# Installation and Service Data, NM72, NM82, and V82

**Anyone using this document must read this document in its entirety before performing any work.**

**Any questions or concerns regarding any of the instructions contained in this document must be referred to Vestas.**

| Turbine type | Mk version |
|---|---|
| NM72C–1.5 MW | EVO 1 and EVO 2 |
| NM82-1.5 MW | EVO 1 and EVO 2 |
| NM72-1.65 MW | |
| NM82-1.65 MW | |
| V82-1.65 MW | Mk 2-5 |

## History of this document

| Version no. | Date | Description of changes |
|---|---|---|
| 16 | 2013-06-28 | Combined with 5001166, 5001054, 5001053, 5001537, 5001055, and 5001597. |

## Table of contents

| | **General** |
|---|---|
| | Note: This installation and service data document is valid only for standard turbine types. For project-specific turbines, refer to project-specific documentation. |

| | **Units** |
|---|---|
| | Note: All weights and dimensions in this document are specified in metric units (SI Units). |

# 1 Abbreviations and Technical Terms

| Abbreviation | Spelled-out form / explanation |
|---|---|
| HSS | High-Speed Shaft |
| LSS | Low-Speed Shaft |
| NDE | Non-Drive End |
| NSRG | Never-Seez Regular Grade |
| UPS | Uninterruptible Power Supply |
| VPM | Vestas Platform Module |

*Table 1-1: Abbreviations*

# 2 Tower

## 2.1 Bolt Torques

| Placement | Dim. | Quality | Surface treatment | Torque [Nm] | Lubrication, etc. |
|---|---|---|---|---|---|
| Bolt joints between tower sections | M36 | EN 14399-4/6 10.9 | tZn | 2800 | None |
| Tower base section / Embedded section (not all turbines) | M36 | EN 14399-4/6 10.9 | tZn | 2800 | None |
| Tower base section / foundation (turbines installed on foundation with anchors) | M36 | ISO 898-1 10.9 | | Refer to foundation drawing | None |
| Tower base section / Embedded section (not all turbines, the bolts are stretched) | M36 | DIN 6916 10.9 | | 2800 | None |
| Tower top flange / Nacelle | M30 | 10.9 | tZn | 1650 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 1475 | NSRG |
| Bottom / Foundation joint | Welded | | | | |

# 3 Avanti Service Lift

## 3.1 Maximum Load

| | |
|---|---|
| Maximum weight load | 240 kg |
| Maximum number of persons in the lift | 2 persons |

## 3.2 Hoisting Device (Tirak.X.402 P)

| | |
|---|---|
| Wire speed | 18 m/minute |
| Power | 1.5 kW |
| Current by 400 V | 3.5 A |
| Current by 690 V | 2.0 A |
| Wire diameter | 8 mm |
| Weight of device | 29.5 kg |

## 3.3 Trapping Device

| | |
|---|---|
| Loading capacity | 500 kg |
| Maximum wire speed (trapping point) | 18 m/minute |
| Wire diameter | 8 mm |
| Weight of device | 4.7 kg |
| Lubrication | Light oil |

## 3.4 Hoisting Wire and Safety Wire

| | |
|---|---|
| Wire diameter | 8 mm |
| Surface treatment | Galvanised |
| Minimum breaking strength | 39.7 kN |
| Connection to cross beam | 1/2 in 2000 kg shackle |
| Marking | Red string |
| Lubrication | Light oil |

## 3.5 Guide Wire

| | |
|---|---|
| Diameter | 8 mm |
| Minimum breaking strength | 85 kN |
| Surface treatment | Galvanised |
| Pre-tensioning | 2–4 kN |

| | |
|---|---|
| Connection to cross beam | G2130 shackle |
| Lubrication | Light oil |

## 3.6 Drills and Hole Depths for Anchor Bolts

| | |
|---|---|
| Diameter of drill for anchor bolt for guide wires | 16 mm |
| Diameter of drill for anchor bolt for safety wire | 8 mm |
| Hole depth for anchor bolt for guide wire | 75 mm |
| Hole depth for anchor bolt for safety wire | 75 mm |

## 3.7 Wire and Spring Stretching Lengths When Tightening Wires

| | |
|---|---|
| Guide wires | 55 mm |
| Spring on safety wire | 15 mm |

## 3.8 Locking Fluid and Seal for Attachment Beam Bolts

| | |
|---|---|
| Locking fluid | Loctite 2701 |
| Seal (Red) | Loctite 7400 |

# 4 Yaw System

## 4.1 Bolt Torques

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Yaw brake pad locating end stop (bolt quality can vary) | M16 | 10.9 | - | 220 | None |
| | | | | 219 | NSRG |
| Yaw brake pad locating end stop (bolt quality can vary) | M16 | 12.9 | - | 260 | None |
| Yaw brake pad locating end stop (FCHR 90 Calliper) | M20 | | | 360 | None |
| Yaw brake pad locating end stop (Calliper type BCH76A) | M16 | 8.8 | Zinc plated | 210 | None |
| Yaw brake pad locating end stop (Calliper type BCH859A) | M16 | 10.9 | Lacquer | 320 | Grease Molykote Rapid G+ |
| | | | Varnish Molykote 7409 | 140 | |

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Yaw brake pad locating end stop (calliper type FCHR90A) | M20 | 10.9 | Zinc plated | 210 | Grease Molykote Rapid G+ |
| Yaw brake pad locating end stop (calliper type FCHR90+90A) | M20 | 10.9 | Zinc plated | 320 | Grease Molykote Rapid G+ |
| Yaw gear | M12 | DIN 7991 8.8 | Black | 65 | Thread locking agent. Apply on thread. |
| Yaw bearing / Base frame | M30 | DIN 931-10.9 | tZn | 1700 | Mobiltac 81or Mobiltemp SHC460 Special |
| | | | | 1475 | NSRG |
| Yaw gear / Base frame (bolt size may vary) | M27 | 10.9 | tZn | 1250 | Mobiltac 81or Mobiltemp SHC460 Special |
| | | | HDG | 1080 | NSRG |
| Yaw gear / Base frame (bolt size may vary) | M16 | 10.9 | tZn | 240 | Mobiltac 81or Mobiltemp SHC460 Special |
| | | | | 219 | NSRG |
| Yaw brake calliper / Base frame | M27 | DIN 931-10.9 | tZn | 1250 | Mobiltac 81or Mobiltemp SHC460 Special |
| | | | | 1080 | NSRG |
| Yaw brake mounting plate / Base frame (not all turbines) | M20 | DIN 931-10.9 | tZn | 480 | Mobiltac 81or Mobiltemp SHC460 Special |
| | | | | 425 | NSRG |

## 4.2 Hydraulic Pressures - Yaw Brake Unit – Parker Version 1 and 2 (Turbines With Separate Yaw Hydraulic Unit)

| Component/function | | Reference pressure |
|---|---|---|
| Trimat TF56 lining.<br>Pads marked with:<br>Blue colour - RAL 5015 | Start hydraulic yaw | 150 bar |
| | Stop hydraulic yaw | 160 bar |
| | Relief valve (no. 0.16) | 25 bar/0 bar |
| | Relief valve (no. 0.12) | 180 bar |
| Standard (US 2.5) lining.<br>No colour or black marking | Start hydraulic yaw | 140 bar |
| | Stop hydraulic yaw | 150 bar |
| | Relief valve (no. 0.16) | 15 bar/0 bar |

| | | |
|---|---|---|
| | Relief valve (no. 0.12) | 170 bar |
| Accumulator pre-charge (main block) | | 90 bar |

## 4.3 Lubrication System

| Component (manufacturer) | Oil/grease type | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Yaw bearing – automatic lubrication | Mobil SHC Grease 460 WT | Fill up to level indicator. | Fill up to level indicator. |
| Yaw ring teeth | Omega 73 grease | 250-300 g | 75-150 g.<br>Apply extra grease only if necessary. |
| Yaw gear oil (1) (2) | Shell Omala S4 WE 320 (Shell Tivela S 320) | - | Check and fill up to level indicator. |
| Yaw gear grease (3) | Shell Gadus S2 V220AC 2 | | |
| Yaw ring bearing – manual lubrication (R. Erde) | Mobil SHC Grease 460 WT | | App. 300G (23g/nipple) |
| Yaw ring bearing – manual lubrication (IMO) | Mobil SHC Grease 460 WT | | App. 1300G (200g/nipple) |
| **Hydraulic power unit for yaw brakes (When Separate Hydraulic Unit – Parker Unit)** | | | |
| Hydraulic oil - yaw brakes | Mobil SHC 524 | - | Fill up to level indicator. |

**(1)** Some of the old yaw gears can contain either Mobilgear SHC XMP 320 or Shell Omala S4 WE 320 oil.

Service technicians must verify the type of yaw gear oil used, in case of refilling/changing it. The yaw gear oil information can be found from the nameplate and/or Sticker on the yaw gear.

**(2)** Do not mix Mobilgear SHC XMP 320 with Shell Omala S4 WE 320. Use the same oil type for refilling/changing.

**(3)** This product has also been known as Shell Retinax HD-2.

## 4.4 Yaw Brake – Lining Thickness

| Component/function | Value |
|---|---|
| Minimum brake lining thickness (excluding back plate) | 2 mm |

## 4.5 Matrix for Use of Yaw Brake Pads

| WTG Type | Revision | Design IEC Class | No. of Callipers | Yaw motor brake torque [Nm] | IEC 1 | | IEC 2 & 3 | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Black brake pad | Blue brake pad | Black brake pad | Blue brake pad |
| NM64C/1500 | – | IEC2b | 5 | 8 | Yes | No | Yes | Yes |
| NM72C/1500 | EVO 1 | IEC2b | 5 | 8 | Yes | No | Yes | Yes |
| NM72C/1500 | EVO 2 | IEC2b | 5 | 8 | Yes | No | Yes | Yes |
| NM72/1650 | – | IEC 1 | 6 | 15 | Yes | No | Yes | Yes |
| NM82/1500 | – | WZ II | 5 | 8/15 check type plate | Yes | No | Yes | Yes |
| NM82/1650 | – | IEC2a | 6 | 15 | Yes | No | Yes | Yes |
| V82–1.65 | – | IEC2a | 6 | 15 | Yes | No | Yes | Yes |

**NOTE** The first priority is to use black brake pads. If noise occurs, use blue brake pads according to the matrix.

# 5 Combined Yaw and Disc Brake Unit

## 5.1 Hydraulic Pressures

### 5.1.1 AVN BK 05

| | Combined Yaw and Disc Brake Unit – AVN BK 05 | | |
|---|---|---|---|
| | **Component / function** | | **Reference pressure** |
| | Standard (US2.5) lining **No colour or black marking** | Start hydraulic Yaw | 140 bar |
| | | Stop hydraulic Yaw | 150 bar |
| | | Relief valve (brake pressure when yawing) | 15 bar / 0 bar |
| | | Start hydraulic Disc Brake | 140 bar |
| | | Stop hydraulic Disc Brake | 150 bar |
| | | Relief valve (disc brake) | 170 bar |
| | Trimat TF 56 | Start hydraulic Yaw | 150 bar |
| | | Stop hydraulic Yaw | 160 bar |

| | **Combined Yaw and Disc Brake Unit – AVN BK 05** | | |
|---|---|---|---|
| | **Pads marked with:**<br>**Blue colour - RAL 5015** | Relief valve (brake pressure when yawing) | 25 bar / 0 bar |
| | | Relief valve (disc brake) | 170 bar |
| | Accumulator pre-charge (main block) | | 90 bar |
| | Accumulator pre-charge (1.0 L) / Disc brake | | 45 bar |

### 5.1.2 AVN BK 07 – AVN BK 08

| | **Combined Yaw and Disc Brake Unit – AVN BK 07 – AVN BK 08** | | |
|---|---|---|---|
| | **Component / function** | | **Reference pressure** |
| | Trimat TF56 lining.<br>Pads marked with:<br>Blue colour - RAL 5015 | Start hydraulic Yaw | 150 bar |
| | | Stop hydraulic Yaw | 160 bar |
| | | Relief valve (brake pressure when yawing) | 25 bar / 0 bar |
| | | Start hydraulic Disc Brake | 150 bar |
| | | Stop hydraulic Disc Brake | 160 bar |
| | | Relief valve (disc brake) | 180bar |
| | Standard (US2.5) lining<br>No colour or black marking | Start hydraulic Yaw | 140 bar |
| | | Stop hydraulic Yaw | 150 bar |
| | | Relief valve (brake pressure when yawing) | 15 bar / 0 bar |
| | | Start hydraulic Disc Brake | 140 bar |
| | | Stop hydraulic Disc Brake | 150 bar |
| | | Relief valve (disc brake) | 170 bar |
| | Accumulator pre-charge (main block) | | 90 bar |
| | Accumulator pre-charge (1.0 L) / Disc brake | | 45 bar |

## 5.2 Lubrication System

| **Component (manufacturer)** | **Oil/grease type** | **Quantity** | |
|---|---|---|---|
| | | **Initial** | **Service** |
| **Hydraulic power unit for Combined Yaw & Disc Brake Unit – AVN BK 07** | | | |
| Hydraulic oil combined yaw & disc brake unit | Mobil SHC 524 | - | Fill up to level indicator. |

# 6 Main Shaft and Main Bearing

## 6.1 Bolt Torques

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Main shaft / hub | M36x410 ***(EVO 1+ 2 hub)*** | ISO 4014 10.9 U | tZn | 2560 | NSRG<br>To be torqued as standard until properly tested. |
| | | | | Installation: 1260Nm +120º Inspection torque: 2320Nm | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | M36x350 ***(Mk 3 hub)*** | | | 2560 | To be torqued as standard until properly tested. |
| | | | | Installation: 1150Nm +90º Inspection torque: 2320Nm | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | M36 | EN 24014-10.9 | tZn | 2900 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| Bearing housing / base frame (bolt quality can vary) | M60 | 10.9 U | tZn | 14200 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 12250 | NSRG<br>Molycote P74 |
| Bearing housing / base frame (bolt quality can vary) | M60 | 8.8 | tZn | 10100 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | HDG | 9150 | NSRG |
| Main bearing cover-front | M24 | 8.8 | tZn | 590 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 535 | NSRG |
| Main bearing cover-rear | M16 | 8.8 | tZn | 170 | Mobiltac 81 or Mobiltemp SHC 460 Special |

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| | | | | 156 | NSRG |
| Lip seal cover (front / rear) | M12 | 8.8 | tZn | 69 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 62 | NSRG |

## 6.2 Lubrication System

| Component (manufacturer) | grease type | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Main bearing | SKF LGWM 1 | 18 kg in new bearing. | Fill up to level indicator on grease pump. |
| | Mobil SHC Grease 460 WT | Manual: 13.5 kg<br>Auto: according to level indicator | Manual: 800g<br>Auto: according to level indicator |
| Sealing ring | Mobil SHC Grease 460 WT | | Nipple: Lubricate until a surplus of grease is observed coming evenly out of the circumference of the lip seal or lubricate the lip seal manually using a brush. Manually lubricating the lip seal with a brush must only be done on bearing seal housings with no grease nipple. On these bearings there is only one internal seal that is lubricated with the bearing grease during operation. Bearings with a grease nipple have two internal seals, of which the outermost is lubricated via the grease nipple. |

# 7 Pitch Block (for V82-1.65 MW Mk 4-5 Only)

| Position | Description (Model Code) | Tightening Torque |
|---|---|---|
| 205, 205A | 4WREE 10 R75-2X/G24K31/F1V-741 | 12.5 Nm |
| 210, 215 | KSDEU1CB/HN0V | 60 (+5) Nm |
| 211, 216 | COIL GZ37-4 24VDC 22W | 5 (+1) Nm |
| 225 | CHECK VALVE – M-SR 15KE02-1X/ | |
| 226 | CHECK VALVE – M-SR 15KE50-1X/ | |
| 230, 235, 250 | HY-CHECK VALVE – KED0R2DA/HV | 100-110 Nm |
| 240, 245 | HY-CHECK VALVE – KGD0R2BA/HV | 100-110 Nm |
| 255 | ORIFICE 1, 2-7-M6X6-ST | 3.5 Nm |
| 256 | ORIFICE 0, 8-7-M6X6-ST | 3.5 Nm |
| 270, 275 | ORIFICE 3, 4-7-R1/4-ST | 40-48 Nm |
| 278, 279 | FILTER ELEMENT 99.133409G100-S00-0-0 | 7.5 Nm |
| 290 | PRESSURE TRANSDUCER MBS3000-3611-1GB04 | 40 (+10) Nm |
| 280-284 | TEST PT.FITTING AB20-11/K1 G1/4 | 30 Nm |
| 220 | PRESS. RELIEF VALVE A510-04J-G01 | 45 (+5) Nm |
| 222 | THROTTLE VALVE A401-22J-G01 | 45 (+5) Nm |
| 223 | STAR KNOB 9/16 KOMPL. 991-034 | |
| #1 | SCREW PLUG RN1-14321-G1/8-ST | 10 Nm |
| #3 | SCREW PLUG RN1-14321-G3/8-ST | 35 Nm |
| #4 | SCREW PLUG RN1-14321-G1/2-ST | 60 Nm |
| #5 | SCREW PLUG RN1-14321-G3/4-ST | 90 Nm |
| #8 | O-RING 32, 92X3, 53-N-NBR90 | |
| | SOCKET HEAD SCREW ISO4762-M6X40-10.9 | |

# 8 High-Speed Shaft (HSS) Brake - Disc Brake (for V82-1.65 MW Only)

## 8.1 Lubrication System

| Component (manufacturer) | Oil / grease type | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Hydraulic oil disc brake unit | Mobil SHC 524 | - | Fill up to level indicator. |

## 8.2 Hydraulic Pressures

| Component/function | Reference pressure |
|---|---|
| Start hydraulic pump | 105 bar |
| Stop hydraulic pump | 115 bar |
| Relief valve | 160 bar ± 3 |
| Accumulator pre-charge (1 l) | 60 bar ± 3 at 20°C |
| Accumulator pre-charge (0.5 l) | 31 bar ± 2 at 20°C |

## 8.3 Other Information

| Component/function | Value |
|---|---|
| Minimum brake lining thickness (excluding back plate) | 2 mm |
| Thickness of brake disc | Minimum 26 mm |
| Distortion brake disc | Maximum 0.5 mm |

# 9 Brembo Disc Brake Calliper

## 9.1 Bolt Torques

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Mounting bracket / Gearbox | M20 | ISO 4014 10.9 | tZn | 480 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 425 | NSRG |

## 9.2 Other Information

| Component/function | Value |
|---|---|
| Minimum brake lining thickness (exclusive backplate) | 2 mm |
| Thickness of brake disc | Minimum 26 mm |
| Distortion brake disc | Maximum 0.5 mm |

# 10 SIME Disc Brake Calliper

## 10.1 Bolt Torques - SIME SHD7E

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Shrink disc / Gearbox shaft | M20 | DIN 931 – 10.9 | tZn | 480 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 425 | NSRG |
| Brake / Brake bracket | M24 | 10.9 | tZn | 840 | Mobiltac 81 or Mobiltemp SHC 460 Special NSRG |
| | | | | 735 | NSRG |
| Brake bracket / Gearbox | M20 | DIN 931 – 10.9 | tZn | 425 | Thread locking agent |
| | | | | 480 | Loctite 243 |
| | | | | 520 | Loctite 243 |

## 10.2 Other Information

| Component/function | Value |
|---|---|
| Thickness of the remaining brake lining on each pad | 3 mm – 4 mm* |
| Thickness of brake disc | Minimum 26 mm |
| Distortion brake disc | Maximum 0.5 mm |

*The thickness of the brake pad for turbines with very few errors causing brake activation is 3 mm. The thickness of the brake pad for turbines with frequent errors causing brake activation is 4 mm.

# 11 Svendborg Disc Brake Calliper

## 11.1 Bolt Torques - Svendborg BSFI 3000

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Brake mounting bolts ( not all types) | M36 | 8.8 | - | 1960 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| Shrink disc / Gearbox shaft | M20 | DIN 931 – 10.9 | tZn | 480 | Mobiltac 81 *or* Mobiltemp SHC 460 Special |

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Brake callipers / Brake base (big) – (Bolt quality can vary) | M24 | 10.9 | - | 840 | Mobiltac 81 *or* Mobiltemp SHC 460 Special |
| Brake callipers / Brake base (small) – (Bolt quality can vary) | M20 | 10.9 | - | 492 | Mobiltac 81 *or* Mobiltemp SHC 460 Special |
| Brake callipers / Brake base (big) – (Bolt quality can vary) | M24 | A4 | - | 640 | Mobiltac 81 *or* Mobiltemp SHC 460 Special |
| Brake callipers / Brake base (dmall) – (Bolt quality can vary) | M20 | A4 | - | 370 | Mobiltac 81 *or* Mobiltemp SHC 460 Special |
| Brake bracket / Gearbox | M20 | DIN 931 – 10.9 | tZn | 480<br>520 | Loctite 243 |

## 11.2 Bolt Torques - Svendborg BSFI 3040

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Shrink disc / Gearbox shaft | M20 | DIN 931 – 10.9 | tZn | 425 | NSRG |
| Brake callipers / Brake base (big) | M24 | 10.9 | - | 740 | NSRG |
| Brake callipers / Brake base (small) | M20 | 10.9 | - | 425 | NSRG |
| Brake callipers / Brake base (big) | M24 | A4 | - | 370 | NSRG |
| Brake callipers / Brake base (small) | M20 | A4 | - | 270 | NSRG |
| Brake bracket / Gearbox | M20 | DIN 931 – 10.9 | tZn | 425 | Thread locking agent |

## 11.3 Other Information

| Component/function | Value |
|---|---|
| Brake worn-switch | 12 mm |
| Thickness of brake pad | Minimum 27 mm |
| Thickness of brake disc | Minimum 26 mm |
| Distortion brake disc | Maximum 0.5 mm |

# 12 Gearbox

## 12.1 Bolt Torques

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Main shaft / shrink disc Type HSD 720-81-1 (indicated on shrink disc) | M33 | 12.9 | Black | See label, otherwise 2500 | NSRG |
| | | | | 2650 | Use Stüwe bolts with M0S2 with grease on thread and surface under bolt head. Tighten in a star pattern. Bolt head must be corrosion protected. |
| Main shaft / shrink disc Type HSD 720-22-7 (indicated on shrink disc) | M33 | 10.9 | Black | See label, otherwise 2080 | NSRG |
| | | | | See label, otherwise 1985 | Tighten in a star pattern |
| Main shaft / shrink disc Type TAS 317.1-720 (indicated on shrink disc) | M33 | 12.9 | Black | See label, otherwise 2150 | NSRG |
| | | | | 2150 | Use Stüwe bolts with M0S2 with grease on thread and surface under bolt head. Tighten in a star pattern. Bolt head must be corrosion protected. |
| Main shaft / shrink disc Type FSD 720 (indicated on shrink disc) | M30 | 10.9 | Black | See label, otherwise 1540 | NSRG Tighten in a star pattern. |
| Gear stay / Base frame | M24 | 10.9 | tZn | 840 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 735 | NSRG |
| Gear Stay / Base Frame | M27 | 10.9 | tZn | 1250 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 1080 | NSRG |

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Bolts in shrink disc | M30 | ISO 4014 12.9 | Black | 1700 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| Rotor blocking / Gearbox | M20 | DIN 931 10.9 | tZn | 480 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 425 | NSRG |

## 12.2 Lubrication System

| Component (manufacturer) | Oil / grease type | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Gearbox (Hansen EH803) | Mobilgear SHC XMP 320 | 265 l - Fill up to level indicator. | Fill up to level indicator. |
| | Castrol Optigear Synthetic CT 320 | | |
| Gearbox (Winergy PEAB 4420) | Mobilgear SHC XMP 320 | 260 l - Fill up to level indicator. | Fill up to level indicator. |
| | Castrol Optigear Synthetic CT 320 | | |
| Gearbox (JaKe PSC1431 or 1430) | Mobilgear SHC XMP 320 | 260 l - Fill up to level indicator. | Fill up to level indicator. |
| | Castrol Optigear Synthetic CT 320 | | |
| Gearbox (Flender) | Mobilgear SHC XMP 320 | 225 l - Fill up to level indicator | According to level indicator |
| | Castrol Optigear Synthetic CT 320 | | |
| Gearbox (Metso) | Mobilgear SHC XMP 320 | 220 l - Fill up to level indicator | According to level indicator |
| | Castrol Optigear Synthetic CT 320 | | |
| Gearbox (L+S/Rexroth GPV42)) | Mobilgear SHC XMP 320 | 300 l - Fill up to level indicator | According to level indicator |
| | Castrol Optigear Synthetic CT 320 | | |

## 13 Centalink Coupling

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Link element / shrink disc | M20 | ISO 4762 | - | 400 | NSRG |
| Link element / rubber element | M20 | ISO 4762 | - | 400 | NSRG |
| Bolts in rubber element | M16 | ISO 4762 | - | 230 | NSRG |
| Brake disc / coupling | M16 | ISO 4762 | - | 240 | NSRG |
| Brake disc / coupling | M20 | ISO 4014 10.9 | tZn | 480 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 425 | NSRG |
| Coupling / generator | M20 | ISO 4014 10.9 | tZn | 480 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 425 | NSRG |
| Coupling element / coupling | M20 | ISO 4014 10.9 | tZn | 480 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 425 | NSRG |
| Shrink disc on generator shaft | M20 | ISO 4014 10.9 | tZn | 480 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 425 | NSRG |

## 14 Generator

### 14.1 Bolt Torques

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Generator / generator support | M24 | 8.8 | tZn | 590 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 535 | NSRG |
| Generator / generator support (not standard) | M20 | 8.8 | tZn | 310 | NSRG |
| | | | | 340 | Loctite 243 |

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Generator support / base frame | M12 | 8.8 | tZn | 69 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 62 | NSRG |

## 14.2 Lubrication System

### 14.2.1 For V82-1.65 MW Mk 4-5

| Component (manufacturer) | Oil / grease type | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Drive End / N-DE Bearing (Winergy LOHER) | Mobilith SHC 100 | 980 g | Fill up to level indicator on grease pump. |
| Drive End / N-DE Bearing Winergy 60 Hz and 50 Hz From serial number 514655 | Klüberplex BEM 41-141 | 980 g | Fill up to level indicator on grease pump. |
| Drive End / N-DE Bearing ELIN 60 Hz, 504954A-D ELIN 50 Hz, 504958A-B ELIN 50 Hz, 505050A | Mobilith SHC 100 | 1.1 kg | Fill up to level indicator on grease pump. |
| Drive End / N-DE Bearing ELIN :60 Hz, 5054954E-F ELIN50 Hz, 504958C-D ELIN50 Hz, 505050B | Klüberplex BEM 41-141 | 980 g | Fill up to level indicator on grease pump. |

### 14.2.2 For V82-1.65 MW Mk 2-3, NM72/82-1.65 MW, and NM82-1.5 MW

| Component (manufacturer) | Oil / grease type | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Front / rear bearing (Elin) – Automatic lubrication | Mobilith SHC 100 | 980 g | Fill up to level indicator |

### 14.2.3 For NM72C-1.5 MW

| Component (manufacturer) | Oil / grease type | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Front bearing (50 Hz ABB generator) | Shell Gadus S2 V100 3 (Shell Alvania RL 3) | | 80 g |
| Rear bearing (50 Hz ABB generator) | Shell Gadus S2 V100 3 (Shell Alvania RL 3) | | 70 g |
| Front bearing (60 Hz ABB generator) | Mobilith SHC 100 | | 80 g |

| Component (manufacturer) | Oil / grease type | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Rear bearing (60 Hz ABB generator) | Mobilith SHC 100 | | 70 g |
| Front / rear bearing (Elin) | Mobilith SHC 100 | 980 g | 160 g / bearing |

## 14.3 Generator Support - Maximum and Minimum Adjustment Distance

| Component/function | Value |
|---|---|
| Minimum adjustment distance | 82 mm |
| Maximum adjustment distance | 112 mm |

## 14.4 Cooling System

| Component (manufacturer) | Coolant | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Generator cooling system (ABB) | Standard & Tropical<br>44% glycol / 56% demineralised water | 63 l (preliminary data) | At installation:<br>Approximately 25 l. |
| | Arctic<br>55% glycol / 45% demineralised water | | |
| Elin Winergy (LOHER) | Standard & Tropical<br>44% glycol / 56% demineralised water | 53 l | At installation:<br>Approximately 25 l. |
| | Arctic<br>55% glycol / 45% demineralised water | | |

# 15 Blades

## 15.1 Stud Bolt Protrusion Length From Blade Root Flange

| Blade bearing | Protrusion length |
|---|---|
| Rothe Erde | 270 mm ± 5 mm |
| IMO | 258 mm ± 5 mm |
| Laulagun | 270 mm ± 5 mm |

## 15.2 Stud Bolt Lengths

| Blade type | Bearing type | Dimension | Quality | Surface treatment | Stud length |
|---|---|---|---|---|---|
| LM | IMO, Rothe Erde and Laulagun | M30 | 10.9 | Delta GZ | 574 |
| AL | IMO | M30 | 10.9 | Delta GZ | 390 |
| AL | Rothe Erde and Laulagun | M30 | 10.9 | Delta GZ | 405 |

## 16 Nacelle Cover and Base Frame

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Top part of nacelle cover / Rubber damper | M20 | ISO 4014 8.8 | tZn | 310 | NSRG |
| Base part of nacelle cover / Rubber damper | M20 | ISO 4014 8.8 U | tZn | 310 | NSRG |
| Rubber damper mounting plate / Top part of nacelle cover | M12 | ISO 4014 8.8 U | tZn | 69 | Thread locking agent or Loctite 243 |
| Rubber damper / Spacer plate | M12 | ISO 4014 – 8.8 U | tZn | 69 | Thread locking agent |
| Rubber damper / base frame | M12 | ISO 4014 – 8.8 U | tZn | 69 | Thread locking agent |
| Rubber damper / base frame | M20 | ISO 4014 – 8.8 | tZn | 360 | Loctite 243 |
| Base frame front / Base frame rear (bolt quality can vary – check on bolt head) | M24 | ISO 4014 – 10.9 | tZn | 840 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 735 | NSRG |
| Base frame front / Base frame rear (bolt quality can vary – check on bolt head) | M24 | ISO 4014 – 8.8 | tZn | 590 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| | | | | 535 | NSRG |

# 17 Fast Active Stall System – EVO 2

## 17.1 Bolt Torques

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Actuator bearing blocks / Hub | M30 | 10.9 | Delta GZ | 1400 | None |
| | | | | 1200 | Molycote P74 (only tZn bolts) |
| | | | | 1700 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| Hub / Blade bearing (bolt surface treatment may vary) | M30 | 10.9 U | Delta GZ tZn | 1475 | NSRG<br>To be torqued as standard until property tested. |
| | | | | Installation: 580Nm +60o<br>Inspection torque: 960Nm | Molycote P74 (only tZn bolts) |
| | | | | 1200 | None |
| Blade bearing / Blade | M30 | 10.9 | Delta GZ | 1475 | NSRG<br>Note: reduced shank diameter |
| | | | | 1400 | None |
| | | | | Installation: 700Nm + 90o<br>Inspection torque: 1120Nm | |
| Hub frame / Hub | M20 | A4–70 | | 220 | None |
| Hub frame / Hub | M20 | 8.8 | Delta Gz | 320 | None |
| Pump manifold / manifold studs | M20 | A4-70 or 8.8 | Delta Gz (if 8.8) | 320 | None |

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Actuator rod end bearing | M24 | 10.9 | NEL | 710 | None for the screw |
| Actuator rod end bearing | M20 | 10.9 | Black | 520 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| Motor / Motor support plate fasteners | M12 | 10.9 | NEL | 79 | None |
| Motor / Motor support plate fasteners | M12 | A4-70 | | 50 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| Motor / Motor support plate fasteners | M12 | 8.8 | A3C | 62 | NSRG |
| Accumulator bracket top clamp bolts | M12 | A4-70 | | 50 | Mobiltac 81 or Mobiltemp SHC 460 Special |
| Accumulator bracket top clamp bolts | M16 | A4-70 | | 73 | None |
| Actuator bearing blocks / Hub | M30 | 10.9 | Delta GZ | 1400 | None |
| Trunnion block jacking bolt | M33/M27 | Brass | | 20 | None |
| Counter nut for trunnion block jacking screws | M33/M27 | A4-70 | | 420 | None |
| Distribution manifold / Frame | M10 | 10.9 | NEL | 46 | None |
| Distribution manifold / Frame | M10 | 8.8 | A3C | 35 | NSRG |
| Pump / Filter manifold | M10 | 10.9 | NEL | 46 | None |
| Pump / Filter manifold | M10 | 8.8 | A3C | 35 | NSRG |
| Pump / Bell housing | M12 | 10.9 | NEL | 79 | None |
| Pump / Bell housing | M12 | 8.8 | A3C | 40 | NSRG |
| E-motor / Bell housing | M16 | 10.9 | NEL | 100 | None |
| E-motor / Bell housing | M16 | 8.8 | A3C | 100 | NSRG |
| Bearing attachment pin / Bearing attachment plate | M30 | 10.9 | HDG | 1800 | Mobiltac 81 or Mobiltemp SHC 460 Special |

## 17.2 Hydraulic Pressures

### 17.2.1 EVO 2

| Component/function | Reference pressure |
|---|---|
| Start hydraulic | 210 bar |
| Stop hydraulic | 230 bar |
| Relief valve | 248 bar or 250 bar (sub-supplier may vary) |
| Accumulator pre-charge (24.5 l) | 115 bar |
| Accumulator pre-charge (0.75 l) | 0.1 bar |

### 17.2.2 AVN B1884 (Standard, Tropical)

| Component/function | Reference pressure |
|---|---|
| Start hydraulic | 1. Stop pitch recharge done on alarm 448 < 80 bar<br>2. Middle pitch recharge pressure 170 bar<br>3. Run pitch recharge pressure 175 bar |
| Stop hydraulic | 1. Charge acc press (stop pos) 120 bar<br>2. Charge acc press (mid pos) 180 bar<br>3. Charge acc press (run pos) 190 bar |
| Relief valve | 215 bar |
| Accumulator pre-charge (0.07 l) / if present | 10 bar |
| Accumulator pre-charge (35 l) | 97 bar |
| Accumulator pre-charge (0.75 l) | 0.1 bar |

### 17.2.3 AVN B1933 (Arctic)

Under preparation.

## 17.3 Lubrication System

| Component (manufacturer) | Oil / grease type | Quantity | |
|---|---|---|---|
| | | Initial | Service |
| Blade bearings, standard/tropical turbines (automatic by grease pump) | Molykote long term 2 plus grease | Fill up to level indicator | Fill up to level indicator |
| Blade bearings, arctic turbines (automatic by lubrication pump) | Fuchs Stabyl LT50 | Fill up to level indicator | Fill up to level indicator |
| Actuator rod end bearing | Shell Rhodina BBZ<br>Shell Gadus S2 V100 3 (Shell Alvania RL 3) | | 20 g |
| Actuator trunnion block | Shell Rhodina BBZ<br>Shell Gadus S2 V100 3 (Shell Alvania RL 3) | | 20 g |
| Rotating union | Shell Rhodina BBZ<br>Shell Gadus S2 V100 3 (Shell Alvania RL 3) | | 40 g |
| Hydraulic oil active stall unit, (standard and high temperature versions) | Mobil SHC 524 | Approximately 280 l | Fill up to level indicator |
| Hydraulic oil active stall unit, (low temperature version) | Mobil AERO HF A or Mobil AERO HF | Approximately 280 l | Fill up to level indicator |
| High-pressure pump electrical motor bearings | Mobilith SHC 100 | | 15 g each bearing |

## 18 Nacelle Crane (TKS Crane)

| Component | Criteria |
|---|---|
| Overload lamella | From factory, clutch must be adjusted to be between 470 and 510 kg. |
| | Load must not exceed 250 kg. |
| Motor brake | |
| Air gap, 50 Hz version | Minimum 0.2 mm; Maximum 0.7 mm. |
| Air gap, 60 Hz version | Must not exceed 0.45 mm. |
| Thickness of brake rotor | If less than 4.5 mm, change complete motor with brake. |
| Crane hook and safety clip | Maximum allowable wear: 3 mm. |
| Thickness of hook | If less than 24 mm, replace crane hook. |
| Chain (5 links x 15 mm = 75 mm) | Maximum allowable wear (stretch) over 5 links is +1 mm. If wear exceeds the specified value, replace chain. |

## 19 Turbine-Specific Bolt Torques

The turbine-specific bolt torques are defined according to 920098 ‘Torque Wrench Settings’ or 960501 ‘Bolt Connections’. Bolts which are not listed under the turbine-specific bolt torques are torqued according to the general bolt torques.

### 19.1 General

Never retighten bolts secured with Loctite.

### 19.2 Low Temperature Requirements

All bolts from the nominal diameter M16 and up must respond to the following requirements:

- Quality 8.8 or 10.9.
- Impact strength of minimum 27 J at -40°C.

### 19.3 Vestas Platform Module (VPM)

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Threaded holes in adjustable legs of VPM sections. | All | - | - | 50 | None |

# 20 General Bolt Torques

The general bolt torques is found according to 920098 'Torque Wrench Settings' or 960501 'Bolt Connections'. The general bolt torques is only used for bolts which are not listed under the turbine specific bolt torques.

## 20.1 ISO 4014, ISO 4017, ISO 4762, Delta/Dacromet/Geomet-Treated Bolts Lubricated With Never-Seez Regular Grade

**NOTE** Quality **10.9 tZn** and **10.9 Zinc-flake-treated** (e.g. Delta-treated) bolts have the same torque at sizes larger than M10.

| **8.8** | | | **10.9** | | | **12.9** | | |
|---|---|---|---|---|---|---|---|---|
| M6 | 8 | Nm | M6 | 11 | Nm | M6 | 13 | Nm |
| M8 | 18 | Nm | M8 | 26 | Nm | M8 | 31 | Nm |
| M10 | 36 | Nm | M10 | 51 | Nm | M10 | 61 | Nm |
| M12 | 63 | Nm | M12 | 89 | Nm | M12 | 107 | Nm |
| M16 | 156 | Nm | M16 | 219 | Nm | M16 | 263 | Nm |
| M20 | 305 | Nm | M20 | 425 | Nm | M20 | 510 | Nm |
| M24 | 525 | Nm | M24 | 735 | Nm | M24 | 885 | Nm |
| M27 | 770 | Nm | M27 | 1080 | Nm | M27 | 1300 | Nm |
| M30 | 1050 | Nm | M30 | 1475 | Nm | M30 | 1770 | Nm |
| M33 | 1415 | Nm | M33 | 1990 | Nm | M33 | 2380 | Nm |
| M36 | 1820 | Nm | M36 | 2560 | Nm | M36 | 3080 | Nm |
| M39 | 2350 | Nm | M39 | 3300 | Nm | M39 | 3960 | Nm |
| M42 | 2910 | Nm | M42 | 4100 | Nm | M42 | 4920 | Nm |
| M45 | 3620 | Nm | M45 | 5100 | Nm | M45 | 6100 | Nm |
| M48 | 4400 | Nm | M48 | 6200 | Nm | M48 | 7400 | Nm |
| M52 | 5650 | Nm | M52 | 7900 | Nm | M52 | 9500 | Nm |
| M56 | 7050 | Nm | M56 | 9900 | Nm | M56 | 11850 | Nm |
| M60 | 8700 | Nm | M60 | 12250 | Nm | M60 | 14650 | Nm |
| M64 | 10500 | Nm | M64 | 14750 | Nm | M64 | 17700 | Nm |

*Table 20-1: Delta/Dacromet/Geomet-treated bolts lubricated with Never-Seez Regular Grade*

## 20.2 ISO 4014, ISO 4017, ISO 4762, tZn and Electroplated Bolts Lubricated With Never-Seez Regular Grade

**NOTE** Quality **10.9 tZn** and **10.9 zinc flake treated** (e.g. Delta-treated) bolts have the same torque at sizes larger than M10.

| 8.8 | | | 10.9 | | |
|---|---|---|---|---|---|
| M6 | 7 | Nm | M6 | 10 | Nm |
| M8 | 18 | Nm | M8 | 25 | Nm |
| M10 | 35 | Nm | M10 | 50 | Nm |
| M12 | 62 | Nm | M12 | 89 | Nm |
| M16 | 156 | Nm | M16 | 219 | Nm |
| M20 | 310 | Nm | M20 | 425 | Nm |
| M24 | 535 | Nm | M24 | 735 | Nm |
| M27 | 790 | Nm | M27 | 1080 | Nm |
| M30 | 1080 | Nm | M30 | 1475 | Nm |
| M33 | 1465 | Nm | M33 | 1990 | Nm |
| M36 | 1890 | Nm | M36 | 2560 | Nm |
| M39 | 2450 | Nm | M39 | 3300 | Nm |
| M42 | 3020 | Nm | M42 | 4100 | Nm |
| M45 | 3780 | Nm | M45 | 5100 | Nm |
| M48 | 4580 | Nm | M48 | 6200 | Nm |
| M52 | 5900 | Nm | M52 | 7900 | Nm |
| M56 | 7350 | Nm | M56 | 9900 | Nm |
| M60 | 9150 | Nm | M60 | 12250 | Nm |
| M64 | 11000 | Nm | M64 | 14750 | Nm |

*Table 20-2: tZn and electroplated bolts lubricated with Never-Seez Regular Grade*

## 20.3 ISO 4014, ISO 4017, ISO 4762, Untreated (Black) Bolts Lubricated With Never-Seez Regular Grade

| 8.8 | | | 10.9 | | | 12.9 | | |
|---|---|---|---|---|---|---|---|---|
| M6 | 8 | Nm | M6 | 11 | Nm | M6 | 13 | Nm |
| M8 | 19 | Nm | M8 | 27 | Nm | M8 | 33 | Nm |
| M10 | 38 | Nm | M10 | 54 | Nm | M10 | 65 | Nm |
| M12 | 66 | Nm | M12 | 93 | Nm | M12 | 112 | Nm |
| M16 | 163 | Nm | M16 | 230 | Nm | M16 | 275 | Nm |

| 8.8 | | | 10.9 | | | 12.9 | | |
|---|---|---|---|---|---|---|---|---|
| M20 | 320 | Nm | M20 | 445 | Nm | M20 | 535 | Nm |
| M24 | 550 | Nm | M24 | 770 | Nm | M24 | 925 | Nm |
| M27 | 805 | Nm | M27 | 1135 | Nm | M27 | 1360 | Nm |
| M30 | 1100 | Nm | M30 | 1540 | Nm | M30 | 1850 | Nm |
| M33 | 1480 | Nm | M33 | 2080 | Nm | M33 | 2500 | Nm |
| M36 | 1910 | Nm | M36 | 2680 | Nm | M36 | 3220 | Nm |
| M39 | 2460 | Nm | M39 | 3460 | Nm | M39 | 4160 | Nm |
| M42 | 3060 | Nm | M42 | 4300 | Nm | M42 | 5150 | Nm |
| M45 | 3800 | Nm | M45 | 5350 | Nm | M45 | 6400 | Nm |
| M48 | 4600 | Nm | M48 | 6450 | Nm | M48 | 7750 | Nm |
| M52 | 5900 | Nm | M52 | 8300 | Nm | M52 | 9950 | Nm |
| M56 | 7350 | Nm | M56 | 10350 | Nm | M56 | 12450 | Nm |
| M60 | 9100 | Nm | M60 | 12800 | Nm | M60 | 15350 | Nm |
| M64 | 11000 | Nm | M64 | 15450 | Nm | M64 | 18550 | Nm |

*Table 20-3: Untreated (black) bolts lubricated with Never-Seez Regular Grade*

## 20.4 ISO 4014, ISO 4017, ISO 4762, tZn and Electroplated Bolts, Dry or Locking Agent

**NOTE** Locking agent can only be used up to and including M20. This is because the clearance in the thread of larger bolts prevents the agent from growing stiff.

| 8.8 | | | 10.9 | | |
|---|---|---|---|---|---|
| M6 | 9 | Nm | M6 | 13 | Nm |
| M8 | 24 | Nm | M8 | 34 | Nm |
| M10 | 48 | Nm | M10 | 68 | Nm |
| M12 | 85 | Nm | M12 | 120 | Nm |
| M16 | 218 | Nm | M16 | 305 | Nm |
| M20 | 430 | Nm | M20 | 600 | Nm |
| M24 | 740 | Nm | M24 | 1045 | Nm |
| M27 | 1110 | Nm | M27 | 1560 | Nm |
| M30 | 1510 | Nm | M30 | 2120 | Nm |
| M33 | 2060 | Nm | M33 | 2900 | Nm |
| M36 | 2650 | Nm | M36 | 3720 | Nm |
| M39 | 3440 | Nm | M39 | 4860 | Nm |
| M42 | 4260 | Nm | M42 | 6000 | Nm |
| M45 | 5350 | Nm | M45 | 7500 | Nm |
| M48 | 6450 | Nm | M48 | 9100 | Nm |
| M52 | 8350 | Nm | M52 | 11750 | Nm |
| M56 | 10400 | Nm | M56 | 14650 | Nm |
| M60 | 13000 | Nm | M60 | 18250 | Nm |
| M64 | 15650 | Nm | M64 | 22000 | Nm |

*Table 20-4: tZn and electroplated bolts, dry or locking agent*

## 20.5 ISO 4014, ISO 4017, ISO 4762, Untreated (Black) Bolts, Dry or Locking Agent

| 8.8 | | | 10.9 | | | 12.9 | | |
|---|---|---|---|---|---|---|---|---|
| M6 | 11 | Nm | M6 | 15 | Nm | M6 | 19 | Nm |
| M8 | 27 | Nm | M8 | 38 | Nm | M8 | 45 | Nm |
| M10 | 53 | Nm | M10 | 75 | Nm | M10 | 90 | Nm |
| M12 | 93 | Nm | M12 | 131 | Nm | M12 | 157 | Nm |
| M16 | 232 | Nm | M16 | 325 | Nm | M16 | 390 | Nm |
| M20 | 450 | Nm | M20 | 635 | Nm | M20 | 765 | Nm |
| M24 | 780 | Nm | M24 | 1095 | Nm | M24 | 1315 | Nm |
| M27 | 1160 | Nm | M27 | 1630 | Nm | M27 | 1950 | Nm |
| M30 | 1570 | Nm | M30 | 2210 | Nm | M30 | 2650 | Nm |
| M33 | 2130 | Nm | M33 | 3000 | Nm | M33 | 3600 | Nm |
| M36 | 2740 | Nm | M36 | 3860 | Nm | M36 | 4620 | Nm |
| M39 | 3560 | Nm | M39 | 5000 | Nm | M39 | 6000 | Nm |
| M42 | 4400 | Nm | M42 | 6200 | Nm | M42 | 7400 | Nm |
| M45 | 5500 | Nm | M45 | 7750 | Nm | M45 | 9300 | Nm |
| M48 | 6650 | Nm | M48 | 9350 | Nm | M48 | 11200 | Nm |
| M52 | 8550 | Nm | M52 | 12050 | Nm | M52 | 14450 | Nm |
| M56 | 10700 | Nm | M56 | 15000 | Nm | M56 | 18050 | Nm |
| M60 | 13300 | Nm | M60 | 18650 | Nm | M60 | 22400 | Nm |
| M64 | 16000 | Nm | M64 | 22450 | Nm | M64 | 26950 | Nm |

*Table 20-5: Untreated (black) bolts, dry or locking agent*

## 20.6 ISO 10642, DIN 7991 Bolts Lubricated With Never-Seez Regular Grade

| A2/A4 - 70 | | | Quality 10.9 | | |
|---|---|---|---|---|---|
| M3 | 0.5 | Nm | M3 | 1 | Nm |
| M4 | 1.0 | Nm | M4 | 2 | Nm |
| M5 | 2.5 | Nm | M5 | 5 | Nm |
| M6 | 4.5 | Nm | M6 | 9 | Nm |
| M8 | 8 | Nm | M8 | 15 | Nm |
| M10 | 20 | Nm | M10 | 40 | Nm |
| M12 | 33 | Nm | M12 | 65 | Nm |
| M14 | 50 | Nm | M14 | 100 | Nm |
| M16 | 55 | Nm | M16 | 110 | Nm |

| A2/A4 - 70 | | | Quality 10.9 | | |
|---|---|---|---|---|---|
| M20 | 75 | Nm | M20 | 150 | Nm |
| M24 | 200 | Nm | M24 | 400 | Nm |

*Table 20-6: ISO 10642, DIN 7991 bolts lubricated with Never-Seez Regular Grade*

## 20.7 Flange Bolt / Flange Nut Delta Treated, Lubricated With Never-Seez Regular Grade

| 8.8 | | |
|---|---|---|
| M5 | 4 | Nm |
| M6 | 8 | Nm |
| M8 | 19 | Nm |
| M10 | 37 | Nm |
| M12 | 66 | Nm |
| M16 | 162 | Nm |
| M20 | 320 | Nm |

*Table 20-7: Flange bolt/flange nut, Delta-treated, lubricated with Never-Seez Regular Grade*

## 20.8 ISO 4014, ISO 4017, ISO 4762, Stainless Steel A2 and A4 Bolts and Nuts With Solid Lubricant or Wax Dispersion

| Class 70 | | | Class 80 | | |
|---|---|---|---|---|---|
| M3 | 0.9 | Nm | M3 | 1.2 | Nm |
| M4 | 2.0 | Nm | M4 | 2.7 | Nm |
| M5 | 4.1 | Nm | M5 | 5.4 | Nm |
| M6 | 7 | Nm | M6 | 9 | Nm |
| M8 | 17 | Nm | M8 | 22 | Nm |
| M10 | 33 | Nm | M10 | 44 | Nm |
| M12 | 57 | Nm | M12 | 76 | Nm |
| M14 | 90 | Nm | M14 | 120 | Nm |
| M16 | 140 | Nm | M16 | 190 | Nm |
| M20 | 270 | Nm | M20 | 360 | Nm |
| M24 | 470 | Nm | M24 | 630 | Nm |
| M27 | 680 | Nm | M27 | 900 | Nm |
| M30 | 930 | Nm | M30 | 1250 | Nm |
| M33 | 1250 | Nm | M33 | 1650 | Nm |
| M36 | 1600 | Nm | M36 | 2200 | Nm |

| Class 70 | | | Class 80 | | |
|---|---|---|---|---|---|
| M39 | 2100 | Nm | M39 | 2800 | Nm |

*Table 20-8: Stainless steel A2 and A4 bolts and nuts with solid lubricant or wax dispersion*

## 20.9 General Electrical Parts

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| Generator Ring Terminals | M12 | 8.8 | - | 60 | None |
| Generator Terminals | M10 | 8.8 | - | 40 | None |
| Generator Terminals | M8 | 8.8 | - | 20 | None |
| Generator clamps | As indicated in the termination box on the generator. (Engraved or on a label) | | | | |

## 20.10 Vestas Electrical Parts

| Placement | Dimension | Quality | Surface treatment | Torque [Nm] | Lubrication etc. |
|---|---|---|---|---|---|
| General | M6 | Standard | | 6 | None |
| General | M8 | Standard | | 24 | None |
| General | M10 | Standard | | 48 | None |

## 21 Vestas Crimp Table for Crimp Connectors – Type KST

This table is valid for Elpress cable lugs crimped with an Elpress V1300C press head or an Elpress PV1300 accu-tool.

| Cable size | Tube terminal size | Skinning length | Dye number | Number of crimps with PV1300 | Number of crimps with V1300 C | Maximum N-dimension |
|---|---|---|---|---|---|---|
| 70 mm² | KST70 | 25.5 + 2 | B16 | 1 + 1 | 1 + 1 | 13.2 |
| 70 mm² | KSF70 | 25.5 + 2 | B17 | 1 + 1 | 1 + 1 | 13.4 |

This table is valid for Elpress cable lugs crimped with an Elpress 600 accu-tool..

| Cable size | Tube terminal size | Skinning length | Dye number | Number of crimps with PV1300 | Number of crimps with V1300 C | Maximum N-dimension |
|---|---|---|---|---|---|---|
| 70 mm² | KST70 | 25.5 + 2 | TB8-17 | 2 + 2 | 2 + 2 | 13.4 |

## 22 Vestas Crimp Table for Cable Lugs, Type KRT

This table is valid for Elpress cable lugs crimped with an Elpress V1300C press head or an Elpress PV1300 accu-tool.

| Cable size | Tube terminal size | Skinning length | Dye number | Number of crimps with PV1300 | Number of crimps with V1300 C | Maximum N-dimension |
|---|---|---|---|---|---|---|
| 10 mm² | KRT10 | 9 | 7 | 1 | 1 | 5.9 |
| 16 mm² | KRT16 | 13 | 8.5 | 1 | 1 | 7.5 |
| 25 mm² | KRT25 | 15 | 10 | 1 | 1 | 8.2 |
| 35 mm² | KRT35 | 18 | 12 | 1 | 1 | 10.2 |
| 50 mm² | KRT50 | 20 | 14 | 1 | 1 | 11.7 |
| 70 mm² | KRT70 | 21 | 16 | 1 | 1 | 13.2 |
| 95 mm² | KRT95 | 24 | 18 | 1 | 1 | 14.1 |
| 120 mm² | KRT120 | 24 | 19 | 1 | 1 | 15.4 |
| 150 mm² | KRT150 | 28 | 22 | 1 | 1 | 16.3 |
| 185 mm² | KRT185 | 30 | 24 | 1 | 2 | 17.8 |
| 240 mm² | KRT240 | 35 | 26 | 2 | 2 | 19.6 |
| 300 mm² | KRT300 | 40 | 30 | 2 | 2 | 23.4 |
| 400 mm² | KRT400 | 42 | 32 | 2 | 2 | 24.6 |

## 23 Miscellaneous Service Data

### 23.1 Hydraulics

| Component/function | Treatment |
|---|---|
| Hydraulic fittings | All fittings (except stainless steel) are treated and maintained with Elisol ELS-33. |

## 23.2 Electrical

| Component/function | Value |
|---|---|
| Inductive sensor distance | 1.5 – 3.0 mm |

| Component/function | Service |
|---|---|
| Uninterruptible Power Supply (UPS) Battery | Replace according to Service Plan & Check List. |

## 23.3 Sealants

| Component/function | Sealant |
|---|---|
| Yaw bearing / Base frame | Loctite 640 on contact surface |
| Tower flange / Tower flange | SikaFlex 521-UV or Loctite 574 |
| Tower top flange / Nacelle flange | Loctite 640 |
| Joint filler for embedded cylinder and foundation transition | Sikaflex – 15M |
| Primer for embedded cylinder and foundation transition | SikaPrimer – 35 |
| Sealant for blade cuffs | Sikaflex 521 UV |
| Seal between main shaft and sealing cap | Loctite 5066 or Loctite 5068 (alternatively 5065, 5066 or 5067) |
| Cleaner for seal between main shaft and sealing cap | Loctite 7063 |
| Radiator cover to nacelle | Loctite 5068 or Danaseal 40 |
| Blade cuff to blade | SikaFlex 521 |

## 23.4 Surface Treatment

| Component/function | Paint / surface treatment |
|---|---|
| Surface treatment for tower flanges | Interzinc 22 |
| Electrical protection | KEMA - ELS 33 |
| Metal cleaner | KEMA – MA 4000 |

## 23.5 Lubrication of Other Components

| Component | Oil / grease type |
|---|---|
| Hinges, etc. | Light oil |
| Tower door | Light oil |

# 24 Controller Settings

| | **Vestas Controller** |
|---|---|
| | TAC 84 settings according to TSW 17000068 (QI 19.011GB) |
| | TAC 85 settings according to TSW 17000069 (QI 19.022GB) |

# 25 Critical Wind Speed Values

## 25.1 Referring to Activity

| **Activity** | **Maximum wind speed, average 10 minutes** |
|---|---|
| Lift of nacelle | 10 m/s |
| Rotor installation | 10 m/s |
| Discharging pressure in the hydraulic system | If the average wind speed exceeds 15 m/s, and if all three systems are to be discharged, then mount the pitch locks. |

## 25.2 Referring to System Design

| **System design** | **Maximum wind speed, average 10 minutes** |
|---|---|
| Yaw lock | See 1001381 ‘Safety Regulations for Operators and Technicians, V82-1.65 MW’. |
| Rotor lock – Low Speed Shaft (LSS) | See 1001381 ‘Safety Regulations for Operators and Technicians, V82-1.65 MW’. |
| Rotor lock – HSS of gearbox | See 1001381 ‘Safety Regulations for Operators and Technicians, V82-1.65 MW’. |

## 25.3 Installation of Tower Without Immediate Installation of Nacelle and Rotor

The towers must not be installed in wind speeds above the critical wind speed values in the table below. Furthermore, the towers cannot be left standing, without having the nacelle installed, for more than 48 hours, unless the long-term weather forecast predicts wind speeds lower than the critical values stated in the following table.

| Hub height (HH) | 10 minute mean [m/s] | | | |
|---|---|---|---|---|
| | NM72C-1.5 MW | NM82-1.5 MW | NM72/NM82-1.65 MW and V82-1.65 MW Mk 2-3 | V82-1.65 MW Mk 4-5 |
| 59 | | | 19-20 | |
| 62 | | 16-20 | | |
| 63.5 | | | 17-20 | |
| 64 | 16 | | | |
| 70 | | 14-17 | 16-19 | |
| 70 US | | 13-16 | 12-16 | 14-17 |
| 70 60Hz | | | 13-16 | |
| 78 | | 11-14 | 11-14 | 11-14 |
| 80 | 13 | | 10-13 | |
| 80 US | | 10-13 | | 10-12 |
| 93.6 | | 12 | | |
| 98 | 11 | | | |
| 108.6 | n/a | | | |