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Redatto da:	Verificato da:	Approvato da:
Federico Pagliacci	-	Davide Trevisani

Committente: **TREVI Energy S.p.A**
Via Larga, 201 – 47522 CESENA (FC)

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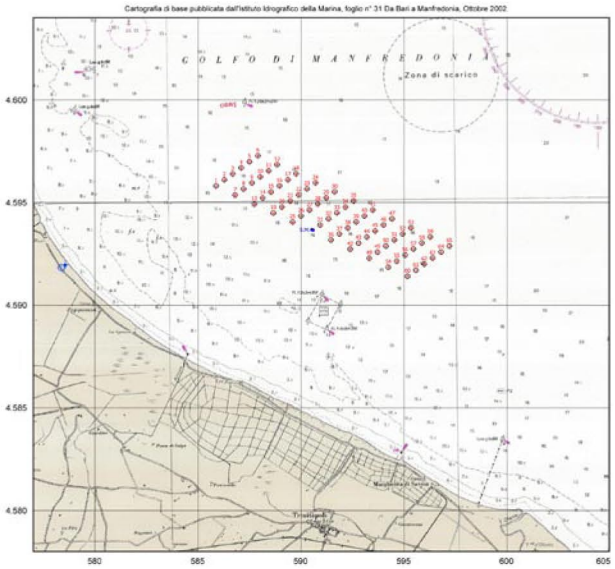

Redattore: **Trevi Energy SpA**
Via Larga, 201
47522 Cesena (FC)

Ing. Fedrico Pagliacci

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Lista degli Allegati.

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Autore: Vestas Wind Systems AS.

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Preliminary Foundation Loads V112 – 3.0 MW HH84, IEC2A 50 Hz

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2009-09-24

General Specification V112-3.0MW IEC IIA

Table of Contents

1 INTRODUCTION

1.1 Purpose of Document

This document provides all the general specification information for the following equipment as supplied by Vestas Wind System A/S (VWS):

Preliminary Version
Please note that this document is a preliminary version and is subject to change without notice

Description
V112-3.0MW Wind Turbine Generator

This document is not, 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.

1.1.1 Copyright Notice

1.2 Contact Addresses

1.2.1 Head Office

Vestas Wind System A/S
Alsvej 21
8940 Randers SV
Denmark
+45 9730 5000

1.3 Symbols and Conventions

1.3.1 In this document

The following words and symbols found throughout this manual alert the operator to specific information relating to Personnel, the Equipment or the Process.

Clarifying information or specific instructions relevant to the immediate instruction.

1.4 Abbreviations

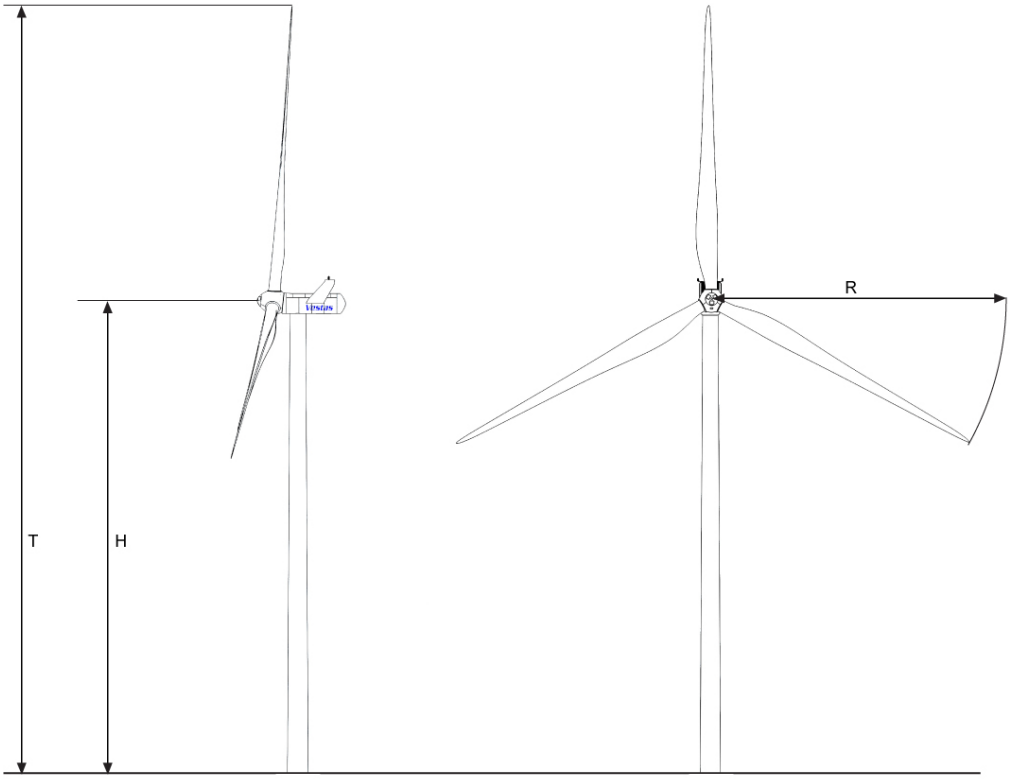
The following abbreviations have been used in this manual:

Abbreviation	Description
AUX	Auxilliary
C_P	Power Coefficient
C_T	Thrust Coefficient
DIBt	Deutsches Institut für Bautechnik
HH	Hub Height
HV	High Voltage
I/O	Input/Output
IEC	International Electrotechnical Commission
LPZ	Lightning Protection Zone
LT	Low Temperature
LV	Low Voltage
L_{wA}	Apparent Sound Power Level
RPM	Revolutions Per Minute
SCADA	Supervisory Control And Data Acquisition
SWL	Safe Working Load
TBA	To Be Advised
UPS	Uninterruptible Power Supply
VMP	Vestas Multi Processor
VWS	Vestas Wind System

2 GENERAL DESCRIPTION

2.1 Turbine Description

The Vestas V112-3.0 MW Wind Turbine Generator is a pitch regulated upwind turbine with an active yaw system and a three-blade rotor. The turbine has a rotor diameter of 112 m with a generator rated at 3.0 MW. The turbine utilizes a microprocessor pitch control system called OptiTip® and the GridStreamer® full scale conversion for variable speed operation. Concepts which enables the turbine to operate the rotor at variable speed (i.e. variable RPM), thus maintaining the output at or near rated power.



V112-3.0 MW

T	Tip Height	H	Hub Height
R	Radius		

2.2 Turbine Data

Item	Description		
Type	V-112 3.0 MW IEC class II A		
Tip Heights	140m	150 m	175 m
Hub Heights (HHs)	84 m	94 m	119 m
DIBt	-	2	2
Radius	56 m		
Nominal Output	3.0 MW		

3 MECHANICAL DESIGN

3.1 Rotor Description

The Rotor consists of the Hub and three Blades. Based on the prevailing wind conditions, the blades are continuously positioned to help optimise the pitch angle

3.2 Rotor Data

Item	Description
Diameter	112 m
Swept Area	9852 m^2
Rotor Speed Ranges	
Low Speed Shaft	4.4 to 17.7 rpm
Nominal Rotor Speed Low Speed Shaft	12.8 rpm
High Speed Shaft	510 to 2000 rpm
Rotational Direction	Clockwise (front view)
Orientation	Upwind
Tilt	6°
Blade Coning	1.0°
Number of Blades	3
Aerodynamic Brakes	3

3.3 Blades Description

The blades are made of carbon and fibre glass and consist of two airfoil shells bonded to a supporting spar.

3.4 Blades Data

Item	Description
Type	Airfoil shells bonded to a supporting beam
Length (each)	54.65 m
Shadowing Length (each)	50.40 m
Material	Fibre glass reinforced epoxy and carbon fibres
Maximum chord	4 m

3.5 Blade Bearings Data

Item	Description
Type	Double row 4-point ball bearing

3.6 Pitch System Description

The turbine is equipped with a hydraulic 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 with the 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.

3.7 Pitch System Data

Item	Data
Type	Hydraulic
Cylinder	Ø125/80 – 922, 1 per blade

3.8 Hub Description

The Hub supports the 3 Blades and transfers the reaction forces from the Blades to the Main Bearing. The Hub structure also supports the Blade Bearings and Pitch Cylinder(s).

3.9 Hub Data

Item	Description
Type	Cast ball shell hub
Material	Cast iron

3.10 Nacelle Description

The nacelle is constructed as a load carrying inner structure onto which equipment, such as gear, generator and transformer, accessories and external nacelle parts are mounted.

The nacelle is a modular design that is optimised for transport and is made up of a front and a rear part and covered in a glasfibre shell.

3.11 Nacelle Data

Item	Data
Overall Weight	150000 kg
Overall Dimensions (HxWxL)	3.7 m x 3.9 x 13 m

3.12 Main Shaft Description

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

3.13 Main Bearing Housing Description

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

3.14 Main Bearing Description

The main bearing carries all thrust loads and is grease lubricated through an automatic lubrication system.

3.15 Gearbox Description

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

The gearbox is a four stage differential gearbox where the first 3 stages are planetary stages and the 4th is a helical stage.

3.16 Gearbox Data

Item	Data
Type	Differential gearbox
Ratio (50 Hz & 60 Hz)	1:113.2
Mechanical Power	3.3 MW
Weight	Approx. 26700 kg
Lubrication	
- Type	Pressure oil lubrication
- Temperature control	>30 °C – oil sump < 30 °C – dry sump
Maximum Oil Flow	250 l/min
Maximum Operational Oil Sump Temperature	55 ºC
Oil Cleanliness Codes	ISO 4406 -/15/12
Oil Volume in system	Approx. 1200 l
Shaft Seal	Labyrinth

3.17 High Speed Shaft Coupling Description

The generator is linked to the output shaft of the gear by a high speed coupling that transmits the torque to the generator.

Coupling and shaft are screened for safety reasons and protected from accidental contact.

3.18 High Speed Shaft Coupling Data

Item	Data
Type	Flexible composite coupling

3.19 Yaw System Description

The yaw system is an active system based on a robust spring pretensioned plain bearing concept with PETP as friction material. The bearing friction is damping nacelle movements both when yawing and when parked.

The yaw system is driven by 8 electrically powered yaw drives with torque limiters. The drives consist of 2 planetary stages and a worm drive. The worm drive is self-locking to prevent unintended yawing.

3.20 Yaw System Data

Item	Data
Type	Active with adjustable plain bearing

3.21 Crane Description

The internal nacelle service crane is designed to cover the internal work space and thus assist work to be done inside the turbine.

The service crane can, as an option, be upgraded to a higher SWL by adding accessories.

3.22 Crane Data

Item	Data
Type	Overhead travelling crane
Lifting Capacity	
- For normal service operation	990 kg
- With optional upgade	9500 kg

3.23 Tower Description

The tubular tower is made of sections with flange connections, certified according to the relevant type approvals, and available in different standard heights.

The individual sections are bolted together with flange joints. The bottom section is connected to the foundation a double bolt row T-flange in order to minimise the bolt dimensions that otherwise is an HSE issue.

Platforms, brackets, ladders, etc., are supported vertically (i.e. in the gravitational direction) by a mechanical connection. Horizontal support is provided by magnets as secondary support.

3.24 Tower Data

Item	Description		
Type	Tubular		
Material	Steel		
Hub Heights	84 m	94 m	119 m
Wind classes			
IEC	II A	II A	III A
DIBT	-	2	2
Maximum Diameter	4.176 m		
Foundation	Standard Gravity		
Grounding	Electrical Grounds System		

3.25 Thermal Conditioning System

3.25.1 Thermal Conditioning System General Description

The Thermal Conditioning System consists of a few, but robust, components:

- The Vestas cooler top located on top of the rear end of the Nacelle. The cooler top is a free flow cooler thus ensuring that there are no electrical components in the Thermal Conditioning System placed outside the Nacelle.
- Liquid cooling system I, which serves the Gear and Hydraulic systems and is driven by a single electrical pump.
- Liquid cooling system II, which serves the Generator and Converter systems and is driven by a single electrical pump.
- The Transformer cooling comprising an electrical blower.
- The Nacelle cooling comprising two electrical blowers.

3.25.2 Thermal Conditioning System General Data

Item	Cooler Type
Nacelle	Forced air
Rotor	Ambient air
Gear	Liquid
Generator	Liquid
Radiator on roof	Free flow air/water
Transformer	Forced air
Hydraulic unit	Liquid

3.25.3 Lubricating Oil Cooling Description

The gear lubrication system allows the gearbox to run in wet and dry sump mode.

The system is a two tank system with one tank above the wet sump level in the gearbox. This ensures that the gearbox runs in wet sump mode at grid loss/emergency mode, but in dry sump mode during production.

4 ELECTRICAL DESIGN

4.1 Generator Description

The generator is a 3-phase permanent magnet, synchronous generator, connected to the converter system via the stator.

The generator is air-to-water cooled with an internal and external cooling circuit. The external circuit is water cooled with controlled cooling water temperature.

The generator has 8-poles and is form wound on the stator. There are no windings on the rotor, instead permanent magnets are mounted to generate the magnetic field.

The generator is controlled by the converter via feedback from an encoder.

4.2 Transformer Description

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

The low voltage winding is star connected. The low voltage system from the generator via the converter is a TN-S system, the star point of the transformer is therefore directly connected to earth.

The Nacelle auxiliary power supply is supplied from a separate 650/400V transformer.

The Transformer is located in a separate locked room in the Nacelle with surge arresters mounted on the high voltage side of the Transformer.

4.3 Transformer Data

Item	Data
Type	Dry type
Primary Voltage	Various voltages from 10 to 35 kV
Rated Apparent Power	3350 kVA
Secondary Voltage 1	650 V
Rated Power 1 at 1000 V	3350 kVA
Vector Group	Dyn5 (Dyn11 or YNyn0)
Frequency	50 Hz (60 Hz)
HV-Tappings	+/-2*2.5%
Short Circuit Impedance	8%
Insulation Class	F (155°C)
Climate Class	C2
Environmental Class	E2
Fire Behaviour Class	F1

4.4 Converter Description

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

The converter consists of four converter units operating in parallel with a common controller. If a failure occurs in one of the parallel units, this unit is disconnected and the system continues to operate at de-rated power level.

The converter system is water cooled and connected to the general cooling system cooler top of the turbine.

4.5 Auxilliary System Description

The Auxilliary (AUX) System is connected to the main power system by the auxiliary transformer. The auxiliary transformer provides 400 V power to the turbine from the main power system which includes the main transformer, converter system, and generator.

The 400V power supply is distributed and controlled by a cabinet located in the nacelle. This control cabinet is in turn connected to the tower and hub cabinets.

The auxiliary system is the power supply for all equipment in the turbine that is not part of the main power system. This includes yaw drives, hydraulic pumps, cooling pumps and fans, heaters, lubrication pumps, the control system, the UPS, lights, and outlets.

4.6 Auxilliary System Data

Power Sockets

Item	Data
Single Phase	230 V AC / 13 A
Three Phase	400 V AC / 16 A

4.7 Wind Sensor Description

4.8 Wind Sensor Data

Item	Data
Type	
Operating Principle	
Heater Power Comsumption	

4.9 Turbine Controller Software Description

The Turbine Controller Software is the VMP Global™ program.

The Phoenix program main tasks are:

- Overall control of the turbine.

- Support to the service organisation in monitoring and troubleshooting the wind turbines locally (on site) and remotely.
- Provide data and commands to SCADA for remote control and data analysis.

4.10 VMP (Vestas Multi Processor) Controller

The turbine is controlled and monitored by the VMP6000 control system that is part of the VMP Global™ program.

VMP6000 is a multiprocessor control system comprised of 4 main processors, placed in the Tower, Nacelle, Hub and within the Converter) interconnected by an optical-based 10 Mbit ArcNet network.

In addition to the 4 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 in order to limit the inrush current.
- Operating the wind turbine during various situations.
- Automatic yawing of the nacelle.
- 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.

4.11 Uninterruptible Power Supply Description

The Uninterruptible Power Supply (UPS) consists of a 19” UPS rack and optional 19” rack batteries. The UPS is placed inside the Tower Control cabinet and maintains a continuous supply of electric power to the turbine control equipment by supplying power from batteries when the grid is not available.

5 TURBINE PROTECTION SYSTEMS

5.1 Braking Concept

5.1.1 Blade Braking

The main brake on the turbine is aerodynamic. Braking the turbine is done by full feathering the three blades (individual turning of each blade). Each blade has a hydraulic accumulator that suplies 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.

5.1.2 Gear Brake

A mechanical disc brake is fitted on the high speed shaft of the gearbox. The mechanical brake is only used as a parking brake and when activating the emergency stop push buttons. At an emergency stop the disc brake is used to bring the rotor to a complete stop.

5.2 Short Circuit Protection

Breakers	**Breaker for Aux. power Type: T4S 250 PR222DS/ PD LSIG 690V**	**Breakers for converter modules Type: T7H 1000 PR332/P LSIG 690 V**
Breaking Capacity, I_{cu} I_{cs}	 50 kA @ 690V 50 kA @ 690V	 42 kA @ 690 V 42 kA @ 690 V
Making Capacity, I_{cm}	52.5 kA @ 690 V	88.2 kA @ 690 V
L, Overload - Time delay t_1	100-250 A 3-18 S	400-1000 A 3-144 S
S, Short circuit - Time delay t_2	1.5-2.5 kA 0.3 S	0.6-10 kA 0.1-0.8 S
I, Short circuit - Instantaneous t_3	0.375-3 kA K	1.5-15 kA K
G, Earth fault - Time delay t_4	50-250 A 0.1-0.8 S	200-1000 A 0.1-0.8 S

5.3 Overspeed Protection

The turbine is equipped with an overspeed protection system, that functions independently of the turbine controller. This is to protect the turbine against an overspeed situation.

The overspeed protection system continuously monitors the RPM of the low speed rotor shaft and, in case of an overspeed situation, the protection system activates emergency feathering of the rotor independently of the turbine controller.

This protection function complies with the standard IEC 61400 – 1.

5.4 Lightning Protection System Description

The Lightning Protection System consists of three main parts:

- Lightning receptors.
- Down conducting system.
- Earthing system.

The Lightning Protection System is designed according to IEC 61400-24CD which is more specific compared to IEC 62305-1:2006 which is also complied. The IEC 61400-24CD is expected to change from Committee Draft version to an operative standard before the V112 release.

Lightning strikes are considered force majeure, i.e. damage caused by lightning strikes is not warranted by Vestas.

5.5 Lightning Protection System Data

Design Parameters			**Lightning 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
Steepness	di/dt	[kA/µs]	200

6 SAFETY

6.1 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 lift.

Access to the nacelle from the top platform is by ladder.

Access to the transformer room in the nacelle is equipped with a lock.

Unauthorized access to electrical switchboards and power panels in the turbine is prohibited according to IEC 60204-1 2006

6.2 Escape

In addition to the normal access routes, alternative escape routes from the nacelle are through the crane hatch or from the roof of the nacelle.

An anchorage point for the emergency descent equipment is located above the crane hatch.

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

Escape from the tower lift is by ladder.

6.3 Climbing Facilities

A ladder with a fall arrest system (rigid rail or wire system) is mounted inside the tower connecting the bottom of the tower with each of the tower section platforms and the top platform.

There is one platform per tower section.

Rest platforms are provided at intervals of 9 metres along the tower ladder between platforms in accordance with the EN 50308 standard.

There are anchorage points in the tower, nacelle, hub and on the roof for attaching a fall arrest harness. The anchorage points are coloured yellow, and are designed and tested to 22.2 kN in accordance with the ANZI Z359.1-2007 standard.

6.4 Working Areas

The working areas in the turbine comprises of the tower platforms, the rest platforms along the ladder and the nacelle floor.

The floors of the platforms and the nacelle are fitted with anti-slip surfaces.

Connection points for electrical tools are located on each of the tower platforms and inside the nacelle.

At various locations in the turbine additional foot supports are provided to facilitate maintenance and service work.

6.5 Protection of Moving Parts and Blocking Devices

Moving parts in the nacelle are shielded with guards.

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

It is possible to block the pitch cylinder with mechanical tools in the hub.

6.6 Lighting

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

In case the electrical power to these light fixtures is lost, self contained power supplies, located in each light fixture, provide emergency light.

6.7 Noise

When the turbine is out of operation for maintenance, the sound level inside the nacelle is below 80 dB(A).

In operating mode ear protection is required.

6.8 Emergency Stop and Power Disconnection

Emergency Stop

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

Power Disconnection

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

6.9 Fire Extinguisher, First Aid Kit and Fire Blankets

The turbine is equipped with the following fire fighting and first aid equipment:

- A 5 kg CO_2 fire extinguisher located in the nacelle.
- A fire blanket is located above the generator. This blanket can be used to put out small fires.
- A first aid kit is placed on the wall of the nacelle.

The location of the fire extinguisher and first aid kit, and how to use it, must be confirmed before operating the turbine.

7 ENVIRONMENT

7.1 Chemicals

Chemicals used in the turbine are evaluated according to VWS Environmental system which is certified according to ISO 14001:2004.

8 APPROVALS, CERTIFICATES AND DESIGN CODES

8.1 Type Approvals

The turbine is type certified according to the following certification standards:

Standard	Conditions	Hub Height
IEC 61400-22	IEC Class IIA	84 m, 94 m
	IEC Class IIIA	119 m
DIBt Anlage 2.7/10	DIBt 2	94 m, 119 m

8.2 Structural Design Codes

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

Item	Standard
Nacelle and Hub	IEC 61400-1 Edition 3
Bedframe	IEC 61400-1 Edition 3
Tower	IEC 61400-1 Edition 3

8.3 Mechanical Equipment Design Codes

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

Item	Standard
Gear	TBA
Blades	TBA

8.4 I/O Network System design Codes

Document no. 901795 General Conditions for Electronics in Wind Turbines serve as reference on data for performance criteria and test levels.

8.4.1 Environment

Item	Standard
Salt Mist Test	IEC 60068-2-52
Damp Heat, Cyclic	IEC 60068-2-30
Vibration Sinus	IEC 60068-2-6
Cold	IEC 60068-2-1
Enclosure	IEC 60529
Damp Heat, Steady State	IEC 60068-2-56
Vibration Random	IEC 60068-2-64

Item	Standard
Dry Heat	IEC 60068-2-2
Temperature Shock	IEC 60068-2-14
Free Fall	IEC 60068-2-32

8.4.2 EMC Tests

The WTG is subject to fulfil the EMC directive 2004/108/EC.

The WTG is due to its large size not suitable for normal EMC testing. Therefore, all sub-components in the WTG which contain electronic devices, and are covered by the EMC directive, have been tested and documented in a separate test report according to the standards below. Furthermore additional Vestas robustness requirements with regards to lightning protection zones and cable lenght apply.

Test	Standard
Immunity	EN 61000-6-2
	+ additional tests for equipment placed in LPZ 2
	+ additional tests for equipment placed in LPZ 1
	+ additional tests for equipment placed in LPZ 0B
	+ additional test for equipment with long cables
Emission	EN 61000-6-4 or EN 61000-6-3 or FCC part 15 (US)

Lightning Protection Zones (LPZs)
LPZ0B: areas where a "direct strike" is likely.
LPZ1: areas where equipment is mounted near lightning current pathways.
LPZ2: areas where equipment is protected against lightning current pathways.

A full scale WTG emission test according to EN 61000-6-4:2005 is measured on a representive type. Whereas the immunity of the fullscale WTG relies on the good engineering practices according to EMC, lightning protection and grounding.

Full documentation will apply when the WTG has bveen installed.

8.5 Lightning Protection System Design Codes

The Lightning System design is based on and complies with the following international standards and guidelines:

Item	Code
Lightning Protection Level	1
Design Standards	IEC 61400-24CD, Lightning protection of wind turbines
	IEC 62305-1: 2006, Protection against lightning – Part 1: General principles

Item	Code
	IEC 62305-3: 2006, Protection against lightning – Part 3: Physical damage to structures and life hazard.
	IEC 62305-4: 2006, Protection against lightning – Part 4: Electrical and electronic systems within structures.
Non Harmonized Standard and Technically Normative Documents	IEC/TR 61400-24:2002

8.6 Earthing System Design Codes

The Earthing System design is based on and complies with the following international standards and guidelines:

Item	Code
Design Standards	IEC 62305-1: 2006, Protection against lightning – Part 1: General principles
	IEC 62305-3: 2006, Protection against lightning – Part 3: Physical damage to structures and life hazard.
	IEC 62305-4: 2006, Protection against lightning – Part 4: Electrical and electronic systems within structures.
	IEC/TR 61400-24. First edition. 2002-07. Wind turbine generator systems - Part 24: Lightning protection.
	IEC 60364-5-54. Second edition 2002-06. Electrical installations of buildings - Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, protective conductors and protective bonding conductors.
	IEC 61936-1. First edition. 2002-10. Power installations exceeding 1kV a.c.- Part 1: Common rules.

9 COLOUR AND SURFACE TREATMENT

9.1 Nacelle Surface Treatment

Item	Standard
Colour	RAL 7035 (light grey)
Gloss	According to ISO 2813

9.2 Tower Surface Treatment

Item	Standard	
	External	Intermal
Colours	RAL 7035 (light grey)	RAL 9001 (cream white)
Gloss	50 to 80% UV resistant	Maximum 30%
Corrosion Class	C4	C3

9.3 Blades Surface Treatment

Item	Standard
Blade Colour	RAL 7035 (Light Grey)
Blade Tip Colour	RAL 2009 (Traffic Orange) RAL 3000 (Flame Red) RAL 3020 (Traffic Red)
Gloss	<=30, DS/ISO 2813

10 OPERATIONAL ENVELOPE AND PERFORMANCE GUIDELINES

Actual climatic and site conditions have many variables and must 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.

Because evaluation of climate and site conditions is complex always consult Vestas for every project. The positioning of each turbine will then be verified by means of the Vestas Site Check program.

10.1 Climate and Site Conditions

The following values refer to Hub Height.

Extreme Design Parameters

Wind Climate	IEC 2A
Ambient Temperature Interval	-40° to +50°C
Extreme Wind Speed (10 min. average)	42.5 m/s
Survival Wind Speed (3 sec. gust)	59.5 m/s

Average Design Parameters

Wind Climate	IEC 2A
Wind Speed	8.5 m/s
A-factor	9.59 m/s
Form Factor, c	2.0
Turbulence Intensity acc. to IEC 61400-1, including Wind Farm Turbulence (@15 m/s – 90% quantile)	18%
Wind Shear	0.20
Inflow Angle (vertical)	8°

Complex Terrain

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

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

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

Altitude

The turbine is designed for use at altitudes up to 1500 m above sea level as standard.

Above 1500 m special considerations must be taken regarding for example HV installations and cooling performance. Consult Vestas for further information.

Wind Farm Layout

Turbine spacing must be evaluated specifically for each site by means of the Vestas Site Check program.

Spacing, however, must be minimum five times the rotor diameter between turbines in the main wind direction and three times the rotor diameter between turbines perpendicular to the main wind direction.

10.2 Operational Envelope - Temperature and Wind

The following values refer to hub height and are as determined by the sensors and the turbine control system.

Item	Value
Ambient Temperature Ranges	
Normal Temperature	-20 °C to +40 °C
Low Temperature	-30 °C to +40 °C
Cut-in (10 min. average)	3 m/s
Cut-out (10 min. exponential average)	25 m/s
Re-cut in (10 min. exponential average)	23 m/s

10.3 Operational Envelope - Grid Connection

It is assumed that, over the turbine lifetime, grid drop-outs are to occur at an average of no more than 20 times a year.

The values refer to hub height and are as determined by the sensors and control system of the turbine.

Grid Connection Data	
Nominal Phase Voltage ($U_{P,\ nom}$)	400 V
Nominal Frequency (f_{nom})	50 Hz
Maximum steady state voltage jump	±2 %
Maximum frequency gradient	± 4 Hz/sec
Maximum negative sequence voltage	3 %

The generator and the converter will be disconnected if:

- Voltage is above 110 % of nominal for 60 seconds.
- Voltage is above 115 % of nominal for 2 seconds.

- Voltage is above 120 % of nominal for 0.08 seconds.
- Voltage is above 125 % of nominal for 0.005 seconds.
- Voltage is below 90 % of nominal for 60 seconds.
- Voltage is below 85 % of nominal for 11 seconds.
- Frequency is above 53 Hz for 0.2 seconds.
- Frequency is below 47 Hz for 0.2 seconds.

10.4 Operational Envelope - Ct Values, Sound Power Levels and Power Curve

The following conditions apply for the Ct Values, Sound Power Levels and Power Curve:

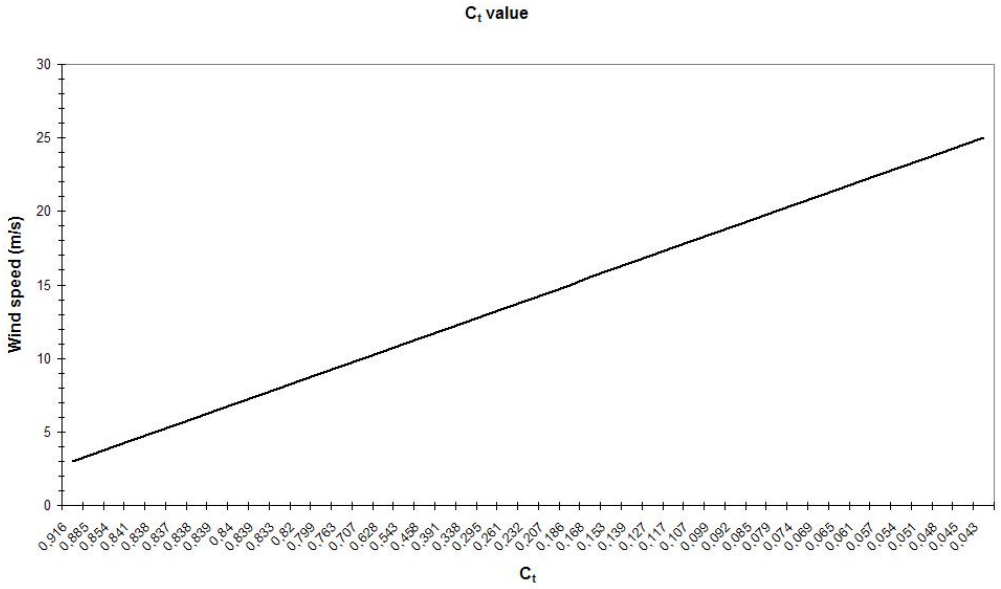
The values in the table below refer to Hub Height.

Item	Value
Wind Shear	0.10 - 0.16 (10 min. average)
Turbulence Intensity	8 - 12% (10 min. average)
Blades	Clean
Rain	Not present
Ice/Snow on Blades	Not present
Leading Edge	No damage
Terrain	IEC 61400-12-1
Inflow Angle (Vertical)	0 ± 2°
Grid Frequency	50 ± 0.5 Hz

10.4.1 Performance Ct Values

Wind Speed (m/s	C_t Mode 0
3	0.916
3.5	0.885
4	0.854
4.5	0.841
5	0.838
5.5	0.837
6	0.838
6.5	0.839
7	0.840
7.5	0.839
8	0.833
8.5	0.820
9	0.799
9.5	0.763

Wind Speed (m/s	C_t Mode 0
10	0.707
10.5	0.628
11	0.543
11.5	0.458
12	0.391
12.5	0.338
13	0.295
13.5	0.261
14	0.232
14.5	0.207
15	0.186
15.5	0.168
16	0.153
16.5	0.139
17	0.127
17.5	0.117
18	0.107
18.5	0.099
19	0.092
19.5	0.085
20	0.079
20.5	0.074
21	0.069
21.5	0.065
22	0.061
22.5	0.057
23	0.054
23.5	0.051
24	0.048
24.5	0.045
25	0.043



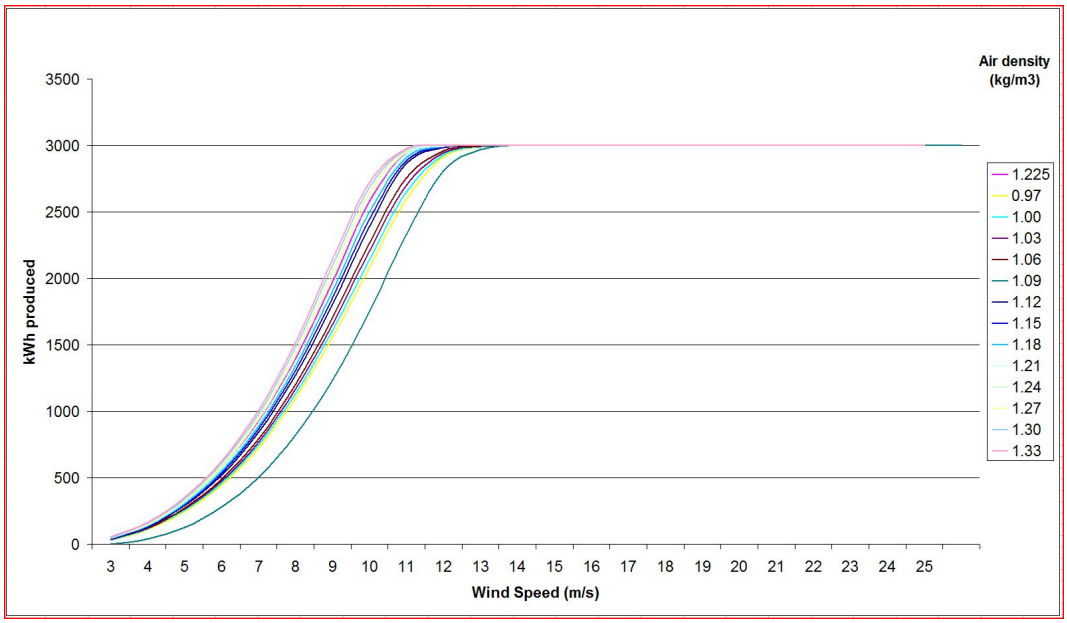
10.4.2 Sound Power Levels, Mode 0

Item	Value
Conditions for Sound Power Level	Measurement standard IEC 61400-11 ed. 2 2002 Wind shear: 0.16 Max. turbulence at 10 meter height: 16% Inflow angle (vertical): 0 ± 2° Air density: 1.225 kg/m^3
HH	94 m
L_{wA} @ 3 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	95.0 4.3
L_{wA} @ 4 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	97.7 5.7
L_{wA} @ 5 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	102.5 7.2
L_{wA} @ 6 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	105.7 8.6
L_{wA} @ 7 to 25 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	106.5 10
L_{wA} @ 8 to 25 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	106.5 11.5
L_{wA} @ 9 to 25 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	106.5 12.9

Item	Value
L_{wA} @ 10 to 25 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	106.5 14.3
L_{wA} @ 11 to 25 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	106.5 15.8
L_{wA} @ 12 to 25 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	106.5 17.2
L_{wA} @ 13 to 25 m/s (10 m above ground) [dBA] Wind speed at HH [m/sec]	106.5 18.6

10.4.3 Estimated Power Curve, Mode 0

WiSpeed (m/s)	Air density kg/m^3													
	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.18	1.21	1.225	1.24	1.27	1.30	1.33
3	30	32	34	36	38	40	42	44	46	47	48	50	52	54
4	108	113	118	123	127	132	137	142	147	149	151	156	160	165
5	245	254	263	271	280	289	298	307	316	320	325	334	342	351
6	445	460	475	490	505	520	535	550	565	573	580	596	611	626
7	725	749	772	796	820	844	868	892	915	927	939	963	986	1010
8	1095	1130	1165	1201	1236	1271	1306	1342	1377	1395	1412	1447	1482	1517
9	1558	1608	1657	1706	1756	1805	1854	1903	1952	1977	2001	2050	2098	2146
10	2083	2145	2208	2270	2332	2395	2449	2503	2557	2584	2606	2651	2691	2727
11	2596	2649	2702	2756	2809	2863	2887	2911	2935	2947	2952	2963	2971	2977
12	2915	2929	2944	2958	2972	2987	2990	2993	2996	2998	2998	3000	3000	3000
13	2990	2992	2994	2996	2998	3000	3000	3000	3000	3000	3000	3000	3000	3000
14	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
15	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
16	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
17	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
18	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
19	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
20	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
21	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
22	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
23	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
24	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000
25	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000



Class I
Item no.: 0005-8547.V00
2009.09.11

Preliminary Foundation Loads

V112 3.0 MW HH 84 m IEC2A

50 Hz

History of Document

Rev. no.:	Date:	Description of change
0	2009.09.11	New document

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1. Introduction

This document presents **preliminary and not certified foundation loads** from the V112 3.0 MW HH 84 m IEC2A load spectrum. The loads are simulated in accordance with IEC61400-1 Edition 3, ref. [1]. The tower used for calculating the loads can be found in ref [4].

The foundation loads presented in this document are only to be used for preliminary foundation designs and not for detailed design.

2. References

Reference	Document	Doc. No.
[1] Design Code	IEC61400-1 Edition 3	
[2] GL Guideline	GL Rule and Guidelines, edition 2003 with supplements 2004	
[3]	Additional Tower and Foundation Requirements for Foundations with Anchors	0005-6289.V00
[4] Tower drawing	V112-3.0 MW HH84 IEC2a	0003-1884.V00
[5] Flex input file	FLEX input file - Tower	0005-1702.V00

Table 2.1 References.

Flex Data	Location
VTS path	X:\3MW\V1123000.084\iec2a.019\

Table 2.2 VTS references

3. Extreme Loads

Foundation loads components at the instant of extreme resulting bending moment are given in Table 3.1 and Table 3.2. 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

M_{res}: Extreme resulting bending moment.
M_z: Simultaneous torsion moment.
F_{res}: Simultaneous resulting shear force.
F_z: Simultaneous vertical force.

3.1 Resulting Extreme Load

Extreme resulting tower bottom moment according to ref [1] incl. own weight moment contribution due to tower out of vertical.

Characteristic Extreme Load for Normal Load Cases (PLF = 1.35)					
M_{res}	M_z	F_{res}	F_z	PLF	Design Load Case
[kNm]	[kNm]	[kN]	[kN]	[-]	[-]
59600	-388.0	712.0	-3600	1.35	3.2 (32PREogVrp2.int)

Table 3.1 Characteristic extreme load for normal load cases, PLF = 1.35. PLF not included.

Characteristic Extreme Load for Abnormal Load Cases (PLF = 1.10)					
M_{res}	M_z	F_{res}	F_z	PLF	Design Load Case
[kNm]	[kNm]	[kN]	[kN]	[-]	[-]
70500	1781	923.0	-3500	1.10	6.2 (62E50b075(fam139))

Table 3.2 Characteristic extreme load for abnormal load cases, PLF = 1.10. PLF not included.

3.2 Extreme Load during Normal Operation

The extreme load during normal operation is based upon; DLC 1.1, 3.1 and 4.1 according to ref [2] incl. own weight moment contribution due to tower out of vertical.

Characteristic Extreme Load during normal operation (PLF = 1.35)					
M_{res}	M_z	F_{res}	F_z	PLF	Design Load Case
[kNm]	[kNm]	[kN]	[kN]	[-]	[-]
40367.59	-869.97	507.50	-3637.88	1.35	1.1 (1112a(fam))

Table 3.3 Characteristic Extreme Load during normal operation.

3.3 Own Weight Moment

The **preliminary** own weight moment contribution due to tower out of vertical is listed in Table 3.4.

Tower Own Weight Moment		
Tower out of vertical:	0.008	m/m
Tower top mass:	188236	kg
Height tower top to tower top mass:	1.720	m
Partial load factor:	1.10	-
Moment due to tower out of vertical:	1684.19	kNm

Table 3.4 Tower own weight moment. PLF not included.

4. Fatigue Loads

4.1 Equivalent and Mean Load

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]	221.8	296.6	293.4
Mx	[kNm]	-16490	19070	21590

Table 4.1 Equivalent fatigue foundation loads. Neq=1e7.

5. Stiffness of Foundation

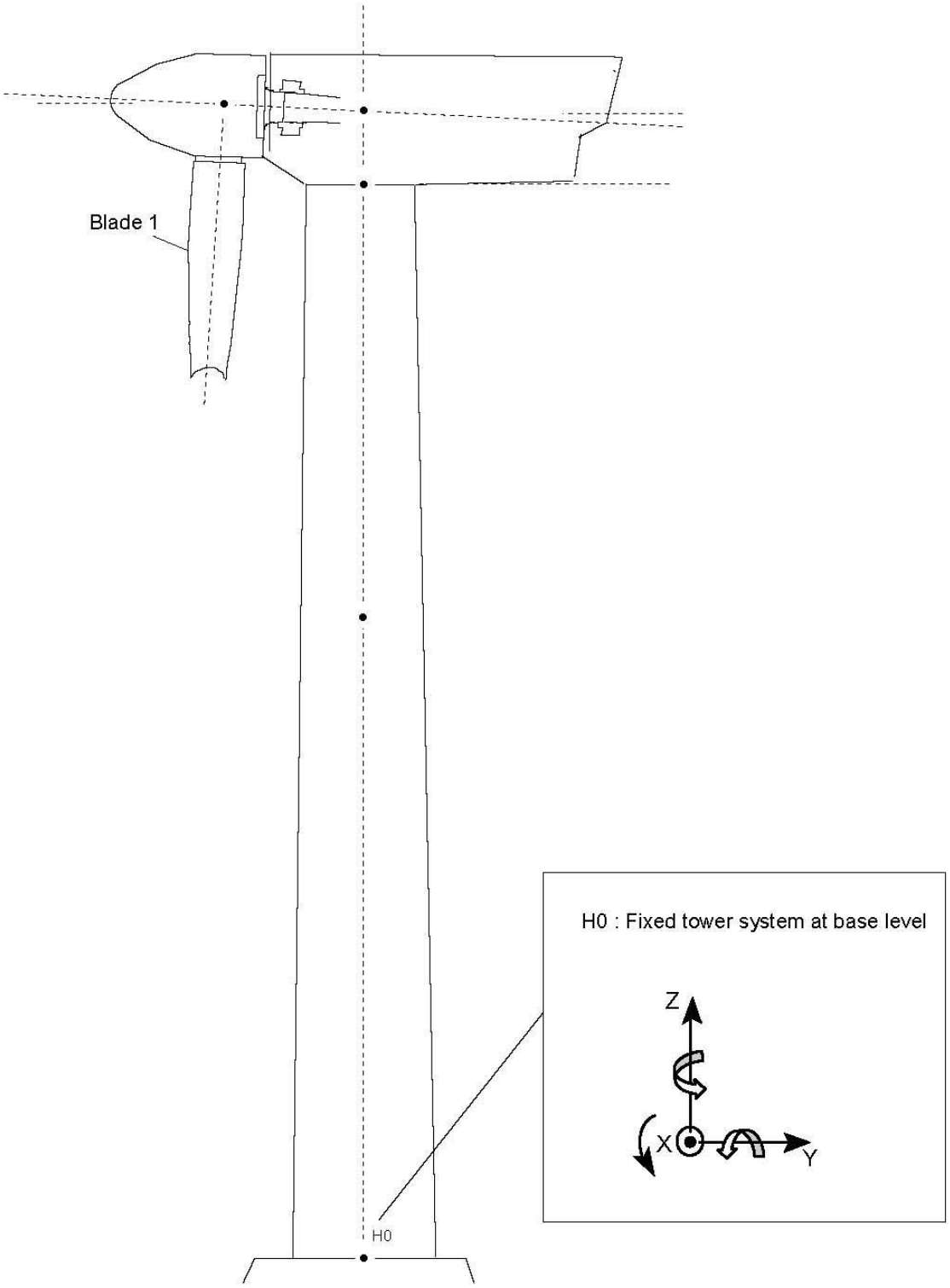
The nominal spring stiffness used for the load calculations is 89 GNm/rad resulting in a nominal tower frequency of 0.253 Hz. The spring stiffness of the foundation must be at least $C_{\varphi,dyn} \geq 30$ GNm/rad for the loads to be valid. The minimum lateral stiffness of the foundations is given in Table 5.1 as a function of the rotational stiffness.

Minimum Lateral Stiffness										
Rotational stiffness	[GNm/rad]	30	51.3	72.5	93.8	115	136.3	157.5	178.8	200
Lateral stiffness	[MN/m]	5000.5	12.1	8.5	7.5	6.9	6.5	6.3	6.2	6.1

Table 5.1 Minimum lateral stiffness.

The natural frequency of the tower must be within the frequency interval [0.243 Hz; 0.266 Hz].

Co-ordinate Systems



Rain flow Spectrum

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

Foundation Fatigue Load Spectrum			
Tower shear, bottom F_y [kN]		Tower bending, bottom M_x [kNm]	
Range	Frequency	Range	Frequency
7.6320E+02	3.7500E+01	6.3046E+04	3.7500E+01
7.4793E+02	0.0000E+00	6.1785E+04	0.0000E+00
7.3267E+02	0.0000E+00	6.0524E+04	0.0000E+00
7.1740E+02	0.0000E+00	5.9263E+04	0.0000E+00
7.0214E+02	3.7500E+01	5.8002E+04	0.0000E+00
6.8688E+02	3.3500E+01	5.6741E+04	0.0000E+00
6.7161E+02	1.0850E+02	5.5480E+04	7.5000E+01
6.5635E+02	2.8400E+02	5.4219E+04	1.4600E+02
6.4108E+02	1.2500E+01	5.2958E+04	1.3800E+02
6.2582E+02	1.0000E+00	5.1697E+04	6.7000E+01
6.1056E+02	0.0000E+00	5.0437E+04	0.0000E+00
5.9529E+02	2.1600E+02	4.9176E+04	1.2500E+01
5.8003E+02	1.5850E+02	4.7915E+04	1.7950E+02
5.6476E+02	5.0000E+01	4.6654E+04	1.0450E+02
5.4950E+02	1.6150E+02	4.5393E+04	1.0000E+00
5.3424E+02	5.5350E+02	4.4132E+04	8.4500E+01
5.1897E+02	1.5500E+02	4.2871E+04	2.2300E+02
5.0371E+02	1.0445E+03	4.1610E+04	1.2500E+01
4.8845E+02	6.1650E+02	4.0349E+04	1.3500E+01
4.7318E+02	6.1150E+02	3.9088E+04	9.2500E+01
4.5792E+02	2.7723E+04	3.7827E+04	6.4500E+01
4.4265E+02	4.0049E+04	3.6567E+04	3.0390E+04
4.2739E+02	4.8675E+04	3.5306E+04	2.3448E+04
4.1213E+02	5.6264E+04	3.4045E+04	5.2735E+04
3.9686E+02	8.4878E+04	3.2784E+04	1.5878E+04
3.8160E+02	1.2020E+05	3.1523E+04	5.7836E+04
3.6633E+02	1.7184E+05	3.0262E+04	5.4024E+04
3.5107E+02	1.8814E+05	2.9001E+04	1.1784E+05
3.3581E+02	2.4374E+05	2.7740E+04	1.1559E+05
3.2054E+02	3.0916E+05	2.6479E+04	1.7869E+05
3.0528E+02	3.5239E+05	2.5218E+04	1.0154E+05
2.9001E+02	5.1105E+05	2.3957E+04	2.5889E+05
2.7475E+02	5.9143E+05	2.2696E+04	2.0859E+05
2.5949E+02	8.4746E+05	2.1436E+04	2.6757E+05
2.4422E+02	9.7112E+05	2.0175E+04	3.4053E+05
2.2896E+02	1.3206E+06	1.8914E+04	5.2672E+05
2.1369E+02	1.7586E+06	1.7653E+04	6.0539E+05
1.9843E+02	2.2629E+06	1.6392E+04	7.1435E+05
1.8317E+02	2.9924E+06	1.5131E+04	1.0969E+06
1.6790E+02	4.4241E+06	1.3870E+04	1.2936E+06
1.5264E+02	5.9770E+06	1.2609E+04	1.9089E+06
1.3738E+02	9.0445E+06	1.1348E+04	2.2127E+06

1.2211E+02	1.3931E+07	1.0087E+04	3.4222E+06
1.0685E+02	2.2035E+07	8.8264E+03	4.7085E+06
9.1583E+01	3.5683E+07	7.5655E+03	7.3675E+06
7.6320E+01	5.8535E+07	6.3046E+03	1.1664E+07
6.1056E+01	9.4257E+07	5.0437E+03	1.9446E+07
4.5792E+01	1.4372E+08	3.7827E+03	3.3027E+07
3.0528E+01	2.1258E+08	2.5218E+03	7.6003E+07
1.5264E+01	3.3837E+08	1.2609E+03	2.8380E+08

Markov Matrices

This appendix contains the Markov Matrices for the tower bottom bending moment (Mx).

Markov Matrices			
Level	Range	Cycles	Cum. Cycles
1.93E+04	1.26E+03	2.50E+01	2.50E+01
1.93E+04	0.00E+00	7.50E+01	1.00E+02
1.79E+04	1.26E+03	7.50E+01	1.75E+02
1.79E+04	0.00E+00	9.20E+01	2.67E+02
1.65E+04	1.26E+03	1.34E+02	4.01E+02
1.51E+04	1.26E+03	6.70E+01	4.68E+02
1.51E+04	0.00E+00	1.17E+02	5.85E+02
1.38E+04	1.26E+03	1.34E+02	7.19E+02
1.38E+04	0.00E+00	2.17E+02	9.36E+02
1.24E+04	1.26E+03	2.01E+02	1.14E+03
1.24E+04	0.00E+00	5.26E+02	1.66E+03
1.10E+04	3.78E+03	6.70E+01	1.73E+03
1.10E+04	1.26E+03	7.50E+01	1.81E+03
1.10E+04	0.00E+00	6.41E+02	2.45E+03
9.64E+03	1.26E+03	7.50E+01	2.52E+03
9.64E+03	0.00E+00	7.09E+02	3.23E+03
8.26E+03	3.15E+04	7.50E+01	3.31E+03
8.26E+03	2.02E+04	3.35E+01	3.34E+03
8.26E+03	1.77E+04	3.35E+01	3.37E+03
8.26E+03	8.83E+03	1.34E+02	3.51E+03
8.26E+03	6.30E+03	1.34E+02	3.64E+03
8.26E+03	1.26E+03	5.60E+01	3.70E+03
8.26E+03	0.00E+00	1.08E+03	4.77E+03
6.89E+03	4.29E+04	3.75E+01	4.81E+03
6.89E+03	2.52E+04	7.50E+01	4.88E+03
6.89E+03	2.40E+04	7.10E+01	4.95E+03
6.89E+03	2.27E+04	3.75E+01	4.99E+03
6.89E+03	8.83E+03	4.76E+03	9.76E+03
6.89E+03	7.57E+03	1.43E+03	1.12E+04
6.89E+03	6.30E+03	6.70E+01	1.13E+04
6.89E+03	2.52E+03	4.69E+03	1.59E+04
6.89E+03	1.26E+03	1.05E+04	2.64E+04
6.89E+03	0.00E+00	3.23E+04	5.87E+04
5.51E+03	3.28E+04	7.50E+01	5.88E+04
5.51E+03	2.27E+04	1.09E+02	5.89E+04
5.51E+03	1.77E+04	6.70E+01	5.90E+04
5.51E+03	1.64E+04	3.35E+01	5.90E+04
5.51E+03	1.51E+04	7.50E+01	5.91E+04
5.51E+03	1.39E+04	3.33E+03	6.24E+04
5.51E+03	1.26E+04	7.50E+01	6.25E+04
5.51E+03	1.01E+04	1.62E+03	6.41E+04
5.51E+03	8.83E+03	1.43E+03	6.55E+04
5.51E+03	7.57E+03	8.10E+03	7.36E+04
5.51E+03	6.30E+03	6.70E+01	7.37E+04

5.51E+03	2.52E+03	2.94E+03	7.67E+04
5.51E+03	1.26E+03	5.95E+03	8.26E+04
5.51E+03	0.00E+00	6.52E+03	8.91E+04
4.13E+03	2.90E+04	2.50E+01	8.91E+04
4.13E+03	2.77E+04	7.10E+01	8.92E+04
4.13E+03	2.65E+04	7.10E+01	8.93E+04
4.13E+03	1.89E+04	7.10E+01	8.94E+04
4.13E+03	1.77E+04	3.36E+03	9.27E+04
4.13E+03	1.51E+04	2.42E+03	9.51E+04
4.13E+03	1.26E+04	6.70E+01	9.52E+04
4.13E+03	1.01E+04	7.80E+01	9.53E+04
4.13E+03	8.83E+03	6.70E+01	9.53E+04
4.13E+03	7.57E+03	1.34E+02	9.55E+04
4.13E+03	3.78E+03	8.68E+03	1.04E+05
4.13E+03	2.52E+03	4.09E+04	1.45E+05
4.13E+03	1.26E+03	2.39E+04	1.69E+05
4.13E+03	0.00E+00	3.09E+05	4.78E+05
2.75E+03	3.28E+04	1.88E+02	4.78E+05
2.75E+03	3.15E+04	1.13E+02	4.78E+05
2.75E+03	3.03E+04	3.75E+01	4.78E+05
2.75E+03	2.90E+04	3.75E+01	4.78E+05
2.75E+03	2.65E+04	3.75E+01	4.78E+05
2.75E+03	2.52E+04	1.80E+02	4.78E+05
2.75E+03	2.40E+04	5.00E+01	4.78E+05
2.75E+03	2.27E+04	1.50E+02	4.78E+05
2.75E+03	2.02E+04	3.75E+01	4.78E+05
2.75E+03	1.89E+04	7.50E+01	4.79E+05
2.75E+03	1.77E+04	1.80E+02	4.79E+05
2.75E+03	1.64E+04	5.46E+03	4.84E+05
2.75E+03	1.51E+04	1.66E+03	4.86E+05
2.75E+03	1.39E+04	1.85E+03	4.88E+05
2.75E+03	1.26E+04	9.71E+02	4.89E+05
2.75E+03	1.13E+04	8.84E+02	4.90E+05
2.75E+03	1.01E+04	7.64E+02	4.90E+05
2.75E+03	8.83E+03	2.06E+04	5.11E+05
2.75E+03	7.57E+03	4.72E+04	5.58E+05
2.75E+03	6.30E+03	6.71E+04	6.25E+05
2.75E+03	5.04E+03	7.68E+04	7.02E+05
2.75E+03	3.78E+03	1.51E+05	8.53E+05
2.75E+03	2.52E+03	4.77E+05	1.33E+06
2.75E+03	1.26E+03	1.87E+06	3.20E+06
2.75E+03	0.00E+00	1.67E+07	1.99E+07
1.38E+03	3.78E+04	1.25E+01	1.99E+07
1.38E+03	3.03E+04	3.75E+01	1.99E+07
1.38E+03	2.90E+04	3.75E+01	1.99E+07
1.38E+03	2.77E+04	7.50E+01	1.99E+07
1.38E+03	2.65E+04	1.13E+02	1.99E+07
1.38E+03	2.52E+04	1.13E+02	1.99E+07
1.38E+03	2.40E+04	2.92E+02	1.99E+07
1.38E+03	2.27E+04	1.75E+02	1.99E+07
1.38E+03	2.14E+04	3.97E+02	1.99E+07

1.38E+03	2.02E+04	4.34E+02	1.99E+07
1.38E+03	1.89E+04	2.59E+02	1.99E+07
1.38E+03	1.77E+04	2.51E+02	1.99E+07
1.38E+03	1.64E+04	1.38E+02	1.99E+07
1.38E+03	1.51E+04	1.46E+02	1.99E+07
1.38E+03	1.39E+04	1.46E+03	1.99E+07
1.38E+03	1.26E+04	4.63E+02	1.99E+07
1.38E+03	1.13E+04	1.03E+03	1.99E+07
1.38E+03	1.01E+04	8.47E+03	1.99E+07
1.38E+03	8.83E+03	1.90E+03	1.99E+07
1.38E+03	7.57E+03	6.43E+02	1.99E+07
1.38E+03	6.30E+03	6.52E+04	2.00E+07
1.38E+03	5.04E+03	9.30E+04	2.01E+07
1.38E+03	3.78E+03	1.18E+05	2.02E+07
1.38E+03	2.52E+03	3.80E+05	2.06E+07
1.38E+03	1.26E+03	1.24E+06	2.18E+07
1.38E+03	0.00E+00	4.17E+06	2.60E+07
0.00E+00	3.28E+04	5.00E+01	2.60E+07
0.00E+00	3.03E+04	1.25E+01	2.60E+07
0.00E+00	2.90E+04	6.25E+01	2.60E+07
0.00E+00	2.52E+04	5.60E+01	2.60E+07
0.00E+00	2.40E+04	2.00E+02	2.60E+07
0.00E+00	2.27E+04	2.00E+02	2.60E+07
0.00E+00	2.14E+04	1.00E+02	2.60E+07
0.00E+00	2.02E+04	1.00E+02	2.60E+07
0.00E+00	1.89E+04	6.55E+02	2.60E+07
0.00E+00	1.77E+04	6.17E+02	2.60E+07
0.00E+00	1.64E+04	2.02E+03	2.60E+07
0.00E+00	1.51E+04	9.57E+03	2.60E+07
0.00E+00	1.39E+04	1.15E+03	2.60E+07
0.00E+00	1.26E+04	1.42E+03	2.60E+07
0.00E+00	1.13E+04	7.14E+02	2.60E+07
0.00E+00	1.01E+04	1.81E+04	2.60E+07
0.00E+00	8.83E+03	7.89E+04	2.61E+07
0.00E+00	7.57E+03	6.42E+04	2.61E+07
0.00E+00	6.30E+03	1.11E+05	2.63E+07
0.00E+00	5.04E+03	2.50E+05	2.65E+07
0.00E+00	3.78E+03	3.33E+05	2.68E+07
0.00E+00	2.52E+03	8.29E+05	2.77E+07
0.00E+00	1.26E+03	1.60E+06	2.93E+07
0.00E+00	0.00E+00	6.26E+06	3.55E+07
-1.38E+03	3.03E+04	1.50E+02	3.55E+07
-1.38E+03	2.90E+04	9.10E+01	3.55E+07
-1.38E+03	2.77E+04	8.20E+01	3.55E+07
-1.38E+03	2.65E+04	1.50E+02	3.55E+07
-1.38E+03	2.52E+04	2.80E+01	3.55E+07
-1.38E+03	2.40E+04	1.00E+02	3.55E+07
-1.38E+03	2.14E+04	2.48E+02	3.55E+07
-1.38E+03	2.02E+04	1.31E+03	3.55E+07
-1.38E+03	1.89E+04	1.72E+03	3.55E+07
-1.38E+03	1.77E+04	1.27E+03	3.55E+07

-1.38E+03	1.64E+04	3.65E+03	3.55E+07
-1.38E+03	1.51E+04	4.09E+03	3.55E+07
-1.38E+03	1.39E+04	1.56E+04	3.56E+07
-1.38E+03	1.26E+04	1.23E+04	3.56E+07
-1.38E+03	1.13E+04	3.40E+03	3.56E+07
-1.38E+03	1.01E+04	1.74E+04	3.56E+07
-1.38E+03	8.83E+03	4.57E+04	3.56E+07
-1.38E+03	7.57E+03	1.88E+05	3.58E+07
-1.38E+03	6.30E+03	2.97E+05	3.61E+07
-1.38E+03	5.04E+03	5.59E+05	3.67E+07
-1.38E+03	3.78E+03	7.72E+05	3.75E+07
-1.38E+03	2.52E+03	8.91E+05	3.83E+07
-1.38E+03	1.26E+03	1.50E+06	3.98E+07
-1.38E+03	0.00E+00	8.71E+06	4.86E+07
-2.75E+03	3.40E+04	2.00E+00	4.86E+07
-2.75E+03	3.15E+04	4.10E+01	4.86E+07
-2.75E+03	3.03E+04	2.80E+01	4.86E+07
-2.75E+03	2.90E+04	1.63E+02	4.86E+07
-2.75E+03	2.77E+04	1.15E+02	4.86E+07
-2.75E+03	2.65E+04	3.10E+01	4.86E+07
-2.75E+03	2.52E+04	2.80E+02	4.86E+07
-2.75E+03	2.40E+04	1.05E+02	4.86E+07
-2.75E+03	2.27E+04	1.40E+02	4.86E+07
-2.75E+03	2.14E+04	1.40E+02	4.86E+07
-2.75E+03	2.02E+04	5.36E+02	4.86E+07
-2.75E+03	1.89E+04	5.06E+02	4.86E+07
-2.75E+03	1.77E+04	2.76E+02	4.86E+07
-2.75E+03	1.64E+04	1.63E+03	4.86E+07
-2.75E+03	1.51E+04	2.00E+04	4.86E+07
-2.75E+03	1.39E+04	1.79E+04	4.86E+07
-2.75E+03	1.26E+04	2.52E+04	4.86E+07
-2.75E+03	1.13E+04	2.33E+04	4.86E+07
-2.75E+03	1.01E+04	6.33E+04	4.87E+07
-2.75E+03	8.83E+03	7.60E+04	4.88E+07
-2.75E+03	7.57E+03	1.88E+05	4.90E+07
-2.75E+03	6.30E+03	3.16E+05	4.93E+07
-2.75E+03	5.04E+03	6.35E+05	4.99E+07
-2.75E+03	3.78E+03	7.33E+05	5.07E+07
-2.75E+03	2.52E+03	1.17E+06	5.18E+07
-2.75E+03	1.26E+03	1.23E+06	5.31E+07
-2.75E+03	0.00E+00	9.86E+06	6.29E+07
-4.13E+03	6.30E+04	3.75E+01	6.29E+07
-4.13E+03	4.92E+04	1.25E+01	6.29E+07
-4.13E+03	4.03E+04	1.25E+01	6.29E+07
-4.13E+03	3.40E+04	1.00E+00	6.29E+07
-4.13E+03	3.28E+04	6.00E+00	6.29E+07
-4.13E+03	2.90E+04	9.00E+00	6.29E+07
-4.13E+03	2.77E+04	1.60E+01	6.29E+07
-4.13E+03	2.65E+04	2.00E+00	6.29E+07
-4.13E+03	2.52E+04	6.40E+01	6.29E+07
-4.13E+03	2.40E+04	1.19E+02	6.29E+07

-4.13E+03	2.27E+04	4.50E+02	6.29E+07
-4.13E+03	2.14E+04	2.44E+02	6.29E+07
-4.13E+03	2.02E+04	6.25E+01	6.29E+07
-4.13E+03	1.89E+04	6.65E+03	6.29E+07
-4.13E+03	1.77E+04	1.33E+04	6.29E+07
-4.13E+03	1.64E+04	1.35E+04	6.30E+07
-4.13E+03	1.51E+04	7.46E+02	6.30E+07
-4.13E+03	1.39E+04	1.37E+04	6.30E+07
-4.13E+03	1.26E+04	2.18E+04	6.30E+07
-4.13E+03	1.13E+04	5.21E+04	6.30E+07
-4.13E+03	1.01E+04	7.78E+04	6.31E+07
-4.13E+03	8.83E+03	6.38E+04	6.32E+07
-4.13E+03	7.57E+03	1.52E+05	6.33E+07
-4.13E+03	6.30E+03	2.63E+05	6.36E+07
-4.13E+03	5.04E+03	8.98E+05	6.45E+07
-4.13E+03	3.78E+03	1.40E+06	6.59E+07
-4.13E+03	2.52E+03	1.91E+06	6.78E+07
-4.13E+03	1.26E+03	1.49E+06	6.93E+07
-4.13E+03	0.00E+00	1.20E+07	8.13E+07
-5.51E+03	4.79E+04	3.75E+01	8.13E+07
-5.51E+03	4.41E+04	5.10E+01	8.13E+07
-5.51E+03	4.29E+04	3.75E+01	8.13E+07
-5.51E+03	4.16E+04	1.25E+01	8.13E+07
-5.51E+03	3.91E+04	2.00E+00	8.13E+07
-5.51E+03	3.78E+04	1.00E+00	8.13E+07
-5.51E+03	3.66E+04	2.00E+00	8.13E+07
-5.51E+03	3.53E+04	8.00E+00	8.13E+07
-5.51E+03	3.40E+04	1.25E+01	8.13E+07
-5.51E+03	3.28E+04	1.20E+01	8.13E+07
-5.51E+03	3.15E+04	2.85E+01	8.13E+07
-5.51E+03	3.03E+04	2.00E+00	8.13E+07
-5.51E+03	2.90E+04	1.35E+01	8.13E+07
-5.51E+03	2.77E+04	1.70E+01	8.13E+07
-5.51E+03	2.65E+04	4.10E+01	8.13E+07
-5.51E+03	2.52E+04	5.30E+01	8.13E+07
-5.51E+03	2.40E+04	1.40E+01	8.13E+07
-5.51E+03	2.27E+04	7.00E+00	8.13E+07
-5.51E+03	2.14E+04	6.00E+01	8.13E+07
-5.51E+03	2.02E+04	1.92E+04	8.13E+07
-5.51E+03	1.89E+04	1.27E+04	8.13E+07
-5.51E+03	1.77E+04	2.58E+04	8.14E+07
-5.51E+03	1.64E+04	1.96E+04	8.14E+07
-5.51E+03	1.51E+04	1.28E+04	8.14E+07
-5.51E+03	1.39E+04	8.20E+02	8.14E+07
-5.51E+03	1.26E+04	2.85E+04	8.14E+07
-5.51E+03	1.13E+04	3.87E+02	8.14E+07
-5.51E+03	1.01E+04	2.74E+04	8.15E+07
-5.51E+03	8.83E+03	7.06E+04	8.15E+07
-5.51E+03	7.57E+03	1.50E+05	8.17E+07
-5.51E+03	6.30E+03	2.76E+05	8.19E+07
-5.51E+03	5.04E+03	7.34E+05	8.27E+07

-5.51E+03	3.78E+03	1.13E+06	8.38E+07
-5.51E+03	2.52E+03	2.15E+06	8.60E+07
-5.51E+03	1.26E+03	1.77E+06	8.77E+07
-5.51E+03	0.00E+00	1.52E+07	1.03E+08
-6.89E+03	5.17E+04	3.35E+01	1.03E+08
-6.89E+03	4.54E+04	1.00E+00	1.03E+08
-6.89E+03	4.41E+04	3.35E+01	1.03E+08
-6.89E+03	4.29E+04	3.75E+01	1.03E+08
-6.89E+03	3.91E+04	5.30E+01	1.03E+08
-6.89E+03	3.66E+04	1.35E+01	1.03E+08
-6.89E+03	3.53E+04	2.00E+01	1.03E+08
-6.89E+03	3.40E+04	3.95E+01	1.03E+08
-6.89E+03	3.28E+04	4.00E+00	1.03E+08
-6.89E+03	3.15E+04	6.00E+00	1.03E+08
-6.89E+03	3.03E+04	4.00E+00	1.03E+08
-6.89E+03	2.90E+04	1.60E+01	1.03E+08
-6.89E+03	2.77E+04	1.00E+01	1.03E+08
-6.89E+03	2.65E+04	2.95E+01	1.03E+08
-6.89E+03	2.52E+04	1.90E+01	1.03E+08
-6.89E+03	2.40E+04	2.80E+01	1.03E+08
-6.89E+03	2.27E+04	6.49E+03	1.03E+08
-6.89E+03	2.14E+04	1.00E+01	1.03E+08
-6.89E+03	2.02E+04	6.49E+03	1.03E+08
-6.89E+03	1.89E+04	1.09E+02	1.03E+08
-6.89E+03	1.77E+04	6.40E+03	1.03E+08
-6.89E+03	1.64E+04	1.41E+04	1.03E+08
-6.89E+03	1.51E+04	1.29E+04	1.03E+08
-6.89E+03	1.39E+04	1.28E+04	1.03E+08
-6.89E+03	1.26E+04	3.08E+04	1.03E+08
-6.89E+03	1.13E+04	6.53E+03	1.03E+08
-6.89E+03	1.01E+04	1.28E+04	1.03E+08
-6.89E+03	8.83E+03	1.54E+04	1.03E+08
-6.89E+03	7.57E+03	7.38E+04	1.03E+08
-6.89E+03	6.30E+03	1.93E+05	1.03E+08
-6.89E+03	5.04E+03	4.68E+05	1.04E+08
-6.89E+03	3.78E+03	9.68E+05	1.05E+08
-6.89E+03	2.52E+03	1.77E+06	1.07E+08
-6.89E+03	1.26E+03	2.23E+06	1.09E+08
-6.89E+03	0.00E+00	1.51E+07	1.24E+08
-8.26E+03	5.55E+04	3.75E+01	1.24E+08
-8.26E+03	5.42E+04	1.09E+02	1.24E+08
-8.26E+03	4.29E+04	2.00E+00	1.24E+08
-8.26E+03	4.03E+04	1.00E+00	1.24E+08
-8.26E+03	3.66E+04	3.00E+00	1.24E+08
-8.26E+03	3.53E+04	5.00E+00	1.24E+08
-8.26E+03	3.40E+04	3.00E+00	1.24E+08
-8.26E+03	3.28E+04	2.00E+00	1.24E+08
-8.26E+03	2.90E+04	1.00E+01	1.24E+08
-8.26E+03	2.77E+04	1.06E+02	1.24E+08
-8.26E+03	2.65E+04	7.00E+00	1.24E+08
-8.26E+03	2.52E+04	6.00E+00	1.24E+08

-8.26E+03	2.40E+04	6.00E+00	1.24E+08
-8.26E+03	2.27E+04	6.00E+00	1.24E+08
-8.26E+03	2.14E+04	2.00E+00	1.24E+08
-8.26E+03	2.02E+04	6.34E+03	1.24E+08
-8.26E+03	1.89E+04	2.00E+00	1.24E+08
-8.26E+03	1.77E+04	2.75E+02	1.24E+08
-8.26E+03	1.64E+04	5.35E+01	1.24E+08
-8.26E+03	1.51E+04	2.48E+02	1.24E+08
-8.26E+03	1.39E+04	2.12E+02	1.24E+08
-8.26E+03	1.26E+04	3.30E+04	1.24E+08
-8.26E+03	1.13E+04	4.35E+04	1.24E+08
-8.26E+03	1.01E+04	2.54E+04	1.24E+08
-8.26E+03	8.83E+03	1.54E+04	1.24E+08
-8.26E+03	7.57E+03	3.31E+04	1.24E+08
-8.26E+03	6.30E+03	1.44E+05	1.24E+08
-8.26E+03	5.04E+03	3.67E+05	1.24E+08
-8.26E+03	3.78E+03	7.43E+05	1.25E+08
-8.26E+03	2.52E+03	1.71E+06	1.27E+08
-8.26E+03	1.26E+03	2.80E+06	1.30E+08
-8.26E+03	0.00E+00	1.69E+07	1.47E+08
-9.64E+03	5.55E+04	3.75E+01	1.47E+08
-9.64E+03	5.42E+04	3.75E+01	1.47E+08
-9.64E+03	5.30E+04	6.70E+01	1.47E+08
-9.64E+03	4.67E+04	3.35E+01	1.47E+08
-9.64E+03	3.78E+04	1.00E+00	1.47E+08
-9.64E+03	3.40E+04	5.20E+01	1.47E+08
-9.64E+03	2.65E+04	6.00E+00	1.47E+08
-9.64E+03	2.52E+04	6.00E+00	1.47E+08
-9.64E+03	2.27E+04	1.08E+02	1.47E+08
-9.64E+03	2.14E+04	1.06E+02	1.47E+08
-9.64E+03	2.02E+04	7.67E+03	1.47E+08
-9.64E+03	1.89E+04	7.66E+03	1.47E+08
-9.64E+03	1.77E+04	1.08E+02	1.47E+08
-9.64E+03	1.64E+04	3.09E+04	1.47E+08
-9.64E+03	1.51E+04	7.87E+03	1.47E+08
-9.64E+03	1.39E+04	7.76E+03	1.47E+08
-9.64E+03	1.26E+04	2.96E+04	1.47E+08
-9.64E+03	1.13E+04	4.64E+04	1.47E+08
-9.64E+03	1.01E+04	1.02E+02	1.47E+08
-9.64E+03	8.83E+03	3.57E+04	1.47E+08
-9.64E+03	7.57E+03	3.11E+04	1.47E+08
-9.64E+03	6.30E+03	1.24E+05	1.47E+08
-9.64E+03	5.04E+03	1.94E+05	1.47E+08
-9.64E+03	3.78E+03	7.17E+05	1.48E+08
-9.64E+03	2.52E+03	1.54E+06	1.49E+08
-9.64E+03	1.26E+03	3.03E+06	1.52E+08
-9.64E+03	0.00E+00	1.72E+07	1.70E+08
-1.10E+04	5.17E+04	3.35E+01	1.70E+08
-1.10E+04	4.29E+04	3.75E+01	1.70E+08
-1.10E+04	3.91E+04	3.75E+01	1.70E+08
-1.10E+04	3.78E+04	5.00E+01	1.70E+08

-1.10E+04	3.53E+04	2.00E+00	1.70E+08
-1.10E+04	3.28E+04	4.00E+00	1.70E+08
-1.10E+04	2.90E+04	7.70E+01	1.70E+08
-1.10E+04	2.77E+04	2.00E+00	1.70E+08
-1.10E+04	2.40E+04	1.53E+04	1.70E+08
-1.10E+04	2.27E+04	9.05E+01	1.70E+08
-1.10E+04	2.14E+04	1.53E+04	1.70E+08
-1.10E+04	2.02E+04	1.04E+02	1.70E+08
-1.10E+04	1.89E+04	2.00E+00	1.70E+08
-1.10E+04	1.64E+04	7.68E+03	1.70E+08
-1.10E+04	1.51E+04	2.30E+04	1.70E+08
-1.10E+04	1.39E+04	1.53E+04	1.70E+08
-1.10E+04	1.26E+04	3.12E+04	1.70E+08
-1.10E+04	1.13E+04	1.01E+02	1.70E+08
-1.10E+04	1.01E+04	4.67E+04	1.70E+08
-1.10E+04	8.83E+03	1.46E+04	1.70E+08
-1.10E+04	7.57E+03	3.59E+04	1.70E+08
-1.10E+04	6.30E+03	3.18E+04	1.70E+08
-1.10E+04	5.04E+03	1.55E+05	1.70E+08
-1.10E+04	3.78E+03	5.01E+05	1.71E+08
-1.10E+04	2.52E+03	1.67E+06	1.72E+08
-1.10E+04	1.26E+03	4.18E+06	1.76E+08
-1.10E+04	0.00E+00	1.91E+07	1.96E+08
-1.24E+04	5.30E+04	7.10E+01	1.96E+08
-1.24E+04	4.67E+04	7.10E+01	1.96E+08
-1.24E+04	3.53E+04	5.00E+01	1.96E+08
-1.24E+04	2.90E+04	9.05E+01	1.96E+08
-1.24E+04	2.77E+04	5.00E+01	1.96E+08
-1.24E+04	2.52E+04	7.76E+03	1.96E+08
-1.24E+04	2.40E+04	2.30E+04	1.96E+08
-1.24E+04	2.27E+04	1.53E+04	1.96E+08
-1.24E+04	2.14E+04	1.81E+02	1.96E+08
-1.24E+04	2.02E+04	7.74E+03	1.96E+08
-1.24E+04	1.77E+04	1.56E+04	1.96E+08
-1.24E+04	1.64E+04	2.37E+04	1.96E+08
-1.24E+04	1.51E+04	8.09E+02	1.96E+08
-1.24E+04	1.39E+04	5.43E+02	1.96E+08
-1.24E+04	1.26E+04	8.92E+03	1.96E+08
-1.24E+04	1.13E+04	2.38E+04	1.96E+08
-1.24E+04	1.01E+04	1.14E+04	1.96E+08
-1.24E+04	8.83E+03	8.73E+03	1.96E+08
-1.24E+04	7.57E+03	6.50E+04	1.96E+08
-1.24E+04	6.30E+03	5.03E+04	1.96E+08
-1.24E+04	5.04E+03	2.03E+05	1.96E+08
-1.24E+04	3.78E+03	7.86E+05	1.97E+08
-1.24E+04	2.52E+03	2.04E+06	1.99E+08
-1.24E+04	1.26E+03	4.76E+06	2.04E+08
-1.24E+04	0.00E+00	1.92E+07	2.23E+08
-1.38E+04	4.79E+04	1.42E+02	2.23E+08
-1.38E+04	3.66E+04	5.00E+01	2.23E+08
-1.38E+04	3.28E+04	9.05E+01	2.23E+08

-1.38E+04	2.90E+04	3.07E+04	2.23E+08
-1.38E+04	2.77E+04	1.56E+04	2.23E+08
-1.38E+04	2.65E+04	2.33E+04	2.23E+08
-1.38E+04	2.52E+04	1.81E+02	2.23E+08
-1.38E+04	2.40E+04	5.04E+02	2.23E+08
-1.38E+04	2.27E+04	2.34E+04	2.23E+08
-1.38E+04	2.14E+04	8.02E+03	2.23E+08
-1.38E+04	2.02E+04	1.63E+04	2.23E+08
-1.38E+04	1.89E+04	1.73E+04	2.23E+08
-1.38E+04	1.77E+04	2.90E+03	2.23E+08
-1.38E+04	1.64E+04	5.10E+03	2.23E+08
-1.38E+04	1.51E+04	3.89E+04	2.23E+08
-1.38E+04	1.39E+04	8.99E+03	2.23E+08
-1.38E+04	1.26E+04	2.97E+04	2.23E+08
-1.38E+04	1.13E+04	1.64E+04	2.23E+08
-1.38E+04	1.01E+04	5.04E+04	2.23E+08
-1.38E+04	8.83E+03	1.97E+04	2.23E+08
-1.38E+04	7.57E+03	8.59E+04	2.23E+08
-1.38E+04	6.30E+03	9.53E+04	2.23E+08
-1.38E+04	5.04E+03	2.45E+05	2.24E+08
-1.38E+04	3.78E+03	6.57E+05	2.24E+08
-1.38E+04	2.52E+03	2.35E+06	2.27E+08
-1.38E+04	1.26E+03	6.21E+06	2.33E+08
-1.38E+04	0.00E+00	1.95E+07	2.52E+08
-1.51E+04	4.29E+04	7.10E+01	2.52E+08
-1.51E+04	3.15E+04	7.84E+03	2.52E+08
-1.51E+04	3.03E+04	9.05E+01	2.52E+08
-1.51E+04	2.90E+04	1.56E+04	2.52E+08
-1.51E+04	2.77E+04	2.41E+04	2.52E+08
-1.51E+04	2.65E+04	2.42E+04	2.52E+08
-1.51E+04	2.52E+04	1.74E+04	2.52E+08
-1.51E+04	2.40E+04	1.05E+04	2.52E+08
-1.51E+04	2.27E+04	3.74E+03	2.52E+08
-1.51E+04	2.14E+04	5.79E+03	2.52E+08
-1.51E+04	2.02E+04	3.46E+04	2.52E+08
-1.51E+04	1.89E+04	3.28E+04	2.52E+08
-1.51E+04	1.77E+04	5.30E+04	2.53E+08
-1.51E+04	1.64E+04	5.12E+04	2.53E+08
-1.51E+04	1.51E+04	8.74E+04	2.53E+08
-1.51E+04	1.39E+04	5.75E+04	2.53E+08
-1.51E+04	1.26E+04	7.46E+04	2.53E+08
-1.51E+04	1.13E+04	1.67E+05	2.53E+08
-1.51E+04	1.01E+04	1.20E+05	2.53E+08
-1.51E+04	8.83E+03	1.51E+05	2.53E+08
-1.51E+04	7.57E+03	1.28E+05	2.53E+08
-1.51E+04	6.30E+03	2.20E+05	2.54E+08
-1.51E+04	5.04E+03	2.99E+05	2.54E+08
-1.51E+04	3.78E+03	9.78E+05	2.55E+08
-1.51E+04	2.52E+03	2.57E+06	2.57E+08
-1.51E+04	1.26E+03	7.13E+06	2.65E+08
-1.51E+04	0.00E+00	1.94E+07	2.84E+08

-1.65E+04	3.53E+04	9.05E+01	2.84E+08
-1.65E+04	3.40E+04	1.55E+04	2.84E+08
-1.65E+04	3.28E+04	1.41E+02	2.84E+08
-1.65E+04	3.15E+04	1.54E+04	2.84E+08
-1.65E+04	3.03E+04	1.09E+03	2.84E+08
-1.65E+04	2.90E+04	8.02E+03	2.84E+08
-1.65E+04	2.77E+04	1.70E+04	2.84E+08
-1.65E+04	2.65E+04	1.80E+03	2.84E+08
-1.65E+04	2.52E+04	2.15E+03	2.84E+08
-1.65E+04	2.40E+04	1.38E+04	2.84E+08
-1.65E+04	2.27E+04	2.27E+04	2.84E+08
-1.65E+04	2.14E+04	1.07E+04	2.84E+08
-1.65E+04	2.02E+04	2.17E+04	2.84E+08
-1.65E+04	1.89E+04	2.68E+04	2.84E+08
-1.65E+04	1.77E+04	4.50E+04	2.84E+08
-1.65E+04	1.64E+04	7.35E+04	2.84E+08
-1.65E+04	1.51E+04	8.55E+04	2.84E+08
-1.65E+04	1.39E+04	1.45E+05	2.84E+08
-1.65E+04	1.26E+04	2.00E+05	2.85E+08
-1.65E+04	1.13E+04	1.91E+05	2.85E+08
-1.65E+04	1.01E+04	2.09E+05	2.85E+08
-1.65E+04	8.83E+03	2.66E+05	2.85E+08
-1.65E+04	7.57E+03	3.39E+05	2.86E+08
-1.65E+04	6.30E+03	3.98E+05	2.86E+08
-1.65E+04	5.04E+03	4.66E+05	2.87E+08
-1.65E+04	3.78E+03	1.08E+06	2.88E+08
-1.65E+04	2.52E+03	3.14E+06	2.91E+08
-1.65E+04	1.26E+03	1.04E+07	3.01E+08
-1.65E+04	0.00E+00	2.26E+07	3.24E+08
-1.79E+04	3.66E+04	2.28E+04	3.24E+08
-1.79E+04	3.53E+04	1.52E+04	3.24E+08
-1.79E+04	3.40E+04	1.51E+04	3.24E+08
-1.79E+04	3.28E+04	7.75E+03	3.24E+08
-1.79E+04	3.15E+04	7.75E+03	3.24E+08
-1.79E+04	3.03E+04	7.55E+03	3.24E+08
-1.79E+04	2.65E+04	2.23E+03	3.24E+08
-1.79E+04	2.52E+04	3.54E+03	3.24E+08
-1.79E+04	2.40E+04	9.63E+03	3.24E+08
-1.79E+04	2.27E+04	1.10E+04	3.24E+08
-1.79E+04	2.14E+04	1.63E+04	3.24E+08
-1.79E+04	2.02E+04	2.21E+04	3.24E+08
-1.79E+04	1.89E+04	3.01E+04	3.24E+08
-1.79E+04	1.77E+04	4.37E+04	3.24E+08
-1.79E+04	1.64E+04	4.84E+04	3.24E+08
-1.79E+04	1.51E+04	6.65E+04	3.24E+08
-1.79E+04	1.39E+04	1.29E+05	3.24E+08
-1.79E+04	1.26E+04	1.56E+05	3.24E+08
-1.79E+04	1.13E+04	2.23E+05	3.25E+08
-1.79E+04	1.01E+04	2.98E+05	3.25E+08
-1.79E+04	8.83E+03	3.56E+05	3.25E+08
-1.79E+04	7.57E+03	4.66E+05	3.26E+08

-1.79E+04	6.30E+03	5.14E+05	3.26E+08
-1.79E+04	5.04E+03	6.55E+05	3.27E+08
-1.79E+04	3.78E+03	1.45E+06	3.28E+08
-1.79E+04	2.52E+03	3.68E+06	3.32E+08
-1.79E+04	1.26E+03	1.32E+07	3.45E+08
-1.79E+04	0.00E+00	2.43E+07	3.70E+08
-1.93E+04	3.66E+04	7.55E+03	3.70E+08
-1.93E+04	3.53E+04	8.06E+03	3.70E+08
-1.93E+04	3.40E+04	1.56E+04	3.70E+08
-1.93E+04	3.15E+04	1.52E+04	3.70E+08
-1.93E+04	3.03E+04	2.17E+04	3.70E+08
-1.93E+04	2.90E+04	1.23E+03	3.70E+08
-1.93E+04	2.77E+04	2.56E+03	3.70E+08
-1.93E+04	2.65E+04	4.99E+03	3.70E+08
-1.93E+04	2.52E+04	2.78E+03	3.70E+08
-1.93E+04	2.40E+04	2.13E+04	3.70E+08
-1.93E+04	2.27E+04	6.05E+03	3.70E+08
-1.93E+04	2.14E+04	1.22E+04	3.70E+08
-1.93E+04	2.02E+04	2.73E+04	3.70E+08
-1.93E+04	1.89E+04	3.72E+04	3.70E+08
-1.93E+04	1.77E+04	4.02E+04	3.70E+08
-1.93E+04	1.64E+04	2.84E+04	3.70E+08
-1.93E+04	1.51E+04	1.03E+05	3.70E+08
-1.93E+04	1.39E+04	1.25E+05	3.70E+08
-1.93E+04	1.26E+04	1.53E+05	3.70E+08
-1.93E+04	1.13E+04	1.93E+05	3.70E+08
-1.93E+04	1.01E+04	3.07E+05	3.71E+08
-1.93E+04	8.83E+03	2.87E+05	3.71E+08
-1.93E+04	7.57E+03	4.70E+05	3.71E+08
-1.93E+04	6.30E+03	6.44E+05	3.72E+08
-1.93E+04	5.04E+03	7.40E+05	3.73E+08
-1.93E+04	3.78E+03	1.64E+06	3.74E+08
-1.93E+04	2.52E+03	4.45E+06	3.79E+08
-1.93E+04	1.26E+03	1.49E+07	3.94E+08
-1.93E+04	0.00E+00	2.66E+07	4.20E+08
-2.07E+04	3.40E+04	6.40E+03	4.20E+08
-2.07E+04	3.28E+04	7.55E+03	4.20E+08
-2.07E+04	3.15E+04	7.59E+03	4.20E+08
-2.07E+04	3.03E+04	8.58E+03	4.20E+08
-2.07E+04	2.90E+04	4.74E+04	4.21E+08
-2.07E+04	2.77E+04	5.04E+02	4.21E+08
-2.07E+04	2.65E+04	7.55E+03	4.21E+08
-2.07E+04	2.52E+04	1.90E+03	4.21E+08
-2.07E+04	2.40E+04	1.05E+04	4.21E+08
-2.07E+04	2.27E+04	8.46E+03	4.21E+08
-2.07E+04	2.14E+04	1.55E+04	4.21E+08
-2.07E+04	2.02E+04	1.07E+04	4.21E+08
-2.07E+04	1.89E+04	5.33E+04	4.21E+08
-2.07E+04	1.77E+04	3.50E+04	4.21E+08
-2.07E+04	1.64E+04	5.05E+04	4.21E+08
-2.07E+04	1.51E+04	7.67E+04	4.21E+08

-2.07E+04	1.39E+04	8.59E+04	4.21E+08
-2.07E+04	1.26E+04	9.61E+04	4.21E+08
-2.07E+04	1.13E+04	1.78E+05	4.21E+08
-2.07E+04	1.01E+04	2.49E+05	4.21E+08
-2.07E+04	8.83E+03	3.29E+05	4.22E+08
-2.07E+04	7.57E+03	4.03E+05	4.22E+08
-2.07E+04	6.30E+03	7.02E+05	4.23E+08
-2.07E+04	5.04E+03	9.10E+05	4.24E+08
-2.07E+04	3.78E+03	1.64E+06	4.25E+08
-2.07E+04	2.52E+03	4.33E+06	4.30E+08
-2.07E+04	1.26E+03	1.62E+07	4.46E+08
-2.07E+04	0.00E+00	2.73E+07	4.73E+08
-2.20E+04	3.15E+04	1.90E+03	4.73E+08
-2.20E+04	3.03E+04	1.47E+04	4.73E+08
-2.20E+04	2.90E+04	7.55E+03	4.73E+08
-2.20E+04	2.77E+04	3.23E+04	4.73E+08
-2.20E+04	2.65E+04	2.27E+04	4.73E+08
-2.20E+04	2.52E+04	5.71E+03	4.73E+08
-2.20E+04	2.40E+04	3.35E+04	4.73E+08
-2.20E+04	2.27E+04	1.33E+04	4.73E+08
-2.20E+04	2.14E+04	6.74E+03	4.73E+08
-2.20E+04	2.02E+04	8.02E+03	4.73E+08
-2.20E+04	1.89E+04	1.27E+04	4.73E+08
-2.20E+04	1.77E+04	4.07E+04	4.73E+08
-2.20E+04	1.64E+04	2.74E+04	4.73E+08
-2.20E+04	1.51E+04	5.60E+04	4.74E+08
-2.20E+04	1.39E+04	7.37E+04	4.74E+08
-2.20E+04	1.26E+04	1.26E+05	4.74E+08
-2.20E+04	1.13E+04	1.68E+05	4.74E+08
-2.20E+04	1.01E+04	2.10E+05	4.74E+08
-2.20E+04	8.83E+03	3.04E+05	4.74E+08
-2.20E+04	7.57E+03	5.08E+05	4.75E+08
-2.20E+04	6.30E+03	6.59E+05	4.76E+08
-2.20E+04	5.04E+03	8.91E+05	4.76E+08
-2.20E+04	3.78E+03	1.62E+06	4.78E+08
-2.20E+04	2.52E+03	4.45E+06	4.83E+08
-2.20E+04	1.26E+03	1.72E+07	5.00E+08
-2.20E+04	0.00E+00	2.92E+07	5.29E+08
-2.34E+04	3.15E+04	1.90E+03	5.29E+08
-2.34E+04	2.90E+04	6.68E+03	5.29E+08
-2.34E+04	2.77E+04	1.66E+04	5.29E+08
-2.34E+04	2.65E+04	6.37E+04	5.29E+08
-2.34E+04	2.52E+04	1.51E+04	5.29E+08
-2.34E+04	2.40E+04	5.33E+04	5.29E+08
-2.34E+04	2.27E+04	4.48E+04	5.29E+08
-2.34E+04	2.14E+04	4.79E+04	5.29E+08
-2.34E+04	2.02E+04	6.99E+03	5.29E+08
-2.34E+04	1.89E+04	2.84E+04	5.29E+08
-2.34E+04	1.77E+04	1.44E+04	5.29E+08
-2.34E+04	1.64E+04	3.28E+04	5.29E+08
-2.34E+04	1.51E+04	3.90E+04	5.29E+08

-2.34E+04	1.39E+04	5.35E+04	5.29E+08
-2.34E+04	1.26E+04	1.08E+05	5.29E+08
-2.34E+04	1.13E+04	1.08E+05	5.30E+08
-2.34E+04	1.01E+04	1.68E+05	5.30E+08
-2.34E+04	8.83E+03	2.73E+05	5.30E+08
-2.34E+04	7.57E+03	4.30E+05	5.30E+08
-2.34E+04	6.30E+03	4.83E+05	5.31E+08
-2.34E+04	5.04E+03	1.04E+06	5.32E+08
-2.34E+04	3.78E+03	1.59E+06	5.34E+08
-2.34E+04	2.52E+03	3.74E+06	5.37E+08
-2.34E+04	1.26E+03	1.64E+07	5.54E+08
-2.34E+04	0.00E+00	2.66E+07	5.80E+08
-2.48E+04	2.77E+04	6.37E+03	5.80E+08
-2.48E+04	2.65E+04	6.61E+03	5.80E+08
-2.48E+04	2.52E+04	2.50E+04	5.80E+08
-2.48E+04	2.40E+04	4.08E+04	5.80E+08
-2.48E+04	2.27E+04	9.55E+03	5.80E+08
-2.48E+04	2.14E+04	5.78E+04	5.80E+08
-2.48E+04	2.02E+04	5.86E+04	5.80E+08
-2.48E+04	1.89E+04	2.58E+04	5.80E+08
-2.48E+04	1.77E+04	3.94E+04	5.81E+08
-2.48E+04	1.64E+04	3.87E+04	5.81E+08
-2.48E+04	1.51E+04	1.21E+05	5.81E+08
-2.48E+04	1.39E+04	9.56E+04	5.81E+08
-2.48E+04	1.26E+04	6.58E+04	5.81E+08
-2.48E+04	1.13E+04	1.03E+05	5.81E+08
-2.48E+04	1.01E+04	1.70E+05	5.81E+08
-2.48E+04	8.83E+03	1.77E+05	5.81E+08
-2.48E+04	7.57E+03	2.89E+05	5.82E+08
-2.48E+04	6.30E+03	4.72E+05	5.82E+08
-2.48E+04	5.04E+03	8.24E+05	5.83E+08
-2.48E+04	3.78E+03	1.43E+06	5.84E+08
-2.48E+04	2.52E+03	3.68E+06	5.88E+08
-2.48E+04	1.26E+03	1.57E+07	6.04E+08
-2.48E+04	0.00E+00	2.51E+07	6.29E+08
-2.62E+04	2.65E+04	1.64E+04	6.29E+08
-2.62E+04	2.52E+04	1.43E+04	6.29E+08
-2.62E+04	2.40E+04	1.76E+04	6.29E+08
-2.62E+04	2.27E+04	2.27E+04	6.29E+08
-2.62E+04	2.14E+04	4.01E+04	6.29E+08
-2.62E+04	2.02E+04	3.26E+04	6.29E+08
-2.62E+04	1.89E+04	1.28E+05	6.29E+08
-2.62E+04	1.77E+04	8.33E+04	6.29E+08
-2.62E+04	1.64E+04	2.82E+04	6.29E+08
-2.62E+04	1.51E+04	8.77E+04	6.29E+08
-2.62E+04	1.39E+04	5.90E+04	6.29E+08
-2.62E+04	1.26E+04	1.19E+05	6.29E+08
-2.62E+04	1.13E+04	6.26E+04	6.29E+08
-2.62E+04	1.01E+04	1.78E+05	6.30E+08
-2.62E+04	8.83E+03	1.65E+05	6.30E+08
-2.62E+04	7.57E+03	2.95E+05	6.30E+08

-2.62E+04	6.30E+03	4.21E+05	6.31E+08
-2.62E+04	5.04E+03	5.26E+05	6.31E+08
-2.62E+04	3.78E+03	1.26E+06	6.32E+08
-2.62E+04	2.52E+03	3.58E+06	6.36E+08
-2.62E+04	1.26E+03	1.52E+07	6.51E+08
-2.62E+04	0.00E+00	2.42E+07	6.75E+08
-2.75E+04	2.65E+04	4.78E+03	6.75E+08
-2.75E+04	2.52E+04	4.78E+03	6.75E+08
-2.75E+04	2.40E+04	8.08E+03	6.75E+08
-2.75E+04	2.27E+04	1.48E+04	6.75E+08
-2.75E+04	2.14E+04	2.48E+04	6.75E+08
-2.75E+04	2.02E+04	4.33E+04	6.75E+08
-2.75E+04	1.89E+04	7.04E+04	6.76E+08
-2.75E+04	1.77E+04	1.09E+05	6.76E+08
-2.75E+04	1.64E+04	1.66E+05	6.76E+08
-2.75E+04	1.51E+04	1.53E+05	6.76E+08
-2.75E+04	1.39E+04	1.44E+05	6.76E+08
-2.75E+04	1.26E+04	1.28E+05	6.76E+08
-2.75E+04	1.13E+04	7.17E+04	6.76E+08
-2.75E+04	1.01E+04	1.32E+05	6.76E+08
-2.75E+04	8.83E+03	1.87E+05	6.77E+08
-2.75E+04	7.57E+03	2.45E+05	6.77E+08
-2.75E+04	6.30E+03	4.01E+05	6.77E+08
-2.75E+04	5.04E+03	7.12E+05	6.78E+08
-2.75E+04	3.78E+03	1.13E+06	6.79E+08
-2.75E+04	2.52E+03	3.20E+06	6.82E+08
-2.75E+04	1.26E+03	1.59E+07	6.98E+08
-2.75E+04	0.00E+00	2.46E+07	7.23E+08
-2.89E+04	2.27E+04	4.78E+03	7.23E+08
-2.89E+04	2.14E+04	4.90E+03	7.23E+08
-2.89E+04	2.02E+04	8.32E+03	7.23E+08
-2.89E+04	1.89E+04	2.40E+04	7.23E+08
-2.89E+04	1.77E+04	3.08E+04	7.23E+08
-2.89E+04	1.64E+04	4.21E+04	7.23E+08
-2.89E+04	1.51E+04	6.84E+04	7.23E+08
-2.89E+04	1.39E+04	1.63E+05	7.23E+08
-2.89E+04	1.26E+04	2.24E+05	7.23E+08
-2.89E+04	1.13E+04	2.14E+05	7.24E+08
-2.89E+04	1.01E+04	2.24E+05	7.24E+08
-2.89E+04	8.83E+03	2.38E+05	7.24E+08
-2.89E+04	7.57E+03	3.05E+05	7.24E+08
-2.89E+04	6.30E+03	3.98E+05	7.25E+08
-2.89E+04	5.04E+03	7.59E+05	7.26E+08
-2.89E+04	3.78E+03	1.39E+06	7.27E+08
-2.89E+04	2.52E+03	4.01E+06	7.31E+08
-2.89E+04	1.26E+03	2.08E+07	7.52E+08
-2.89E+04	0.00E+00	3.41E+07	7.86E+08
-3.03E+04	1.89E+04	9.56E+03	7.86E+08
-3.03E+04	1.77E+04	2.40E+02	7.86E+08
-3.03E+04	1.64E+04	7.10E+01	7.86E+08
-3.03E+04	1.51E+04	1.70E+04	7.86E+08

-3.03E+04	1.39E+04	4.85E+04	7.86E+08
-3.03E+04	1.26E+04	1.79E+05	7.86E+08
-3.03E+04	1.13E+04	2.19E+05	7.86E+08
-3.03E+04	1.01E+04	4.80E+05	7.87E+08
-3.03E+04	8.83E+03	7.35E+05	7.88E+08
-3.03E+04	7.57E+03	1.09E+06	7.89E+08
-3.03E+04	6.30E+03	1.60E+06	7.90E+08
-3.03E+04	5.04E+03	2.46E+06	7.93E+08
-3.03E+04	3.78E+03	3.18E+06	7.96E+08
-3.03E+04	2.52E+03	6.19E+06	8.02E+08
-3.03E+04	1.26E+03	3.00E+07	8.32E+08
-3.03E+04	0.00E+00	4.69E+07	8.79E+08
-3.17E+04	1.39E+04	1.11E+04	8.79E+08
-3.17E+04	1.26E+04	2.54E+04	8.79E+08
-3.17E+04	1.13E+04	9.70E+04	8.79E+08
-3.17E+04	1.01E+04	3.15E+05	8.80E+08
-3.17E+04	8.83E+03	7.13E+05	8.80E+08
-3.17E+04	7.57E+03	1.21E+06	8.81E+08
-3.17E+04	6.30E+03	2.49E+06	8.84E+08
-3.17E+04	5.04E+03	3.73E+06	8.88E+08
-3.17E+04	3.78E+03	4.61E+06	8.92E+08
-3.17E+04	2.52E+03	7.45E+06	9.00E+08
-3.17E+04	1.26E+03	3.42E+07	9.34E+08
-3.17E+04	0.00E+00	5.16E+07	9.85E+08
-3.31E+04	1.13E+04	2.40E+02	9.85E+08
-3.31E+04	8.83E+03	5.38E+04	9.86E+08
-3.31E+04	7.57E+03	6.64E+04	9.86E+08
-3.31E+04	6.30E+03	2.25E+05	9.86E+08
-3.31E+04	5.04E+03	5.51E+05	9.86E+08
-3.31E+04	3.78E+03	9.51E+05	9.87E+08
-3.31E+04	2.52E+03	2.22E+06	9.90E+08
-3.31E+04	1.26E+03	1.70E+07	1.01E+09
-3.31E+04	0.00E+00	2.95E+07	1.04E+09
-3.44E+04	5.04E+03	6.40E+03	1.04E+09
-3.44E+04	3.78E+03	3.57E+04	1.04E+09
-3.44E+04	2.52E+03	3.47E+05	1.04E+09
-3.44E+04	1.26E+03	4.92E+06	1.04E+09
-3.44E+04	0.00E+00	9.24E+06	1.05E+09
-3.58E+04	2.52E+03	5.11E+04	1.05E+09
-3.58E+04	1.26E+03	5.82E+05	1.05E+09
-3.58E+04	0.00E+00	1.55E+06	1.05E+09
-3.72E+04	2.52E+03	9.56E+03	1.05E+09
-3.72E+04	1.26E+03	4.88E+04	1.05E+09
-3.72E+04	0.00E+00	2.71E+05	1.05E+09
-3.86E+04	1.26E+03	1.66E+04	1.05E+09
-3.86E+04	0.00E+00	4.90E+04	1.05E+09
-3.99E+04	0.00E+00	9.56E+03	1.05E+09

Memo

Date: 11. September 2009

To: Offshore Foundation Designers

From: Technical Project Management, Vestas Offshore A/S PELNI

Re.: **Information for Offshore use of the document:**
Preliminary Foundation Loads – V112 3.0 MW HH 84 m IEC2A
Item no.: 0005-8547.V00

CC:

This memo is indented as a supplement to Item no.: 0005-8547.V00 “Preliminary Foundation Loads V112 3.0 MW HH 84 m IEC2A” when the loads are used for preliminary design of offshore foundation for V112 3.0 MW Offshore.

The following bullet points have to be kept in mind:

- The foundation loads in 0005-8547.V00 are simulated using an onshore setup, i.e. **no effects of hydrodynamic loading, foundation geometry and soil conditions are included in the loads**.

- The foundation loads in 0005-8547.V00 are simulated for a tower height of 81.6 m whereas a typical offshore tower will have a height of approximately 62 m* (HH 81 m MSL). Hence, the use of the foundation loads in 0005-8547.V00 will result in slightly conservative foundation designs.
  *The actual tower height is subject to site specific hub height requirements.

- The **permissible eigenfrequency interval** for the integrated V112 offshore wind turbine and foundation structure is **0.250 Hz – 0.266 Hz**.
  The stiffness requirements mentioned in Section 5 on page 6 do not apply for offshore foundations. Only the above mentioned eigenfrequency requirements have to be fulfilled.

- The IEC2A equivalent foundation fatigue loads in 0005-8547.V00 are equivalent to the loads corresponding to an IECS wind climate with a mean wind speed of 9.5 m/s and Class B turbulence.

The loads in 0005-8547.V00 are only to be used for preliminary offshore foundation designs and <u>not</u> for detailed design.

Vestas Wind Systems A/S
Alsvej 21, 8940 Randers SV, Denmark
Tel: +45 9730 0000, Fax: +45 9730 0001, E-mail: vestas@vestas.com, Web: www.vestas.com
Bank: Nordea Bank Danmark A/S, Reg. No.: 2100, Account No.: DKK 0651 117097 - EUR 5005 677997
Company Reg. No.: 10 40 37 82
Company Reg. Name: Vestas Wind Systems A/S