03	-2.8766E+04	3.0042E+03	9.7211E+06			
-1.5906E+01	1.1214E+02	1.8764E+04	-2.8766E+04	1.5021E+03	1.5501E+07			
-1.5906E+01	9.3454E+01	3.1964E+04	-2.8766E+04	0.0000E+00	9.0598E+06			
-1.5906E+01	7.4763E+01	2.1557E+04	-3.0404E+04	3.6050E+04	3.1828E+03			
-1.5906E+01	5.6072E+01	3.9302E+04	-3.0404E+04	3.4548E+04	3.1828E+03			
-1.5906E+01	3.7381E+01	6.5157E+04	-3.0404E+04	3.3046E+04	9.5858E+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
-1.5906E+01	1.8691E+01	2.9675E+05	-3.0404E+04	3.1544E+04	3.1828E+03			
-1.5906E+01	0.0000E+00	2.2085E+06	-3.0404E+04	3.0042E+04	1.3357E+04			
-3.8109E+01	6.1679E+02	1.7500E+00	-3.0404E+04	2.8540E+04	5.6209E+04			
-3.8109E+01	5.6072E+02	3.5000E+00	-3.0404E+04	2.7038E+04	3.1618E+04			
-3.8109E+01	5.2334E+02	3.5000E+00	-3.0404E+04	2.5536E+04	2.3226E+04			
-3.8109E+01	5.0465E+02	1.7500E+00	-3.0404E+04	2.4034E+04	5.8893E+04			
-3.8109E+01	4.8596E+02	1.7500E+00	-3.0404E+04	2.2531E+04	6.1742E+04			
-3.8109E+01	4.4858E+02	1.7500E+00	-3.0404E+04	2.1029E+04	7.7000E+04			
-3.8109E+01	4.2989E+02	3.5000E+00	-3.0404E+04	1.9527E+04	5.5504E+04			
-3.8109E+01	4.1120E+02	1.0500E+01	-3.0404E+04	1.8025E+04	1.2662E+05			
-3.8109E+01	3.9251E+02	7.0000E+00	-3.0404E+04	1.6523E+04	1.0220E+05			
-3.8109E+01	3.7381E+02	1.0500E+01	-3.0404E+04	1.5021E+04	2.0430E+05			
-3.8109E+01	3.5512E+02	5.2500E+00	-3.0404E+04	1.3519E+04	3.6677E+05			
-3.8109E+01	3.3643E+02	7.0000E+00	-3.0404E+04	1.2017E+04	3.5905E+05			
-3.8109E+01	3.1774E+02	8.7500E+00	-3.0404E+04	1.0515E+04	4.1111E+05			
-3.8109E+01	2.9905E+02	1.7500E+00	-3.0404E+04	9.0126E+03	6.4887E+05			
-3.8109E+01	2.8036E+02	9.5000E+00	-3.0404E+04	7.5105E+03	9.8170E+05			
-3.8109E+01	2.6167E+02	1.4000E+01	-3.0404E+04	6.0084E+03	1.8845E+06			
-3.8109E+01	2.4298E+02	3.3386E+03	-3.0404E+04	4.5063E+03	5.0558E+06			
-3.8109E+01	2.2429E+02	1.4158E+02	-3.0404E+04	3.0042E+03	1.1245E+07			
-3.8109E+01	2.0560E+02	2.7750E+01	-3.0404E+04	1.5021E+03	1.6318E+07			
-3.8109E+01	1.8691E+02	3.3803E+03	-3.0404E+04	0.0000E+00	9.3300E+06			
-3.8109E+01	1.6822E+02	3.6167E+02	-3.2041E+04	3.7552E+04	1.9042E+03			
-3.8109E+01	1.4953E+02	1.0409E+04	-3.2041E+04	3.4548E+04	5.0870E+03			
-3.8109E+01	1.3084E+02	1.7045E+04	-3.2041E+04	3.3046E+04	9.5483E+03			
-3.8109E+01	1.1214E+02	7.2900E+02	-3.2041E+04	3.1544E+04	3.1828E+03			
-3.8109E+01	9.3454E+01	7.9900E+02	-3.2041E+04	3.0042E+04	3.1828E+03			
-3.8109E+01	7.4763E+01	4.7151E+02	-3.2041E+04	2.8540E+04	9.5483E+03			
-3.8109E+01	5.6072E+01	7.3710E+03	-3.2041E+04	2.7038E+04	2.8079E+04			
-3.8109E+01	3.7381E+01	4.7779E+03	-3.2041E+04	2.5536E+04	8.0446E+04			
-3.8109E+01	1.8691E+01	2.0542E+04	-3.2041E+04	2.4034E+04	1.0486E+05			
-3.8109E+01	0.0000E+00	2.9115E+05	-3.2041E+04	2.2531E+04	4.5116E+04			
-6.0311E+01	5.4203E+02	1.7500E+00	-3.2041E+04	2.1029E+04	5.0946E+04			
-6.0311E+01	5.2334E+02	1.7500E+00	-3.2041E+04	1.9527E+04	1.0087E+05			
-6.0311E+01	4.6727E+02	1.7500E+00	-3.2041E+04	1.8025E+04	1.3051E+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
-6.0311E+01	4.4858E+02	5.2500E+00	-3.2041E+04	1.6523E+04	1.2427E+05			
-6.0311E+01	4.2989E+02	1.0500E+01	-3.2041E+04	1.5021E+04	2.2417E+05			
-6.0311E+01	4.1120E+02	1.0500E+01	-3.2041E+04	1.3519E+04	3.4432E+05			
-6.0311E+01	3.9251E+02	1.7500E+00	-3.2041E+04	1.2017E+04	2.8196E+05			
-6.0311E+01	3.7381E+02	1.7500E+00	-3.2041E+04	1.0515E+04	3.0345E+05			
-6.0311E+01	3.5512E+02	1.2250E+01	-3.2041E+04	9.0126E+03	6.0630E+05			
-6.0311E+01	3.3643E+02	5.7500E+01	-3.2041E+04	7.5105E+03	9.3346E+05			
-6.0311E+01	3.1774E+02	5.2500E+00	-3.2041E+04	6.0084E+03	2.1620E+06			
-6.0311E+01	2.9905E+02	1.5750E+01	-3.2041E+04	4.5063E+03	6.0731E+06			
-6.0311E+01	2.8036E+02	1.7500E+01	-3.2041E+04	3.0042E+03	1.2664E+07			
-6.0311E+01	2.6167E+02	4.9500E+01	-3.2041E+04	1.5021E+03	1.8424E+07			
-6.0311E+01	2.4298E+02	9.0750E+01	-3.2041E+04	0.0000E+00	9.5958E+06			
-6.0311E+01	2.2429E+02	5.8500E+01	-3.3678E+04	3.4548E+04	3.1828E+03			
-6.0311E+01	2.0560E+02	5.6667E+01	-3.3678E+04	3.3046E+04	3.1828E+03			
-6.0311E+01	1.8691E+02	1.4000E+01	-3.3678E+04	3.1544E+04	6.3655E+03			
-6.0311E+01	1.6822E+02	7.5750E+01	-3.3678E+04	3.0042E+04	1.2769E+04			
-6.0311E+01	1.4953E+02	1.6500E+01	-3.3678E+04	2.8540E+04	3.1828E+03			
-6.0311E+01	1.3084E+02	4.2500E+01	-3.3678E+04	2.7038E+04	3.1828E+03			
-6.0311E+01	1.1214E+02	5.0000E+01	-3.3678E+04	2.5536E+04	3.8218E+04			
-6.0311E+01	9.3454E+01	2.3867E+02	-3.3678E+04	2.4034E+04	4.9413E+04			
-6.0311E+01	7.4763E+01	3.1100E+02	-3.3678E+04	2.2531E+04	1.1470E+05			
-6.0311E+01	5.6072E+01	3.4467E+02	-3.3678E+04	2.1029E+04	6.4464E+04			
-6.0311E+01	3.7381E+01	1.0558E+03	-3.3678E+04	1.9527E+04	1.3872E+05			
-6.0311E+01	1.8691E+01	3.9733E+04	-3.3678E+04	1.8025E+04	1.4046E+05			
-6.0311E+01	0.0000E+00	1.9169E+05	-3.3678E+04	1.6523E+04	1.9783E+05			
-8.2513E+01	4.8596E+02	3.5000E+00	-3.3678E+04	1.5021E+04	1.2480E+05			
-8.2513E+01	4.6727E+02	3.5000E+00	-3.3678E+04	1.3519E+04	3.4155E+05			
-8.2513E+01	4.4858E+02	5.2500E+00	-3.3678E+04	1.2017E+04	3.5070E+05			
-8.2513E+01	4.2989E+02	7.0000E+00	-3.3678E+04	1.0515E+04	3.6104E+05			
-8.2513E+01	4.1120E+02	1.7500E+00	-3.3678E+04	9.0126E+03	8.3058E+05			
-8.2513E+01	3.9251E+02	1.7500E+00	-3.3678E+04	7.5105E+03	1.4424E+06			
-8.2513E+01	3.7381E+02	1.0500E+01	-3.3678E+04	6.0084E+03	3.0921E+06			
-8.2513E+01	3.5512E+02	8.2000E+01	-3.3678E+04	4.5063E+03	7.3138E+06			
-8.2513E+01	3.3643E+02	4.4500E+01	-3.3678E+04	3.0042E+03	1.5692E+07			
-8.2513E+01	3.1774E+02	1.7500E+00	-3.3678E+04	1.5021E+03	2.1892E+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
-8.2513E+01	2.9905E+02	7.0000E+00	-3.3678E+04	0.0000E+00	1.1619E+07			
-8.2513E+01	2.8036E+02	8.7500E+00	-3.5315E+04	3.0042E+04	4.7803E+03			
-8.2513E+01	2.6167E+02	7.0000E+00	-3.5315E+04	2.8540E+04	9.5606E+03			
-8.2513E+01	2.4298E+02	1.2250E+01	-3.5315E+04	2.7038E+04	4.7803E+03			
-8.2513E+01	2.2429E+02	6.0000E+00	-3.5315E+04	2.5536E+04	3.1828E+03			
-8.2513E+01	2.0560E+02	1.2000E+01	-3.5315E+04	2.4034E+04	3.5047E+04			
-8.2513E+01	1.8691E+02	2.0000E+01	-3.5315E+04	2.2531E+04	6.4001E+04			
-8.2513E+01	1.6822E+02	9.5000E+01	-3.5315E+04	2.1029E+04	6.2466E+04			
-8.2513E+01	1.4953E+02	1.4000E+01	-3.5315E+04	1.9527E+04	1.7387E+05			
-8.2513E+01	1.3084E+02	1.0950E+02	-3.5315E+04	1.8025E+04	1.9329E+05			
-8.2513E+01	1.1214E+02	1.1258E+02	-3.5315E+04	1.6523E+04	2.3016E+05			
-8.2513E+01	9.3454E+01	9.2500E+01	-3.5315E+04	1.5021E+04	4.0328E+05			
-8.2513E+01	7.4763E+01	1.9625E+02	-3.5315E+04	1.3519E+04	6.1960E+05			
-8.2513E+01	5.6072E+01	2.1150E+02	-3.5315E+04	1.2017E+04	7.4755E+05			
-8.2513E+01	3.7381E+01	7.2125E+03	-3.5315E+04	1.0515E+04	1.2009E+06			
-8.2513E+01	1.8691E+01	2.1750E+04	-3.5315E+04	9.0126E+03	1.7435E+06			
-8.2513E+01	0.0000E+00	7.0366E+04	-3.5315E+04	7.5105E+03	2.3356E+06			
-1.0472E+02	5.6072E+02	1.7500E+00	-3.5315E+04	6.0084E+03	4.7232E+06			
-1.0472E+02	5.2334E+02	1.7500E+00	-3.5315E+04	4.5063E+03	1.0539E+07			
-1.0472E+02	4.2989E+02	4.1000E+01	-3.5315E+04	3.0042E+03	2.0585E+07			
-1.0472E+02	4.1120E+02	3.5000E+00	-3.5315E+04	1.5021E+03	2.8981E+07			
-1.0472E+02	3.9251E+02	3.5000E+00	-3.5315E+04	0.0000E+00	1.4818E+07			
-1.0472E+02	3.7381E+02	1.7500E+00	-3.6953E+04	2.5536E+04	4.7803E+03			
-1.0472E+02	3.3643E+02	1.7500E+00	-3.6953E+04	2.4034E+04	1.7500E+00			
-1.0472E+02	3.1774E+02	1.7500E+00	-3.6953E+04	2.2531E+04	1.1183E+04			
-1.0472E+02	2.9905E+02	5.2500E+00	-3.6953E+04	2.1029E+04	1.5964E+04			
-1.0472E+02	2.8036E+02	1.7500E+00	-3.6953E+04	1.9527E+04	2.7159E+04			
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-1.0472E+02	1.8691E+02	1.9000E+01	-3.6953E+04	1.5021E+04	2.8036E+05			
-1.0472E+02	1.6822E+02	1.9917E+01	-3.6953E+04	1.3519E+04	4.4009E+05			
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-1.0472E+02	1.3084E+02	4.0917E+01	-3.6953E+04	1.0515E+04	1.3600E+06			
-1.0472E+02	1.1214E+02	1.0350E+02	-3.6953E+04	9.0126E+03	2.2070E+06			
-1.0472E+02	9.3454E+01	5.9417E+01	-3.6953E+04	7.5105E+03	3.0485E+06			

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+02	7.4763E+01	9.5000E+01	-3.6953E+04	6.0084E+03	5.2719E+06			
-1.0472E+02	5.6072E+01	6.8000E+01	-3.6953E+04	4.5063E+03	1.0846E+07			
-1.0472E+02	3.7381E+01	6.8447E+03	-3.6953E+04	3.0042E+03	2.2102E+07			
-1.0472E+02	1.8691E+01	1.3982E+04	-3.6953E+04	1.5021E+03	3.1063E+07			
-1.0472E+02	0.0000E+00	9.6338E+03	-3.6953E+04	0.0000E+00	1.5479E+07			
-1.2692E+02	5.0465E+02	1.7500E+00	-3.8590E+04	2.2531E+04	3.7500E+01			
-1.2692E+02	4.1120E+02	3.5000E+00	-3.8590E+04	1.6523E+04	3.5000E+00			
-1.2692E+02	3.3643E+02	2.5000E+00	-3.8590E+04	1.5021E+04	5.5977E+04			
-1.2692E+02	3.1774E+02	2.5000E+00	-3.8590E+04	1.3519E+04	1.7770E+05			
-1.2692E+02	2.2429E+02	2.5000E+00	-3.8590E+04	1.2017E+04	3.5810E+05			
-1.2692E+02	2.0560E+02	3.5000E+00	-3.8590E+04	1.0515E+04	4.9674E+05			
-1.2692E+02	1.8691E+02	9.5000E+00	-3.8590E+04	9.0126E+03	9.1823E+05			
-1.2692E+02	1.6822E+02	5.0000E+00	-3.8590E+04	7.5105E+03	1.5698E+06			
-1.2692E+02	1.4953E+02	1.2000E+01	-3.8590E+04	6.0084E+03	3.1368E+06			
-1.2692E+02	1.3084E+02	2.0000E+01	-3.8590E+04	4.5063E+03	7.0919E+06			
-1.2692E+02	1.1214E+02	2.6000E+01	-3.8590E+04	3.0042E+03	1.5466E+07			
-1.2692E+02	9.3454E+01	4.3417E+01	-3.8590E+04	1.5021E+03	2.3828E+07			
-1.2692E+02	7.4763E+01	2.0100E+02	-3.8590E+04	0.0000E+00	1.1520E+07			
-1.2692E+02	5.6072E+01	1.2475E+02	-4.0227E+04	1.6523E+04	6.4030E+03			
-1.2692E+02	3.7381E+01	1.6775E+02	-4.0227E+04	1.3519E+04	1.2806E+04			
-1.2692E+02	1.8691E+01	3.0309E+02	-4.0227E+04	1.2017E+04	4.1577E+04			
-1.2692E+02	0.0000E+00	3.7659E+02	-4.0227E+04	1.0515E+04	5.1259E+04			
-1.4912E+02	5.0465E+02	1.7500E+00	-4.0227E+04	9.0126E+03	1.9864E+05			
-1.4912E+02	2.4298E+02	2.5000E+00	-4.0227E+04	7.5105E+03	4.9973E+05			
-1.4912E+02	2.0560E+02	2.5000E+00	-4.0227E+04	6.0084E+03	1.1794E+06			
-1.4912E+02	1.8691E+02	8.5500E+01	-4.0227E+04	4.5063E+03	2.9433E+06			
-1.4912E+02	1.4953E+02	2.0000E+01	-4.0227E+04	3.0042E+03	7.4833E+06			
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-1.4912E+02	7.4763E+01	3.5242E+02	-4.1864E+04	9.0126E+03	1.7500E+00			
-1.4912E+02	5.6072E+01	1.4050E+02	-4.1864E+04	7.5105E+03	6.3913E+04			
-1.4912E+02	3.7381E+01	2.8000E+01	-4.1864E+04	6.0084E+03	1.6254E+05			
-1.4912E+02	1.8691E+01	2.5008E+02	-4.1864E+04	4.5063E+03	7.8773E+05			
-1.4912E+02	0.0000E+00	2.5550E+02	-4.1864E+04	3.0042E+03	2.1988E+06			

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
-1.7132E+02	2.4298E+02	2.5000E+00	-4.1864E+04	1.5021E+03	3.8470E+06			
-1.7132E+02	2.0560E+02	3.5000E+00	-4.1864E+04	0.0000E+00	2.0613E+06			
-1.7132E+02	1.8691E+02	9.5000E+00	-4.3502E+04	6.0084E+03	3.5736E+04			
-1.7132E+02	1.6822E+02	1.5500E+01	-4.3502E+04	4.5063E+03	8.0145E+04			
-1.7132E+02	1.3084E+02	7.0000E+00	-4.3502E+04	3.0042E+03	2.4593E+05			
-1.7132E+02	1.1214E+02	9.9500E+01	-4.3502E+04	1.5021E+03	5.2879E+05			
-1.7132E+02	9.3454E+01	2.1000E+01	-4.3502E+04	0.0000E+00	4.3325E+05			
-1.7132E+02	7.4763E+01	8.9000E+01	-4.5139E+04	6.0084E+03	1.0174E+04			
-1.7132E+02	5.6072E+01	2.7917E+01	-4.5139E+04	4.5063E+03	1.9175E+04			
-1.7132E+02	3.7381E+01	9.5000E+00	-4.5139E+04	3.0042E+03	7.0234E+04			
-1.7132E+02	1.8691E+01	2.7000E+01	-4.5139E+04	1.5021E+03	1.0943E+05			
-1.7132E+02	0.0000E+00	9.6000E+01	-4.5139E+04	0.0000E+00	4.9223E+04			
-1.9352E+02	2.0560E+02	6.0000E+00	-4.6776E+04	4.5063E+03	7.5000E+01			
-1.9352E+02	1.3084E+02	3.5000E+00	-4.6776E+04	3.0042E+03	1.9247E+04			
-1.9352E+02	1.1214E+02	9.5000E+01	-4.6776E+04	1.5021E+03	1.5926E+04			
-1.9352E+02	9.3454E+01	2.0000E+01	-4.6776E+04	0.0000E+00	1.8450E+02			
-1.9352E+02	7.4763E+01	7.8500E+01	-4.8413E+04	0.0000E+00	1.5926E+04			
-1.9352E+02	5.6072E+01	8.2000E+01						
-1.9352E+02	3.7381E+01	2.4500E+01						
-1.9352E+02	1.8691E+01	2.4500E+01						
-1.9352E+02	0.0000E+00	1.6500E+01						
-2.1573E+02	1.4953E+02	7.0000E+00						
-2.1573E+02	1.3084E+02	7.0000E+00						
-2.1573E+02	9.3454E+01	3.5000E+00						
-2.1573E+02	7.4763E+01	3.5000E+00						
-2.1573E+02	5.6072E+01	7.0000E+00						
-2.1573E+02	3.7381E+01	7.0000E+00						
-2.1573E+02	1.8691E+01	1.0500E+01						
-2.1573E+02	0.0000E+00	1.0500E+01						
-2.3793E+02	1.3084E+02	7.0000E+00						
-2.3793E+02	9.3454E+01	3.5000E+00						
-2.3793E+02	7.4763E+01	7.0000E+00						
-2.3793E+02	5.6072E+01	7.0000E+00						
-2.3793E+02	3.7381E+01	7.0000E+00						
-2.3793E+02	0.0000E+00	7.0000E+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
-2.6013E+02	1.6822E+02	2.5000E+00						
-2.6013E+02	1.4953E+02	3.5000E+00						
-2.6013E+02	1.1214E+02	7.5000E+01						
-2.6013E+02	9.3454E+01	3.5000E+00						
-2.8233E+02	7.4763E+01	3.5000E+00						
-2.8233E+02	3.7381E+01	3.5000E+00						

Figure 2 – Tower Base Flange Section

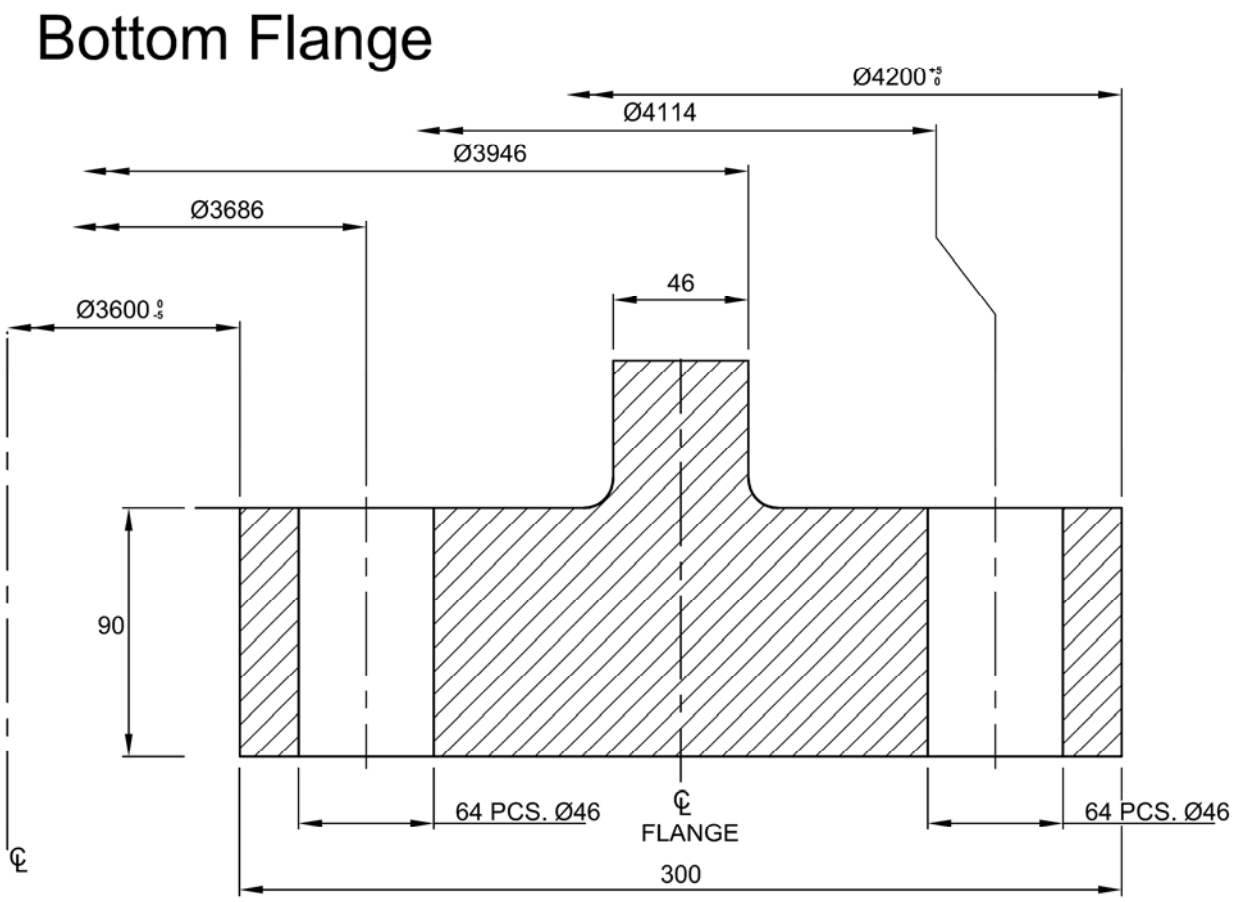


Figure 3 – Typical Conduit Layout

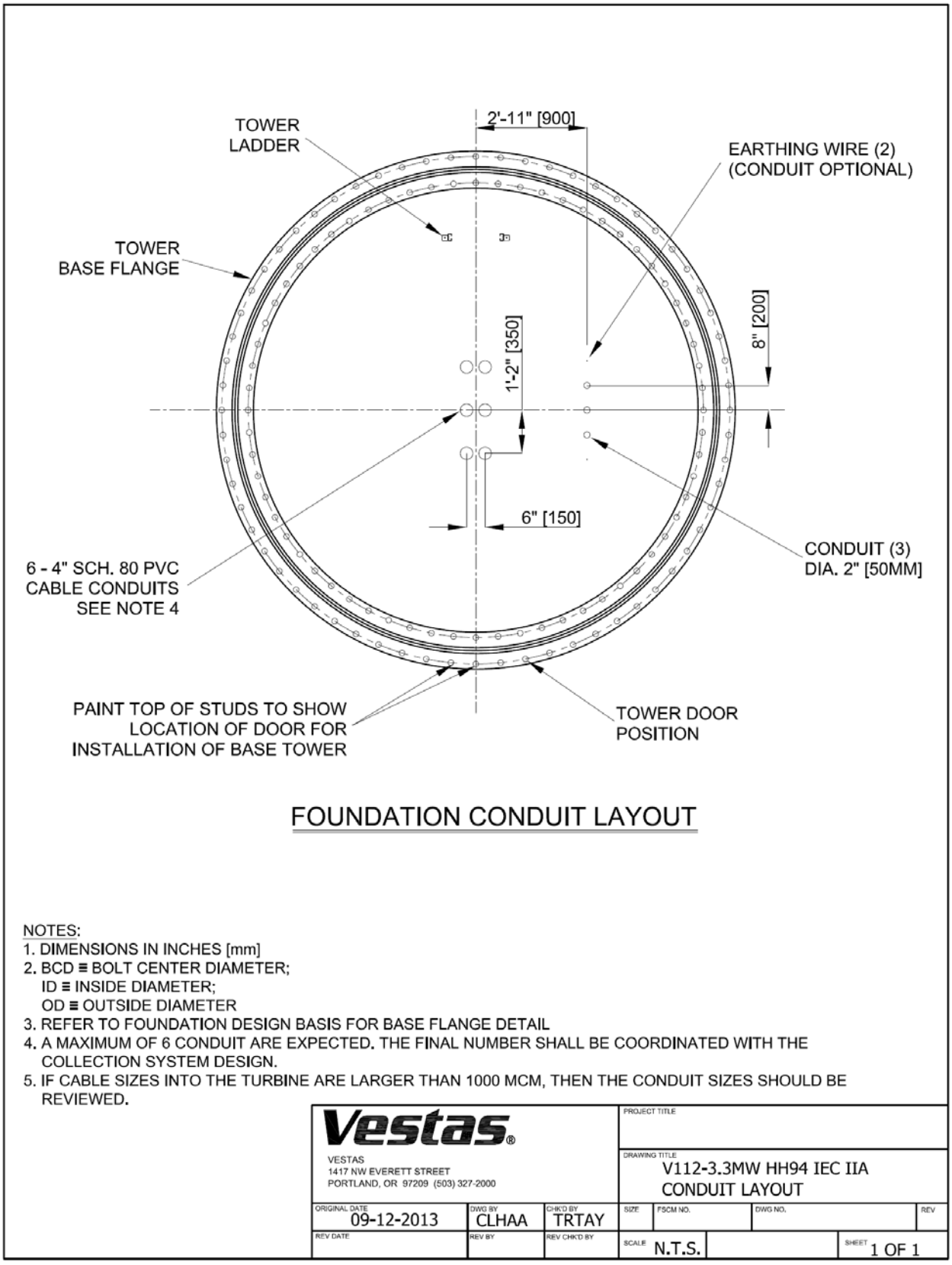


Figure 4 – Tower Foundation Bolt Template Ring

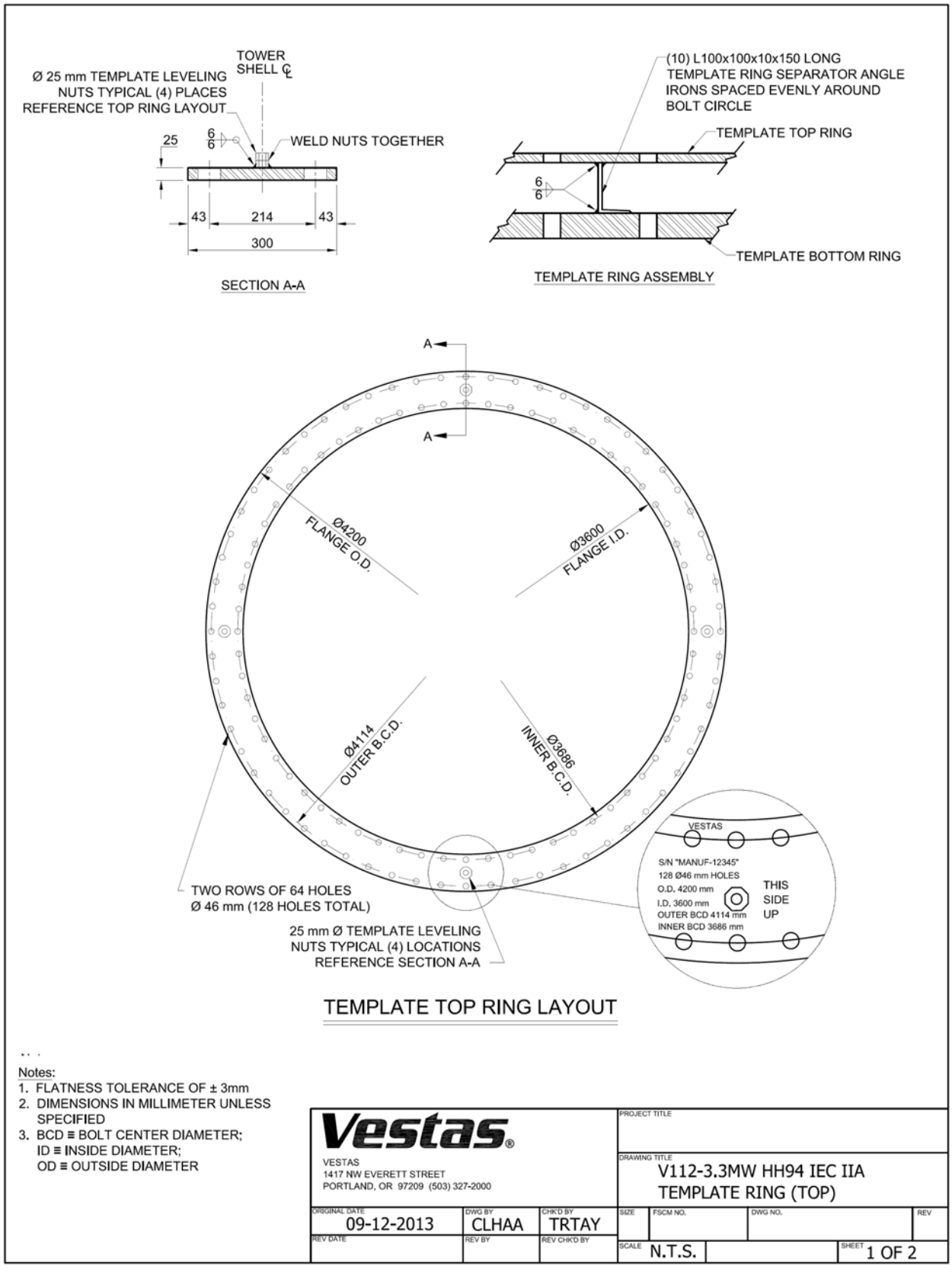


Figure 4 – Tower Foundation Bolt Template Ring (Cont.)

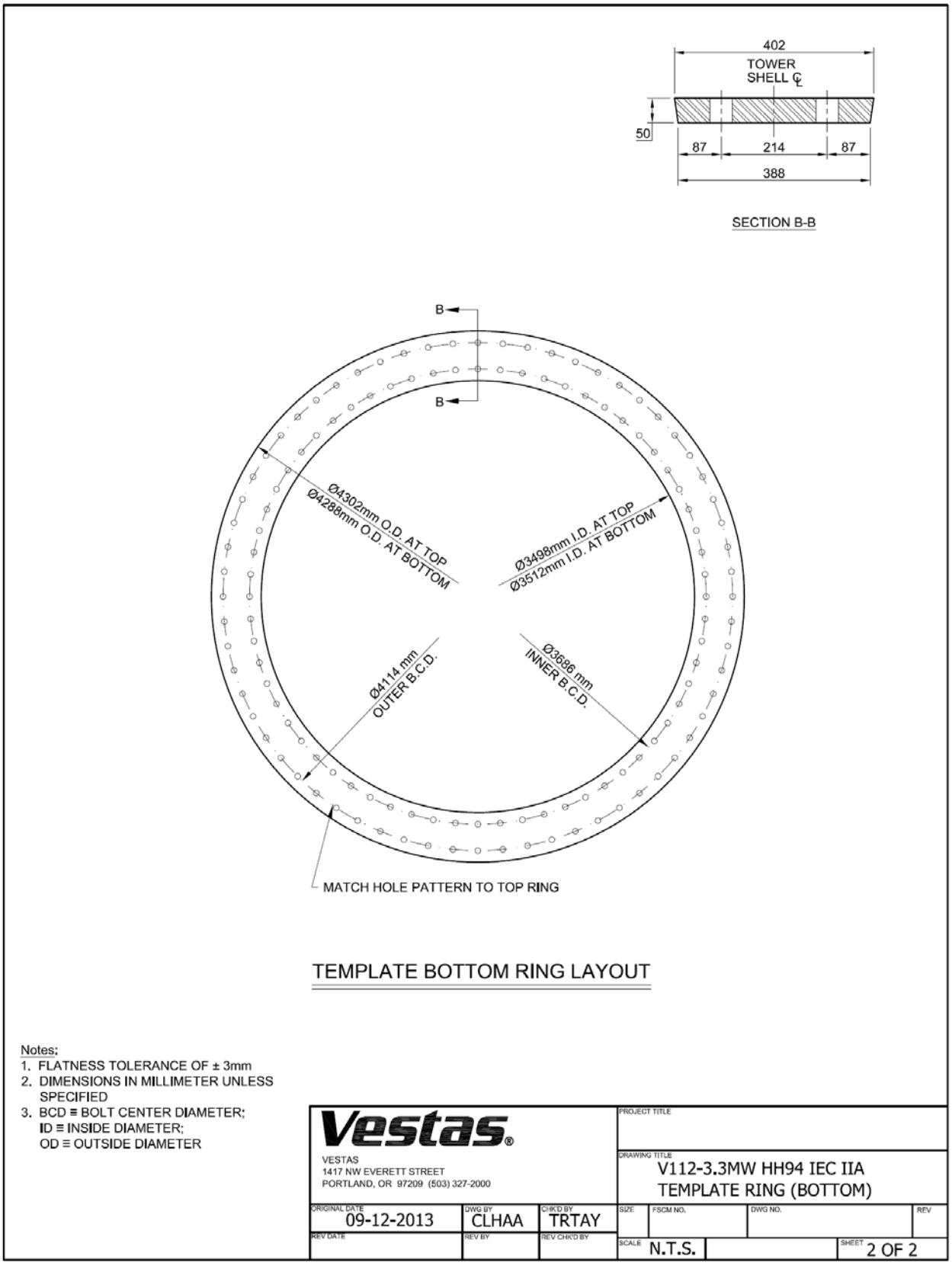
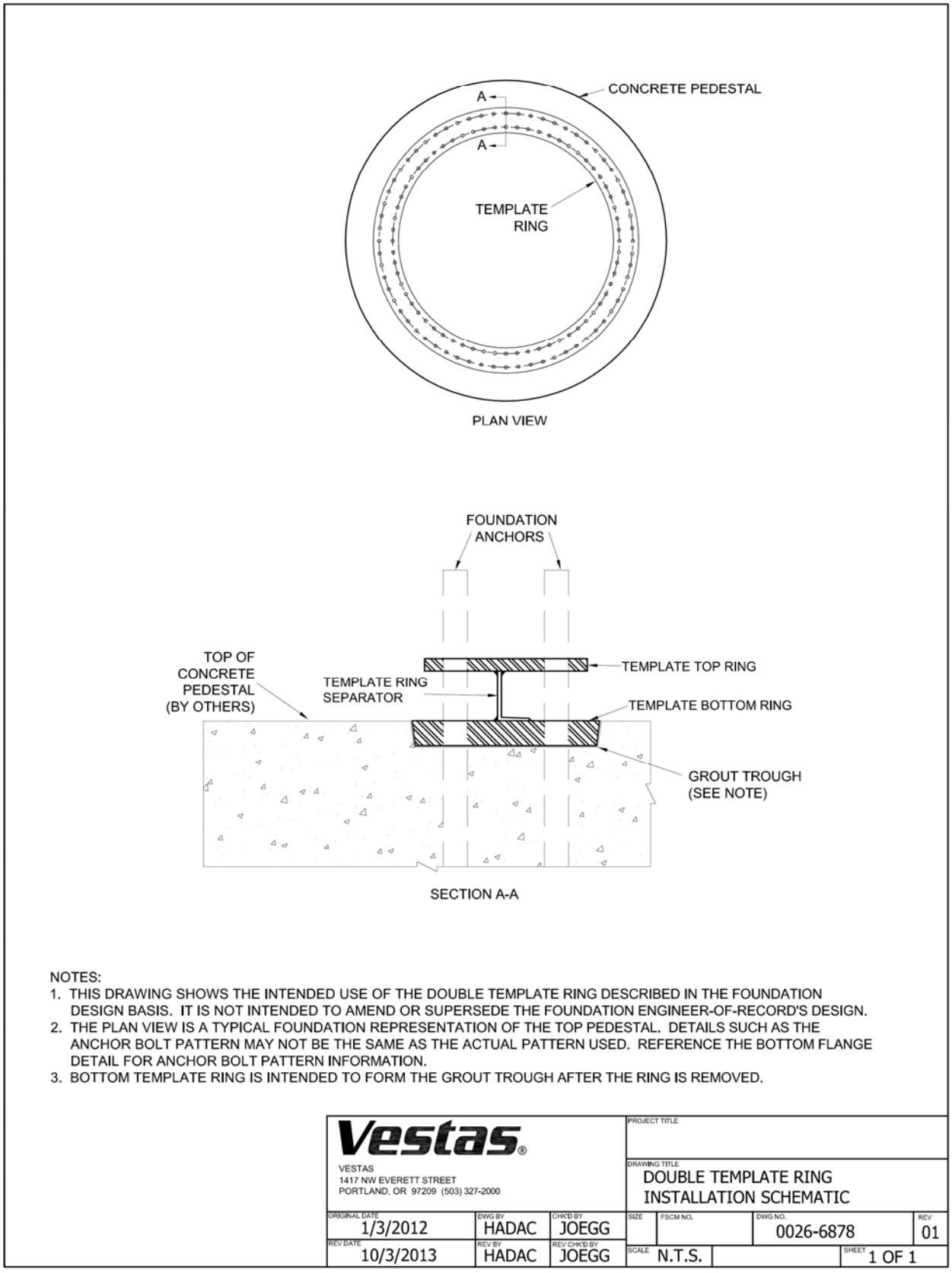


Figure 5 – Tower Foundation Bolt Template Ring Installation Schematic



NOTES:
1. THIS DRAWING SHOWS THE INTENDED USE OF THE DOUBLE TEMPLATE RING DESCRIBED IN THE FOUNDATION DESIGN BASIS. IT IS NOT INTENDED TO AMEND OR SUPERSEDE THE FOUNDATION ENGINEER-OF-RECORD'S DESIGN.
2. THE PLAN VIEW IS A TYPICAL FOUNDATION REPRESENTATION OF THE TOP PEDESTAL. DETAILS SUCH AS THE ANCHOR BOLT PATTERN MAY NOT BE THE SAME AS THE ACTUAL PATTERN USED. REFERENCE THE BOTTOM FLANGE DETAIL FOR ANCHOR BOLT PATTERN INFORMATION.
3. BOTTOM TEMPLATE RING IS INTENDED TO FORM THE GROUT TROUGH AFTER THE RING IS REMOVED.

Vestas®

VESTAS
1417 NW EVERETT STREET
PORTLAND, OR 97209 (503) 327-2000

PROJECT TITLE

DRAWING TITLE: DOUBLE TEMPLATE RING INSTALLATION SCHEMATIC

ORIGINAL DATE	DWG BY	CHK'D BY	SIZE	FSCM NO.	DWG NO.	REV
1/3/2012	HADAC	JOEGG			0026-6878	01
REV DATE	REV BY	REV CHK'D BY	SCALE			SHEET
10/3/2013	HADAC	JOEGG	N.T.S.			1 OF 1

Restricted
Document no.: 0034-7282 V04
2013-04-04

General Specification

V112–3.3 MW 50/60 Hz

Vestas Wind Systems A/S · Hedeager 44 · 8200 Aarhus N · Denmark · www.vestas.com

Table of contents

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See general reservations, notes and disclaimers (including, section 11, p. 33) to this general specification

1 General Description

The Vestas V112-3.3 MW wind turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The Vestas V112-3.3 MW turbine has a rotor diameter of 112 m and a rated output power of 3.3 MW. The turbine utilises the OptiTip® concept and a power system based on a permanent magnet or induction generator and full-scale converter. With these features, the wind turbine is able to operate the rotor at variable speed and thereby maintaining the power output at or near rated power even in high wind speed. At low wind speed, the OptiTip® concept and the power system work together to maximise the power output by operating at the optimal rotor speed and pitch angle.

2 Mechanical Design

2.1 Rotor

The V112-3.3 MW is equipped with a 112-meter rotor consisting of three blades and a hub. The blades are controlled by the microprocessor pitch control system OptiTip®. Based on the prevailing wind conditions, the blades are continuously positioned to optimise the pitch angle.

Rotor	
Diameter	112 m
Swept Area	9852 m^2
Speed, Dynamic Operation Range	6.2-17.7
Rotational Direction	Clockwise (front view)
Orientation	Upwind
Tilt	6°
Blade Coning	4°
Number of Blades	3
Aerodynamic Brakes	Full feathering

Table 2-1: Rotor data

2.2 Blades

The blades are made of carbon and fibreglass and consist of two airfoil shells bonded to a supporting beam.

Blades	
Type Description	Airfoil shells bonded to supporting beam
Blade Length	54.65 m
Material	Fibreglass reinforced epoxy and carbon fibres
Blade Connection	Steel roots inserted

Blades	
Airfoils	High-lift profile
Maximum Chord	4.0 m

Table 2-2: Blades data

2.3 Blade Bearing

The blade bearings are double-row four-point contact ball bearings.

Blade Bearing	
Lubrication	Grease

Table 2-3: Blade bearing data

2.4 Pitch System

The turbine is equipped with a pitch system for each blade and a distributor block, all located in the hub. Each pitch system is connected to the distributor block with flexible hoses. The distributor block is connected to the pipes of the hydraulic rotating transfer unit in the hub by means of three hoses (pressure line, return line and drain line).

Each pitch system consists of a hydraulic cylinder mounted to the hub and a piston rod mounted to the blade via a torque arm shaft. Valves facilitating operation of the pitch cylinder are installed on a pitch block bolted directly onto the cylinder.

Pitch System	
Type	Hydraulic
Number	1 per blade
Range	-9° to 90°

Table 2-4: Pitch system data

Hydraulic System	
Main Pump	Two redundant internal-gear oil pumps
Pressure	260 bar
Filtration	3 µm (absolute)

Table 2-5: Hydraulic system data.

2.5 Hub

The hub supports the three blades and transfers the reaction forces to the main bearing and the torque to the gearbox. The hub structure also supports blade bearings and pitch cylinder.

Hub	
Type	Cast ball shell hub
Material	Cast iron

Table 2-6: Hub data

2.6 Main Shaft

The main shaft transfers the reaction forces to the main bearing and the torque to the gearbox.

Main Shaft	
Type Description	Hollow shaft
Material	Cast iron

Table 2-7: Main shaft data

2.7 Main Bearing Housing

The main bearing housing covers the main bearing and is the first connection point for the drive train system to the bedplate.

Main Bearing Housing	
Material	Cast iron

Table 2-8: Main bearing housing data

2.8 Main Bearing

The main bearing carries all thrust loads.

Main Bearing	
Type	Double-row spherical roller bearing
Lubrication	Automatic grease lubrication

Table 2-9: Main bearing data

2.9 Gearbox

The main gear converts the low-speed rotation of the rotor to high-speed generator rotation.

The disc brake is mounted on the high-speed shaft. The gearbox lubrication system is a pressure-fed system.

Gearbox	
Type	Planetary stages + one helical stage
Gear House Material	Cast

Gearbox	
Lubrication System	Pressure oil lubrication
Backup Lubrication System	Oil sump filled from external gravity tank
Total Gear Oil Volume	1000-1200
Oil Cleanliness Codes	ISO 4406-/15/12
Shaft Seals	Labyrinth

Table 2-10: Gearbox data

2.10 Generator Bearings

The bearings are grease lubricated and grease is supplied continuously from an automatic lubrication unit.

2.11 High-Speed Shaft Coupling

The coupling transmits the torque of the gearbox high-speed output shaft to the generator input shaft.

The coupling consists of two 4-link laminate packages and a fibreglass intermediate tube with two metal flanges. The coupling is fitted to two-armed hubs on the brake disc and the generator hub.

2.12 Yaw System

The yaw system is an active system based on a robust pre-tensioned plain yaw-bearing concept with PETP as friction material.

The yaw gears have a torque limiter.

Yaw System	
Type	Plain bearing system
Material	Forged yaw ring heat-treated. Plain bearings PETP
Yawing Speed (50 Hz)	0.46°/sec.
Yawing Speed (60 Hz)	0.6°/sec.

Table 2-11: Yaw system data

Yaw Gear	
Type	Multiple stages geared
Ratio Total	944:1
Rotational Speed at Full Load	1.4 rpm at output shaft

Table 2-12: Yaw gear data

2.13 Crane

The nacelle houses the internal safe working load (SWL) service crane. The crane is a single system hoist.

Crane	
Lifting Capacity	Maximum 800 kg

Table 2-13: Crane data

2.14 Towers

Tubular towers with flange connections, certified according to relevant type approvals, are available in different standard heights. The towers are designed with the majority of internal welded connections replaced by magnet supports to create a predominantly smooth-walled tower. Magnets provide load support in a horizontal direction and internals, such as platforms, ladders, etc., are supported vertically (i.e. in the gravitational direction) by a mechanical connection. The smooth tower design reduces the required steel thickness, rendering the tower lighter compared to one with all internals welded to the tower shells.

The hub heights listed include a distance from the foundation section to the ground level of approximately 0.2 m depending on the thickness of the bottom flange and a distance from the tower top flange to the centre of the hub of 2.2 m.

Towers	
Type	Cylindrical/conical tubular
Hub Heights	84 m/94 m/119 m/140 m
Hub Heights (North America)	84 m/94 m
Material	

Table 2-14: Tower structure data

2.15 Nacelle Bedplate and Cover

The nacelle cover is made of fibreglass. Hatches are positioned in the floor for lowering or hoisting equipment to the nacelle and evacuation of personnel. The roof section is equipped with wind sensors and skylights. The skylights can be opened from both inside the nacelle to access the roof and from outside to access the nacelle. Access from the tower to the nacelle is through the yaw system.

The nacelle bedplate is in two parts and consists of a cast iron front part and a girder structure rear part. The front of the nacelle bedplate is the foundation for the drive train and transmits forces from the rotor to the tower through the yaw system. The bottom surface is machined and connected to the yaw bearing and the yaw gears are bolted to the front nacelle bedplate.

The crane girders are attached to the top structure. The lower beams of the girder structure are connected at the rear end. The rear part of the bedplate serves as the foundation for controller panels, the cooling system and transformer. The nacelle cover is mounted on the nacelle bedplate.

Type Description	Material
Nacelle Cover	GRP
Bedplate Front	Cast iron
Bedplate Rear	Girder structure

Table 2-15: Nacelle bedplate and cover data

2.16 Thermal Conditioning System

The thermal conditioning system consists of a few robust components:

- The Vestas CoolerTop® located on top of the rear end of the nacelle. The CoolerTop® is a free flow cooler, thus ensuring that there are no electrical components in the thermal conditioning system located outside the nacelle.
- The Liquid Cooling System, which serves the gearbox, hydraulic systems, generator and converter is driven by an electrical pumping system.
- The transformer forced air cooling comprised of an electrical fan.

2.16.1 Generator and Converter Cooling

The generator and converter cooling systems operate in parallel. A dynamic flow valve mounted in the generator cooling circuit divides the cooling liquid flow. The cooling liquid removes heat from the generator and converter unit using a free-air flow radiator placed on the top of the nacelle. In addition to the generator, converter unit and radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

2.16.2 Gearbox and Hydraulic Cooling

The gearbox and hydraulic cooling systems are coupled in parallel. A dynamic flow valve mounted in the gearbox cooling circuit divides the cooling flow. The cooling liquid removes heat from the gearbox and the hydraulic power unit through heat exchangers and a free-air flow radiator placed on the top of the nacelle. In addition to the heat exchangers and the radiator, the circulation system includes an electrical pump and a three-way thermostatic valve.

2.16.3 Transformer Cooling

The transformer is equipped with forced-air cooling. The ventilator system consists of a central fan, located below the service floor and an air duct leading the air to locations beneath and between the high voltage and low voltage windings of the transformer.

2.16.4 Nacelle Cooling

Hot air generated by mechanical and electrical equipment is removed from the nacelle by a fan system located in the nacelle.

3 Electrical Design

3.1 Generator

The generator is a three-phase synchronous generator with a permanent magnet rotor or a three phase asynchronous induction generator with cage rotor that is connected to the grid through a full scale converter.

The generator housing is built with a cylindrical jacket and channels. The channels circulate cooling liquid around the generator internal stator housing.

Generator	Alternative 1	Alternative 2
Type	Synchronous with permanent magnets	Asynchronous with cage rotor
Frequency [f_N]	0- 200 Hz	0-100 Hz
Voltage, Stator [U_{NS}]	3 x 710 V (at rated speed)	3 x 750 V (at rated speed)
Number of Poles	12	4/6
Winding Type	Form with VPI (Vacuum Pressurized Impregnation)	Form with VPI (Vacuum Pressurized Impregnation)
Winding Connection	Star	Star or Delta
Rated rpm	1450-1550 rpm	1450-1550 rpm
Overspeed Limit Acc. to IEC (2 minutes)	2400 rpm	2400 rpm
Generator Bearing	Hybrid/ceramic	Hybrid/ceramic
Temperature Sensors, Stator	3 PT100 sensors placed at hot spots and 3 as back-up	3 PT100 sensors placed at hot spots and 3 as back-up
Temperature Sensors, Bearings	1 per bearing	1 per bearing
Insulation Class	F or H	F or H
Enclosure	IP54	IP54

Table 3-1: Generator data

3.2 Converter

The converter is a full-scale converter system controlling both the generator and the power quality delivered to the grid.

The converter consists of multiple converter units operating in parallel with a common controller.

The converter controls conversion of variable frequency power from the generator into fixed frequency AC power with desired active and reactive power levels (and other grid connection parameters) suitable for the grid. The converter is located in the nacelle and has a grid side voltage rating of 650 V. The generator side voltage rating is up to 710 V dependent on generator speed.

Converter	
Rated Grid Voltage	650 V

Table 3-2: Converter data

3.3 HV Transformer

The step-up transformer is located in a separate locked room in the back of the nacelle.

The transformer is a three-phase, two-winding, dry-type transformer that is self-extinguishing. The windings are delta-connected on the high-voltage side unless otherwise specified.

3.1 IEC 50Hz/60Hz version

For 50Hz regions the transformer is as default designed according to IEC standards. However on special request, a 60Hz transformer based on IEC standards could also be delivered.

Transformer	
Type description	Dry-type cast resin transformer.
Basic layout	3 phase, 2 winding transformer.
Applied standards	IEC 60076-11, IEC 60076-16, Cenelec HD 637:S1.
Cooling method	AF
Rated power	3750 kVA
Nominal voltage, turbine side	
U_m 1.1kV	0.650 kV
Nominal voltage, grid side	
U_m 12.0kV	10.0-11.0 kV
U_m 24.0kV	11.1-22.0 kV
U_m 36.0kV	22.1-33.0 kV
U_m 41.5kV	33.1-35.0 kV
Insulation level AC / LI / LIC	
U_m 1.1kV	3^1 / - / - kV
U_m 12.0kV	28^1 / 75 / 75 kV
U_m 24.0kV	50^1 / 125 / 125 kV
U_m 36.0kV	70^1 / 170 / 170 kV
U_m 41.5kV	80^1 / 170 / 170 kV
Off-circuit tap changer	±2 x 2.5 %
Frequency	50 Hz / 60Hz
Vector group	Dyn5 / YNyn0
No-load loss [2]	5.3 kW
Load loss @ rated power HV, 120°C [2]	31.5 kW
No-load reactive power [3]	16kVAr
Full load reactive power [3]	330kVAr
Positive sequence short-circuit impedance @ rated power, 120°C [4]	8.7 %
Positive sequence short-circuit resistance@ rated power, 120°C[3]	0.7 %
Zero sequence short-circuit	8.7 %

impedance@ rated power, 120°C[3]	
Zero sequence short-circuit resistance@ rated power, 120°C[3]	0.7 %
Inrush peak current [3]	
Dyn5	6-9 x $\hat{I}_n$
YNyn0	8-12 x $\hat{I}_n$
Half crest time [3]	~ 0.7 s
Sound power level	≤ 80 dB(A)
Average temperature rise @ 1000m	≤80 K
Max altitude [5]	2000 m
Insulation class	155 (F)
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1
Corrosion class	C4
Weight	≤8500 kg
Temperature monitoring	PT100 sensors in LV windings and core
Overvoltage protection	Surge arresters on HV terminals
Temporary earthing	3 x Ø20mm earthing ball points

Table 3-3: Transformer data for IEC 50Hz/60Hzversion

NOTE

[1] @1000m. According to IEC 60076-11, AC test voltage is altitude dependent.
[2] Based on an average of measured values during qualification tests across voltages and manufacturers.
[3] Based on an average of calculated values across voltages and manufacturers.
[4] Subjected to standard IEC tolerances.
[5] Max hub height altitude will depend on site location.

3.2 IEEE 60Hz version

For 60Hz regions the transformer is as default designed mainly according to IEEE standards but on areas not covered by IEEE standards, the design is also based on parts of the IEC standards.

Transformer	
Type description	Dry-type cast resin transformer.
Basic layout	3 phase, 2 winding transformer.
Applied standards	UL 1562, CSA C22.2 No. 47, IEEE C57.12, IEC 60076-11, IEC 60076-16, Cenelec HD 637:S1.
Cooling method	AFA
Rated power	3750 kVA
Nominal voltage, turbine side	
N_{LL} 1.2 kV	0.650 kV
Nominal voltage, grid side	
N_{LL} 15.0 kV	10.0-15.0 kV
N_{LL} 25.0 kV	15.1-25.0 kV
N_{LL} 34.5 kV	25.1-34.5 kV

Insulation level AC / LI & LIC	
N_{LL} 1.2 kV	4[1] / +10 kV
N_{LL} 15.0 kV	34[1] / +95 kV
N_{LL} 25.0 kV	50[1] / +125 kV
N_{LL} 34.5 kV	70[1] / (+150 & -170) or +170 kV
Off-circuit tap changer	±2 x 2.5 %
Frequency	60 Hz
Vector group	Dyn5 / YNyn0
No-load loss [2]	5.3 kW
Load loss @ rated power HV, 120°C [2]	31.5 kW
No-load reactive power [3]	16 kVAr
Full load reactive power [3]	330 kVAr
Positive sequence short-circuit impedance @ rated power, 120°C [4]	8.7 %
Positive sequence short-circuit resistance @ rated power, 120°C [3]	0.7 %
Zero sequence short-circuit impedance @ rated power, 120°C [3]	8.7 %
Zero sequence short-circuit resistance @ rated power, 120°C [3]	0.7 %
Inrush peak current [3]	
Dyn5	6-9 x $\hat{I}_n$
YNyn0	8-12 x $\hat{I}_n$
Half crest time [3]	~ 0.7 s
Sound power level	≤ 80 dB(A)
Average temperature rise @ 1000m	≤ 80 K
Max altitude [5]	2000 m
Insulation class	150°C
Environmental class	E2
Climatic class	C2
Fire behaviour class	F1
Corrosion class	C4
Weight	≤ 8500 kg
Temperature monitoring	PT100 sensors in LV windings and core
Overvoltage protection	Surge arresters on HV terminals
Temporary earthing	3 x Ø20mm earthing ball points

Table 3-4: Transformer data for IEEE 60Hz version

NOTE

[1] @1000m. According to IEEE C57.12, AC test voltage is altitude dependent.
[2] Based on an average of measured values during qualification tests across voltages and manufacturers.
[3] Based on an average of calculated values across voltages and manufacturers.
[4] Subjected to standard IEEE C57.12 tolerances.
[5] Max hub height altitude will depend on site location.

3.4 HV Cables

The high voltage cable runs from the transformer in the nacelle down the tower to the switchgear located at the bottom of the tower. The high voltage cable is a four-core, rubber-insulated, halogen-free, high voltage cable.

HV Cables	
High Voltage Cable Insulation Compound	Improved ethylene-propylene (EP) based material-EPR or high modulus or hard grade ethylene-propylene rubber-HEPR
Conductor Cross Section	3 x 70 / 70 mm^2
Maximum Voltage	24 kV for 10-22 kV rated voltage 42 kV for 22.1-35 kV rated voltage

Table 3-5: HV cables data

3.5 HV Switchgear

The high voltage switchgear is located in the bottom of the tower.

HV Switchgear			
Type	Gas insulated SF6		
Nominal Frequency	50/60 Hz		
Nominal Rated Voltage	10–22 kV	22.1–33 kV	33.1–35 kV
Maximum Voltage	24 kV	36 kV	40.5 kV
Maximum Short Circuit Current (1 second)	20 kA	25 kA	25 kA

Table 3-6: HV switchgear data

3.6 AUX System

The AUX system is supplied from a separate 650/400 V transformer located in the nacelle. All motors, pumps, fans and heaters are supplied from this system.

All 230 V consumers are supplied from a 400/230 V transformer located in the tower base.

Power Sockets	
Single Phase (Nacelle and Tower Platforms)	230 V (16 A)/110 V (16 A)/ 2 x 55 V (16 A)
Three Phase (Nacelle and Tower Base)	3 x 400 V (16 A)

Table 3-7: AUX system data.

3.7 Wind Sensors

The turbine is either equipped with two ultrasonic wind sensors or one ultrasonic wind sensor and one mechanical wind vane and anemometer. The sensors have built-in heaters to minimise interference from ice and snow. The wind sensors are redundant, and the turbine is able to operate with one sensor only.

3.8 Vestas Multi Processor (VMP) Controller

The turbine is controlled and monitored by the VMP6000 control system.

VMP6000 is a multiprocessor control system comprised of four main processors (ground, nacelle, hub and converter) interconnected by an optically based 2.5 Mbit ArcNet network.

In addition to the four main processors, the VMP6000 consists of a number of distributed I/O modules interconnected by a 500 kbit CAN network.

I/O modules are connected to CAN interface modules by a serial digital bus, CTBus.

The VMP6000 controller serves the following main functions:

- Monitoring and supervision of overall operation.
- Synchronizing of the generator to the grid during connection sequence.
- Operating the wind turbine during various fault situations.
- Automatic yawing of the nacelle.
- OptiTip® - blade pitch control.
- Reactive power control and variable speed operation.
- Noise emission control.
- Monitoring of ambient conditions.
- Monitoring of the grid.
- Monitoring of the smoke detection system.

3.9 Uninterruptible Power Supply (UPS)

The UPS is equipped with an AC/DC, DC/AC converter (double conversions) and battery cells placed in the same cabinet as the converter. During grid outage, the UPS will supply specific components with 230 V AC.

The backup time for the UPS system is proportional to the power consumption. Actual backup time may vary.

UPS						
Battery Type	Valve-Regulated Lead Acid (VRLA)					
Rated Battery Voltage	2 x 8 x 12 V (192 V)					
Converter Type	Double conversion					
Converter Input	230 V +/-20%					
Rated Output Voltage	230 Vac					
Backup Time**	**Aviation Lights**		**0 hr.**	**1 hr.**	**8 hrs.**	**>8 hrs.**
	Control System*	**15 min.**	1 EXB	1 EXB	3 EXB	4 EXB (max. 630min.)
		1 hr.	1 EXB	3 EXB	4 EXB	N.A.
		2 hrs.	2 EXB	3 EXB	4 EXB	N.A.
		3 hrs.	3 EXB	4 EXB	N.A.	N.A.
		>3 hrs.	4 EXB (max. 230min.)	N.A.	N.A.	N.A.
Re-charging Time	80%		Approximately 3 hours			
	100%		Approximately 8 hours			

Table 3-8: UPS data

N.A. = desired back-up time not possible

EXB = optional extra battery pack.

**The control system includes: the turbine controller (System 6000), switchgear functions, and remote control system. Internal lights are fed by separate built-in batteries in light armatures.*

NOTE ** For alternative backup times, consult Vestas.

4 Turbine Protection Systems

4.1 Braking Concept

The main brake on the turbine is aerodynamic. Braking the turbine is done by full feathering the three blades (individually turning each blade). Each blade has a hydraulic accumulator to supply power for turning the blade.

In addition, there is a mechanical disc brake on the high-speed shaft of the gearbox with a dedicated hydraulic system. The mechanical brake is only used as a parking brake and when activating the emergency stop push buttons.

4.2 Short Circuit Protections

Breakers	**Breaker for Aux. Power.** **T4L 250A TMD 4P** **690 V**	**Breaker for Converter Modules** **T7M1200L PR332/P LSIG 1000 A 3P** **690 V**
Breaking Capacity, Icu, Ics	70 kA@690 V	50 kA @690 V
Making Capacity, Icm	154 kA@690 V	105 kA @690 V

Table 4-1: Short circuit protection data

4.3 Overspeed Protection

The generator rpm and the main shaft rpm are registered by inductive sensors and calculated by the wind turbine controller to protect against overspeed and rotating errors.

In addition, the turbine is equipped with a safety PLC, an independent computer module that measures the rotor rpm. In case of an overspeed situation, the safety PLC activates the emergency feathered position (full feathering) of the three blades independently of the turbine controller.

Overspeed Protection	
Sensors Type	Inductive
Trip Level	17.66 (rotor rpm)/2000 (generator RPM)

Table 4-3: Overspeed protection data

4.4 Lightning Protection of Blades, Nacelle, Hub and Tower

The Lightning Protection System (LPS) helps protect the wind turbine against the physical damage caused by lightning strikes. The LPS consists of five main parts:

- Lightning receptors.
- Down conducting system (a system to conduct the lightning current down through the wind turbine to help avoid or minimise damage to the LPS itself or other parts of the wind turbine).

- Protection against over-voltage and over-current.
- Shielding against magnetic and electrical fields.
- Earthing system.

Lightning Protection Design Parameters			Protection Level I
Current Peak Value	i_{max}	[kA]	200
Impulse Charge	$Q_{impulse}$	[C]	100
Long Duration Charge	Q_{long}	[C]	200
Total Charge	Q_{total}	[C]	300
Specific Energy	W/R	[MJ/Ω]	10
Average Steepness	di/dt	[kA/μs]	200

Table 4-4: Lightning protection design parameters

NOTE The Lightning Protection System is designed according to IEC standards (see 7 Approvals and Design Codes, p. 22).

4.5 EMC System

The turbine and related equipment fulfils the EU Electromagnetic Compatibility (EMC) legislation:

- DIRECTIVE 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC.

4.6 Earthing

The Vestas Earthing System consists of a number of individual earthing electrodes interconnected as one joint earthing system.

The Vestas Earthing System includes the TN-system and the Lightning Protection System for each wind turbine. It works as an earthing system for the medium voltage distribution system within the wind farm.

The Vestas Earthing System is adapted for the different types of turbine foundations. A separate set of documents describe the earthing system in detail, depending on the type of foundation.

In terms of lightning protection of the wind turbine, Vestas has no separate requirements for a certain minimum resistance to remote earth (measured in ohms) for this system. The earthing for the lightning protection system is based on the design and construction of the Vestas Earthing System.

A primary part of the Vestas Earthing System is the main earth bonding bar placed where all cables enter the wind turbine. All earthing electrodes are connected to this main earth bonding bar. Additionally, equipotential connections are made to all cables entering or leaving the wind turbine.

Requirements in the Vestas Earthing System specifications and work descriptions are minimum requirements from Vestas and IEC. Local and national requirements, as well as project requirements, may require additional measures.

4.7 Corrosion Protection

Classification of corrosion protection is according to ISO 12944-2.

Corrosion Protection	External Areas	Internal Areas
Nacelle	C5	Minimum C3
Hub	C5	C3
Tower	C4	C3

Table 4-5: Corrosion protection data for nacelle, hub and tower

5 Safety

The safety specifications in this section provide limited general information about the safety features of the turbine and are not a substitute for Buyer and its agents taking all appropriate safety precautions, including but not limited to (a) complying with all applicable safety, operation, maintenance, and service agreements, instructions, and requirements, (b) complying with all safety-related laws, regulations, and ordinances, and (c) conducting all appropriate safety training and education.

5.1 Access

Access to the turbine from the outside is through the bottom of the tower. The door is equipped with a lock. Access to the top platform in the tower is by a ladder or service lift. Access to the nacelle from the top platform is by ladder. Access to the transformer room in the nacelle is controlled with a lock. Unauthorised access to electrical switchboards and power panels in the turbine is prohibited according to IEC 60204-1 2006.

5.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch, from the spinner by opening the nose cone, or from the roof of the nacelle. Rescue equipment is placed in the nacelle.

The hatch in the roof can be opened from both the inside and outside.

Escape from the service lift is by ladder.

An emergency response plan, placed in the turbine, describes evacuation and escape routes.

5.3 Rooms/Working Areas

The tower and nacelle are equipped with power sockets for electrical tools for service and maintenance of the turbine.

5.4 Floors, Platforms, Standing and Working Places

All floors have anti-slip surfaces.

There is one floor per tower section.

Rest platforms are provided at intervals of 9 metres along the tower ladder between platforms.

Foot supports are placed in the turbine for maintenance and service purposes.

5.5 Service Lift

The V112-3.3 MW turbine is delivered optionally with a service lift installed.

5.6 Climbing Facilities

A ladder with a fall arrest system (rigid rail) is mounted through the tower.

There are anchor points in the tower, nacelle and hub, and on the roof for attaching fall arrest equipment (full body harness).

Over the crane hatch there is an anchor point for the emergency descent equipment.

Anchor points are coloured yellow and are calculated and tested to 22.2 kN.

5.7 Moving Parts, Guards and Blocking Devices

All moving parts in the nacelle are shielded.

The turbine is equipped with a rotor lock to block the rotor and drive train.

Blocking the pitch of the cylinder can be done with mechanical tools in the hub.

5.8 Lights

The turbine is equipped with lights in the tower, nacelle, transformer room and hub.

There is emergency light in case of the loss of electrical power.

5.9 Emergency Stop

There are emergency stop push buttons in the nacelle, hub and bottom of the tower.

5.10 Power Disconnection

The turbine is equipped with breakers to allow for disconnection from all power sources during inspection or maintenance. The switches are marked with signs and are located in the nacelle and bottom of the tower.

5.11 Fire Protection/First Aid

A handheld 5-6 kg CO_2 fire extinguisher, first aid kit and fire blanket are required to be located in the nacelle during service and maintenance.

- A handheld 5-6 kg CO_2 fire extinguisher is required only during service and maintenance activities, unless a permanently mounted fire extinguisher located in the nacelle is mandatorily required by authorities.
- First aid kits are required only during service and maintenance activities.
- Fire blankets are required only during non-electrical hot work activities.

5.12 Warning Signs

Warning signs placed inside or on the turbine must be reviewed before operating or servicing the turbine.

5.13 Manuals and Warnings

The Vestas Corporate OH&S Manual and manuals for operation, maintenance and service of the turbine provide additional safety rules and information for operating, servicing or maintaining the turbine.

6 Environment

6.1 Chemicals

Chemicals used in the turbine are evaluated according to the Vestas Wind Systems A/S Environmental System certified according to ISO 14001:2004. The following chemicals are used in the turbine:

- Anti-freeze to help prevent the cooling system from freezing.
- Gear oil for lubricating the gearbox.
- Hydraulic oil to pitch the blades and operate the brake.
- Grease to lubricate bearings.
- Various cleaning agents and chemicals for maintenance of the turbine.

7 Approvals and Design Codes

7.1 Type Approvals

The standard turbine is type certified according to the certification standards listed below:

Certification	Wind Class	Hub Height
IEC61400-22	IEC IIA	84 m / 94 m
DIBt Anlage 2.7/10	DIBt III	84 m / 94 m

Table 7-1: Type approvals data

7.2 Design Codes – Structural Design

The turbine design has been developed and tested with regard to, but not limited to, the following main standards:

Design Codes	
Nacelle and Hub	IEC 61400-1 Edition 3 EN 50308
Tower	IEC 61400-1 Edition 3 Eurocode 3
Blades	DNV-OS-J102 IEC 1024-1 IEC 60721-2-4 IEC 61400 (Part 1, 12 and 23) IEC WT 01 IEC DEFU R25 ISO 2813 DS/EN ISO 12944-2
Gearbox	ISO 81400-4
Generator	IEC 60034
Transformer	IEC 60076-11, IEC 60076-16, CENELEC HD637 S1
Lightning Protection	IEC 62305-1: 2006 IEC 62305-3: 2006 IEC 62305-4: 2006 IEC/TR 61400-24:2002
Rotating Electrical Machines	IEC 34
Safety of Machinery, Safety-related Parts of Control Systems	IEC 13849-1
Safety of Machinery – Electrical Equipment of Machines	IEC 60204-1

Table 7-2: Design codes

8 Colours

8.1 Nacelle Colour

Colour of Vestas Nacelles	
Standard Nacelle Colour	RAL 7035 (light grey)
Standard Logo	Vestas

Table 8-1: Colour, nacelle

8.2 Tower Colour

Colour of Vestas Tower Section		
	External:	**Internal:**
Standard Tower Colour	RAL 7035 (light grey)	RAL 9001 (cream white)

Table 8-2: Colour, tower

8.3 Blades Colour

Blades Colour	
Standard Blade Colour	RAL 7035 (light grey)
Tip-End Colour Variants	RAL 2009 (traffic orange), RAL 3020 (traffic red)
Gloss	< 30% DS/EN ISO 2813

Table 8-3: Colour, blades

9 Operational Envelope and Performance Guidelines

Actual climate and site conditions have many variables and should be considered in evaluating actual turbine performance. The design and operating parameters set forth in this section do not constitute warranties, guarantees, or representations as to turbine performance at actual sites.

9.1 Climate and Site Conditions

Values refer to hub height:

Extreme Design Parameters	
Wind Climate	**IEC IIA**
Ambient Temperature Interval (Standard Temperature Turbine)	-40° to +50°C
Extreme Wind Speed (10 Minute Average)	42.5 m/s
Survival Wind Speed (3 Second Gust)	59.5 m/s

Table 9-1: Extreme design parameters

Average Design Parameters	
Wind Climate	**IEC IIA**
Wind Speed	8.5 m/s
A-Factor	9.59 m/s
Form Factor, c	2.0

Average Design Parameters	
Wind Climate	**IEC IIA**
Turbulence Intensity According to IEC 61400-1, Including Wind Farm Turbulence (@15 m/s – 90% quartile)	18%
Wind Shear	0.20
Inflow Angle (vertical)	8°

Table 9-2: Average design parameters

9.1.1 Complex Terrain

Classification of complex terrain according to IEC 61400-1:2005 Chapter 11.2.

For sites classified as complex, appropriate measures are to be included in site assessment.

Positioning of each turbine must be verified via the Vestas Site Check programme.

9.1.2 Altitude

The turbine is designed for use at altitudes up to 1000 m above sea level as standard and optional up to 2000 m above sea level.

9.1.3 Wind Power Plant Layout

Turbine spacing is to be evaluated site-specifically. Spacing, in any case, must not be below three rotor diameters (3D).

NOTE As evaluation of climate and site conditions is complex, consult Vestas for every project. If conditions exceed the above parameters, Vestas must be consulted.

9.2 Operational Envelope – Temperature and Wind

Values refer to hub height and are determined by the sensors and control system of the turbine.

Operational Envelope – Temperature and Wind	
Ambient Temperature Interval (Standard Turbine)	-20° to +45°C
Ambient Temperature Interval (Low Temperature Turbine)	-30° to +45°C
Cut-In	3 m/s
Cut-Out (10 Minute Exponential Average)	25 m/s
Re-Cut In (10 Minute Exponential Average)	23 m/s

Table 9-3: Operational envelope – temperature and wind

NOTE At ambient temperatures above +30°C, the turbine will maintain derated production, within the component capacity as seen in figure 9-1 page 26.

The wind turbine will stop producing power at ambient temperatures above 45°C.

For the Low temperature options of the wind turbine, consult 'Vestas'.

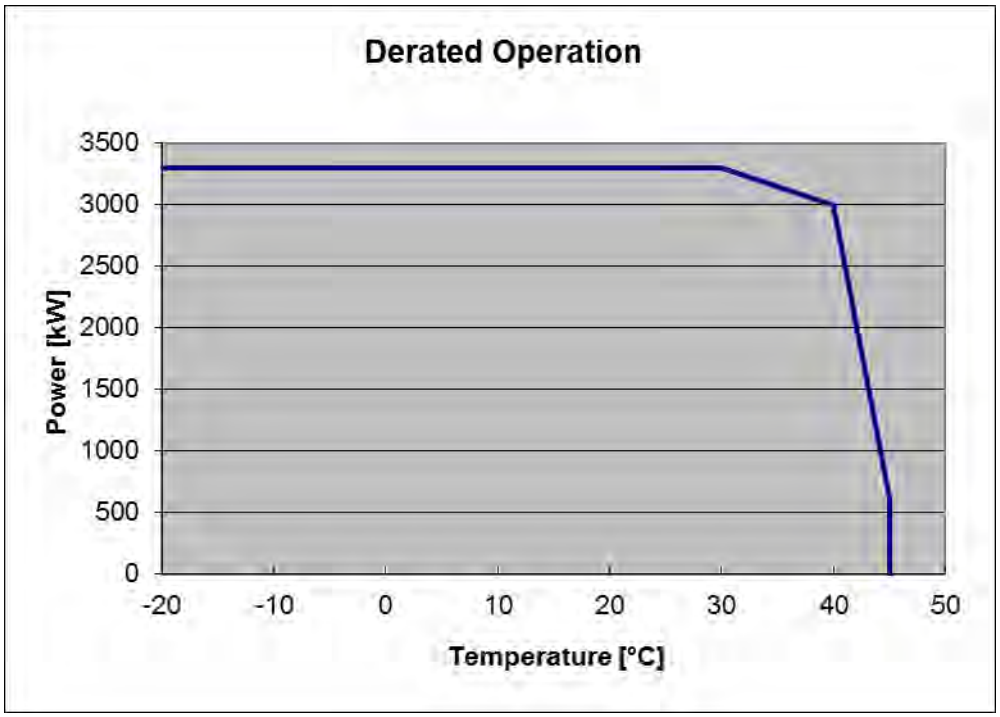

Figure 9-1: Derated Operation

9.3 Operational Envelope – Grid Connection

Operational Envelope – Grid Connection		
Nominal Phase Voltage	[U_{NP}]	650 V
Nominal Frequency	[f_N]	50/60 Hz
Maximum Steady State Voltage Jump	±2% (from turbine) ±4% (from grid)	
Maximum Frequency Gradient	±4 Hz/sec.	
Maximum Negative Sequence Voltage	3% (connection) 2% (operation)	
Minimum Required Short Circuit Ratio at Turbine HV Connection	5.0	
Maximum Short Circuit Current Contribution	1.05 p.u. (continuous) 1.45 p.u. (peak)	

Table 9-4: Operational envelope – grid connection

The generator and the converter will be disconnected if*:

Protection Settings	
Voltage Above 110% of Nominal for 3600 Seconds	715 V
Voltage Above 121% of Nominal for 2 Seconds	787 V
Voltage Above 136% of Nominal for 0.150 Seconds	884 V
Voltage Below 90% of Nominal for 60 Seconds	585 V
Voltage Below 80% of Nominal for 10 Seconds	520 V
Frequency is Above 106% of Nominal for 0.2 Seconds	53/63.6 Hz
Frequency is Below 94% of Nominal for 0.2 Seconds	47/56.4 Hz

Table 9-5: Generator and converter disconnecting values

NOTE * Over the turbine lifetime, grid drop-outs are to occur at an average of no more than 50 times a year.

9.4 Operational Envelope – Reactive Power Capability

The turbine has a reactive power capability as illustrated:

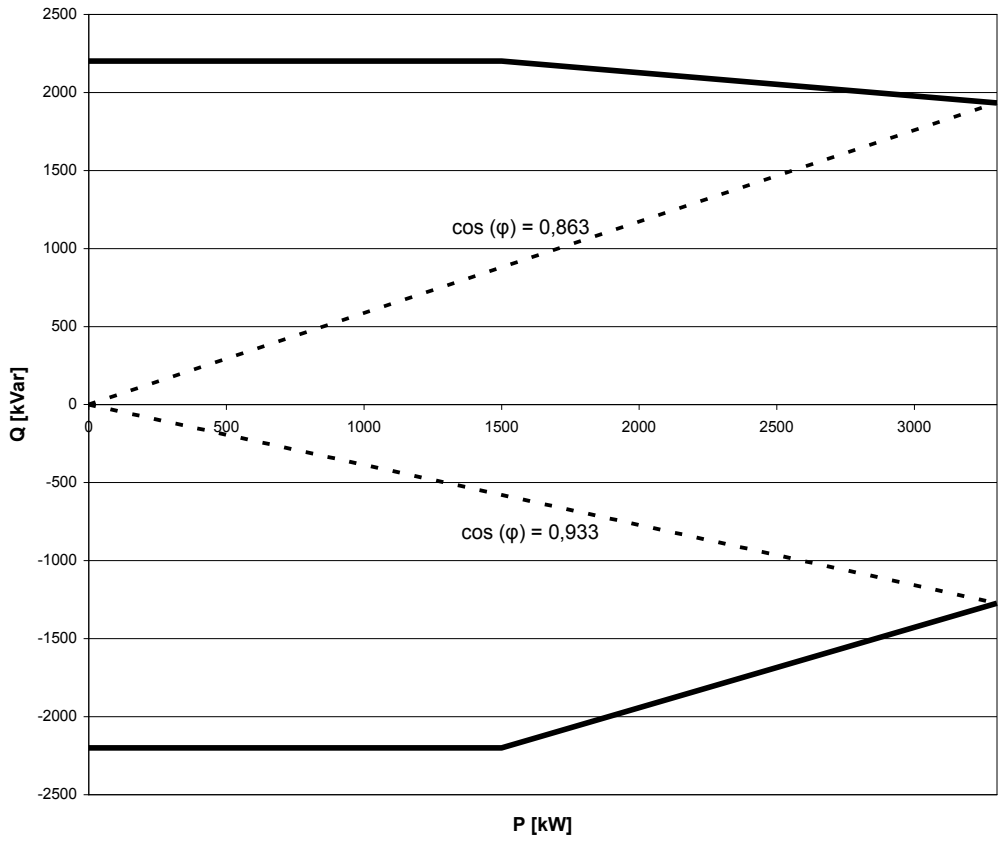

Figure 9-2: Reactive power capability

The above chart applies at the low voltage side of the HV transformer at nominal voltage ±10% and nominal frequency ±6%.

Reactive power capability at full load on high voltage side of the HV transformer is approximately cosφ = 0.90/0.90 capacitive/inductive.

Reactive power is produced by the full-scale converter. Traditional capacitors are, therefore, not used in the turbine.

The turbine is able to maintain the reactive power capability at low wind with no active power production.

9.5 Performance – Fault Ride Through

The turbine is equipped with a full-scale converter to gain better control of the wind turbine during grid faults. The turbine control system continues to run during grid faults.

The turbine is designed to stay connected during grid disturbances within the voltage tolerance curve as illustrated:

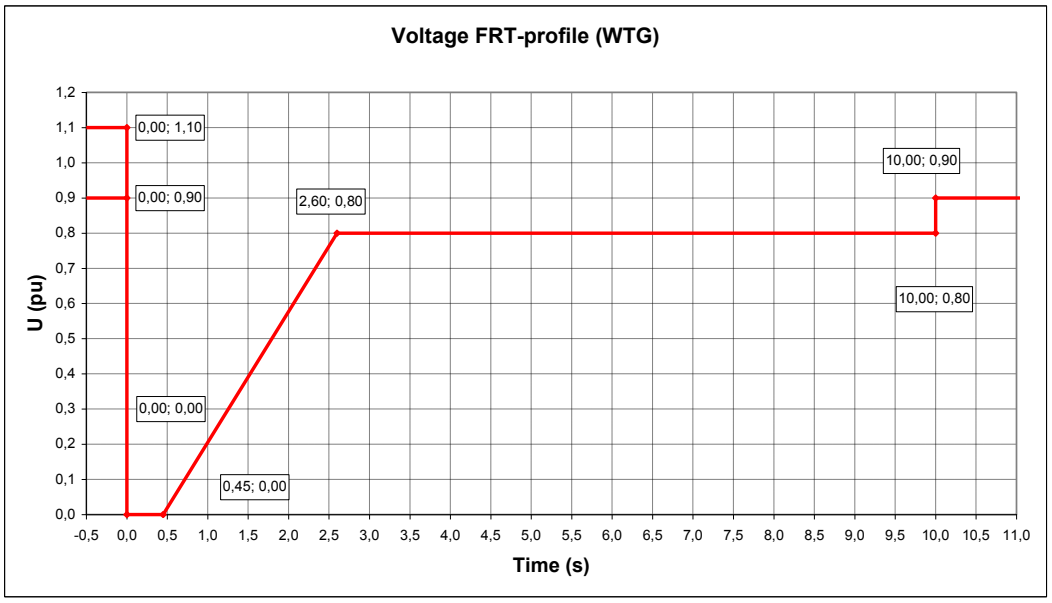

Figure 9-3: Low voltage tolerance curve for symmetrical and asymmetrical faults, where U represents voltage as measured on the grid

For grid disturbances outside the protection curve in Figure 9-, p. 28 the turbine will be disconnected from the grid.

Power Recovery Time	
Power Recovery to 90% of Pre-Fault Level	Maximum 0.1 seconds

Table 9-6: Power recovery time

9.6 Performance – Reactive Current Contribution

The reactive current contribution depends on whether the fault applied to the turbine is symmetrical or asymmetrical.

9.6.1 Symmetrical Reactive Current Contribution

During symmetrical voltage dips, the wind farm will inject reactive current to support the grid voltage. The reactive current injected is a function of the measured grid voltage.

The default value gives a reactive current part of 1 pu of the rated active current at the high voltage side of the HV transformer. Figure 9-, p. 29 indicates the reactive current contribution as a function of the voltage. The reactive current contribution is independent from the actual wind conditions and pre-fault power level.

As seen in Figure 9-, p. 29, the default current injection slope is 2% reactive current increase per 1% voltage decrease. The slope can be parameterized between 0 and 10 to adapt to site specific requirements.

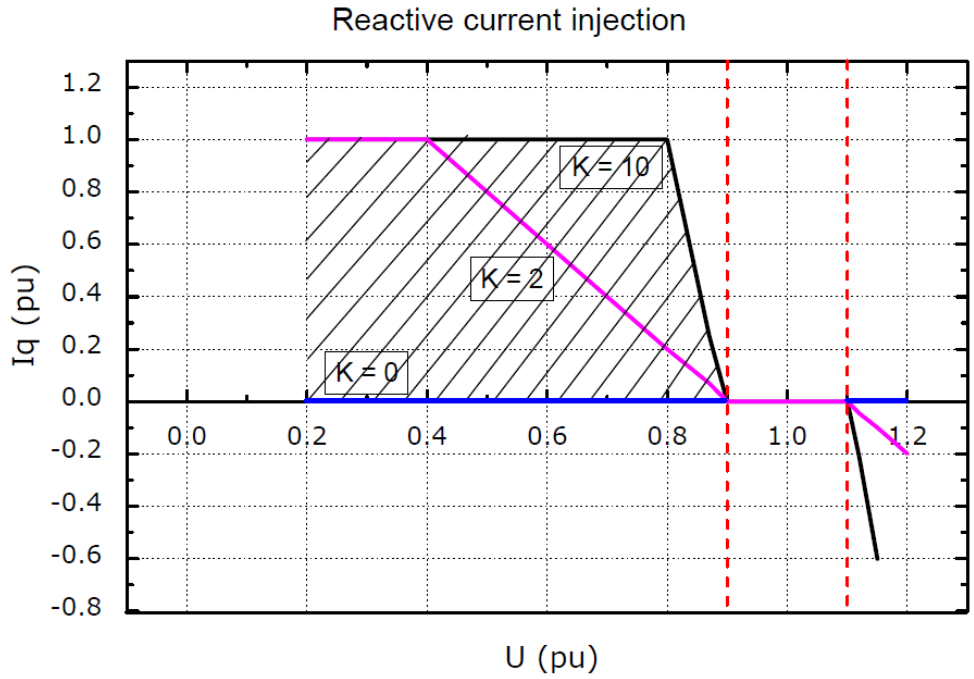

Figure 9-4: Reactive current injection

9.6.2 Asymmetrical Reactive Current Contribution

The injected current is based on the measured positive sequence voltage and the used K-factor. During asymmetrical voltage dips, the reactive current injection is limited to approximate 0.4 pu to limit the potential voltage increase on the healthy phases.

9.7 Performance – Multiple Voltage Dips

The turbine is designed to handle re-closure events and multiple voltage dips within a short period of time due to the fact that voltage dips are not evenly

distributed during the year. For example, the turbine is designed to handle 10 voltage dips of duration of 200 ms, down to 20% voltage, within 30 minutes.

9.8 Performance – Active and Reactive Power Control

The turbine is designed for control of active and reactive power via the VestasOnline® SCADA system.

Maximum Ramp Rates for External Control	
Active Power	0.1 pu/sec (330 kW/sec)
Reactive Power	20 pu/sec (66 MVAr/sec)

Table 9-7: Active/reactive power ramp rates

To support grid stability the turbine is capable to stay connected to the grid at active power references down to 10 % of nominal power for the turbine. For active power references below 10 % the turbine may disconnect from the grid.

9.9 Performance – Voltage Control

The turbine is designed for integration with VestasOnline® voltage control by utilising the turbine reactive power capability.

9.10 Performance – Frequency Control

The turbine can be configured to perform frequency control by decreasing the output power as a linear function of the grid frequency (over frequency).

Dead band and slope for the frequency control function are configurable.

9.11 Main Contributors to Own Consumption

The consumption of electrical power by the wind turbine is defined as the power used by the wind turbine when it is not providing energy to the grid. This is defined in the control system as Production Generator 0 (zero).The following components have the largest influence on the own consumption of the wind turbine (the average own consumption depends on the actual conditions, the climate, the wind turbine output, the cut-off hours, etc.):

Main contributors to **Own Consumption**	
Hydraulic Motor	2 x 15 kW (master/slave)
Yaw Motors	Maximum 18 kW in total
Water Heating	10 kW
Water Pumps	2.2 + 5.5 kW
Oil Heating	7.9 kW
Oil Pump for Gearbox Lubrication	10 kW
Controller Including Heating Elements for the Hydraulics and all Controllers	Approximately 3 kW

Main contributors to **Own Consumption**	
HV Transformer No-load Loss	See section 3.3 HV Transformer, p. 12

Table 9-8: Main contributors to own consumption data

9.12 Operational Envelope – Conditions for Power Curve and Ct Values (at Hub Height)

Consult section 12 Appendices, p. 35 for power curves and C_t values.

Conditions for Power Curve and C_t Values (at Hub Height)	
Wind Shear	0.00-0.30 (10 minute average)
Turbulence Intensity	6-12% (10 minute average)
Blades	Clean
Rain	No
Ice/Snow on Blades	No
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 ±2°
Grid Frequency	Nominal Frequency ±0.5 Hz

Table 9-9: Conditions for power curve and C_t values

9.13 Noise Modes

The noise modes listed in Table 9-10, below are available for the V112-3.3 MW turbine.

Available Noise Modes for V112-3.3 MW		
Mode No.	**Mode Name**	**Maximum Noise Level**
0	Optimised Power	106.5 dB
2	Maximum 104.5 dB	104.5 dB
3	Maximum 102.5 dB	102.5 dB
4	Maximum 101.0 dB	101.0 dB
5	DK Noise Mode	105.5 dB

Table 9-10: Available noise modes

The noise modes are available for the hub heights listed in table tower structure data in section 2.14 Towers, p. 9, except for noise mode 4 with is not available for hub height 119 m.

For further details on Noise Modes, see section 12 Appendices, p35, or contact Vestas Wind Systems A/S

10 Drawings

10.1 Structural Design – Illustration of Outer Dimensions

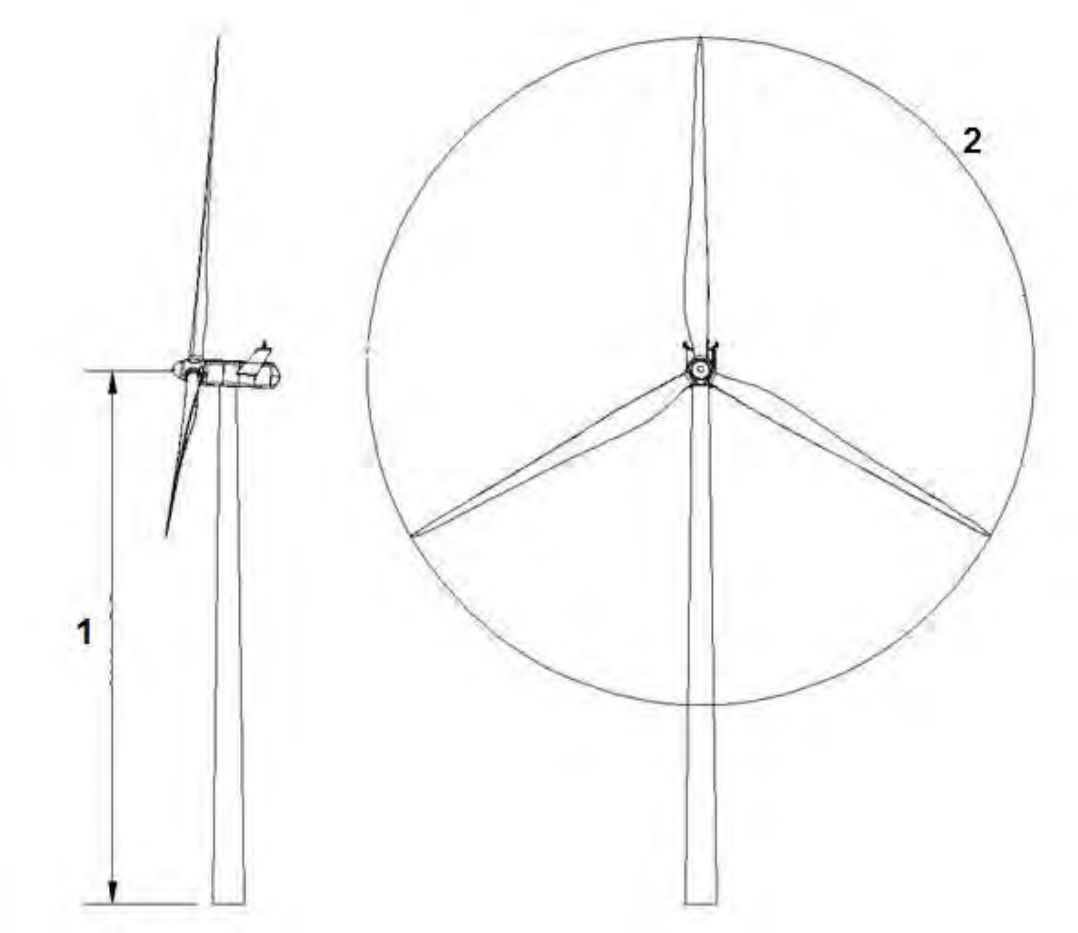

Figure 10-1: Illustration of outer dimensions – structure

1 Hub height 84/94/119/140 m **2** Diameter: 112 m

10.2 Structural Design – Side View Drawing

Figure 10-2: Side-view drawing

11 General Reservations, Notes and Disclaimers

- The general specifications described in this document apply to the current version of the V112-3.3 MW wind turbine. Updated versions of the V112-3.3 MW wind turbine, which may be manufactured in the future, may differ from these general specifications. In the event that Vestas supplies an updated version of the V112-3.3 MW wind turbine, Vestas will provide an updated general specification applicable to the updated version.
- Vestas recommends that the grid be as close to nominal as possible with limited variation in frequency and voltage.
- A certain time allowance for turbine warm-up must be expected following grid dropout and/or periods of very low ambient temperature.
- All listed start/stop parameters (e. g. wind speeds and temperatures) are equipped with hysteresis control. This can, in certain borderline situations, result in turbine stops even though the ambient conditions are within the listed operation parameters.

- The earthing system must comply with the minimum requirements from Vestas, and be in accordance with local and national requirements and codes of standards.
- This document, General Specification, is not an offer for sale, and does not contain any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method). Any guarantee, warranty and/or verification of the power curve and noise (including, without limitation, the power curve and noise verification method) must be agreed to separately in writing.

12 Appendices

12.1 Mode 0, "Optimised Power"

12.1.1 Power Curves, Noise Mode 0, "Optimised Power"

Air density [kg/m^3]														
Wind speed [m/s]	**1.225**	**0.95**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3.0	**23**	9	10	12	13	14	15	17	18	19	21	22	25	26
3.5	**72**	44	47	49	52	54	57	59	62	64	67	69	74	77
4.0	**133**	92	96	100	103	107	111	114	118	122	126	129	137	141
4.5	**208**	151	156	161	167	172	177	182	187	193	198	203	213	219
5.0	**302**	223	230	238	245	252	259	266	274	281	288	295	309	317
5.5	**417**	312	321	331	340	350	359	369	378	388	398	407	426	436
6.0	**555**	418	431	443	456	468	480	493	505	517	530	542	567	579
6.5	**718**	545	560	576	592	608	623	639	655	671	686	702	734	749
7.0	**911**	694	714	733	753	773	792	812	832	851	871	891	930	950
7.5	**1131**	864	888	912	936	961	985	1009	1034	1058	1082	1107	1155	1179
8.0	**1382**	1058	1087	1117	1147	1176	1206	1235	1265	1294	1324	1353	1411	1441
8.5	**1663**	1277	1312	1348	1383	1418	1453	1488	1523	1559	1593	1628	1698	1732
9.0	**1969**	1519	1560	1602	1643	1684	1725	1766	1807	1848	1888	1929	2009	2048
9.5	**2277**	1776	1823	1870	1917	1964	2009	2054	2100	2145	2189	2233	2320	2362
10.0	**2570**	2038	2088	2139	2190	2242	2290	2338	2386	2434	2479	2525	2613	2657
10.5	**2832**	2287	2341	2395	2448	2502	2551	2601	2650	2699	2744	2788	2872	2911
11.0	**3034**	2519	2573	2628	2683	2737	2783	2830	2876	2922	2959	2996	3064	3095
11.5	**3178**	2731	2784	2837	2890	2944	2982	3021	3060	3099	3125	3151	3197	3217
12.0	**3258**	2921	2967	3013	3059	3105	3132	3159	3186	3213	3228	3243	3266	3275
12.5	**3290**	3076	3110	3144	3177	3212	3226	3241	3256	3271	3277	3283	3292	3295
13.0	**3298**	3186	3206	3226	3247	3268	3274	3280	3287	3293	3295	3297	3299	3299
13.5	**3299**	3238	3249	3260	3272	3283	3286	3289	3292	3296	3297	3298	3299	3300
14.0	**3300**	3273	3278	3284	3289	3294	3296	3297	3298	3299	3300	3300	3300	3300
14.5	**3300**	3289	3291	3294	3296	3299	3299	3299	3300	3300	3300	3300	3300	3300
15.0	**3300**	3296	3297	3298	3299	3300	3300	3300	3300	3300	3300	3300	3300	3300
15.5	**3300**	3298	3299	3299	3299	3300	3300	3300	3300	3300	3300	3300	3300	3300
16.0	**3300**	3299	3299	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
16.5	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
17.0	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
17.5	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
18.0	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
18.5	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
19.0	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
19.5	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
20.0	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
20.5	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
21.0	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
21.5	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
22.0	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
22.5	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
23.0	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
23.5	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
24.0	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
24.5	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
25.0	**3300**	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300

Table 12-1: Power curve, noise mode 0

12.1.2 C_t Values, Noise Mode 0, "Optimised Power"

Air density kg/m^3														
Wind speed [m/s]	**1.225**	**0.950**	**0.975**	**1.0**	**1.025**	**1.05**	**1.075**	**1.1**	**1.125**	**1.15**	**1.175**	**1.2**	**1.25**	**1.275**
3.0	**0.912**	0.915	0.915	0.914	0.914	0.914	0.913	0.913	0.913	0.912	0.912	0.912	0.911	0.911
3.5	**0.865**	0.867	0.867	0.867	0.867	0.866	0.866	0.866	0.866	0.865	0.865	0.865	0.865	0.864
4.0	**0.822**	0.824	0.824	0.824	0.824	0.824	0.823	0.823	0.823	0.823	0.823	0.823	0.822	0.822
4.5	**0.808**	0.810	0.810	0.809	0.809	0.809	0.809	0.809	0.808	0.808	0.808	0.808	0.807	0.807
5.0	**0.804**	0.807	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.804	0.804	0.804	0.803	0.803
5.5	**0.803**	0.806	0.806	0.806	0.805	0.805	0.805	0.805	0.804	0.804	0.804	0.803	0.803	0.802
6.0	**0.799**	0.804	0.804	0.803	0.803	0.802	0.802	0.801	0.801	0.801	0.800	0.800	0.799	0.798
6.5	**0.795**	0.801	0.800	0.800	0.799	0.799	0.798	0.798	0.797	0.797	0.796	0.796	0.795	0.794
7.0	**0.790**	0.797	0.796	0.796	0.795	0.795	0.794	0.793	0.793	0.792	0.791	0.791	0.789	0.789
7.5	**0.785**	0.793	0.793	0.792	0.791	0.791	0.790	0.789	0.788	0.788	0.787	0.786	0.784	0.784
8.0	**0.783**	0.792	0.792	0.791	0.790	0.789	0.788	0.787	0.787	0.786	0.785	0.784	0.782	0.781
8.5	**0.783**	0.794	0.793	0.792	0.791	0.790	0.789	0.788	0.787	0.786	0.785	0.784	0.782	0.781
9.0	**0.775**	0.792	0.791	0.790	0.789	0.788	0.786	0.784	0.783	0.781	0.779	0.777	0.773	0.770
9.5	**0.744**	0.778	0.776	0.774	0.771	0.769	0.766	0.762	0.759	0.756	0.752	0.748	0.739	0.735
10.0	**0.689**	0.743	0.739	0.735	0.731	0.727	0.722	0.717	0.711	0.706	0.701	0.695	0.684	0.678
10.5	**0.627**	0.692	0.687	0.682	0.676	0.671	0.665	0.659	0.653	0.647	0.640	0.634	0.620	0.613
11.0	**0.562**	0.637	0.631	0.625	0.619	0.613	0.606	0.599	0.592	0.585	0.577	0.570	0.554	0.546
11.5	**0.498**	0.585	0.579	0.572	0.565	0.559	0.550	0.542	0.534	0.525	0.516	0.507	0.489	0.480
12.0	**0.437**	0.537	0.529	0.521	0.512	0.504	0.495	0.485	0.475	0.466	0.456	0.446	0.427	0.418
12.5	**0.380**	0.489	0.479	0.469	0.460	0.450	0.439	0.429	0.419	0.409	0.399	0.390	0.371	0.363
13.0	**0.332**	0.440	0.429	0.418	0.408	0.397	0.387	0.377	0.367	0.357	0.349	0.340	0.324	0.317
13.5	**0.293**	0.392	0.381	0.371	0.360	0.350	0.341	0.333	0.324	0.315	0.308	0.301	0.287	0.280
14.0	**0.260**	0.348	0.338	0.329	0.319	0.309	0.302	0.294	0.287	0.279	0.273	0.266	0.254	0.249
14.5	**0.232**	0.309	0.300	0.292	0.284	0.275	0.268	0.262	0.255	0.248	0.243	0.237	0.227	0.222
15.0	**0.207**	0.274	0.267	0.259	0.252	0.245	0.239	0.233	0.227	0.221	0.217	0.212	0.203	0.199
15.5	**0.187**	0.246	0.239	0.233	0.227	0.220	0.215	0.210	0.205	0.200	0.195	0.191	0.183	0.180
16.0	**0.170**	0.222	0.216	0.210	0.205	0.199	0.194	0.190	0.185	0.181	0.177	0.173	0.166	0.163
16.5	**0.154**	0.201	0.196	0.191	0.186	0.181	0.177	0.173	0.169	0.164	0.161	0.158	0.151	0.148
17.0	**0.141**	0.183	0.178	0.174	0.169	0.165	0.161	0.158	0.154	0.150	0.147	0.144	0.138	0.136
17.5	**0.129**	0.167	0.163	0.159	0.155	0.151	0.148	0.144	0.141	0.138	0.135	0.132	0.127	0.125
18.0	**0.119**	0.153	0.150	0.146	0.142	0.139	0.136	0.133	0.130	0.127	0.124	0.122	0.117	0.115
18.5	**0.110**	0.141	0.138	0.135	0.131	0.128	0.125	0.122	0.120	0.117	0.115	0.112	0.108	0.106
19.0	**0.101**	0.130	0.127	0.123	0.120	0.117	0.115	0.112	0.110	0.107	0.105	0.103	0.099	0.097
19.5	**0.094**	0.120	0.117	0.114	0.112	0.109	0.106	0.104	0.102	0.100	0.098	0.096	0.092	0.091
20.0	**0.087**	0.111	0.109	0.106	0.104	0.101	0.099	0.097	0.095	0.093	0.091	0.089	0.086	0.084
20.5	**0.081**	0.103	0.101	0.099	0.096	0.094	0.092	0.090	0.088	0.086	0.085	0.083	0.080	0.079
21.0	**0.076**	0.096	0.094	0.092	0.090	0.088	0.086	0.084	0.082	0.081	0.079	0.078	0.075	0.073
21.5	**0.072**	0.091	0.089	0.087	0.085	0.083	0.081	0.079	0.078	0.076	0.075	0.073	0.071	0.069
22.0	**0.067**	0.085	0.083	0.081	0.079	0.077	0.076	0.074	0.073	0.071	0.070	0.069	0.066	0.065
22.5	**0.063**	0.080	0.078	0.076	0.074	0.073	0.071	0.070	0.068	0.067	0.066	0.064	0.062	0.061
23.0	**0.059**	0.075	0.073	0.071	0.070	0.068	0.067	0.065	0.064	0.063	0.061	0.060	0.058	0.057
23.5	**0.056**	0.070	0.069	0.067	0.066	0.064	0.063	0.061	0.060	0.059	0.058	0.057	0.055	0.054
24.0	**0.053**	0.066	0.065	0.063	0.062	0.060	0.059	0.058	0.057	0.056	0.055	0.054	0.052	0.051
24.5	**0.050**	0.062	0.061	0.060	0.058	0.057	0.056	0.055	0.054	0.053	0.052	0.051	0.049	0.048
25.0	**0.047**	0.059	0.058	0.056	0.055	0.054	0.053	0.052	0.051	0.050	0.049	0.048	0.046	0.046

Table 12-2: C_t values, noise mode 0

12.1.3 Noise Curves, Noise Mode 0, "Optimised Power"

Sound Power Level at Hub Height, Noise Mode 0		
Conditions for Sound Power Level:	**Measurement standard IEC 61400-11 ed. 2 2002** **Wind shear: 0.16** **Maximum turbulence at 10 metre height: 16%** **Inflow angle (vertical): 0 ±2°** **Air density: 1.225 kg/m^3**	
Hub Height	**84 m**	**94 m**
LwA @ 3 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	94.4 4.2	94.5 4.3
LwA @ 4 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	97.2 5.6	97.5 5.7
LwA @ 5 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	100.8 7.0	101.2 7.2
LwA @ 6 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	104.4 8.4	104.7 8.6
LwA @ 7 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 9.8	106.5 10.0
LwA @ 8 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 11.2	106.5 11.4
LwA @ 9 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 12.7	106.5 12.9
LwA @ 10 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 14.1	106.5 14.3
LwA @ 11 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 15.5	106.5 15.7
LwA @ 12 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 16.9	106.5 17.2
LwA @ 13 m/s (10 m above ground) [dBA] Wind speed at hub height [m/s]	106.5 18.3	106.5 18.6

Table 12-3: Noise curves, noise mode 0

LandWorks

Landscape Architecture

Planning

Graphic Design

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Memo

To: Josh Bagnato

Date: 11-7-13

Company: First Wind

No. of Pages: 1

Address:

From: David Raphael

Re: Turbine model change

Project: Bingham Wind

❑ attachment/enclosure

This memo is in response to a request to review a change in the turbine model for the proposed Bingham Wind Project. The model used in conducting the Visual Impact Assessment submitted in April 2013 was a Vestas V112-3.0 with a hub height of 94 meters and a rotor diameter of 112 meters, and a total maximum turbine height of 150 meters. The new turbine model being considered is a Vestas V112-3.3, which has the same dimensions as the V112-3.0 (hub of 94 meters and rotor of 112 meters). Because there is no change in the height or dimensions of the turbine being considered, the conclusions expressed in the Visual Impact Assessment from April 2013 remain the same.

Copies to:

LandWorks

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Planning

Graphic Design

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Memo

To: Josh Bagnato

Date: 10-28-13

Company: First Wind

No. of Pages: 1

Address:

From: David Raphael

Re: Gen-Lead Amendment

Project: Bingham Wind

❑ attachment/enclosure

This memo is in response to a request to review some minor design changes in the Generator Lead Line for the Bingham Wind Project in Somerset County, Maine.

The first section that is being revised is between structures #1 and #6 as provided for in Drawing #782-13-1300, dated 7/31/13, as prepared by SGC Engineering for the Bingham Wind Project. The reason provided for the change, as set forth in the "Alternate Design" and noted on the drawings, was "to provide additional ground clearance, which includes shorter spans to reduce wire sag and slightly taller poles."

There are three additional structures at 80 feet high. Original structures #4 and #6 increase by 5 feet each.

The second section that is being revised is between structures 39 and 47 as provided for in Drawing #782-13-1301, dated 9/24/13, as prepared by SGC Engineering for the Bingham Wind Project. Pole heights in this section were increased for ground clearance as well, and the number of structures reduced from 9 to 6.

Pole heights for structures 40, 42, 44, and 46 have been increased in height from the original 75' height to 85', 110', 125' and 110' respectively.

The resource of state or national significance that we are charged to review impacts from is the Piscataquis River. In both instances, the pole height increases do not substantively change the line or structure visibility. Based on the combination of field reconnaissance, aerial photographic interpretation, and desktop analysis, we do not believe the line, with the proposed changes will be readily visible, or visible to any extent that would have any potential impact to users of the river for recreational or scenic interest. This lack of visibility or impact is based on the fact that the river is situated below the surrounding landscape and river banks coupled with the existence of extensive and continuous river bank vegetation. The orientation of the river is not directly in line with the Generator Lead Line corridor, further diminishing the potential for visibility or visual impact. Finally, given that the first section of the line is 3/4 mile from the river and the second section being revised is over 1.5 miles from the river, it also likely that the distance alone would diminish the visual "presence" of the line and corridor to river users/viewers.

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