# ATTACHMENT 1

# OPERATION AND MAINTENANCE (O&M) AGREEMENT

**between**

## SOUTHERN CALIFORNIA PUBLIC POWER AUTHORITY

**and**

**[_____]**

**Dated as of**

**[_____]**

**Project: Linden Wind Energy Project (50MW)**

**Location: Goldendale, WA**

**TABLE OF CONTENTS**

**Page**

# OPERATION AND MAINTENANCE AGREEMENT

This OPERATION AND MAINTENANCE AGREEMENT (this "Agreement"), is dated as of [_____] ("Effective Date") between Southern California Public Power Authority, a California Joint Powers Authority ("Owner"), and [_____], a [_____] ("O&M Contractor"). Owner and O&M Contractor are sometimes referred to in this Agreement individually as a "Party" and collectively as the "Parties."

## R E C I T A L S

A. Owner purchased from Northwest Wind Partners, LLC ("NWWP") the Wind Plant located in Klickitat County, Washington, on the Wind Plant Site, comprised of, among other things, twenty-five (25) WECs.

B. On [_____, 2025], Owner issued a request for proposals for the operation and maintenance of the WECs.

C. O&M Contractor submitted its response to Owner's request for proposals, and following negotiation, Owner desires to engage O&M Contractor, as an independent contractor, to operate and maintain the WECs and perform certain other duties, including administration on behalf of Owner, and O&M Contractor desires to provide such services to Owner, on the terms and conditions set forth herein.

NOW, THEREFORE, in consideration of the foregoing Recitals, which are incorporated herein, the mutual promises and agreements contained herein and of other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Parties agree as follows:

## ARTICLE 1
## DEFINITIONS

### 1.1 Definitions.

As used in this Agreement, all capitalized terms shall have the respective meanings given to them in this Agreement and in the Schedule of Definitions attached hereto as Exhibit A.

### 1.2 Construction.

All references herein to any agreement or document shall be a reference to such agreement or document as amended, supplemented, modified or restated from time to time. All references to a particular entity shall include a reference to such entity's successors and permitted assigns, and in the case of a Governmental Authority, such entity succeeding to its functions and capabilities. The words "herein," "hereof" and "hereunder" shall refer to this Agreement as a whole and not to any particular section or subsection of this Agreement. The singular shall include the plural and the masculine shall include the feminine and neuter and vice versa. "Includes" or "including" shall mean "including, without limitation." All exhibits and schedules to this Agreement are hereby incorporated herein by reference. In case of a conflict between the terms and conditions in the body of this Agreement (excluding the exhibits) and an exhibit attached hereto, the provisions in the body of this Agreement (excluding the exhibits) shall control and prevail.

Subject to the foregoing, if any requirements specified in any exhibit are in conflict with any other requirements in such exhibit or in any other exhibit, the more detailed requirements shall control and prevail. Notwithstanding the foregoing, the provisions of this Agreement, including all exhibits, shall be, wherever possible, construed as complementary rather than conflicting.

### 1.3 Day.

As used in this Agreement, references to "days" mean calendar days, unless the term "Business Days" is used. If the time for performing an obligation under this Agreement expires on a day that is not a Business Day, the time will be extended until that time on the next Business Day.

## ARTICLE 2
## ENGAGEMENT OF THE O&M CONTRACTOR

### 2.1 Engagement of O&M Contractor.

Owner hereby engages O&M Contractor as an independent contractor to operate, maintain and repair the WECs, to perform certain administration and management services, and to perform certain other services and duties, including Fixed Fee Services, Cost Reimbursable Services (including Repair Services) and such other services as may be agreed under a Quote, all as set forth in this Agreement (the "Services"). O&M Contractor accepts such engagement and agrees to perform such Services in accordance with the terms and conditions hereof.

### 2.2 Relationship.

O&M Contractor is an independent contractor. Neither O&M Contractor nor O&M Contractor's employees or agents are employees of Owner or Operating Agent and shall not be entitled to any employment benefits or rights afforded by Owner or Operating Agent to their employees, including, but not limited to, sick leave, vacation leave, paid leave, holiday pay, retirement benefits, worker's compensation, or other insurance benefits. O&M Contractor hereby warrants that: (1) O&M Contractor and its employees and agents are free from the control and direction of Owner and Operating Agent connection with the performance of the work to be provided hereunder, both under this Agreement and in fact, (2) O&M Contractor and its employees and agents perform work that is outside the usual course of Owner's business, and (3) O&M Contractor and its employees and agents performing work under this Agreement are customarily engaged in an independently established trade, occupation, or business of the same nature as that involved in the work to be performed under this Agreement. O&M Contractor shall furnish the work according to its own manner and methods except as required by applicable laws and this Agreement. O&M Contractor shall have no authority, express or implied, to act on behalf of or bind Owner or Operating Agent to any obligation in any capacity whatsoever as agent or otherwise. O&M Contractor's visit to and time spent at Wind Plant shall be subject to normal business hours, appropriate safety standards and security requirements applicable to the Wind Plant Site, and Emergency requirements, and the requirements of this Agreement.

(c) Work by persons deemed to be employees of O&M Contractor may be subject to prevailing wages under California Labor Code 1770 et seq. or under other applicable Law, including without limitation the Prevailing Wage Requirements to the extent applicable to the Services. O&M Contractor is solely responsible for compliance with all such requirements, where applicable.

(d) O&M Contractor shall indemnify, defend, and hold harmless Owner, its Members, Operating Agent, and their respective officers, employees, assigns, and successors in interest from and against any and all liability, claims, suits, demands, damages, fines, penalties, wages, costs or expenses pertaining to (i) prevailing wage laws, including the Prevailing Wage Requirements, and (ii) the payment of any employee and/or employer contributions for the California Public Employees Retirement System ("PERS") benefits on behalf of O&M Contractor or its employees, agents, or subcontractors, as well as for the payment of any penalties, catch-up payments, and interest on such contributions which would otherwise be the responsibility of Owner or Operating Agent. This indemnification is intended to supplement and is not intended to limit or exclude the application of the indemnification requirements provided elsewhere in this Agreement.

**2.3 Engagement of Third Parties.**

Subject to Section 4.1(c), O&M Contractor may engage third party Subcontractors for the purpose of performing Scheduled Maintenance under this Agreement; provided, however, that such engagement shall not relieve O&M Contractor of any of its obligations or liabilities under this Agreement, including those set forth in ARTICLE 12; and provided further that O&M Contractor's use of Subcontractors shall not modify or increase the compensation payable to O&M Contractor pursuant to ARTICLE 7.

As between Owner and O&M Contractor, O&M Contractor shall be solely responsible for the acts, errors, omissions and defaults of its Subcontractors and their employees, and all Persons engaged by O&M Contractor pursuant to this Section 2.3 with respect to services provided by such Persons on behalf of O&M Contractor. Nothing in this Agreement shall be construed to impose on Owner any obligation, liability or duty to a Subcontractor, or to create any contractual relationship between such Subcontractor and Owner, including the obligation to pay or see to the payment of any moneys due such Subcontractor.

All Subcontractors retained by O&M Contractor shall be duly licensed as required by law. Subcontractors shall be provided with a copy of this Agreement and O&M Contractor shall cause all Subcontractors to comply with the same and agree in a separate writing to be bound by its terms.

If O&M Contractor intends to enter into a subcontract for Cost Reimbursable Expenses with an Affiliate, O&M Contractor shall first disclose such relationship to Owner. O&M Contractor may enter into such subcontract only with prior written approval from Owner.

## ARTICLE 3
## TERM AND RENEWAL

### 3.1 Term.

The term of this Agreement shall commence on the Effective Date and shall continue for a period of three (3) years from the Effective date (the "Initial Term").

### 3.2 Extensions of Term.

Unless sooner terminated as set forth in ARTICLE 13, the Initial Term of this Agreement shall automatically be extended for two (2) additional two (2) year periods (each, an "Extension Term") from the end of the Initial Term, or the first Extension Term, as applicable, unless either Party provides written notice to the other Party that it does not desire such extension to occur. Such written notice shall be provided not later than three (3) months prior to the end of the Initial Term, or the first Extension Term, as applicable. All terms and conditions set forth herein shall apply during the Term.

## ARTICLE 4
## DUTIES OF O&M CONTRACTOR

In consideration of the fees and cost reimbursements payable to O&M Contractor hereunder, O&M Contractor agrees to operate and maintain the WECs, and perform the Services in accordance with the terms of this Agreement, including the standards set forth herein, and in furtherance thereof to provide the following services during the Term of this Agreement.

### 4.1 General Operating Standards.

(a) In performing its obligations hereunder, O&M Contractor shall use commercially reasonable efforts to, consistent with the requirements of this Agreement, and the Requirements of the Project Agreements, maximize revenues generated by the operation of the WECs and minimize associated expenses, based on direction received by O&M Contractor from Owner Representative.

(b) O&M Contractor shall perform its obligations hereunder and cause the WECs to operate in accordance with the terms of this Agreement, Prudent Industry Practices, Applicable Laws and other legal requirements, including Environmental Laws and Safety Laws, Permits, the Maintenance Manual, those requirements of the Project Agreements set forth in Exhibit J ("Requirements of the Project Agreements"), the Wind Plant Policies and Procedures, the requirements under the insurance policies maintained by O&M Contractor with respect to the WECs, and any Subcontractor, vendor and manufacturer warranties or guarantees applicable to the Wind Plant and the WECs, including any warranties and guarantees under the Turbine Supply and Commissioning Contract, and in a manner that will not violate, invalidate or otherwise limit the scope of such warranties and guarantees (collectively, the "Standards of Performance"). O&M Contractor shall furnish any documents described above to Owner at Owner's request.

(c) O&M Contractor acknowledges that the major policies and business decisions concerning the Wind Plant, including those listed below, shall be established by Owner. O&M Contractor shall obtain Owner's written permission before

engaging in activities with respect to the Wind Plant that are not within the scope of this Agreement or required by an Emergency, including scheduling non-Emergency interruptions in the delivery of electricity. O&M Contractor shall not, under any circumstances, unless otherwise directed by the Owner in writing, undertake any of the following actions:

(i) cause the creation or assumption by Owner of any indebtedness for borrowed money, or cause any Encumbrance on any assets or properties of the Wind Plant or any part thereof, or any other property or assets of Owner;

(ii) pledge the credit of Owner or its Affiliates in any way in respect of any commitments or cause Owner to act as surety, grant guaranties, or incur similar liabilities on behalf of third parties, directly or indirectly, whether for borrowed money or otherwise;

(iii) cause the conveyance, sale, transfer or other disposition of any part of the Wind Plant or any other property or assets of Owner;

(iv) solicit, negotiate, arrange or engage in any transaction on behalf of Owner not permitted under this Agreement, including taking any action to waive any of Owner's rights under, suspend Owner's performance under, or execute, terminate or amend any Project Agreement, contract, agreement, document or Permit on behalf of Owner;

(v) modify or alter the WECs, Wind Plant, Wind Plant Site or any part thereof in a manner that adversely affects the operation, availability, output, efficiency, maintenance costs, or repair costs of any of the WECs, or change the capacity characteristics of the WECs or Wind Plant;

(vi) settle, compromise, assign, pledge, transfer, release or consent to the compromise, assignment, pledge, transfer or release for Owner, the Wind Plant, the WECs comprised therein or the Wind Plant Site any Claim, whether the same arises against, in favor of or otherwise pertains to Owner, the Wind Plant, the WECs or the Wind Plant Site (including, agreeing to any penalty for violation of any applicable Permits), nor will O&M Contractor submit any such Claim to arbitration or judicial process, or stipulate in respect thereof to a judgment, or consent to do the same, except for Claims by O&M Contractor against Owner or Claims subject to O&M Contractor indemnification under ARTICLE 12 (and O&M Contractor agrees that Owner shall retain full control of all such legal actions, demands, negotiations and compromises with respect to any of the aforementioned Claims, except for Claims by O&M Contractor against Owner);

(vii) subcontract any of its obligations hereunder if the subcontract provides for compensation to the Subcontractor in excess of Twenty Thousand Dollars ($20,000) within one (1) calendar year without providing written notice of such subcontract to Owner; provided that any

such subcontract relating to the performance of Services constituting Reimbursable Expenses shall require prior written approval of Owner, which shall not unreasonably be withheld;

(viii) make or commit to make any Reimbursable Expenses or acquire on a reimbursable cost basis any equipment, materials, assets, or other items, except as otherwise approved in writing by Owner pursuant to Section 7.2; provided that in the event of an Emergency, affecting the safety or protection of Persons or endangering the Wind Plant or the WECs, O&M Contractor, without approval from Owner, shall be authorized to take all reasonable actions consistent with Prudent Industry Practices, to prevent such threatened damage, injury or loss in accordance with Section 4.4; and provided further that notwithstanding any other provision of this Agreement, O&M Contractor shall not, without the prior written consent of Owner, perform any Services resulting in Reimbursable Expenses in an amount greater than Twenty-Five Thousand Dollars ($25,000); provided that if, notwithstanding O&M Contractor's diligent efforts to contact Owner, O&M Contractor is unable to do so, O&M Contractor shall be authorized to perform such services resulting in Reimbursable Expenses in excess of Twenty-Five Thousand Dollars ($25,000) in the event of an Emergency;

(d) O&M Contractor shall respond to information and/or data requests of Owner within forty-eight (48) hours; provided that where the information or data requested will not be available within such time period, O&M Contractor shall respond to Owner in such forty-eight (48) hour period with the date on which such requested information or data shall be available; provided, further, that if any information or data request requires O&M Contractor to obtain or compile data from sources other than those routinely used in the performance of the services under this Agreement (including the extraction of data embedded in such sources that is not readily available), or to prepare analyses of the relevant information or data, the reasonable cost for O&M Contractor to perform such services shall constitute a Reimbursable Expense so long as O&M Contractor notifies Owner that the request involves work outside its scope of services and receives Owner's preapproval in accordance with Section 7.2.

**4.2 Operation, Maintenance, and Repair Services.**

(a) During the Term of this Agreement O&M Contractor shall perform all Services set forth in Exhibit B, any Cost Reimbursable Services requested by Owner or otherwise required by the Agreement, and provide Availability of the WECs as set forth in Exhibit D.

(b) All material and Spare Parts procured or utilized by O&M Contractor for performance under this Agreement during the term of any equipment warranties shall be of specification and quality required so as to in no way invalidate such warranties, or any portion thereof. Spare Parts may include new, used or rebuilt parts, provided that any used or rebuilt parts shall comply with the requirements set forth in Exhibit B.

### 4.3 Other Services.

During the Term of this Agreement, O&M Contractor shall perform all other services required by this Agreement, such additional services or changed services to which O&M Contractor and Owner may agree pursuant to ARTICLE 8.

### 4.4 Emergencies.

In the event of any Emergency involving the Wind Plant endangering life or property, O&M Contractor shall take such action as may be reasonable and necessary in accordance with Prudent Industry Practices to prevent, avoid or mitigate injury, damage or loss and shall, as soon as practicable, including outside of Normal Business Hours if necessary, telephonically report any such Emergency, including O&M Contractor's response thereto, to Owner, followed by written notice to Owner, which notice shall include detail with respect to any action being taken by O&M Contractor in response thereto and any expenditure incurred, or expected to be incurred, by O&M Contractor in connection with such Emergency. O&M Contractor shall take all steps to minimize the cost to Owner of its actions, having regard to the circumstances and the need to act promptly. Following such notification, at the request of Owner, the Parties shall discuss without delay the further actions which should be taken as a result of the Emergency and the estimated expenditure associated therewith and time to recover therefrom.

### 4.5 Permits.

O&M Contractor shall identify, procure, obtain, maintain, and comply with (as the case may be), at its cost and expense, all Permits which may be required under Applicable Laws for the performance of the Services by O&M Contractor pursuant to this Agreement (except O&M Contractor shall not be required to procure, obtain, and maintain, but shall be obligated to comply with such Permits that must be procured or obtained by Owner or the WEC Manufacturer pursuant to Applicable Laws). Owner shall provide O&M Contractor with such assistance and cooperation as may reasonably be required to obtain and maintain all such Permits. O&M Contractor shall provide Owner and the Owner's Separate Contractors, if applicable, with such assistance and cooperation as may reasonably be required to obtain and maintain any Permits that may be required to be obtained and maintained by them.

### 4.6 Performance by Owner.

(a) If (i) O&M Contractor fails to perform any of its obligations under this Agreement, (ii) such failure, in the reasonable judgment of Owner, is remediable, and (iii) O&M Contractor has failed to commence appropriate remedial action within ten (10) days' notice from Owner or, after such remedial action commences, O&M Contractor fails to diligently prosecute such remedial action (provided that, where the appropriate remedial action cannot be completed or commenced within ten (10) days, O&M Contractor may satisfy this requirement by providing Owner with a plan for performing the appropriate remedial action within such period), then Owner may, but shall not be obligated to, upon five (5) days' prior notice to O&M Contractor (A) perform (or cause to be performed through the engagement of one or more third parties) the obligations of O&M Contractor hereunder and (B) suspend O&M Contractor's performance of all or part of the Services for such period of time as determined by Owner. Following the exercise of such rights, Owner may

direct O&M Contractor to recommence performance of the suspended Services, and Owner shall not be liable for any costs associated mobilization, demobilization, or any other costs associated with O&M Contractor's recommencement of performance of the suspended Services.

(b) O&M Contractor shall cause its Subcontractors and Representatives (and any Person within the control of O&M Contractor) to give Owner and its Representatives control of the operation and maintenance of the WECs to the extent necessary to enable Owner to exercise its rights under Section 4.6(a).

(c) O&M Contractor shall reimburse Owner for all reasonable, substantiated out of pocket costs and expenses that are incurred by Owner in exercising its rights under Section 4.6(a). Owner shall be obligated to pay O&M Contractor only that pro rata portion of the Fixed Fee that relates to the WEC(s) for which O&M Contractor is continuing performance of its Services and obligations related thereto during the period that Owner is exercising its rights under Section 4.6(a).

(d) Owner's exercise of its rights (or election to not exercise its rights) under Section 4.6(a) shall not relieve O&M Contractor of any obligation under this Agreement and shall not constitute a waiver of any right or remedy available to Owner.

(e) In no event shall Owner be liable to O&M Contractor for Owner's exercise of Owner's rights under Section 4.6(a).

### 4.7 Payment Bond

O&M Contractor shall furnish a payment bond, or any other bond, required by Applicable Law. Any bond required pursuant to this Agreement shall be in a form reasonably acceptable to Owner and consistent with any Applicable Law.

## ARTICLE 5
## O&M CONTRACTOR'S GENERAL COVENANTS

### 5.1 Safety Standards.

(a) O&M Contractor shall perform and shall cause its Subcontractors and personnel to perform O&M Contractor's obligations hereunder in compliance with all applicable health, safety, security, and evacuation Laws ("Safety Laws") and all Environmental Laws. These include, but are not be limited to, the Laws promulgated by OSHA, EPA, the Washington Department of Ecology, and air quality regulators. Where the requirements of such Governmental Authorities overlap, the most protective Laws apply.

(b) O&M Contractor shall conduct safety meetings for its personnel and Subcontractors, including first aid instruction applicable to and appropriate for the Services, at least as frequently as required by Applicable Laws.

(c) If O&M Contractor becomes aware of noncompliance with applicable Safety Laws or Environmental Laws or the Wind Plant Policies and Procedures by BOP Contractor or its Representatives, it shall provide notice of same to Owner in a timely fashion. If Owner notifies O&M Contractor, or O&M Contractor otherwise becomes

aware, of noncompliance by O&M Contractor or the Subcontractors with Safety Laws, or the Wind Plant Policies and Procedures O&M Contractor shall immediately make all efforts to correct such noncompliance. If O&M Contractor fails or refuses to take immediate corrective action, Owner may: (1) correct the conditions resulting in such noncompliance or have such conditions corrected by others at O&M Contractor's expense, or (2) issue an order stopping the performance of the Services until satisfactory corrective action has been taken. Owner's failure to notify O&M Contractor of any noncompliance with Safety Laws or the or the Wind Plant Policies and Procedures shall not relieve O&M Contractor from any of its obligations under this Section 5.1. If O&M Contractor disagrees in good faith with Owner's interpretation of the Safety Laws or the or the Wind Plant Policies and Procedures in question or the corrective action to be taken, O&M Contractor will perform those compliance actions required by Owner and the Parties will submit their dispute to dispute resolution under ARTICLE 21 of this Agreement. If O&M Contractor prevails in such dispute resolution proceedings, Owner shall pay to O&M Contractor the reasonable and documented cost of O&M Contractor's performance of the corrective actions required by Owner.

(d) O&M Contractor shall notify Owner immediately of any OSHA-reportable accident.

(e) O&M Contractor shall maintain accurate accident records and injury reports related to its personnel and Subcontractors and shall furnish a copy of all accident reports to Owner on a monthly basis.

(f) O&M Contractor shall perform the Services in a safe and careful manner, and shall furnish safety and health equipment for, and enforce the use of such equipment by, its personnel and Subcontractors on the Wind Plant Site. O&M Contractor shall take such precautions as are necessary to to protect its employees, agents, contractors, Subcontractors, invitees, Owner's employees and agents, and the public from bodily injury and property damage. O&M Contractor shall assign a competent person during working hours to manage, coordinate and enforce its safety program during performance of the Services.

(g) O&M Contractor shall immediately notify Owner if O&M Contractor becomes aware of any damage to Owner's equipment and/or property.

**5.2 Environmental Matters.**

(a) O&M Contractor shall not, nor shall it permit its Representatives or Subcontractors of any tier to, bring any Hazardous Materials onto the Wind Plant Site or incorporate any Hazardous Materials into any portion of the Wind Plant, other than Hazardous Materials to be used by O&M Contractor, its Representatives or Subcontractors in a manner that both (i) does not violate any Applicable Laws, and (ii) is consistent with Prudent Industry Practices and the requirements of this Agreement. O&M Contractor shall be responsible for any Release of any Hazardous Materials brought onto the Wind Plant Site by O&M Contractor, its Representatives or Subcontractors of any tier, or caused by O&M Contractor, its Representatives or Subcontractors of any tier, during the Term of this Agreement, and shall at its sole cost and expense, promptly take any and all action necessary to clean up such Release if required by Applicable Law or required as a condition to the issuance or continuing effectiveness of any Permit. O&M Contractor

shall, and shall cause its Representatives or Subcontractors of any tier to, minimize the use of Hazardous Materials in the performance of its obligations under this Agreement. Notwithstanding the foregoing, O&M Contractor shall not be required to investigate, clean up or take any action with respect to Pre-Existing Contamination, regardless of whether such contamination has migrated, chemically changed or otherwise changed in location or character, except to the extent any release or exacerbation of any such Pre-Existing Contamination was caused by the acts or omissions of O&M Contractor, its Representatives or Subcontractors of any tier.

(b) O&M Contractor shall maintain an updated file of all safety data sheets for all Hazardous Materials used in connection with performance of its obligations under this Agreement, or used by or on behalf of O&M Contractor or any Subcontractor at the Wind Plant Site and shall deliver an update of such file to Owner no more than thirty (30) days after receipt of a written request from Owner. O&M Contractor shall ensure that all of its Representatives and Subcontractors comply with applicable Environmental Laws with respect to the proper handling, use, storage and disposal of Hazardous Materials and the development, implementation and enforcement of procedures for notification of Owner and appropriate Governmental Authorities about, and clean-up of, spills and other emissions of Hazardous Materials in connection with the performance of O&M Contractor's obligations under this Agreement.

### 5.3 Personnel

O&M Contractor shall provide the labor and professional, supervisory and managerial personnel required to perform its obligations hereunder. Such personnel and any Persons engaged by O&M Contractor pursuant to Section 2.3 shall be qualified (including possessing appropriate licenses, certificates or registrations) and Experienced or trained in operating and maintaining WECs similar to those installed at the Wind Plant and shall be qualified and Experienced in the duties to which they are assigned. Owner shall have the right to require immediate replacement of any personnel not meeting the foregoing standard. O&M Contractor shall be solely responsible for the training of its personnel. O&M Contractor shall retain sole authority, control and responsibility with respect to labor matters in connection with the performance of the Services of its personnel and the working hours, rates of compensation and all other matters relating to the employment of such personnel shall be determined solely by O&M Contractor or the appropriate Subcontractor. Owner shall have the right to require the immediate removal and permanent expulsion from the Wind Plant Site of any Person that at any time is found under the influence of or in possession of any amount of alcohol, marijuana or illegal drugs; provided, however, that O&M Contractor shall not be required to terminate such employee or cause the termination of the employment of such Person, except in O&M Contractor's sole discretion.

### 5.4 Liens

O&M Contractor shall not, as a consequence of its own acts or omissions or the acts or omissions of its suppliers and Subcontractors regardless of tier, suffer or permit Encumbrances to attach to the Wind Plant or the Wind Plant Site or any component thereof. If any lien is filed or otherwise imposed as a result of any act or omission by or claim against, or through O&M Contractor or any of its suppliers or Subcontractors, and if O&M Contractor does not, within thirty (30) days after a request by Owner, cause such

lien to be released and discharged, or file a bond satisfactory to Owner in lieu thereof, Owner shall have the right to pay all or any portion of the sums necessary to obtain such release and discharge such lien. O&M Contractor shall reimburse Owner for all such costs incurred by Owner, including reasonable attorneys' fees, within thirty (30) days after Owner's demand therefor or Owner may offset any of such costs incurred against its Payment Obligations. O&M Contractor agrees to indemnify, defend and hold harmless Owner from and against all Losses that arise out of or result from the filing or imposition of any such Encumbrance.

### 5.5 Cooperation of O&M Contractor.

O&M Contractor acknowledges that concurrently with the performance of the services under this Agreement, other contractors, vendors, suppliers and consultants, including the BOP Contractor ( "Separate Contractor"), may be supplying, engineering, constructing, installing, commissioning, testing, operating, and maintaining other aspects of the Wind Plant on behalf of Owner pursuant to their respective separate contracts. O&M Contractor shall cooperate with such Separate Contractors and shall coordinate the performance of its obligations hereunder to minimize any interference with the work of the Separate Contractors, but not to the extent of disrupting O&M Contractor's schedule or sequence of the Services. Owner shall instruct the Separate Contractors to coordinate the performance of their work with O&M Contractor to minimize any interference with O&M Contractor's performance of the Services. O&M Contractor shall schedule daily meetings with all Subcontractors and Separate Contractors to the extent necessary to allow for proper coordination of the Services with the work of the Separate Contractors.

## ARTICLE 6
## PARTY REPRESENTATIVES

### 6.1 Representatives.

(a) O&M Contractor has appointed an individual Representative (the "O&M Contractor Representative") who is authorized and empowered to act for and on behalf of O&M Contractor on all matters concerning this Agreement and O&M Contractor's obligations hereunder. The O&M Contractor Representative is set forth on Exhibit K. O&M Contractor Representative shall: (a) act as the liaison for O&M Contractor's communications with Owner; (b) be responsible for receiving all reports due under this Agreement from Owner and delivering all reports due hereunder to Owner; (c) be Experienced and have authority to make prompt means and methods decisions at the Wind Plant Site on a real time basis; (d) be available at all times during Normal Business Hours, and as necessary to address any Emergencies. O&M Contractor Representative may appoint a temporary alternate with delegated authority to act on behalf of O&M Contractor and fulfill the obligations of O&M Contractor by providing written notice to Owner.

(b) Owner and O&M Contractor acknowledge and agree that Owner has appointed the Los Angeles Department of Water and Power to be the operating agent for the Wind Plant (the "Operating Agent"). The Operating Agent is authorized and empowered to act for and on behalf of Owner on all matters concerning this Agreement and Owner's obligations hereunder. The Operating Agent has designated the individual(s) identified on Exhibit K to be the "Owner Representative."

(c) Neither O&M Contractor Representative nor Owner Representative shall have the authority to amend any provision of this Agreement.

(d) Each Party shall be bound by the written communications, directions, requests and decisions made by O&M Contractor Representative or Owner Representative, as the case may be, subject to the prohibition to amend this Agreement set forth in the preceding sentence.

(e) O&M Contractor shall notify Owner in writing of any changes to the identity of O&M Contractor Representative and Owner shall notify O&M Contractor in writing of any changes to the identity of Owner Representative.

## ARTICLE 7
## FEES AND COST REIMBURSEMENT

### 7.1 Fixed Fees.

(a) Fixed Fee. During the Term of this Agreement, Owner shall pay O&M Contractor a fixed annual (the "Fixed Fee") as compensation for performing the Fixed Fee Services. The Fixed Fee shall be deemed to cover all Fixed Fee Services performed at any time during any day (whether during or outside of regular work hours or work days) and all costs and expenses incurred by O&M Contractor in connection with the performance of all such Fixed Fee Services, including O&M Contractor's compliance with the Prevailing Wage Requirements.

(b) Liquidated Damages. During the Availability Term, WECs will be subject to the terms and conditions regarding Availability set forth in Exhibit D. Failure to comply with Availability covenants set forth in Exhibit D will result in liquidated damages as set forth in Exhibit D.

### 7.2 Reimbursable Expenses.

(a) Expenses incurred by O&M Contractor for Cost Reimbursable Services shall be paid for as reimbursable expenses ("Reimbursable Expenses"), so long as such expenses were (i) preapproved by Owner in accordance with Article 8, or (ii) incurred by O&M Contractor in accordance with Section 4.1(c)**Error! Reference source not found.**, Section 4.1(d), Section 14.4.

(b) O&M Contractor shall be entitled to Reimbursable Expenses if O&M Contractor performs Cost Reimbursable Services at Owner's request after a WEC has suffered damage or incurred a fault or defect as a result of: (i) Force Majeure; or (ii) any willful act or omission of or negligence by the Owner or the Separate Contractors.

(c) Unless the Parties otherwise agree to a fixed fee for any Reimbursable Expenses, Owner shall be billed on a time and materials basis as set forth in Exhibit G for Reimbursable Expenses.

(d) The Reimbursable Expenses shall be payable as set forth in Section 7.3.

**7.3 Payment Procedure.**

(a) The Fixed Fee shall be paid in quarterly installments. O&M Contractor shall submit an invoice to Owner no later than fifteen (15) days prior to the beginning of each calendar quarter (except with respect for the first quarter of the Term, which invoice will be submitted on or after the Effective Date) for the next quarterly installment of the Fixed Fee. Owner shall pay such quarterly installment of the Fixed Fee no later than sixty (60) days after receipt of the invoice from Contractor.

(b) On or before the fifteenth ($15^{th}$) day of each month following the Effective Date, O&M Contractor shall submit to Owner a detailed invoice of any Reimbursable Expenses for work which has been fully performed with sufficient supporting documentation and explanation for all costs incurred by O&M Contractor with respect to the just ended month.

(i) Invoices for Reimbursable Expenses shall be itemized and include details such as number of labor hours, personnel associated with each line item (including any Subcontractors), costs of parts and materials, proof of payment, and if applicable shall include any associated Quote, Quote Number, and Service Order Report.

(ii) In the case of a conflict or discrepancy between the content of a Service Order Report, a Quote, or any other materials submitted by O&M Contractor pursuant to this Section 7.3, Owner shall pay O&M Contractor based on the lowest cost provided in any supporting materials.

(iii) any Subcontractor charges shall be invoiced to Owner at cost without a markup, except that O&M Contractor may charge an administrative fee equal to **[•]** percent (**[•]**%) of such Subcontractor charges for costs necessary to administer any Subcontract.

(iv) O&M Contractor shall provide any additional documentation requested by Owner necessary to pay the invoice.

(v) All payments of Reimbursable Expenses shall be paid within (60) days after receipt of any undisputed invoice and supporting documentation.

(vi) Reimbursable Expenses incurred by O&M Contractor more than three (3) months prior to the first day of the month such invoice is issued shall not be included on any invoice or payable to O&M Contractor without the consent of Owner, and O&M Contractor shall first obtain Owner's written approval before commencing any work which cannot be completed and invoiced to Owner within three (3) months from the date O&M Contractor incurs such expense.

(c) All payments made by Owner to O&M Contractor under this ARTICLE 7 shall be paid by wire transfer of immediately available funds to O&M Contractor at an account designated in writing by O&M Contractor.

(d) Owner is entitled to withhold from any payment due O&M Contractor such amount as reasonably determined by Owner to protect Owner due to: (a) the filing of any lien or other Encumbrances or evidence indicating the probable filing or asserting of any lien or other Encumbrances in connection with the Services against Owner, the Wind Plant Site or any portion thereof which O&M Contractor has not addressed in accordance with Section 5.4; (b) Losses incurred and Claims for which O&M Contractor has an obligation to indemnify an Owner Indemnified Party under this Agreement; and (c) defective or incomplete Services by O&M Contractor or any of its Subcontractors; (d) any amounts due and payable by O&M Contractor to Owner under this Agreement; and (e) O&M Contractor's failure to pay its Subcontractors, unless such payments are being disputed in good faith by O&M Contractor (and provided that if such failure is not the subject of a good faith dispute, Owner may, but is not obligated to, and without assuming any liability to O&M Contractor or such Subcontractor, pay any undisputed amount to a Subcontractor).

If and when the cause or causes for withholding any such payment as provided under this Section 7.3(d) are remedied or removed and satisfactory evidence of such remedy or removal has been presented to Owner, the payments withheld shall be made promptly to O&M Contractor.

### 7.4 Records and Audits.

Except as otherwise required by Applicable Laws affecting O&M Contractor, O&M Contractor shall keep books and records in accordance with U.S. generally accepted accounting principles consistently applied ("GAAP"), with respect to any work performed pursuant to this Agreement throughout the Term. O&M Contractor shall make such books and records available upon no less than twenty-four (24) hours' notice to O&M Contractor, with such notice being given on a Business Day, for inspection and audit by Owner and/or its designated Representatives during O&M Contractor's Normal Business Hours and at the Wind Plant Site; provided that O&M Contractor's company software, books and records not related to this Agreement shall not be subject to inspection or audit, except to the extent such software, books, records, or personnel records relate to any Reimbursable Expense or are relevant to verifying compliance with this Agreement. If any such inspection or audit discloses that any error has occurred and that, as a result thereof, any overpayment or any underpayment has occurred, the amount thereof shall promptly be paid to the Party to whom it is owed by the other Party; provided that neither Party shall be liable for any amounts after three (3) years from the date of the inspection or audit conducted by Owner. Neither Owner nor any of its Representatives shall have any obligation to take any action based upon what it may or could discover in the course of any document review or inspection of the Wind Plant or the books and records and neither (i) Owner's nor its Representatives' exercise of Owner's right to inspect and review, (ii) Owner's failure to exercise such right to inspect or review or (iii) Owner's or any of its Representatives' failure to take any action or report any observations as a result of such inspection or review, shall in any such case constitute a waiver of any rights or remedies that Owner may have under this Agreement. Owner's review and/or approval of materials and documents submitted by O&M Contractor shall not relieve O&M Contractor of its obligations to meet all the requirements hereof, nor shall Owner be liable to O&M Contractor or any other Person by reason of its review and/or approval of such materials and documents.

### 7.5 Disputed Amounts.

(a) If a dispute arises regarding the payments to be made to either Party hereunder, Owner or O&M Contractor, as applicable, shall pay all undisputed amounts, and the Parties shall attempt in good faith to resolve the dispute as promptly as practicable and, if unsuccessful, shall resolve the payment dispute in accordance with the dispute resolution provisions in Article 21.

### 7.6 Taxes.

O&M Contractor shall be responsible for the payment of all Taxes assessed or based upon the income or property of O&M Contractor. At the request of Owner, O&M Contractor shall make available to Owner and claim any and all applicable sales, use, excise, value added or other similar transactional tax exemptions, credits or deductions relating to the services provided by O&M Contractor pursuant to this Agreement available to O&M Contractor or Owner, including any sale-for-resale exemption and any manufacturing machinery or equipment exemption. At the request and expense of Owner, O&M Contractor agrees to take such action as may be reasonably required to allow any of the Services to qualify for any applicable exemption from sales, use, excise, value added or similar transactional tax. If a change in Applicable Laws after the Effective Date would result in an increase in Taxes payable by Owner under this Agreement, O&M Contractor shall, in consultation with Owner and at Owner's expense, use reasonable efforts to mitigate the effects of such increase in Taxes.

## ARTICLE 8
## REQUESTS, QUOTES AND TASK ORDERS.

### 8.1 Requests for Quotes.

Owner may at any time prior to the expiration of the Term, request additional services, or request changes to the Services provided by O&M Contractor pursuant to this Agreement, by submitting to O&M Contractor a written or oral quote request ("Quote Request") specifying in reasonably precise detail such additional services or such changes to Services specified in this Agreement.

### 8.2 Quotes.

Promptly following receipt of a Quote Request pursuant to Section 8.1, O&M Contractor will deliver to Owner (i) a quote for the additional services set forth in such Quote Request or the changes to the Services set forth in such Quote Request (each, a "Quote") or (ii) a written or oral explanation of why certain services and/or parts set forth in such Quote Request cannot be provided pursuant hereto. Each Quote will:

(a) specify with reasonable precision the Services to be provided by O&M Contractor, including a description of work, projected labor hours, classification for personnel to perform the Services, whether any Subcontractors will be utilized in the performance of the Services, projected labor costs, and total costs;

(b) for each Service specified in such Quote, specify that such Service is to be provided on the basis of (i) a fixed price set forth in the Quote, (ii) time and

materials charges based on Exhibit G or (iii) a combination a fixed price and time and materials charges;

(c) for each part specified in such Quote, specify a fixed price;

(d) for each part sourced from O&M Contractor internal procurement department, O&M Contractor must provide information sufficient to demonstrate that the cost for part(s) is equal to or lower than the price for such part in the market. This may be demonstrated by providing a second quote for such part from an external source, including BOP Contractor; and

(e) identify the Quote by specifying a unique Quote number for the Quote (each, a "Quote Number").

(f) identify a date by which the Owner may accept the Quote and O&M Contractor must honor the Quote (the "Quote Expiration Date").

**8.3 Approval.**

Not later than the Quote Expiration Date, Owner may confirm and approve such Quote by delivering to O&M Contractor a written confirmation by Owner's identifying the applicable Quote Number and requesting that O&M Contractor perform the services set forth in such Quote.

**8.4 Quote for Proactive Maintenance.**

The Parties acknowledge that as of the Effective Date, O&M Contractor has provided to Owner a Quote for the performance of certain proactive maintenance and services on the WECs as further described in Exhibit L ("Proactive Maintenance"), along with a lump sum, fixed price and schedule to complete such Proactive Maintenance. Owner will have the right, but not the obligation, to accept O&M Contractor's Quote for Proactive Maintenance, in which case the provisions of Exhibit L will apply.

## ARTICLE 9
## O&M FACILITY

O&M Contractor acknowledges and agrees that the O&M Facility shall be used by both O&M Contractor and BOP Contractor and that the portion of the O&M Facility dedicated for use by O&M Contractor is of sufficient size and proper design for the purpose of performing its obligations under this Agreement, including storing Spare Parts and O&M Contractor's service trucks and tools and providing office space for O&M Contractor's supervisors and employees. Owner will provide all services (cleaning, etc.), utilities, and consumables for the O&M Facility, including telephone and broadband services. O&M Contractor will establish and maintain an inventory control system with respect to all Spare Parts and tools at the Wind Plant.

## ARTICLE 10
## RIGHTS OF OWNER; USE OF OWNER'S PROPERTY

### 10.1 Owner's Property.

Title to all equipment, parts, materials, components, goods, supplies, Consumables, and Spare Parts for the WECs (collectively, "Parts") shall pass free and clear of any Encumbrances to Owner upon the earliest of any of (a) installation of such Part in a WEC (b) delivery of such Part to the Wind Plant Site or (c) payment for such Part. All materials, documents, reports, records, books, papers, print outs, plans, designs, or other work product generated, received, developed or purchased by O&M Contractor resulting from the performance of its obligations under this Agreement or otherwise developed by O&M Contractor in connection with this Agreement, (collectively, "Work Product", and collectively with Parts, "Owner's Property") shall be "works made for hire" according to U.S. Copyright law and similar laws, and shall be owned exclusively by Owner. If any portion of the Work Product is not considered a "works made for hire" or as otherwise necessary to ensure full ownership of the Work Product to Owner, O&M Contractor hereby irrevocably assigns to Owner all right, title, and interest in and to such Work Product, including all Intellectual Property Rights therein. O&M Contractor further agrees to deliver to Owner all Work Product (including any copies thereof) upon expiration or termination of this Agreement and upon request of Owner. For the purposes of this Section 10.1, "Owner's Property" shall not include (i) O&M Contractor's proprietary software applications or any proprietary modifications to the design of O&M Contractor's or WEC Manufacturer's products or services or software applications for use with such products or services that result from O&M Contractor's use of Owner's WEC Data pursuant to the rights granted under Section 10.2, (ii) books and records not directly related to this Agreement, and (iii) O&M Contractor's personnel records.

### 10.2 Use of Owner's Property/Improvements.

Owner hereby grants O&M Contractor a limited right to use Owner's Property during the Term for the sole and exclusive purpose of performing the Services hereunder for the sole benefit of Owner. In addition, Owner grants O&M Contractor a limited right to use the data from the WECs (the "Owner's WEC Data") solely for O&M Contractor's internal business purposes, specifically, for the sole and exclusive purpose of creating and/or testing modifications to the design of its or WEC Manufacturer's products or services or software applications to be used in connection with those products or services. Owner's WEC Data shall be considered Confidential Information under ARTICLE 20 and shall be provided to O&M Contractor AS IS, WHERE IS, without any representations and warranties, express or implied. The use of Owner's WEC Data shall be at O&M Contractor's sole risk. In the event that O&M Contractor conceives, invents or develops, either by itself or in conjunction with others, any innovation, enhancement, modification or improvement relating to or useful in connection with the WECs or the Wind Plant solely using Owner's WEC Data (including all data and records pertaining thereto) (each an "Improvement") and begins to commercialize such Improvements, O&M Contractor (a) will promptly disclose such Improvement in writing to Owner, (b) will make available to Owner and will grant, and hereby does grant, to Owner an irrevocable, fully paid-up, royalty-free, nonexclusive right and license, with the right to sub-license, to practice, use, modify, make, have made, and otherwise exploit such Improvement in connection with its ownership and operation of the Wind Plant, and (c) shall not commercialize such Improvement without

Owner's prior written consent. If any Improvement has been developed by O&M Contractor using data from other wind generating facilities in addition to Owner's WEC Data and O&M Contractor begins to commercialize such Improvement, O&M Contractor shall promptly disclose such Improvement in writing to Owner.

**10.3 Title in Replacement Parts.**

Insofar as O&M Contractor installs any Parts in performing the Repair Services:

(a) any such Part shall become Owner's Property as set forth in Section 10.1;

(b) the part that O&M Contractor removes from the WEC and replaces with such Part shall continue to be the property of Owner until such time as Owner directs O&M Contractor to remove the part from the Wind Plant Site. The part shall automatically cease to be Owner's Property upon its removal from the Wind Plant Site and shall become the property of O&M Contractor upon its removal from the Wind Plant Site; and

(c) At the request of Owner, O&M Contractor shall promptly remove from the Wind Plant Site any part that is removed from the WEC pursuant to Section 10.3(b).

## ARTICLE 11
## REPRESENTATIONS AND WARRANTIES

**11.1 O&M Contractor's Representations and Warranties.**

O&M Contractor hereby represents and warrants to Owner that:

(a) O&M Contractor is a [_____] duly organized and validly existing under the laws of [_____], and has the full power and authority to execute and deliver this Agreement and to perform its obligations hereunder.

(b) O&M Contractor's execution and delivery of, and the performance of its obligations under, this Agreement have been duly authorized by all necessary action of O&M Contractor. This Agreement constitutes the legal, valid and binding obligation of O&M Contractor and is enforceable against it in accordance with its terms, except as such enforcement may be limited by any bankruptcy, insolvency, moratorium or similar law or by general equitable principles (regardless of whether enforcement is sought in a proceeding in equity or at law).

(c) None of the execution or delivery of this Agreement or the performance by O&M Contractor of its obligations hereunder shall: (i) conflict with or violate any provision of O&M Contractor's organizational documents; (ii) conflict with, violate or result in a breach of, any Applicable Laws in effect as of the Effective Date; or (iii) conflict with, violate or result in a breach of, or constitute a default under or result in the imposition or creation of, any security under any agreement or instrument to which O&M Contractor is a party or by which it or any of its properties or assets are bound. O&M Contractor is not in default of its obligations under any agreement or instrument to which O&M Contractor is a party which could reasonably be expected to have a material adverse effect on O&M Contractor or its ability to perform its obligations under this Agreement.

(d) O&M Contractor has obtained all Permits as required under Applicable Laws to enable O&M Contractor to perform its obligations hereunder, as required under Section 4.5, and no registration, declaration or filing with any Governmental Authority is required on the part of O&M Contractor in connection with the execution, delivery and performance by it of this Agreement, except for those Permits (i) which have already been duly obtained or made, were validly issued and are in full force and effect and have become final and are not subject to appeal and all appeal periods with respect thereto shall have expired or (ii) which O&M Contractor has no reason to believe will not be granted prior to the time such Permit is required to be obtained under Applicable Laws.

(e) O&M Contractor is qualified to operate and maintain the Wind Plant and to perform its obligations hereunder. All of O&M Contractor's personnel performing the Services set forth in this Agreement shall be qualified to perform such obligations and shall be Experienced or shall be properly trained in performing the tasks which they shall perform.

(f) There are no actions, suits, claims, complaints, investigations or legal or administrative or arbitration proceedings pending or, to O&M Contractor's knowledge, threatened, whether at law or in equity, whether civil or criminal in nature, or whether before any Governmental Authority or arbitrator, against or affecting O&M Contractor which could reasonably be expected to have a material adverse effect on O&M Contractor or its ability to perform its obligations under this Agreement. There is no outstanding order, writ, injunction, decree, judgment or award by any court, arbitration panel or Governmental Authority against or affecting O&M Contractor which could reasonably be expected to have a material adverse effect on O&M Contractor or its ability to perform its obligations under this Agreement.

(g) O&M Contractor is not entitled to, and will not, take any tax position that is inconsistent with O&M Contractor's being a service provider to Owner with respect to the Wind Plant, including the WECs. Accordingly, O&M Contractor shall not claim, among other things, any depreciation or amortization deduction, investment tax credit, production tax credit, or environmental attribute, with respect to the Wind Plant, including the WECs.

## ARTICLE 12
## INDEMNIFICATION

### 12.1 Indemnification by O&M Contractor.

O&M Contractor shall indemnify, hold harmless and, at the option of Owner, defend, any Owner Indemnified Party from and against (i) any Losses that arise, or any Claims brought as a result of, the Release of Hazardous Materials or other environmental conditions due to the action or inaction or willful misconduct of any O&M Contractor Party; (ii) (x) all Claims of injury or death to any Person, including any Claims by any O&M Contractor Party, and any Losses incurred by the Owner Indemnified Party as a result of such Claims, or (y) any Losses incurred by any Owner Indemnified Party or Claims brought against any Owner Indemnified Party due to loss of, damage to, or destruction of property of such Owner Indemnified Party or third persons, that, in the case of clauses (x) and (y), arises out of or is otherwise in connection with the acts, errors, or omissions of any O&M

Contractor Party incident to the performance of this Agreement on the part of any O&M Contractor Party or breach by O&M Contractor of any provision of this Agreement; (iii) Losses incurred by, and Claims brought against, an Owner Indemnified Party resulting from Encumbrances created by, through, or under an O&M Contractor Party (unless due to Owner's failure to make payments to O&M Contractor as specified in this Agreement); or (iv) Losses incurred by, or Claims asserted against, an Owner Indemnified Party on account of any violation of or noncompliance with any Applicable Law to which the O&M Contractor Parties are subject, including O&M Contractor's and its Subcontractors' compliance with the Prevailing Wage Requirements. O&M Contractor shall also indemnify each Owner Indemnified Party against any Claims on the Wind Plant or the Wind Plant Site from O&M Contractor's creditors, other than Claims due to the failure of Owner to make all Payment Obligations. Notwithstanding anything to the contrary in this Agreement, O&M Contractor shall not have a duty to defend, indemnify, save or hold harmless any Owner Indemnified Party to the extent such Losses or Claims arise out of the negligence or willful misconduct of any Owner Indemnified Party. Solely and expressly for the purpose of the obligations to defend and indemnify as set forth in this Section 12.1, O&M Contractor specifically waives any immunity it may have under the State Industrial Insurance Law, Title 51 RCW ("Title 51 RCW"). O&M Contractor further acknowledges and agrees that this waiver of immunity under Title 51 RCW has been specifically entered into pursuant to the provisions of RCW 4.24.115 and has been the subject of mutual negotiations and agrees that the waiver provided by this Section 12.1 shall be limited to Claims asserted by employees of O&M Contractor, directly or indirectly, against Owner, irrespective of the type of relief sought or demanded, and irrespective of whether the damage alleged is bodily injury (including death), damage to property, economic loss, general damage, special damages or punitive damages.

### 12.2 Intellectual Property Indemnification.

O&M Contractor agrees to indemnify, defend, and hold harmless any Owner Indemnified Party from and against any Losses arising from, or related to any Claim that the Work Product, O&M Contractor's performance of the Services under this Agreement, or Owner's receipt, use or disposition of the same for their intended purposes, infringe upon or otherwise conflict with any Intellectual Property Rights of any Person. Owner (i) will notify O&M Contractor promptly of the receipt of any such Claim, (ii) will provide O&M Contractor with any information reasonably available to Owner required by O&M Contractor to settle and defend the Claim. O&M Contractor shall, at its own expense and option, (i) settle or defend the Claim and pay all damages and costs awarded against Owner, (ii) procure for Owner the right to continue to use the materials, equipment, or other items that are the subject of the Claim, (iii) modify such materials, equipment, or other items or the performance of the Services to eliminate the alleged infringement, or (iv) replace the infringing equipment, materials, or other items or re-perform the infringing Services. If, in any suit arising from such Claim, the continued use of the materials, equipment other items, or Services or the purpose intended thereof is forbidden by any court of competent jurisdiction, O&M Contractor shall at its option take one or more of the actions under clauses (ii), (ii), or (iv) above.

### 12.3 Attorneys' fees.

O&M Contractor shall be liable for the reasonable attorneys' fees, costs, and expenses, incurred by any Owner Indemnified Party and associated with defending or preparing to defend any Claim covered by this Article 12.

### 12.4 Survival.

Notwithstanding any other provision of this Agreement, the provisions of this ARTICLE 12 are intended to and shall survive termination of this Agreement.

## ARTICLE 13
## TERMINATION

### 13.1 Termination by Either Party.

Either O&M Contractor or Owner ("Terminating Party") may terminate this Agreement without limiting any other rights or remedies it may have:

(a) if the other Party fails to make any undisputed payment required to be made hereunder when such payment is due and owing under this Agreement, and such failure shall continue for ninety (90) days after written notice thereof has been given to the non-paying Party; or

(b) if the other Party has filed against it petitions under any insolvency or bankruptcy Law of any jurisdiction which are not dismissed within sixty (60) days of the date filed, proposes any dissolution, liquidation, composition, financial reorganization or recapitalization with creditors, makes an assignment for the benefit of creditors, files a voluntary petition in bankruptcy under any provision of Applicable Law or consents to the filing of any bankruptcy or reorganization petition against it under any similar Law, or if receivers, trustees, custodians or similar agents are appointed or take possession with respect to any property or business of such Party.

### 13.2 Termination by Owner.

Owner shall be entitled to terminate this Agreement by delivery of written notice of termination to O&M Contractor in any of the following events:

(a) O&M Contractor fails to comply with the Requirements of the Project Agreements and such failure causes or is likely to cause Owner to be in breach of one or more of the Project Agreements and such failure is not cured within thirty (30) days after written notice thereof has been given to O&M Contractor;

(b) O&M Contractor fails to comply in any material respect with any term, provision or covenant of this Agreement, other than the payment of sums to be paid hereunder (which failure is addressed in Section 13.1), and such failure continues for thirty (30) days after written notice thereof has been given to O&M Contractor, unless O&M Contractor demonstrates to Owner's reasonable satisfaction that such failure cannot reasonably be cured within said thirty (30) days and O&M Contractor shall have commenced to cure, in which case O&M Contractor shall have a commercially reasonable time period to cure such default not to exceed sixty (60) days in the aggregate;

(c) In the event that O&M Contractor is prevented from performing its obligations hereunder for a period of one hundred eighty (180) days due to an event or events of Force Majeure affecting Owner;

(d) O&M Contractor abandons the operation of the WECs and the performance of the Services under this Agreement for a period of two (2) consecutive Business Days without the prior written consent of Owner;

(e) any representation or warranty made by O&M Contractor in this Agreement shall contain an untrue or misleading statement of a material fact as of the date made, and such untrue or misleading statement has, or Owner reasonably determines could have, a material adverse effect on the Owner, the Wind Plant or O&M Contractor's ability to perform its obligations under this Agreement.

(f) O&M Contractor's failure to comply with the Emergency requirements provided in Section 4.4.

(g) If Measured Average Availability is less than eighty percent (80%) in any two (2) consecutive Production Periods, then Owner may, in its sole discretion, elect to terminate this Agreement by providing Contractor with sixty (60) days' prior notice of its intent. Owner's notice of intent to terminate must be provided to Contractor within ninety (90) days following the calculation of Measured Average Availability for the second Production Period in which such Measured Average Availability is less than eighty percent (80%).

**13.3 Termination by O&M Contractor**.

Except as provided in Section 13.1(a), O&M Contractor may terminate this Agreement if Owner fails to comply in any material respect with any term, provision or covenant of this Agreement, other than the payment of sums to be paid hereunder, and such failure shall continue for thirty (30) days after written notice thereof has been given to Owner, Owner demonstrates to O&M Contractor's reasonable satisfaction that such failure cannot reasonably be cured within said thirty (30) days, and Owner shall have commenced to cure, in which case Owner shall have a commercially reasonable time period to cure such default not to exceed sixty (60) days in the aggregate.

**13.4 Additional Remedies**.

Upon the occurrence of an event set forth in Sections 13.1, 13.2, or 13.3, the non-breaching Party may pursue any remedy at law or in equity, including termination of this Agreement, without prejudice to any rights or actions or remedies it may have in respect of any breach of this Agreement or any rights or obligations which expressly survive termination of this Agreement. Except as expressly provided to the contrary in this Agreement, upon the occurrence of a breach by a Party in the performance of its obligations under this Agreement, all rights and remedies of the non-breaching Party are cumulative of each other and of every other right or remedy available at law or in equity to such non-breaching Party, and the exercise of one or more rights or remedies shall not prejudice or impair the concurrent or subsequent exercise of other rights and remedies.

**13.5 Termination Without Cause**. This Agreement may be terminated by Owner, without cause, upon thirty (30) days' written notice to O&M Contractor, and O&M Contractor shall stop all work under this Agreement on the date for termination set forth in such notice. O&M Contractor shall be entitled to payment for all materials and services performed to the date of termination and shall be compensated at the rates set forth in Schedule 7.2.

**13.6 Wind Plant Condition at End of Term.**

Upon expiration or termination of this Agreement, O&M Contractor shall forthwith deliver to Owner any Owner Property and all other project-specific books, records, papers, or other information or materials documenting the Services performed or necessary for Owner to operate and maintain the WECs or the Wind Plant. O&M Contractor shall reasonably cooperate with Owner or the successor to O&M Contractor to ensure that any transfer of the duties and responsibilities of O&M Contractor shall be effected with as little disruption to the WECs and the Wind Plant as possible, and shall thereafter promptly remove its personnel from the Wind Plant Site. O&M Contractor shall leave the WECs, the Wind Plant Site and the O&M Facility in as good condition as on the Effective Date, normal wear and tear and casualty excepted. Owner shall also have the right, in its sole discretion, to directly assume and become liable for any contracts or obligations that O&M Contractor may have undertaken with third parties in connection with the services under this Agreement to the extent such contracts are assignable. O&M Contractor shall execute all documents and take all other reasonable steps reasonably requested by Owner that may be required to assign such contracts or obligations to Owner and otherwise transfer the Owner's Property to Owner.

## ARTICLE 14
## WARRANTIES AND GUARANTEES

**14.1 Services Warranty.**

O&M Contractor warrants to Owner that all of the Services performed by O&M Contractor under this Agreement shall be: (a) performed: (i) in accordance with this Agreement (including the Standards of Performance) and (ii) by qualified personnel, licensed in accordance with Applicable Laws, where required, and (b) free from defects in materials and workmanship (the "Services Warranty"). The Services Warranty and the remedy set forth below apply to any defect that appears within twelve (12) months from the date the work giving rise to the claim was performed ("Services Warranty Period"); provided, however, that to the extent that a Services Warranty claim arises out of defects in materials or equipment purchased by O&M Contractor under this Agreement (and not, for the avoidance of doubt, the installation, maintenance, or other services necessary to utilize such materials or equipment, which shall be subject to the Services Warranty), the warranty with respect to such materials or equipment shall be that provided by the original equipment manufacturer of such material or equipment; provided that Owner has been given an opportunity to review the applicable warranty coverage prior to O&M Contractor's purchase of such materials or equipment; and provided further that as . O&M Contractor further warrants in favor of Owner that all Services Warranty corrections performed by O&M Contractor pursuant to this Agreement shall conform to the requirements of the Services Warranty and shall be warranted until the later of (i) the date that is twelve (12) months from the date such Services Warranty correction was performed, or (ii) the end of

the original Services Warranty period; provided that in no event will any Services Warranty (or Services Warranty correction) extend beyond the date that is twelve (12) months from the end of the Term.

**14.2 Exclusive Remedy.**

(a) Subject to ARTICLE 15 (and except as otherwise provided in Section 12.1, Section 12.2, or Section 13.2), the exclusive remedy for any Claim based on a breach of the Services Warranty by O&M Contractor under this Agreement shall be the replacement by O&M Contractor of any defective parts or materials and re-performance by O&M Contractor of the defective portion of any Services, in each case at O&M Contractor's sole expense. If O&M Contractor fails to promptly commence any Services Warranty correction, or fails to properly complete any Services Warranty correction within a reasonable period of time of becoming aware of such defect, Owner may, but shall not be obligated to, perform the Services Warranty correction at O&M Contractor's sole expense, and O&M Contractor shall reimburse Owner for such expenses within sixty (60) days after Owner provides an invoice therefor.

(b) The foregoing Services Warranty as set forth in Section 14.1 shall not apply to the extent such breach of Services Warranty occurs as a result of Owner's failure to act in accordance with Prudent Industry Practice or to comply with the terms of this Agreement or the Maintenance Manual or as a result of Owner's gross negligence or willful misconduct.

**14.3 Exclusive Services Warranty.**

Except for the guarantee set forth in Section 14.5 or as otherwise expressly stated in this Agreement, the Services Warranty contained in Section 14.1 is exclusive and in lieu of all other warranties, whether written, oral, implied or statutory, with respect to goods and Services provided by O&M Contractor pursuant to this Agreement, but does not affect any separate express warranty provided by any equipment or materials supplier to the Wind Plant. NO IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY.

**14.4 Assignment of Warranties.**

Unless otherwise agreed as part of a Quote (including in connection with the Proactive Maintenance, which is addressed in Exhibit L), O&M Contractor shall secure commercially reasonable manufacturers' warranties, consistent with Prudent Industry Practices, with respect to any Parts, including Spare Parts, provided and used by O&M Contractor under this Agreement and shall ensure that such warranties are assignable to Owner upon the completion of work or upon the end of the Term of this Agreement, as applicable. O&M Contractor shall provide to Owner the terms of any extended warranty that is available for any Part that O&M Contractor procures or intends to procure after the Effective Date. If Owner approves of such terms and requests that O&M Contractor obtain such extended warranty, then O&M Contractor shall obtain such extended Warranty, and the cost of such extended warranty shall be a Reimbursable Expense. Owner shall be entitled to the benefit of any Subcontractor or manufacturer warranty that extends beyond the Services Warranty Period to the extent that any such warranty is assignable, and O&M Contractor shall use its best efforts to ensure that such warranties are assigned to Owner

and shall execute any assignments or other documents reasonably necessary to assign to Owner such warranties.

**14.5 Technical Availability Guarantee.**

O&M Contractor guarantees that Wind Plant will operate in accordance with the terms and conditions set forth in Exhibit D.

## ARTICLE 15
## WAIVER OF CONSEQUENTIAL DAMAGES

**15.1 Waiver of Consequential Damages**.

EXCEPT AS EXPRESSLY SET FORTH IN THIS AGREEMENT, IN NO EVENT, WHETHER BASED ON CONTRACT, INDEMNITY, WARRANTY, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY OR OTHERWISE, SHALL EITHER PARTY BE LIABLE FOR THE OTHER PARTY'S SPECIAL, INCIDENTAL, EXEMPLARY, INDIRECT OR CONSEQUENTIAL DAMAGES; PROVIDED, HOWEVER, THAT THE FOREGOING LIMITATION SHALL NOT APPLY TO DAMAGES ARISING FROM (I) THIRD PARTY INDEMNIFICATION OBLIGATIONS UNDER ARTICLE 12 OR (II) A PARTY'S GROSS NEGLIGENCE OR WILLFUL MISCONDUCT.

## ARTICLE 16
## FORCE MAJEURE

**16.1 Force Majeure.**

(a) Notwithstanding any other provision of this Agreement each Party's obligations under this Agreement shall be suspended by any Force Majeure if and to the extent that such Party is prevented or delayed from performing by reason of the Force Majeure; provided, however, that (i) the suspension of performance shall be of no greater scope and of no longer duration than is necessarily caused by the Force Majeure and required by any remedial measures, (ii) no obligations of any Party that arose before the occurrence of such causes shall be excused as the result of the occurrence, and (iii) each Party shall use diligent efforts to remedy its inability to perform; and provided further that no Force Majeure shall excuse any Payment Obligations of either O&M Contractor or Owner otherwise due hereunder. If the performance by either Party of its obligations under this Agreement is affected by any Force Majeure, such Party shall as soon as practicable notify the other Party of the nature and extent thereof.

(b) Following the occurrence of any Force Majeure, the Party declaring Force Majeure (the "Affected Party") shall:

(i) provide prompt notice to the other Party of the Force Majeure, giving an estimate of its expected duration and the probable impact on the performance by the Affected Party of its obligations hereunder;

(ii) exercise all efforts to continue to perform its obligations hereunder not so affected;

(iii) expeditiously act to correct or cure the Force Majeure;

(iv) exercise all efforts to mitigate or limit damages to the other Party;

(v) provide prompt notice to the other Party of the cessation of the Force Majeure and the resumption by the Affected Party of the performance of the affected obligations.

## ARTICLE 17
## INSURANCE

### 17.1 O&M Contractor Insurance.

O&M Contractor shall, at its sole cost and expense, procure, maintain and provide Owner with acceptable evidence (in form and substance satisfactory to Owner) of the existence of the types and amounts of insurance specified in Exhibit C during the Term of this Agreement.

### 17.2 Additional Requirements.

Each policy of insurance required by this ARTICLE 17 shall:

(a) The specified insurance shall also, either by an Acord certificate of insurance accompanied by the required endorsements specified in Exhibit C or by provisions in the policies, or by other endorsement attached to such policies, include an endorsement to the policy naming Owner, its Members, its directors, officers, employees, Representatives and agents as an additional insured as respects O&M Contractor's negligent acts, errors, or omissions in its performance of the Agreement, hereunder or other related functions performed by or on behalf of O&M Contractor. Such insurance shall not limit or qualify the liabilities and obligations of the O&M Contractor assumed under the Agreement.

(b) provide that all such insurance shall be Primary and Noncontributing with any other insurance held by Owner and its Members where liability arises out of or results from the negligent acts, errors, or omissions of O&M Contractor, its agents, employees, officers, assigns, or any person or entity acting for or on behalf of O&M Contractor. Any insurance carried by Owner which may be applicable shall be deemed to be excess insurance and the O&M Contractor's insurance is primary for all purposes despite any conflicting provision in the O&M Contractor's policies to the contrary.

The limits of insurance coverage shall in no way diminish O&M Contractor's liability.

### 17.3 Waiver of Subrogation.

All liability insurance policies specified in Exhibit C shall include a waiver of any right of subrogation of the insurers against Owner and its Members, and of any right of the insurers to any set-off or counterclaim or any other deduction, whether by attachment or otherwise, in respect of any liability of any such Person insured under such policy.

## ARTICLE 18
## ACCESS TO WIND PLANT

### 18.1 By O&M Contractor.

Subject to any requirements of Applicable Law and the terms of this Agreement, Owner shall provide O&M Contractor and its Subcontractors, agents and employees with reasonable access to the Wind Plant and the Wind Plant Site in accordance with the terms and conditions of the Real Property Documents and the Wind Plant Policies and Procedures at all times and without prior notice for the purpose of performing O&M Contractor's duties under this Agreement.

### 18.2 By the Owner.

Owner and its agents, employees and invitees shall have full and free access to the Wind Plant and Wind Plant Site to perform any investigations, studies, operations and maintenance work or other activities deemed appropriate by Owner in its sole discretion. During any such access to the Wind Plant Site, any such agents, employees and invitees shall comply with all reasonable safety and security procedures, including the Wind Plant Policies and Procedures.

## ARTICLE 19
## NOTICES

### 19.1 Notices.

All notices, consents, approvals and other communications required or permitted by this Agreement or by Applicable Law to be served upon, delivered, provided, or given to a Party by the other Party must be in writing (whether or not a writing is expressly required by the applicable provision of this Agreement or the Applicable Law) and shall be deemed duly served, delivered, provided, or given and received (i) on the date of service, if served personally or sent electronic mail (each with appropriate confirmation of receipt) to the Party to whom notice is to be given at the address or email address set forth below, or (ii) upon receipt, as evidenced by (a) a return receipt if mailed by first class registered or certified mail, postage prepaid, or (b) a tracking number if sent by a nationally recognized courier for next day service, in each case, to the address set forth below.

**If to Owner**:

Southern California Public Power Authority
Attn: Executive Director
1160 Nicole Court
Glendora, CA 91740
Telephone: (626) 793-9364
Email: executivedirector@scppa.org

With copies to:

Los Angeles Department of Water and Power
RE: Linden Wind Energy Project
111 N. Hope Street, Room 1263
Los Angeles, California 90012
Attention: External Energy Resources Group

Email: RPSOPS@ladwp.com

**If to O&M Contractor**: [.....]

The Parties, by like notice in writing, may designate, from time to time, another address or office to which notices shall be given pursuant to this Agreement.

## ARTICLE 20
## CONFIDENTIALITY

### 20.1 Confidential Information.

Each Party agrees, and shall use reasonable efforts to cause its parent, subsidiary and Affiliates, and its and their respective Representatives, as a condition to receiving confidential information hereunder, to keep confidential, except as required by Applicable Law, all documents, data, drawings, studies, projections, plans and other written information that relate to the economic benefits to or amounts payable by either Party under this Agreement, and documents that are clearly marked "Confidential" at the time a Party shares such information with the other Party ("Confidential Information"). The provisions of this ARTICLE 20 shall survive and shall continue to be binding upon the Parties for period of one (1) year following the date of termination of this Agreement. Notwithstanding the foregoing, information shall not be considered Confidential Information if such information (i) is disclosed with the prior written consent of the originating Party, (ii) was in the public domain prior to disclosure or is or becomes publicly known or available other than through the action of the receiving Party in violation of this Agreement, (iii) was lawfully in a Party's possession or acquired by a Party outside of this Agreement, which acquisition was not known by the receiving Party to be in breach of any confidentiality obligation, or (iv) is developed independently by a Party based solely on information that is not considered confidential under this Agreement.

### 20.2 Permitted Disclosure.

Either Party may, without violating this ARTICLE 20, disclose matters that are made confidential by this Agreement:

(a) to its counsel, accountants, auditors, advisors, other professional consultants, credit rating agencies, actual or prospective co-owners, investors, lenders, underwriters, contractors, suppliers, and others involved in operation and financing transactions and arrangements, provided that the parties to which disclosure is made are bound by confidentiality obligations at least as protective as those contained in this ARTICLE 20; and

(b) to governmental officials and parties involved in any proceeding in which either Party is seeking a permit, certificate, or other regulatory approval or order necessary or appropriate to carry out this Agreement;

(c) to governmental officials or the public as required by any Applicable Law, including without limitation oral questions, discovery requests, subpoenas, civil

investigations or similar processes and laws or regulations requiring disclosure of financial information, information material to financial matters, and filing of financial reports.

If a Party is requested or required, pursuant to any Applicable Law, discovery request, subpoena, civil investigation or similar process to disclose any of the Confidential Information, such Party shall provide prompt written notice to the other Party of such request or requirement so that at such other Party's expense, such other Party can seek a protective order or other appropriate remedy concerning such disclosure.

**20.3 Required Disclosure.**

Notwithstanding the foregoing or any other provision of this Agreement, O&M Contractor acknowledges that Owner, as a California joint powers authority, is subject to disclosure as required by the California Public Records Act, Cal. Govt. Code §§ 6250 et. seq. ("CPRA") and the Ralph M. Brown Act, Cal. Govt. Code §§ 54950 et. seq. ("Brown Act"). Confidential Information of O&M Contractor provided to Owner pursuant to this Agreement shall become the property of Owner and O&M Contractor acknowledges that Owner shall not be in breach of this Agreement or have any liability whatsoever under this Agreement or otherwise for any claims or causes of action whatsoever resulting from or arising out of Owner's copying or releasing to a third party any of the Confidential Information of O&M Contractor pursuant to the CPRA or Brown Act. Notwithstanding the foregoing or any other provision of this Agreement, Owner may record, register, deliver, and file all such notices, statements, instruments, and other documents as may be necessary or advisable to render fully valid, perfected and enforceable under all applicable Law any credit support contemplated by this Agreement and the rights, liens, and priorities of Owner with respect to any credit support.

**20.4 CPRA Requests.**

If Owner receives a CPRA request for Confidential Information of O&M Contractor, and Owner determines that such Confidential Information is subject to disclosure under the CPRA, then Owner will notify O&M Contractor of the request and its intent to disclose the documents. Owner, as required by the CPRA, will release such documents unless O&M Contractor timely obtains a court order prohibiting such release. If O&M Contractor, (a) at its sole expense, chooses to seek a court order prohibiting the release of Confidential Information pursuant to a CPRA request, (b) notifies Owner of its intention to seek a court order within five (5) days after receipt of notice of such CPRA request and (c) undertakes and agrees to defend, indemnify and hold harmless Owner Indemnified Parties from and against all suits, claims, and causes of action brought against any Owner Indemnified Party for Owner's refusal to disclose Confidential Information of O&M Contractor to any Person making a request pursuant to CPRA pursuant to documentation in form and substance reasonably satisfactory to Owner, then Owner shall, only if authorized under CPRA, delay release of the Confidential Information until O&M Contractor has had the opportunity to seek such court order. O&M Contractor's indemnity obligations shall include, but are not limited to, all actual costs incurred by the Owner Indemnified Parties, and specifically includes costs of experts and consultants, as well as all damages or liability of any nature whatsoever arising out of any such suits, claims, and causes of action brought against any Owner Indemnified Party, through and including any appellate proceedings. O&M Contractor's obligations to all Owner Indemnified Parties under this Section 20.4 shall be due and payable on a monthly, ongoing basis within thirty (30) days

after each submission to O&M Contractor of Owner's governed by the terms of Section 12.1.

### 20.5 Disclosure of Tax Structure or Treatment.

Notwithstanding anything to the contrary set forth herein or in any other agreement to which O&M Contractor and Owner are parties or by which they are bound, the obligations of confidentiality contained herein and therein, as they relate to this transaction, shall not apply to the U.S. federal tax structure or U.S. federal tax treatment of this transaction, and each Party (and any Representative of any Party hereto) may disclose to any and all persons, without limitation of any kind, the United States federal tax structure and United States federal tax treatment of this transaction. The preceding sentence is intended to cause this transaction not to be treated as having been offered under conditions of confidentiality for purposes of Section 1.6011-4(b)(3) (or any successor provision) of the Treasury Regulations promulgated under Section 6011 of the Code and shall be construed in a manner consistent with such purpose. In addition, O&M Contractor and Owner each acknowledge that it has no proprietary or exclusive rights to the tax structure of this transaction or any tax matter or tax idea related to this transaction.

## ARTICLE 21
## DISPUTE RESOLUTION

### 21.1 Step Negotiations.

The Parties shall attempt in good faith to resolve all disputes promptly by negotiation, as set forth below.

(a) First Step. Either Party may give the other Party written notice of any dispute not resolved in the normal course of business. Representatives of both Parties at levels one level above the personnel who have previously been involved in the dispute shall meet at a mutually acceptable time and place within ten (10) days after delivery of such notice, and thereafter as often as they reasonably deem necessary, to exchange relevant information and to attempt to resolve the dispute (the "First Step").

(b) Second Step. If the representatives of the Parties are unable to resolve the matter pursuant to First Step within fifteen (15) days after referral of the dispute to such representatives, or if no meeting of such representatives has taken place within fifteen (15) days after such referral, the matter shall be referred, by written notice, to the senior executives of each Party who shall meet at a mutually acceptable time and place within ten (10) days after delivery of such notice, and thereafter as often as they reasonably deem necessary, to exchange relevant information and to attempt to resolve the dispute (the "Second Step").

(c) Final Step. If the senior executives are unable to resolve, or do not anticipate being able to resolve, the dispute pursuant to the Second Step within twenty (20) days after receiving notice of such dispute (or such longer time as they may mutually agree in writing), either Party may initiate litigation to pursue any legal remedy available to it at law and in equity in accordance with Section 22.1(b).

(d) Step Negotiation Procedures. If a Party intends to be accompanied at a meeting by an attorney, the other Party shall be given at least three (3) Business

Days' notice of such intention so the other Party may also be accompanied by an attorney. All negotiations pursuant to this Section 21.1 are confidential and shall be treated as compromise and settlement negotiations for purposes of the Federal Rules of Evidence and state rules of evidence. Each Party shall bear its own costs for this dispute resolution phase.

(e) Claims Presentment Under California Law. In addition to the dispute resolution process set forth in this Section, the Parties must comply with California Law governing claims against public entities and presentment of such claims.

**21.2 Continued Prosecution of the Work.**

In case of any dispute, O&M Contractor shall continue to diligently prosecute the work as set forth in this Agreement and maintain its progress, and Owner shall continue to make payments to O&M Contractor for those portions of the work completed that are not the subject of dispute in accordance with the Agreement.

## ARTICLE 22
## MISCELLANEOUS

**22.1 Execution; Governing Law and Venue.**

(a) This Agreement may be executed in counterparts, and, upon execution by each signatory, each executed counterpart shall have the same force and effect as an original instrument and as if all signatories had signed the same instrument. Any signature page of this Agreement may be detached from any counterpart of this Agreement without impairing the legal effect of any signature thereon, and may be attached to another counterpart of this Agreement identical in form hereto by having attached to it one or more signature pages.

The Parties may execute this Agreement by manual signature or by electronic signature, each of which shall have the same force and effect. A signed copy of this Agreement transmitted by facsimile, email or other means of electronic transmission shall be deemed to have the same legal effect as delivery of an original executed copy of this Agreement for all purposes, to the extent provided under applicable law, including California's Uniform Electronic Transactions Act.

(b) This Agreement shall be governed by, interpreted and enforced in accordance with and construed under the laws of the State of California without regard to conflict of law principles. All litigation arising out of, or relating to this Agreement, shall be brought in a state or federal court in the County of Los Angeles in the State of California. The Parties irrevocably agree to submit to the exclusive jurisdiction of such courts in the State of California and waive any defense of forum non conveniens.

**22.2 Amendments, Supplements, Etc.**

Neither this Agreement nor any of the terms hereof may be amended, supplemented, or modified orally, but only by an instrument in writing signed by O&M Contractor and by Owner.

### 22.3 Headings.

The headings of the Articles and Sections of this Agreement have been inserted for convenience of reference only and shall not modify, define or limit any of the terms or provisions hereof.

### 22.4 Assignment.

O&M Contractor may not assign, pledge or otherwise transfer this Agreement without the prior written consent of Owner. This Agreement may be assigned by Owner to a successor owner of the Wind Plant without O&M Contractor's prior consent. Owner may, without consent of O&M Contractor assign this Agreement to any Member or assignee proposed by Owner that has a current long-term credit rating (corporate or long-term senior unsecured debt) of (1) "A3" or higher by Moody's Investors Service, Inc. or (2) "A" or higher by Standard & Poor's. Any attempted assignment, pledge or other transfer in violation of this Section 22.4 shall be null and void.

### 22.5 Successors and Assigns.

This Agreement shall be binding upon and inure to the benefit of the Parties, and their respective successors and assigns, to the extent that assignment is permitted hereunder.

### 22.6 Waiver.

The failure of either Party to this Agreement to enforce or insist upon compliance with or strict performance of any of the terms or conditions hereof, or to take advantage of any of its rights hereunder, shall not constitute a waiver or relinquishment of any such terms, conditions or rights, but the same shall be and remain at all times in full force and effect. Notwithstanding anything express or implied herein to the contrary, nothing contained herein shall preclude either Party from pursuing any available remedies for breaches not rising to the level of a default, including without limitation recovery of damages caused by the breach and specific performance or any other remedy given under this Agreement now or hereafter existing in law or equity or otherwise.

### 22.7 Severability.

If any provision of this Agreement is declared by a court of competent jurisdiction to be illegal, unenforceable or void, that provision shall be modified so as to be enforceable and as nearly as possible reflect the original intention of the Parties, it being agreed and understood by the Parties that (i) this Agreement and all the provisions hereof shall be enforceable in accordance with their respective terms to the fullest extent permitted by Law, and (ii) the remainder of this Agreement shall remain in full force and effect.

### 22.8 Construction.

Every term and provision of this Agreement shall be construed as if both Parties jointly prepared it, and any uncertainty or ambiguity in the Agreement shall not be interpreted against any one Party.

### 22.9 Survival.

Upon the expiration or termination of this Agreement, this Agreement shall have no further force and effect, except that any rights and remedies that have arisen or accrued to a Party prior to such expiration or termination, or any obligations or liabilities that have arisen or accrued before such expiration or termination, and that expressly survive such expiration or termination pursuant to this Agreement, shall in each case survive expiration or termination. Except as otherwise set forth herein, (i) all representations, warranties and covenants of O&M Contractor set forth herein shall survive in full force and effect the expiration or termination of this Agreement until the expiration of the applicable statute of limitations, (ii) the rights, remedies and obligations set forth in ARTICLE 13 (Termination), ARTICLE 19 (Notices), ARTICLE 20 (Confidential Information), ARTICLE 21 (Dispute Resolution), and ARTICLE 22 (Miscellaneous Provisions), shall survive in full force and effect the expiration or termination of this Agreement to the extent necessary to enable a Party to exercise any of such accrued rights and remedies, and (iii) the rights, remedies and obligations set forth in Section 15.1 (Waiver of Consequential Damages) shall survive in full force and effect the expiration or termination of this Agreement, and (iv) the rights, remedies and obligations set forth in ARTICLE 12 (Indemnification) shall survive expiration or termination of this Agreement. This Section 22.9 shall survive in full force and effect the expiration or termination of this Agreement.

### 22.10 Entire Agreement.

This Agreement, including the exhibits and schedules attached hereto, which are hereby incorporated by this reference as though fully set forth herein, constitutes the entire contract between the Parties with respect to the subject matter hereof. Nothing in this Agreement, express or implied, is intended to confer upon any Person other than the Parties any rights, remedies, obligations or liabilities under or by reason of this Agreement.

[SIGNATURE PAGE FOLLOWS]

IN WITNESS WHEREOF, the duly authorized officers of the Parties have executed this Agreement on behalf of the Parties, all as of the date first stated above.

**[_____]**

By: _____
Signature

_____
Name

_____
Title

By: _____
Signature

_____
Name

_____
Title

**SOUTHERN CALIFORNIA PUBLIC POWER AUTHORITY**

By: _____
Signature

_____
Name

_____
Title

**EXHIBIT A**
**SCHEDULE OF DEFINITIONS**

When used in the Agreement (as defined below), unless otherwise defined therein, the following terms shall have the respective meanings set forth below:

"Affiliate" of a Person ("First Person") shall mean a Person which directly or indirectly controls, or is controlled by, or is under common control with, the First Person, and shall also include any limited partnership or limited liability company of which the First Person or Affiliate thereof is the general partner, managing member or manager, as the case may be. If Owner is the First Person, any current or future member of the First Person shall constitute an Affiliate. "Control" of a Person for purposes of this definition shall mean the possession, directly or indirectly, of the power to direct or cause the direction of management, policies, or activities of a Person, whether through ownership of voting securities, by contract or otherwise.

"Agreement" shall have the meaning given thereto in the Preamble.

"Applicable Law" shall mean all local, state and federal Laws which are applicable to or which affect O&M Contractor, Owner, the Wind Plant or the Wind Plant Site, including the operation, maintenance or use of the Wind Plant Site, the Wind Plant, and the Interconnection Facilities, including any Permits, Environmental Laws, Safety Laws, bankruptcy Law, and zoning, sanitation, siting or building Laws. Applicable Law shall also include any requirements, rules or regulations set forth by the North American Electric Reliability Corporation or Western Electricity Coordinating Council.

"Availability" has the meaning set forth in Section 3.2 of Exhibit D.

**"**Balance of Plant" shall mean all equipment and materials and other items incorporated in the Wind Plant, except for the WECs. Balance of Plant includes, but is not limited to, the civil, electrical and mechanical construction works, principally roads, foundations for transformers and WECs, cable and pipe ducting, pad-mount transformers, switch gears, electrical cables, communication cables and system, SCADA system, meteorological station, and Wind Plant meter. Substations and Interconnection Facilities are not included in the Balance of Plant.

"BOP Contractor" shall mean any contractor performing Balance of Plant operation and maintenance services at the Wind Plant Site.

"Brown Act" shall have the meaning given thereto in Section 20.3.

"Business Day" shall mean any day except a Saturday, Sunday or other day on which commercial banks in the State of California or the State of Washington, are authorized by law to close.

"CPRA" shall have the meaning given thereto in Section 20.3.

"Claims" shall mean claims, charges, controversies, disputes, actions, suits, proceedings, demands or judgments against a Person.

"Confidential Information" shall have the meaning given thereto in Section 20.1.

"Consumables" shall mean those items that are installed, added to or otherwise used by the technicians in the process of performing Scheduled Maintenance; including rags, solvents, grease, lubricants and WEC parts (such as seals, o-rings, springs, hydraulic fittings, hoses, etc.), and excluding those items specifically identified as Spare Parts under this Agreement.

"Cost Reimbursable Services" means the services performed by O&M Contractor that are not Fixed Fee Services.

"Effective Date" shall have the meaning given thereto in the Preamble of this Agreement.

"Emergency" shall mean an event occurring at the Wind Plant Site, or any adjoining property, that (a) poses actual, or imminent risk of, (i) serious personal injury or (ii) material physical damage to one or more WECs or to the Wind Plant and (b) requiring, in the good faith determination of O&M Contractor or Owner, immediate preventative or remedial action.

"Encumbrance" shall mean (a) any mortgage, charge, lien, pledge, hypothecation, title retention arrangement or other security interest, as or in effect as security for the payment of a monetary obligation or the observance of any other obligation; (b) any easement, servitude, restrictive covenant, equity or interest in the nature of an encumbrance, garnishee order, writ of execution, right of set-off, lease, license to use or occupy, assignment of income or monetary claim; and (c) any agreement to create any of the foregoing or allow any of the foregoing to exist.

"Experienced" shall mean to have demonstrated experience of at least five (5) years providing the same or similar services to wind generation facilities of a type and size similar to the WECs and the Wind Plant.

"Extension Term" shall have the meaning given thereto in Section 3.2.

"Environmental Laws" shall mean all Laws relating to (i) the control of any pollutant, or protection of the air, water, or land, (ii) solid, gaseous or liquid waste generation, handling, treatment, storage, disposal or transportation, (iii) exposure to hazardous, toxic or other harmful substances, and (iv) the protection and enhancement of the environment. Environmental Laws shall include the Clean Air Act, 42 U.S.C. § 7401 et seq., the Clean Water Act, 33 U.S.C. § 1251 et seq., the National Environmental Policy Act, 42 U.S.C. § 4321 et seq., the Endangered Species Act, 16 U.S.C. § 1531 et seq., the Resource Conservation Recovery Act, 42 U.S.C. § 6901 et seq., the Safe Drinking Water Act 42 U.S.C. § 300f et seq., the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act, 32 U.S.C. § 9601 et seq., the Federal Insecticide, Fungicide and Rodenticide Act, 7 U.S.C. § 136 et seq., the Hazardous Materials Transportation Act, 49 U.S.C. § 1801 et seq., the Toxic Substances Control Act, 15 U.S.C. § 2601 et seq., and the Emergency Planning and Community Right-to-Know Act, 42 U.S.C. § 11001 et seq., any state or local laws relating to Permits, such as the Washington State Environmental Policy Act, RCW Ch. 43.21C et seq., the Energy Site Evaluation Council Act, RCW Ch. 80.50 et seq., the State

Water Code, RCW Ch. 90.03 et seq., and local land use control ordinances or similar laws, any state or local laws implementing or substantially equivalent to the foregoing federal requirements, such as the Model Toxics Control Act, RCW Ch. 70.105D et seq., the Hazardous Waste Management Act, RCW Ch. 70.105 et seq., the Solid Waste Management Act, RCW Ch. 70.95 et seq., the Washington Clean Air Act, RCW Ch. 70.94 et seq., the Washington Aquifer Protection Areas Act, RCW Ch. 36.36 et seq., the Washington Water Pollution Control Act, RCW Ch. 90.48 et seq., and other similar Laws.

"Fail" means that the Part (a) ceases to operate; or (b) actually and materially fails to perform its intended function. For the avoidance of doubt, a Failed Part includes a Part that can only continue to operate or to perform its intended function because of Contractor implemented de-rating or parameter changes. "Failure" and "Failed" will have a correlative meaning.

"First Step" shall have the meaning given thereto in Section 21.1(a).

"Fixed Fee" shall have the meaning given thereto in Section 7.1(a).

"Fixed Fee Services" means the services set forth in Exhibit B of this Agreement.

"Force Majeure" shall mean any act of God, labor disturbance of a regional, national or sector-wide nature, and not directed solely against the affected Party, act of the public enemy, war, insurrection, riot, fire, extreme and severe storm or flood, explosion, or any order, regulation or restriction imposed by governmental, military or lawfully established civilian authorities occurring after the Effective Date (i) which prevents one Party from performing any of its obligations under this Agreement, (ii) which could not reasonably be anticipated as of the Effective Date, (iii) which is not within the reasonable control of, or the result of negligence, willful misconduct, breach of contract, intentional act or omission or wrongdoing on the part of the affected Party (or any subcontractor or Affiliate of that Party, or any Person under the control of that Party or any of its subcontractors or Affiliates, or any Person for whose acts such subcontractor or Affiliate is responsible), and (iv) which by the exercise of due diligence the affected Party is unable to overcome or avoid or cause to be avoided; provided that nothing in this clause (iv) shall be construed so as to require either Party to accede or agree to any provision not satisfactory to it in order to settle and terminate a strike or labor dispute in which it may be involved. Without limiting the generality of the foregoing, a Force Majeure does not include any of the following: (1) events arising from the failure by O&M Contractor to operate or maintain the Wind Plant in accordance with this Agreement; (2) any increase of any kind in any cost; (3) delays in or inability of a Party to obtain financing or other economic hardship of any kind; (4) failure of third parties to provide goods or services essential to a Party's performance; (5) Wind Plant or equipment failure of any kind; or (6) any changes in the financial condition of the Owner, O&M Contractor, any Representative, or any Subcontractor or supplier affecting the affected Party's ability to perform its obligations under this Agreement.

"Governmental Authority" shall mean any federal, provincial, state or local government authority, agency, court or other body, officer or public entity, including any zoning authority, building inspector, or health or safety inspector.

"Hazardous Materials" shall mean any dangerous, hazardous or toxic substance or constituent or pollutant or contaminant which, pursuant to any Applicable Law, has been determined, to be hazardous, toxic or dangerous to human health or the environment, including but not limited to any hazardous substance under the Comprehensive Environmental Response, Compensation and Liability Act, as amended (42 U.S.C.A. § 9601 et. seq.), any solid waste under the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C.A. § 6901 et. seq.), or any contaminant, pollutant, waste or toxic substance under the Clean Air Act, as amended (42 U.S.C.A. § 7401 et. seq.), the Federal Water Pollution Control Act, as amended (33 U.S.C.A. § 1251 et. seq.), the Safe Drinking Water Act, as amended (42 U.S.C.A. § 300f et. seq.), the Emergency Planning and Community Right-To-Know Act, as amended (42 U.S.C.A. § 110001 et. seq.), the Occupational Safety and Health Act, as amended (29 U.S.C.A. § 651 et. seq.), the Hazardous Materials Transportation Act, as amended, (49 U.S.C.A. § 5101 et. seq.), or the Toxic Substances Control Act, as amended (15 U.S.C.A. § 2601 et. seq.), and any equivalent or applicable state or local laws.

"Improvement" shall have the meaning given thereto in Section 10.2.

"Initial Term" shall have the meaning given thereto in Section 3.1**.**

"Intellectual Property Rights" means all (i) intellectual property rights existing from time to time under any laws or regulations, including copyrights, patents, industrial design rights, trademarks, logos, slogans, corporate names, trade names, rights of priority, and applications and registrations for any of the foregoing, and (ii) trade secrets, know how, mask works, software, firmware, specifications, algorithms, designs, drawings, methodologies, ideas, concepts, inventions, plans, processes, techniques, tools, hardware, works of authorship, and other technology, whether or not protectable by any form of intellectual property rights.

"Interconnection Facilities" shall mean facilities and devices (e.g., circuit breakers, filters, protection devices, relays and metering) necessary to interconnect and deliver power from the Wind Plant to the utility transmission system.

"Laws" shall mean all laws, statutes, orders, decrees, injunctions, licenses, permits, approvals, agreements and regulations of any Governmental Authority having jurisdiction over the matter in question.

"Losses" means losses, costs, expenses, liabilities, damages, fines or penalties, including court costs, reasonable attorneys' and professionals' fees and expenses and other litigation or settlement expenses.

"Maintenance Manual" means the then-current revisions of the manuals and other documents applicable to the Serviced Equipment, as well as all operating manuals supplied by all vendors or manufacturers for all Parts, components and systems of the WEC and which fully and completely describe the proper operation and maintenance of the Wind Plant and include a complete and integrated set of as-built drawings and equipment descriptions of the Wind Plant, including (i) Operating Manual – Senvion MM92 [doc. no. 0077-9484 V00]; (ii) Safety Regulations for Operators and Technicians – Senvion MM92 [doc. no. 0077-9501 V00]; and (iii) SIF 6M & 12M Maintenance Checklist – Senvion MM92 [doc. no. 0077-9197 V01.

"Measured Average Availability" or "MAA" has the meaning set forth in Section 3.2 of Exhibit D.

"Member" shall mean any current or future member of Owner.

"Nominal Condition" shall mean that condition that allows for the functioning of a WEC in accordance with the Technical Specifications without the need for any further repair or replacement works having to be carried out on the WEC or its component parts.

"Normal Business Hours" means Monday though Friday, excluding days that are not Business Days, between the hours of 7:00 a.m. and 4:00 p.m., prevailing local time where the Wind Plant is located.

"NWWP" shall have the meaning given thereto in the Recitals.

"O&M Contractor" shall have the meaning given thereto in the introductory paragraph of this Agreement, and its successors and permitted assigns, if any.

"O&M Contractor Party" shall mean O&M Contractor, its Affiliates, Subcontractors, and Representatives and the Representatives of O&M Contractor's Subcontractors and Affiliates.

"O&M Contractor Representative" shall have the meaning given thereto in Section 6.1.

"O&M Facility" means the facility to be used by BOP Contractor and O&M Contractor as a warehouse, shop, and office facility located on, or in reasonable proximity, to the Wind Plant Site.

"Operating Agent" shall have the meaning given thereto in Section 6.1.

"Owner" shall have the meaning given thereto in the introductory paragraph of the Agreement, and its permitted successors and assigns, if any, under the Agreement.

"Owner Indemnified Party" shall mean Owner, Owner's Affiliates and Members, the Operating Agent, and all of the officers, directors, employees, agents, advisors, representatives assigns and successors in interest of each.

"Owner Representative" shall have the meaning given thereto in Section 6.1.

"Owner's Property" shall have the meaning given thereto in Section 10.1.

"Owner's WEC Data" shall have the meaning given thereto in Section 10.2.

"Parties" shall have the meaning given thereto in the Preamble.

"Parts" shall have the meaning given thereto in Section 10.1.

"Party" shall have the meaning given thereto in the Preamble.

"Payment Obligations" shall mean payments as and when required under this Agreement.

"Permit" shall mean any waiver, exemption, variance, franchise, certification, approval, permit, authorization, license, consent, or similar order of or from any Governmental Authority having jurisdiction over the matter in question.

"Person" shall mean any individual, partnership, joint stock company, corporation, trust, unincorporated association or joint venture, a government or any department or agency thereof, or any other entity.

"Prevailing Wage Requirements" means the requirements regarding prevailing wages as described under Sections 48(a)(10), 45(b)(7), 48E(d)(3), and 45Y(g)(9) of the Internal Revenue Code of 1986, as amended (the "Code") with respect to a production tax credits, or Sections 48(a)(10) and 48(a)(11) or 48E(d)(3) and 48E(d)(4) with respect to the investment tax credits, IRS Notice 2022-61, and those rules promulgated and published by Treasury Decision 9998 at 89 Fed Reg 53184 (June 25, 2024) as corrected at 89 Fed Reg 66560 (Aug. 16, 2024), as may be amended, modified, or supplemented and, in each case, any final, proposed, or temporary Treasury Regulations promulgated thereunder and any IRS or U.S. Department of Labor guidance (including notices, revenue rulings, revenue procedures, and announcements) or official interpretation with respect thereto.

"Pre-Existing Contamination" shall mean any Hazardous Material present in any environmental medium as a result of a Release at the Wind Plant Site prior to the commencement of O&M Contractor's performance of work at the Wind Plant Site and not arising from or relating to the activities of O&M Contractor or any of its Subcontractors.

"Production Period" shall have the meaning given thereto in Exhibit D.

"Project Agreements" shall mean the Transmission and Interconnection Agreements, the Real Property Documents, and any documents in replacement thereof.

"Prudent Industry Practice" shall mean the practices, methods and acts engaged in or approved by a significant portion of the wind power industry in the United States that, at a particular time, in the exercise of reasonable judgment in light of the facts known or that should reasonably have been known at the time a decision was made, would have been expected to accomplish the desired result in a manner consistent with Laws, regulations, codes, standards, equipment manufacturer's recommendations, reliability, safety, environmental protection, economy and expedition. Prudent Industry Practice does not necessarily mean the highest standard in the industry.

"Quote" shall have the meaning given thereto in Section 8.2.

"Quote Expiration Date" shall have the meaning given thereto in Section 8.2(f).

"Quote Number" shall have the meaning given thereto in Section 8.2(e).

"Quote Request" shall have the meaning given thereto in Section 8.1.

"Real Property Documents" shall mean easements, option agreements, leases, subordinations and other real property agreements that create or evidence any real property interests relating to the Wind Plant, as amended, restated or otherwise modified from time to time.

"Reimbursable Expenses" shall have the meaning given thereto in Section 7.2(a).

"Release" shall mean any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment (including the abandonment or discarding of barrels, containers, and other closed receptacles containing any Hazardous Materials).

"Repair Services" shall have the meaning given thereto in Exhibit B.

"Representative" shall mean, with respect to any Person, any officer, director, shareholder, member, partner, principal, agent, employee, attorney, advisor or other representative of such Person, provided that in no event shall (a) Owner be deemed to be a representative of O&M Contractor or (b) O&M Contractor be deemed to· be a representative of Owner.

"Requirements of the Project Agreements" means the requirements of the Project Agreements set forth in Exhibit J.

"Safety Laws" shall have the meaning given thereto in Section 5.1(a).

"Schedule of Definitions" shall mean this Schedule of Definitions.

"Scheduled Maintenance" means any maintenance, inspection or repair of, or other services scheduled to be performed on, the Serviced Equipment.

"Second Step" shall have the meaning given thereto in Section 21.1(b).

"Separate Contractor" shall have the meaning given thereto in Section 5.5.

"Serviced Equipment" means the WECs from the bottom flange up (including all WEC controller hardware, blade bearings, service lifts, climb assists, and condition monitor systems). Serviced Equipment does not include transformers, blades, tower foundations, tower foundation anchor bolts and fasteners, electrical infrastructure of balance of plant, Owner SCADA system, substation, aviation, lighting, switchgear, controller software, and balance of plant work.

"Service Inspection Form" means the document SIF 6M & 12M Maintenance Checklist – Senvion MM92, doc. no. 0077-9197 V01, as the same may be updated by Contractor from time to time.

"Service Order Report" shall have the meaning given thereto in Section 5a. of Exhibit B.

"Services Warranty" shall have the meaning given thereto in Section 14.1.

"Services Warranty Period" shall have the meaning given thereto in Section 14.1.

"Spare Parts" shall mean all replacement parts, instruments, accessories, furnishings and other equipment of whatever nature (excluding Consumables) which may be from time to time installed in or attached to any WEC by the O&M Contractor.

"Subcontractors" means any subcontractor, of any tier, or supplier of materials, equipment or services to O&M Contractor or any subcontractor, of any tier, of any Person engaged or employed by O&M Contractor or any Subcontractor in connection with the performance of the scope of this Agreement.

"Taxes" shall mean each federal, state, provincial, county, local and other (a) net income, gross income, gross receipts, sales, use, ad valorem, business or occupation, transfer, franchise, profits, withholding, payroll, employment, excise, property or leasehold excise, tax, (b) customs, duty or other fee, assessment or charge of any kind whatsoever, together with any interest and any penalties, additions to tax or additional amount with respect thereto.

"Technical Specifications" means the general specifications for the Wind Turbines, as set forth on Exhibit F, as the same may be updated and supplemented from time to time.

"Term" shall mean the Initial Term and, if applicable, the Extension Term.

"Terminating Party" shall have the meaning given thereto in Section 13.1.

"WEC" means the twenty-five (25) Senvion MM92 2.0 MW wind turbine generators at the Project Site, each including the following: a turbine nacelle, a blade set, a hub (including blade bearings), controller hardware, control panels, and anemometers.

"WEC Manufacturer" shall mean REpower Systems SE, and its successors and assigns.

"Wind Plant" shall mean the WECs and the Balance of Plant constructed on the Wind Plant Site.

"Wind Plant Policies and Procedures" means the safety and security policies of Owner applicable to the Wind Plant Site.

"Wind Plant Site" shall mean the site, including the Real Property Documents, on which the Wind Plant is located, as described in Exhibit I.

"Work Product" has the meaning set forth in Section 10.1.

**EXHIBIT B**
**FIXED FEE SERVICES**

1. Scheduled Maintenance. O&M Contractor shall perform Scheduled Maintenance in accordance with the intervals set forth in the Maintenance Manual and in accordance with the Scheduled Maintenance Calendar. Scheduled Maintenance shall also include (i) an annual walk-down and inspection of all WECs, and on the basis of such inspection, O&M Contractor shall prepare a list of deficiencies in the condition of each WEC and provide such list to Owner; and (ii) an annual site condition report supported by materials, including pictures and other supporting material for reference of each condition mentioned in the site condition report.

2. Repair Services. From time to time the WECs and their components may require repair or replacement as a result of damage, the occurrence of faults or defects or fair wear and tear. O&M Contractor shall perform such repairs and replacements as may be necessary in accordance with the Technical Specifications, including any non-routine maintenance and repairs of the Wind Plant and major repairs, inspections, maintenance, repairs or other services that are not included as part of Scheduled Maintenance, for the purposes of achieving and maintaining the Nominal Condition of each WEC (the "Repair Services"). In performing the Repair Services, the following terms shall apply:

    a. O&M Contractor will, in consultation with Owner, make and manage any warranty claims regarding any parts or materials that are the subject of Repair Services.

    b. O&M Contractor shall be entitled to utilize used or rebuilt Spare Parts that have been reconditioned, repaired, or overhauled, so long as (a) each such Spare Part has been inspected and conforms to the Technical Specifications for such Spare Part and (b) the use of such Spare Part will not negatively impact any warranties and guarantees that may apply to, or have an adverse impact on the performance of, the WECs or any parts or components thereof.

    c. O&M Contractor shall use commercially reasonable efforts to inform Owner thirty-six (36) hours before performing any Repair Service that involves carrying out substantial work; and inform Owner seventy-two (72) hours before performing any Repair Service that involves using cranes or heavy lifting equipment at the Wind Plant Site; and

    d. O&M Contractor shall have no obligation to perform any Repair Services in respect of components or parts that do not comprise the WECs, except to the extent that such components or parts are procured or used by O&M Contractor in the performances of the services under this Agreement.

    e. O&M Contractor's performance of Repair Services necessary to return WECs to Nominal Condition shall take priority over any Scheduled Maintenance.

    f. On not less than an annual basis during the Term on a schedule to be agreed with Owner, O&M Contractor shall perform a Quality Assurance inspection ("QA Inspection") of each WEC, in the presence of a representative of Owner, to determine the condition of the WECs. O&M Contractor shall provide Owner with a written report of its findings upon completion of the QA Inspection. If the QA

Inspection reveals conditions that require performance of Repair Services pursuant to this Section 2 of Exhibit B, O&M Contractor shall perform those Repair Services within (a) six (6) months following completion of the QA Inspection, or (b) sixty (60) days if it is a condition requiring only non-substantial Repair Services; provided any Repair Services required as a result of the QA Inspection shall be completed by the O&M Contractor prior to the expiration of the Term of the Agreement. The Parties agree that the first QA Inspection following the Effective Date, including the inspection of all WECs, shall begin in [_____] and shall be completed by no later than [_____].

3. System Monitoring and Control Services. During the Term and subject to Owner's compliance with Section 4.2 of the Agreement, O&M Contractor will (i) monitor the WECs remotely twenty-four (24) hours per day, seven (7) days a week; and (ii) perform remote resets on the WECs on an as-needed basis at no additional cost to Owner, except that event codes that cannot be reset remotely.

4. Remote Monitoring Services. During the Term, O&M Contractor will:

   a. Operate the SCADA system for the WECs and remotely monitor the WECs and all messages from the WECs twenty-four (24) hours per day, seven (7) days a week, three hundred sixty-five (365) days per year.

   b. Make sure all WEC Data is available to Owner or Owner's designated representative as set forth in this Agreement without additional charge.

   c. Remotely reset WECs if possible and prudent, or call-out O&M Contractor's technician for on-site reset if not possible or prudent.

   d. O&M Contractor shall work with Owner to formalize a written procedure for remote reset of WECs to minimize possibility of component failures.

   e. Establish and maintain work clearance procedures to regulate jurisdictional control of WECs and safeguard personnel.

   f. Perform outage clearance coordination.

   g. Callout of local emergency first responders.

   h. Provide hardware for remote monitoring functions at O&M Contractor's off-site operations control center ("OCC") site, including computer, display, modem or broadband access.

   i. Make sure access is available to Owner and Owner Designated Representative of all WEC Data available and utilized by O&M Contractor for performance of Services set forth in this Exhibit B.

   j. Maintain a log of WEC events and downtime tracking. Provide daily summary report of events including call-outs; clearances issued; and warranty notices.

k. Provide a monthly summary of WEC events and downtime tracking.

5. Communication and Reporting.

a. Service Order Reports. For each visit to perform Fixed Fee Services or Cost Reimbursable Services to a WEC, O&M Contractor shall prepare a written service report ("Service Order Report") which describes (i) the parts used or replaced on the WEC and (ii) the Fixed Fee Services and/or Cost Reimbursable Services performed by O&M Contractor on the WEC during such visit. If Cost Reimbursable Services were performed, the Service Order Report shall identify any applicable Quote and Quote Number associated with the Cost Reimbursable Services. O&M Contractor shall provide Owner copies of all Service Order Report for each WEC serviced by O&M Contractor on a monthly basis. Such reports may be provided in electronic format and emailed to Owner to an email address identified by Owner Representative. O&M Contractor Representative shall sign off on each Service Order Report.

b. Monthly Performance Reports. O&M Contractor shall provide to Owner by the tenth (10th) Business Day of each month a written report on the form attached hereto as Exhibit E (a "Monthly Performance Report") for the prior calendar month which includes a summary of production, Measured Average Availability, event codes, Scheduled Maintenance, health assessment of the WECs, and maintenance history (including Repair Services), and any other relevant issues with respect to the WECs. Such reports may be provided in electronic format and emailed to Owner at an email address identified by Owner Representative. Any Owner identified disputes with the Monthly Performance Report must be addressed within thirty (30) calendar days.

c. Emergency Notification. Upon obtaining knowledge thereof, O&M Contractor shall immediately notify Owner verbally (with written notice to follow thereafter) of any emergency or hazardous condition or occurrence of which O&M Contractor becomes aware that in any way affects, or could affect, the safe operation of the WECs or the Project and the safety of personnel at the Project Site. Such written notice may be provided in electronic format and emailed to Owner to an email address identified by Owner Representative.

6. Meetings

a. Annual Calendaring of Scheduled Maintenance. Once as reasonably practicable following the Effective Date and once annually thereafter, the Parties shall meet to discuss and agree upon the projected dates and times for the immediately following period during which O&M Contractor shall perform the Scheduled Maintenance on the Serviced Equipment (the "Scheduled Maintenance Calendar"). The Scheduled Maintenance Calendar will be developed in accordance with the Maintenance Manual and the Service Inspection Form. The dates and times in the Scheduled Maintenance Calendar may be amended thereafter by mutual agreement of the Representatives.

b. Monthly Status Reviews. Prior to the fifteenth (15th) Business Day of each calendar month, the Representatives shall meet to discuss and review (i) the

information contained in the Monthly Performance Reports, (ii) the monthly Measured Average Availability of WECs, (iii) any technical issues which may have arisen with respect to the performance, Measured Average Availability or maintenance and servicing of the Wind Turbines, (iv) Scheduled Maintenance and Repair Services performed during the preceding calendar month, (v) any and all failures by a Wind Turbine and the causes thereof, and (vi) Scheduled Maintenance and any Repir Services to occur during the next following calendar month.

**EXHIBIT C**
**O&M CONTRACTOR INSURANCE**

1.1 General. O&M Contractor shall maintain or cause to be maintained the insurance required by this Exhibit C with insurance coverage from licensed and/ or admitted insurer carriers with an A minus (A-), VII, or better rating from A.M. Best. The requirements of this Exhibit C as to insurance and the acceptability of insurers and insurance to be maintained by O&M Contractor are not intended to and shall not in any manner limit or qualify the liabilities and obligations assumed by O&M Contractor under the Agreement unless otherwise expressly indicated herein or in the Agreement.

1.2 Notification. A Party shall notify the other Party of any incident of loss or damage to or arising from the Serviced Equipment that would reasonably be expected to result in an insurance claim for an amount in excess of Fifty Thousand Dollars (U.S. $50,000) and keep the other Party timely apprised of insurance claim proceedings.

1.3 O&M Contractor's Insurance. O&M Contractor shall maintain or cause to be maintained the following:

1.3.1 Commercial General Liability Insurance. Coverage for the activities of O&M Contractor under the Agreement on an "occurrence" basis, including coverage for products and completed operations and contractual liability and at least as broad as the coverage provided by the Commercial General Liability Coverage Form CG 00 01 published by the Insurance Services Office as of the Effective Date, with minimum primary coverage limits of at least One Million Dollars (U.S. $1,000,000) for injuries or death to one or more persons or damage to property resulting from any one occurrence and at least Two Million Dollars (U.S. $2,000,000) minimum annual aggregate limit. Policy exclusions which are not standard to the Commercial General Liability Coverage Form or are added by manual or manuscript endorsements and restrict coverage shall require the prior approval of Owner.

1.3.2 Commercial Automobile Liability Insurance. Coverage for the activities of O&M Contractor under the Agreement on an "occurrence" basis, including coverage for owned, non-owned and hired automobiles for both bodily injury and property damage and containing appropriate no fault insurance provisions or other endorsements in accordance with applicable laws, with minimum limits of at least One Million Dollars (U.S. $1,000,000) combined single limit per accident with respect to bodily injury, property damage or death.

1.3.3 Excess/Umbrella Liability Insurance. Coverage for the activities of O&M Contractor under the Agreement with minimum limits of at least Ten Million Dollars (U.S. $10,000,000) in the annual aggregate. Such coverage shall be on a following form "occurrence" basis and over and above the coverage provided by the policies described in Sections 1.3.1, 1.3.2 and 1.3.4 (with regard to employer's liability) of this Exhibit C. The excess policies shall not contain endorsements which restrict coverages as set forth in Sections 1.3.1, 1.3.2 and 1.3.4 (with regard to employer's liability) of this Exhibit C and which are provided in the underlying policies.

1.3.4 Workers' Compensation and Employer's Liability. Such forms of insurance as are required by Applicable Law to provide for the activities of Contractor under the Agreement on an "occurrence" basis covering claims resulting from injury, sickness, disability or death of the employees of Contractor, with minimum limits of at least One Million Dollars (U.S. $1,000,000) per accident, at least One Million Dollars (U.S. $1,000,000) for disease, and at least One Million Dollars (U.S. $1,000,000) for each employee.

1.3.5 Error & Omissions/Professional Liability insurance. Coverage for the activities of O&M Contractor under the Agreement with minimum limits of at least one million dollars ($1,000,000) per claim and in the aggregate for professional liability arising out of its negligent performance under this Agreement.

1.3.6 Cyber Liability/Network Privacy insurance. O&M Contractor shall procure and maintain coverage with minimum limits of at least One Million Dollars (U.S. $1,000,000) per claim and at least Three Million Dollars (U.S. $3,000,000) in the aggregate for cyber liabilities and financial loss resulting, or arising, from acts, errors, or omissions, in connection with services provided under this agreement. Coverage shall include protection for liability arising from data theft, damage, destruction, or corruption, including without limitation, unauthorized access, unauthorized use, identity theft, theft of personally identifiable information or confidential corporate information, transmission of a computer virus or other type of malicious code; and participation in a denial of service attack on a third party.

1.5 Additional Insurance Policies. O&M Contractor may, at its own expense, purchase and maintain or cause to be maintained such other or additional insurance (as to risks covered, policy amounts, policy provisions or otherwise) which Owner may require.

1.6 Verification of Coverage. Prior to the commencement of the Term, and at each renewal thereafter until the end of the Term, O&M Contractor shall deliver to Owner certificates of insurance verifying that the insurance coverages outlined in this Exhibit C are in full force and effect and, to the extent applicable, naming the Owner as an additional insured or loss payee, as applicable.

1.7 Deductibles. Unless and to the extent that a claim is covered by an indemnity set forth in the Agreement, payment of the deductible shall be the responsibility of O&M Contractor. O&M Contractor shall obtain the prior written approval of Owner to any deductible amount exceeding One Million Dollars (U.S. $1,000,000) for any policy of insurance hereunder.

1.8 Terms and Provisions of the Policies. All policies of insurance required to be maintained by O&M Contractor under this Exhibit C shall: (a) for policies naming both Parties as insureds, provide a severability of interests clause and be deemed to constitute a separate policy with each insured; (b) with the exception of worker's compensation and employer's liability insurance, be endorsed to name Owner and its successors and assigns and the Los Angeles Department of Water and Power, its officers, employees, and agents as additional insureds with respect to either Party's activities under the Agreement. and (c) provide that such policy may not be canceled, nor non-renewed (or their renewal refused) or materially changed without thirty (30) days' prior written notice or in the event of nonpayment of premium, on ten

(10) days' prior written notice. An insured shall be deemed to have notice of a loss or occurrence only when such notice shall have been delivered in accordance with the Agreement.

1.9 Subrogation Waiver. Except as otherwise provided in this Exhibit C, Owner and O&M Contractor waive all subrogation rights against (a) each other, and (b) any of the other's subcontractors (of any tier), agents and employees, for damages caused by any and all causes of loss. The policies of insurance applicable to the work of separate contractors and/or subcontractors, if any, shall provide such waivers of subrogation including claims involving work performed by separate contractors by endorsement or otherwise. Such insurance shall provide that the insurers thereof waive any rights of subrogation against O&M Contractor and its contractors and subcontractors (of any tier).

1.10 Other Contractors and Subcontractors. O&M Contractor shall cause all of its subcontractors working at the Project Site to obtain and maintain commercial general liability, automobile, excess/umbrella and workers compensation insurance comparable in form and coverage amounts to the insurance required of O&M Contractor under this Agreement.

1.11 Insurance Certificate Holder Information.

For Contractor:
[.....]

For Owner:
Southern California Public Power Authority
1160 Nicole Court
Glendora, CA 91740
Telephone: 626 793 9364
Attention: Executive Director
Email: projects@scppa.org

Additional Owner insured parties (lenders, developers, etc.) – List names and addresses

Southern California Public Power Authority
c/o Los Angeles Department of Water & Power
111 N. Hope Street, RM 465
Los Angeles, CA 90012
Attention: Risk Management
Email: riskmanagement@ladwp.com

The Los Angeles Department of Water and Power, its officers, employees, and agents
111 N. Hope Street, RM 465
Los Angeles, CA 90012
Attention: Risk Management
Email: riskmanagement@ladwp.com

1.12 Descriptions not limitations. The coverages referred to above are set forth in full in the respective policy forms, and the foregoing descriptions of such policies are not intended to be complete, nor to alter or amend any provision of the actual policies and in matters, if any, in which the said description may be conflicting with such instruments, the provisions of the policies of the insurance shall govern; provided, however, that neither the content of any insurance policy or certificate nor approval thereof shall relieve Parties of any of their obligations under this Agreement.

## EXHIBIT D

## TECHNICAL AVAILABILITY GUARANTEE

1. Defined Terms. Initially-capitalized terms used herein without other definition have the meanings specified in the Agreement unless the context requires otherwise. In addition, the following terms have the following respective meanings:

"AEP" has the meaning set forth in Section 3.2.

"$AEP_n$" has the meaning set forth in Section 3.2.

"Agreement" means the Operation and Maintenance Agreement of which this Exhibit D is a part.

"Availability" has the meaning set forth in Section 3.2.

"Availability Bonus" has the meaning set forth in Section 3.1.

"Availability Liquidated Damages" has the meaning set forth in Section 3.1.

"Availability Term" means the period commencing on the date that is ninety (90) days after the Commencement Date and ending on expiration of the Term.

"Average Energy Price" means the average Dollar per MWh rate determined by dividing the gross revenues obtained by Owner from the sale of energy production during the relevant Production Period, by the total MWh of energy production sold during the relevant Production Period.

"Bonus Rate" has the meaning set forth in Section 3.7(a).

"ED" has the meaning set forth in Section 3.2.

"$ED_n$" has the meaning set forth in Section 3.2.

"Event Code Allocation Table" means Exhibit H of the Agreement, as updated in accordance with Section 3.5.

"Excluded Energy" has the meaning set forth in Section 3.4.

"Excluded Events" has the meaning set forth in Section 3.4.

"First Production Period" means the period commencing on the start of the Availability Term and ending on the day immediately preceding the first anniversary of the Commencement Date.

"LD Rate" has the meaning set forth in Section 3.6(a).

"List of Neighboring Wind Turbines" means the list attached as Schedule 1 to this Exhibit D.

"Measured Average Availability" or "MAA" has the meaning set forth in Section 3.2.

"N" has the meaning set forth in Section 3.2.

"Power Curve" means the power curve attached as Schedule 2 to this Exhibit D.

"Primary Neighbor Turbine" means, for Wind Turbine "n," the Wind Turbine denoted as its primary neighbor turbine in the List of Neighboring Wind Turbines.

"Production Period" means the First Production Period and each of the consecutive twelve (12) month periods beginning on the expiration of the First Production Period, or the anniversary thereof, and continuing until the end of the Availability Term. If the last Production Period would be less than twelve (12) months due to the end of the Term, or its earlier termination, then (x) if such time period is shorter than six (6) months, it will be added to the prior Production Period and the calculation of MAA and any Availability Bonus or Availability Liquidated Damages will be re-calculated for such expanded Production Period; and (y) if such time period is six (6) months or longer, it will constitute a stand-alone Production Period.

"Projected Average Availability" or "PAA" has the meaning set forth in Section 3.6.

"Scheduled Maintenance Hour Allowance" means sixty (60) hours per Wind Turbine in each Production Period allocated to perform Scheduled Maintenance on the Wind Turbines.

"Secondary Neighbor Turbine" means, for Wind Turbine "n," the Wind Turbine denoted as its secondary neighbor turbine in the List of Neighboring Wind Turbines.

"Step" has the meaning set forth in Section 3.3.

"Wind Turbines" or "WECs" means all or any portion of the 2 Megawatt Model REpower MM92 wind turbine generators, each including equipment and machinery related thereto, provided to Owner pursuant to the Turbine and Supply and Commissioning Contract, including the following components: a tower, a turbine nacelle, blades (including blade bearings, studs, etc.), controller (including interconnecting cabling from the turbine nacelle to the ground controller), control panels, converters, any var control technology, wind vanes, FAA lighting (if and as required), grounding, and anemometers. WEC shall also include any service lifts, climbing assists, and condition monitoring systems.

2. Interpretation. The rules of interpretation set forth in the Agreement apply to this Exhibit D, except that references in this Exhibit D to a section or paragraph are to a section or paragraph of this Exhibit D unless otherwise indicated.

3. Available Production

3.1 Availability Covenant. During the Availability Term, subject to this Exhibit D and the Agreement, to the extent that the Measured Average Availability for a Production Period (a) is less than the Projected Average Availability for such Production Period, O&M Contractor shall pay to Owner liquidated damages for such Production Period (the "Availability Liquidated Damages"), calculated pursuant to the formula set forth in Section 3.6; or (b) is greater than the Projected Average Availability for such Production Period, Owner shall pay to O&M Contractor a bonus for such Production Period (the "Availability Bonus"), calculated pursuant to the formula set forth in Section 3.7.

3.2 Availability Calculation. Within thirty (30) days after the end of each Production Period during the Availability Term, O&M Contractor shall calculate the MAA for such Production Period as follows:

$$MAA = AEP / (AEP + ED)$$

where

1. $N$ = total number of Wind Turbines in the Project

2. $AEP_n$ = actual energy produced (expressed in MWh) by Wind Turbine "n" during the Production Period when in normal operation between cut in and cut out wind speeds, as recorded by the SCADA System

3. $AEP = \sum_{n=1}^{N} AEP_n$ , or the sum of $AEP_n$ of all Wind Turbines in the Project

4. $ED_n$ = energy deficit (expressed in MWh) for Wind Turbine "n" during the Production Period, which is the expected energy lost during the Production Period due to an event recorded by the SCADA System that is attributed to Manufacturer in the Event Code Allocation Table (other than Excluded Energy), and will be determined in accordance with Section 3.3.

5. $ED = \sum_{n=1}^{N} ED_n$ , or the sum of $ED_n$ of all Wind Turbines in the Project

3.3 $ED_n$ Calculation. For each 10 minute time step ("Step") of the SCADA System, the deemed $ED_n$ of Wind Turbine "n" during such Step, will be calculated as follows:

(a) $ED_n$ during the Step equals the energy produced (expressed in MWh) during the Step by Wind Turbine "n's" Primary Neighbor Turbine, provided that the Primary Neighbor Turbine was available to produce energy during the entire 10 minutes of the Step.

(b) If the Primary Neighbor Turbine was unavailable to produce energy at any time during the Step, then $ED_n$ during the Step equals the energy produced (expressed in MWh) during the Step by Wind Turbine "n's" Secondary Neighbor Turbine, provided that the Secondary Neighbor Turbine was available to produce energy during the entire 10 minutes of the Step.

(c) If the Primary Neighbor Turbine and Secondary Neighbor Turbines each are unavailable to produce energy at any time during the Step, then $ED_n$ during the Step equals the average energy produced (expressed in MWh) during the Step by all other Wind Turbines that were available to produce energy during the entire 10 minutes of the Step (*example*: If 10 of 12 other Wind Turbines were available to produce energy during the entire 10 minutes of the Step, and those 10 Wind Turbines produced X MWh during the Step, then $ED_n$ = X/10 MWh).

(d) If all of the Wind Turbines other than Wind Turbine "n" each are not available to produce energy at any time during the Step, then $ED_n$ will be calculated based upon the site wind speed measured at the reference anemometer on the Project Site during the Step and the Power Curve, corrected to account for any curtailment or derating of Wind Turbine "n" (other than curtailment or derating required by Supplier or its Subcontractors) that would have occurred during such Step if such Wind Turbine was operating).

3.4 "Excluded Energy" means energy not produced by the Wind Turbine during the applicable Production Period due to one or more of the following events ("Excluded Events"), which will be excluded from ED (except to the extent one or more of the following is the result of acts or omissions of a O&M Contractor Responsible Party):

(1) a shutdown of the Wind Turbine in response to an Emergency or safety issue other than an Emergency or safety issue caused by a Failed Part;

(2) Owner failing to comply with its obligations under the Agreement in a manner that delays or prevents O&M Contractor from performing its obligations under the Agreement or otherwise prevents or adversely affects the performance or operation of the Wind Turbine;

(3) O&M Contractor being unable to perform or delayed in performing Site Services due to a Change in Law, Force Majeure Event, or due to crane equipment required for O&M Contractor to perform its obligations under the Agreement being unavailable through the use of commercially reasonable efforts;

(4) the Wind Turbine being paused or withdrawn from use by Owner, any Owner Responsible Party or any Governmental Authority for any reason other than for safety reasons related to a Failed Part;

(5) the Wind Turbine being withdrawn from operation, paused or shut down due to curtailment;

(6) the shutdown or derating of a Wind Turbine due to conditions outside the operating parameters or Technical Specifications of the Wind Turbine;

(7) when the Wind Turbine is untwisting without an equipment fault.

provided, however, that if any of the events described above occur simultaneously, then the relevant energy will only be counted once in order to prevent double counting.

3.5 Availability Calculation Verification.

(a) Promptly after O&M Contractor calculates the Measured Average Availability in accordance with Section 3.2, O&M Contractor shall provide to Owner written notice of the results of such calculation. Promptly following receipt by Owner of O&M Contractor's calculation of the Measured Average Availability, and in any event within thirty (30) days thereafter, the Parties shall meet to review such calculation and the underlying data supporting such calculation, including any adjustments thereto to reflect inaccuracies or defects in the counters or other errors, if any, as the case may be. The Parties shall use commercially reasonable efforts to agree upon the calculation of the Measured Average Availability within thirty (30) days following receipt by Owner of O&M Contractor's calculation thereof.

(b) Owner, BOP Contractor, and O&M Contractor shall meet periodically (and in no event less than monthly) to discuss the allocation of events categorized as $ED_n$ and events excluded from $ED_n$ based upon the various hour counters and event codes returned by the SCADA System in accordance with the Event Code Allocation Table. The Parties shall mutually agree upon any proposed adjustments to the various hour counters and event codes returned by the SCADA System in accordance with the Event Code Allocation Table to reflect any inaccuracies or defects in such hour counters, event codes or the Event Code Allocation Table; provided that if the Parties are unable to agree upon any such adjustments within fifteen (15) days after the commencement of meetings therefor, either Party may submit the matter to dispute resolution in accordance with the provisions of Article 21 of this Agreement. The Parties shall periodically review the Event Code Allocation Table and, to the extent that the Parties agree in writing that changes thereto are reasonably appropriate based upon the operating history of the Project such table will be revised and attached hereto.

3.6 Availability Damages.

(a) If and to the extent that MAA is less than PAA for a Production Period, then O&M Contractor shall pay to Owner Availability Liquidated Damages for that Production Period, calculated as follows:

Availability Liquidated Damages =
(PAA – MAA) × LD Rate × (AEP + ED)
where:

PAA = 97% for each Production Period

LD Rate = the lesser of $80 per MWh and the Average Energy Price.

(b) O&M Contractor shall pay Availability Liquidated Damages, if any, to Owner within thirty (30) days after the date on which the calculation made pursuant to Section 3.2 is agreed upon in accordance with Section 3.5; provided that if there is a good faith dispute between the Parties regarding the calculation or the responsibility for the failure, O&M Contractor shall pay the undisputed portion of the Availability Liquidated Damages and the balance, if any, will be paid upon resolution of such dispute in accordance with the dispute resolution provisions set forth in Article 21 of the Agreement.

3.7 Availability Bonus.

(a) If for any Production Period the Measured Average Availability for such Production Period is greater than Projected Average Availability, Owner shall pay O&M Contractor an Availability Bonus for such Production Period, calculated pursuant to the formula set forth below:

Availability Bonus = (MAA – PAA) × Bonus Rate × AEP

Where:

Bonus Rate = 50% of the LD Rate.

(b) Owner shall pay the Availability Bonus, if any, to O&M Contractor within thirty (30) days after the date on which the calculation made pursuant to Section 3.2 is agreed upon in accordance with Section 3.5; provided that if there is a good faith dispute between the Parties regarding the calculation, Owner shall pay the undisputed portion of the Availability Bonus and the balance, if any, will be paid upon resolution of such dispute in accordance with the dispute resolution provisions set forth in Article 21 of the Agreement.

4. Audit Rights. Owner shall have the right to review all data reasonably necessary to verify the Measured Average Availability calculation provided by O&M Contractor pursuant to this Exhibit D. O&M Contractor shall provide such information to Owner within ten (10) days following receipt of a written request from Owner for such information. If Owner disputes the accuracy of any calculation of the Measured Average Availability, including the allocation of faults as set forth in the Event Code Allocation Table, Owner shall notify O&M Contractor in writing no later than thirty (30) days following receipt of the foregoing information. Owner's rights under this Section 4 will terminate ninety (90) days after termination of this Agreement.

5. Remedies Not a Penalty. The Parties acknowledge and agree that it is difficult or impossible to determine with precision the amount of damages that would or might be incurred by Owner as a result of the failure of the Wind Turbines to maintain the Projected Average Availability. It is understood and agreed by the Parties that (i) Owner shall be damaged by the failure of the Wind Turbines to maintain the Projected Average Availability, (ii) it would be impracticable or extremely difficult to fix the actual damages resulting therefrom, (iii) any sums which would be payable under this Exhibit D are in the nature of liquidated damages, and not a penalty, and are fair and reasonable, and (iv) each payment represents a reasonable estimate of fair compensation for the Losses that may reasonably be anticipated from each such failure. Payment of the liquidated damages set forth in this Exhibit D and the remedies provided under Section 3 will be the sole and exclusive remedy of Owner and the sole and exclusive liability and exclusive measure of damages of O&M Contractor with respect to any failure of the Wind Turbines to maintain the Projected Average Availability. Once payment of such liquidated damages has been paid, O&M Contractor shall be relieved of any and all further liability in respect of such failure.

**Schedule 1**

**List of Neighboring Turbines**

*Neighboring Wind Turbine to be agreed upon by the Parties no later than 90 days following the Effective Date*

| Turbine ID | Primary | Secondary |
|---|---|---|
| | | |
| | | |
| | | |

**Schedule 2**

**Power Curve**

*Power Curve to be agreed upon by the Parties no later than 90 days following the Effective Date*

**EXHIBIT E**
**MONTHLY REPORT**

See attached.

# Linden Wind Energy Project

**# of WTGs**

SC-#

Reporting month:

**20XX-XX**

## Report contents. All data presented in this report refer to full months.

A_01

List of reporting elements contained in this report.

» **External Attachments to report**

- Appendix Z_01

## Cockpit view

A_02

Cockpit overview for reporting month. All data presented in this report refer to full months.

Production for reporting month

6,853 MWh

Production for current PP

90,344 MWh

Production for current year

56,049 MWh

Availability for current PP

99.39%

*Above Upside Share Level: 97.00%*

Availability for reporting month

98.49%

*Above Upside Share Level: 97.00%*

Capacity Factor for reporting month

24.04%

Capacity Factor for current PP

34.69%

Capacity Factor - 12 months rolling

29.49%

LPF (1 year rolling)

1.03%

LPF for reporting month

1.77%

H&S

| Near Miss | Incident | Hazardous Observation |
|---|---|---|
| 0 | 0 | 0 |

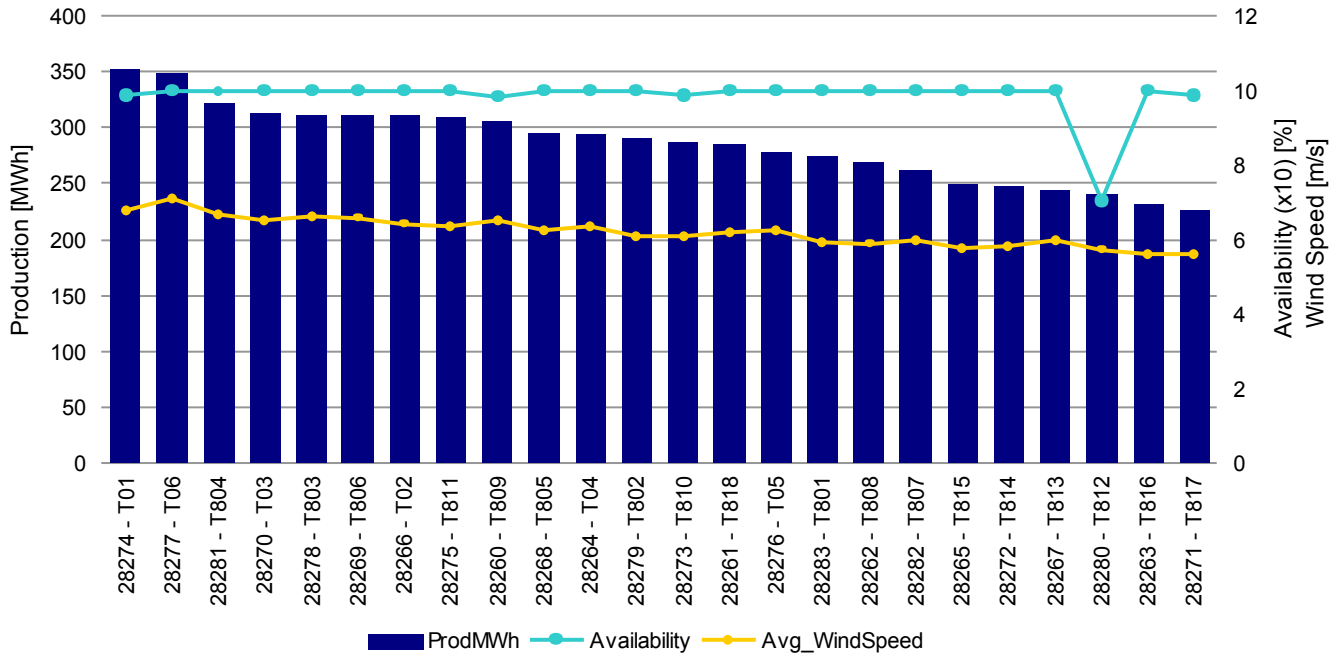
Production Period progress: 9 out of 12 months

Production Period end month: 09-2016

## Turbine Production and Availability

A_03

Production, Availability and Avg WindSpeed per turbine for reporting month



## HSE Events

N_01

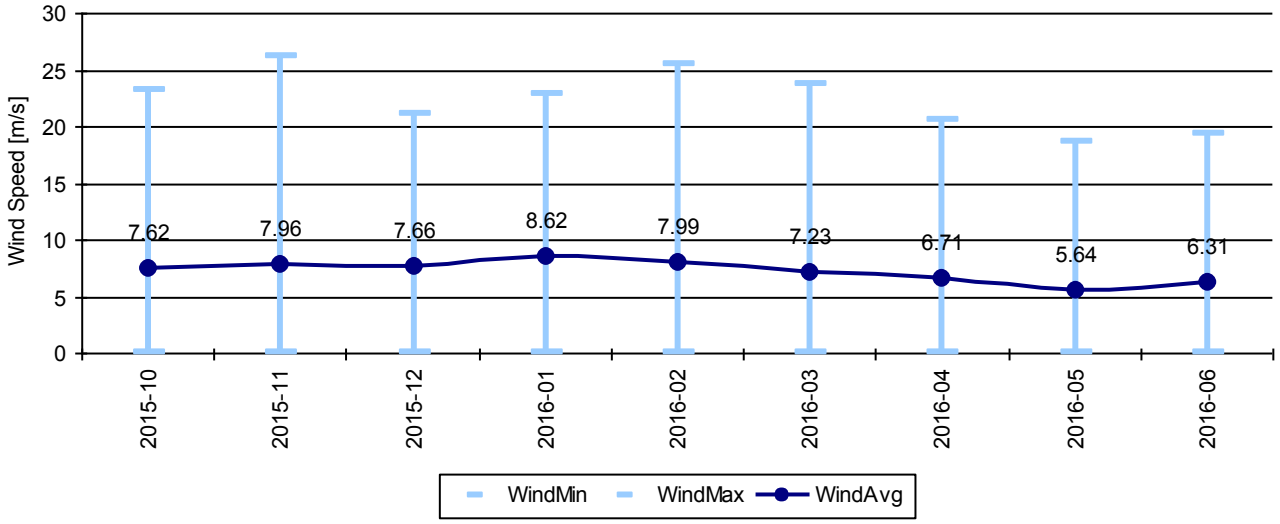
Information about events related to Site and/or turbines in reporting month, such as: incidents, environmental observations, hazardous observations, near misses, asset/product damage etc.

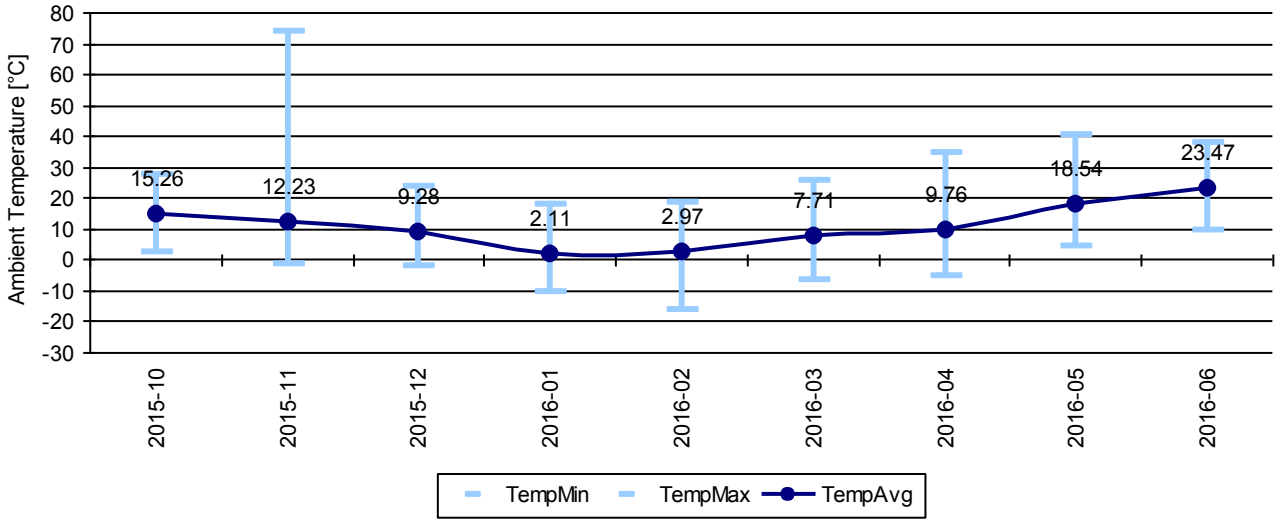
*Comment:*
*No Events to report*

## Monthly Ambient Conditions

P_01

Wind and Temperature conditions on site per month for reporting period

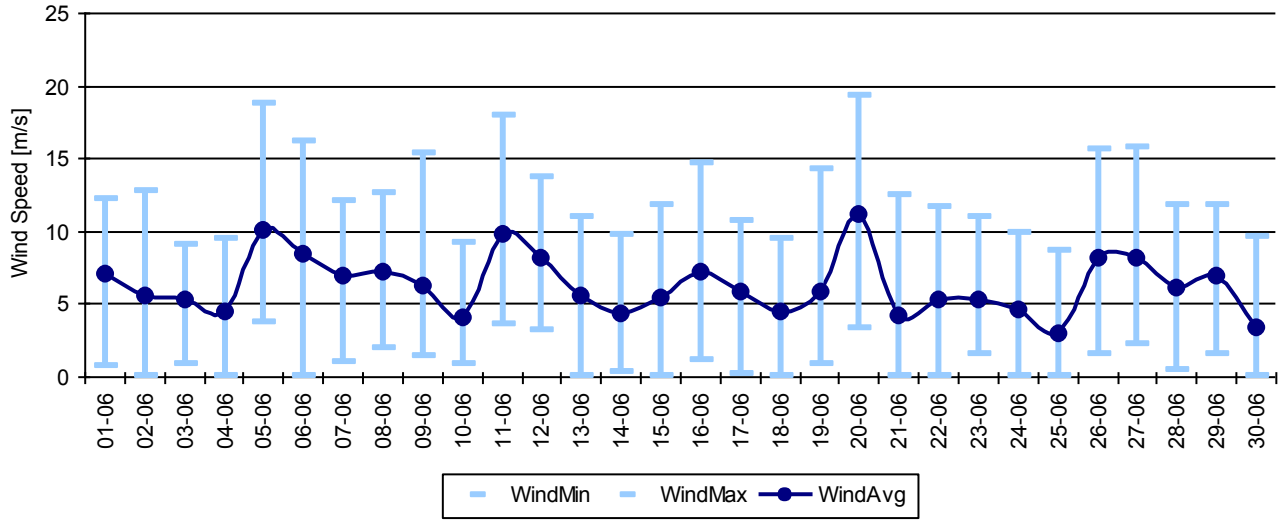


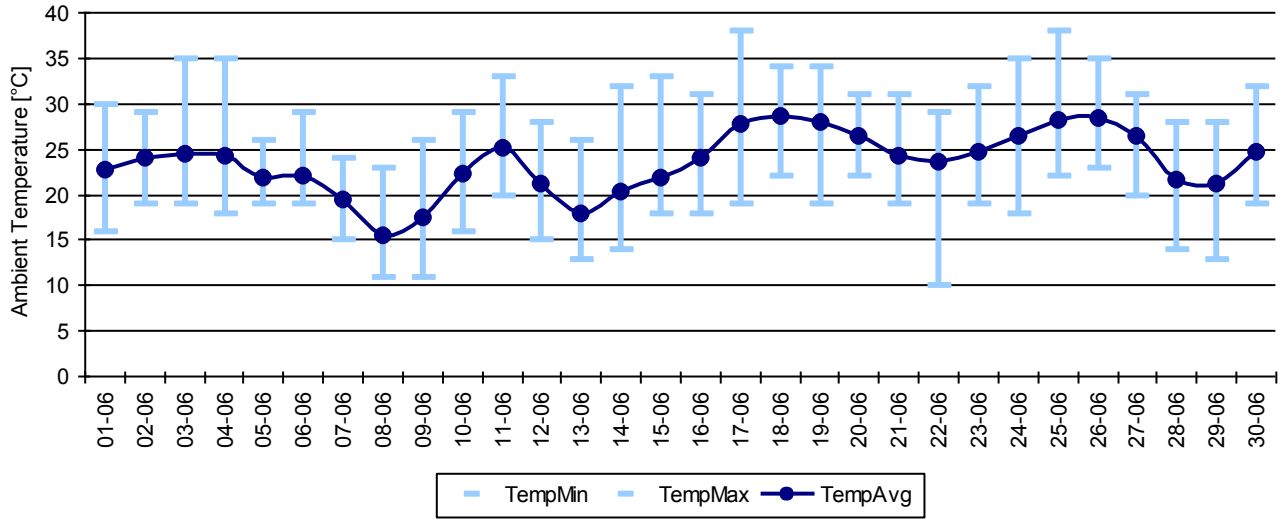



## Daily Ambient Conditions



Wind and Temperature conditions on site per day for reporting month



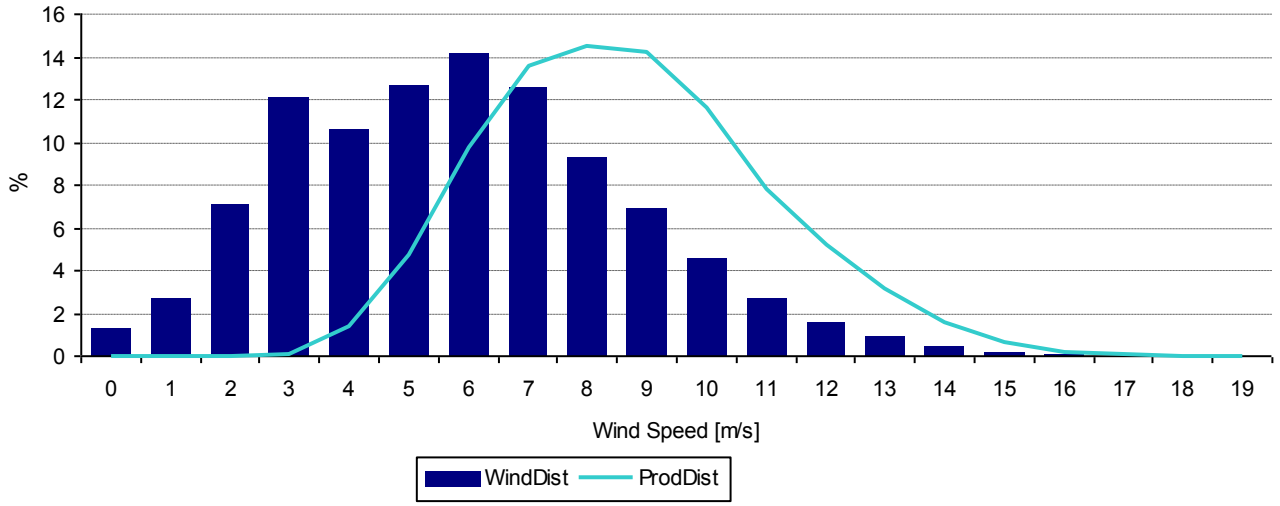



## Ambient Conditions, distributions

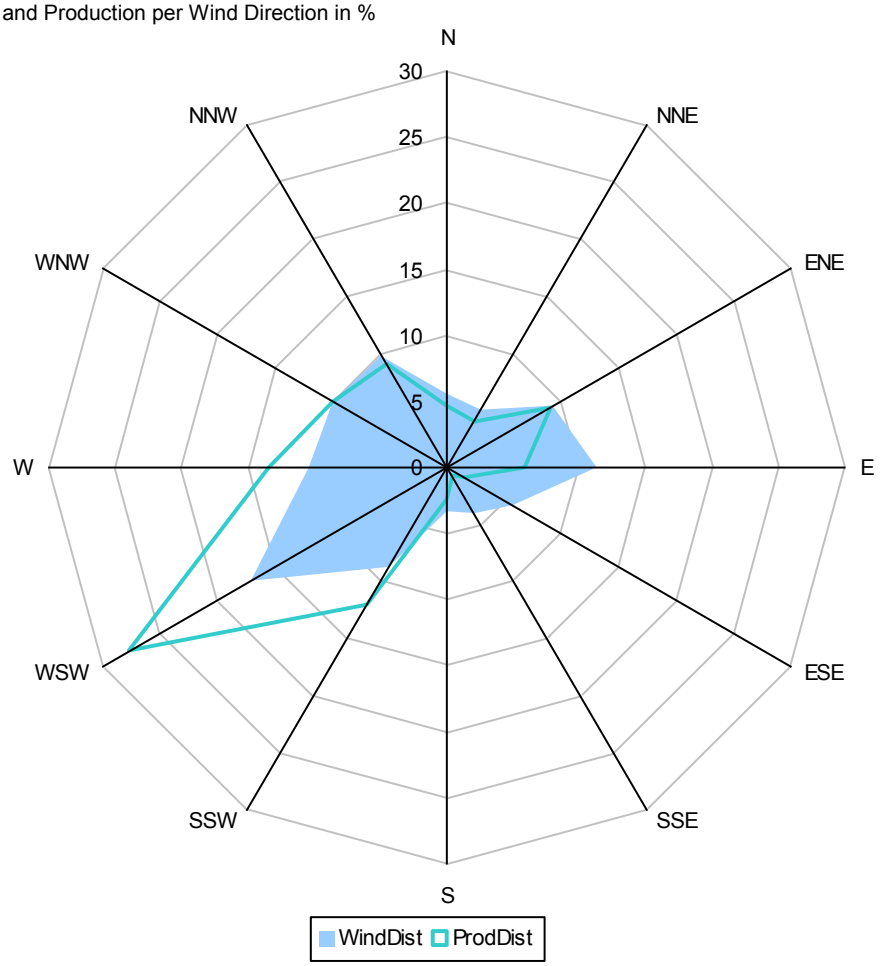


Distribution of wind speed and direction for reporting month

Distribution of Time and Production per Wind Speed in %



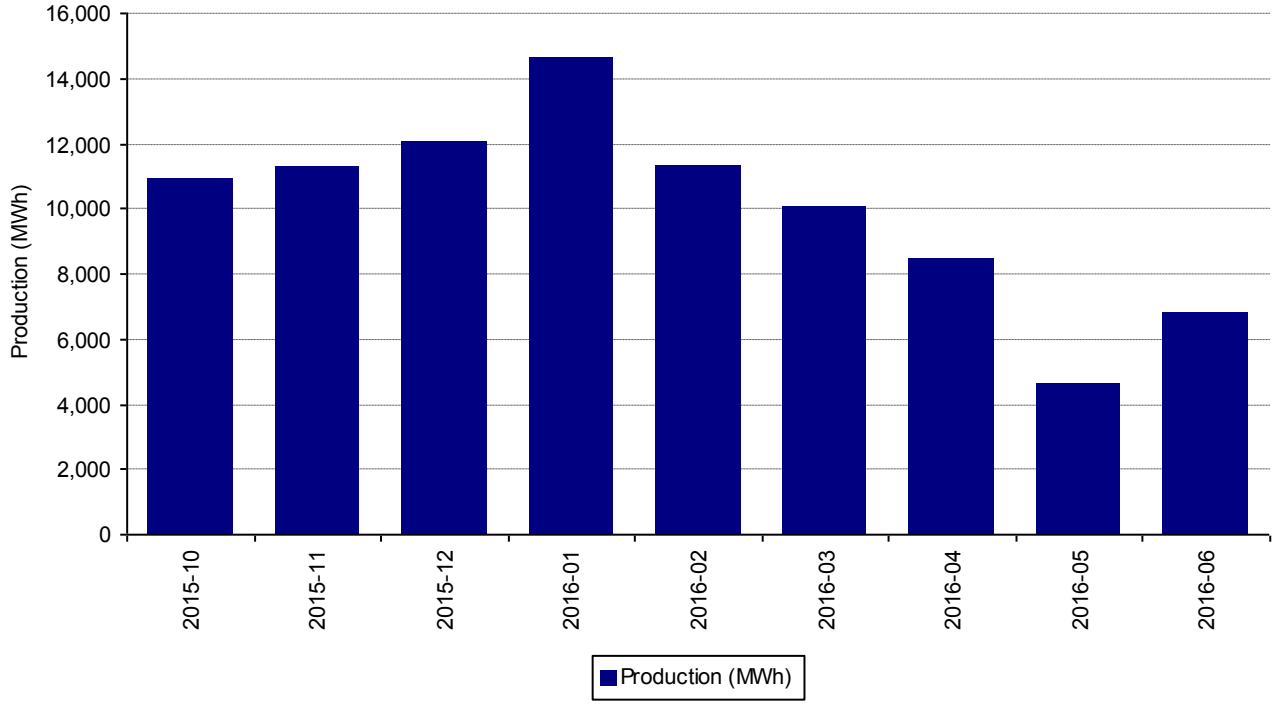

Distribution of Time and Production per Wind Direction in %



## Monthly Production

B_01

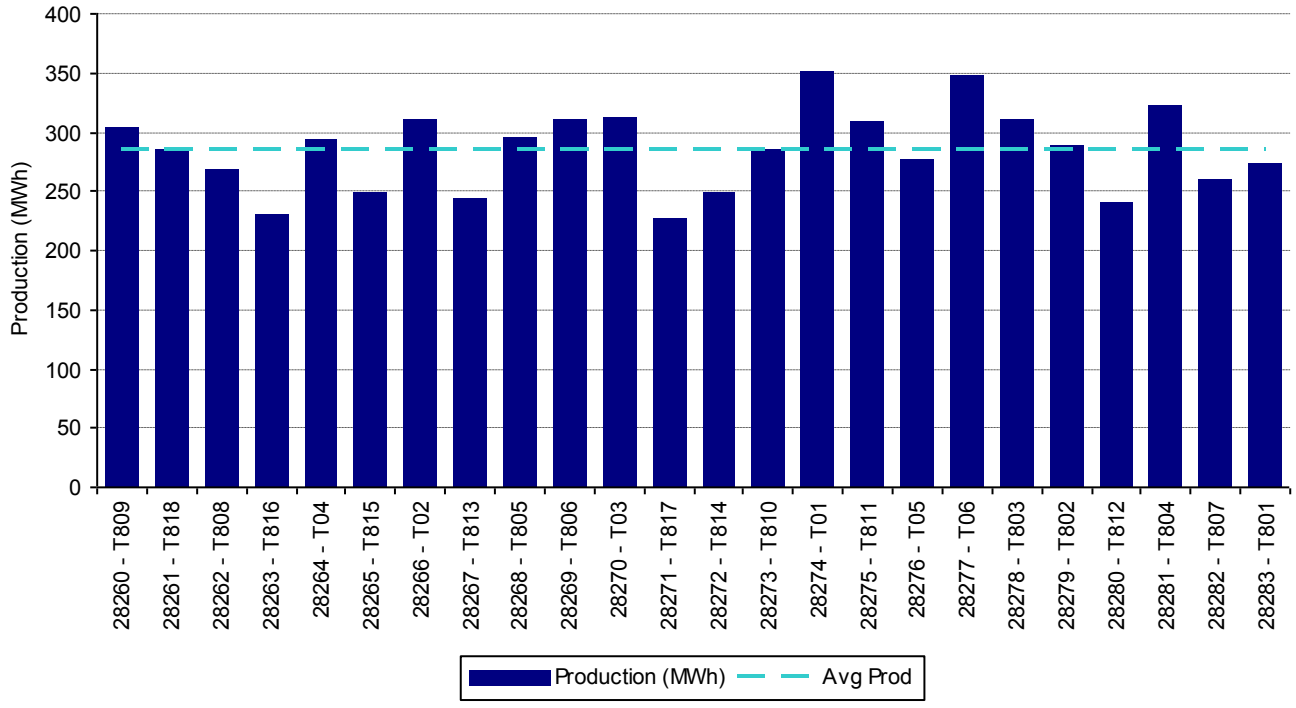
Production per site and month for reporting period




## WTG Production

B_02

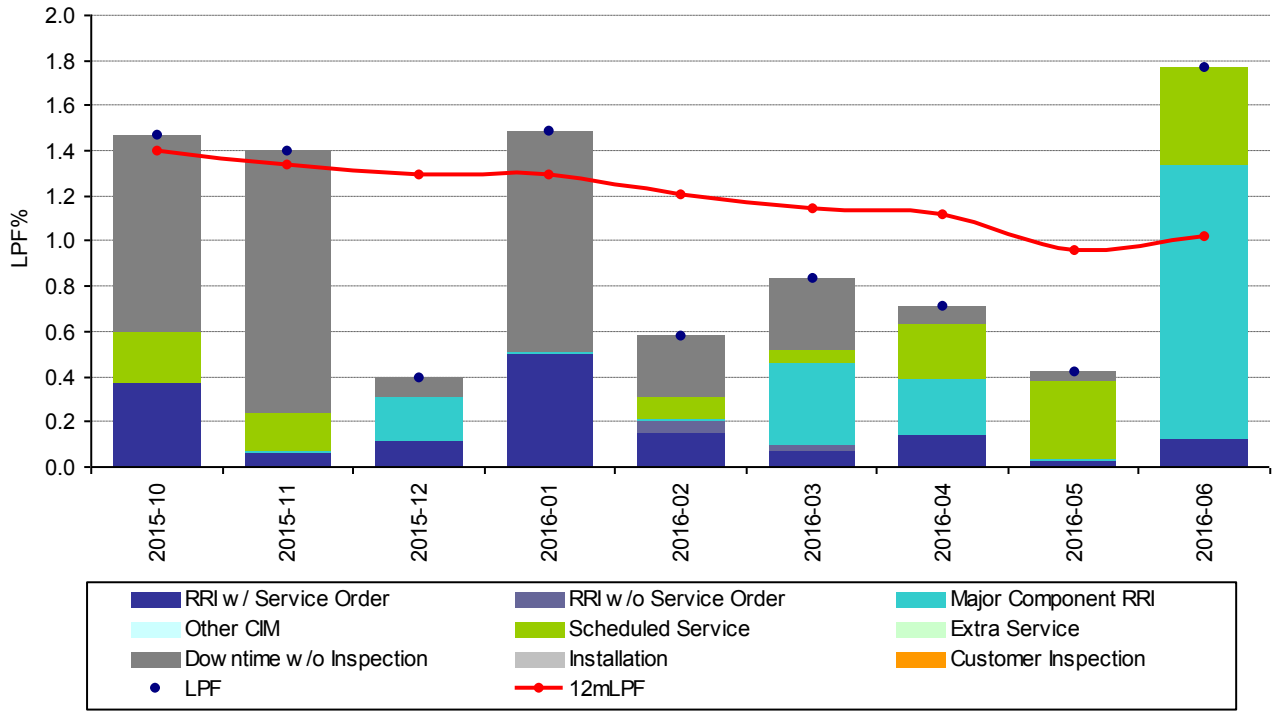
Production per turbine for reporting month



## Monthly LPF%

D_01

Lost Production Factor (LPF) % per month for reporting period, and a rolling 12 month average




RRI = Repair, Replace, Inspect

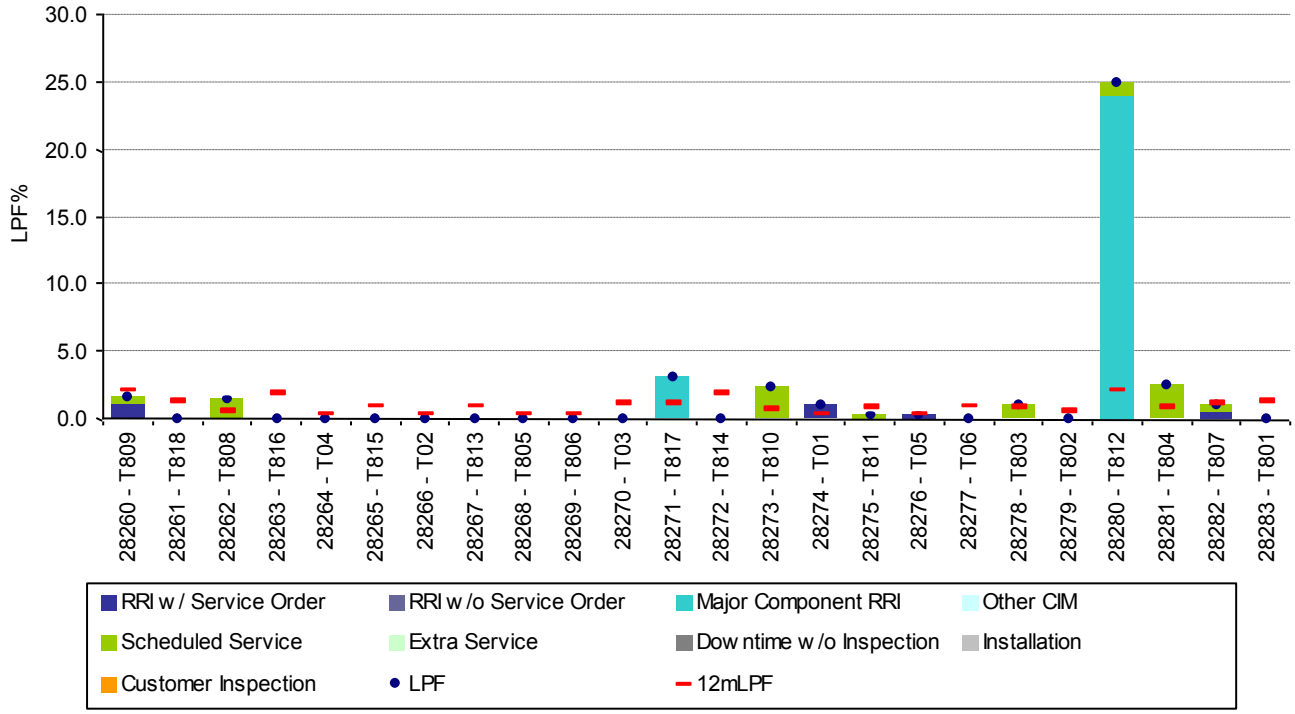
Lost Production Factor (LPF) is the % of possible production lost due to Turbine Error, Controller Off, Pause and Service. It's calculated using the turbines 10-min avg wind speed and a set of power curves for the individual turbines from the last 12 months.

LPF = (Loss during Turbine Error + Loss during Controller Off + Loss during Pause + Loss during Service On) / Possible Production

## WTG LPF%

D_02

Lost Production Factor (LPF) % per turbine for reporting month, and a rolling 12 month average

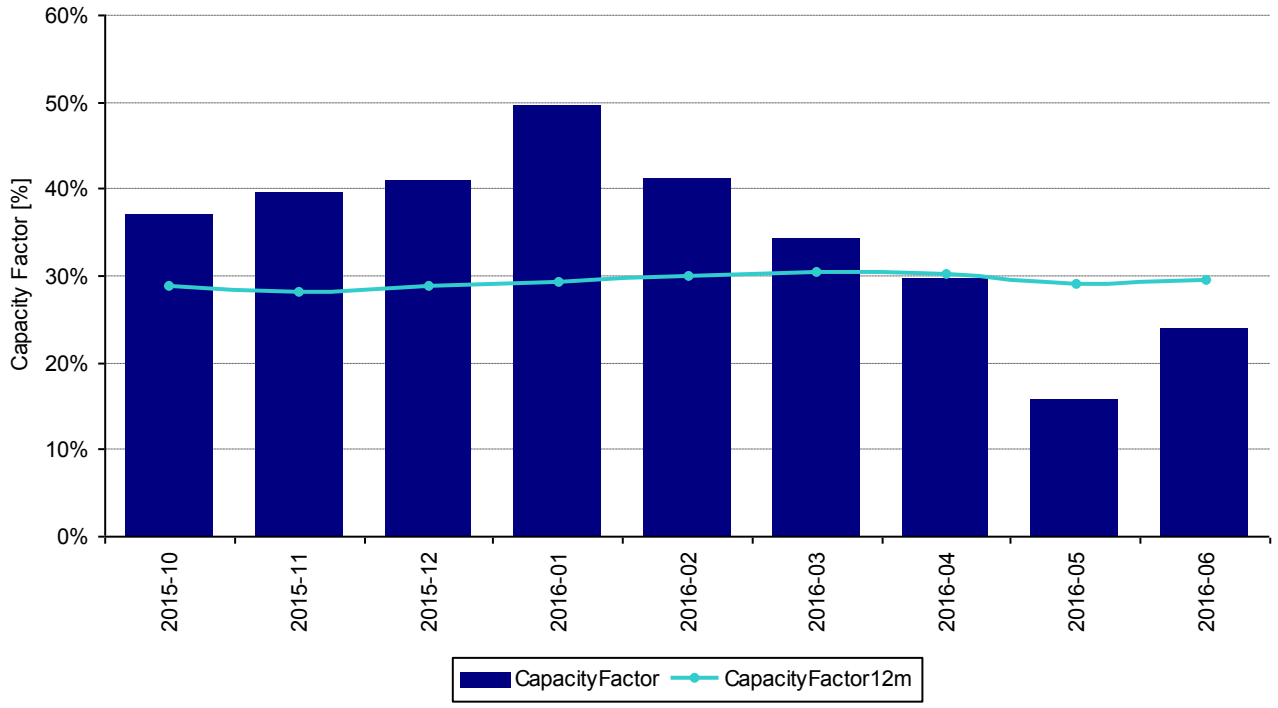



RRI = Repair, Replace, Inspect

## Monthly Capacity Factor

L_01

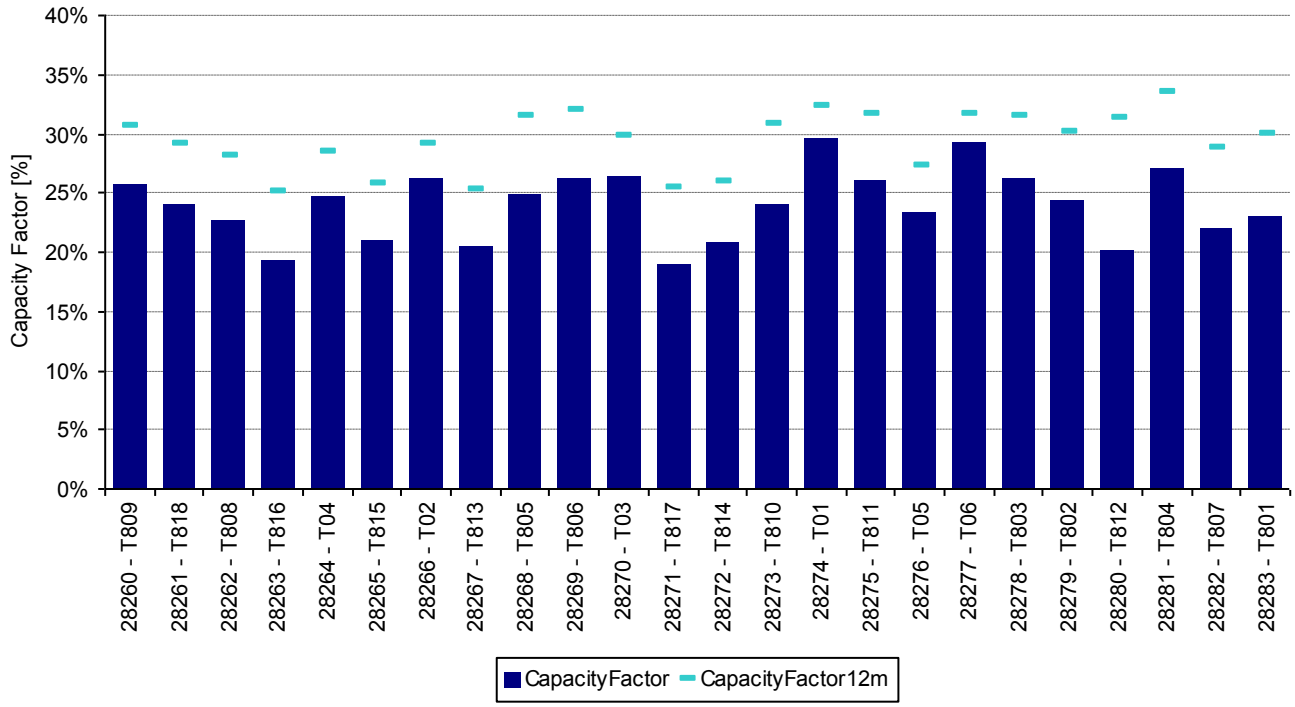
Capacity Factor per site and month for reporting period




## WTG Capacity Factor

L_02

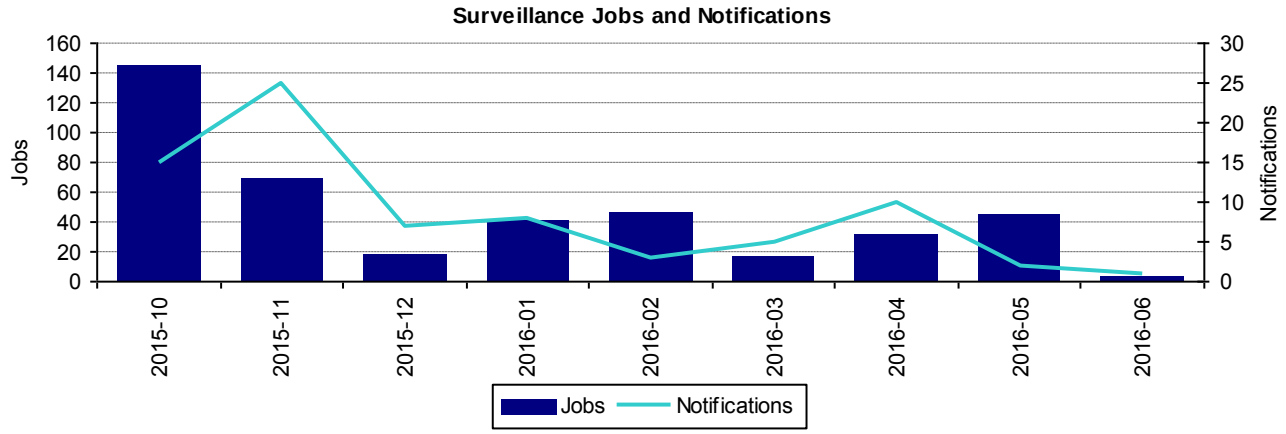
Capacity Factor per turbine for reporting month

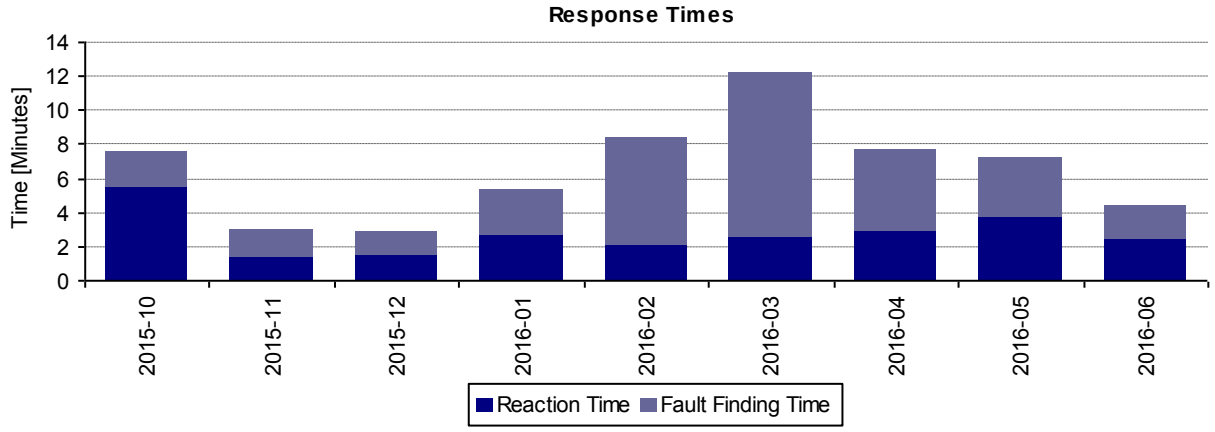


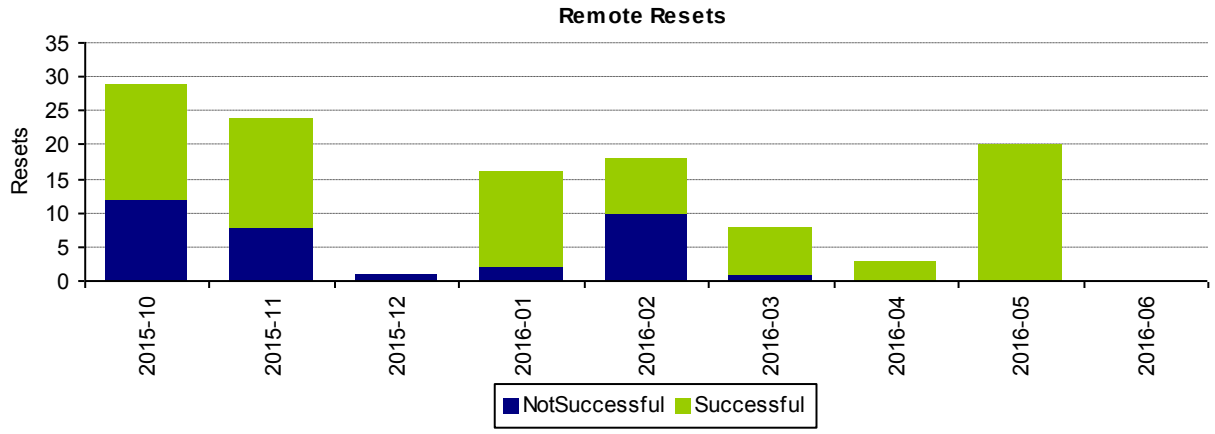
## Surveillance Activity

S_01

Statistics on Surveillance jobs, response times and reset success rate for reporting period.




Surveillance Job: Reaction from Surveillance Technician (can cover 1 or more alarms with same reset time)
Notification: Service Notification created in SAP
Reaction Time: Time from Surveillance Event happened until Operator was assigned
Fault Finding Time: Time from Operator was assigned until Job was completed
Successful Reset: Turbine still running 3 hours after it was reset

## Excel Spreadsheet

X_01

List of data exports included in the attached Excel Spreadsheet

- Production data
- Availability data
- Service Order data
- Material Consumption data
- WTG Material Consumption data
- Material Consumption data with Service Order Number and Turbine
- Ambient Condition data
- LPF

**EXHIBIT F**
**TECHNICAL SPECIFICTIONS**

See attached.

# Turbine Description

## *REpower* MM 92 – 60Hz

**Table of Contents**

# 1 MM 92 – 60Hz - Technical Description and Data

## 1.1 Concept

The REpower MM 92, like its sister model the MM 70/MM 82, is based on the platform of the tried and trusted MD 70/77. The operational experience with the type MD 70/77 has gone into the development of the MM 92. The MM 92 has been developed starting from the qualities of the MD-Series such as ease of maintenance, clear, sturdy construction, generous and conservative design of the components, construction of the load-bearing structures to match the power flux, environmental compatibility, etc.

By reinforcing certain parts such as the rotor bearing, blade bearing, rotor shaft and gear and using special materials in the area of the rotor blades, the increased loads on the rotor can be safely absorbed.

The turbine with a rated power of 2 megawatts has a rotor diameter of 92.5 metres and a hub height of up to 100 metres.

## 1.2 Rotor

The rotor consists of three rotor blades that are flange-mounted on the cast hub via a pivoted double row four-point contact bearing. The rotor blades can thus be adjusted along their linear axis via pitch drives that rotate with the blades. The rotor is operated in a speed range from 7.8 to 15.0 +12.5% rpm. In order to ensure the continued operation of the blade tilt in the event of a power failure or turbine malfunction, each blade has its own, independent, storage battery set that rotates with the blade.

In the partial load range, i.e. when the turbine is operated below the rated power, the turbine works at a constant blade angle and variable speed to exploit the optimum rotor aerodynamics.

In the rated load range, i.e. when the turbine is operated above the rated speed, the turbine is operated at a constant rated moment. Changes in speed due to changing wind speeds are compensated by adjusting the blade angle.

Wind energy from strong gusts of wind is stored by an acceleration of the rotor and only then converted into damped electrical energy via the blade pitch and fed into the grid.

## 1.3 Drive Train

The geometric configuration of the load-transferring structure according to the "tilted-cone" principle guarantees an optimum transfer of the rotor loads into the tower and permits a optimum layout of the components for load transfer. The drive train is supported at three points immediately above the head flange of the tower, whose conical geometry provides a wide basis to absorb the loads. The inclination of the rotor shaft by 5 ° in connection with the 3.5° conical angle of the blade hub permits an extremely short overhang between rotor centre and tower axis, thus reducing any "head trim" for the turbine requiring a significant volume of material.

## 1.4 Gear Box

The gear box is designed as a planetary / helical gear. The toothing has been optimised with respect to efficiency and noise emission. Elastic bushings are integrated in the torque arm of the gear that rest on the base frame via support pieces. The elastic bearing allows an effective sound and vibration decoupling from the base frame.

## 1.5 Electrical System

The turbine is equipped with a variable-speed generator-converter system. A frequency inverter is switched in the rotor circuit that impresses a voltage with adjustable frequency on the rotor. This allows the speed to be adjusted within a range of +/-40% of the synchronous speed. In connection with the electrical blade pitch, the variable-speed drive train offers very good results with respect to mechanical stress and electrical grid quality.

The turbine is operated in the following operating ranges depending on the prevalent wind speed:

- In the subsynchronous range (partial load range) the generator stator provides 100 % of the electrical power into the grid. Slip power is also provided to the rotor from the converter via the generator's slip rings.
- In the oversynchronous range (rated load range) the generator stator provides 83 % of the electrical power directly to the grid without passing through the converter. The remaining 17 % of the power is fed into the grid from the rotor via the converter.

There are no physical losses and the overall efficiency and technical availability are much better.

The generator is in protective class IP 54, it is cooled via an air-air heat exchanger. Thermocouples are installed in the bearings and coils to monitor the machine temperature.

Covers ensure that no contact can be made with rotating parts. The generator housing is earthed for potential compensation. The generator is borne on sound and vibration-decoupling elements on the base frame for better sound insulation and decoupling.

Please find further information about the electrical system in the “Electrical Description”.

## 1.6 Brake Systems

Braking is carried out by adjusting the rotor blades in the 91° blade position. Each of the three adjustment devices on the rotor blade is completely independent. In the event of a power failure the drives are supplied via the storage batteries that rotate with the rotor.

The twist of one blade is enough to bring the turbine into a safe speed range. This leads to a triple redundant safety system. The mechanical disk brake is also activated if one of the primary safety systems fails and stops the rotor in conjunction with the blade adjustment system.

The brake systems are designed for a "fail-safe" function. This means that if only one component in the brake system malfunctions or fails, the turbine immediately switches to a safe status.

## 1.7 Yaw System

The nacelle is connected to the tower via a four point contact bearing. Yawing of the nacelle is achieved by means of four gear motors. 14 hydraulic brake callipers keep the nacelle in the wind direction. The brakes are active in a currentless state.

An electronic wind direction sensor with corresponding software controls the switch-on times and direction of rotation of the motors. It also ensures the automatic cable untwist if the nacelle changes its position several times in one direction with changing wind conditions.

## 1.8 Nacelle

To meet today's demands on an innovative wind turbine, the cabin has been designed by a renowned designer. The result is a slim, aerodynamic design.

Glassfibre reinforced plastic (GRP) was chosen as a cabin material. In addition to the sound insulation, the inside of the covering also has an insulating layer. The nacelle has been generously dimensioned to create optimum conditions for service and maintenance. Maintenance work can be carried out with the nacelle closed.

Access to the nacelle from the tower is via a hatch in the base fame. A maintenance platform has also been installed so that the components below the base frame can also be reached.

All components, such as the yaw system or the hydraulics, can be operated from the control system in the nacelle. An "Emergency Stop" button has also been installed for safety.

## 1.9 Tower

The tower is designed as a conical, tubular steel tower consisting of between three and five segments depending on the hub height. There is a door in the tower base that permits access to the nacelle from inside the tower (thus protected against inclement weather) via a ladder with climb protection system. Each segment of the tower is equipped with platforms and emergency lighting.

The switch cabinets for the converter are mounted in the tower base on a separate platform. The generator power is transferred to the tower base via screened bus bars. All control signals for the operations computer are transmitted via optical glassfibre cables and comply with all of today's requirements with respect to electromagnetic compatibility (EMC).

An optional lift system can be provided for higher hub heights.

## 1.10 Corrosion Protection

All parts of the turbine are protected against corrosion and other environmental influences by a special multilayer coating. The coating system meets all the requirements of DIN EN ISO 12944.

## 1.11 Lightning Protection

The wind turbine is fitted with a lighting protection system built by lighting protection experts and complies with Protection Class II as required by the international standard IEC 61024-1. It is discharged from the rotor to the tower via the slip rings and spark gaps. The lighting current is thus discharged to earth via foundation and earth electrode.

Please find further information about lightning protection in the “Description Lightning Protection”.

## 1.12 Control System

All functions of the wind turbine are monitored with a microprocessor-based control system. The use of optical fibres guarantees a maximum baud rate and at the same time protects against electromagnetic stray voltages.

The critical functions have a redundant control. The emergency stop is triggered by a "hard"-wired safety loop parallel to the operations computer. This allows the turbine to be brought into a safe status even if the computer fails.

# 2 Technical Data

## Basic Design Data

| | | |
|---|---|---|
| cut-in wind speed: | approx. 3.0 | m/s |
| rated wind speed: | approx. 11.0 | m/s |
| cut-out wind speed: | 24.0 | m/s |

## Rotor

| | | |
|---|---|---|
| diameter: | 92.5 | m |
| swept area: | 6,648 | $m^2$ |
| number of blades: | 3 | |
| material: | Glass fibre reinforced material GRP (CRP) | |
| speed range: | 7.8 to 15.0 +12,5 % | $min^{-1}$ |
| tip speed: | 72.6 | m/s |
| rotor axis inclination: | 5 | ° |
| rotor cone angle: | -3.5 | ° |
| sense of rotation: | clockwise | |
| rotor position: | up-wind | |

## Pitch system

| | | |
|---|---|---|
| principle: | electro-drive, single blade pitch | |
| power control: | pitch and rotor speed control | |
| maximum blade angle: | 91 | ° |
| pitch drives: | synchronised DC motors with battery buffer | |

## Gear Box

| | | |
|---|---|---|
| type: | 3 stage planetary/spur gear system | |
| nominal power: | 2,160 | kW |
| nominal torque: | 1,378 | kNm |
| ratio: | approx. 96 | |

## Electrical System

| | | |
|---|---|---|
| nominal power : | 2,000 | kW |
| generator type: | twin-fed, six pole asynchronous generator with slip rings | |
| inverter type: | pulse-width modulated IGBT inverter | |
| protection class: | IP 54 | |
| speed range: | 720 to 1,440 (max 1680) | $min^{-1}$ |
| voltage: | 575 | V |
| frequency: | 60 | Hz |

## Tower

| | | |
|---|---|---|
| type: | coned solid wall steel tower | |
| hub height (prototype): | 78.5; 80 and 100 | m |
| diameter of head flange: | approx. 3.0 | m |
| diameter of bottom flange: | approx. 4.0 | m |

## Yaw System

| | | |
|---|---|---|
| type: | 4 geared drives, 14 yaw brakes | |
| yaw rate: | 0.5 | °/s |
| bearing: | four-point bearing with external toothing | |

## Controller

| | |
|---|---|
| type: | micro-processor |
| signal transfer: | optical fibres |
| remote control: | PC-modem, graphical interface |

## Weights

| | | |
|---|---|---|
| rotor blade: | approx. 8.0 | t |
| hub complete incl. pitch system: | approx. 17.0 | t |
| nacelle (excl. rotor): | approx. 71 | t |

**Document-No. (Version):**

**M-2.6-GP.WA.01-A-C-US**

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**Date:** 11.08.2008

**Pages:**

continuously numbered: 1 - 512

additionally inserted: ___
subsequently removed: ___

**Issue:**

- ☑ Original
- ☐ Reg. Copy No.: ___
- ☐ Copy (not registrated)

**Status:**

- ☐ Draft
- ☐ Draft for external check
- ☑ released Version

**Classification:**

- ☐ strictly confidential
- ☐ internal
- ☑ Customer confidential
- ☐ public

**QM document control:**

- ☑ yes
- ☐ no
- ☐ limited until: _____

# Wind Turbine

# *REpower MM92 (60 Hz)*

# Maintenance Manual

# *RE*guard Control B

# Wind Turbine

# MM92

(60Hz)

## Version C

Maintenance Manual

2008 August 11| Document-No.: M-2.6-GP.WA.01-A-C-US

This manual is based on the document "Service Manual Wind Turbine MM70 / MM82 Platform / MM92" *(T-2.1-GP.WA.02-A-C-EN)*.

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Disclaimer

This manual is to be used only for maintenance works on Wind Turbines MM92 (60 Hz) for the Project Goodnoe Hills (USA).

The manual does not necessarily correspond with the project-specific-requirements.
The purpose of this manual is to illustrate the complex procedure of maintenance works on Wind Turbines MM92 on the basis of examples.
This manual does not replace the written instructions and specifications to be used in each individual case. As a result, the activities and operational procedures shown in this manual do not represent the binding instructions for action. Nor can claims of any kind be derived from it.

All work procedures shown in this manual comply with German and the company's own safety specifications. The national law of other countries may require further safety specifications. It is essential that all precautionary measures, both project-and country specific, be strictly enforced. It is the duty of each company, to inform them selves of these measures implement and enforce them.
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Regarding the information about sizes, dimensions and other technical details, the manual does not refer to measures of the United States.

**"We have taken knowledge of the above and herewith agree with it. No warranty and no liability whether implied or not shall apply".**

Signature .....

# LIST OF CHANGES

### Changes in this document

| *Revision* | *Date of issue* | *Changed chapters* | *changes* |
|---|---|---|---|
| *A* | *2007-12-13* | *-* | *First issue* |
| *B* | *2008-04-11* | *1* | *“List of changes” replaced by “Components of Wind Turbine”* |
| | | *2.1* | *Advice added in first paragraph.* |
| | | *6.2.5* | *Photo of trimming weight added.* |
| | | *6.5.9.1* | *New* |
| | | *6.6.5* | *Only US-version: new* |
| | | *6.9.2.1* | *15. erased* |
| | | *6.9* | *Completed by Eickhoff-gear* |
| | | *6.9.16* | *8.: added* |
| | | *6.9.18.2* | *21.: added* |
| | | *6.9.18.8* | *6.: added* |
| | | *6.10.2.2* | *New* |
| | | *6.11.4* | *“Ware adjustment” replaced by “Positioning”*<br>*“Warning” added* |
| | | *6.11.6* | *“Warning” added* |
| | | *6.13* | *Completed by Winergy-generator* |
| | | *6.13.10* | *“Danger” added.* |
| | | *6.13.11.2* | *“Danger” added.* |
| | | *6.15.7* | *60 Hz-version added.* |
| | | *6.16.4* | *Cross reference “6.16.6” replaced by “6.16.3”* |
| | | *6.20.2._* | *“Vibration analyzer” replaced by “oszillation sensor” or “vibration switch”* |

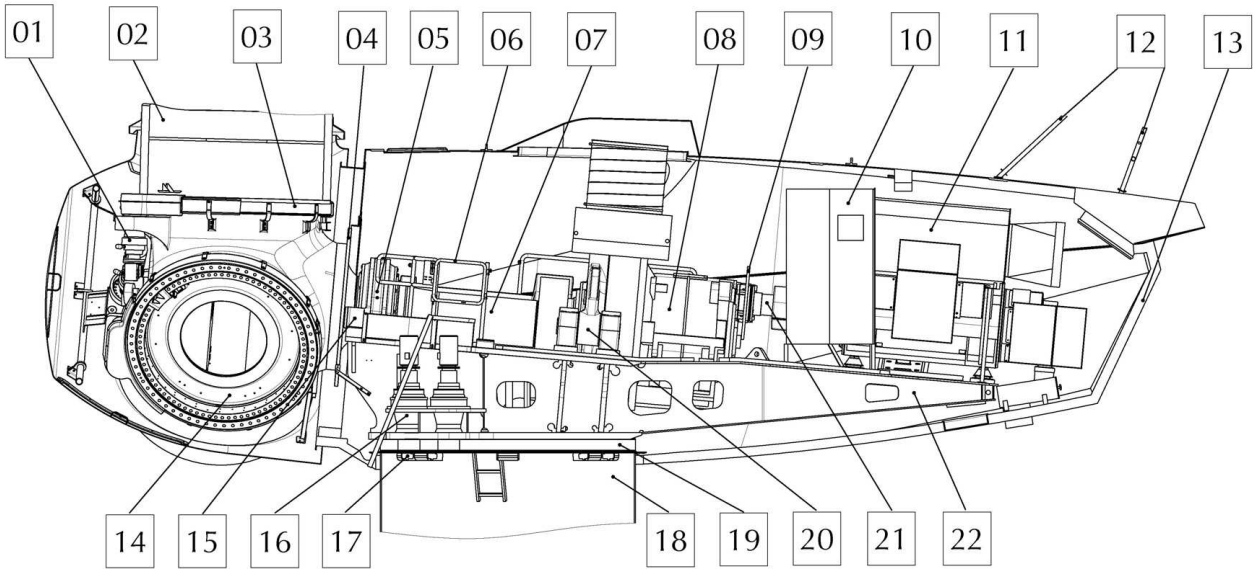
| | | | |
|---|---|---|---|
| | | *6.21.4* | *4. added* |
| | | *6.21.5 6.21.7* | *Photos of US- door version added.* |
| | | *6.21.8* | *Fig. 2 changed.* |
| | | *6.21.16* | *New.* |
| | | *6.22.18* | *“Required tools...“ erased.* |
| | | *6.22.19* | *Base flange US-Version added.* |
| | | *Generell* | *“Camera” replaced by “Digital camera”.* |
| | | *Generell* | *“Hub boxes” replaced by “converter boxes”.* |
| | | *Generell* | *“NOTICE Risk of damage to components …“: “specialist” replaced by “licensed electrician”.* |
| | | *Generell* | *Spelling mistakes and other formal mistakes corrected.* |
| *C* | *2008-08-11* | *-* | *Release of the Maintenance Manual for other projects* |
| | | *6.7.6* | *Added.* |
| | | *6.22.16 - 6.22.19* | *Numbering corrected* |
| | | *Appendix B* | *New Revision E* |

**Applicable Repower documents:**

| | |
|---|---|
| Service Booklet : | Wind Turbine MM70, MM82 Platform; MM92<br>Document-No.: T-2.1-GP.WA.02-A-C-EN |
| Operating Manual | Wind Turbine MM92 (60 Hz)<br>Document-No.: G-2.6-GP.BH.01-A-A-US |

**TABLE OF CONTENTS**

# 1 COMPONENTS OF THE WIND TURBINE




| | | | |
|---|---|---|---|
| 1 | Rotor blade pitch system | 12 | Weather mast |
| 2 | Rotor blade | 13 | Nacelle enclosure |
| 3 | Rotor blade bearing | 14 | Rotor hub |
| 4 | Rotor locking disk | 15 | Rotor locking bolt |
| 5 | Rotor bearing | 16 | Yaw drive (in the outer yaw area) |
| 6 | Rotor safety door | 17 | Yaw brake |
| 7 | Rotor shaft | 18 | Internal yaw area, tower |
| 8 | Gearbox | 19 | Yaw bearing |
| 9 | Rotor holding brake | 20 | Torque support |
| 10 | Topbox | 21 | Coupling |
| 11 | Generator | 22 | Machine base |

# 2 USING THE MAINTENANCE MANUAL

## 2.1 General notes

Carefully read all safety notices in the maintenance manual, in the associated operating manual, and at the components of the wind turbine, particularly with regard to the qualification of the service technicians (ref. chapter 1).

The maintenance manual is based on the service booklet which details the entire maintenance to be performed at the wind turbine.

The individual maintenance sections are detailed in chapter 6 of the maintenance manual. The structure of the service booklet has been maintained in that context.

In other words, the maintenance section 5.2 "Oil change pitch gearbox" in the service booklet may be found in 6.5.2 "Performing an oil change pitch gearbox" in the maintenance manual etc.

Each maintenance section is comprehensively described. If multiple steps should or could be completed together in order to save time or for safety reasons, a note has been added to the respective chapters.

The initial maintenance which generally tends to be the most complex one is primarily described in the maintenance manual. For that reason, the maintenance interval in the service booklet needs to be observed for subsequent maintenance work.

The service booklet also contains notes with regard to required torque values, lubricants, and tools.

## 2.2 Safety notices

As each maintenance section has been comprehensively described, i.e. independently of the other sections, there are repetitions, especially of the safety notices.

The respective safety notices contain references to the operating manual and chapter 5 "Safety and hazard notices" of the maintenance manual (also refer to chapter 3.3).

Safety notices that are valid for an entire section are included in the main chapter. This means that the service personnel need to inform themselves about the respectively applicable safety notices in the main chapter (e.g. 6.13 "Generator") prior to performing a maintenance step.

All safety notices in the operating manual need to be observed on principle. Among others, this also contains details regarding the qualification required for service technicians.

## 2.3 Used symbols

**DANGER** DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

**WARNING** WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

**CAUTION** CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

**NOTICE** NOTICE is used to address practices not related to personal injury.

**Note:** Additional information is labeled with "Note:".

## 2.4 REguard control B

References to menus of the REguard control B are structured in the following manner:

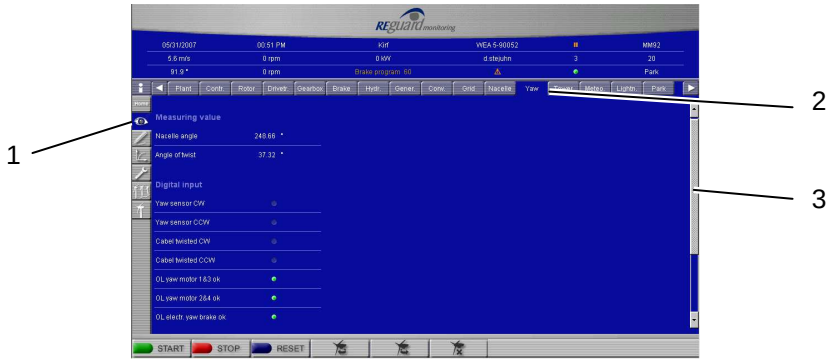



Fig. … - REguard Monitoring

- REguard Monitoring: select Monitoring menu → Yaw → Digital inputs

That means

1. Select the main menu (example: "Monitoring") via the left menu bar (1)
2. Select the submenu (example: "Yaw") via the upper menu bar (2)
3. Use the scroll bar (3) to scroll to the respective field (in the example: "Digital inputs")

## 2.5 Figures and positioning

The figures and the components in the figures within a chapter are numbered consecutively. This means that a component keeps its position number within a chapter.

If a text refers to this component, its position number is included in parentheses following the identification of the component.

Example:

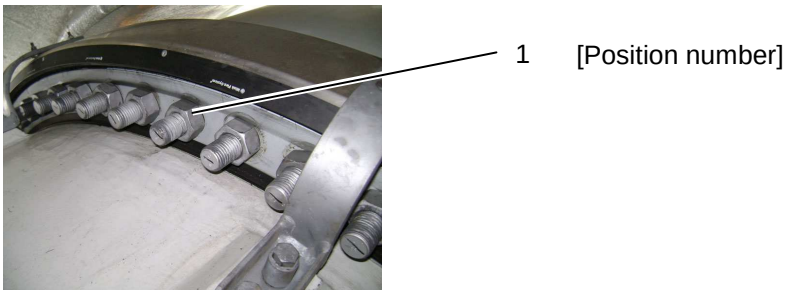



Fig. 6.3.5 – 1 Rotor blade bolt

Release the nut of a rotor blade bolt (1)

[Position number]

# 3 GENERAL MAINTENANCE NOTES

## 3.1 Constantly recurring operations

The following basic knowledge of constantly recurring operations is assumed:

- Operating the rotor holding brake (ref. chapter 4.7 operating manual)
- Engaging and releasing the rotor lock (ref. chapter 4.2 operating manual)
- Operating the EMERGENCY STOP pushbutton (ref. chapter 4.1 operating manual)
- Activating the service switch (ref. chapter 7.5 operating manual)
- Mode of operation of the safety chain (ref. chapter 4.5 operating manual)
- Notifying the system service (ref. chapter 5.5 operating manual)
- Login and logout procedures (ref. chapter 6 operating manual)
- Manual system operation (ref. chapter 7 operating manual)
- Operating hydraulic power screwdrivers (only by personnel authorized and trained by the manufacturer)
- Operating the REguard control B (ref. chapter 6 operating manual etc.)
- Handling chain hoists
- Securely attaching heavy components
- Operating the deck crane (ref. operating manual)

## 3.2 Lubrication

The used lubricants and manufacturers are detailed in the lubrication schedule of the respective system.

The use of other lubricants without approval by the system manufacturer is not permitted because incorrect lubricants or mixing different lubricants may cause substantial damage to the affected components!

Escaped lubricants generally need to be removed and disposed of in an environmentally friendly manner.

The skin must be protected by wearing gloves and applying suitable skin protection creme when working with the different lubricants and oil types.

## 3.3 Inspecting screw connections

The directive "Checking the screw connection with a torque as detailed in the service booklet" includes the following steps:

1. Set the torque wrench to the testing torque as detailed in the service booklet.
2. Attach the plug attachment to the torque wrench
3. Check the screw with a torque as detailed in the service booklet.

**If the screw connection does not withstand the testing torque:**

4. Release the screw connection
5. Clean the thread and the contact area
6. Lubricate the thread with a lubricant as detailed in the service booklet or apply an adhesive compound as detailed in the service booklet
7. Tighten the screw connection with a tightening torque as detailed in the service booklet

All screws of the specified connections need to be checked during the initial service.

All screw connections need to be subjected to thorough visual and tightness inspections during the subsequent service appointments. In addition, certain connections need to be tightened following a certain pattern. In that context, the inspection is limited to the respectively specified number of screws.

The screws checked by re-tightening generally need to be marked. Respective other screws will be re-tightened during the next service appointment.

The visual and tightness inspections consist of visually inspecting the screws for noticeable problems and touching the screws in order to test the tightness.

If one of the inspected screw connections does not exhibit the required preload, all screws of the connection need to be inspected.

The screw connections have been assembled with a lubricant exhibiting a friction coefficient µges. = 0.08 (e.g. Molykote G-Rapid plus). It is important to ensure the use of the same lubricant when replacing individual screws.

The position of the inspected and improper screw connections needs to be documented in the service evaluation and/or the summary. The adjustment amount needs to be specified in clock minutes in that context (an entire forward turn would be +60, half a forward turn would be +30 etc.).

If a screw connection that has been secured with Loctite can be moved during a screw inspection, the adhesive connection will need to be restored.

## 3.4 Documentation of defects and damage

The maintenance manual requires the documentation of defects and damage in the service booklet. This includes the following scope.

- Describing the defect or the damage
- Taking meaningful and focused photographs and labeling the photographs with specific identifications if possible
- Documenting in the service booklet whether the defect or the damage could be repaired
- Immediately notifying the service control room of severe damage

# 4 RECOMMENDED MINIMUM EQUIPMENT FOR MAINTENANCE WORK

## 4.1 Tools

- Hydraulic power screwdriver with box nuts (wrench widths 36 through 56)
- Drill
- Drill bit set
- Step drill
- Die set (internal and external thread)
- Angle sander
- Cordless screwdriver
- Heat gun
- Sabre saw
- Jab saw
- File set
- Digital camera
- Extension cable
- Blade gage for the B hub
- Feeler gauge set
- Shut-off screwdriver with angle of rotation adjustment
- Torque wrench (15 lb.-ft. through 740 lb.-ft.);(20 through 1000 Nm)
- Measuring device for hydraulic pressure
- Clip-on ammeter
- Electrical multi-range measuring device
- Test box HSP 500 with test adaptor with Harting plug
- Megger
- Industrial vacuum cleaner and vacuum cleaner bags
- Various grease guns
- Canister pump
- Oil sample set
- Extension cable (approx. 65 ft. (20m))
- Penlight

- Ropes
- Chain hoist (550 lb., 1700 lb., 3400 lb.); (250 kg, 750 kg, 1500 kg)
- Standard tools for electricians
- Standard tools for mechanical work (e.g. screwdrivers, jaw wrenches, pliers, box nuts, ratchets etc.)

## 4.2 Auxiliary means

- Bucket
- Waste oil canister
- Hoses
- Cloths
- Funnel
- Scraper
- Stable trash bags
- Cleaning cloths
- Non-fraying cloths
- Hand brush
- Brushes
- Oil and grease-free brushes
- Cable ties
- Hand cleaning towels
- Hand creme
- Respirator masks
- Disposable gloves, gloves

## 4.3 Operating means

- Chain grease
- Brake cleaner
- Fat-solving cleaning agent
- Various lubricants
- Adhesive compounds
- (Loctite 243)
- Lacke

## 4.4 Spare parts

- Various filters
- Range of carbon brushes
- Screws, nuts, washers

# 5 SAFETY INSTRUCTIONS

## 5.1 Signal word panels used in this manual

**DANGER** **DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

**WARNING** **WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

**CAUTION** **CAUTION, used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.**

**NOTICE** **NOTICE is used to address practices not related to personal injury.**

## 5.2 Symbols used on safety signs, hazard signs and safety instructions

### 5.2.1 Mandatory regulations

Wear fall protection equipment!

Secure safety lanyard with energy absorber to attachment point!

Wear safety helmet!

Wear safety shoes!

Wear safety clothes!

Wear ear protection!

Wear safety glasses!

Wear face protection!

Wear safety gloves!

Wear respiratory protection!

Carry mobile phone!

Disconnect power!

### 5.2.2 Warning symbols

Attention – Danger!

Electrical danger!

Danger of electric shock!

Danger due to pending loads!

Danger due to pending loads!

Danger of falling!

Danger of falling!

Danger of falling due to overload platforms!

Danger of falling ice chunks!

### 5.2.3 Prohibitions

No switching!

No drilling!

No step!

No access!

No smoking!

No access for pacemaker wearers!

### 5.2.4 Rescue symbols

Escape route

Direction indicator for escape route

Use phone / mobile phone!

Use rescue device!

### 5.2.5 Locations

First-Aid kit

Eye wash station

Fire extinguisher

Deposited documents

## 5.3 General safety instructions

### 5.3.1 General

**DANGER**

**Evacuate the wind turbine immediately and save your life in case of:**

1. Fire
2. Thunder storm
3. Uncontrolled excessive rotor speed
4. High wind in excess of 35 knots (18 m/s)

**WARNING**

**Unauthorized changes or modifications affect safety and can cause accidents.**

- No changes or modifications unless authorized by REpower in advance and in writing.

**WARNING**

**Never work alone to ensure your own safety.**

- For all work at least two people are required.

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in this chapter.
- Instructions and regulations in the individual chapters.
- State, local and OSHA safety regulations.
- Safety signs.

**NOTICE**

**No heavy loads on platforms.**

- Observe load limits to avoid property damage.
  - 60 lb/ft²
  - 1 ton per platform

**NOTICE**

**Watch your step and use designated walk ways.**

- Do not step on equipment, parts or accessories to avoid property damage.

## 5.3.2 Weather conditions


**High winds are dangerous.**

- Check for maximum wind speeds for installation, maintenance and repair (see chapter XXX).


**Falling ice is dangerous.**

- If the rotor blades could be icy, the wind turbine shall be stopped if located less than 800 ft away from buildings or public roads.
- Nobody allowed closer than 800 ft from the wind turbine if the rotor blades could be icy.


**Thunder storms are dangerous.**

- Stop all work and leave the wind turbine immediately.
- Keep at least 1600 ft distance from the wind turbine.
- Do not approach the wind turbine until at least one hour after the wind turbine stopped.
- Do not touch if you hear sizzling noises (electrostatic charge).

## 5.3.3 Qualifications and communication


**Lack of training and physical fitness can lead to death.**

- Only fully trained and REpower authorized personnel to work in or at the wind turbine.
- Physical fitness and certification for working at heights required.


**Work with high voltage equipment is extremely dangerous.**

Lack of knowledge and experience can cause injury or death.

- Only licensed electricians with 3 + years experience permitted.

**DANGER**

**Experience and skill required for wind turbine erection.**

Lack of knowledge and experience can cause injury or death.

- Only personnel with 3 + years experience permitted.

**WARNING**

**Continuous communication between personnel required to avoid accidents.**

- Always carry a cell phone and a walkie-talkie.

### 5.3.4 Safety gear

**DANGER**

**Always wear your safety gear when required to avoid injury or death.**

- Follow the instructions in this manual at all times.

**DANGER**

**The rescue device is absolutely necessary for emergency exit and rescue.**

- Bring the rescue device for all work in the nacelle.

**WARNING**

**Use only correct and undamaged personal safety gear to avoid accidents.**

- Check the labels, operating manuals and follow the manufacturer's instructions.
- Check safety gear for damage and expiration dates.
- Replace safety gear if damaged or expired.

### 5.3.5 Lifting

**DANGER**

**Wear your safety gear when working on lifting equipment to avoid injury or death.**

- Follow the instructions in this manual at all times.

**DANGER**

**Lifted loads can slip in the harness, fall and kill.**

- Stay clear of all lifted loads at all times.

**WARNING**

**Continuous communication between all lifting personnel required to avoid injury or property damage.**

- At least three people are required.
- Use walkie-talkie, voice or hand signals.

**WARNING**

**Know the load for safe lifting to avoid accidents caused by shifting or falling loads.**

- Check weight and center of gravity. This information will be found on heavy objects or loads.

**WARNING**

**Use only correct and undamaged lifting equipment for all lifting and transporting operations to avoid injury or property damage.**

- Check the labels, operating manuals and follow the manufacturer's instructions.
- Check lifting equipment for damage before every use.

**WARNING**

**Accidental unhooking can cause the load to fall.**

- Use only hooks with safety latches to avoid injury or property damage.

**NOTICE**

**Avoid damage to lifting equipment.**

- Do not tie ropes, chains and belts in knots.
- Do not twist ropes, chains and belts.
- Do not stretch ropes, chains and belts.
- Do not pull ropes, chains and belts over sharp corners.

**NOTICE**

**If lifting equipment gets caught it can cause property damage.**

- Make sure the hooks or lifting equipment are clear of load after removal.

### 5.3.6 Mechanical connections

**DANGER**

**Experience and skill required for wind turbine erection.**

Lack of knowledge and experience can cause injury or death.

- Only personnel with 3 + years experience permitted.

### 5.3.7 Electrical connections and cabling

**DANGER**

**Work with high voltage equipment is extremely dangerous.**

Lack of knowledge and experience can cause injury and death.

- All work on electrical equipment to be carried out only by fully trained and licensed electricians with 3 + years experience.
- Electricians shall obey the 5 safety rules:

1. Disconnect power
2. Secure against accidental restart
3. Verify that power is disconnected
4. Ground and short-circuit
5. Cover neighboring life parts

**DANGER**

**Work on high voltage connections is extremely dangerous.**

Loose or wrong connections lead to injury or death caused by short-circuits or thermal damage.

- Only licensed electricians with 3 + years experience permitted.
- Read the wiring manual and follow the required sequence.
- Match the cable match marks and feeder identifications.
- Tighten all cable connections with a torque wrench.

**WARNING**

**Danger of injury with electro technical works.**

Protective equipment avoids corporal injuries.

- Wear your safety gear.
- Use protective equipment.

**WARNING**

**Cables are heavy.**

- Protect your back.
- Request help when handling heavy cables.
- When lowering cables secure with ropes.

**NOTICE**

**Improper installation can cause malfunctions.**

Avoid damage to insulation and to the seal between cable and related electronic box/equipment cable gland.

- Install all cables in a straight line.
- Do not overtighten the cable straps.
- Check for proper installation of all cable straps.

**NOTICE**

**Cut cables to required lengths.**

Cables that are too short can cause malfunctions.

- Refer to instructions for details.

**NOTICE**

**In the area of the cable loop cable straps are not permitted.**

Cable straps in the cable loop area can cause damage to the cables.

### 5.3.8 Use of hazardous substances

**WARNING**

**Solvents/cleaning agents, sealants and other special chemicals can be poisonous, flammable and skin irritant.**

Skin or eye contact, inhaling or swallowing can cause injuries or death.

- Obey manufacturer's instructions.
- Wear your personal safety gear.
- Handle with care and only in well ventilated areas.
- Seek immediate medical help in case of injury.

## 5.4 Special safety instructions

### 5.4.1 Fall arrest system

Information on the fall arrest system is attached to the access of the ladder. The example shows information to the fall arrest system H50 of Hailo.

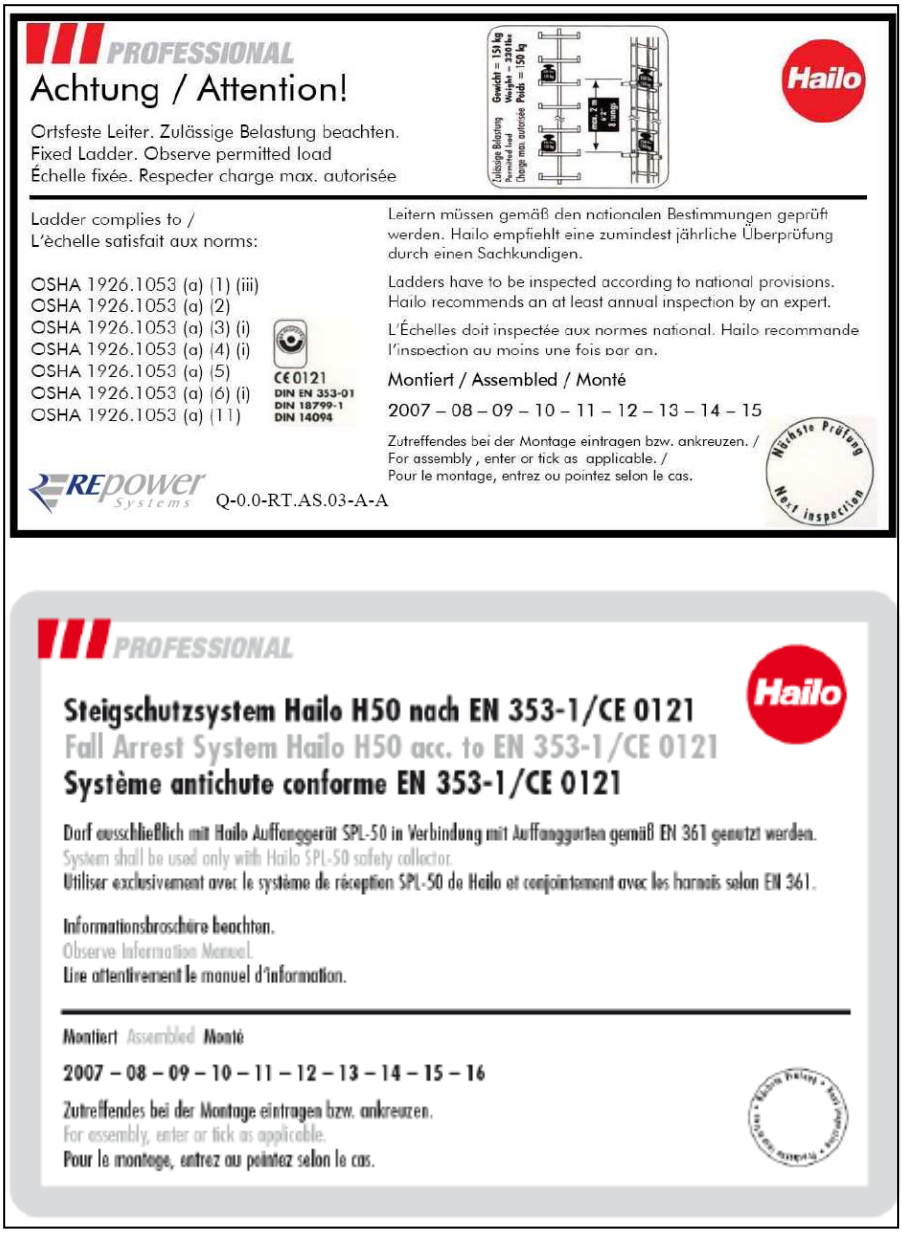



Fig. 5.4.1 – 1: Information to the fall arrest system

## 5.4.2 Attachment points for the personal protection equipment against falling down

**NOTE: All attachment points for the personal protection equipment against falling down and for the rescue device are marked in yellow.**

**DANGER**

**Death or severe injuries due to fall.**

- The personal protective equipment against fall always needs to be used and attached in the following situations:
  - during rappelling
  - while working in the nacelle with an open nacelle roof
  - in case of an open crane hatch
  - while working on the nacelle roof
  - while ascending and descending in the tower
- Only use the attachment points highlighted in yellow.
- Wear a hard hat.

### 5.4.2.1 Attachment points of the nacelle

**DANGER Death or severe injuries due to fall. Use the attachment point at the weather mast for securing a single person only. Do not use the attachment point to secure the rescue device.**

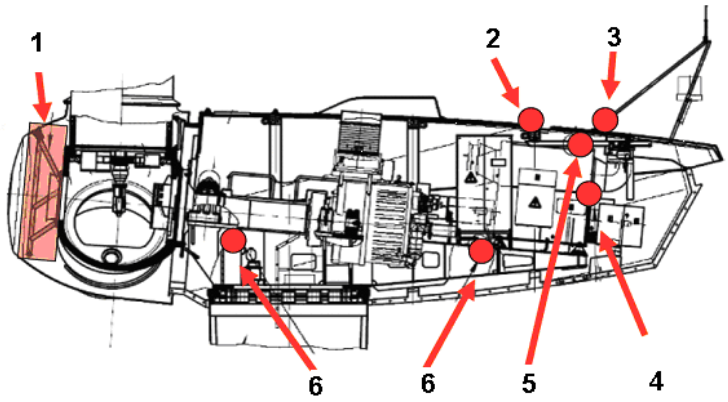



Fig. 5.4.2.1 – 1: Attachment points of the nacelle

1. Spinner mount
2. Transport loops on the roof of the nacelle
3. Weather mast
4. Transport loop of the generator
5. Crane carrier

6. Transport loops of the main frame

### 5.4.2.2 Attachment points on the roof of the nacelle

**DANGER Death or severe injuries due to fall. Use the attachment point at the weather mast (3) for securing a single person only. Do not use the attachment point to secure the rescue device.**

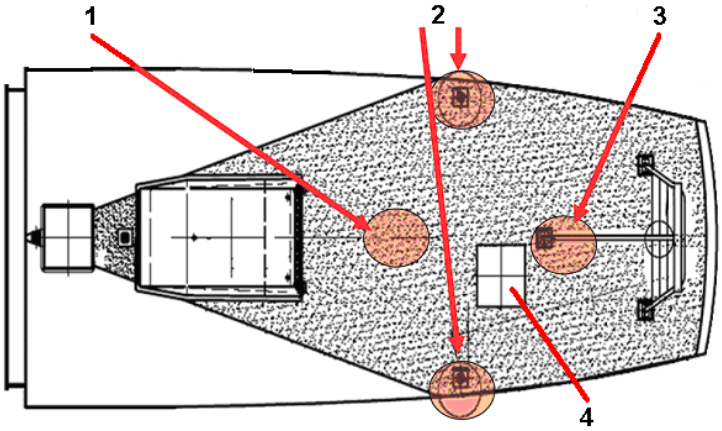



Fig. 5.4.2.2 – 1: Attachment points on the roof of the nacelle

1. Attachment point
2. Transport loops on the roof of the nacelle
3. Weather mast

**NOTE: Only ascend to the nacelle roof via the rear hatch (4) above the generator. When exiting, attach the lanyard to the attachment point weather mast (3).**

## 5.4.3 Escape and rescue plan

### 5.4.3.1 Location in the tower base

**NOTE: Only use the escape routes identified in the following figure.**

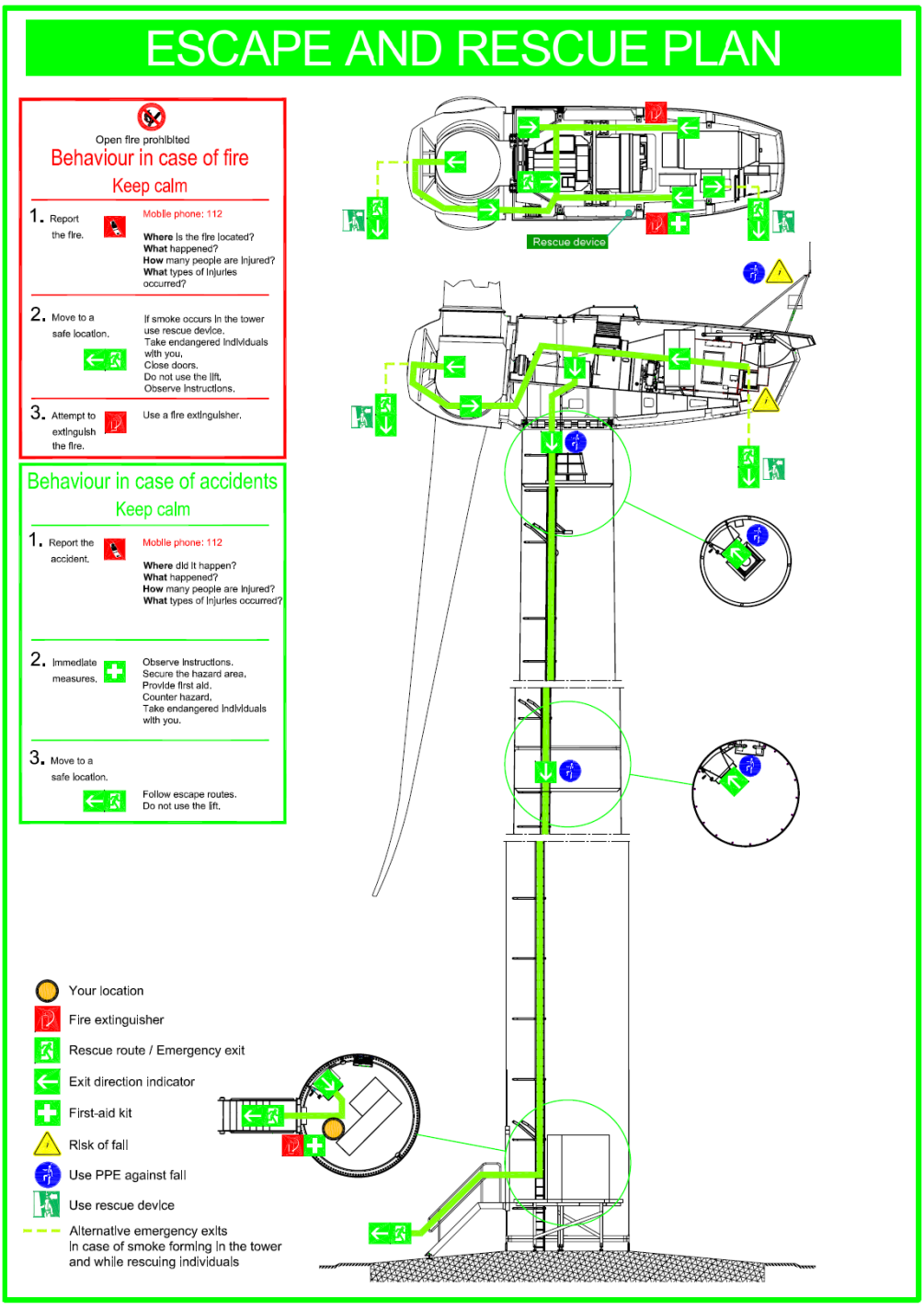



Fig. 5.4.3.1 – 1: Escape and rescue plan – location tower base

### 5.4.3.2 Location in the nacelle

**NOTE: Only use the escape routes identified in the following figure.**

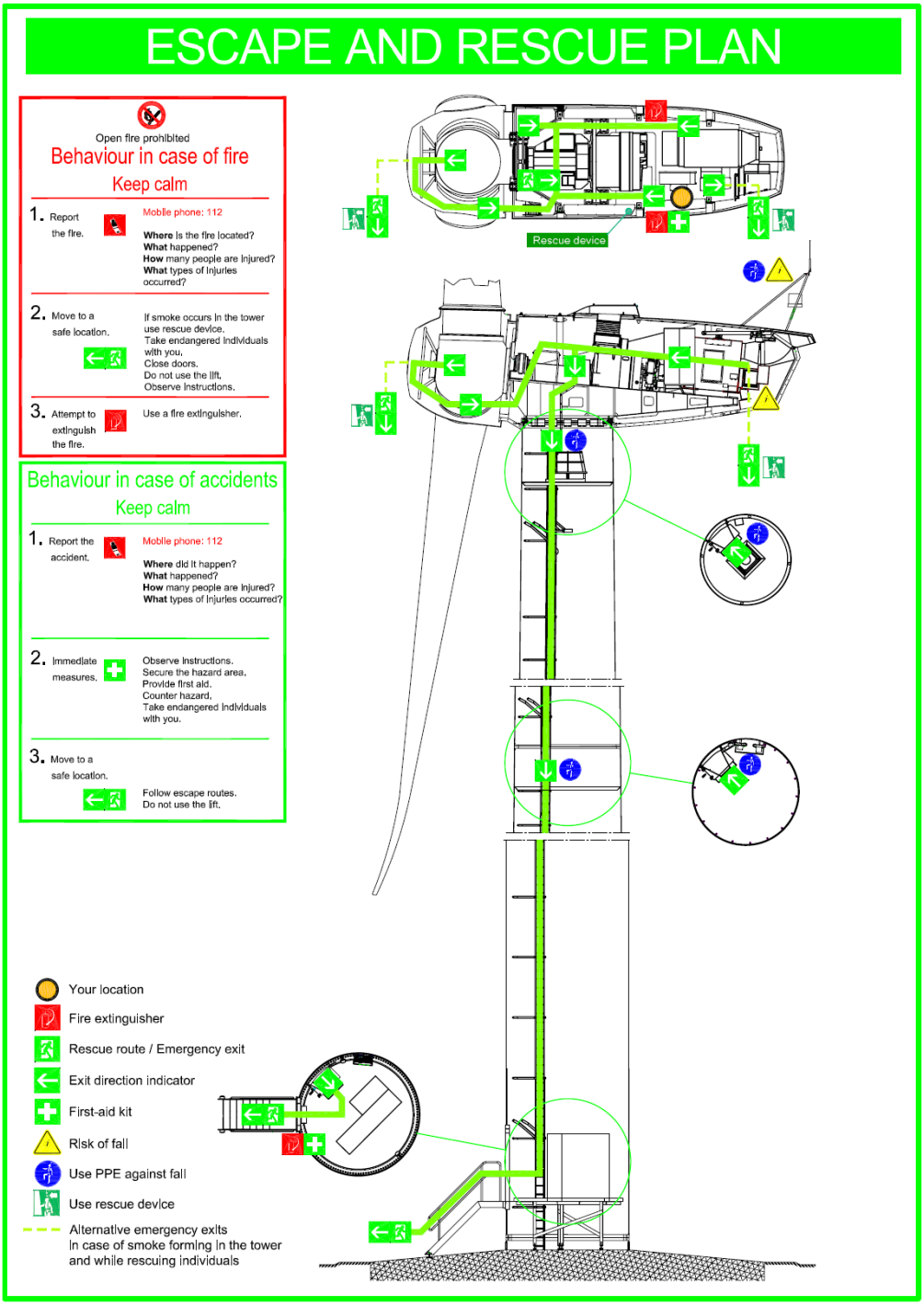



Fig. 5.4.3.2 – 1: Escape and rescue plan – location nacelle

# 6 MAINTENANCE

## 6.1 General controls


**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local and OSHA safety regulations.
- Safety signs.


**Risk of life while accessing the rotor hub**

- Move the rotor blade to the V position and engage the rotor lock (ref. operating manual) prior to accessing the hub.
- Activate the service switch and remove the key (ref. operating manual).
- Keep the rotor holding brake closed (ref. operating manual).


**Risk of life due to fall**

- Never open the end cover of the rotor blade pointing perpendicularly downward.
- The rotor must be turned 120° (ref. operating manu al) in order to reach this rotor blade.

## 6.1.1 Checking the machine base for cracks and damage

**Required tools / operating and auxiliary means:**

- Flashlight
- Ratchet
- No. 5 Allen wrench plug insert
- Digital camera
- Sandpaper
- Varnishing brush
- Metal varnish in accordance with the HEMPEL Repair procedure (ref. attachment)
- Respirator mask

**Directive:**

**⚠ WARNING Risk of life when accessing the outer yaw area. Engage the rotor lock prior to accessing the outer yaw area (ref. operating manual). Activate the service switch (ref. operating manual) and remove the key.**

**Note:** Also check for corrosion of the machine base and repair any corrosion spots in the context of this maintenance section. With regard to the content, this belongs to maintenance section 6.1.4 "Checking the entire wind turbine for corrosion".

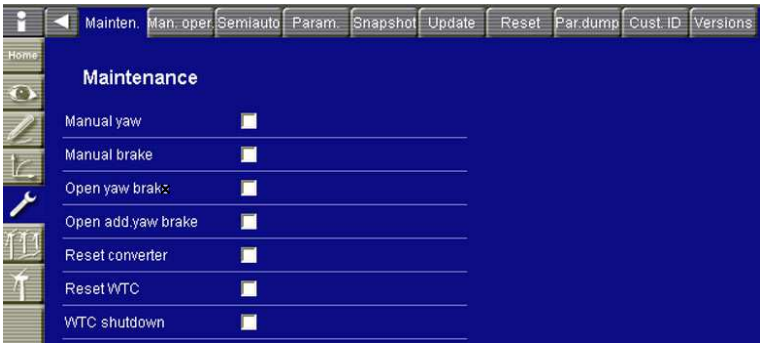



Fig. 6.1.1 – 1 Activating "Manual yaw"

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).
2. Use a key to set the service switch at the top box to "I" and remove the key.

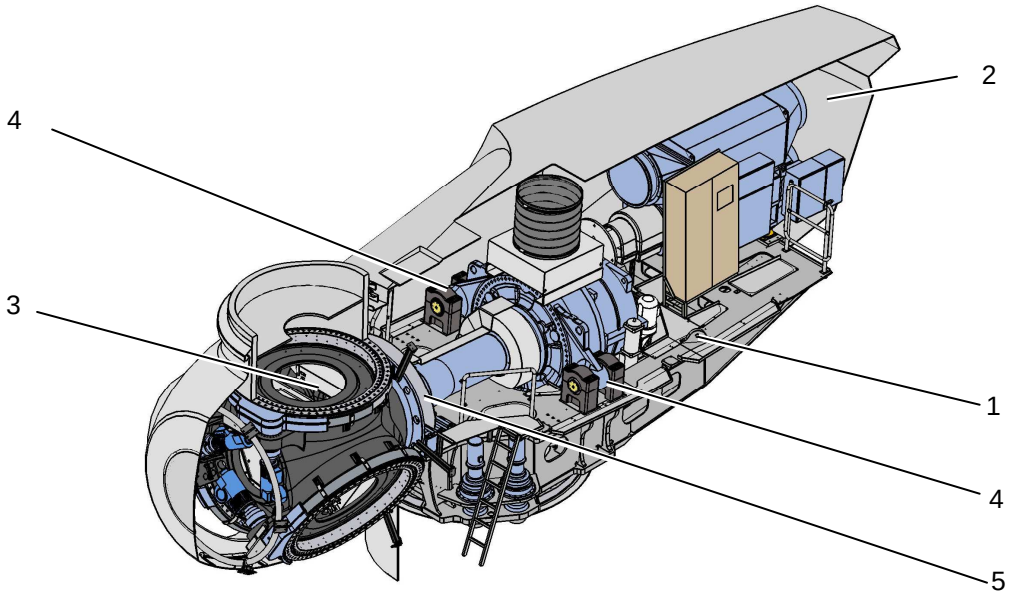



Fig. 6.1.1 – 2 Nacelle (without rotor blades)

| | |
|---|---|
| 1 | Machine base |
| 2 | Nacelle enclosure |
| 3 | Rotor hub (without rotor blades) |
| 4 | Torque supports of the gearbox |
| 5 | Rotor bearing |

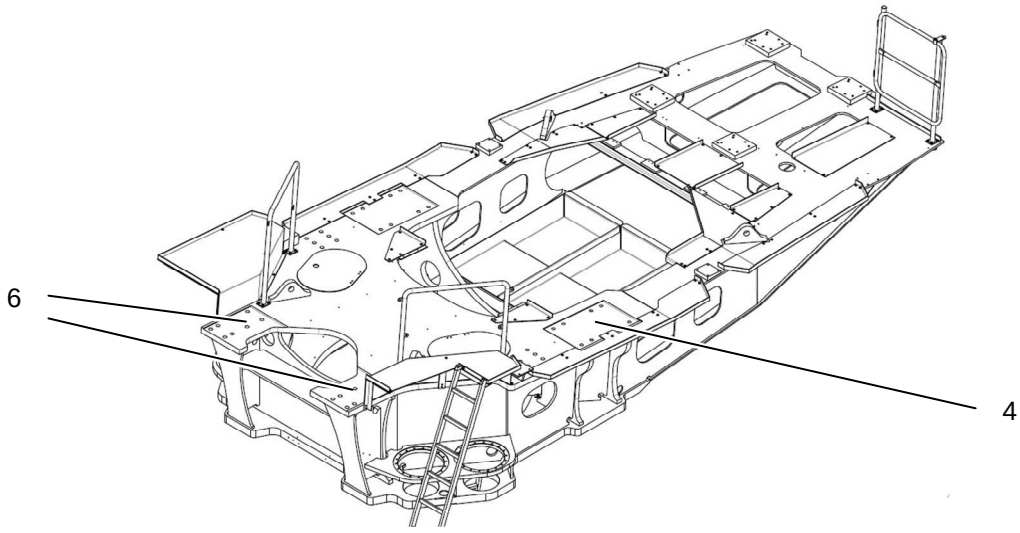



Fig. 6.1.1 - 3 Machine base (without superstructural parts)

**Check the machine base for corrosion:**

3. Check the entire machine base (1) for corrosion.

4. Grind down corrosion spots.

**⚠ CAUTION Danger due to solvent vapors. Wear a respirator mask and ensure good ventilation if possible while performing varnishing work.**

5. Renew the paint coat in accordance with the HEMPEL Repair procedure (ref. attachment).

**Check the machine base for damage:**

**⚠ WARNING Shut down the wind turbine and notify the REpower service or the service authorized by REpower in case of cracks and damage (this does not mean corrosion) at the load-bearing structures!**

6. Document damage in the service booklet.
7. Check the machine base for cracks, damage, and corrosion.
8. Check the welding seams for damage.
9. Perform particularly thorough checks in the range of the torque supports of the gearbox (4) and at the rotor bearing.

**⚠ WARNING Danger due to rotating system components. Perform all safety measures detailed above prior to descending to the outer yaw area.**

**⚠ CAUTION Danger due to spatial tightness and rough surfaces. Wear all protective clothing in order to avoid injuries.**

10. Carefully check the machine base in the outer yaw area for cracks, damage, and corrosion as well.

Fig. 6.1.1 – 4 Hatch to the section below the machine base

(Floor plate in the coupling area has already been removed)

11. Release the floor plate and put it to the side.
12. Check the machine base in this range for cracks, damage, and corrosion as well.
13. Tighten the floor plate again.

## 6.1.2 Checking the nacelle for leaks and water penetration

**Required tools / operating and auxiliary means:**

- Flashlight
- Digital camera
- Silicon with cartouche
- Additional tools as required by the type of damage

**Directive:**

- Check the nacelle for leaks.
- Determine and rectify the causes.
- If the removal of insulation is necessary in order to pinpoint a leak, re-attach the insulation after the completion of the repair work.
- Document leaks in the service booklet.
- Immediately report bigger leaks that may not be repaired during the maintenance.

### 6.1.3 Checking for unusual noise

**Required tools / operating and auxiliary means:**

- Depending on the type of the occurred damage

**Directive:**

- This maintenance section may be performed on the side during the entire maintenance.
- Pinpoint unusual noise and describe it in the service booklet.
- Determine the possible cause and act in accordance with the severity of the probable damage.
- In case of doubt, notify the REpower Service or the service authorized by REpower.
- If severe damage that may pose an imminent danger to persons and the wind turbine is suspected, shut down the wind turbine.

## 6.1.4 Performing the check for corrosion

**Required tools / operating and auxiliary means:**

- Flashlight
- Sandpaper
- Metal varnish in accordance with the HEMPEL Repair procedure (ref. attachment)
- Varnishing brush
- Thinner, cloth
- Respirator mask

**Directive:**

**Note:** Perform the check of the machine base for corrosion in the context of maintenance section 6.1.1.

- Inspect the entire wind turbine for corrosion.

**DANGER** **Risk of life due to fall. Only repair corrosion spots that may be accessed without danger. Always ensure personal safety (ref. chapter 5).**

- Grind down corrosion spots.

**CAUTION** **Danger due to solvent vapors. Wear a respirator mask and ensure good ventilation if possible while performing varnishing work.**

- Renew the paint coat in accordance with the HEMPEL Repair procedure (ref. attachment).

# 6.2 Rotor blades, general

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local and OSHA safety regulations.
- Safety signs.

**DANGER**

**Risk of life while accessing the rotor hub**

- Move the rotor blade to the V position and engage the rotor lock (ref. operating manual) prior to accessing the hub.
- Activate the service switch and remove the key (ref. operating manual).
- Keep the rotor holding brake closed (ref. operating manual).

**DANGER**

**Risk of life due to fall**

- Never open the end cover of the rotor blade pointing perpendicularly downward.
- The rotor must be turned 120° (ref. operating manu al) in order to reach this rotor blade.

**CAUTION**

**Danger due to spatial tightness and rough surfaces in the rotor hub**

- Wear all protective clothing in order to avoid injuries.

**NOTICE**

**Risk of damage to components**

- Do not damage cable and tube connections while working in the rotor hub.
- Report damage.
- A licensed electrician needs to replace damaged cable immediately.

## 6.2.1 Checking the rotor blade surface, rotor blade tip, and receptor

**Required tools / operating and auxiliary means:**

- Binoculars

**Directive for the control from the ground:**

1. Check for an even flow sound during the operation of the wind turbine
2. Document irregularities in the service booklet:
3. Manually stop the wind turbine (ref. operating manual):

Inspect the rotor blades with the binoculars from the ground. The rotor blades are numbered. Assign determined defects to the rotor blade and describe as well as document them in the service booklet. If the weather prevents a detailed visual inspection, all aspects that are not being inspected must be crossed out. The respective reason needs to be documented in the service booklet.

Inspection of the following aspects

- Traces of smoke residue
- Chippings, bubbles
- General condition
- Erosion
- Condition erosion foil
- Soiling
- Cracks
- Fit of the rain deflector
- Condition of the vortex generators (optional)
- Condition of the trailing edge rails (140°) (optio nal)
- Condition of the barbed tapes (optional)

**Directive for the inspection via the inspection hatch in the nacelle:**

**⚠ DANGER Risk of life due to fall. Never exit the nacelle via the front inspection hatch (1) above the rotor shaft. Use the inspection hatch (1) for the visual inspection of the rotor blades only.**

**⚠ CAUTION Danger due to stud bolts and the inspection hatch falling closed. Wear a bump cap in order to avoid head injuries from stud bolts (3). Secure the inspection hatch (1) via both turning knobs (2) against falling closed**


Fig. 6.2.1 – 1 Inspection hatch in the nacelle

4. Open the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual)
5. Open the rotor holding brake while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual); close it again for a more thorough inspection of details

**Note:** The wind turbine is now in idle mode; accordingly, a visual inspection of all blades is possible. The inspection points are identical to those of the inspection from the ground.

6. Re-engage the rotor lock after the completion of the inspection (ref. operating manual)

## 6.2.2 Checking the end cover and the interior of the rotor blade

**Required tools / operating and auxiliary means:**

- Flashlight
- Wear a respirator mask with eye protection and an active carbon filter

**Directive for the visual inspection of the rotor blade interior**

**Note:** Complete this maintenance section together with 6.2.3 and 6.2.4.


Fig. 6.2.2 – 1 End cover to the blade interior

**⚠ CAUTION Risk of gases that are adverse to your health, in particular in new rotor blades. Wear a respirator mask with eye protection. The respirator mask needs to include an oxygen supply in case of longer lasting maintenance work.**

1. Open the end cover (1).

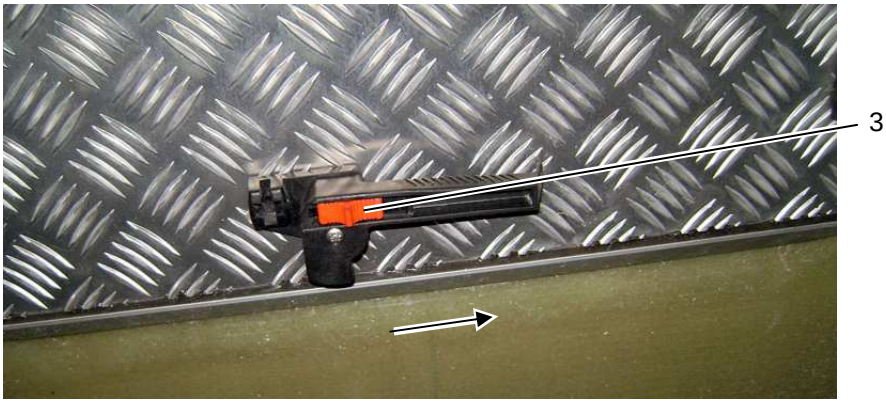



Fig. 6.2.2 – 2 Cover closure with locking mechanism

2. To that end, push the red locking mechanism (3) of each closure (2) in the direction of the arrow (fig. 6.2.2 – 2) and turn the grip towards the blade center.
3. Open up the end cover (1).
4. Climb through the opening into the rotor blade interior.
5. Inspect the rotor blade interior for holes.
6. Document damage including the rotor blade number in the service booklet (ref. type label in the vestibule for the number).
7. Thoroughly search the blade interior for loose components.
8. Remove loose components.

**NOTICE** **Loose components cause severe damage to the rotor blade or the generation of considerable noise.**

**Directive for the inspection of the end cover:**

9. Exit the rotor blade interior after completing the maintenance work.
10. Close the end cover (1) (fig. 6.2.2 – 1).


Fig. 6.2.2 – 3 Cover closure with locking mechanism

11. Turn the closures (2) to the edge and push the red locking mechanism (3) in the direction of the arrow (fig. 6.2.2 – 3).

**NOTICE** **The end cover is safely locked only if the red locking mechanism (3) of the closure (2) has locked in place. Unlocked end covers cause severe damage during the operation of the wind turbine.**

12. Repeat the steps for the rotor blade on the opposite side.

**DANGER** **Risk of life due to fall. Never open the end cover of the rotor blade pointing perpendicularly downward.**

13. Exit the rotor hub and remove all loose components.
14. Turn the rotor 120° and engage the rotor lock ( ref. operating manual).
15. Repeat steps 1 through 13 for the third rotor blade.

## 6.2.3 Inspecting the lightning protection elements

**Required tools / operating and auxiliary means:**

- Flashlight
- Respirator mask with eye protection and an active carbon filter

**Directive:**

**Note:** Complete this maintenance section together with 6.2.2 and 6.2.4.

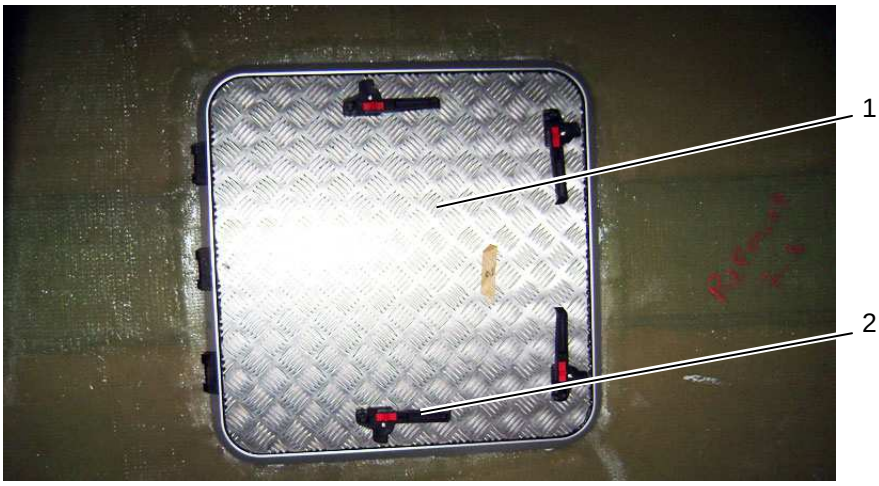



Fig. 6.2.3 – 1 End cover to the blade interior

**⚠ CAUTION Risk of gases that are adverse to your health, in particular in new rotor blades. Wear a respirator mask with eye protection. The respirator mask needs to include an oxygen supply in case of longer lasting maintenance work.**

1. Open the end cover (1)


Fig. 6.2.3 – 2 Cover closure with locking mechanism

2. To that end, push the red locking mechanism (3) of each closure (2) in the direction of the arrow (fig. 6.2.3 – 2) and turn the grip towards the blade center.
3. Open up the end cover (1).
4. Climb through the opening into the rotor blade interior.


Fig. 6.2.3 – 3 Lightning protection element in the rotor blade

5. Check the lightning protection elements (4) in the rotor blade for tight fit, cracks, and corrosion.
6. In that context, follow the lightning protection elements to the vestibule of the rotor blade.
7. Document defects including the blade number in the service booklet (ref. type label in the vestibule for the number).
8. Close the end cover (1) (fig. 6.2.3 – 1) after completing the inspection.


Fig. 6.2.3 – 4 Cover closure with locking mechanism

9. Turn the closures (2) to the edge and push the red locking mechanism (3) in the direction of the arrow (fig. 6.2.3 – 4).

**NOTICE** **The end cover is safely locked only if the red locking mechanism (3) of the closures (2) has locked in place. Unlocked end covers cause severe damage during the operation of the wind turbine.**

10. Continue the inspection of the lightning protection elements in the vestibule of the rotor blade.
11. Repeat the steps for the second rotor blade.

**DANGER** **Risk of life due to fall. Never open the end cover of the rotor blade pointing perpendicularly downward.**

12. Exit the rotor hub and remove all loose components.
13. Turn the rotor 120° and engage the rotor lock ( ref. operating manual).
14. Repeat steps 1 through 12 for the third rotor blade.

## 6.2.4 Checking the lightning counter cards

**Required tools / operating and auxiliary means:**

- Flashlight
- Edding with a fine tip

**Directive:**

**Note:** Complete this maintenance section together with 6.2.2 and 6.2.3

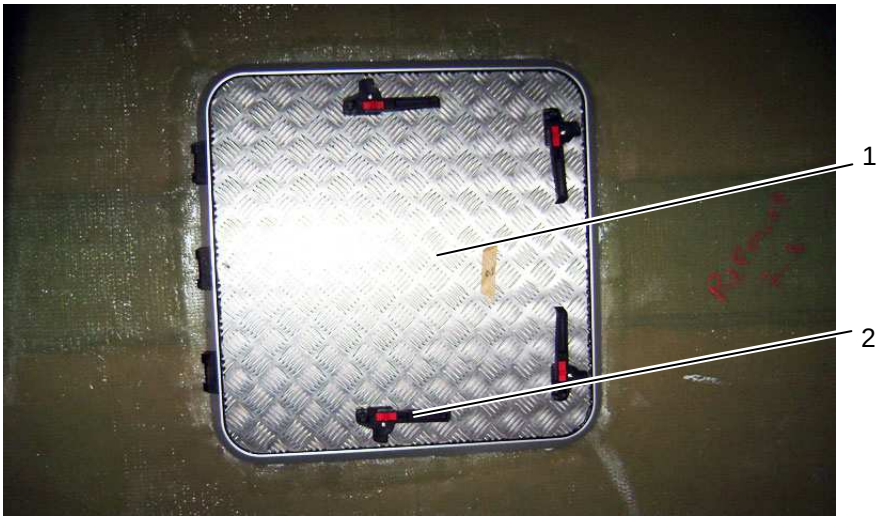



Fig. 6.2.4 – 1 End cover to the blade interior

**⚠ CAUTION Risk of gases that are adverse to your health, in particular in new rotor blades. Wear a respirator mask with eye protection. The respirator mask needs to include an oxygen supply in case of longer lasting maintenance work.**

1. Open the end cover (1).


Fig. 6.2.4 – 2 Cover closure with locking mechanism

2. To that end, push the red locking mechanism (3) of each closure (2) in the direction of the arrow (fig. 6.2.4 – 2) and turn the grip towards the blade center.
3. Open up the end cover (1).
4. Climb through the opening into the rotor blade interior.


Fig. 6.2.4 – 3 Mount for lightning counter cards in the rotor blade


Fig. 6.2.4 – 4 Lightning counter card (front and back)

5. Open the lightning counter card mount (4) and remove the lightning counter card (5).
6. Check and replace the lightning counter cards (observe the maintenance interval).

7. Label the replaced lightning counter cards (5) in the white field.


Fig. 6.2.4 – 5 Type label in the vestibule of a rotor blade

8. Specification of the wind turbine number, the blade manufacturer, and the blade number in accordance with the details on the type label (6), the date of the installation and removal of the lightning counter card, and the name of the wind farm.
9. If lightning damage is determined during the rotor blade inspection (ref. 6.2.1), this will also need to be documented on the lightning counter card of the affected rotor blade.
10. Remove all loose components from the rotor blade after completing the inspection.
11. Close the end cover (1) (fig. 6.2.4 – 1).


Fig. 6.2.4 – 6 Cover closure with locking mechanism

12. Turn the closures (2) to the edge and push the red locking mechanism (3) in the direction of the arrow (fig. 6.2.4 – 6).

**NOTICE** **It is ensured that the end cover is safely locked only if the red locking mechanism (3) of the closures (2) has locked in place. Unlocked end covers cause severe damage during the operation of the wind turbine.**

13. Repeat the steps for the second rotor blade.

**DANGER** **Risk of life due to fall. Never open the end cover of the rotor blade pointing perpendicularly downward.**

14. Exit the rotor hub and remove all loose components.
15. Turn the rotor 120° and engage the rotor lock ( ref. operating manual).
16. Repeat steps 1 through 14 for the third rotor blade.

## 6.2.5 Checking the trimming weights

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

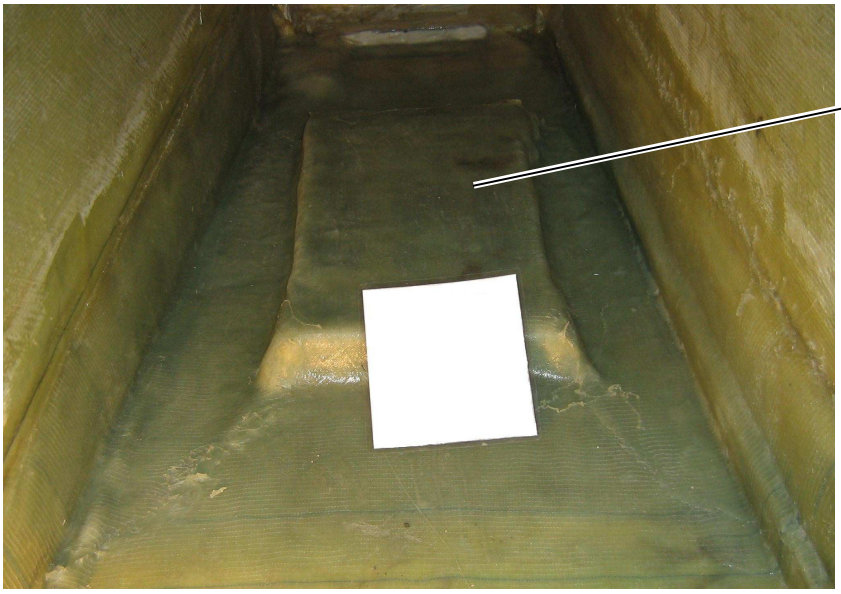



Fig. 6.2.5 – 1 Trimming weights (sheet DIN A4 for comparision only)

1. Check the trimming weights (1) (if present) for tight fight and soiling.


Fig. 6.2.5 – 2 Type label of a rotor blade in the vestibule

2. Document loose trimming weights including the wind turbine number, the blade manufacturer, and the blade number in accordance with the details on the type label (2) in the service booklet

3. Notify the REpower Service or the service authorized by REpower.
4. Tighten loose trimming weights.

**NOTICE** **Loose trimming weights are an indication for an imbalance in the rotor blade. Trimming weights that have completely detached from the rotor blade cause severe damage during the operation of the wind turbine**

5. Repeat steps 1 through 4 for the second rotor blade.

**⚠ DANGER** **Risk of life due to fall. Never open the end cover of the rotor blade pointing perpendicularly downward.**

6. Exit the rotor hub and remove all loose components.
7. Turn the rotor 120° and engage the rotor lock (r ef. operating manual).
8. Repeat steps 1 through 6 for the third rotor blade.

# 6.3 Rotor blade bolts

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local and OSHA safety regulations.
- Safety signs.

**DANGER**

**Risk of life while accessing the rotor hub**

- Move the rotor blade to the V position and engage the rotor lock (ref. operating manual) prior to accessing the hub.
- Activate the service switch and remove the key (ref. operating manual).
- Keep the rotor holding brake closed (ref. operating manual).

**CAUTION**

**Danger due to spatial tightness and rough surfaces in the rotor hub**

- Wear all protective clothing in order to avoid injuries.

**NOTICE**

**Risk of damage to components**

- Do not damage cable and tube connections while working in the rotor hub.
- Report damage.
- A licensed electrician needs to replace damaged cable immediately.

### 6.3.1 Checking the bolt connection between blade bearing and blade hub

Rotor blade LM 34.0 P_3 (MM 70)

### 6.3.2 Checking the bolt connection between blade bearing and blade hub

Rotor blade LM 40.0 P (MM 82B)

**Directive:**

This maintenance section may be performed following the instructions for 6.3.5 "Checking the blade bolt connection between blade bearing and blade hub – Rotor blade LM 45.3 P".

The difference is the number of blade bolts:

- MM82B: 64 pieces
- MM92: 80 pieces

### 6.3.3 Checking the bolt connection between blade bearing and blade hub

Rotor blade RE 40.0

### 6.3.4 Checking the bolt connection between blade bearing and blade hub

Rotor blade LM 34.0 P_3 (MM 70)

## 6.3.5 Checking the bolt connection between blade bearing and blade hub

Rotor blade LM 45.3 P (MM 92)

**Required tools / operating and auxiliary means:**

- Angle wrench
- No. 46 box nut
- Molykote
- Extension cable

**Directive:**

**Inspection of the rotor blade bolt connection**

1. Use a key to set the service switch at the top box to "I" and remove the key.

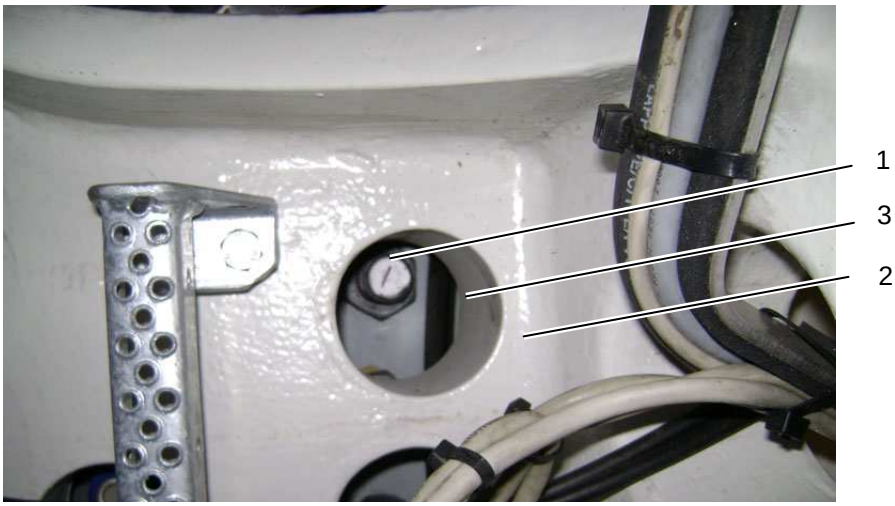



Fig. 6.3.5 – 1 Rotor blade bolt

(directly in front of the hatch to the rotor hub next to the pitch motor)

Rotor blade bolt No. 1 (1) is the bolt that becomes visible in the borehole (3) when the rotor blade is turned from blade pitch 90° in the direction of 0°.

Rotor blade bolts No. 2 through No. 80 become visible after each additional turn of the rotor blade in the direction of 0°. The numbering sequence must be observed under all circumstances.

The identification of the rotor blade bolt is used for the exact definition of damaged or loose bolts. This number is documented in the service booklet.

**Note:** The cooperation of two service technicians is a mandatory requirement for this maintenance section.

**Directive for the skilled electrician that operates the pitch system in converter box +3 BVU:**


Fig. 6.3.5 – 2 Key for opening the hub boxes

2. Use the key (4) to open the cover of converter box +3BVU only (all other hub and rechargeable battery boxes remain closed).

**DANGER Risk of electric shocks. A voltage supply of the converter boxes is required for the function of the pitch system. Do not touch metallic components without insulation!**

**NOTICE The hub box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**


Fig. 6.3.5 – 3 Service switch in converter box +3BVU

3. Set the service switch (5) in converter box +3BVU (below the operating panel of the control) to "ON".


Fig. 6.3.5 - 4 Control of the pitch system

4. Operate the control via the display.
5. Access the menu via "M1" (6).
6. Select a blade by means of M2, M3, or M4 (7).
7. Now the assignment of keys F1 through F5 (8) (ref. display) changes in the following manner:

| | | | | |
|---|---|---|---|---|
| << | < | [REF] | > | >> |
| F1 | F2 | F3 | F4 | F5 |

<< Quick counter-clockwise turning
< Slow counter-clockwise turning
[REF] Modifies the blade pitch settings (do not use;if this field is accidentally activated, use "Esc" (9) to return to the previous menu)
> Slow clockwise turning
>> Quick clockwise turning

8. Inform the first service technician about the imminent movement of the rotor blade.
9. Move the selected rotor blade via the F keys to 90°until the second service technician can see rotor blade bolt No. 1 centrally positioned in the borehole (3) and indicates this visibility.

**Directive for the second service technician that inspects the rotor blade bolts:**

**⚠ WARNING Risk of contusions. Do not reach into rotating system components. Constantly consult the skilled electrician.**

10. Mark rotor blade bolt No. 1.


Fig. 6.3.5 – 5 Rotor blade bolt

11. Release the nut of a rotor blade bolt (1).
12. Clean the thread and the support.
13. Abundantly lubricate with Molykote.
14. Check the nut by means of an angle wrench in accordance with the service booklet.
15. Repeat steps 11 through 14 for all rotor blade bolts that may be reached at this time.

**Directive for the skilled electrician:**

16. Following the feedback from the second service technician, turn the rotor blade until the next rotor blade bolts may easily be accessed by the second service technician.
17. Repeat steps 11 through 16 for the remaining rotor blade bolts.
18. Use the F keys (8) to turn the rotor blade to the 87° position.
19. Activate the "M1" key (6) of the control and use it to return to the "Main window (blades)".
20. Set the service switch (5) to "OFF" after completing the work at the last rotor blade bolt of the rotor blade.
21. Attach the hub box cover to the hinges and close it.

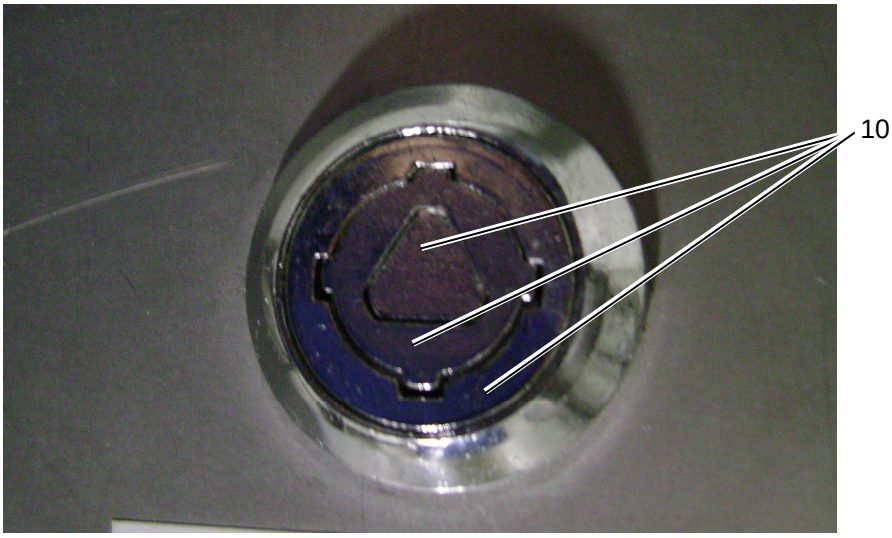



Fig. 6.3.5 – 6 Closure of the hub boxes

**Note:** All elements (10) of the hub boxes closures need to be flush to each other.

**NOTICE** **Closures that have not been properly locked may come loose during the operation of the wind turbine. A loose hub box cover may cause severe damage.**

22. Exit the rotor hub and remove all loose components.
23. Turn the rotor 120° and re-engage the rotor lock.
24. Repeat steps 2 through 23 for the second rotor blade.
25. Repeat steps 2 through 22 for the third rotor blade.

# 6.4 Blade bearing

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local and OSHA safety regulations.
- Safety signs.

**DANGER**

**Risk of life while accessing the rotor hub**

- Move the rotor blade to the V position and engage the rotor lock (ref. operating manual) prior to accessing the hub.
- Activate the service switch and remove the key (ref. operating manual).
- Keep the rotor holding brake closed (ref. operating manual).

**CAUTION**

**Danger due to spatial tightness and rough surfaces in the rotor hub**

- Wear all protective clothing in order to avoid injuries.

**NOTICE**

**Risk of damage to components**

- Do not damage cable and tube connections while working in the rotor hub.
- Report damage.
- A licensed electrician needs to replace damaged cable immediately.

## 6.4.1 Evaluating the condition of the outer and inner seal

**Required tools / operating and auxiliary means:**

- Flashlight
- Digital camera

**Directive:**

1. Use a key to set the service switch at the top box to "I" and remove the key.


Fig. 6.4.1 - 1 Outer seal of the blade bearing

**⚠ CAUTION Risk of injuries: Ensure suitable personal protection while checking the seal (1) at the entire circumference of the blade bearings.**


Fig. 6.4.1 – 2 Inner seal of the blade bearing

2. Visual inspection of the outer (1) and inner seals (2) of all three rotor blades for cracks, porosity and leaks.
3. Visual inspection as to whether the outer (1) and inner seals (2) have been lifted off their normal seats.
4. Visual inspection for the presence of damaged or offset adhesive joints.
5. Document defects including the rotor blade number in the service booklet.
6. Remove escaped grease.
7. Dispose of soiled cloths in the proper manner.

## 6.4.2 Removing escaped lubrication grease

**Required tools / operating and auxiliary means:**

- Flashlight
- Digital camera (for the documentation of defects)
- Fat-solving cleaning agent
- Cloth

**Directive:**

1. Use a key to set the service switch at the top box to "I" and remove the key.

**DANGER** **Risk of life due to high voltages. During the cleaning process, do not open hub and axle boxes under any circumstances.**

**CAUTION** **Risk of injuries: Ensure suitable personal protection while cleaning the rotor hub.**

2. Remove the lubrication grease in the entire hub area.

**Note:** Cleaning the hub facilitates the determination of the success of initiated measures during subsequent maintenance processes.

3. Dispose of soiled cloths in the proper manner.
4. Remove all loose components.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

### 6.4.3 Not used

### 6.4.4 Not used

## 6.4.5 Inspecting the condition of the gearing and the gearing cover

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- No. 13 ring spanner or jaw wrench
- Key for hub boxes (ref. fig.6.5.4 – 2)
- Flashlight
- Lubrication grease in accordance with the lubrication schedule
- Brush
- Cloth

**Directive:**

1. Use a key to set the service switch at the top box to "I" and remove the key.

**Note:** The cooperation of two service technicians is a mandatory requirement for this maintenance section.Complete this maintenance section together with 6.4.9, 6.5.13, and 6.5.14.

**Directive for the first service technician:**

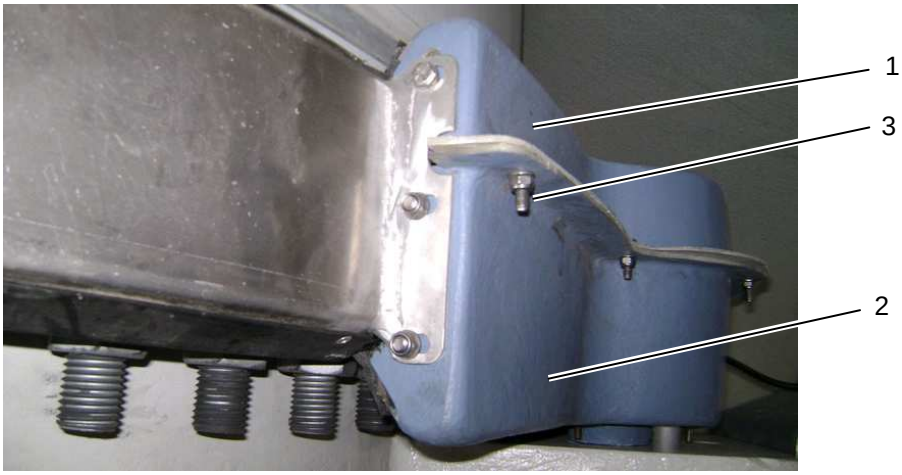



Fig. 6.4.5 - 1 Gearing cover of the blade bearing

**⚠ CAUTION Risk of injuries: Ensure suitable personal protection while removing the upper shell (1).**

2. Release the screws of the gearing cover (3).
3. Safely store the screws, nuts, and washers.
4. You must find components that have fallen down.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

5. Carefully raise the upper shell (1) and store it in a secure manner.

**Directive for the skilled electrician that operates the pitch system in converter +3BVU:**


Fig. 6.4.5 – 2 Key for opening the hub boxes

6. Use the key (4) to open the cover of converter box +3BVU only (all other hub and rechargeable battery boxes remain closed).

**⚠ DANGER** **Risk of electric shocks. A voltage supply of the converter boxes is required for the function of the pitch system. Do not touch metallic components without insulation!**

**NOTICE** **The hub box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**

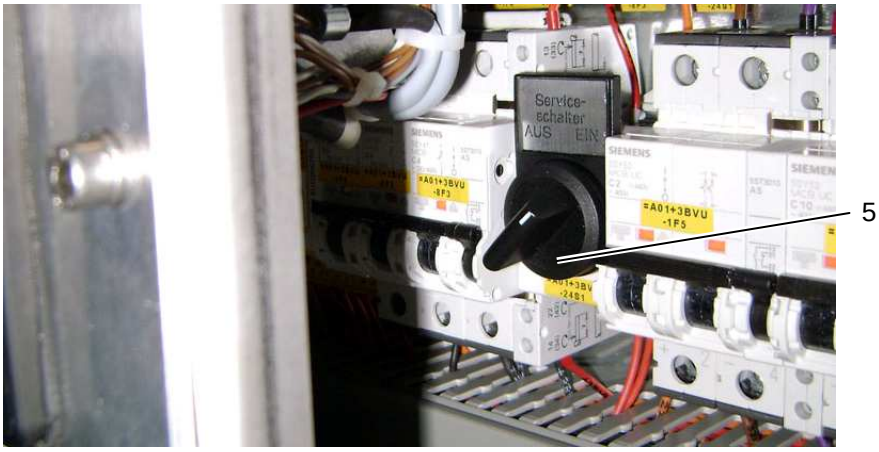



Fig. 6.4.5 – 3 Service switch in converter box +3BVU

7. Set the service switch (5) in converter box +3BVU (below the operating panel of the control) to "ON".

6


Fig. 6.4.5 – 4 Control of the pitch system

8. Access the menu via "M1" (6).
9. Select a blade by means of M2, M3, or M4 (7).
10. Now the assignment of keys F1 through F5 (8) (ref. display) changes in the following manner:

| << | < | [REF] | > | >> |
|---|---|---|---|---|
| F1 | F2 | F3 | F4 | F5 |

<< Quick counter-clockwise turning
< Slow counter-clockwise turning
[REF] Modifies the blade pitch settings (do not use; if this field is accidentally activated, use "Esc" (9) to return to the previous menu)
> Slow clockwise turning
>> Quick clockwise turning


Fig. 6.4.5 – 5 Display of the control of the pitch system

11. Inform the first service technician about the imminent movement of the rotor blade.
12. Turn the rotor blade by means of the F keys (8) in steps from 90° in the direction of 360°.

**Directive for the first service technician**

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into the gearing under any circumstances while turning the rotor blade. Let the rotor blade turn in steps. In that context, consult the skilled electrician at all times.**


Fig. 6.4.5 – 6 Cover of the lubrication pinion

13. Evaluate the condition of the lubrication pinion (10).
14. Examine the gearing and the state of lubrication while turning the rotor blade.
15. Thoroughly lubricate insufficiently lubricated tooth flanks in the range 90° through 360° with lubrication grease in accordance with the lubrication schedule and a brush while in standstill.
16. To that end, instruct the skilled electrician to stop turning the rotor blade.
17. Inspect the state of lubrication of the tooth flanks in the range 0° through 90°, re-lubricate with lubrication grease in accord ance with the lubrication schedule and a brush if applicable.
18. Remove excess lubrication grease with a cloth.
19. Document defects in the service booklet.
20. Reassemble the upper shell of the gearing cover (1) (fig. 6.4.5 – 2).

**Directive for the skilled electrician:**

21. Following the feedback from the first service technician, use the F keys (8) to let the rotor blade turn to the 87° position .
22. Activate "M1" (6) of the control and use it to return to the "Main window (blades)".
23. Select the next blade by means of M2, M3, or M4 (7).
24. Repeat steps 8 through 22 for the other two rotor bearings.
25. Set the service switch (5) to "OFF" after completing the work.
26. Attach the converter box cover to the hinges and close it.

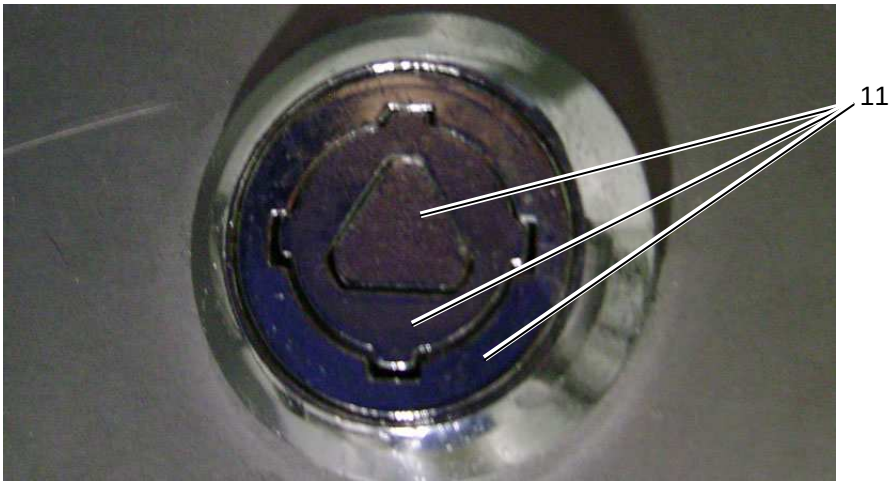



Fig. 6.4.5 – 7 Closure of the hub boxes

**Note:** All elements (11) of the hub boxes closures need to be flush to each other.

HINWEIS **Closures that have not been properly locked may come loose during the operation of the wind turbine. A loose hub box cover may cause severe damage.**

27. Search the rotor hub area for loose components.
28. Remove loose components.
29. Remove all tools from the hub.
30. Dispose of soiled cloths in the proper manner.

## 6.4.6 Checking the screw connection between the blade bearing and the rotor hub

**Required tools / operating and auxiliary means:**

- Hydraulic power screwdriver

**Directive:**

1. Use a key to set the service switch at the top box to "I" and remove the key.
2. Transport the hydraulic power screwdriver to the rotor area.

**DANGER** **Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!**


Fig. 6.4.6 - 1 Screw connection between the rotor hub and the rotor blade bearing

In the vestibule of the rotor blades

3. Check the screws (1) of the connection between the rotor hub (2) and the rotor blade bearing (3) by means of a hydraulic power screwdriver and a torque as detailed in the service booklet
4. Repeat step 3 at the other two rotor blades

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

5. Search the rotor area for loose components
6. Remove loose components
7. Remove all tools from the hub

## 6.4.7 Inspecting the lubrication pump

Equipment with automatic self-lubrication system

**Required tools / operating and auxiliary means:**

- Jaw wrench
- Lubrication grease gun with lubrication grease in accordance with the lubrication schedule
- Flat-headed screwdriver
- Flashlight
- Cloth

**Directive:**

1. Use a key to set the service switch at the top box to "I" and remove the key.
2. Set the motor-circuit switch lubrication pump blade bearing in the top box to STOP.


Fig. 6.4.7 – 1 Lubrication pump

3. Release the screw connection of the lubrication stub (2).
4. Remove the lubrication stub (2).
5. Clean the threading.


Fig. 6.4.7 – 2 Pressing in the lubrication grease

6. Manually tighten the grease gun (3) to the lubrication stub.
7. Press in lubrication grease until the maximum filling mark has been reached at the lubrication grease container (1).
8. Remove the grease gun (3).
9. Clean the threading.
10. Re-attach and tighten the lubrication stub (2).

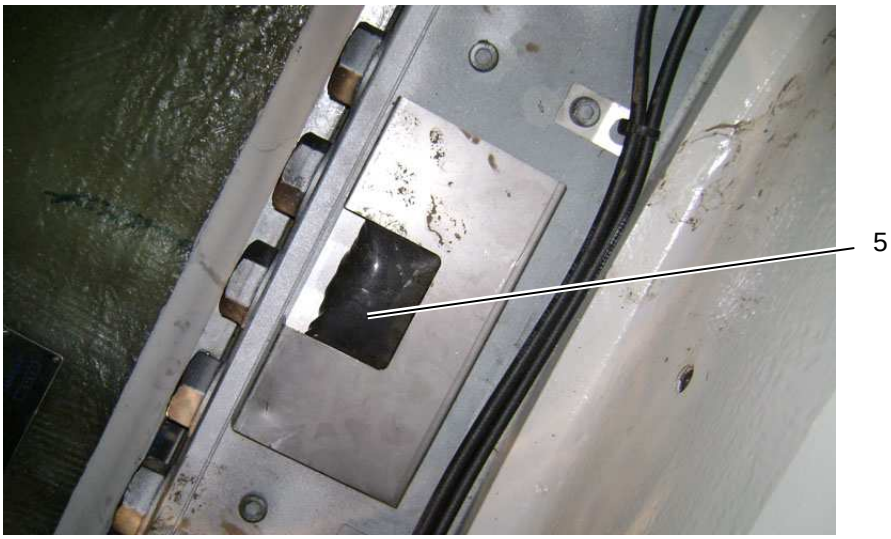



Fig. 6.4.7 – 3 Grease receptacle in the vestibule of the rotor blades

11. Check the grease receptacle (5) in the vestibule of the three rotor bearings.
12. Replace full grease receptacles (5) (ref. maintenance section 6.4.10).

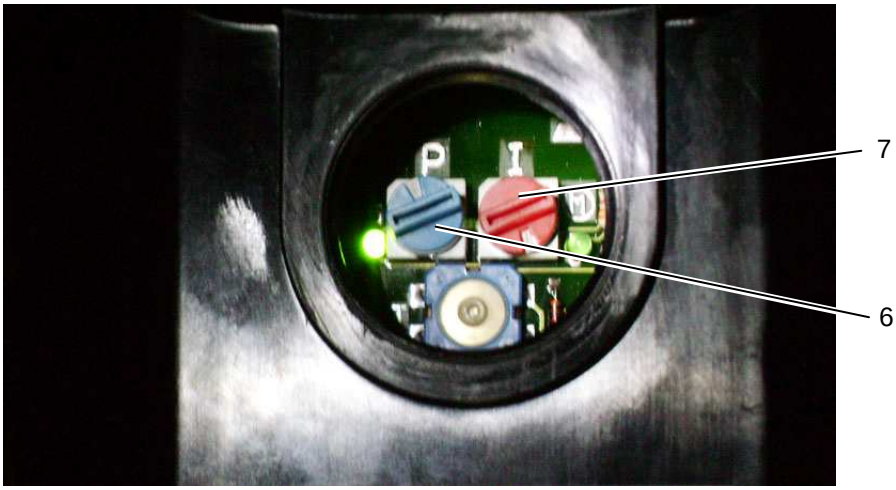



Fig. 6.4.7 – 4 Lubrication pump setting

13. Check the lubrication pump setting in case of deviating lubrication grease consumption.
14. To that end, remove the cross-shaped cover at the lubrication pump.
15. Use a flat-headed screwdriver to set the break time via the blue adjustment disk (6) to the required value (ref. service booklet).
16. Use a flat-headed screwdriver to set the pumping time via the red adjustment disk (7) to the required value (ref. service booklet).
17. Re-attach the cross-shaped cover.


Fig. 6.4.7 – 5 Pressure valve

18. In case of insufficient lubrication grease consumption, generally check as to whether the red pin (8) protrudes from the pressure valve; this would indicate a block of the lubrication line or a splitter.
19. In that case, resolve the block of the lubrication line or the splitter.
20. Remove lubrication grease residue.

21. Search the rotor hub area for loose components.
22. Remove loose components.
23. Remove all tools from the hub.
24. Dispose of soiled cloths in the proper manner.
25. Set the motor-circuit switch lubrication pump blade bearing in the top box to START.

## 6.4.8 Checking the gearing in the range of the rotor blade pitch system 0° through 90°

Equipment with automatic self-lubrication system

**Note:** Complete this maintenance section in the context of 6.4.7.

If the inspection is only intended to cover the range of the rotor blade pitch system 0° through 90°, the adjustment of the rotor blade in the range 90° through 360° and the manual re-lubrication of the g earing in this range will be omitted in the context of maintenance section 6.4.7.

## 6.4.9 Checking the lubrication pinion

**Note:** Complete this maintenance section in the context of 6.4.5.

## 6.4.10 Checking the grease receptacles

**Required tools / operating and auxiliary means:**

- Flashlight
- Curved needle-nosed pliers
- New grease receptacles
- Container for the replaced full grease receptacles
- Cloth

**Directive:**

1. Use a key to set the service switch at the top box to "I" and remove the key.
2. Set the motor-circuit switch lubrication pump blade bearing in the top box to STOP.


Fig. 6.4.10 – 1 Grease receptacle

3. Remove the cover (1) of the grease receptacle (2) by means of curved needle-nosed pliers and put it to the side.
4. Remove the filled grease receptacle (2) and place it in a container.

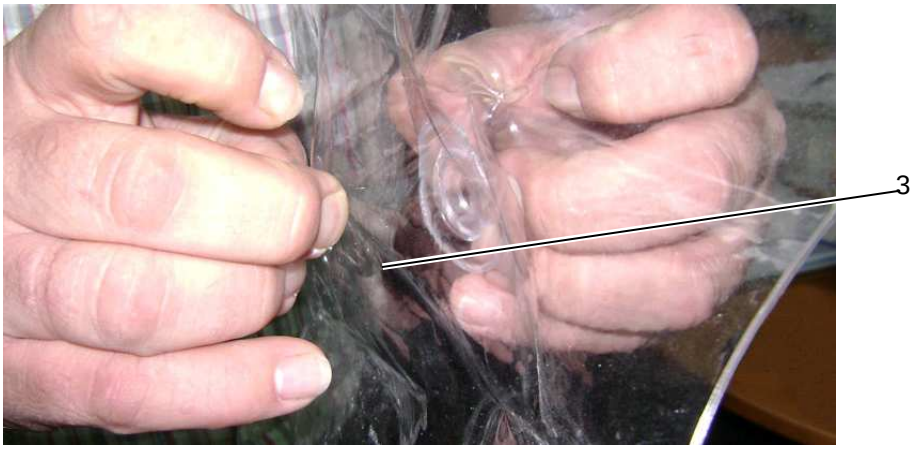



Fig. 6.4.10 – 2 Attaching a new grease receptacle

5. Pull apart new grease receptacles (3) and subsequently push out the air again in order to prevent the plastic foil from sticking together and facilitate the unobstructed entry of the lubrication grease.

Fig. 6.4.10 – 3 Inserting a new grease receptacle

6. Push the new grease receptacle (3) on the stub.
7. Fold the grease receptacle to the format of the mount (1).
8. Re-attach the mount (1).


Fig. 6.4.10 – 4 Locking points of the cover

9. All four corners (4) need to lock into place in an audible manner.

**NOTICE** **It is very important that all corners of the cover (2) lock into place because detached covers cause severe damage during the operation of the wind turbine.**

10. Replace all filled grease receptacles of the three rotor blades in this manner.
11. Remove the tools, the container with the replaced grease receptacles, and the cloths from the hub.
12. Dispose of grease receptacles and soiled cloths in the proper manner.

# 6.5 Blade adjustment mechanism

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local and OSHA safety regulations.
- Safety signs.

**DANGER**

**Risk of life while accessing the rotor hub**

- Move the rotor blade to the V position and engage the rotor lock (ref. operating manual) prior to accessing the hub.
- Activate the service switch and remove the key (ref. operating manual).
- Keep the rotor holding brake closed (ref. operating manual).

**CAUTION**

**Danger due to spatial tightness and rough surfaces in the rotor hub**

- Wear all protective clothing in order to avoid injuries.

**NOTICE**

**Risk of damage to components**

- Do not damage cable and tube connections while working in the rotor hub.
- Report damage.
- A licensed electrician needs to replace damaged cable immediately.

## 6.5.1 Checking the oil level pitch gearbox

### 6.5.1.1 Manufacturer Bonfiglioli

**Requirement:**

- Set the supply pitch UPS in the top box to "OFF"

**Required tools / operating and auxiliary means:**

- Flashlight
- Ratchet with extension
- No. 8 Allen wrench plug insert
- Oil in accordance with the label on the gearbox
- Canister pump

**Directive:**


Fig. 6.5.1.1 - 1 Pitch gearbox

**Note:** The following maintenance work may be omitted if no escaping oil is visible at the pitch gearbox (1):

**Note:** If oil has escaped from the pitch gearbox, the pitch gearbox (1) by the manufacturer Bonfiglioli needs to face perpendicularly downward with the pinion in order to refill gearbox oil (fig. 6.5.1 – 1); that is the case if the associated rotor blade also points perpendicularly downward.

1. Remove the oil screw (2).
2. Use a canister pump to refill oil in accordance with the label on the gearbox until the oil reaches the lower edge of the threading for the oil level control screw.
3. Re-tighten the oil screw.
4. Clean the working area.
5. Dispose of soiled cloths in the proper manner.
6. Exit the rotor area and remove all loose components.
7. Turn the rotor 120° and engage the rotor lock.
8. Repeat the maintenance steps for pitch gearboxes 2 and 3 if oil has escaped at these pitch gearboxes.
9. Remove all tools and other loose items from the rotor area after completing the maintenance work.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.5.2 Performing an oil change pitch gearbox

### 6.5.2.1 Manufacturer Bonfiglioli

**Required tools / operating and auxiliary means:**

- Flashlight
- Ratchet with extension
- No. 8 Allen wrench plug insert
- Waste oil canister for approx. 5 gal. (20 liters) of waste oil
- 3 times 1.6 gal. (6 liters) of oil in accordance with the label on the gear-box
- Canister pump

**Directive:**

**Note:** This maintenance section should ideally be performed at operating temperature in order to facilitate an easier flow of the oil.


Fig. 6.5.2.1 - 1 Pitch gearbox

**Note:** The rotor hub needs to be turned 120° and re-locke d three times for the gearbox oil change of all pitch gearboxes. For that reason, it is recom-mended to combine the steps "Draining the oil" and "Filling the gearbox with oil".

**⚠ CAUTION** **Risk of burns due to hot gearbox oil. Wear oil-proof gloves and closely sealing protective goggles.**

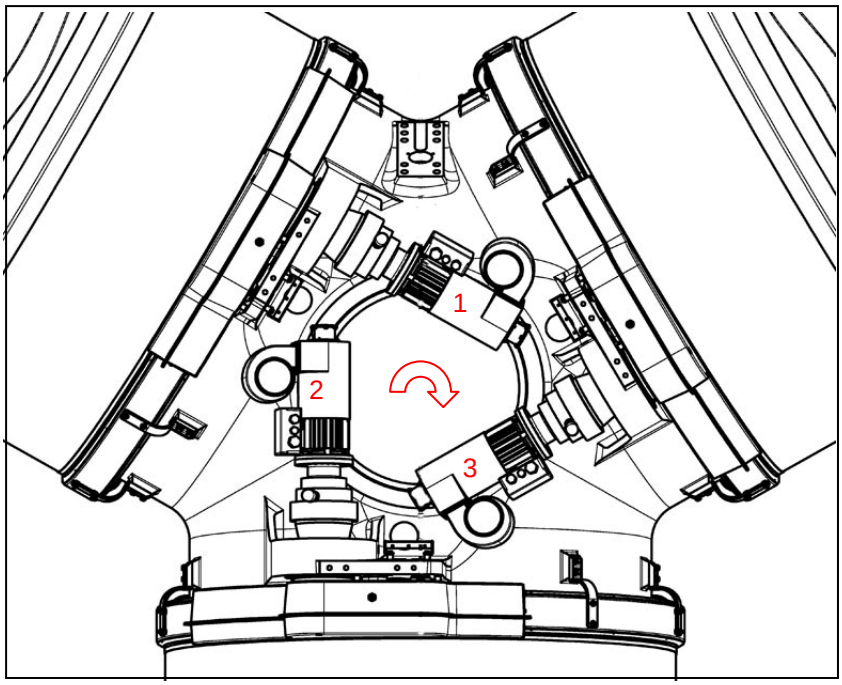



Fig. 6.5.2.1 – 2 Position 0°

**Position 0°(fig. 6.5.2.1 - 2)**

1. Remove the oil screw of pitch gearbox No. 1.
2. Drain the gearbox oil of pitch gearbox No. 1 into the waste oil canister.
3. Re-tighten the oil screw (2) of pitch gearbox No. 1.
4. Clean the working area of oil residues.
5. Exit the rotor area and remove all loose components from the rotor hub.
6. Turn the rotor 120° and re-engage the lock.

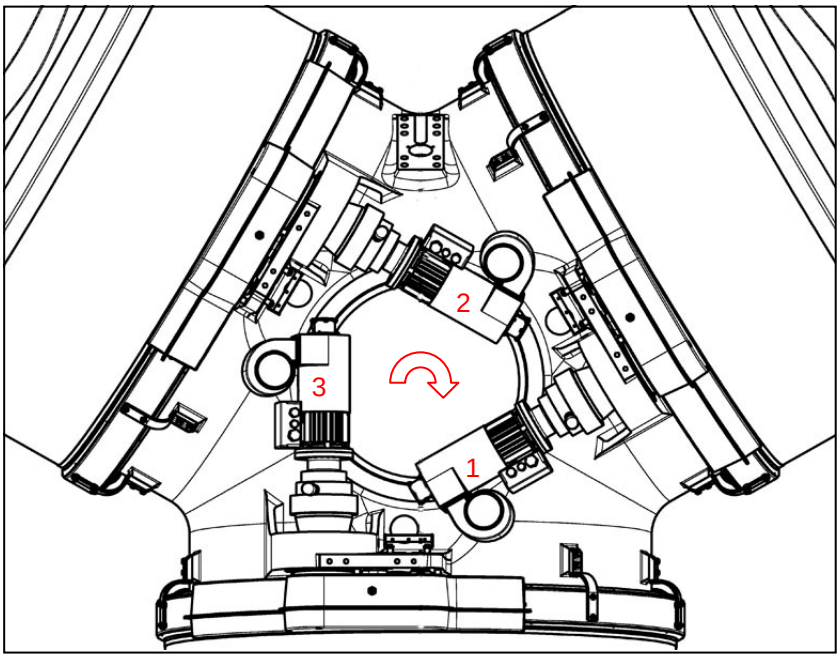



Fig. 6.5.2.1 – 3 Position 120°

**Position 120°(fig. 6.5.2.1 - 3)**

7. Remove the oil screw (2) of pitch gearbox No. 2.
8. Drain the gearbox oil of pitch gearbox No. 2 into the waste oil canister.
9. Re-tighten the oil screw (2) of pitch gearbox No. 2.
10. Clean the working area of oil residues.
11. Exit the rotor area and remove all loose components from the rotor area.
12. Turn the rotor 120° and re-engage the lock.

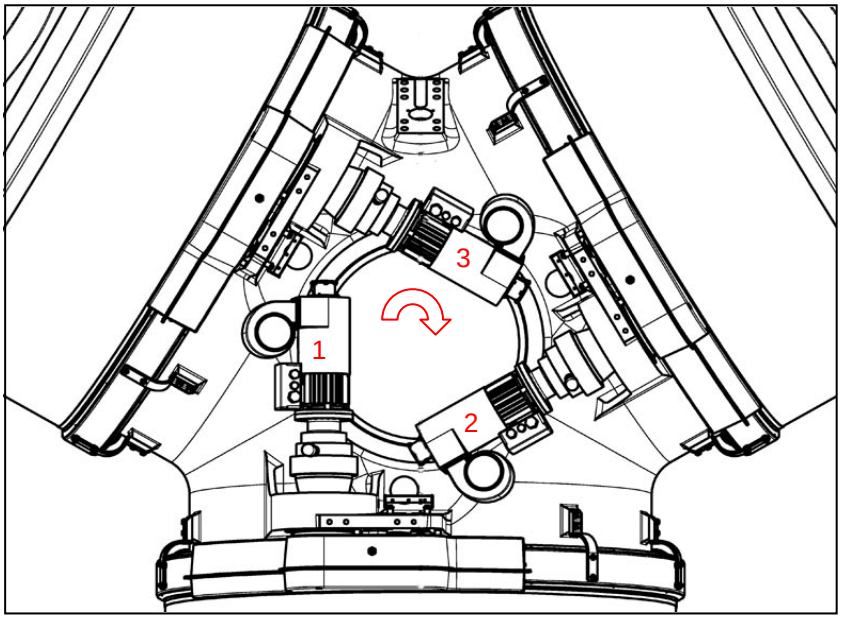



Fig. 6.5.2.1 – 4 Position 240°

**Position 240°(fig. 6.5.2.1 - 4)**

13. Remove the oil screw (2) of pitch gearbox No. 3.
14. Drain the gearbox oil of pitch gearbox No. 3 into the waste oil canister.
15. Re-tighten the oil screw (2) of pitch gearbox No. 3.
16. Clean the working area of oil residues.
17. Remove the oil screw (2) of pitch gearbox No. 1.
18. Use a canister pump to fill approx. 1,6 gal. (6 liters) of fresh gearbox oil into pitch gearbox No. 1 until the gearbox oil reaches the threading for the oil control screw / oil drain screw (2).
19. Re-tighten the oil screw (2).
20. Exit the rotor area and remove all loose components from the rotor area.
21. Turn the rotor 120° and re-engage the lock.
22. Remove the oil screw (2) of pitch gearbox No. 2 (ref. fig. 6.5.2.1 – 2 Position 0°).
23. Use a canister pump to fill approx. 1,6 gal. (6 liters) of fresh gearbox oil into pitch gearbox No. 2 until the gearbox oil reaches the threading for the oil screw (2).
24. Exit the rotor area and remove all loose components from the rotor area.
25. Turn the rotor 120° and re-engage the lock.

26. Remove the oil screw (2) of pitch gearbox No. 3 (ref. fig. 6.5.2.1 – 3 Position 120°).
27. Use a canister pump to fill approx. 1,6 gal. (6 liters) of fresh gearbox oil into pitch gearbox No. 3 until the gearbox oil reaches the threading for the oil screw (2).
28. Remove all tools and other loose items from the rotor area after completing the maintenance work.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.5.3 Replacing the seal between gearbox and e-motor

### 6.5.3.1 Manufacturer Bonfiglioli

**Requirement:**

- Set the supply pitch UPS in the top box to "OFF"

**Required tools / operating and auxiliary means:**

- Flashlight
- No. 19 ring spanner
- Plastic bushing with the same diameter as the shaft gaskets
- New seals
- Chain hoist
- Round loop
- Soft mallet

**Directive:**

**⚠ CAUTION The e-motor of a pitch gearbox weighs approximately 145 lb. (65 kg). Do not lift by hand. Use a chain hoist.**


Fig. 6.5.3.1 - 1 Pitch gearbox

1. Disconnect the plugs belonging to the e-motor from the converter box.
2. Bypass the e-motor (1).

3. Release the cable mounts to ensure that the e-motor (1) may be moved arbitrarily.
4. Place the round loop around the e-motor (1).
5. Safely attach an end of the chain hoist to the e-motor (1) and the suspension of the chain hoist to the spinner ring.
6. Release the screw connections (2).
7. Slowly lift up the e-motor (1) until the seal may be accessed in an unobstructed manner.
8. Remove the old seal with a suitable tool.
9. Insert the new seal with the help of the plastic bushing.
10. Slowly lower the e-motor and place it on the gearbox (3) in a perfectly fitting manner.
11. Tighten the screw connection.
12. Reconnect the e-motor.
13. Reconnect the plugs to the converter boxes.
14. Renew the released cable ties.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

15. Exit the rotor area and remove all loose components.
16. If the seals of the other pitch gearboxes also need to be replaced, turn the rotor 120° and re-engage the lock; repeat steps 1 through 15.

### 6.5.4 Checking the carbon brushes of the pitch gearbox

The directive will be provided at a later time.

### 6.5.5 Checking the battery

The directive will be provided at a later time.

## 6.5.6 Inspecting the plug connections and cables outside the hub and rechargeable battery boxes

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**


Fig. 6.5.6 – 1 Hub box

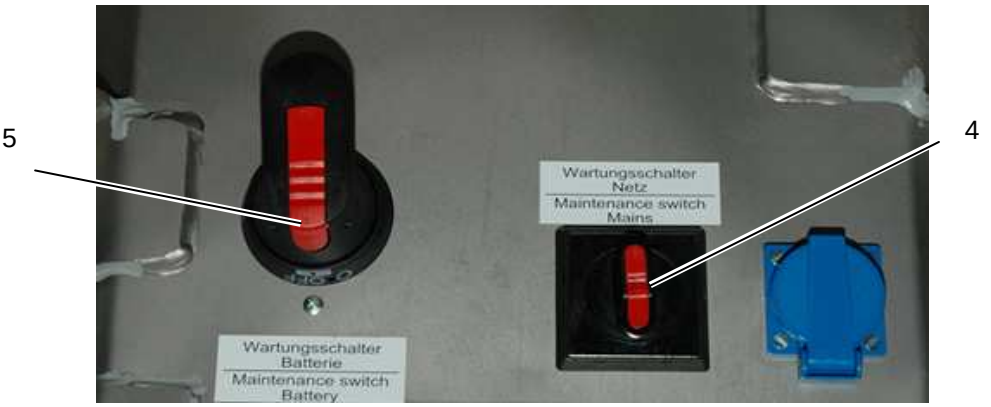



Fig. 6.5.6 – 3 Maintenance switch

1. Set the maintenance switches grid (4) and the maintenance switches battery (5) at all hub and rechargeable battery boxes to "OFF".

**DANGER Risk of life: The rechargeable battery boxes (label: +1BVA, +2BVA, and +3BVA) are permanently connected to 288 V DC! Do not open!**

**DANGER Work at electrical systems may only be performed by authorized skilled electricians.**

2. Check all cables and cable connections (2) for their tight fit and the presence of the seal insert (in 2); tighten if applicable.
3. Check the plugs for their tight fit (3).
4. Document defects including the hub and/or axle box identification in the service booklet.
5. Reactivate the power supply of the hub and rechargeable battery boxes.
6. Remove the tools and other loose components from the rotor area after completing the maintenance work.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.5.7 Inspecting the hub lighting

**Requirement:**

- Circuit breaker "Light hub" in the top box to "I – ON"

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

**Note:** The lighting in the hub is activated together with the tower and nacelle lighting.

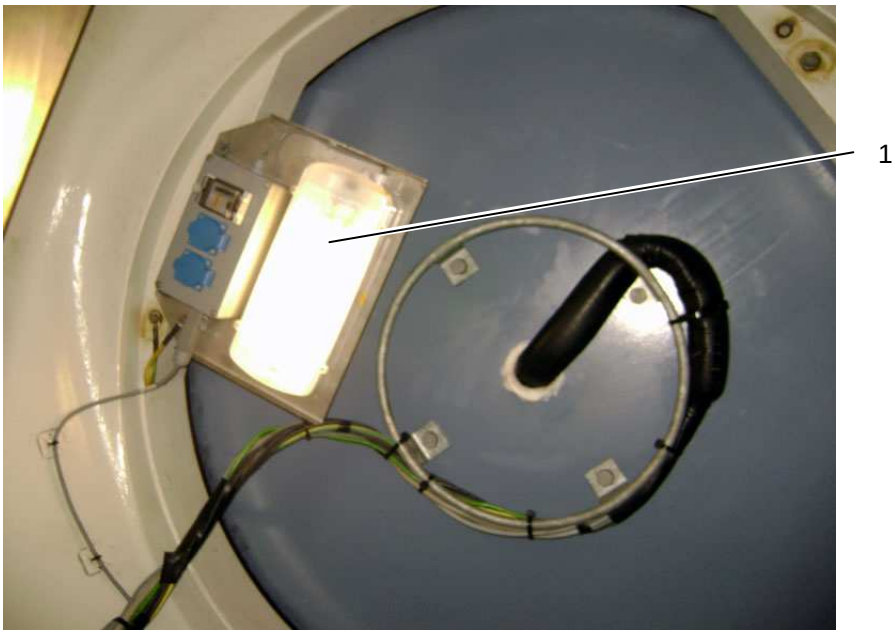



Fig. 6.5.7 – 1 Hub lighting

1. Check the function of the hub lighting (1).
2. If the hub lighting (1) does not emit light, start by deactivating the voltage of the lamp.
3. Replace the lighting means.
4. Remove the tools and other loose components from the rotor area after completing the maintenance work.
5. Reactivate the voltage supply of the lamp.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.5.8 Inspecting the condition of the hub boxes

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

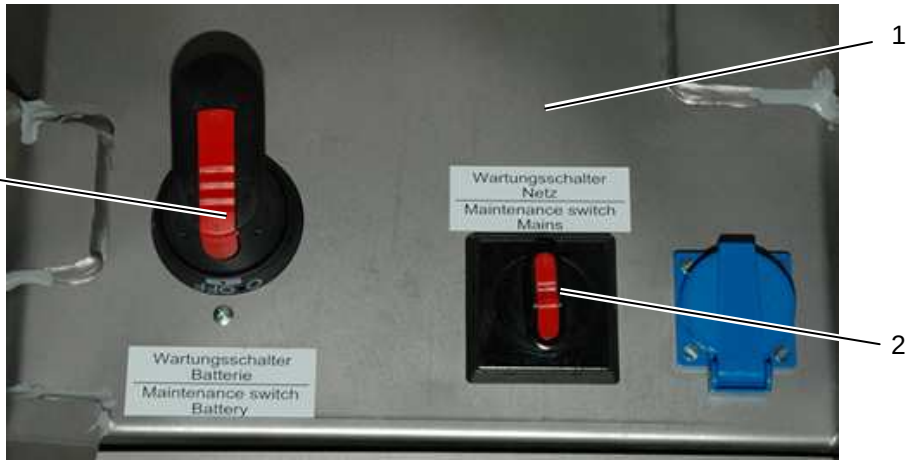



Fig. 6.5.8 – 1 Maintenance switch

1. Set the maintenance switches grid (2) and the maintenance switches battery (3) at all hub and rechargeable battery boxes (1) to "OFF".

**DANGER Risk of life: The rechargeable battery boxes (label: +1BVA, +2BVA, and +3BVA) are permanently connected to 288 V DC! Do not open! Work at electrical systems may only be performed by authorized skilled electricians.**

**Note:** This maintenance section only provides for a visual inspection of the hub boxes.

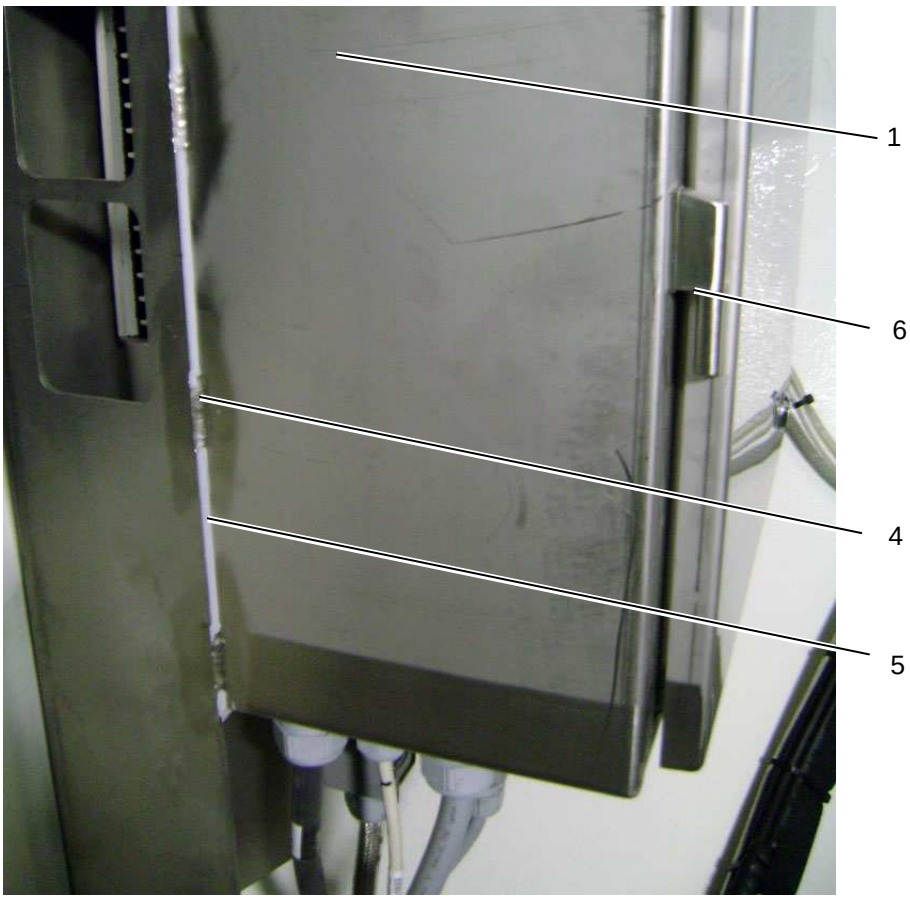



Fig.6.5.8 - 2 Hub box side view

**External visual inspection of the hub boxes (1):**

2. Check the welding seams (4) for corrosion.
3. Inspect the silicon seams (5) for cracks and defects, renew if applicable.
4. Check the hub boxes (1) for cracks.
5. Evaluate the condition of the hinges (6).

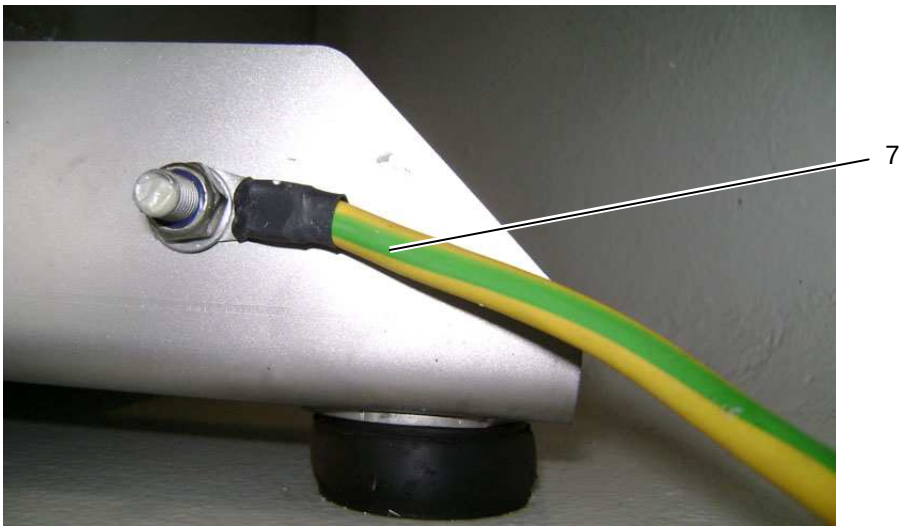



Fig. 6.5.8 -3 Grounding of the hub boxes

6. Check the grounding (7) of the hub boxes (1) for their tight fit.
7. Document defects including the hub box identification in the service booklet.
8. Reactivate the power supply of the hub and rechargeable battery boxes.
9. Remove the tools and other loose components from the rotor area after completing the maintenance work.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.5.9 Inspecting the components of the hub boxes

**Required tools / operating and auxiliary means:**

- Flashlight
- Key to open the hub boxes (fig. 6.5.9 – 2)

**Directive:**


Fig. 6.5.9 – 1 Maintenance switch

1. Set the maintenance switches grid (1) and the maintenance switches battery (2) at all hub and rechargeable battery boxes to "OFF".
2. Disconnect all Harting plugs (5) (ref. fig. 6.5.9 – 10) from the rechargeable battery boxes.

**⚠ DANGER Risk of life: The rechargeable battery boxes (label: +1BVA, +2BVA, and +3BVA) are permanently connected to 288 V DC!**

**Converter box +1BVU**


Fig. 6.5.9 – 2 Key for opening the hub boxes

**NOTICE** **The hub box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**

3. Use the key (3) to open the cover of converter box +1BVU (all other converter and rechargeable battery boxes remain closed).

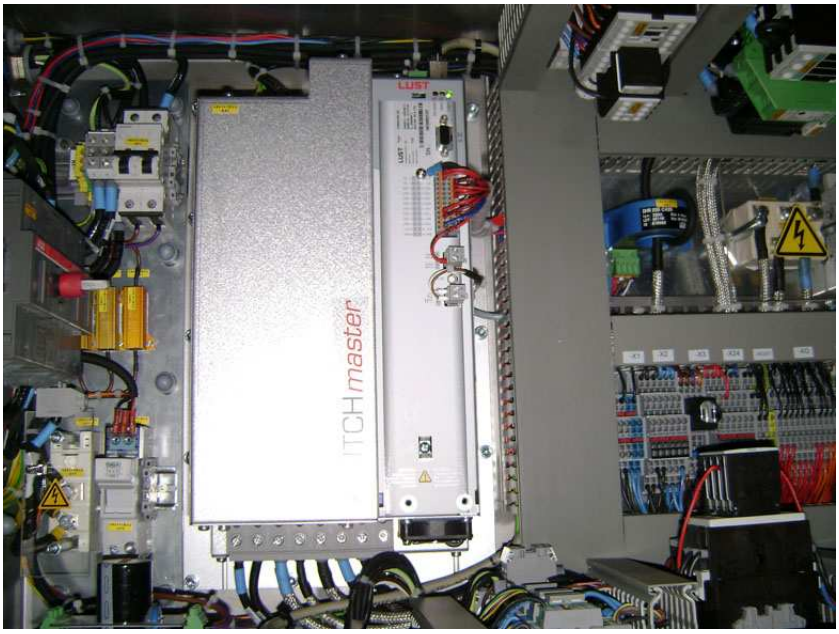



Fig. 6.5.9 – 3 Interior of converter box +1BVU

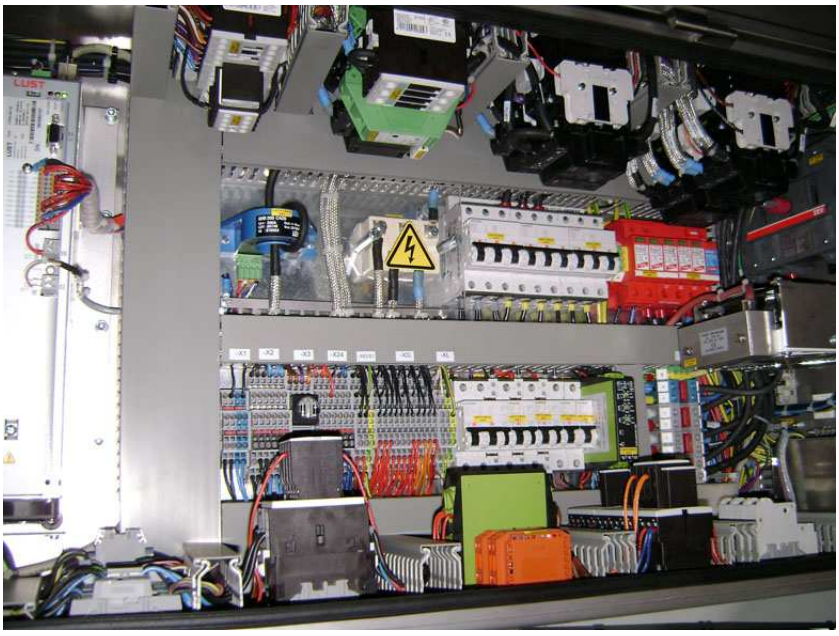


Fig. 6.5.9 – 4 Interior of converter box +1BVU

4. Check the screw connections of all grid and rechargeable battery voltage connections for their tight fit.

**Note:** Maintenance section 6.5.11 "Inspecting the surge protection elements" may be processed at this time.

5. Attach the converter box cover to the hinges and close it.

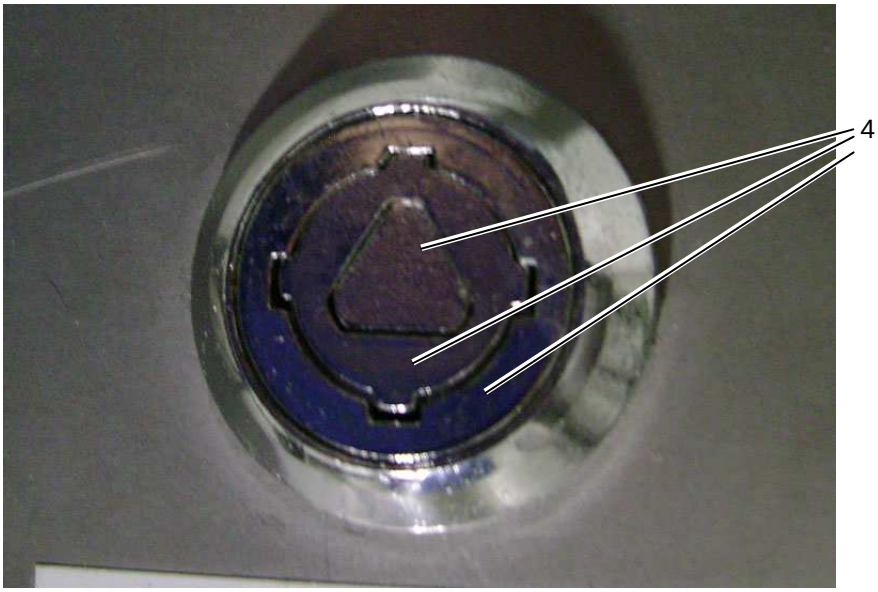



Fig. 6.5.9 – 5 Closure of the hub boxes

**Note:** All elements (4) of the hub box closures need to be flush to each other.

**NOTICE** Closures that have not been properly locked may come loose during the operation of the wind turbine. A loose hub box cover causes severe damage during the operation of the wind turbine.

**Converter box +2BVU**

6. Open the cover of converter box +2BVU while taking the safety instructions for converter box +1BVU into consideration, remove it from the hinges, and put it to the side.

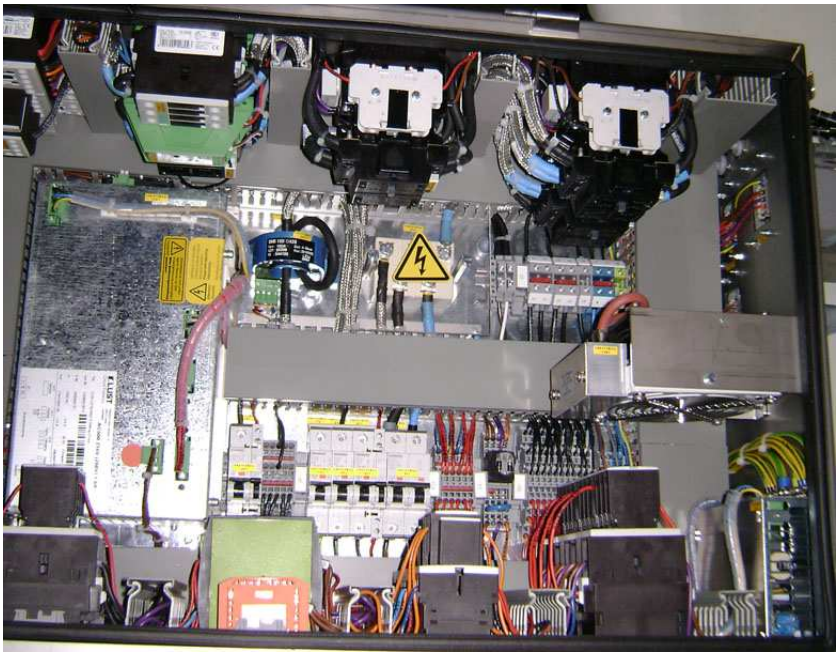


Fig. 6.5.9 – 6 Interior of converter box +2BVU

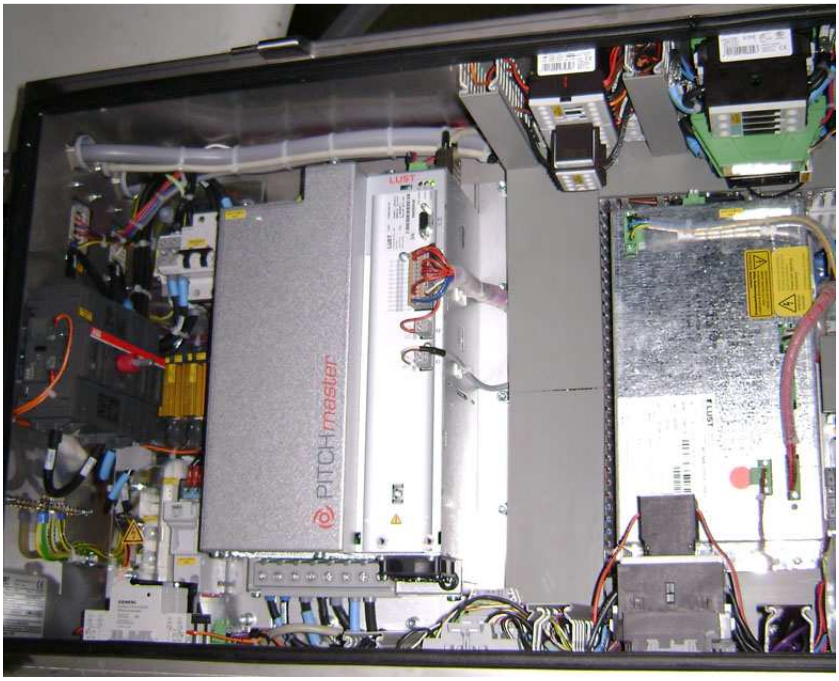



Fig. 6.5.9. – 7 Interior of converter box +2BVU

7. Check the screw connections of all grid and rechargeable battery voltage connections for their tight fit.
8. Attach the cover of converter box +2BVU to the hinges while taking the safety instructions for converter box +1BVU into consideration and close it.

**Converter box +3BVU**

9. Open the cover of converter box +3BVU while taking the safety instructions for converter box +1BVU into consideration, remove it from the hinges, and put it to the side.

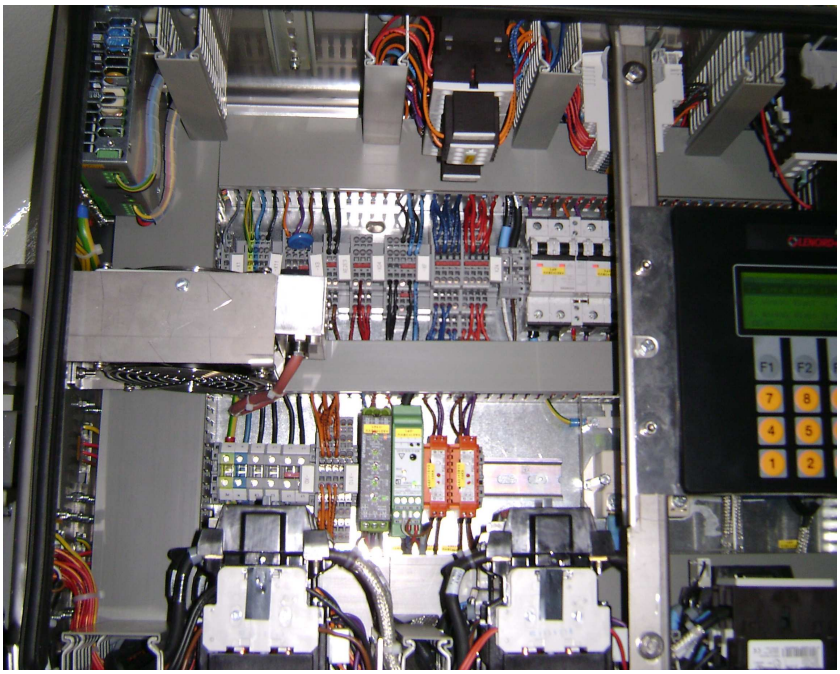


Fig. 6.5.9 – 8 Interior of converter box +3BVU


Fig. 6.5.9 – 9 Interior of converter box +3BVU

10. Check the screw connections of all grid and rechargeable battery voltage connections for their tight fit.
11. Attach the cover of converter box +3BVU to the hinges while taking the safety instructions for converter box +1BVU into consideration and close it.
12. Search the rotor area for loose components.

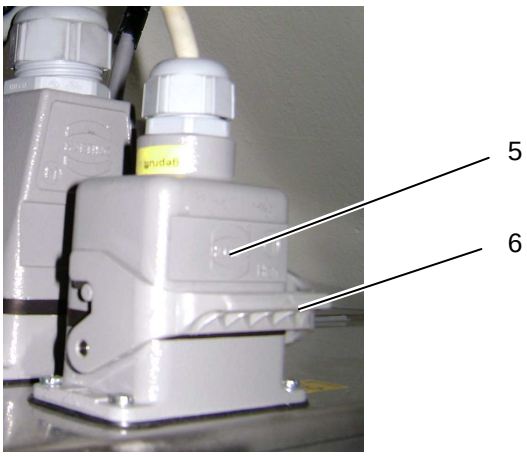



Fig. 6.5.9 – 10 Harting plug

13. Reconnect the Harting plugs (5) of the rechargeable battery boxes and secure them by means of the locking brackets (6).
14. Reactivate the power supply of the hub and rechargeable battery boxes.
15. Remove the tools and other loose components from the rotor area after completing the maintenance work.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

### 6.5.9.1 Controlling the battery voltage monitor for rechargeable pitch batteries (MM92)

**Required tools / operating and auxiliary means:**

- Test box HSP 500 and adapter cable with Harting plug and safety laboratory plug
- Multimeter
- Red permanent marker
- Datasheet of the battery voltage monitor (ref. annex)

**Directive:**

**Note:** The test box HSP 500 must be used because it offers the benefit of an adjustable output voltage up to 500V DC in combination with a high internal resistance. As a result, the output current remains below 10mA. While this current is above the perception threshold, health risks are excluded. However:

**The respective voltages may amount up to 500V DC, avoid touching.**

1. Use a key to set the service switch at the top box to "I" and remove the key.

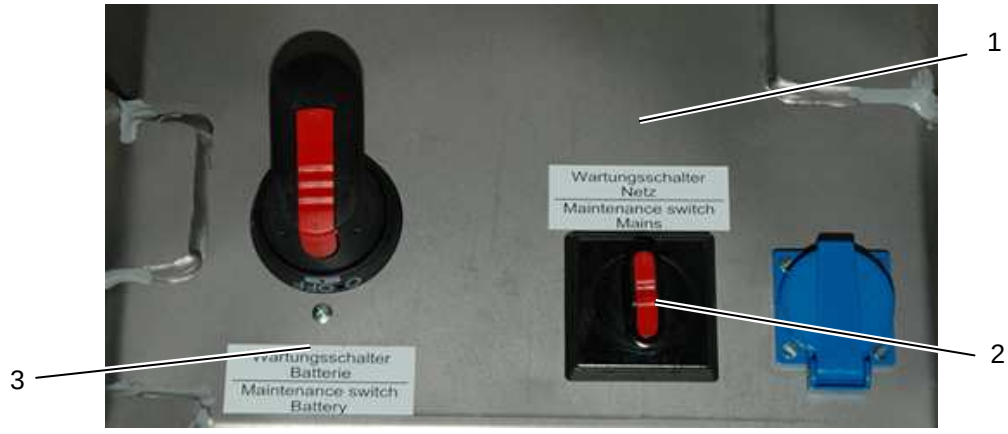



Fig. 6.5.9.1 – 1 Maintenance switch

2. Set the grid maintenance switch (2) at the converter box +1BVU (1) to "OFF".
3. All battery maintenance switches (3) remain switched on.


Fig. 6.5.9.2 - 2 Key for opening the hub box

**NOTICE** **The hub box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**

4. Open the covers of all three converter boxes (+1BVU, +2BVU, and +3BVU) with the key (4) and put them to the side in a safe manner.

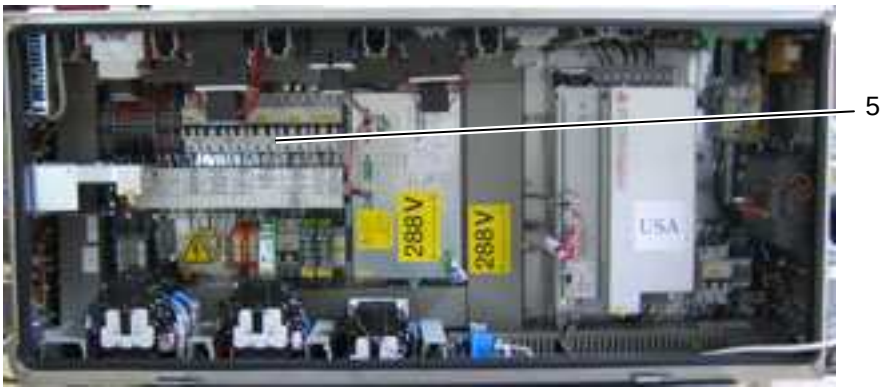



Fig. 6.5.9.2 – 3 Converter box +2BVU

5. Set the secondary circuit breaker 2F2 (5) of the charger at the converter box +2BVU to "OFF".


Fig. 6.5.9.1 – 4 Converter box +1BVU

6. Remove the plug X18 (6) for the 24V voltage supply from the converter (7).
7. Remove the Harting plug labeled with "M" from the converter box +1BVU.
8. Connect the adapter cable with the Harting plug first to the multimeter

while taking the polarity into consideration.

9. Connect the Harting plug of the adapter cable to the socket "M" of the converter box +1BVU.
10. Confirm the deactivation of the current in the direct current range.
11. If the deactivation of the current has been determined: Remove the adapter cable with the Harting plug from the multimeter and connect it to the test box while taking the polarity into consideration.
12. Connect the multimeter parallel to the test box HSP 500 for the exact voltage measurement.

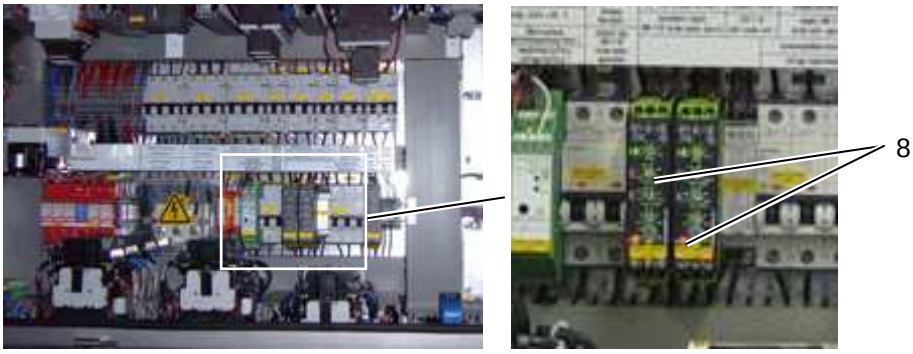



Fig. 6.5.9.1 - 5 Battery voltage monitor (6) in converter box +1BVU

**Note:** The connection of the test box HSP 500 occupies the following connection terminals at the battery voltage monitors (8).

F3: + from the test box HSP 500
E - from the test box HSP 500

**Testing the insufficient voltage monitoring – function U (battery voltage monitor G2UM300VL20)**

13. The parameter values of the battery voltage monitor are detailed in the circuit diagram. A tolerance of +/- 2V is permissible for the detailed voltage values.
14. Check the function and time settings.

**Note:** The green LED "U/t" is continuously lit and indicates operational readiness.

15. Slowly increase the output voltage $U_a$ of the test box HSP 500 until the red LED "min" of the battery voltage monitor switches off and the yellow LED lights up.
16. Determine the voltage at the multimeter. The determined value represents the max.
17. Document the determined value under "Notes" in the service booklet.
18. Slowly lower the output voltage $U_a$ of the test box HSP 500 until the red LED "min" lights up and the yellow LED switches off.
19. Determine the voltage at the multimeter. The determined value represents the min.
20. Document the determined value under "Notes" in the service booklet.
21. In case of deviations of the min. and max. values from the specifications

in the circuit diagram: Adjust the battery voltage monitor accordingly, repeat the test, and also document the new values in the service booklet if applicable.

22. If the potentiometers have been readjusted: Seal the potentiometers with a red permanent marker.

**Testing the surge monitoring – function O (battery voltage monitor G2UM500VL10)**

23. The parameter values of the battery voltage monitor are detailed in the circuit diagram. A tolerance of +/- 2V is permissible for the detailed voltage values.
24. Check the function and time settings.

**Note:** The green LED "U/t" is continuously lit and indicates operational readiness.

25. Slowly increase the output voltage $U_a$ of the test box HSP 500 until the red LED "max" flashes (if a delay has been set) or lights up (if no delay has been set).
26. Determine the voltage at the multimeter. The determined value represents the max.

**Note:** The yellow LED switches off and the red LED "max" lights up once the delay has ended.

27. Document the determined value under "Notes" in the service booklet.
28. Slowly lower the output voltage $U_a$ of the test box HSP 500 until the yellow LED of the battery voltage monitor lights up and the red LED "max" switches off.
29. Determine the voltage at the multimeter. The determined value represents the min.
30. Document the determined value under "Notes" in the service booklet.
31. In case of deviations of the min. and max. values from the specification in the circuit diagram: Adjust the battery voltage monitor accordingly, repeat the test, and also document the new values in the service booklet if applicable.
32. If the potentiometers have been readjusted: Seal the potentiometers with a red permanent marker.
33. If there are doubts regarding the operational reliability of the battery voltage monitor: Replace the battery voltage monitor, perform the settings, and repeat the measurement in the manner detailed above.
34. Remove the adapter cable with the Harting plug from the converter box +1BVU and the test box.
35. Reconnect the plug X18 (6) for the 24V voltage supply to the converter (7).
36. Reconnect the Harting plug to the socket "M" of the converter box +1BVU and secure it with the locking bracket.
37. Repeat steps 6 through 36 for the converter boxes +2BVU and +3BVU.


Fig. 6.5.9.1 - 6 Converter box +3BVU

38. In order to access the battery voltage monitors at converter box +3BVU, first open the operating panel (9) of the L&B controller. Secure it again after completing the maintenance work.
39. Reactivate the secondary circuit breaker 2F2 (5) of the charger at the converter box +2BVU.

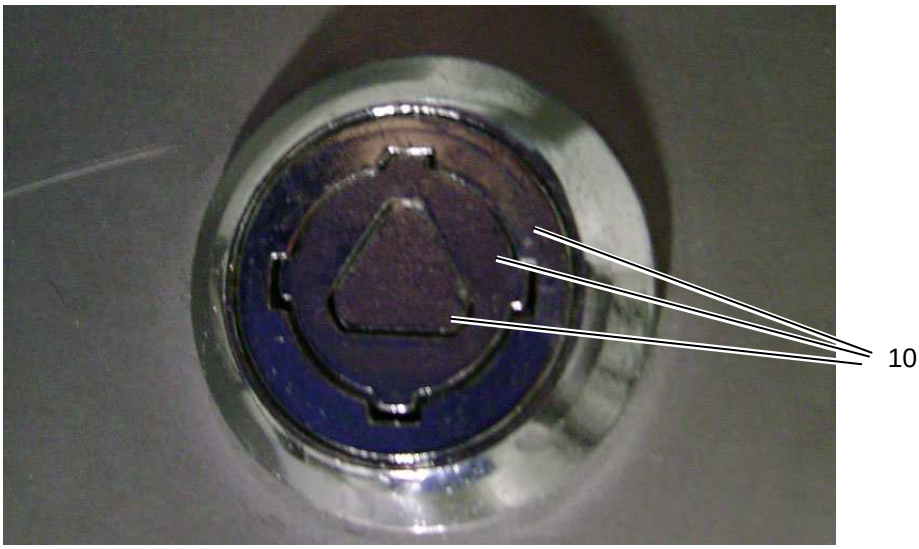



Fig. 6.5.9.1 - 7 Closure of the hub box

40. Attach the covers of the converter boxes to the hinges while taking the markings into consideration and close them.

**Note:** All elements (6) of the hub box cover closures need to be flush to each other.

**NOTICE** **Closures that have not been properly locked may come loose during the operation of the wind turbine. A loose hub box cover may cause severe damage.**

41. Reset the grid maintenance switch (2) at the hub box +1BVU (1) to "ON".
42. Remove the equipment and other loose components from the rotor hub after completing the maintenance work.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.5.10 Inspecting the rechargeable battery boxes

**Required tools / operating and auxiliary means:**

- Flashlight
- Key to open the hub boxes (fig. 6.5.10 – 2)
- Insulated electrician tools

**Directive:**


Fig. 6.5.10 – 1 Maintenance switch

1. Set the maintenance switches grid (1) and the maintenance switches battery (2) at all hub and rechargeable battery boxes to "OFF".
2. Disconnect all Harting plugs (9) (fig. 6.5.10 – 5) from the rechargeable battery boxes.

**⚠ DANGER Risk of life: The rechargeable battery boxes (label: +1BVA, +2BVA, and +3BVA) are permanently connected to 288 V DC! Do not touch metallic components without insulation! Work at electrical systems may only be realized by skilled electricians.**


Fig. 6.5.10 – 2 Key for opening the hub boxes

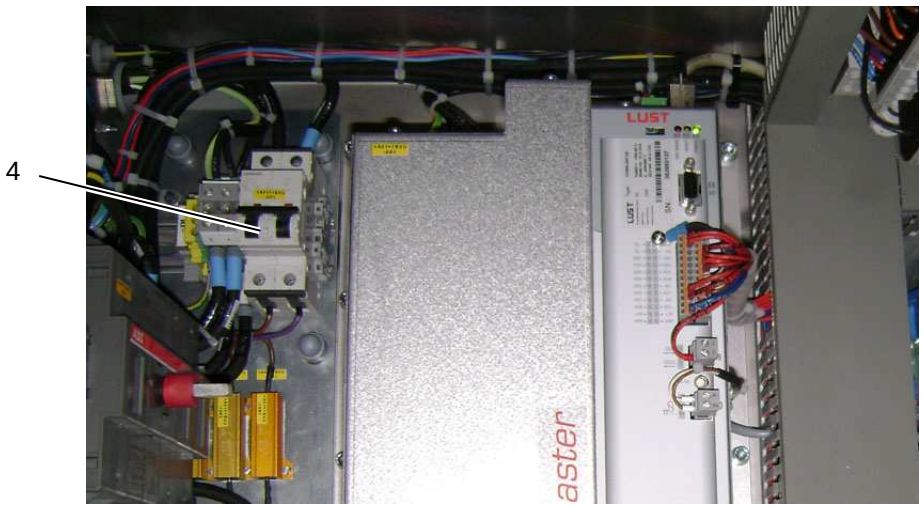



Fig. 6.5.10 – 2 Converter box +1BVU

**NOTICE** **The hub box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**

3. Open the cover of converter box +1BVU with the key (3) and put it to the side in a safe manner.
4. Set the automatic circuit breaker (4) of the battery charger to OFF.
5. Open the cover of the first rechargeable battery box with the key (3) and put it to the side in a safe manner.


Fig. 6.5.10 – 3 Interior of the rechargeable battery box

6. Perform a visual inspection of the components of the rechargeable battery box, check for charred cables.
7. Check for heat build-up.
8. Check the cable bridges (6) for their tight fit.
9. Use the grips (7) to check the tight fit of the four rechargeable battery packs.
10. Evaluate the overall condition of the rechargeable battery box.
11. Document noticeable problems including the rechargeable battery box identification in the service booklet.

12. Attach the rechargeable battery box cover to the hinges and close it.

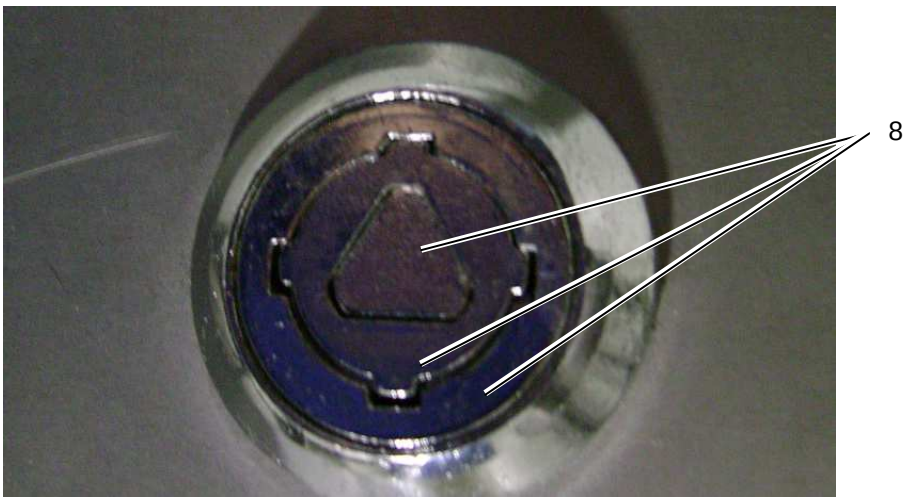



Fig. 6.5.10 – 4 Closure of the hub boxrs

**Note:** All elements (8) of the hub boxes closures need to be flush to each other.

**NOTICE** **Closures that have not been properly locked may come loose during the operation of the wind turbine.**

13. Repeat maintenance steps 5 through 12 for the other two rechargeable battery boxes.

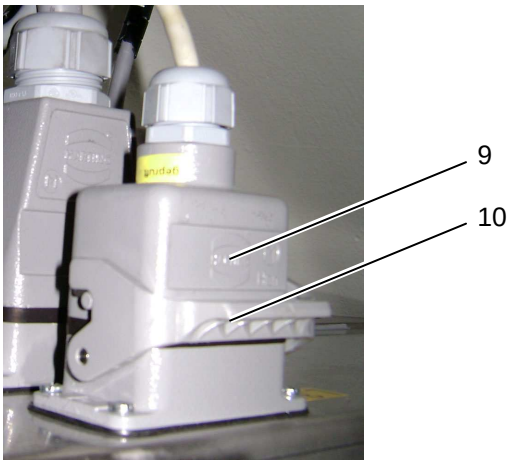



Fig. 6.5.10 – 5 Harting plug

14. Reconnect all Harting plugs (9) of the rechargeable battery boxes and secure them by means of the locking brackets (10).
15. Reactivate the power supply of the hub and rechargeable battery boxes.
16. Set the automatic circuit breaker (4) of the battery charger back to ON.
17. Attach the cover of converter box +1BVU to the hinges and close it.

**Note:** All elements (8) of the hub boxes closures need to be flush to each other.

18. Remove the tools and other loose components from the rotor hub after completing the maintenance work.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.5.11 Inspecting the surge protection elements

**Required tools / operating and auxiliary means:**

- Flashlight
- Insulated electrician tools

**Directive:**


Fig. 6.5.11 – 1 Converter box

1. Set the maintenance switches grid (1) and the maintenance switches battery (2) at all hub and rechargeable battery boxes to "OFF". 1

**DANGER** **Risk of life: The rechargeable battery boxes (label: +1BVA, +2BVA, and +3BVA) are permanently connected to 288 V DC! Do not open! Work at electrical systems may only be realized by skilled electricians.**

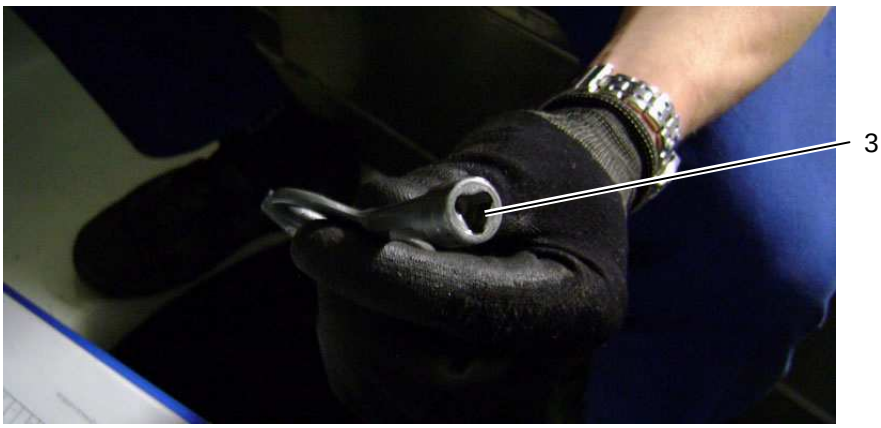



Fig. 6.5.11 – 2 Key for opening the hub boxes

**NOTICE** **The hub box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**

2. Use the key (3) to open the cover of converter box +3BVU (all other hub and rechargeable battery boxes remain closed), put to the side in a safe manner.


Fig. 6.5.11 – 3 Interior of converter box +1BVU


Fig. 6.5.11 – 4 Surge protection elements in converter box +1BVU

3. Control of the surge protection elements (4).
4. If the control panel (5) of the surge protection element is green, it has not been triggered.
5. If the control panel (5) of the surge protection element is red, it will need to be replaced.

**DANGER** **Work at electrical systems may only be performed by skilled electricians.**

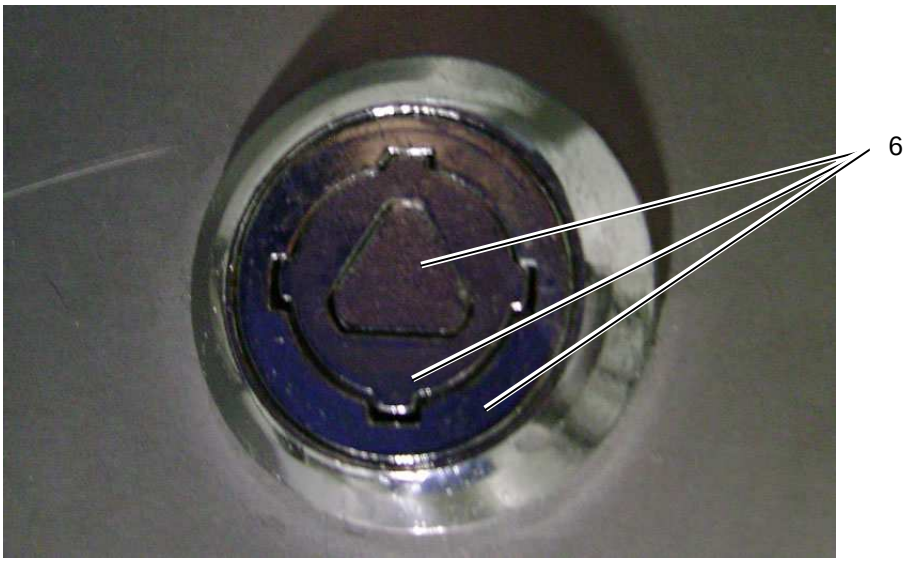



Fig. 6.5.11 – 5 Closure of the hub boxes

6. Attach the converter box cover to the hinges and close it.

**Note:** All elements (6) of the hub boxes closures need to be flush to each other.

**NOTICE** **Closures that have not been properly locked may come loose during the operation of the wind turbine. A loose hub box cover may cause severe damage.**

7. Reactivate the power supply of the hub and rechargeable battery boxes.
8. Search the rotor area for loose components.
9. Remove the tools and other loose components from the rotor area after completing the maintenance work.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.5.12 Checking the setting and the function of the limit switch

**Required tools / operating and auxiliary means:**

- Key for hub boxes (ref. fig.6.5.12 – 1)
- Flashlight
- Ratchet with extension
- No. 13 box nut
- Cloth

**Directive:**

The cooperation of two service technicians is required for this maintenance section. This maintenance section should be processed after 6.5.15.

**Directive for the skilled electrician that operates the pitch system in converter box +3BVU (labeled on the cover of the hub box):**


Fig. 6.5.12 – 1 Key for opening the hub boxes

NOTICE **The hub box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**

1. Use the key (2) to open the cover of converter box +3BVU only; all other converter and rechargeable battery boxes remain closed

⚠ DANGER **A voltage supply of the hub boxes is required for the function of the pitch system. Do not touch metallic components without insulation!**


Fig. 6.5.12 – 2 Service switch in converter box +3BVU

2. Set the service switch (2) in converter box +3BVU (below the operating panel of the control) to "ON"


Fig. 6.5.12 - 3 Control of the pitch system

3. Access the menu via M1 (3)
4. Select a blade by means of M2, M3, or M4 (4)
5. Now the assignment of keys F1 through F5 (5) (ref. display) changes in the following manner:

| << | < | [REF] | > | >> |
|---|---|---|---|---|
| F1 | F2 | F3 | F4 | F5 |

<< Quick counter-clockwise turning
< Slow counter-clockwise turning
[REF] Modifies the blade pitch settings (do not use;if this field is accidentally activated, use "Esc" (6) to return to the previous menu)
> Slow clockwise turning
>> Quick clockwise turning


Fig. 6.5.12 – 4 Display of the control of the pitch system

6. Use the F keys to turn the rotor blade to an [A] value (7) of 90°

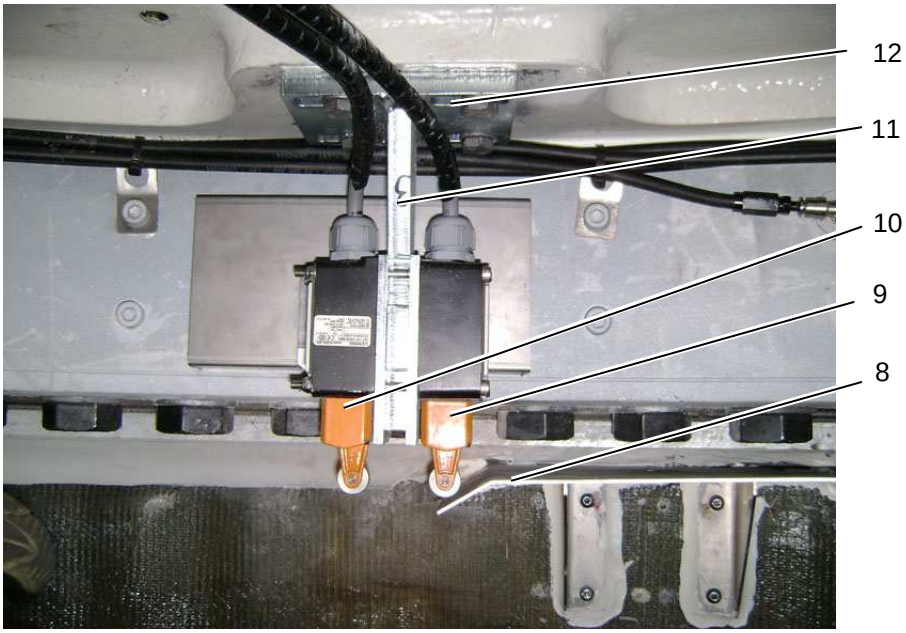



Fig. 6.5.12 – 5 Limit switch

7. The 92°switch (9) needs to directly touch the b lade pitch ramp (8) without being activated at a blade pitch of 90°(7).
8. If that – as shown in fig. 6.5.12 – 5 – is not the case, release the screws of the mount (11) and adjust the correct position via the slotted holes (12).
9. Re-tighten the screws.

10. If the limit switch was correctly positioned, only check the tight fit of the mount (11) and the switches 92°(9) as well as 95° (10).
11. Check the ease of movement of the switches 92° and 95°(lever and roller).
12. Clean sluggish switches.
13. Manually trigger the 95°limit switch (10).
14. Activate M1 (3) of the control and use it to return to the "Main window (blades)".
15. Select the next blade by means of M2, M3, or M4 (4).
16. Repeat all steps 6 through 15 and/or 14 for the other two rotor blades.
17. Set the service switch (2) to "OFF" after completing the work.
18. Attach the hub box cover to the hinges and close it.

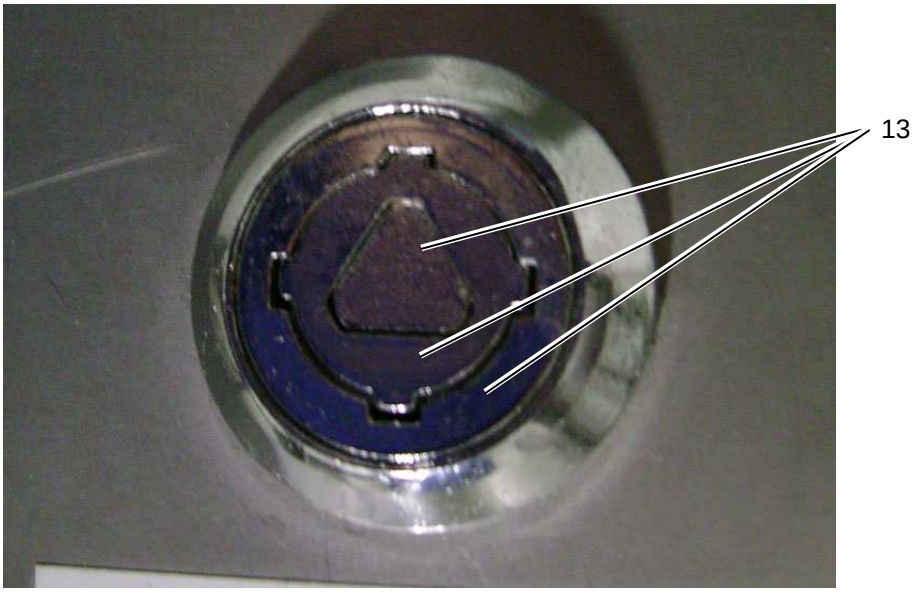



Fig. 6.5.12 – 6 Closure of the hub boxes

All elements (13) of the hub boxes closures need to be flush to each other.

**NOTICE** **Closures that have not been properly locked may come loose during the operation of the wind turbine. A loose hub box cover may cause severe damage.**

19. Search the rotor area for loose components.
20. Remove loose components.
21. Remove all tools from the hub.
22. Dispose of soiled cloths in the proper manner.
23. Exit the rotor hub.
24. Evaluate the protocol of the REguard control B for all three rotor blades and document the result in the service booklet.
25. REguard Monitoring: Select Reports menu → Status menu (16).

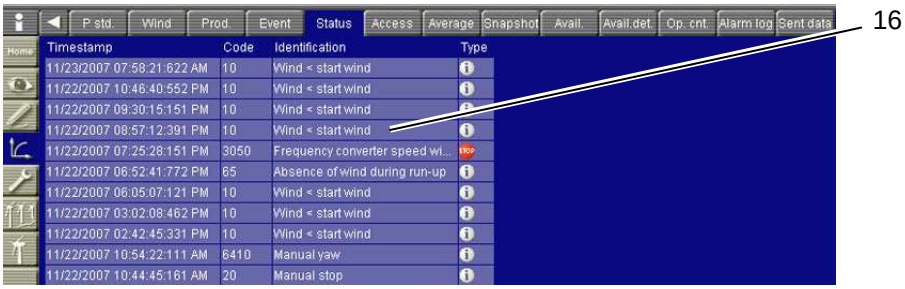



Fig. 6.5.12 – 7 REguard Monitoring

26. The Status menu needs to contain a message that the limit switch 95° and consequently the safety chain has been triggered.
27. Perform a RESET of the wind turbine (ref. operating manual).

## 6.5.13 Checking the IVO sensor for function and tight fit

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- No. 13 ring spanner or jaw wrench
- Key for hub boxes (ref. fig.6.5.13 – 3)
- Flashlight
- Cloth

**Directive:**

**Note**: The cooperation of two service technicians is a mandatory requirement for this maintenance section.

**Note:** Complete this maintenance section together with 6.4.5, 6.4.9, and 6.5.14.


Fig. 6.5.13 - 1 Gearing cover of the blade bearing

**⚠ CAUTION Risk of injuries: Ensure suitable personal protection while removing the upper shell (1).**

1. Remove the screws (3) of the gearing cover (1, 2).
2. Safely store the screws, nuts, and washers.
3. You must find components that have fallen down.

**NOTICE Loose components cause severe damage during the opera-**

**tion of the wind turbine.**

4. Carefully raise the upper shell (1) and store it in a secure manner.


Fig. 6.5.13 – 2 IVO sensor

5. Check the IVO sensor (4) for a tight fit.

**Note:** The pinion (5) of the IVO sensor (4) should be in contact with the cog wheel of the blade bearing without clearance, but also without tension.

6. If the pinion is incorrectly positioned, release the screw connection of the socket (6).
7. Correctly position the IVO sensor (4) via the slotted holes in the socket (6).

**Directive for the skilled electrician that operates the pitch system in converter box +3BVU (labeled on the cover of the hub box):**


Fig. 6.5.13 – 3 Key for opening the hub box

NOTICE **The converter box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**

8. Use the key (7) to open the cover of converter box +3BVU only (all other hub and rechargeable battery boxes remain closed), put to the side in a safe manner.

⚠ DANGER **A voltage supply of the hub boxes is required for the function of the pitch system. Do not touch metallic components without insulation!**


Fig. 6.5.13 – 4 Service switch in converter box +3BVU

9. Set the service switch (8) in converter box +3BVU (below the operating panel of the control) to "ON".


Fig. 6.5.13 - 5 Control of the pitch system

10. Access the menu via M1 (9).
11. Select a blade by means of M2, M3, or M4 (10).
12. Now the assignment of keys F1 through F5 (11) (ref. display) changes in the following manner:

| << | < | [REF] | > | >> |
|---|---|---|---|---|
| F1 | F2 | F3 | F4 | F5 |

<< Quick counter-clockwise turning
< Slow counter-clockwise turning
[REF] Modifies the blade pitch settings (do not use; if this field is accidentally activated, use "Esc" (12) to return to the previous menu)
> Slow clockwise turning
>> Quick clockwise turning

13. Rotate the rotor blade by means of the F keys (11) (consult the second service technician).


Fig. 6.5.13 – 6 Display of the control of the pitch system

**Note:** If the [B] value (13) changes as the rotor blade is turned, the IVO sensor functions correctly.

**Note:** The [B] value may deviate by no more than 0.2° from the [A] value.

**Directive for the second service technician**

**⚠ WARNING Risk of contusions due to rotating system components: Do not reach into the gearing under any circumstances while turning the rotor blade. Always consult the skilled electrician.**

14. Remove excess lubrication grease with a cloth.
15. Document defects in the service booklet.
16. Reassemble the upper shell of the gearing cover (1) (fig. 6.5.13 – 1).

**Directive for the skilled electrician:**

17. Following the feedback from the second specialist, use the F keys (10) to let the rotor blade turn to the 87° position.
18. Activate M1 (7) of the control and use it to return to the "Main window (blades)".
19. Select the next blade by means of M2, M3, or M4 (8).
20. Repeat steps 10 through 19 and/or 18 for the other two rotor blades.
21. Set the service switch (6) to "OFF" after completing the work.

22. Attach the converter box cover to the hinges and close it.

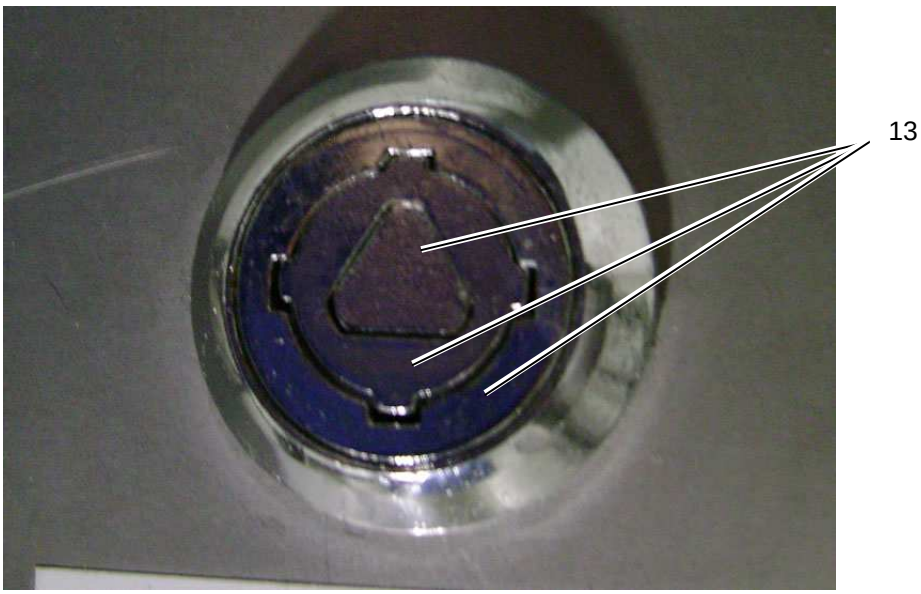



Fig. 6.5.13 – 7 Closure of the hub boxes

**Note:** All elements (13) of the hub boxes closures need to be flush to each other.

**NOTICE** **Closures that have not been properly locked may come loose during the operation of the wind turbine. A loose hub box cover may cause severe damage.**

23. Search the rotor hub area for loose components.
24. Remove loose components.
25. Remove all tools from the hub.
26. Dispose of used cloths in the proper manner.

## 6.5.14 Performing a full turn of the blade

**Required tools / operating and auxiliary means:**

- Key for hub boxes (ref. fig.6.5.13 – 1)
- Flashlight
- Cloth

**Directive:**

**Note:** Complete this maintenance section together with 6.4.5, 6.4.9, and 6.5.13.


Fig. 6.5.14 – 1 Key for opening the hub boxes

**NOTICE** **The hub box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**

1. Use the key (1) to open the cover of converter box +3BVU only (all other hub and rechargeable battery boxes remain closed), put to the side in a safe manner.

**⚠ DANGER** **Risk of electric shocks. A voltage supply of the hub boxes is required for the function of the pitch system. Do not touch live components! Work at electrical systems may only be performed by skilled electricians.**


Fig. 6.5.14 – 2 Service switch in converter box +3BVU

2. Set the service switch (2) in hub box 3 BVU (below the operating panel of the control) to "ON".


Fig. 6.5.14 - 3 Control of the pitch system

3. Access the menu via M1 (3).
4. Select a blade by means of M2, M3, or M4 (4).
5. Now the assignment of keys F1 through F5 (5) (ref. display) changes in the following manner:

| << | < | [REF] | > | >> |
|---|---|---|---|---|
| F1 | F2 | F3 | F4 | F5 |

<< Quick counter-clockwise turning
< Slow counter-clockwise turning
[REF] Modifies the blade pitch settings (do not use; if this field is accidentally activated, use "Esc" (6) to return to the previous menu)
> Slow clockwise turning
>> Quick clockwise turning

6. Rotate the rotor blade by means of the F keys (5) (consult the other service technicians).


Fig. 6.5.14 – 4 Display of the control of the pitch system

7. Turn the blade a total of 330° forward and backw ard.
8. Use the F keys (5) to turn the rotor blade back to 87° after completing the inspection.
9. Activate M1 (3) of the control and use it to return to the "Main window (blades)".
10. Select the next blade by means of M2, M3, or M4 (4).
11. Repeat steps 3 through 10 and/or 9 for the other two rotor blades.
12. Set the service switch (2) to "OFF" after completing the work.
13. Attach the converter box cover to the hinges and close it.

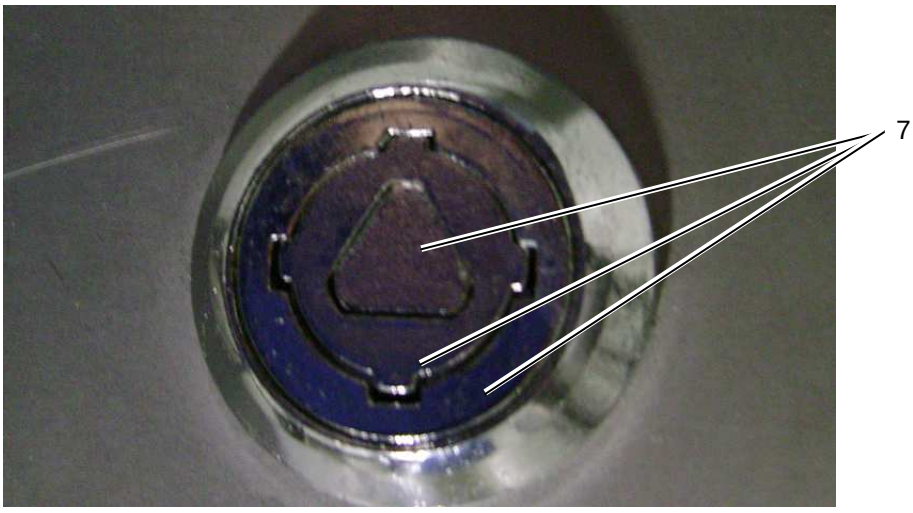



Fig. 6.5.14 - 5 Closure of the hub box

14. All elements (7) of the hub box closures need to be flush to each other.

**NOTICE** **Closures that have not been properly locked may come loose during the operation of the wind turbine. A loose hub box cover may cause severe damage.**

15. Search the rotor area for loose components.
16. Remove loose components.
17. Remove all tools from the hub.
18. Dispose of soiled cloths in the proper manner.

## 6.5.15 Checking the blade setting

**Required tools / operating and auxiliary means:**

- Key for hub boxes (ref. fig.6.5.15 – 1)
- Curved needle-nosed pliers
- Flashlight
- Cloth

**Directive:**

**Note:** The cooperation of two service technicians is required for this maintenance section.


Fig. 6.5.15 – 1 Key for opening the hub boxes

NOTICE **The hub box covers are not secured in the hinge. Accordingly, they need to be removed from the hinge and put to the side in a safe manner.**

1. Use the key (1) to open the cover of converter box +3BVU only (all other hub and rechargeable battery boxes remain closed), put to the side in a safe manner.

⚠ DANGER **A voltage supply of the hub boxes is required for the function of the pitch system. Do not touch metallic components without insulation!**


Fig. 6.5.15 – 2 Service switch in converter box +3BVU

2. Set the service switch (2) in converter box +3BVU (below the operating panel of the control) to "ON".


Fig. 6.5.15 - 3 Control of the pitch system

3. Access the menu via M1 (3).
4. Select a blade by means of M2, M3, or M4 (4).
5. Now the assignment of keys F1 through F5 (5) (ref. display) changes in the following manner:

| << | < | [REF] | > | >> |
|---|---|---|---|---|
| F1 | F2 | F3 | F4 | F5 |

<< Quick counter-clockwise turning
< Slow counter-clockwise turning
[REF] Modifies the blade pitch settings (if this field is accidentally activated, use "Esc" (6) to return to the previous menu)
> Slow clockwise turning
>> Quick clockwise turning


Fig. 6.5.15 – 4 Display of the control of the pitch system

6. Turn the active sensor [A] (7) of the rotor blade via the F keys (6) to 0° (consult the other service technicians).


Fig. 6.15.15 – 5 Using the blade gage

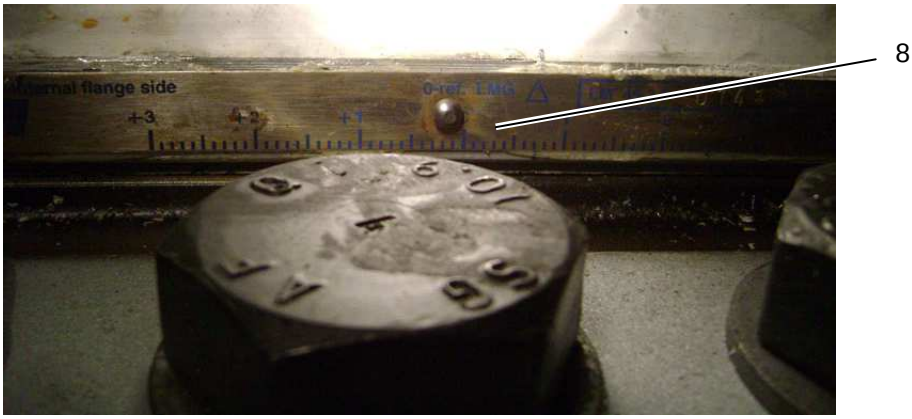



Fig. 6.15.15 – 6 Hub indication

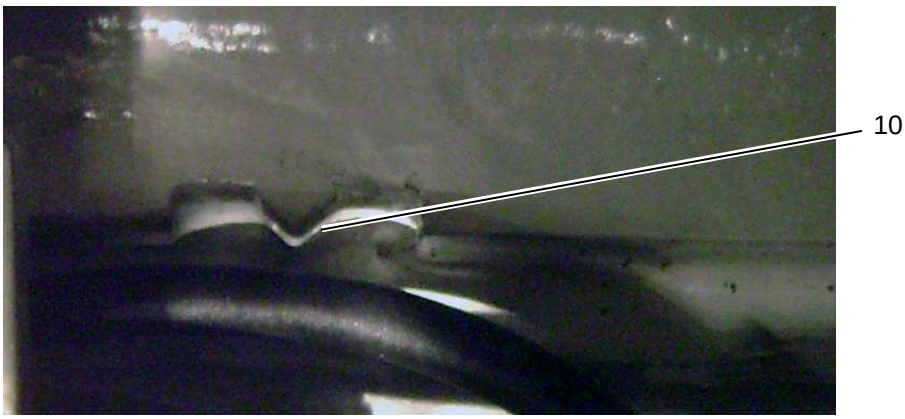



Fig. 6.15.15 – 7 REpower hub indication

7. Use the blade gage (9) for the B hub at the slot of the REpower hub indication (10).
8. Retrieve the blade gage (9) value at the hub indication of the rotor blade manufacturer (8) and document it in the service booklet.

**Note:** If the retrieved value corresponds to the nominal value as detailed in the service booklet, the directives for the calibration of the rotor blade may be skipped.

**Calibrating the rotor blade pitch:**

9. Move the rotor blade via the keys F2 or F4 (5) of the control until the blade gage displays the nominal value as detailed in the service booklet.

**Note:** The nominal value may deviate from 0° in case of the rotor blades by the company LM!

10. Now select F3 (5) at the control.
11. Confirm "Yes" in order to calibrate the newly adjusted zero value.

**Calibrating the end rotor blade pitch**

**Note:** The new adjustment of the rotor blade may have modified the trigger value of the limit switches 92° / 95°. This needs to be checked (ref. maintenance section 6.5.12).

12. Use the F keys (5) to turn the rotor blade back to 87° after completing the inspection.
13. Activate M1 (3) of the control and use it to return to the "Main window (blades)".
14. Select the next blade by means of M2, M3, or M4 (4).
15. Repeat steps 3 through 14 and/or 13 for the other two rotor blades.
16. Set the service switch (2) to "OFF" after completing the work.
17. Attach the converter box cover to the hinges and close it.

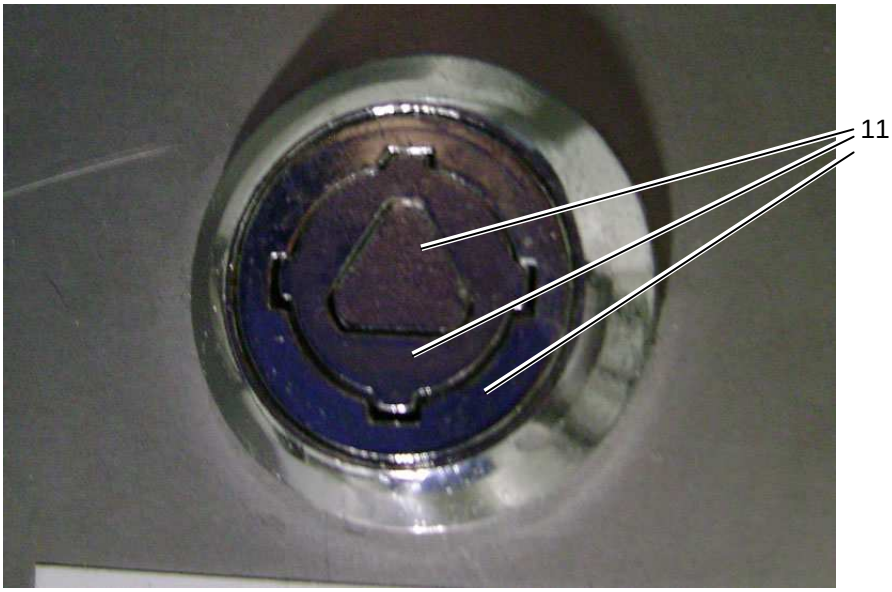



Fig. 6.5.15 - 8 Closure of the hub boxes

**Note:** All elements (11) of the hub boxes closures need to be flush to each other.

**NOTICE** **Closures that have not been properly locked may come loose during the operation of the wind turbine. A loose hub box cover may cause severe damage.**

18. Search the rotor area for loose components.
19. Remove loose components.
20. Remove all tools from the hub.
21. Dispose of soiled cloths in the proper manner.

# 6.6 Rotor hub MM92

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

**DANGER**

**Risk of life while accessing the rotor hub**

- Move the rotor blade to the V position and engage the rotor lock (ref. operating manual) prior to accessing the hub.
- Activate the service switch and remove the key (ref. operating manual).
- Keep the rotor holding brake closed (ref. operating manual).

**CAUTION**

**Danger due to spatial tightness and rough surfaces in the rotor hub**

- Wear all protective clothing in order to avoid injuries.

**NOTICE**

**Risk of damage to components**

- Do not damage cable and tube connections while working in the rotor hub.
- Report damage.
- A specialist needs to replace damaged cable and tube connections immediately.

## 6.6.1 Tightening the screw connection between pitch gearbox and rotor hub

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 24 box nut

**Directive:**

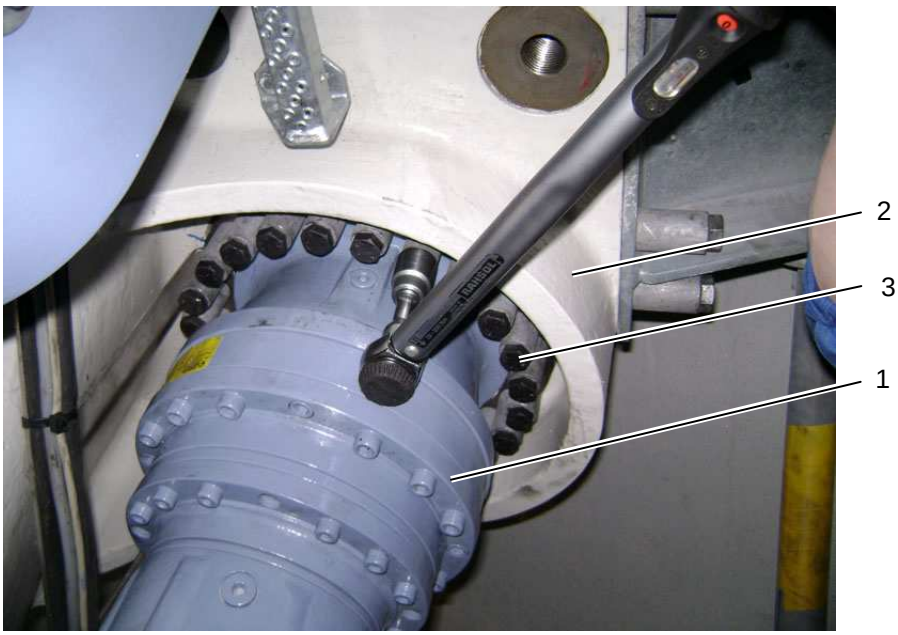



Fig. 6.6.1 - 1 Pitch gearbox

1. Check the screws (3) of the connection between pitch gearbox (1) and rotor hub (2) in accordance with the service booklet.
2. Check the screws of all three pitch motors.
3. Perform a comprehensive search for loose components and remove all tools from the hub prior to exiting the rotor area.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.6.2 Checking the screw connection between hub as well as rechargeable battery boxes and rotor hub

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 24 box nut

**Directive:**

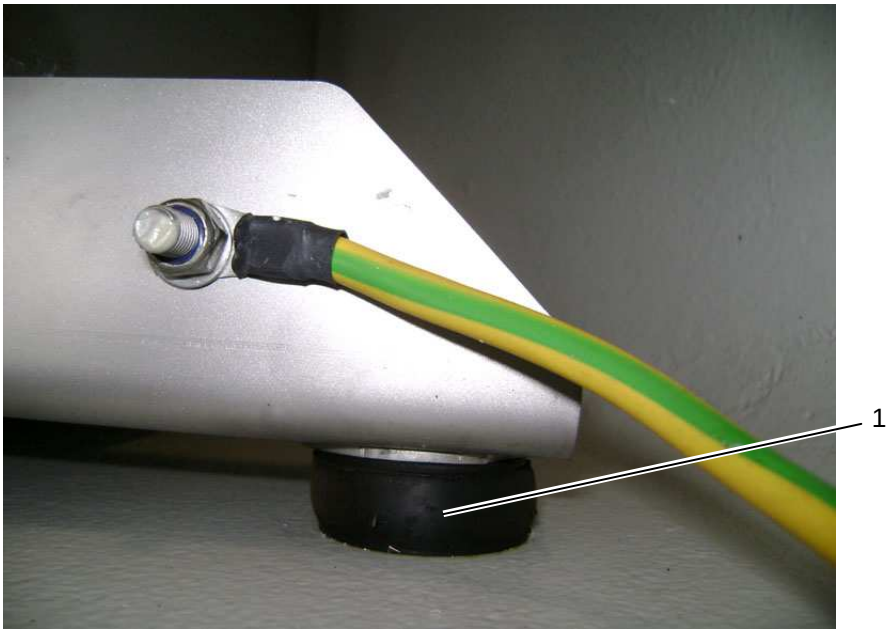



Fig. 6.6.2 – 1 Elastomer bearings of the hub and rechargeable battery boxes

1. Examine elastomer bearings (1) of the hub and rechargeable battery boxes for cracks and damage.
2. Replace damaged elastomer bearings.
3. Document defects in the service booklet.


Fig. 6.6.2 - 2 Hub and rechargeable battery box

4. Check the screws (4) of the connection between all six hub boxes (2) and the rotor hub in accordance with the service booklet.
5. Perform a comprehensive search for loose components and remove all tools from the hub prior to exiting the rotor area.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.6.3 Checking the screw connection between main pitch box and rotor hub

Not used.

## 6.6.4 Checking the screw connection between spinner star and rotor hub

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 36 box nut

**Directive:**

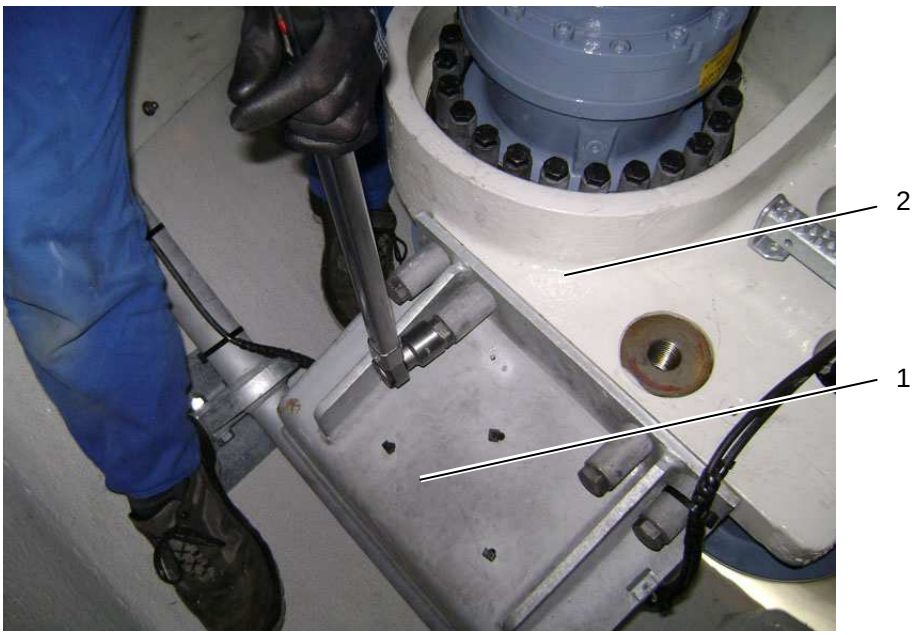



Fig. 6.6.4 - 1 Spinner star

1. Check the screws of the connection between all three spinner stars (1) and the rotor hub (2) in accordance with the service booklet.
2. Perform a comprehensive search for loose components and remove all tools from the hub prior to exiting the rotor area.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.6.5 Tightening the screw connection between spinner retaining bracket windward and spinner star

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 24 box nut

**Directive:**

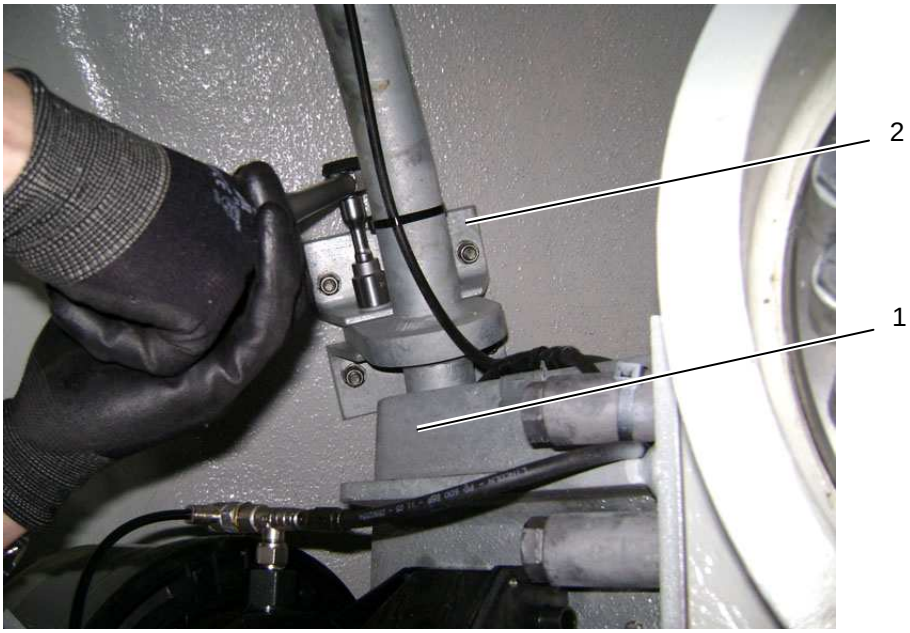



Fig. 6.6.4 – 1 Spinner star

**Note:** The windward side is the side that is located at the hatch to the rotor hub. There are three spinner stars, and there are 2 pcs. spinner retaining bracket (2) windward per spinner star (1).

1. Check the screws of the connection between spinner star (1) and spinner retaining bracket windward (2) in accordance with the service booklet
2. Perform a comprehensive search for loose components and remove all tools from the hub prior to exiting the rotor area.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.6.6 Checking the screw connection spinner mount leeward

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 30 box nut

**Directive:**


Fig. 6.6.6 - 1 Spinner mount leeward


Fig. 6.6.6 – 2 Spinner mount leeward

**Note:** The leeward side is the side that is located on the rotor bearing side.

**CAUTION** **Risk of fall. The spinner mount in the upper range of the rotor hub is difficult to access. Ensure sufficient personal protection.**

1. Check the screws of the connection between the spinner mount leeward (1) and the associated struts (2) and angles (3) in accordance with the service booklet.
2. Perform a comprehensive search for loose components and remove all tools from the hub prior to exiting the rotor area.

**NOTICE** **Loose components cause severe damage during the operation of the wind turbine.**

## 6.6.7 Checking the screw connection between blade bearing cover and rotor hub

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 19 box nut

**Directive:**


Fig. 6.6.7 - 1 Connection element between the blade bearing cover and the rotor hub

**⚠ CAUTION Risk of fall. Some of the connection elements (1) between the blade bearing cover (2) and the rotor hub (3) are difficult to access. Ensure sufficient personal protection.**

1. Check the screws of the connection between blade bearing cover (2) and rotor hub (3) in accordance with the service booklet.
2. Perform a comprehensive search for loose components and remove all tools from the hub prior to exiting the rotor area.

**NOTICE Loose components cause severe damage during the operation of the wind turbine.**

## 6.6.8 Checking the screw connection between the rotor hub and the rotor shaft

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- Edding
- Hydraulic power screwdriver
- No. 55 box nut

**Directive:**

**Note:** Complete this maintenance section together with 6.7.5 "Checking the screw connection between the rotor bearing and the machine base".

1. Engage the rotor lock (ref. operating manual )


Fig. 6.6.8 – 1 Enclosure of the rotor disk

2. Mark the position of the enclosure (1) of the rotor disk (2)


Fig. 6.6.8 - 2 Enclosure of the rotor disk

3. Remove the enclosure (2)
4. Put the enclosure to the side

**⚠ DANGER** Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!


Fig. 6.6.8 – 3 Screw connection between the rotor shaft and the rotor hub

5. Check the accessible screws (3) by means of the hydraulic power screwdriver and a torque as detailed in the service booklet

6. Mark the checked screws

WARNUNG Risk of contusions due to rotating system components. Do not reach into rotating system components.

7. Open the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual)
8. Turn the rotor until the next screws may be accessed
9. Engage the rotor holding brake (ref. operating manual)
10. Engage the rotor lock (ref. operating manual)
11. Repeat steps 5 through 10 until all screws have been checked
12. Reinstall the enclosure (1) of the rotor disk (2) at the original position (observe the indication)

## 6.6.9 Checking the rotor hub for loose components

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

- Perform a comprehensive search for loose components and remove all tools from the hub prior to exiting the rotor area.

NOTICE **Loose components cause severe damage during the operation of the wind turbine.**

## 6.6.10 Greasing the console of the hoisting mechanism

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- Lubrication grease
- 10 pcs. plastic plug for M30 threading

**Directive:**

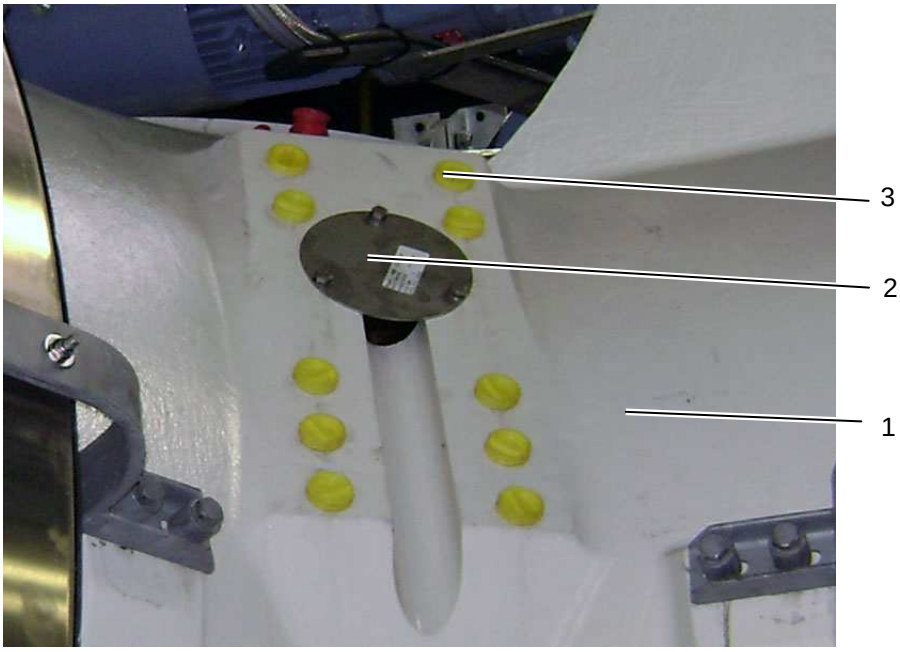



Fig. 6.6.10 - 1 Console of the hoisting mechanism

1. Remove the protective cover (2) from the rotor hub (1).
2. Abundantly grease the center hole located below.
3. Reconnect the protective cover (2).
4. Close the M30 threaded boreholes with plastic plugs (3).
5. Perform a comprehensive search for loose components and remove all tools from the hub prior to exiting the rotor area.

NOTICE **Loose components cause severe damage during the operation of the wind turbine.**

# 6.7 Rotor bearing MM92

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.7.1 Emptying the grease pan

**Required tools / operating and auxiliary means:**

- Narrow scraper (approx. width of 1,5 in (4 cm))
- No. 5 Allen wrench
- Storage container for escaped lubrication grease
- Cloth

**Directive:**

1. If the rotor lock is still engaged, open the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).
2. Locking via the rotor holding brake
3. Put the portable switching device (fig. 6.7.1 – 2) within reach.

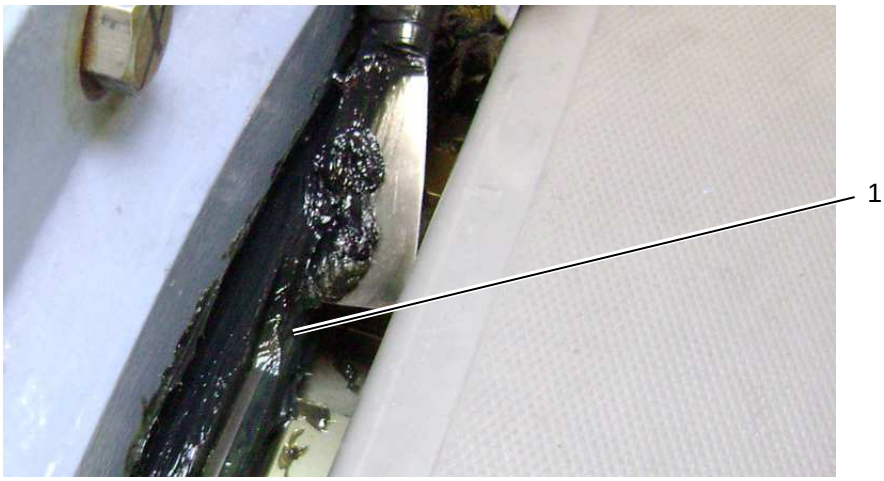



Fig. 6.7.1 – 1 Cleaning the rotor bearing

4. Clean each section of the rotor bearing (1) with a narrow scraper of escaped lubrication grease.
5. Gather escaped grease in a container.

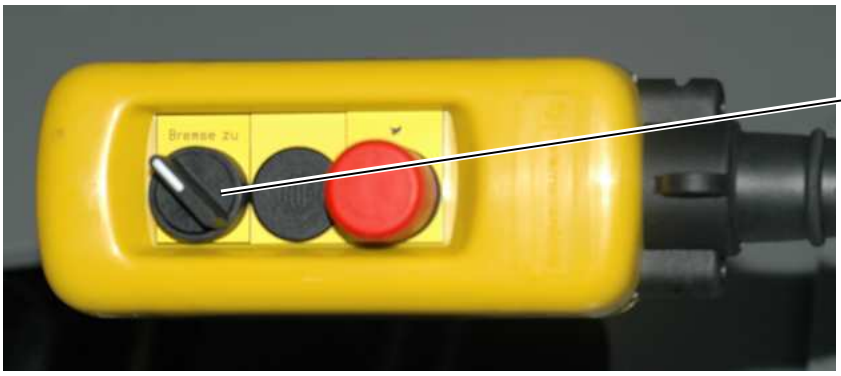



Fig. 6.7.1 – 2 Portable switching device

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

6. After consulting the other service personnel, release the rotor holding brake by means of the portable switching device (2) and let the rotor turn until the next section to be cleaned can be reached.
7. Re-engage the rotor holding brake.
8. Clean the entire circumference of the rotor bearing.
9. Subsequently wipe the rotor bearing with a cloth.
10. Engage the rotor holding brake.

**⚠ CAUTION Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform. Severe falls with head injuries and bruises are possible. Wear a hard hat and descend carefully.**

11. Descend to the inner yaw area.

**⚠ CAUTION Risk of fall due to unstable foothold in the yaw area. Ensure the safe placement of the ladder (ref. chapter 5). Keep both feet on the ladder while working.**


Fig. 6.7.1 – 3 Speed and direction of rotation sensors in the yaw range

12. Carefully clean the proximity sensors (speed and direction of rotation) (3).


Fig. 6.7.1 – 4 Cover grease pan in the yaw area

13. Release and remove the cover of the grease pan (4).

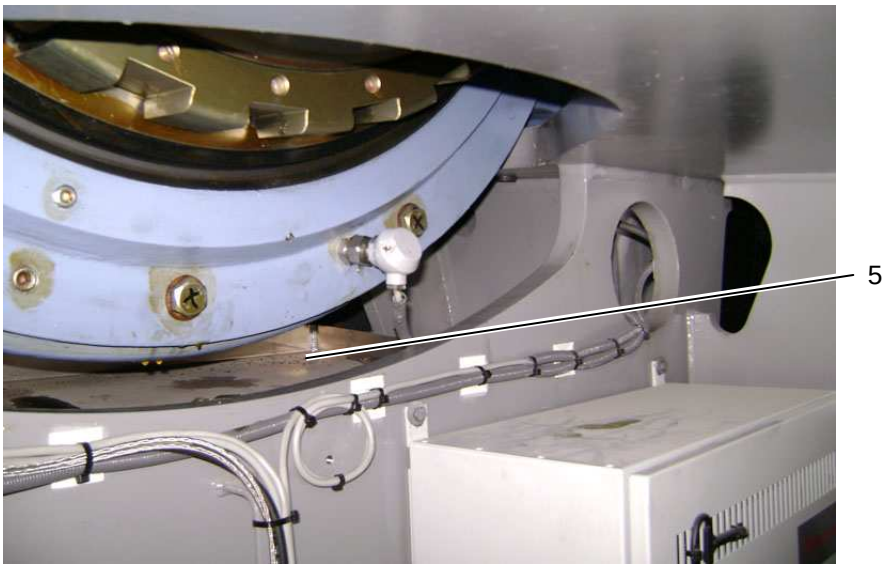



Fig. 6.7.1 – 5 Grease pan in the yaw area

14. Clean the grease pan (5) of the rotor bearing.
15. Re-assemble the cover of the grease pan (4) and ensure not to pinch cables or lines.
16. Evaluate the condition of the escaped lubrication grease and document the following in the service booklet:

    What is the color?
    Does it contain rough contaminations?
    How is its consistency?

17. Estimate the amount of escaped lubrication grease (in lb. (kg)) and document it in the service booklet.
18. Dispose of gathered lubrication grease and soiled cloths in the proper manner.

## 6.7.2 Self-lubrication system rotor bearing – re-filling lubrication grease

**Required tools / operating and auxiliary means:**

- Lubrication grease SKF (max. 6,6 lb. (3 kg))

**Directive:**

**⚠ CAUTION Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform. Severe falls with head injuries and bruises are possible. Wear a hard hat and descend carefully.**

1. Descend to the inner yaw area.

**⚠ CAUTION Risk of fall due to unstable foothold in the yaw area. Ensure the safe placement of the ladder (ref. chapter 5). Keep both feet on the ladder while working.**


Fig. 6.7.2 – 1 Self-lubrication system rotor bearing

2. Remove the blue cover (2) of the storage container (1) of the self-lubrication system.
3. Insert lubrication grease SKF into the storage container (1).
4. Observe the maximum fill level indication on the storage container.
5. Re-attach the blue cover (2).

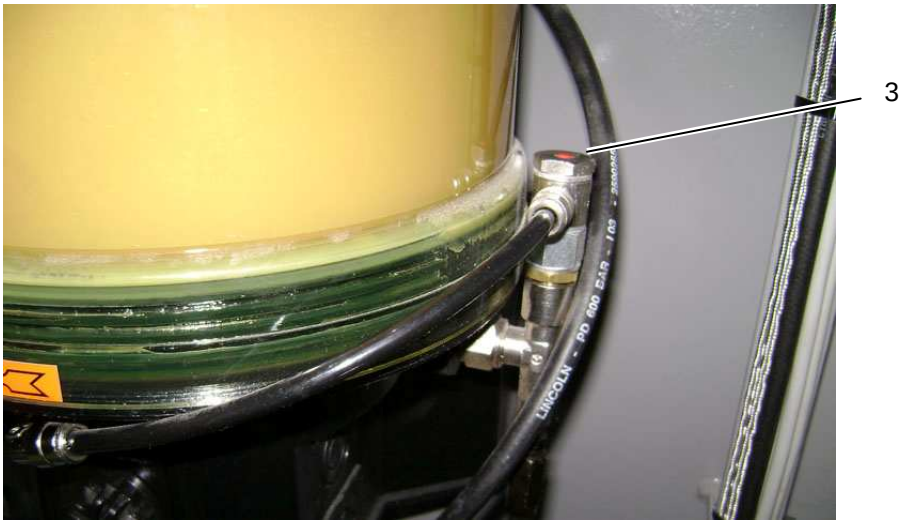



Fig. 6.7.2 – 2 Pressure valve

**Note:** The lubrication grease consumption should amount to approximately 6.6 lb. (3 kg) in 6 months.

6. If the lubrication grease consumption is insufficient, check as to whether the red pin (3) protrudes from the pressure valve.
7. In that case, the lubrication line or a splitter is blocked and needs to be cleaned or replaced.

## 6.7.3 Checking the proximity sensors

**Required tools / operating and auxiliary means:**

- Measuring gage for a gap size 0,079 in. through 0,098 in. (2 through 2.5 mm)
- 2 pcs. No. 24 jaw wrench

**Directive:**

**⚠ CAUTION Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform. Severe falls with head injuries and bruises are possible. Wear a hard hat and descend carefully.**

1. Descend to the inner yaw area.

**⚠ CAUTION Risk of fall due to unstable foothold in the yaw area. Ensure the safe placement of the ladder (ref. chapter 5). Keep both feet on the ladder while working.**

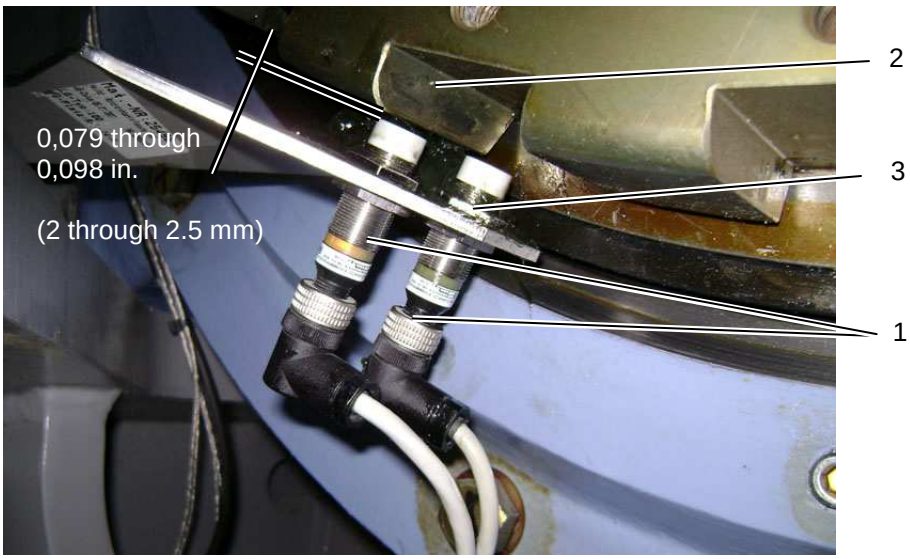



Fig. 6.7.3 – 1 Proximity sensors at the rotor bearing in the yaw area

2. Check the distance between the proximity sensors (1) and the shaft nut (2) by means of the measuring gage (nominal size 0,079 in. through 0,098 in. (2 through 2.5 mm)).
3. In case of a deviation from the nominal size, release the screw connection (3) of the proximity sensor by means of two No. 17 jaw wrenches.
4. Adjust the proximity sensor to the nominal setting.
5. Re-tighten the screw connection (3).

## 6.7.4 Inspecting the lightning protection mechanism

**DANGER**

**Risk of life when accessing the outer yaw area**

- Move the rotor blade to the V position and engage the rotor lock (ref. operating manual) prior to accessing the outer yaw area
- Keep the rotor holding brake closed (ref. operating manual)

**Required tools / operating and auxiliary means:**

- Replacement grounding brush (if needed)
- No. 13 jaw wrench (if needed)
- Grinding means (if needed)

**Directive:**

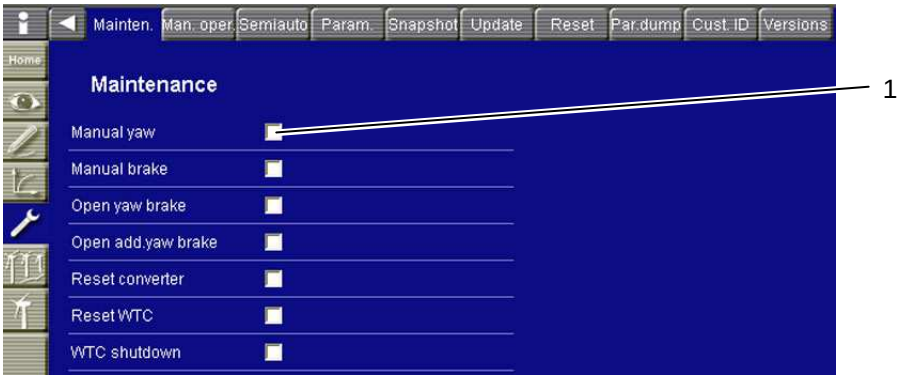



Fig. 6.7.4 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).
2. Activate the service switch (ref. operating manual) and remove the key.
3. Descend to the outer yaw area while observing the safety instructions detailed above.

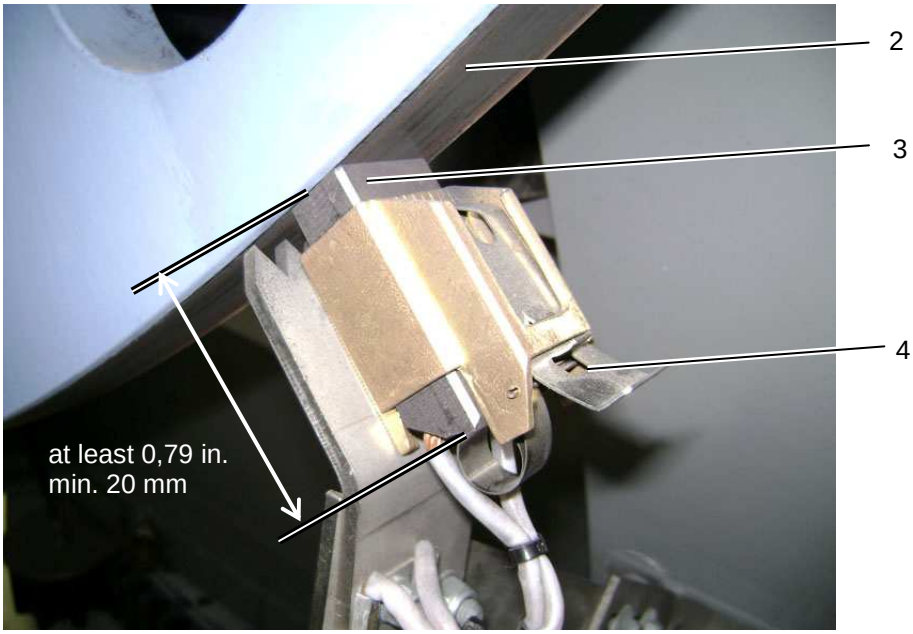



Fig. 6.7.4 – 2 Rotor disk and brush (at the hatch to the rotor hub)

4. Press down and pull out the spring element (4).
5. Remove the grounding brush (3).
6. Check the ease of movement of the grounding brush in the brush pocket mount (5).
7. Remove any soilings or rust spots.
8. Measure the brush length, the brush should exhibit a length of at least 0,79 in. (20 mm).
9. Replace the brush if the measurement is less than the nominal value or if it can be expected that the measurement will drop below the nominal value prior to the next maintenance.

**Replacing the brush**

10. Disconnect the brush (3).
11. Insert a new brush and tighten it.
12. Insert the spring element (4) and let it lock into place.

**End of the directive "Replacing the brush"**

13. Inspect the contact area of the brush (3) for chippings and grooves.
14. In case of damage, ref. "Replacing the brush".
15. Re-insert the brush.
16. Insert the spring element and let it lock into place.
17. Check the spring element (4) for a tight fit.
18. Check the face (2) of the rotor disk for unevenness, grooves.
19. Grind down any rust spots.
20. Document defects in the service booklet.

## 6.7.5 Checking the screw connection between the rotor bearing and the machine base

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- Edding
- Hydraulic power screwdriver
- Torque amplifier
- No. 55 box nut

**Directive:**

**Note:** Complete this maintenance section together with 6.6.8 "Checking the screw connection between the rotor hub and the rotor shaft".

1. Engage the rotor lock (ref. operating manual)


Fig. 6.7.5 – 1 Enclosure of the rotor disk

2. Mark the position of the enclosure (1) of the rotor disk (2)


Fig. 6.7.5 - 2 Enclosure of the rotor disk

3. Remove the enclosure (2)
4. Put the enclosure to the side

**DANGER Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!**


Fig. 6.7.5 – 3 Screw connection between the bearing housing and the machine base

5. Check the screws (4) of the connection between the bearing housing (3) and the machine base (4) by means of a hydraulic power screwdriver and a torque as detailed in the service booklet
6. Reinstall the enclosure (1) of the rotor disk (2) at the original position (observe the indication)

## 6.7.6 Checking the shaft nut

1. Engage the rotor lock (ref. operating manual)


Fig. 6.7.6 – 1 Cover of the rotor shaft

2. Remove the cover (1) of the rotor shaft.

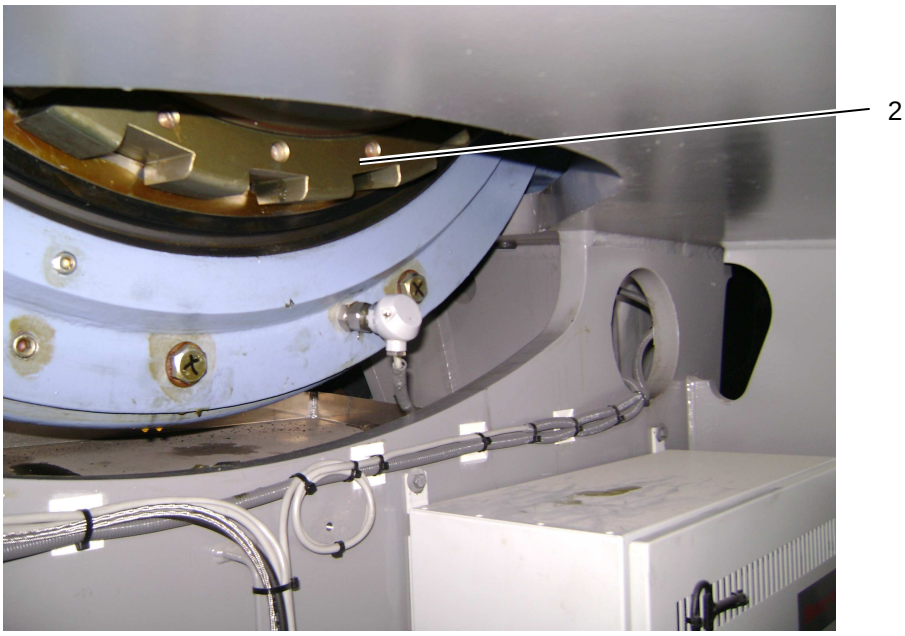



Fig. 6.7.6 – 2 Shaft nut (seen from yaw area)

3. Perform visual inspection and test tightness of the shaft nut (2).
4. Document defects in the service booklet.

# 6.8 Rotor lock

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

**DANGER**

**Risk of life while accessing the rotor hub**

- Nobody may be present in the rotor hub during this maintenance work.

## 6.8.1 Lubricating the locking bolts

**Required tools / operating and auxiliary means:**

- No. 46 jaw wrench (should be placed at the left rotor bearing)
- Grease gun
- Grease in accordance with the lubrication schedule
- Cloth

**Directive:**

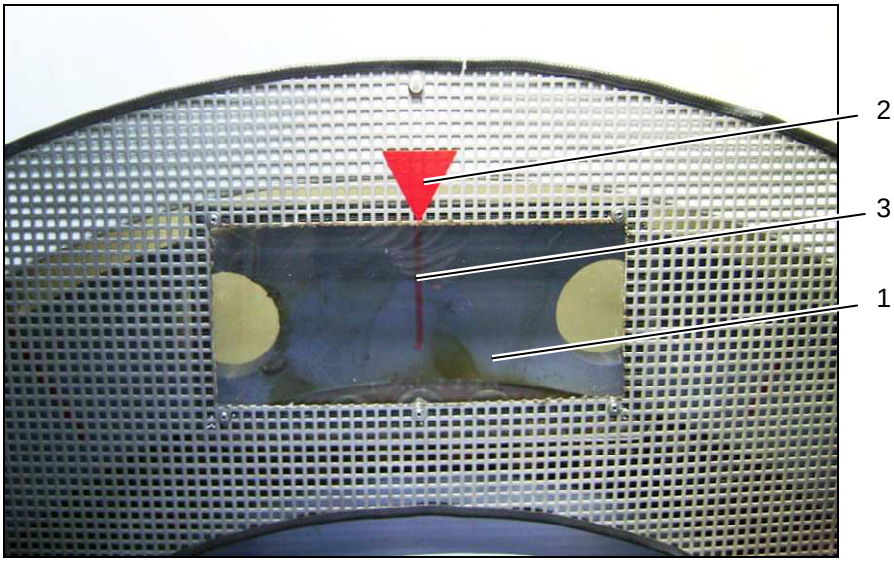



Fig. 6.8.1 – 1 Rotor disk with indication

Perform steps 1 through 5 only if the rotor locking mechanism has not been engaged yet. Observe the safety instructions (7) (fig. 6.8.1 – 3) in front of the rotor bearings.

1. Monitor the indications (3) on the rotor disk (1) and the nacelle enclosure (2).


Fig. 6.8.1 – 2 Portable switching unit

2. Engage the rotor holding brake at the portable switching unit (4) as soon as the indications (2) and (3) are aligned on top of each other.

**Note:** The alignment of the indications (2) and (3) only provides a broad indication as to whether the locking bolt and the borehole in the rotor disk are aligned.

**⚠ DANGER Risk of life. Never use the hub area and the access to the hub area if the rotor locks have not been engaged yet.**

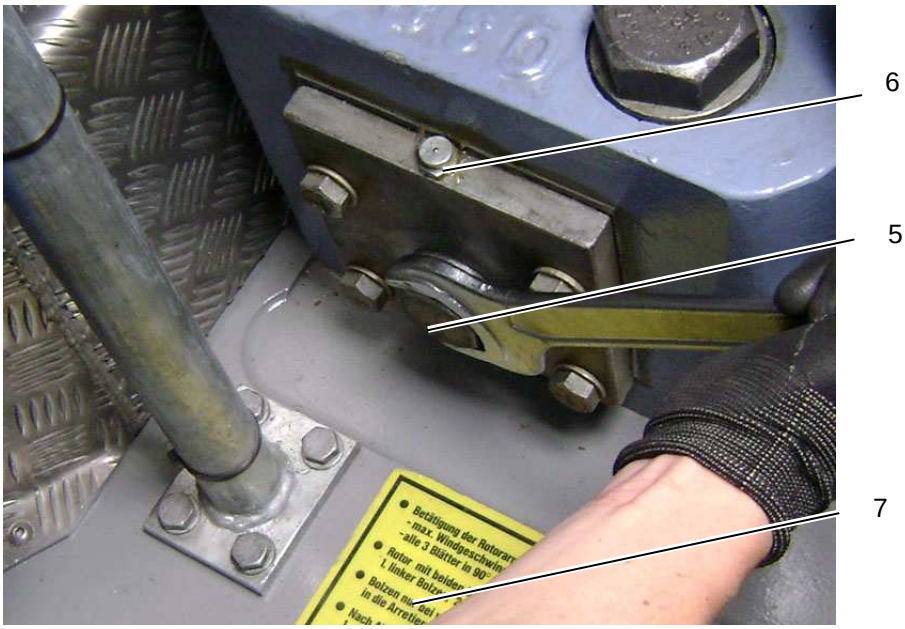



Fig. 6.8.1 – 3 Engaging the rotor lock

3. First set the left locking bolt by turning the screw (5) counter-clockwise by means of a No. 46 jaw wrench.

**Note:** This extends the locking bolt in the direction of the rotor disk.

4. Engage the right locking bolt in the same manner.


Fig. 6.8.1 – 4 Access to the hub

5. Open the door (8); the door may only be opened without the warning signal sounding if both locking bolts (8) have been properly engaged.

**NOTICE** **Risk of severe damage in case of incorrect use of the rotor lock: It is paramount that the respective other locking bolt is properly engaged and also that the rotor holding brake is engaged in order to lubricate a locking bolt (ref. operating manual).**

6. Attach the grease gun to the lubricant intake (6) of the left rotor locking mechanism and press in grease in accordance with the lubrication schedule until fresh grease escapes.
7. Extend and retract the locking bolt with full stroke in order to spread the grease.
8. Engage the left rotor lock.
9. Open the door (8) to the hub access and close it again.
10. If no acoustic warning signal sounds, attach the grease gun to the lubricant intake of the right rotor locking mechanism and press in grease in accordance with the lubrication schedule until fresh grease escapes.
11. The locking bolt needs to be extended and retracted with full stroke in that context.
12. Engage the right rotor lock.
13. Remove escaped grease and dispose of it in the proper manner.

## 6.8.2 Checking the acoustic warning mechanism

**Required tools / operating and auxiliary means:**

- No. 46 jaw wrench (should be placed at the left rotor bearing)

**Directive:**

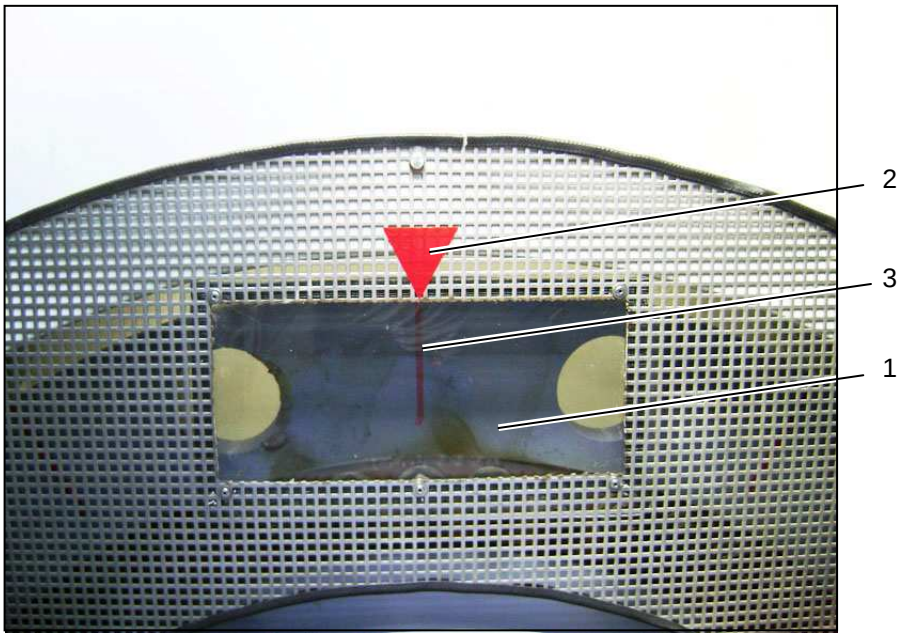



Fig. 6.8.2 – 1 Rotor disk with indication

**NOTICE** **Observe the safety instructions (6) (fig. 6.8.1 – 3) in front of the rotor bearings.**

1. Monitor the indications (3) on the rotor disk (1) and the nacelle enclosure (2).


Fig. 6.8.2 – 2 Portable switching unit

2. Engage the rotor holding brake at the portable switching unit (4) as soon as the indications (2) and (3) are aligned on top of each other.

**Note:** The alignment of the indications (2) and (3) only provides a broad indication as to whether the locking bolt and the borehole in the rotor disk are aligned.

**⚠ DANGER Risk of life. Never use the hub area and the access to the hub area if the rotor locks have not been engaged yet.**

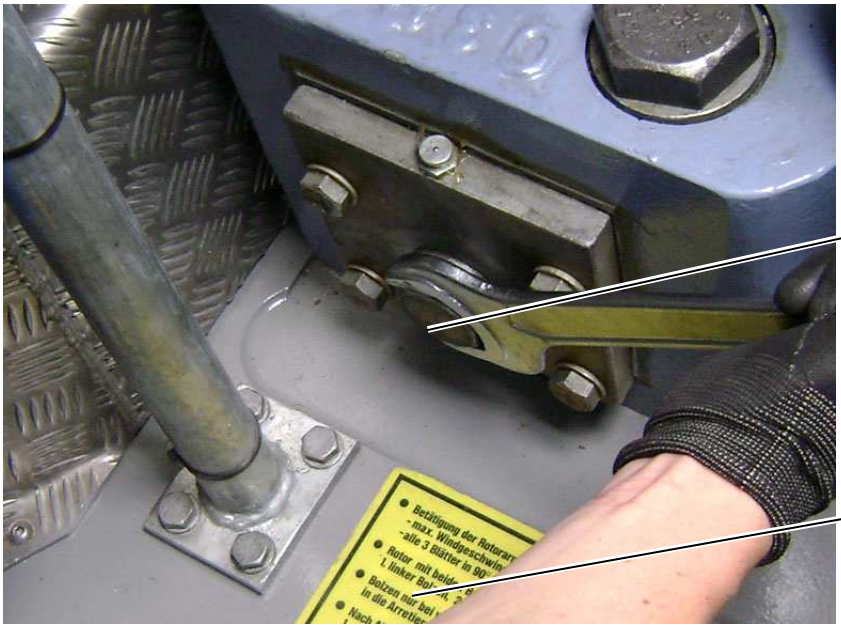



Fig. 6.8.2 – 3 Engaging the rotor lock

3. First set the left locking bolt by turning the screw (5) counter-clockwise by means of a No. 46 jaw wrench.

**Note:** This extends the locking bolt in the direction of the rotor disk.


Fig. 6.8.2 – 4 Access to the hub

4. Open the door (7); an acoustic warning signal must sound.
5. Set the right locking bolt by turning the screw (5) counter-clockwise by means of a No. 46 jaw wrench.

**NOTICE** **Risk of severe damage in case of incorrect use of the rotor lock: Ensure that the right locking bolt has been properly retracted prior to releasing the left locking bolt. In addition, the rotor holding brake must be closed (ref. operating manual).**

6. Open the door (7) to the hub access and close it again.
7. If no acoustic warning signal sounds, release the left locking bolt.
8. Open the door (7); an acoustic warning signal must sound.
9. Re-engage the left rotor locking mechanism.
10. Report malfunctions.

# 6.9 Gearbox
# Manufacturer: Winergy, Eickhoff

**⚠ WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.9.1 Evaluating the condition of the gearbox oil

**⚠ WARNING**

**Risk of contusions due to rotating system components**

- Engage the rotor lock (ref. operating manual).
- Keep the rotor holding brake closed (ref. operating manual).
- Do not reach into rotating system components.

**Required tools / operating and auxiliary means:**

- Respirator mask
- Closely sealing protective goggles
- Oil-proof gloves
- Ratchet with extension and No. 24 box nut
- Flashlight
- Digital camera
- Non-fraying cloths
- Seal for the inspection cover (if needed)

**Directive:**

**NOTICE** **Danger due to objects that have fallen into the gearbox. Empty all pockets prior to commencing the work. Store the screws of the inspection cover in such a manner that they cannot fall into the gearbox.**


Fig. 6.9.1 – 1W Inspection cover (manufacturer Winergy)

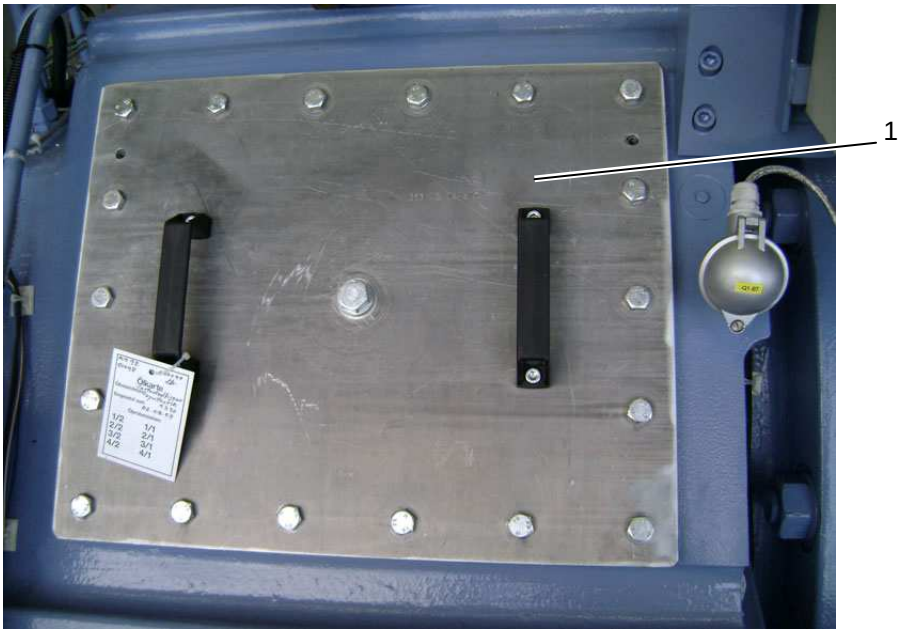



Fig. 6.9.1 – 1E Inspection cover (manufacturer Eickhoff)

1. Release the screws of the inspection cover (1).
2. Clean the area of the inspection cover (1) of chips, paint chippings.
3. Remove small components and tools.

**⚠ CAUTION Danger due to escaping vapors. Wear closely sealing protective goggles and a respirator mask. Ensure sufficient ventilation.**

4. Carefully open the inspection cover in order to avoid damaging the seal.

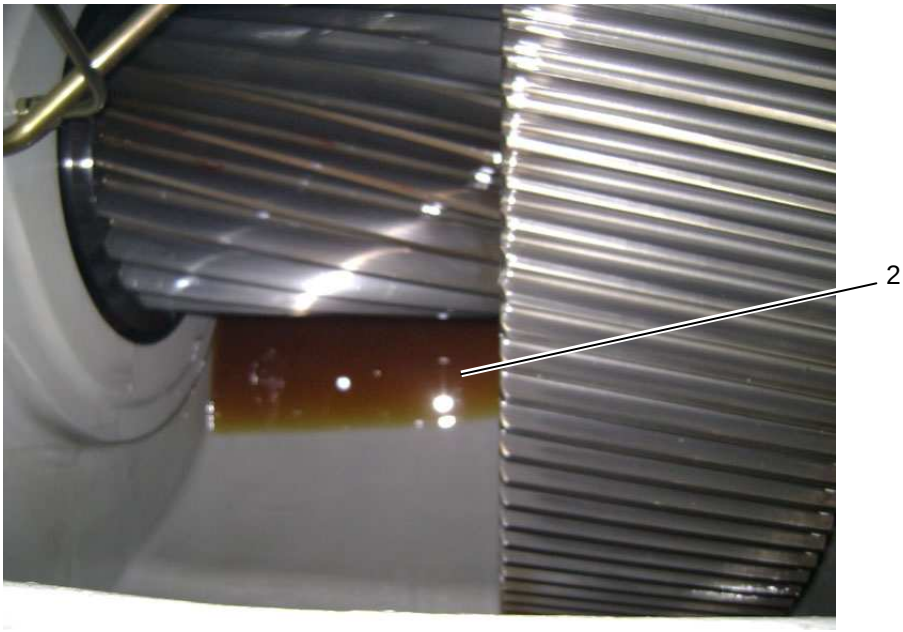



Fig. 6.9.1 – 2 Oilsump (example: manufacturer Winergy)

**⚠ CAUTION** **Risk of burns due to hot gearbox oil. Wear oil-proof gloves. Do not reach into the oilsump.**

**NOTICE** **Secure flashlights and digital cameras that are required for the evaluation and documentation of defects at the wrist.**

5. Visual inspection of the oil (2); use the flashlight.

6. Photograph noticeable problems and document them in the service booklet, take an oil sample if applicable (ref. maintenance section 6.9.7 "Taking an oil sample for an oil analysis").

**Note:** Complete this maintenance section together with 6.9.2 "Inspecting the gearing of the gearbox".

7. Clean the flange range of the inspection cover with a cloth.

**NOTICE** **Risk of gearbox damage. Replace any damaged seals.**

8. Check the seal for proper positioning.
9. Close the inspection cover (1).
10. Re-tighten the screws of the inspection cover (1).

## 6.9.2 Inspecting the gearing of the gearbox Manufacturer: Winergy, Eickhoff

**Required tools / operating and auxiliary means:**

- Respirator mask
- Closely sealing protective goggles
- Gloves
- Ratchet with extension and No. 24 box nut
- Flashlight
- Digital camera
- Non-fraying cloths
- Seal (if needed)

**Directive:**

**NOTICE** **Danger due to objects that have fallen into the gearbox. Empty all pockets prior to commencing the work. Store the screws of the inspection cover in such a manner that they cannot fall into the gearbox.**


Fig. 6.9.2 – 1 Inspection cover (manufacturer Winergy)

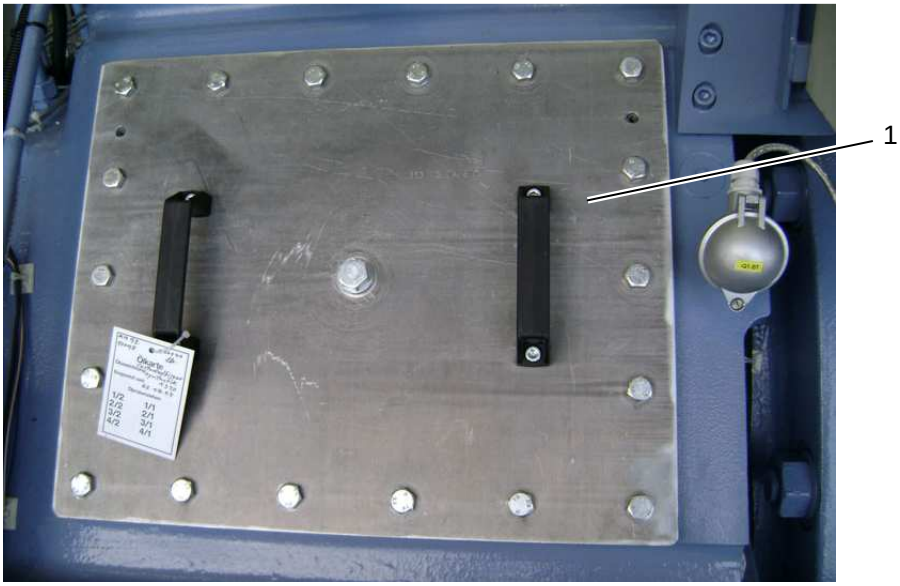



Fig. 6.9.2 – 1E Inspection cover (manufacturer Eickhoff)

1. Release the screws of the inspection cover (1)
2. Clean the area of the inspection cover (1) of chips, paint chippings
3. Remove small components and tools

**⚠ CAUTION Danger due to escaping vapors. Wear closely sealing protective goggles and a respirator mask. Ensure sufficient ventilation.**

4. Carefully open the inspection cover in order to avoid damaging the seal
5. Open the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual)

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

6. Release the rotor holding brake while taking the activities of other service personnel and the wind conditions into consideration (operating manual)

Fig. 6.9.2.1 – 2 Gearing (example: manufacturer Winergy)

**⚠ CAUTION Risk of burns due to hot gearbox oil. Wear oil-proof**

**gloves. Do not reach into the oilsump.**

**NOTICE** **Secure flashlights and digital cameras that are required for the evaluation and documentation of defects at the wrist.**

7. Perform a visual inspection of the gearing (with the flashlight) for damage, seizing, and pitting corrosion

**Note:** The system is in idle mode upon opening the rotor lock and releasing the rotor holding brake. As a result, the entire circumference of the gearing may be checked.

8. In case of noticeable problems, engage the rotor holding brake, take photographs, and document them in the service booklet
9. In case of noticeable problems, e.g. metal abrasion, take an oil sample (ref. maintenance section 6.9.7 "Taking an oil sample for an oil analysis")

**Note:** Complete this maintenance section together with 6.9.1 "Evaluating the condition of the gearbox oil".

10. Clean the flange range of the inspection cover with a cloth

**NOTICE** **Risk of gearbox damage. Replace any damaged seals.**

11. Check the seal for proper positioning
12. Close the cover
13. Re-tighten the screws
14. Engage the rotor lock (ref. operating manual)

## 6.9.3 Not used

## 6.9.4 Checking the gearbox for leaking oil

**Required tools / operating and auxiliary means:**

- Closely sealing protective goggles
- Oil-proof gloves
- Jaw wrench, pipe tongs depending on the type of leak
- Cleaning agent
- Collection container for leaking oil (if needed)
- Non-fraying cloths

**Directive:**


Fig. 6.9.4 – 1W (gearbox and gearbox oil cooler (manufacturer Winergy)

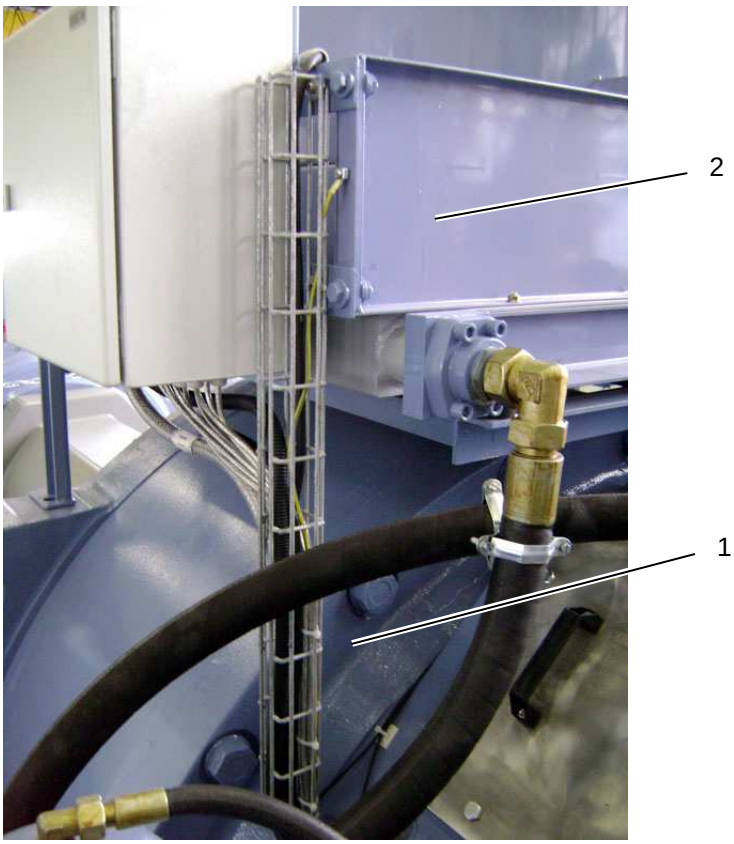



Fig. 6.9.4 – 1E Gearbox and gearbox oil cooler (manufacturer Eickhoff)

1. Thoroughly check the entire gearbox (1) area including the gearbox oil cooler (2) for leaks.
2. Initially re-tighten the screws of affected components.
3. Remove oil spills.
4. Enter the maintenance date at the leak in order to facilitate determining whether the cause of the leak has been repaired during subsequent maintenance procedures.

**⚠ CAUTION** **Risk of burns due to hot gearbox oil. Wear oil-proof gloves and closely sealing protective goggles. Set the motor circuit switch of the gearbox oil pump in the top box to STOP.**

5. Replace defective cables and hoses and resolve the cause of the damage of the replaced elements (e.g. hoses rubbing on sharp edges).
6. Collect escaping oil and dispose of it in the proper manner.
7. Dispose of replaced hoses, pipes, or screw connections in the proper manner.
8. Remove leaking oil with a cleaning agent and cloths.
9. Dispose of soiled cloths in the proper manner.
10. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

## 6.9.5 Gearbox oil level

### 6.9.5.1 Checking the gearbox oil level

**Required tools / operating and auxiliary means:**

- Flashlight
- Foot rule

**Directive:**

1. Set the motor circuit switch of the gearbox oil pump in the top box to STOP.
2. Close the rotor holding brake (ref. operating manual).
3. Wait 30 minutes to let the oil settle in the oilsump.

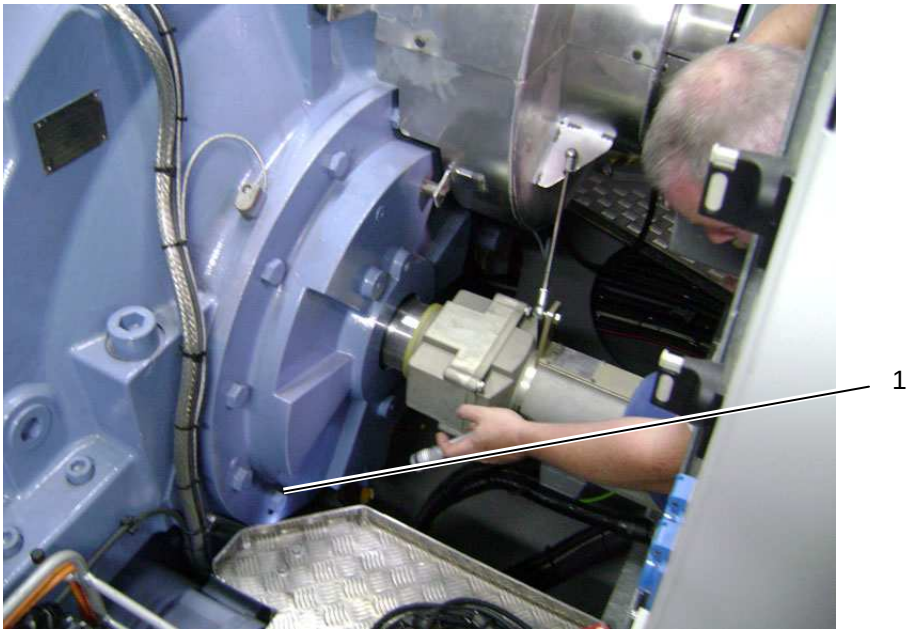



Fig. 6.9.5.1 – 1 Oil level indicator (manufacturer Winergy)

**Note:** The oil level indicator (1) at the Winergy gearbox is located in a disadvantageous position (fig. 6.9.5.1 – 1).

Fig. 6.9.5.1 – 2W shows the indicator prior to the installation of the gearbox in the machine base.

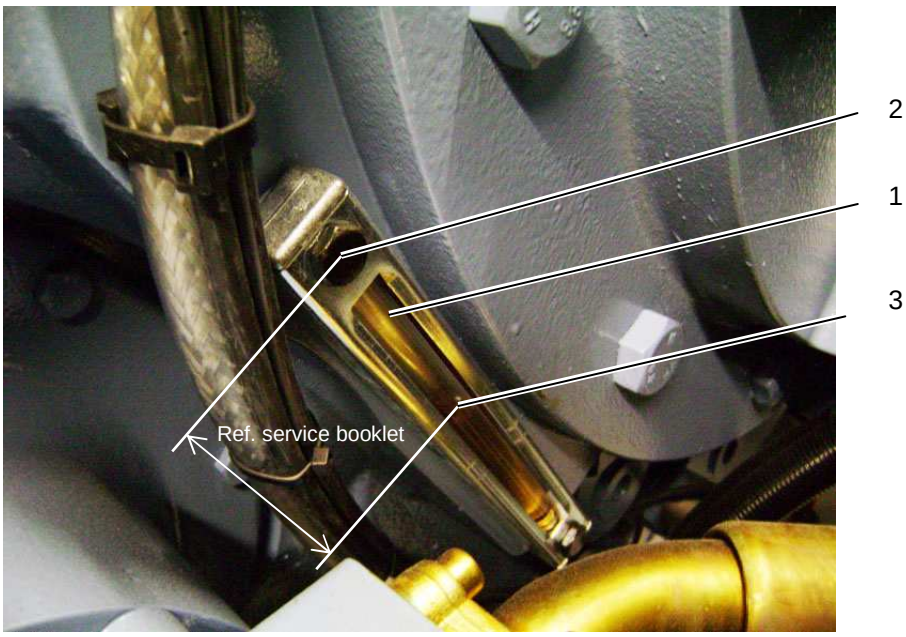



Fig. 6.9.5.1 – 2W  Oil level indicator (manufacturer Winergy)

4. Winergy gearbox: Measure the distance between the upper attachment screw (2) and the oil level (3) and compare it to the nominal value as detailed in the service booklet.

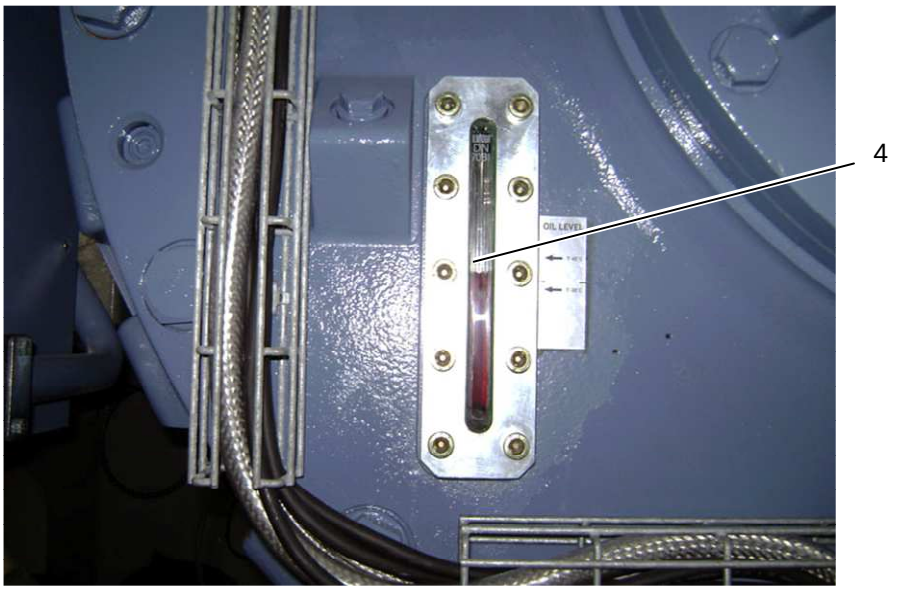



Fig. 6.5.9.1 – 2E  Oil level indicator (manufacturer Eickhoff)

5. Eickhoff gearbox: Check the oil level; the oil level should be displayed in the middle of the level indicator (4).

**NOTICE** An insufficient gearbox oil level may cause severe damage to the gearbox or a reduced power operating mode of the wind turbine.

6. If the oil level is too low, fill in more gearbox oil.
7. If the oil level corresponds to the nominal value:  Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

### 6.9.5.2 Refilling gearbox oil

NOTICE

**Danger due to using incorrect gearbox oil**

Damage to the gearbox due to modified chemical and physical properties when mixing different types of gearbox oil.

- Generally use to gearbox oil type that is already present in the gearbox (ref. oil card or type label at the gearbox).
- Never mix different gearbox oil types or gearbox oil by different manufacturers, especially not synthetic gearbox oil and mineral oil.
- Consult REpower Systems AG when switching to another gearbox oil type.

**Required tools / operating and auxiliary means:**

- Respirator mask
- Closely sealing protective goggles
- Oil-proof gloves
- Ratchet with extension and No. 24 box nut
- Gearbox oil in accordance with the oil card or the specification on the type label
- Non-fraying cloths

**Directive:**

NOTICE **Danger due to objects that have fallen into the gearbox. Empty all pockets prior to commencing the work. Store the screws of the inspection cover in such a manner that they cannot fall into the gearbox.**


Fig. 6.9.5.2 – 1W Inspection cover of the gearbox (manufacturer Winergy)

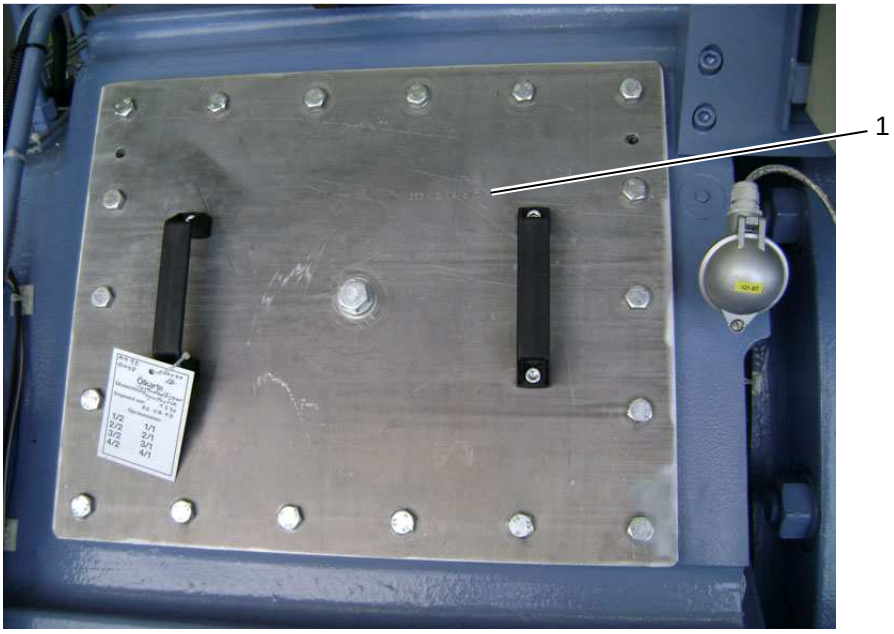



Fig. 6.5.9.2 – 1E Inspection cover (manufacturer Winergy)

1. Release the screws of the inspection cover (1).
2. Clean the area of the inspection cover of chips, paint chippings.
3. Remove small components and tools.

**⚠ CAUTION Danger due to escaping vapors. Wear closely sealing protective goggles and a respirator mask. Ensure sufficient ventilation.**


Fig. 6.9.5.2 – 2 Opened inspection cover (example: manufacturer Winergy)

4. Carefully open the inspection cover (1) in order to avoid damaging the seal.

**⚠ CAUTION Risk of burns due to hot gearbox oil. Wear oil-proof gloves. Do not reach into the oilsump.**

5. Refill gearbox oil in accordance with the oil card or the specifications on the type label via a filter (filter unit < 10µm abs.) through the opened inspection cover until the required gearbox oil level (ref. section 6.9.5.1) has been reached.
6. Clean the flange range of the inspection cover with a cloth.

**NOTICE** **Risk of gearbox damage. Replace any damaged seals.**

7. Check the seal for proper positioning.
8. Close the inspection cover.
9. Re-tighten the screws.
10. Remove leaking oil.
11. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B of the wind turbine.

## 6.9.6 Changing the gearbox oil

Gear oil changes are performed every three years or upon an oil sample determining that the gearbox oil no longer conforms to the requirements. Gearbox oil changes should be performed by specialized companies that possess special tankers and portable pumps with a suitable power.
Observe the “Summery of Proper Gearbox Handling” and documentation by the manufacturer (ref. attachment).

## 6.9.7 Taking an oil sample for an oil analysis

**Required tools / operating and auxiliary means:**

- Oil sample set
- Protective goggles
- Oil-proof gloves
- No. 27 jaw wrench
- No. 10 Allen wrench
- Waste oil canister with funnel (oil amount: approx. 0,13 gal. (0.5 liters))
- Non-fraying cloths

**Directive:**

1. Set the motor circuit switch of the gearbox oil pump in the top box to STOP.
2. Engage the rotor lock (ref. operating manual).
3. Keep rotor holding brake closed (ref. operating manual).
4. Take an oil sample downstream of the oil filter.
5. Ensure cleanliness while taking the oil sample in order to prevent falsifying the sample.

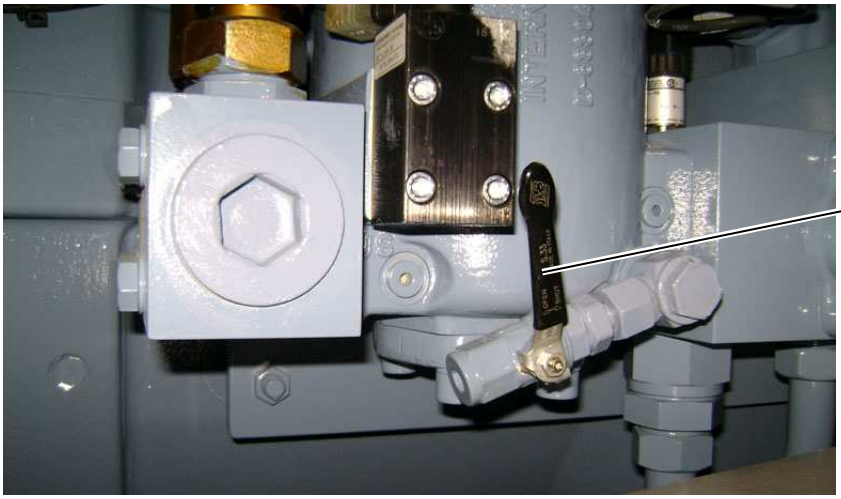



Fig. 6.9.7 – 1 Oil drain valve (example: manufacturer Winergy)

6. The oil drain valve (1) must be closed.

**⚠ CAUTION Risk of burns due to hot gearbox oil. Wear oil-proof gloves and closely sealing protective goggles.**


Fig. 6.9.7 – 2 Releasing the oil drain screw at the oil filter

7. Remove the oil drain screw (2).
8. Place the waste oil canister with the funnel underneath the oil drain.
9. Open the oil drain valve (1) (fig. 6.9.7 – 1).
10. Let approx. 0.13 gal. (0.5 liters) of waste oil drain into the waste oil canister.
11. Close the oil drain valve again.
12. Close the waste oil canister and dispose of the waste oil in the proper manner.
13. Clean the oil drain with cloths.


Fig. 6.9.7 – 3 Filling the oil sample bottle

14. Place the oil sample bottle (3) underneath the oil drain.
15. Open the oil drain valve (1).
16. Drain the oil sample into the oil sample bottle.
17. Close the oil drain valve (1).
18. Immediately close the oil sample bottle and put it to the side in a safe manner.
19. Immediately replace and tighten the oil drain screw (2) (fig. 6.9.7 – 2).
20. Clean the working area.


Fig. 6.9.7 – 4 Labeling the oil sample

21. Degrease the oil sample bottle (3).
22. Remove the bar code (4) from the part identification slip (5) of the oil sample set and attach it to the marked area of the oil sample bottle.
23. Complete the part identification slip, place everything in the associated envelope, and mail it to the laboratory.
24. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

## 6.9.8 Performing the functional test for the oil level monitor

**Required tools / operating and auxiliary means:**

- No. 5 Allen wrench

**Note:** The cooperation of two service technicians is recommended for this maintenance section.

**Directive:**

Fig. 6.9.8 – 1 Hatch to the lower nacelle area

(Floor plate in the coupling area has already been removed)

1. Release the floor plate and put it to the side.

**⚠ CAUTION Risk of head injuries. Wear a bump cap or a hard hat**

2. Descend to the area below the machine base.


Fig. 6.9.8 – 2 Oil level monitor

3. Release the white cover of the oil level monitor (1).

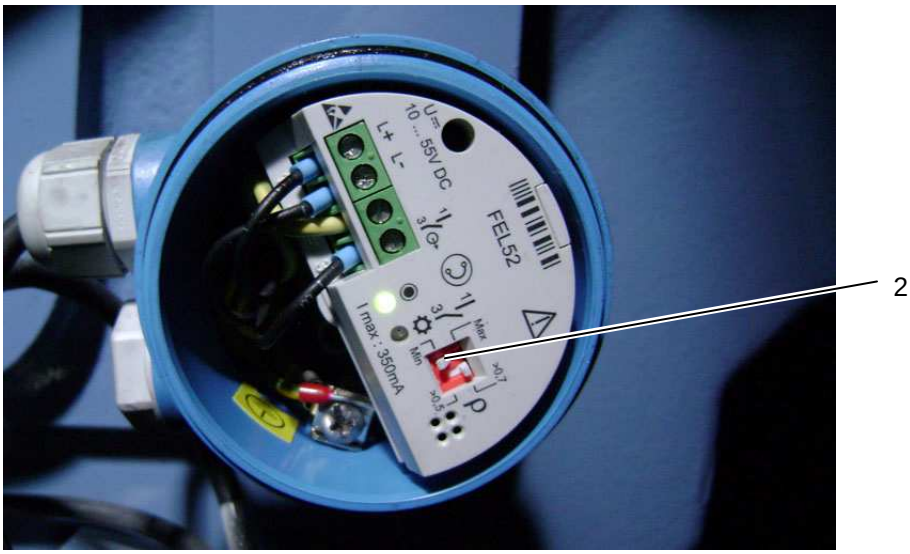



Fig. 6.9.8 – 3 Oil level monitor (view without cover)

4. Switch the DIP switch (2) from "Min" to "Max".

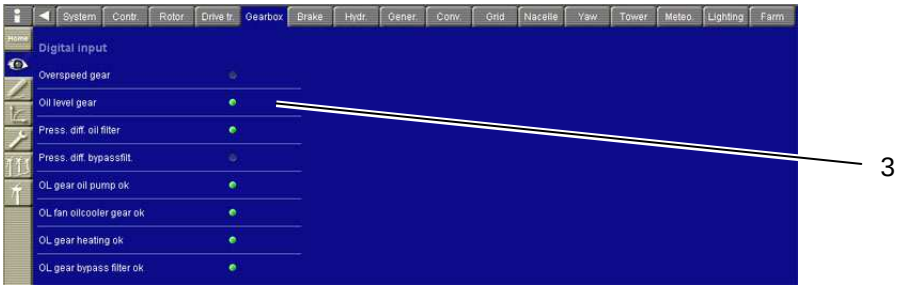



Fig. 6.9.8 -4 REguard Monitoring

5. The second service technician operates the REguard Control B.
6. REguard Monitoring: Select Monitoring menu → Gear → Digital inputs
7. If the DIP switch (2) (fig. 6.9.8 – 3) at the oil level monitor is set to "Max", the green control point (3) needs to turn on at the display; i.e. the oil level monitor will indicate that the oil level is insufficient.
8. Reset the DIP switch (2) (fig. 6.9.8 – 3) at the oil level monitor to "Min".
9. Reattach the white cover (1) (fig. 6.9.8 – 2)
10. Tighten the floor plate.
11. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

## 6.9.9 Inspecting the ventilation filter

**Required tools / operating and auxiliary means:**

- No. 3 Allen wrench
- Approx. 100 ml of gearbox oil (ref. oil card at the gearbox)
- Cloth

**Directive:**

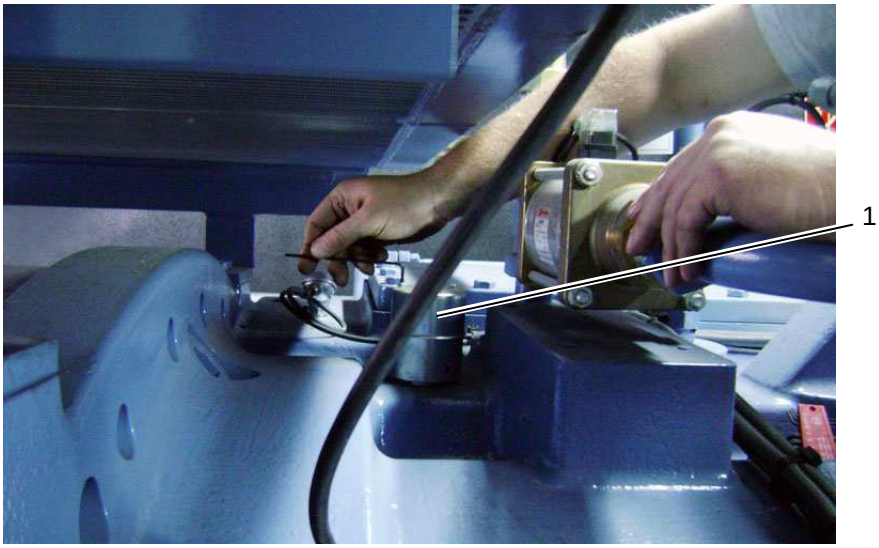



Fig. 6.9.9 – 1 Inspecting the ventilation filter (example: manufacturer Winergy)

1. Release three screws of the protective cover (1) of the ventilation filter my means of the No. 3 Allen wrench.
2. Remove the protective cover (1).


Fig. 6.9.9 – 2 Oil bath filter

3. If soiled, release and clean the filter insert (2).
4. Dispose of oil present in the ventilation filter housing in the proper manner.
5. Seal the threading of the filter insert with Teflon tape.
6. Insert and tighten the filter insert.


Fig. 6.9.9.1 – 3 Ventilation filter

7. Fill the ventilation filter housing with fresh gearbox oil to the oil level indication (3).

**NOTICE** **Gearbox damage if the oil bath filter has not been filled with oil. If the ventilation filter has not been filled with oil, dust or other contaminations enter the gearbox and cause damage.**

8. Attach and tighten the protective cover of the oil bath filter (1) (fig. 6.9.9 – 1).
9. Clean the working area.

## 6.9.10 Evaluating the condition of the elastomer bearings

NOTICE

**Danger due to contact of the elastomer bearings with mineral oil**

Damage of the elastomer bearings

- Avoid contact of the elastomer bearings with mineral oil.
- Immediately wipe off soilings with mineral oil, do not use cleaning agents that contain solvents under any circumstances.

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

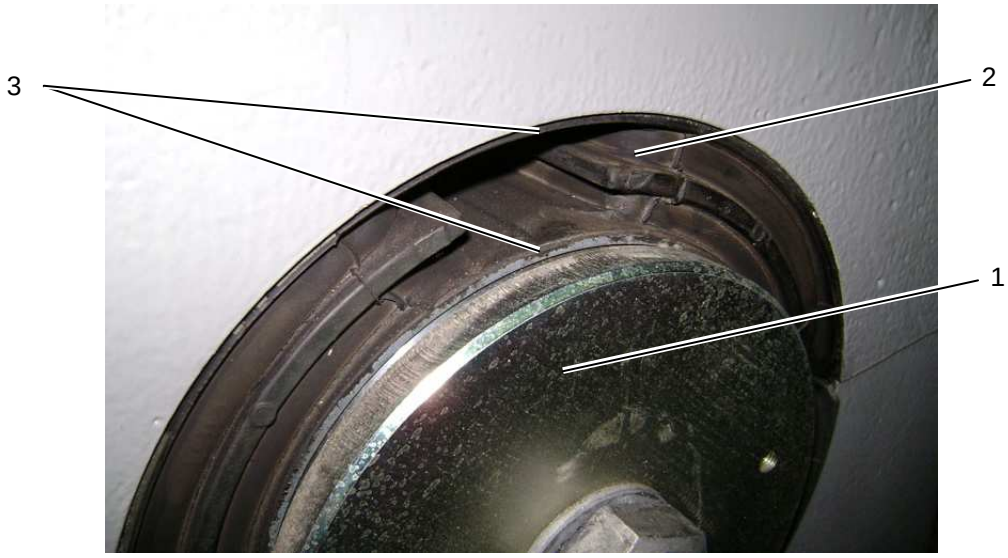



Fig. 6.9.10 – 1 Elastomer bearing

1. Thoroughly inspect the elastomer bearings (1) (fig. 6.9.10 – 1) with a flashlight for cracks, strippings, abrasions, and deformations.
2. Mark existing cracks, document the position of the cracks in the service booklet, and ensure their continued monitoring.
3. Definitely report deformations and shifts in the area (3) – the wind turbine has serious problems.
4. An excessive load of the elastomer bearings is indicated by larger quantities of black wear at the bearing shells.
5. All elastomer bearings on both sides of the gearbox need to be replaced in case of severe damage or a substantial shift.

## 6.9.11 Inspecting the connection cabinet

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**


Fig. 6.9.11 – 1 Connection cabinet

**DANGER Risk of life due to high voltages. Observe the safety notices in chapter 5.**

1. Open the connection cabinet.
2. Verify that the voltage has been deactivated.
3. Check the cables for a tight fit in the spring-loaded clamps (1), insert them properly if applicable.
4. Check the strain relief (2) for a tight fit, tighten if applicable.
5. Check the grounding cable (3) for a tight fit, tighten if applicable.
6. Check the PG screw connections (4) for a tight fit, tighten if applicable.
7. Close the connection cabinet.

## 6.9.12 Checking the proximity sensors and sensor plates

### 6.9.12.1 Mechanical checks

**⚠ WARNING**

**Risk of contusions due to rotating system components**

- Engage the rotor lock (ref. operating manual)
- Keep the rotor holding brake closed (ref. operating manual)

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- 2 pcs. No. 17 jaw wrench

**Directive:**

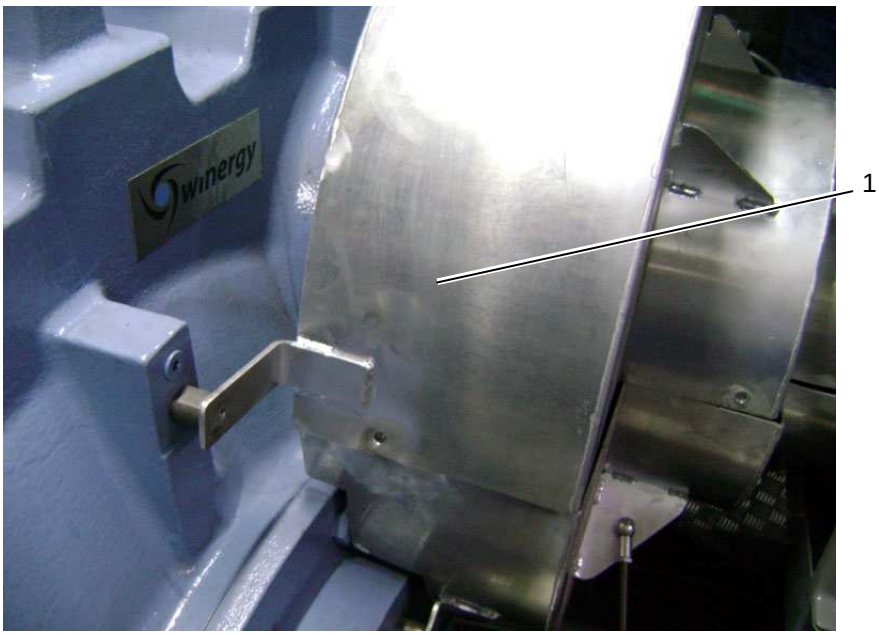



Fig. 6.9.12.1 – 1 Enclosure of the rotor holding brake

1. Release the enclosure (1) of the rotor holding brake and put it to the side.

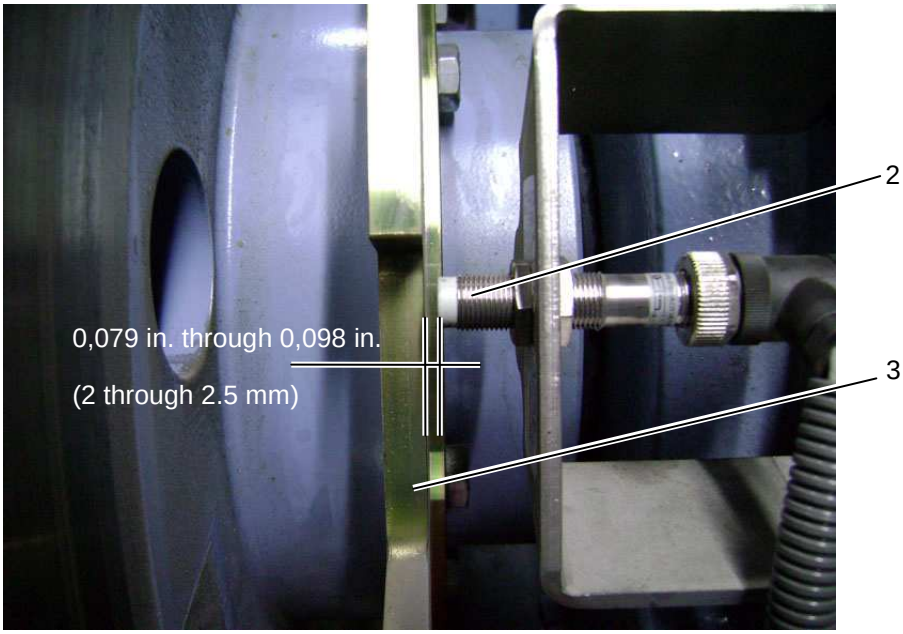



Fig. 6.9.12.1 - 2 Proximity sensor and sensor plate

2. The distance between the proximity sensor (2) and the sensor plate (3) should range from 0,079 in. through 0,098 in. (2 through 2.5 mm).

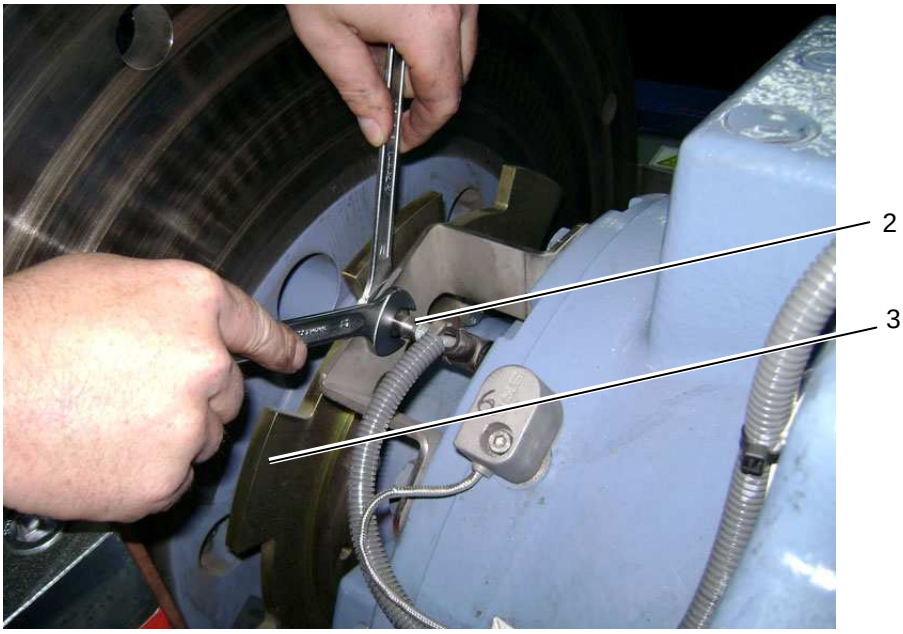



Fig. 6.9.12.1 - 3 Re-adjusting the proximity sensor

3. In case of an incorrect distance to the sensor plate (3), use 2 pcs. No. 17 jaw wrench to adjust the proximity sensor (2) to a distance between 0,079 in. and 0,098 in. (2 and 2.5 mm).
4. Check the sensor plate – sharp edges are a requirement for a precise speed determination.
5. Document damage to the sensor plate (3) in the service booklet.

### 6.9.12.2 Checking the function of the proximity sensor

**WARNING**

**Risk of contusions due to rotating system components**

Contusions

- Do not reach into rotating components.

**Required tools / operating and auxiliary means:**

- None

**Directive:**

1. Open the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).
2. Release the rotor holding brake while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

**Note:** The system is now in idle mode.


Fig. 6.9.12..2 – 1 REguard Monitoring

3. REguard Monitoring: “Monitoring” menu → “Gearbox” → “Measuring values”.
4. A value needs to be displayed in the field "Gear speed".
5. Engage the rotor holding brake.

## 6.9.13 Checking the grounding connection for a tight fit

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut

**Directive:**

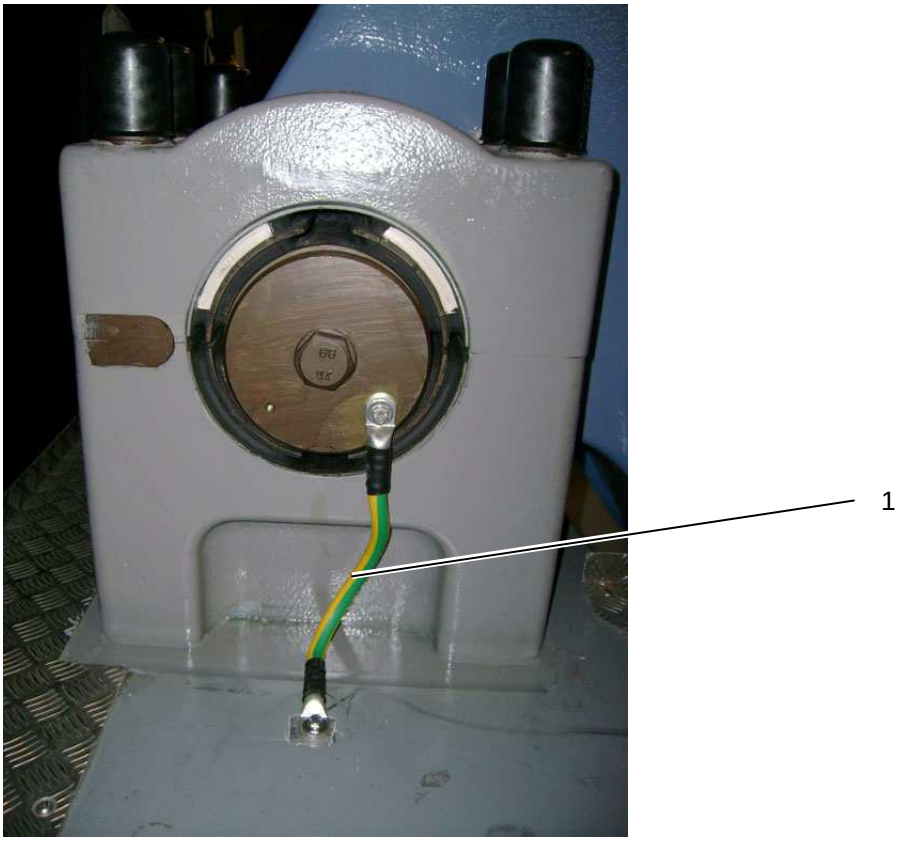



Fig. 6.9.13 – 1 Gearbox grounding

- Check the grounding cable (1) for a tight fit, tighten if applicable.

## 6.9.14 Checking the sensor system, the cables, and the plug connections for their tight fit

**Directive:**

1. Check the cables and the plug connections of the gearbox for a tight fit.
2. Check the entire sensor system for a tight fit (ref. sample photographs).
   Vibration sensors (1)
   Soiling indicator oil filter (2)
   Temperature sensors (3)
   Pressure transducers (4)
3. Rectify defects and document them in the service booklet.

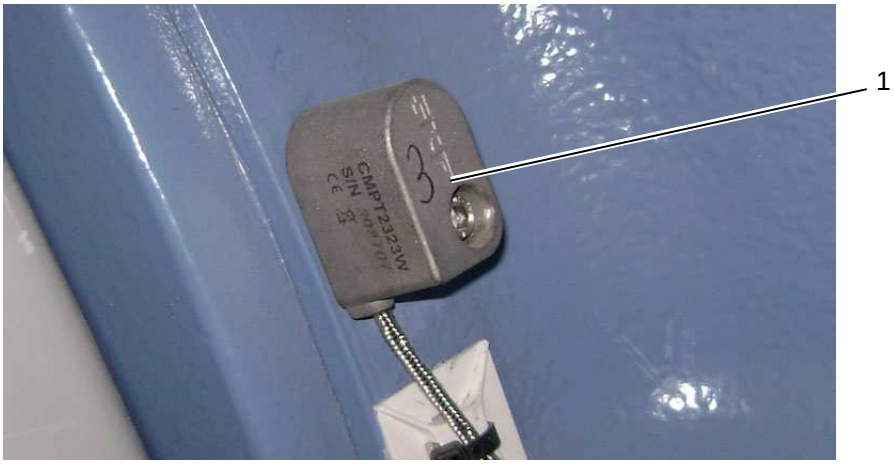



Fig. 6.9.14 – 1 Vibration sensor

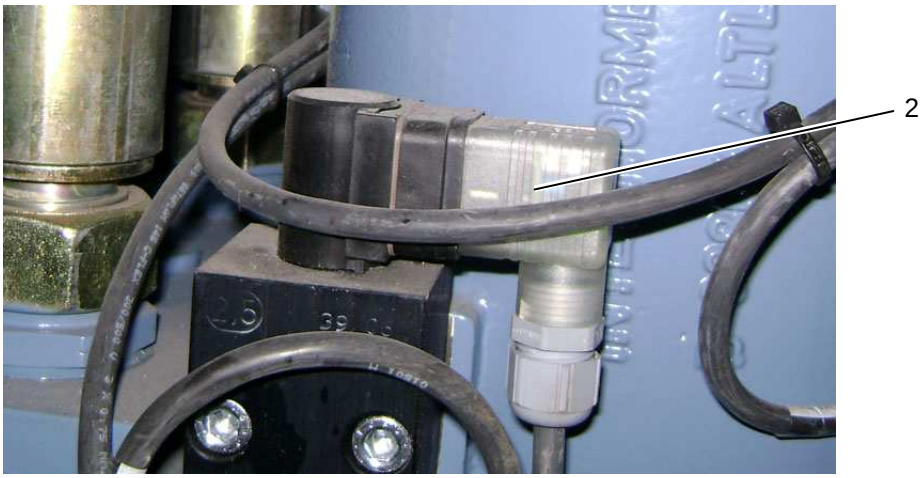



Fig. 6.9.14 – 2 Soiling indicator oil filter


Fig. 6.9.14 – 3 Gearbox (example: manufacturer Winergy)

## 6.9.15 Checking the slip indication on the shrink disk

**Note:** This maintenance section may also be performed together with maintenance section 6.9.16. However, a disassembly of the rotor shaft cover is required in that context.

**Required tools / operating and auxiliary means:**

- Flashlight, Edding

**Directive:**

1. Open the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).
2. Release the rotor holding brake while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).
3. The wind turbine is in idle mode.

**⚠ CAUTION Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform. Severe falls with head injuries and bruises are possible. Wear a hard hat and descend carefully.**

4. Descend to the inner yaw area.

**⚠ CAUTION Risk of fall due to unstable foothold in the yaw area. Ensure the safe placement of the ladder (ref. chapter 5). Keep both feet on the ladder while working.**


Fig. 6.9.15 – 1 Slip indication between the rotor disk and the rotor shaft

Location: yaw area

5. Check the slip indication (1) in the yaw area.

6. Wait until the slip indication (1) becomes visible.
7. Engage the rotor holding brake.
8. Evaluate the slip indication.
9. Add a new indication including the date if the old slip indications are no longer aligned and deviate from each other or no slip indication has been added yet.
10. Document the deviation in the service booklet.
11. Engage the rotor lock.

## 6.9.16 Checking the tension state of the clamping set

**Required tools / operating and auxiliary means:**

- Ratchet
- Extension
- No. 13 box nut
- Hydraulic power screwdriver

**Directive:**

1. Engage the rotor lock (ref. operating manual)
2. Remove the enclosure of the rotor shaft (1).
3. Put the enclosure to the side in a safe manner.


Fig. 6.9.16 – 1 Clamping set

**Clamping set Stüwe HSD-660-83-5:**

4. Perform a visual inspection of the circumference of this clamping set only.
5. Document defects in the service booklet.

**Clamping set Schäfer TAS 3193-660:**

**⚠ DANGER Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!**

6. Check all accessible screws of the clamping set (2) by means of a hydraulic power screwdriver and a torque as detailed in the service booklet.
7. Open the rotor lock while taking the activities of other service personnel and the wind conditions into consideration.
8. Release the rotor holding brake (ref. operating manual).
9. Turn the rotor until the remaining screws may be accessed.
10. Re-engage the rotor lock.
11. Check the remaining screws of the clamping set as detailed in 6.
12. 

**Clamping set Stüwe HSD-660-83-5 and Schäfer TAS 3193-660:**

13. Re-assemble the enclosure of the rotor shaft

## 6.9.17 Screw connection between gearbox bearing and machine base

**Note:**

The work with the hydraulic power screwdriver should be combined per section in order to avoid unnecessary setups and removals of the device.

- Working in the hub
- Working in the nacelle and the yaw area
- Working in the tower

**Required tools / operating and auxiliary means:**

- Hydraulic power screwdriver
- No. 55 box nut

**Directive:**

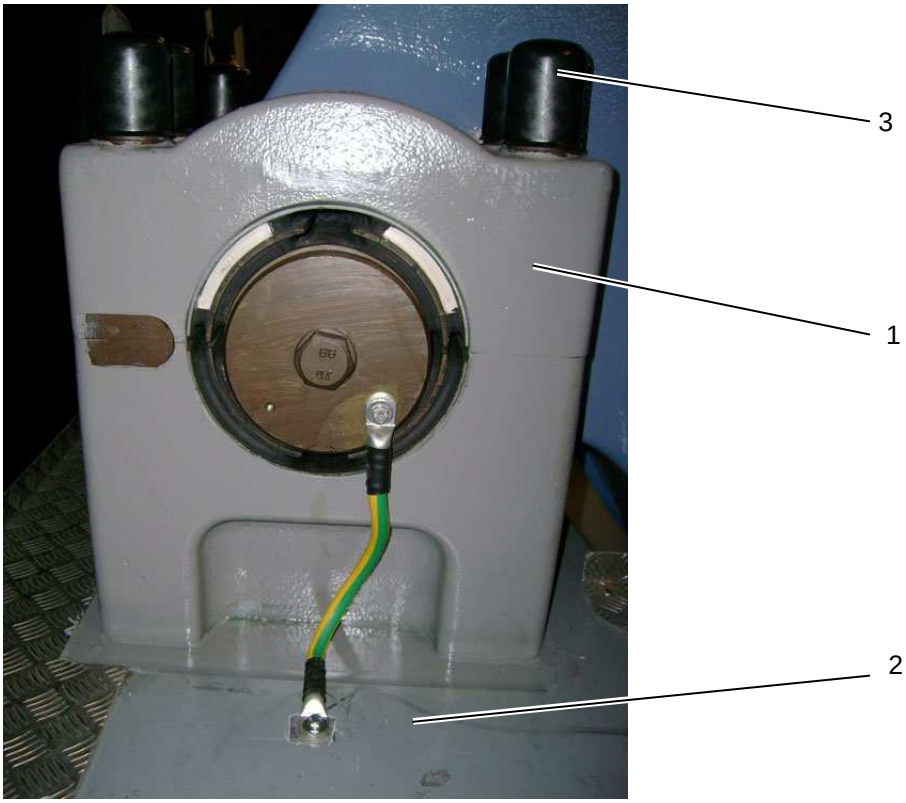



Fig. 6.9.17 – 1 Gearbox bearing

1. Remove 4 pcs. protective cap (3) of the screw connection between the storage block (1) and the machine base (2)

**DANGER** **Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Because of that, the work with hydraulic power screwdrivers is very dangerous. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver!**

2. Check the nut by means of the hydraulic power screwdriver and a torque as detailed in the service booklet
3. Repeat steps 2 through 4 at the other 7 nuts of the first gearbox bearing
4. Repeat steps 1 through 4 at the gearbox bearing on the other side of the gearbox
5. Re-attach the protective caps (3) to the screw connection
6. Secure the hydraulic power screwdriver
7. Clean the working area

## 6.9.18 Maintaining the oil cooling and the oil filter loop

### 6.9.18.1 Checking the oil filter

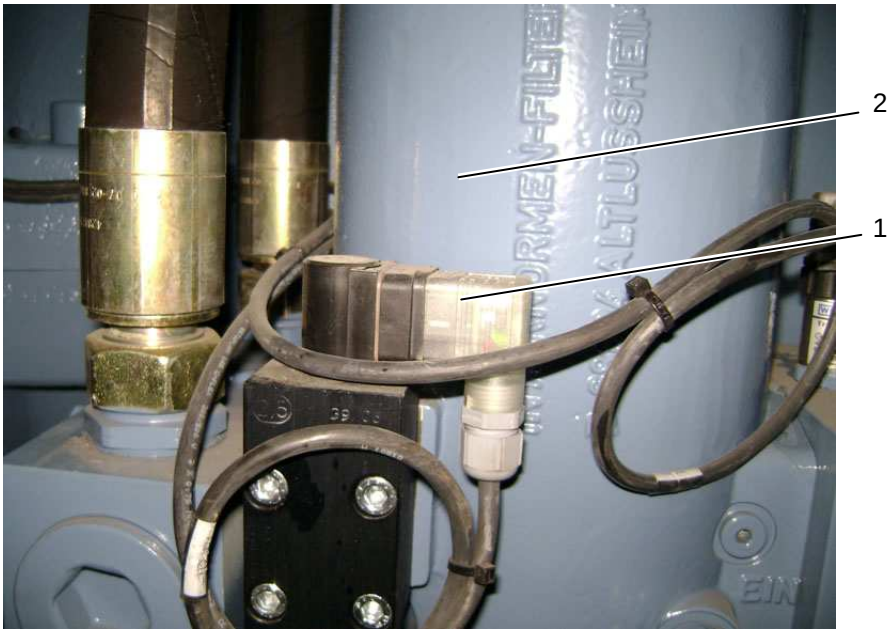



Fig. 6.9.18.1 – 1 Soiling indicator of the oil filter

1. Check the soiling indicator (1) (in the lower range of the oil filter housing (2).
2. If the soiling indicator (1) is lit in green, the condition of the oil filter is ok.
3. If the soiling indicator (1) is lit in red, the oil filter needs to be replaced (ref. chapter 6.9.18.2).
4. If a status message has been received via the REguard Monitoring, the oil filter needs to be replaced within 10 days (ref. chapter 6.9.18.2).

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### 6.9.18.2 Replacing the oil filter

**CAUTION**

**Danger due to escaping vapors**

Escaping vapors may cause breathing difficulties and eye irritations.

- Wear closely sealing protective goggles.
- Wear a respirator mask.
- Ensure sufficient ventilation.

**CAUTION**

**Risk of burns due to hot gearbox oil**

- Engage the rotor lock (ref. operating manual).
- Keep the rotor holding brake closed (ref. operating manual).
- Set the motor circuit switches of the gearbox oil pump and the partial flow filter in the top box to STOP.
- Wear oil-proof gloves.
- Do not reach into the oilsump.

**NOTICE**

**Danger due to using incorrect gearbox oil**

Damage to the gearbox due to modified chemical and physical properties when mixing different types of gearbox oil.

- Generally use to gearbox oil type that is already present in the gearbox (ref. oil card or type label at the gearbox).
- Never mix different gearbox oil types or gearbox oil by different manufacturers, especially not synthetic gearbox oil and mineral oil.
- Consult Repower Systems AG when switching to another gearbox oil type.

**Required tools / operating and auxiliary means:**

- Waste oil canister with funnel
- Ratchet with extension
- No. 5, No. 10, and No. 14 Allen wrench plug inserts
- No. 27 jaw wrench
- 2 containers for storing the filters
- Oil-proof gloves
- Closely sealing protective goggles
- Approx. 0,26 gal. (1 liter) of gearbox oil in accordance with the oil card or the type label of the gearbox
- Non-fraying cloths

**Directive:**

**Note:** This maintenance work should be performed by two service technicians.

Fig. 6.9.18.2 – 1 Hatch to the lower nacelle area

(Floor plate in the coupling area has already been removed)

1. Release the floor plate and put it to the side

**⚠ CAUTION** **Risk of head injuries. Wear a bump cap.**

**Second service technician**:

2. The second service technician should descend into the area below the machine base and support the first service technician in accordance with the instructions.

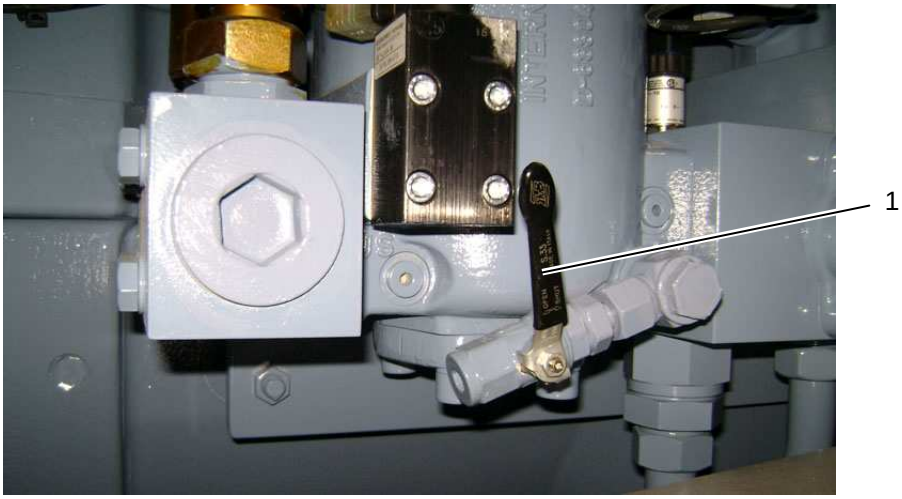



Fig. 6.9.18.2 – 2 Oil drain valve

3. The oil drain valve (1) must be closed.


Fig. 6.9.18.2 – 3 Releasing the oil drain screw at the oil filter

4. Release and remove the oil drain screw (2).
5. Place the waste oil canister with the funnel underneath the oil drain (second service technician).
6. Open the oil drain valve (1) (fig. 6.9.18.2 – 2).
7. Drain the remaining oil into the waste oil canister.
8. Close the oil drain valve again.
9. Clean the oil drain with cloths.


Fig. 6.9.18.2 – 4 Oil filter housing cover with air outlet (example: manufacturer Winergy)

10. Remove the air outlet (2) at the oil filter housing cover (1) and put the tube connection to the side.
11. Release the protective cover (5).
12. Release 4 pcs. hexagon socket screws (6) and put them to the side.

13. Remove the oil filter housing cover (3) and place it in a safe manner on a non-fraying cloth (this protects the seal that has been arranged in the cover).


Fig. 6.9.18.2 – 5 Removing the first filter stage

14. Remove the first filter stage (7), let it drain, and place it in a container.


Fig. 6.9.18.2 – 6 Intermediate ring

**Note:** An intermediate ring is arranged on the second filter stage (8).

15. Carefully pry out the intermediate ring (8), clean it, and put it to the side in a safe manner.

**Note:** The second filter stage is tightly arranged on another ring.

16. Carefully pry out the second filter stage, let it drain, and place it in a container.

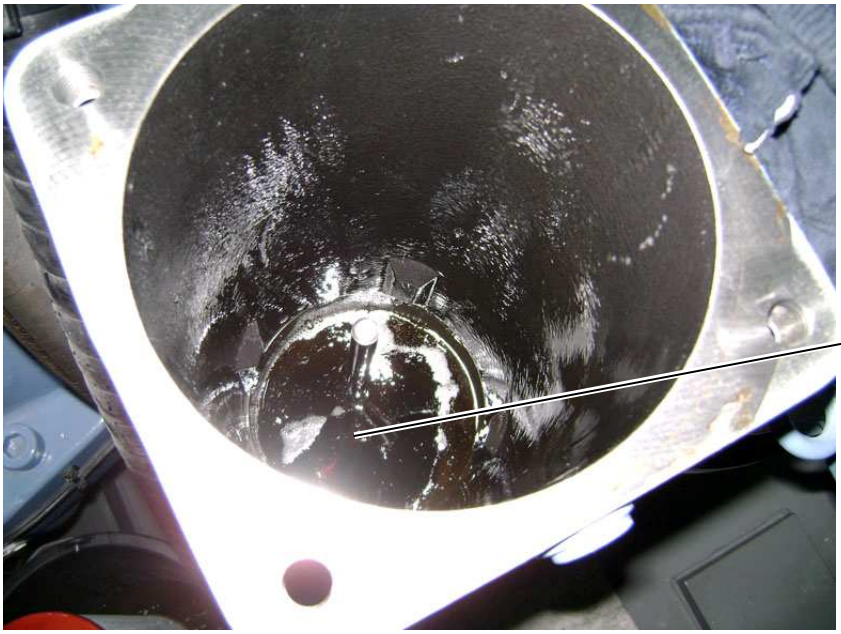



Fig. 6.9.18.2 – 7 Oilsump of the oil filter housing

17. Use a permanent magnet to search the oilsump (9) for metallic residue.
18. Document any metallic residue in the service booklet.
19. Drain the remaining oil in the manner detailed above.
20. Flush with fresh gearbox oil in accordance with the oil card or the type label of the gearbox, subsequently drain this oil as well.
21. Close the oil drain valve again.

**Task of the second service technician:**

22. Close the waste oil canister and dispose of the waste oil in the proper manner.
23. Re-tighten the floor plate.

**Task of the first service technician:**

24. Replace the oil drain screw (2) (fig. 6.9.18.2 – 4) and tighten it.
25. Clean the working area.
26. Insert the new second filter stage and let it lock into place on the ring.
27. Insert the intermediate ring (8).

**Note:** One side of the first filter stage is labeled "top" Observe the direction of insertion!

28. Insert the new first filter stage and let it lock into place on the intermediate ring (8).
29. Clean the oil filter housing flange.

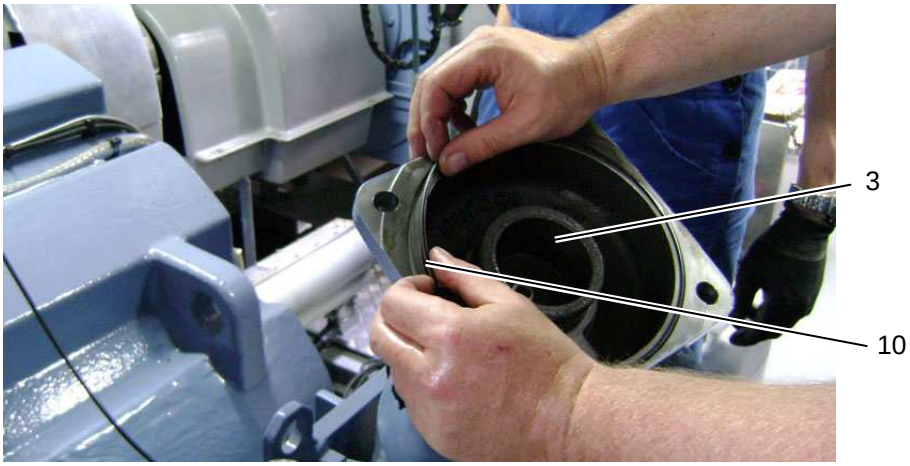



Fig. 6.9.18.2 – 8 Oil filter housing cover

30. Clean the oil filter housing cover (3).
31. Check the seal (10) and insert it correctly.
32. Replace the oil filter housing cover and tighten it.
33. Remove the protective cover (3) (fig. 6.9.18.2 – 2).
34. Attach the air outlet (2) (fig. 6.9.18.2 – 2) to the oil filter housing cover (1).
35. Package replaced filters in oil-proof means and dispose of them in the proper manner.
36. Clean the working area.
37. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

### 6.9.18.3 Checking the condition of the hose lines, pipes, and screw connections

**Required tools / operating and auxiliary means:**

- Closely sealing protective goggles
- Oil-proof gloves
- Flashlight
- Tools as required for the respective repair

**Directive:**

1. Set the motor circuit switches of the gearbox oil pump and the partial flow filter to STOP.

**Hose lines**

2. Check all hose lines for damage and wear of the hose cover and the hose connections.

**⚠ CAUTION** **Risk of burns due to hot gearbox oil. Wear oil-proof gloves and closely sealing protective goggles.**

3. Replace damaged hose lines.
4. To that end, hold ready an oil collecting container and replace the elements in accordance with the list of spare parts by the manufacturer.
5. Cushion endangered points, e.g. friction surfaces.
6. Do not overstretch hose lines.
7. Dispose of waste oil in the proper manner and clean the working area.

**Pipes**

8. Check the pipes for a tight fit and damage.

**⚠ CAUTION** **Risk of burns due to hot gearbox oil. Wear oil-proof gloves and closely sealing protective goggles.**

9. Replace damaged pipes.
10. To that end, hold ready an oil collecting container and replace the elements in accordance with the list of spare parts by the manufacturer.
11. Dispose of waste oil in the proper manner and clean the working area.

**Screw connections**

12. Check the screw connections for a tight fit.
13. Re-tighten and clean leaking screw connections.
14. Hold an oil collecting container ready to that end.

15. Dispose of waste oil in the proper manner and clean the working area.
16. Set the motor circuit switches of the gearbox oil pump and the partial flow filter to START.
17. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

### 6.9.18.4 Checking for leaking oil

**Required tools / operating and auxiliary means:**

- Closely sealing protective goggles
- Oil-proof gloves
- Flashlight
- Tools as required for the respective repair

**Directive:**

- Check the hose lines, the pipes, and the associated screw connections (ref. chapter 6.9.18.3).
- Check the entire gearbox area for leaking oil.
- Check the screw connections for a tight fit.
- Re-tighten and clean leaking screw connections if applicable.
- Clean the gearbox.
- Document bigger leaks in the service booklet.

### 6.9.18.5 Checking the ventilator for damage or soiling

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**


Fig. 6.9.18.5 – 1 Ventilation hose

1. Release the closure (2) of the tension belt (3) of the ventilation hose (1).
2. Lift up the ventilation hose (1).

**⚠ CAUTION Risk of contusions due to rotating system components. Do not reach into rotating system components.**


Fig. 6.9.18.5 – 2 Ventilator

3. Check the axial ventilator (5) of the gearbox oil cooler for damage and soiling.
4. Document defects in the service booklet.

**Note:** Combine this maintenance section with 6.9.18.6.

5. Replace the ventilation hose on the ventilator stub (4).
6. Tighten the tension belt.
7. Ensure the correct position of the ventilation hose.

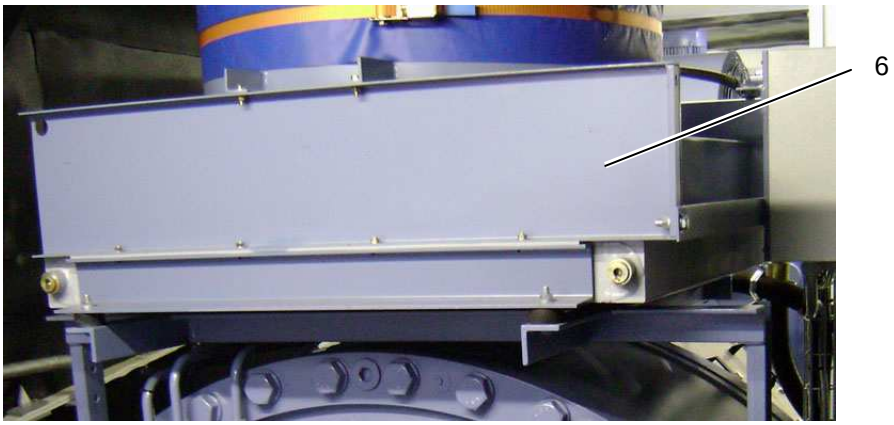



Abb. 6.9.18.5 – 3 Oil cooler (example: manufacturer Winergy)


Abb. 6.9.18.5 – 4 Ribs of the oil cooler

8. Check the ribs (7) of the oil cooler (6) for soiling.
9. Clean with vacuum cleaner and hand brush (if needed).

## 6.9.18.6 Condition of the ventilation hose

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**


Fig. 6.9.18.6 – 1 Ventilation hose

1. Release the closure (2) of the tension belt (3) of the ventilation hose (1)

**⚠ CAUTION Risk of contusions due to rotating system components. Do not reach into rotating system components.**

2. Check the ventilation hose (1) for cracks.
3. Repair smaller cracks, otherwise replace the ventilation hose (1).
4. Document defects in the service booklet.

**Note:** Combine this maintenance section with 6.9.18.5.

5. Replace the ventilation hose (1) on the ventilator stub (4).
6. Tighten the tension belt (3).
7. Ensure the correct position of the ventilation hose (1).

### 6.9.18.7 Checking the function of the ventilator

**Required tools / operating and auxiliary means:**

- none

**Directive:**


Fig. 6.9.18.7– 1 Switch ventilator gearbox oil cooler in the top box

1. Open the plastic cover (2) at the switch (1) of the gearbox oil cooler.
2. Manually activate the switch (1) → The ventilator must start up.
3. Close the plastic cover (2) again.

## 6.9.18.8 Checking the function of the gearbox oil heater

**Required tools / operating and auxiliary means:**

- Clip-on ammeter for alternating current

**Directive:**

1. Determine the terminals for the gearbox oil heater in accordance with the service booklet or the circuit diagram in the top box.


Fig. 6.9.18.8 – 1 Checking the function of the oil heater

2. Close the clip-on ammeter around an individual phase (2).


Fig. 6.9.18.8 – 2 Switch gearbox oil heater

3. Open the plastic cover (3) of the switch gearbox oil heater (4).
4. Manually activate the switch gearbox oil heater in the top box (4).
5. Retrieve the measurement at the clip-on ammeter and document it in the service booklet.
6. Repeat steps 2 through 5 for each phase of each gearbox oil heater.
7. Close the plastic cover (3) again.

# 6.10 Slip ring unit


**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.10.1 Slip ring unit co. Label

Not applicable.

## 6.10.2 Slip ring unit co. Schleifring

### 6.10.2.1 Checking the slip ring unit

**Required tools / operating and auxiliary means:**

- No. 3 Allen wrench
- Flashlight

**Directive:**

**Note:** Slip rings are maintenance-free for five years!

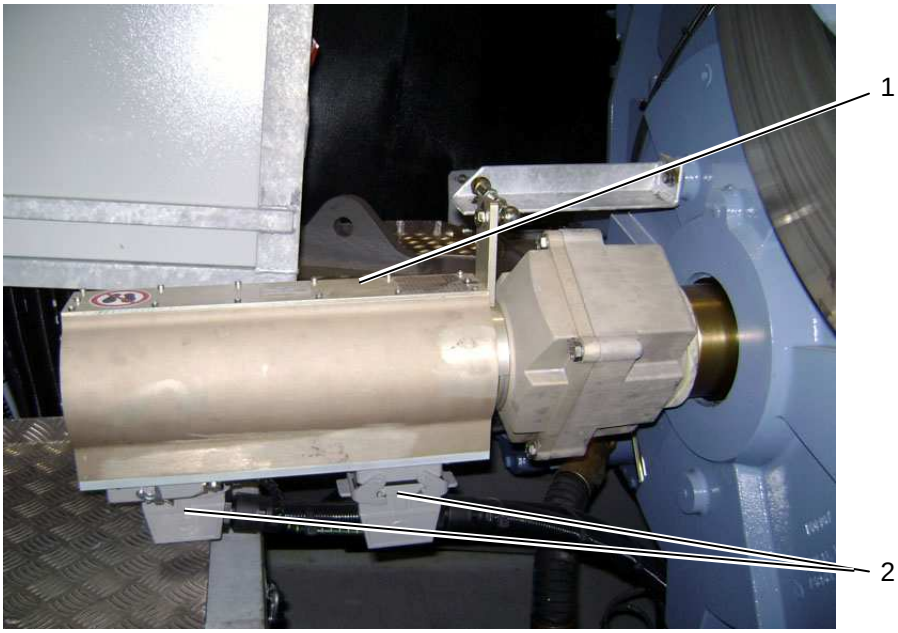



Fig. 6.10.2 -1 Slip ring unit

1. Disconnect the Harting plug (2).
2. Release the screws of the inspection cover (1).
3. Safely put the inspection cover (1) to the side.

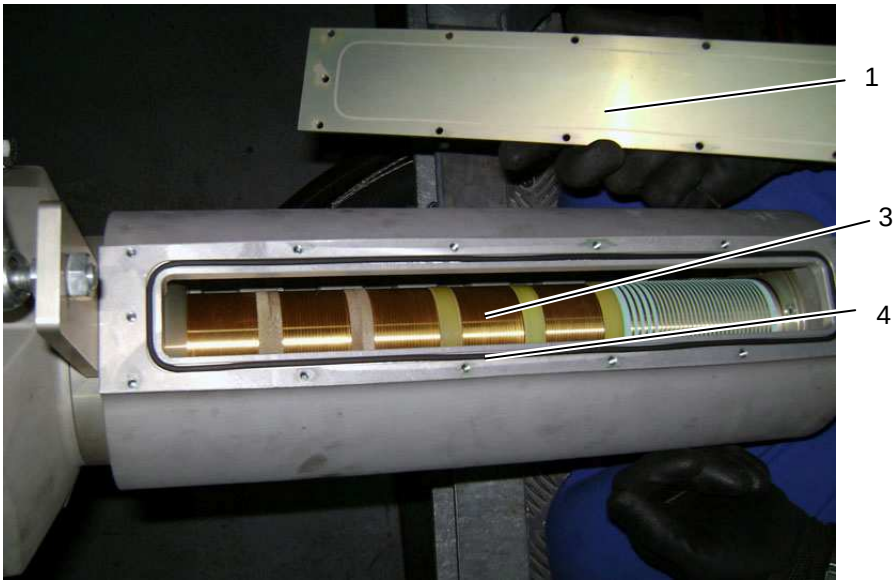



Fig. 6.10.2 – 3 Slip ring unit

4. Perform a visual inspection of the individual slip tracks (3).

**NOTICE** **Failure of the slip ring unit due to defective seals (4). Defective seals (4) need to be replaced.**

5. Inspect the seal (4) for damage.
6. Document soilings of the slip tracks (3) in the service booklet.
7. Re-attach the inspection cover (1).
8. Reconnect and secure the Harting plug (2).

### 6.10.2.2 Performing a revision replacement of the slip ring unit

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut

**Directive:**

**DANGER** **Danger due to high voltages Observe the safety notices in chapter 5. Work at the slip ring unit may only be performed by a skilled electrician and while the wind turbine stands still.**

**NOTICE** **Risk of damage to the slip ring unit. Slip ring units are sensitive to shocks. Avoid severe shocks and vibrations.**

1. Keep a new slip ring unit available.
2. Set the circuit breakers of the pitch and hub lighting supply in the top box to "OFF"
3. Set all motor-circuit switches of the rotor hub components to STOP to disconnect all electric currents, voltages and signals from the slip ring paths (ref. circuit diagram).
4. Use a key to set the service switch at the top box to "I" and remove the key

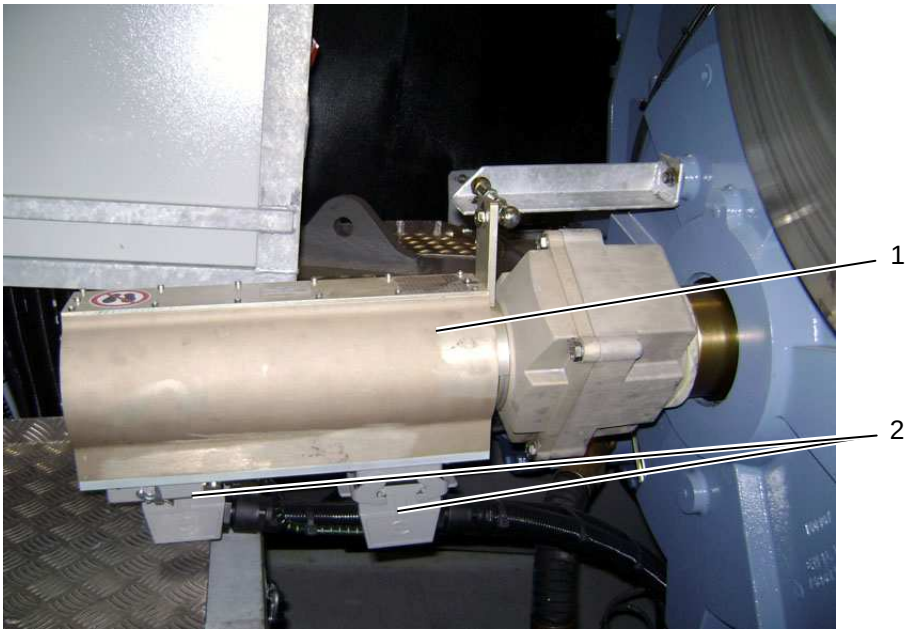



Fig. 6.10.2.2 – 1 Slip ring unit

5. Disconnect both Harting plugs (2) of the slip ring unit (1) and place them in the lower section of the machine base.

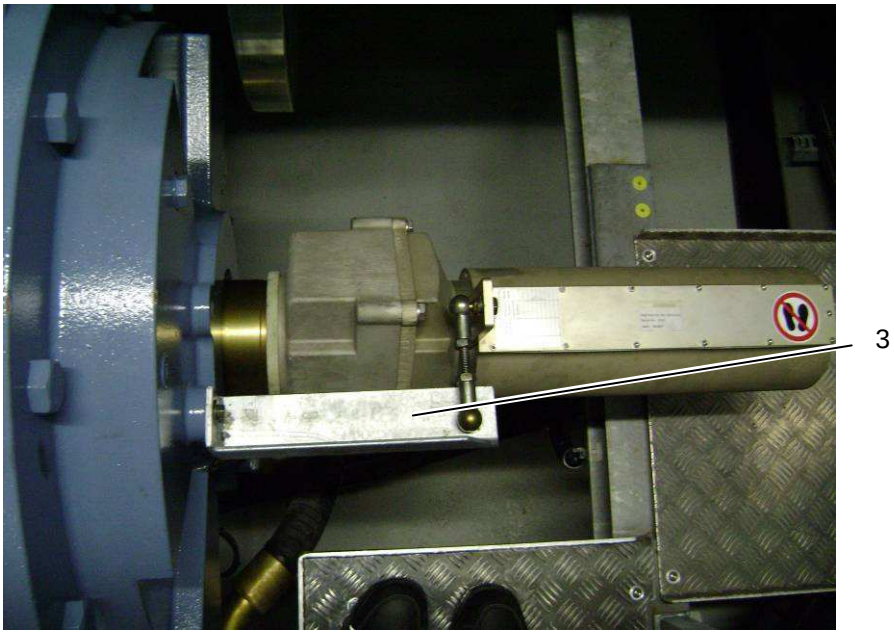



Fig. 6.10.2.2 – 2 Torque support of the slip ring unit

6. Remove the torque support (3) and put it to the side
7. Safely support the slip ring unit (1) prior to the removal; secure it against falling down after the release of the screw connection

**Note:** The slip ring unit weighs approx. 35 kg.

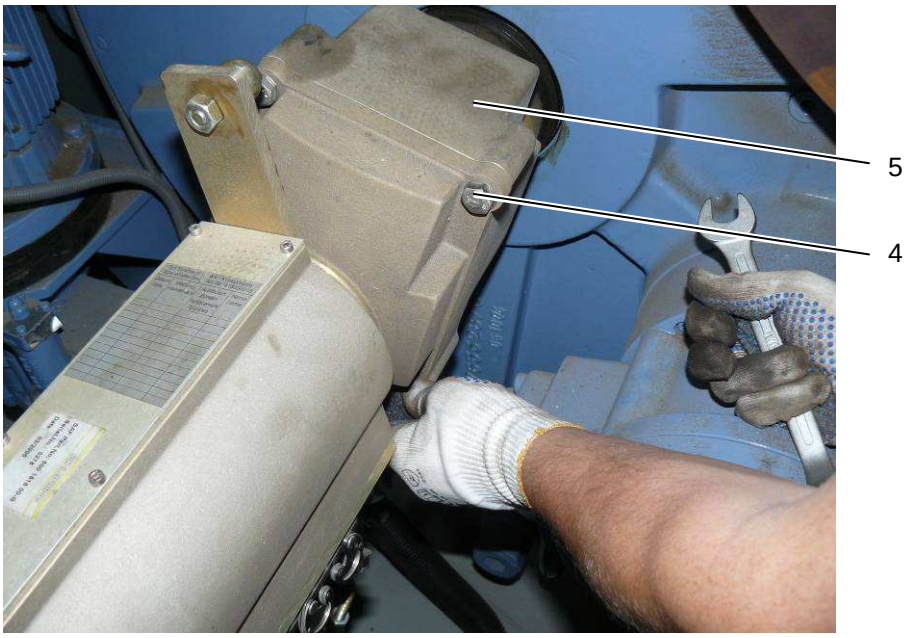



Fig. 6.10.2.2 – 3 Releasing the screw connection

8. Release the screw connection of the slip ring unit.
9. Remove the slip ring unit from the adapter (5) and put it to the side.
10. Keep a new slip ring unit available.
11. Place a new slip ring unit on the adapter and secure it against falling down.

12. Re-tighten the screw connection (4).
13. Manually turn the slip ring unit ten times.
14. Reinstall the torque support (3).
15. Reconnect the Harting plugs (2) and secure them with the locking bracket.
16. Set all circuit breakers and motor-circuit switches in the top box back to "On" or "START".
17. Dispose of the old slip ring unit as waste electrical equipment.

### 6.10.3 Slip ring unit co. Dietrich

Not applicable for USA.

# 6.11 Rotor holding brake

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.11.1 Checking the surface of the brake disk

Manufacturer: SVENDBORG BRAKES – BSAK 3000

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- Flashlight, digital camera

**Directive:**

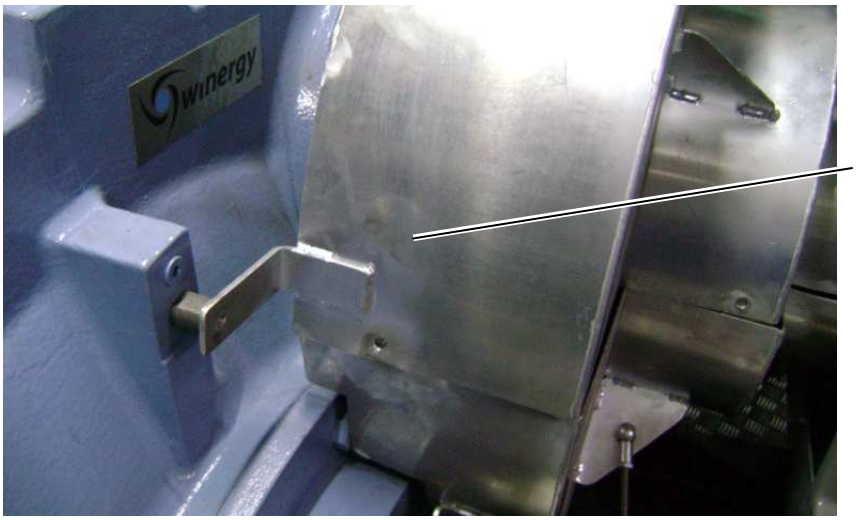



Fig. 6.11.1 – 1 Cover of the rotor holding brake

1. Remove the cover (1) of the rotor holding brake.
2. Put the cover (1) to the side.
3. If the rotor lock has been engaged, open the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

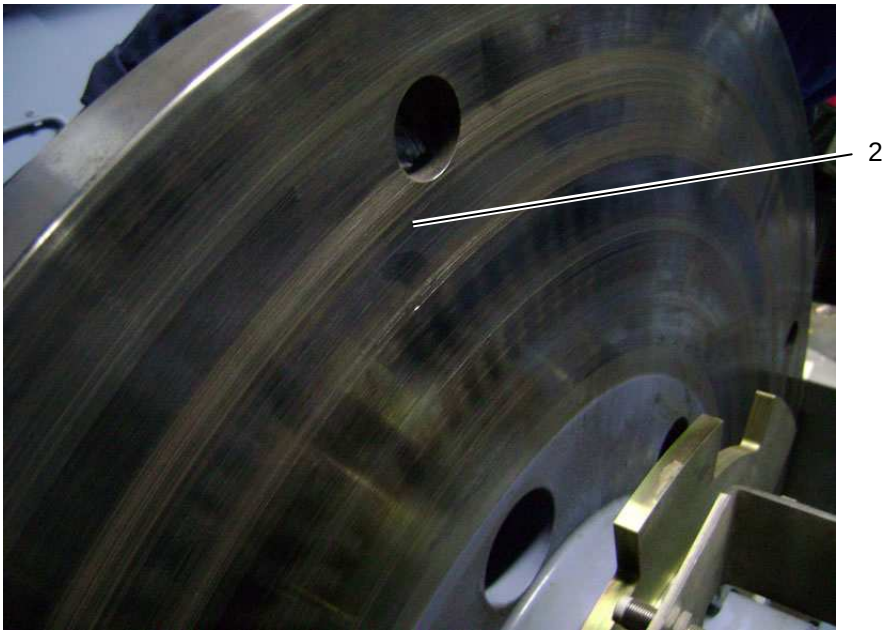



Fig. 6.11.2 – 2 Brake disk

4. Examine the surface of the brake disk (2) for cracks, grooves, chippings, and bumps on both sides.
5. Document defects in the service booklet.

**⚠ WARNING Risk of contusions due to rotating system components: Do not reach into rotating system components.**

6. Release the rotor holding brake after inspecting the first section of the brake disk (2) and continue turning the rotor until the next section of the brake disk (2) becomes visible.
7. Engage the rotor holding brake and inspect the visible section of the brake disk (2).
8. Document defects in the service booklet.
9. Repeat steps 4 through 8 until the entire brake disk (2) has been inspected.

**Note:** Perform this maintenance section together with chapter 6.11.2 "Checking that the brake disk is free from grease and oil".

10. Engage the rotor holding brake.
11. Reinstall the cover (1) of the rotor holding brake.
12. Engage the rotor lock (ref. operating manual).

## 6.11.2 Checking that the brake disk is free from grease and oil

Manufacturer: SVENDBORG BRAKES – BSAK 3000

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- Brake cleaner

**Directive:**


Fig. 6.11.2 – 1 Cover of the rotor holding brake

1. Remove the cover (1) of the rotor holding brake.
2. Put the cover (1) to the side.


Fig. 6.11.2 – 2 Brake disk

3. Check whether the surface of the brake disk (2) is free from oil and grease.
4. If the brake disk (2) has been soiled with grease or oil, start by determining and resolving the cause of the soiling.

**NOTICE** **Danger of system damage due to a soiled brake disk (2) as the brake effect of a brake disk (2) soiled with oil is greatly reduced or cancelled. Observe the following directive.**

5. Remove the brake pads (ref. chapter 6.11.5 "Changing the brake pads").
6. Replace brake pads that have been soiled with oil.
7. Clean the accessible section of the brake disk (2) with brake cleaner (observe the safety notices provided by the manufacturer).

**Note:** The section of the brake disk (2) which is covered by the rotor holding brake needs to be cleaned prior to installing the new or cleaned brake pads. This prevents the brake pads from getting in contact with a brake disk (2) that has been soiled with oil when engaging the rotor holding brake.

8. If the rotor lock has been engaged, open the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

**⚠ WARNING** **Risk of contusions due to rotating system components. Do not reach into rotating components!**

9. Release the rotor holding brake after inspecting the first section of the brake disk (2) and continue turning the rotor until the next section of the brake disk (2) becomes visible.
10. Engage the rotor holding brake as soon as the next section of the brake disk (2) to be cleaned becomes accessible.
11. Clean this section of the brake disk (2).
12. Repeat steps 7 through 11 until the entire brake disk (2) has been cleaned.
13. Embed the brake pads in accordance with the instructions enclosed with the brake pads in the brake disk (2).
14. Engage the rotor holding brake.
15. Reinstall the cover (1) of the rotor holding brake.
16. Engage the rotor lock (ref. operating manual).

## 6.11.3 Inspecting the brake pad surface and the brake pad thickness

Manufacturer: SVENDBORG BRAKES – BSAK 3000

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- 2 pcs. No. 17 jaw wrench
- Feeler gauge for gap sizes up to approx. 0.079 in. (2 mm)
- Ratchet with No. 17 Allen wrench plug insert

**Directive:**

**⚠ WARNING Risk of contusions due to rotating system components. Engage the rotor lock (ref. operating manual). Do not reach into rotating components!**

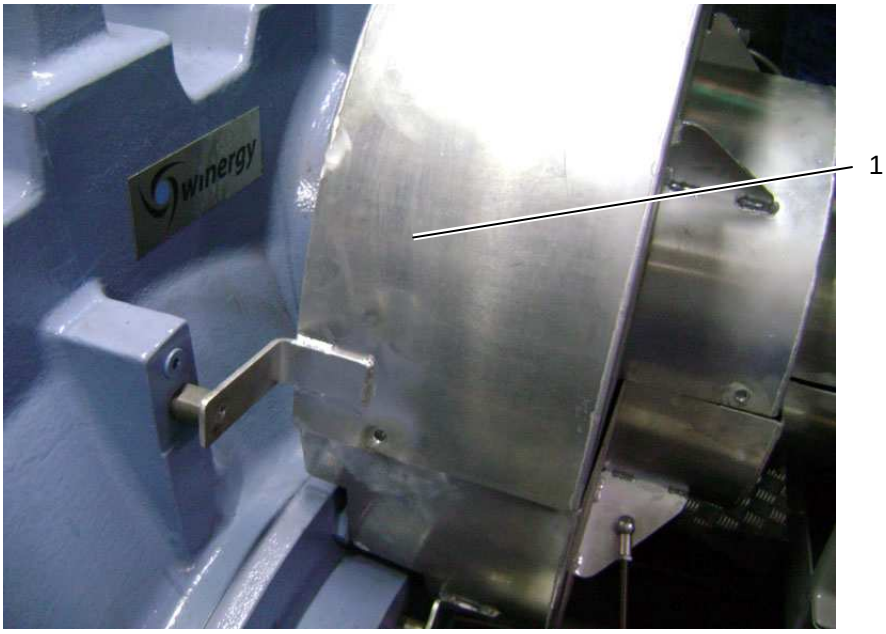



Fig. 6.11.3 – 1 Cover of the rotor holding brake

1. Remove the cover (1) of the rotor holding brake.
2. Put the cover (1) to the side.

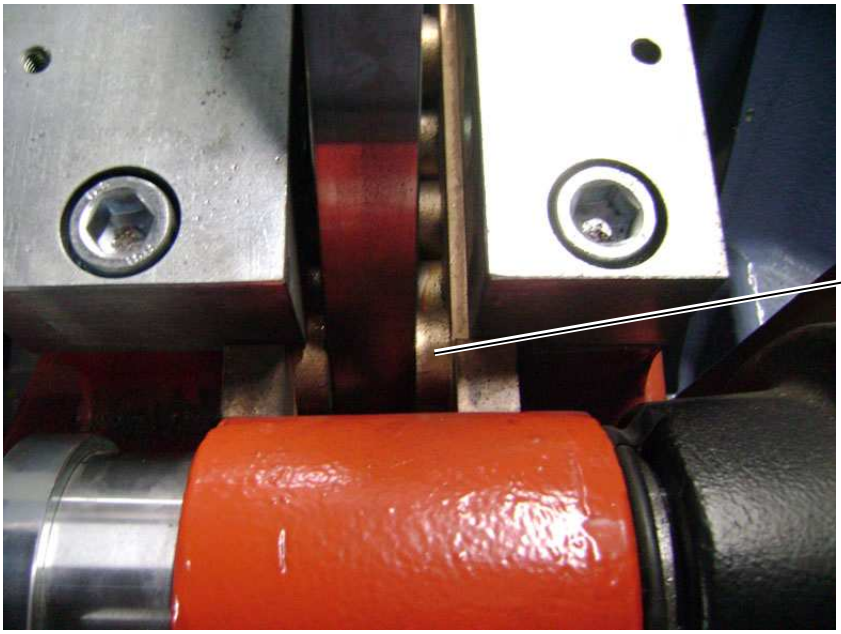



Fig. 6.11.3 – 2 Rotor holding brake

3. Release the rotor holding brake while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual)

**⚠ WARNING Risk of contusions when engaging the rotor holding brake. Make absolutely sure that the rotor holding brake will not be activated during the following maintenance steps!**

**NOTICE Danger due to damaged brake pads (2): Measuring the thickness of the brake pads (2) in the installed condition (fig. 6.11.3 – 2) is insufficient. Damage of the brake pads (2), e.g. chippings and grooves, may only be evaluated after removing the brake pads (2).**

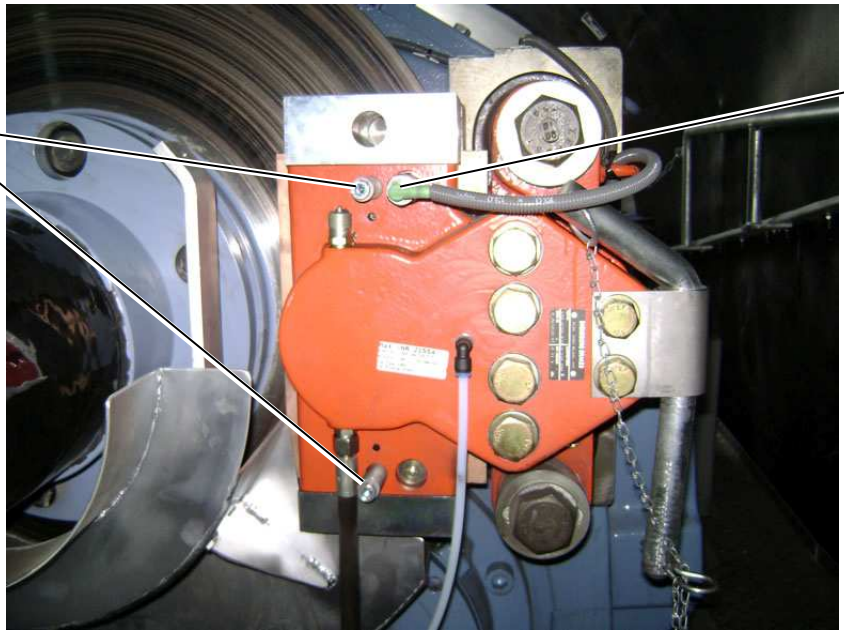



Fig. 6.11.3 – 3 Rotor holding brake


Fig. 6.11.3 – 4 Wear signaling mechanism and pad return spring

4. Release and disconnect the plug (3) of the wear signaling mechanism (4).
5. Remove the wear signaling mechanism (4).

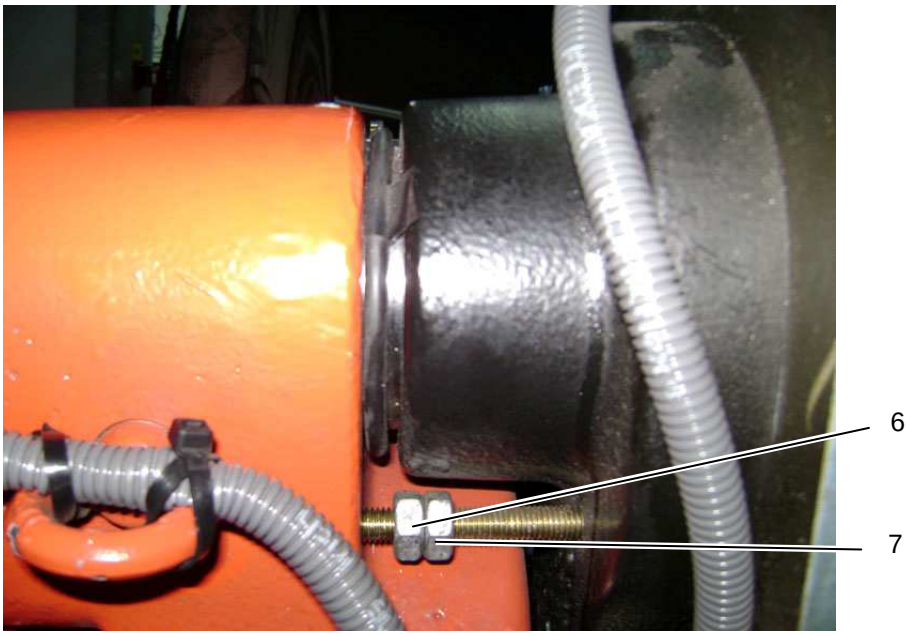



Fig. 6.11.3 – 5 Positioning system

6. Release the check nut (7) and the rating nut (6) of the positioning system.

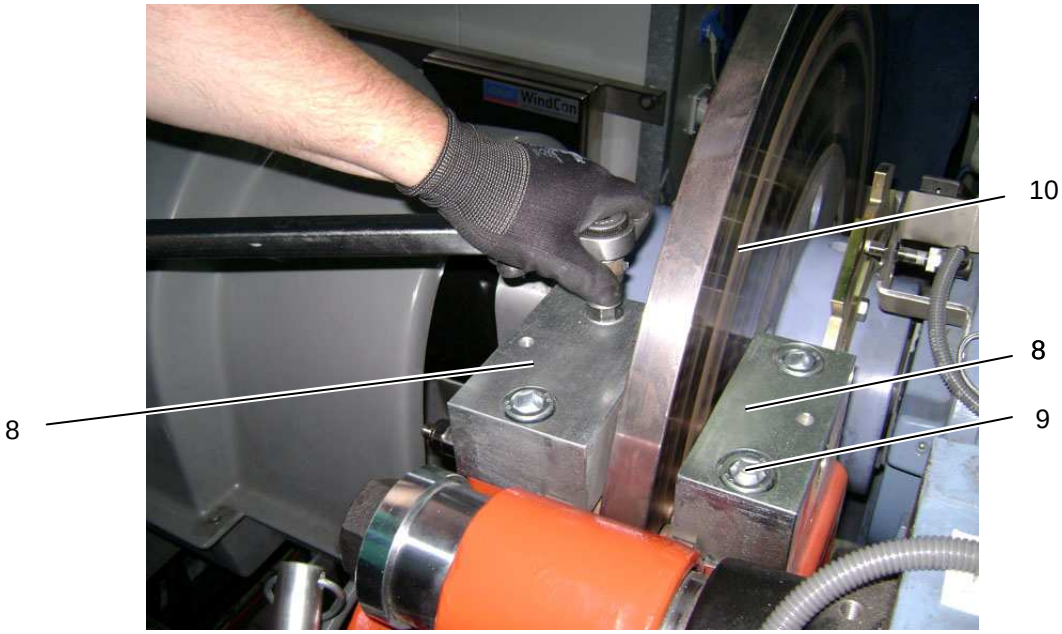



Fig. 6.11.3 – 6 Removing the pad holder

7. Release the 4 hexagon socket screws (9) of the pad holder (8).
8. Remove the pad holder (8) and store it in a secure manner.
9. Release 2 pad return springs (5) per pad and store them in a secure manner.

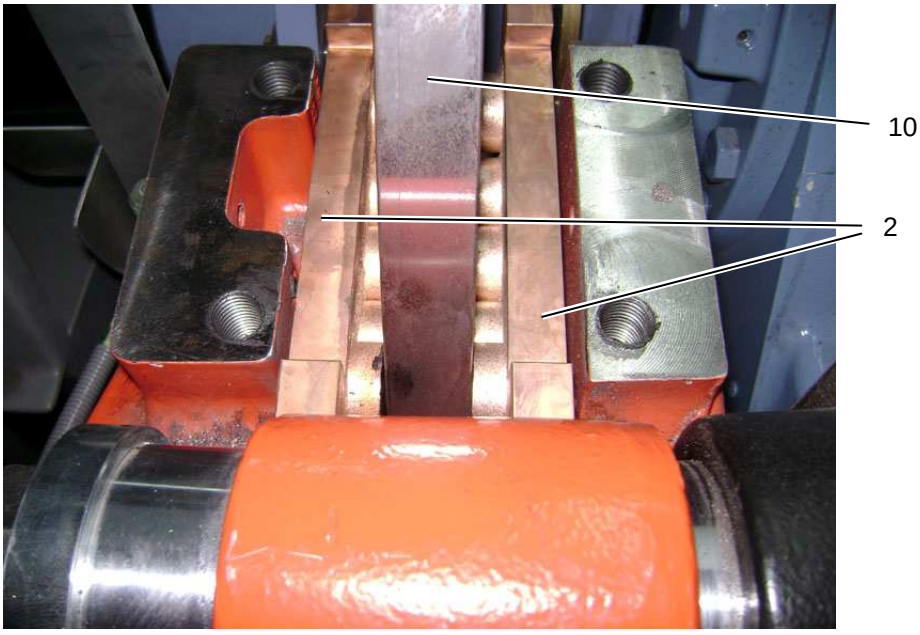



Fig. 6.11.3 – 7 Rotor holding brake without pad holder

10. Pull out the brake pads (2).
11. Push the piston all the way to the bedstop into the yoke.

Fig. 6.11.3 – 8 Measuring the brake pad thickness

12. Measure the brake pad thickness (fig. 6.11.3 – 8): the brake pad including the carrier plate need to exhibit a minimum thickness of 1.14 in. (29mm).
13. Document the actual brake pad thickness values of both brake pads under 6.11.5 in the service booklet.
14. Replace brake pads which do not reach that value.
15. Inspect the surface of the brake pads.

Fig. 6.11.3 – 9 Example of a damaged brake pad

16. If the brake pad has been damaged, both brake pads need to be replaced – observe the direction of installation.

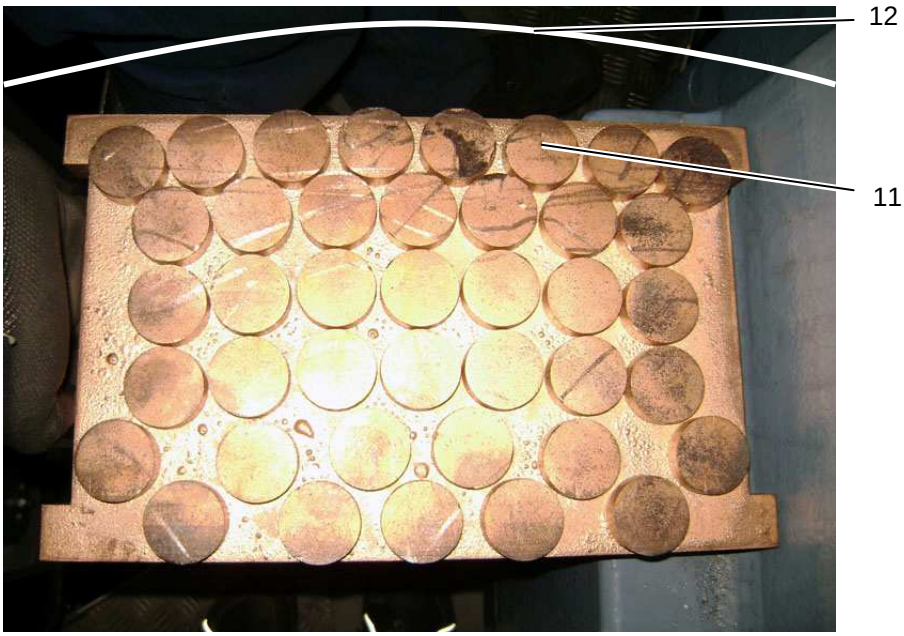



Fig. 6.11.3 – 10 New brake pad

17. Clean the brake disk (10) with brake cleaner prior to reinstalling the brake pads (observe the safety notices provided by the manufacturer).

**Note regarding the direction of installation:** The upper row (11) of the brake pad in fig. 6.11.5 – 10 needs to contact the outer diameter of the brake disk (indicated by (12)).

**NOTICE** **Danger due to incorrect installation position of the brake pads. The brake effect of the rotor holding brake is reduced. This may cause safety problems. Observe the direction of installation.**

18. Re-insert the brake pads while observing the direction of installation.
19. Reinstall the pad holder (8).
20. Reinstall the pad return springs (5) (install the long pad return springs on the left and the short pad return springs on the right).
21. Re-insert the wear signaling mechanism (4).
22. Connect the plug (3) to the wear signaling mechanism (4) and tighten it.

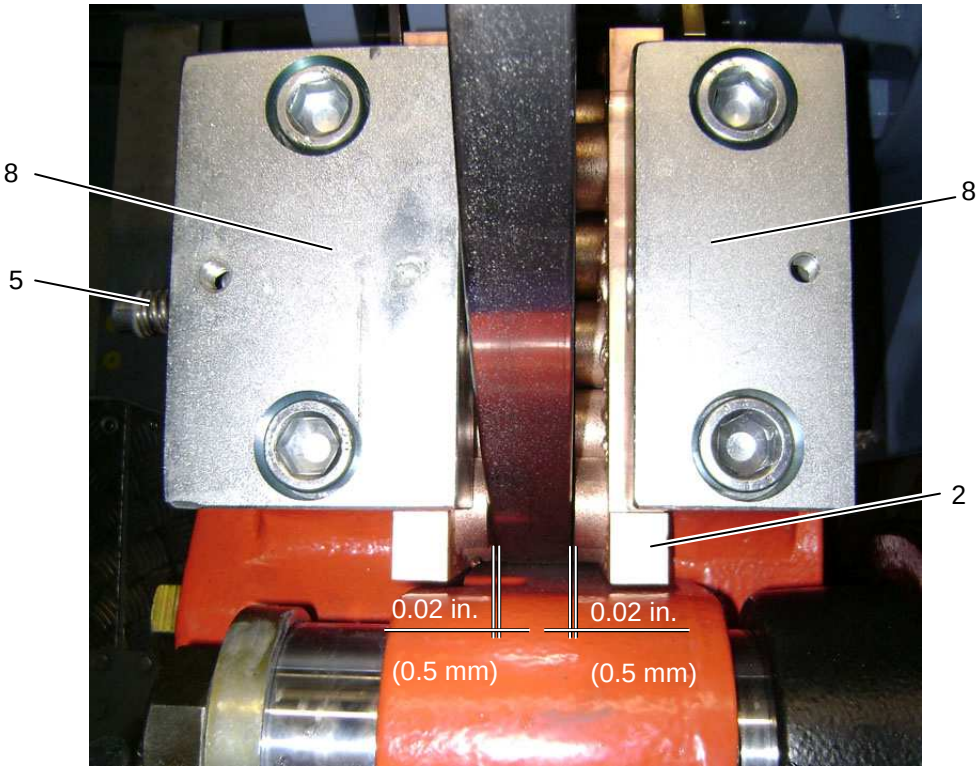



Fig. 6.11.3 – 11 Aligning the brake pads

23. Center the brake pads. To that end, tighten the rating nut (6) (fig. 6.11.5 – 5) (to the left) until both brake pads exhibit the same distance to the brake disk (fig. 6.11.3 – 11).

**Note:** The distance between the brake disk and the brake pad should not exceed 0.02 in. (0.5 mm). The brake pads should not touch the brake disk.

24. Measure the distance between the brake disk and the brake pad
25. If both distances are equal, tighten the locknut (7) (fig. 6.11.5 – 5)
26. Embed new brake pads in accordance with the instructions enclosed with the brake pads in the brake disk.
27. Engage the rotor holding brake.
28. Reinstall the cover (1) of the rotor holding brake.

## 6.11.4 Positioning of the caliber half of the rotor holding brake on the gearbox side

Manufacturer: SVENDBORG BRAKES – BSAK 3000

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- 2 pcs. No. 17 jaw wrench
- Ratchet with No. 17 Allen wrench plug insert
- Feeler gauge for gap sizes up to approx. 0.079 in. (2 mm)
- Brake cleaner

**Directive:**

**⚠ WARNING Risk of contusions due to rotating system components. Engage the rotor lock (ref. operating manual). Do not reach into rotating components!**

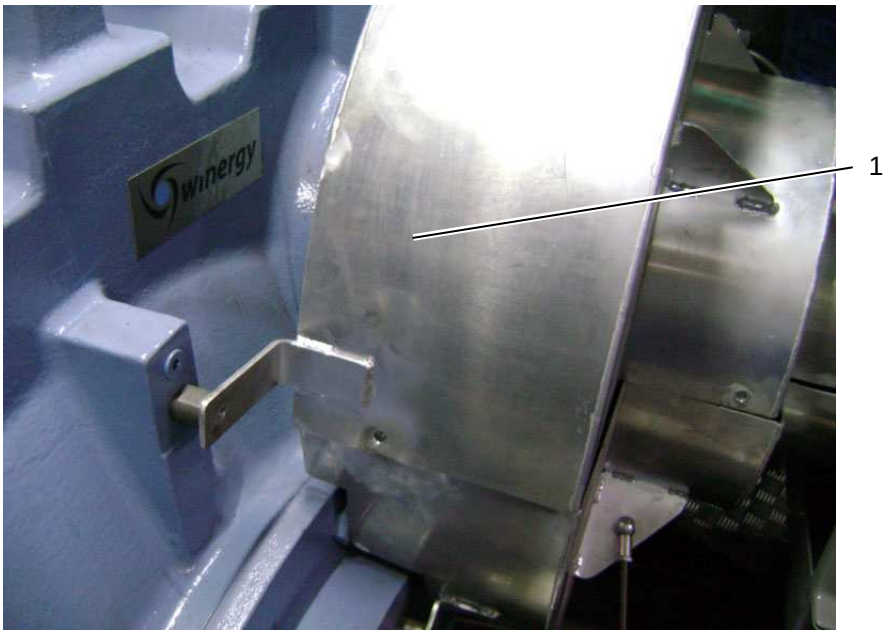



Fig. 6.11.4 – 1 Cover of the rotor holding brake

1. Remove the cover (1) of the rotor holding brake.
2. Put the cover (1) to the side.
3. Release the rotor holding brake while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual)

**⚠ WARNING Risk of contusions when engaging the rotor holding brake. Make absolutely sure that the rotor holding brake will not be activated during the following maintenance steps!**

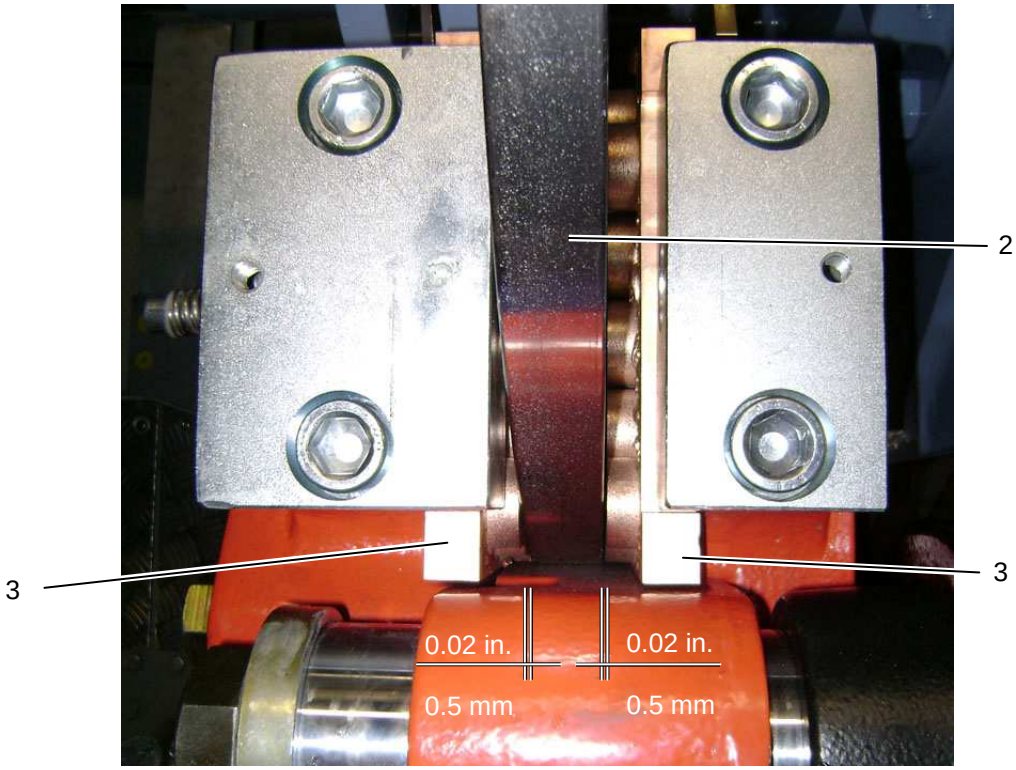



Fig. 6.11.4 – 2 Aligning the brake pads

4. Use the feeler gauge to check whether the distances of the rotor disk (2) to the brake pads (3) are even.
5. If yes, continue with step 11.
6. If no, perform the following steps.

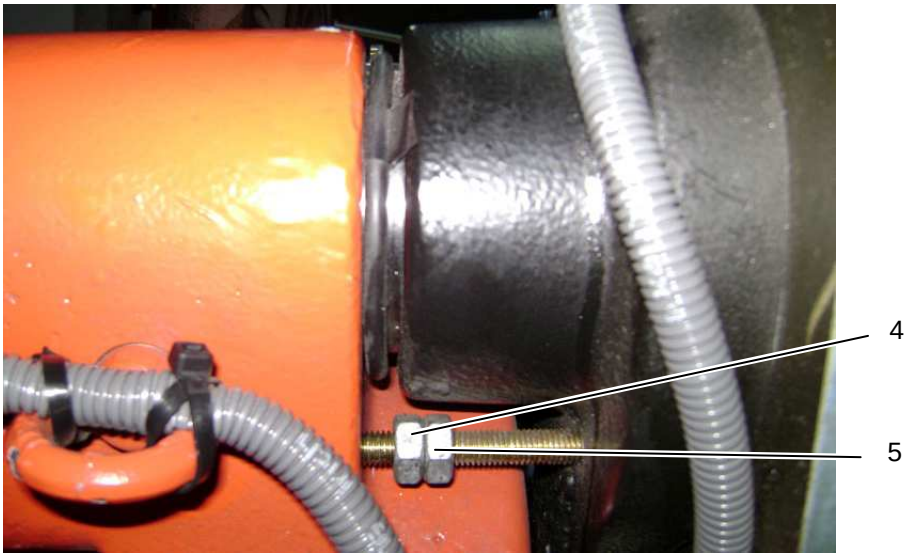



Fig. 6.11.4 – 3 Positioning system

7. Release the check nut (5) of the positioning system.

8. Center the brake pads. To that end, turn the rating nut (4) to the right or left until both brake pads (3) exhibit the same distance to the brake disk (2).

**Note:** The distance between the brake disk (4) and the brake pad (5) should not exceed 0.02 in. (0.5 mm). The brake pads should not touch the brake disk.

9. Re-check the distance between the brake disk (2) and the brake pad (3).
10. If both distances are equal, tighten the check nut (5).
11. Engage the rotor holding brake.
12. Reinstall the cover (1) of the rotor holding brake.

## 6.11.5 Changing brake pads

Manufacturer: SVENDBORG BRAKES – BSAK 3000

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- 2 pcs. No. 17 jaw wrench
- Ratchet with No. 17 Allen wrench plug insert
- Feeler gauges for gap sizes up to approx. 0.079 in. (2 mm)

**Directive:**

**⚠ WARNING Risk of contusions due to rotating system components. Engage the rotor lock (ref. operating manual). Do not reach into rotating components!**


Fig. 6.11.5 – 1 Cover of the rotor holding brake

1. Remove the cover (1) of the rotor holding brake.
2. Put the cover (1) to the side.

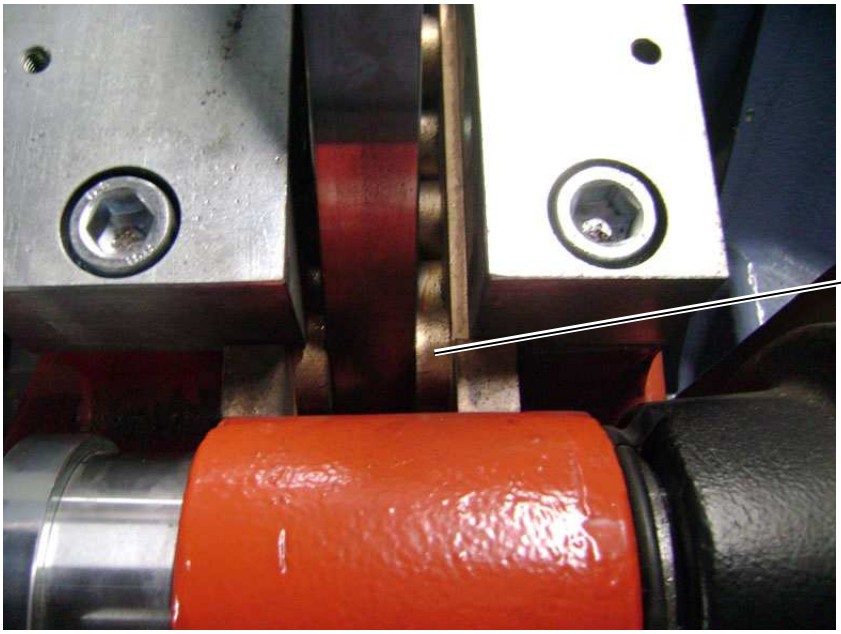



Fig. 6.11.5 – 2 Rotor holding brake

3. Release the rotor holding brake while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual)

**⚠ WARNING Risk of contusions when engaging the rotor holding brake. Make absolutely sure that the rotor holding brake will not be activated during the following maintenance steps!**

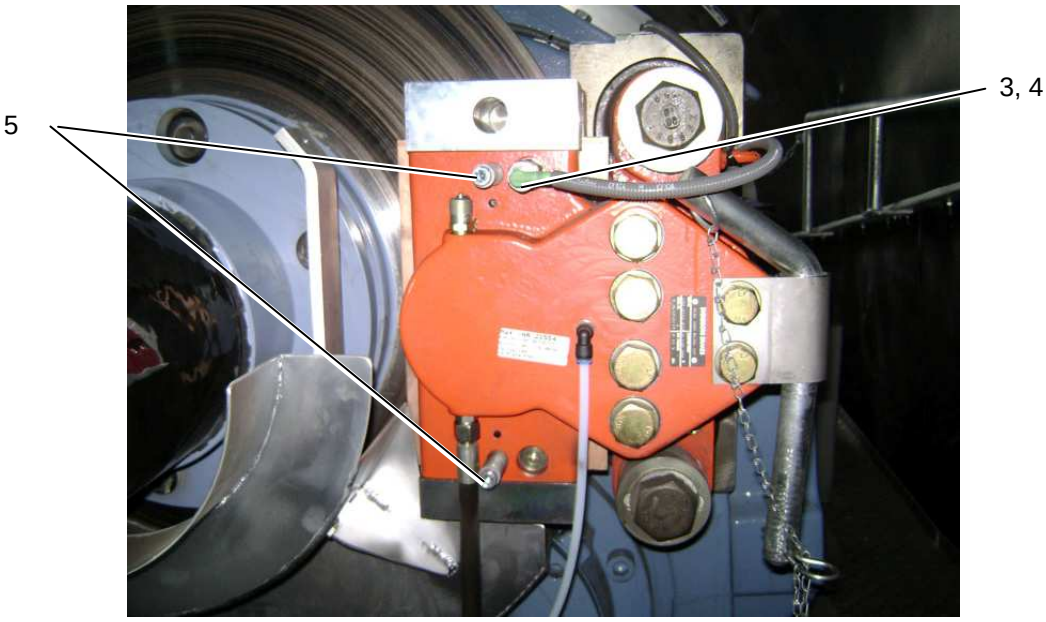



Fig. 6.11.5 – 3 Rotor holding brake


Fig. 6.11.5 – 4 Wear signaling mechanism and pad return spring

4. Release and disconnect the plug (3) of the wear signaling mechanism (4).
5. Remove the wear signaling mechanism (4).

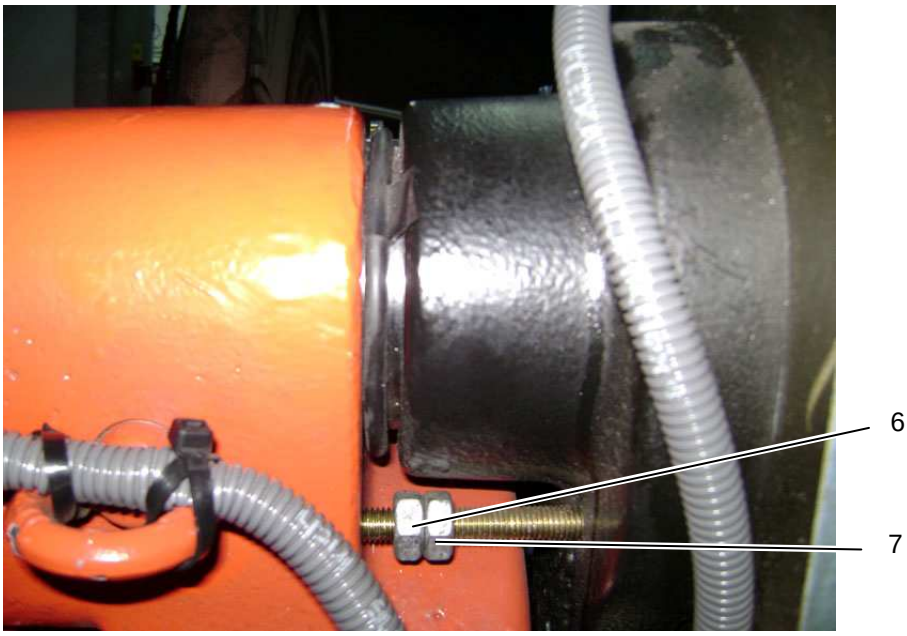



Fig. 6.11.5 – 5 Positioning system

6. Release the check nut (7) and the rating nut (6) of the positioning system.

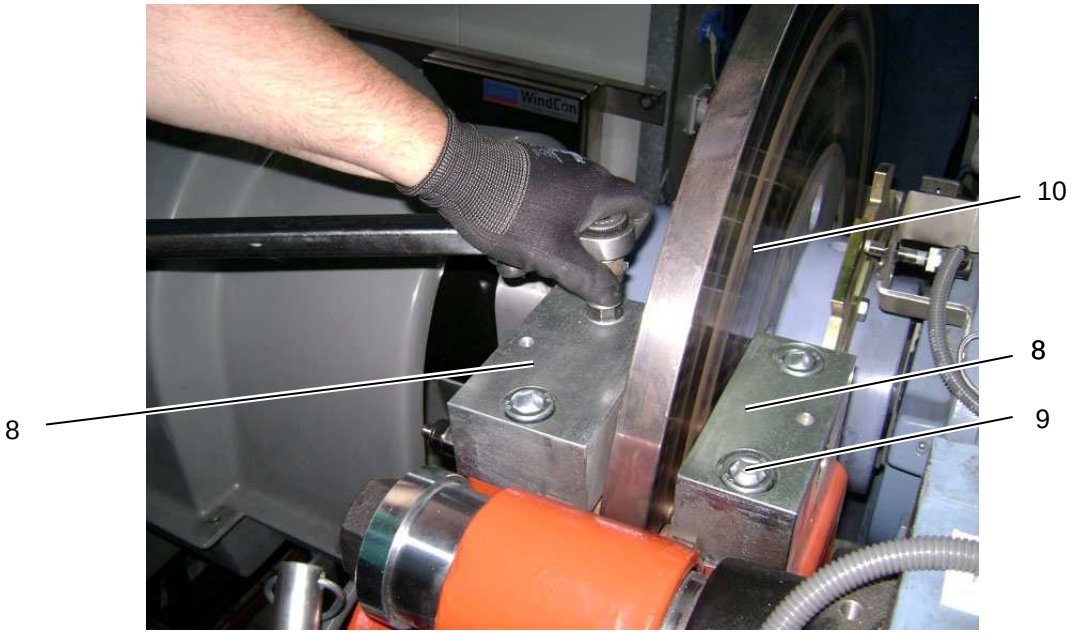



Fig. 6.11.5 – 6 Removing the pad holder

7. Release the 4 hexagon socket screws (9) of the pad holder (8).
8. Remove the pad holder (8) and store it in a secure manner.
9. Release 2 pad return springs (5) per pad and store them in a secure manner.

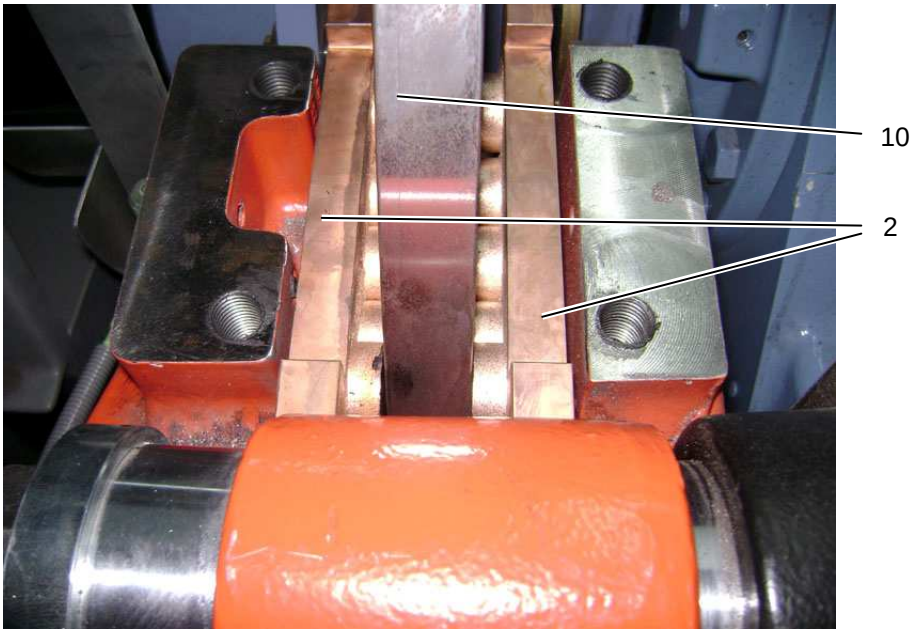



Fig. 6.11.5 – 7 Rotor holding brake without pad holder

10. Pull out the brake pads (2).
11. Push the piston all the way to the bedstop into the yoke.

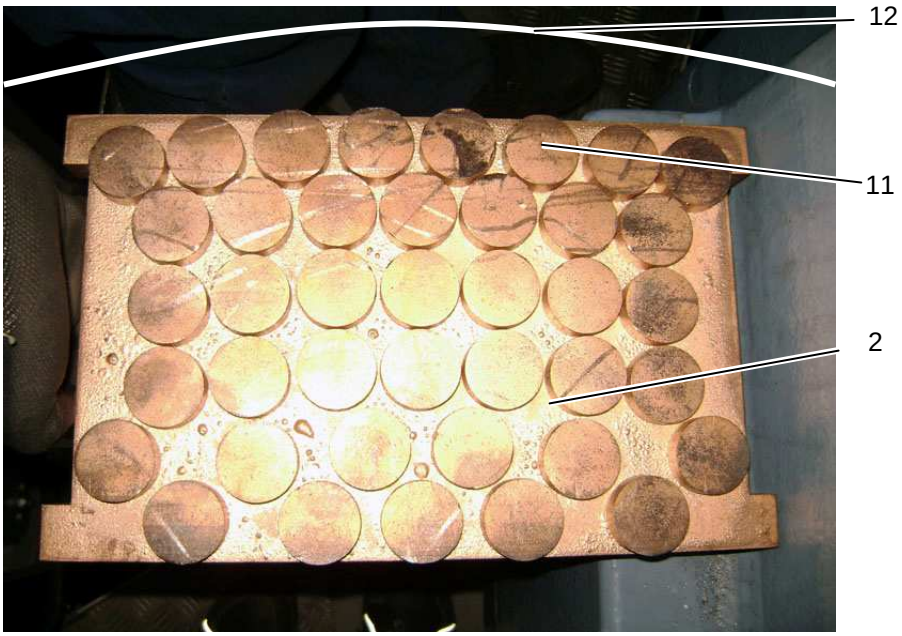



Fig. 6.11.5 – 8 New brake pad

12. Clean the brake disk (10) with brake cleaner prior to reinstalling the brake pads (observe the safety notices provided by the manufacturer).

**Note regarding the direction of installation:** The upper row (11) of the brake pad in fig. 6.11.5 – 8 needs to contact the outer diameter of the brake disk (indicated by (12)).

**NOTICE** **Danger due to incorrect installation position of the brake pads. The brake effect of the rotor holding brake is reduced. This may cause safety problems. Observe the direction of installation.**

13. Re-insert the brake pads (2) while observing the direction of installation.
14. Reinstall the pad holder (8).
15. Reinstall the pad return springs (5) (install the long pad return springs on the left and the short pad return springs on the right).
16. Re-insert the wear signaling mechanism (4).
17. Connect the plug (3) to the wear signaling mechanism (4) and tighten it.

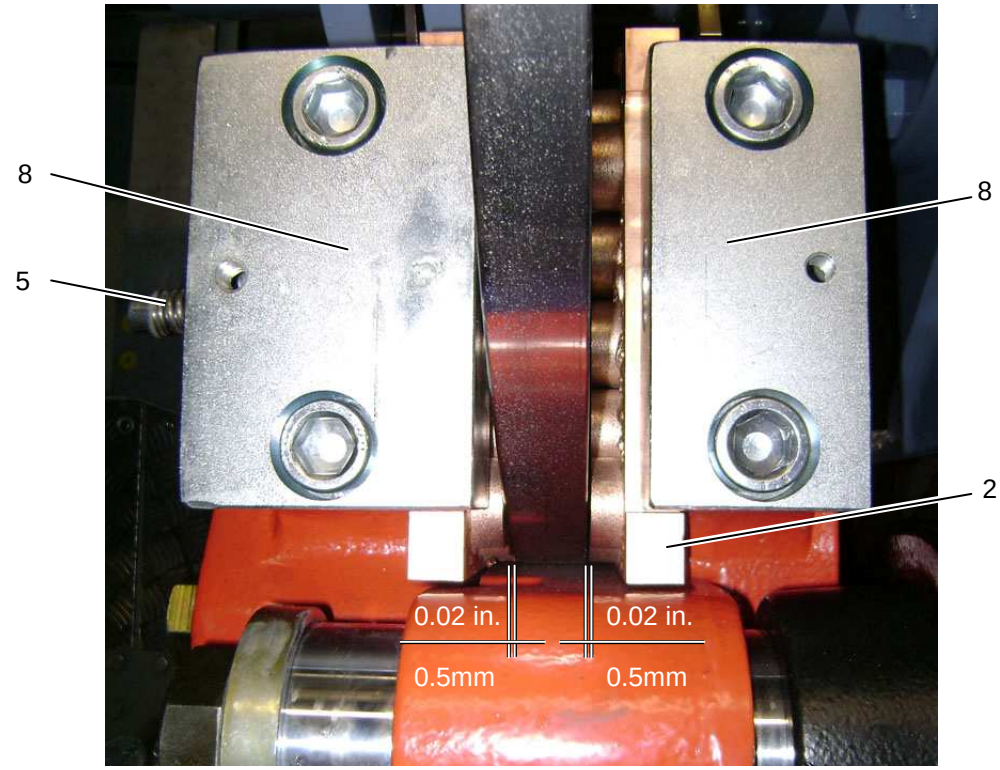



Fig. 6.11.5 – 9 Aligning the brake pads

18. Center the brake pads. To that end, tighten the rating nut (6) (fig. 6.11.5 – 5) (to the left) until both brake pads exhibit the same distance to the brake disk (fig. 6.11.3 – 9).

**Note:** The distance between the brake disk and the brake pad should not exceed 0.02 in. (0.5 mm). The brake pads should not touch the brake disk.

19. Measure the distance between the brake disk and the brake pad.
20. If both distances are equal, tighten the check nut (7).
21. Embed the brake pads in accordance with the instructions enclosed with the brake pads in the brake disk.
22. Engage the rotor holding brake.
23. Reinstall the cover (1) of the rotor holding brake.

## 6.11.6 Performing a visual inspection of the brake calipers and a check for leaking oil

Manufacturer: SVENDBORG BRAKES – BSAK 3000

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- No. 5 Allen wrench if applicable
- Waste oil container if applicable
- Brake cleaner
- Flashlight

**Directive:**


Fig. 6.11.6 – 1 Cover of the rotor holding brake

1. Remove the cover (1) of the rotor holding brake.
2. Put the cover (1) to the side.

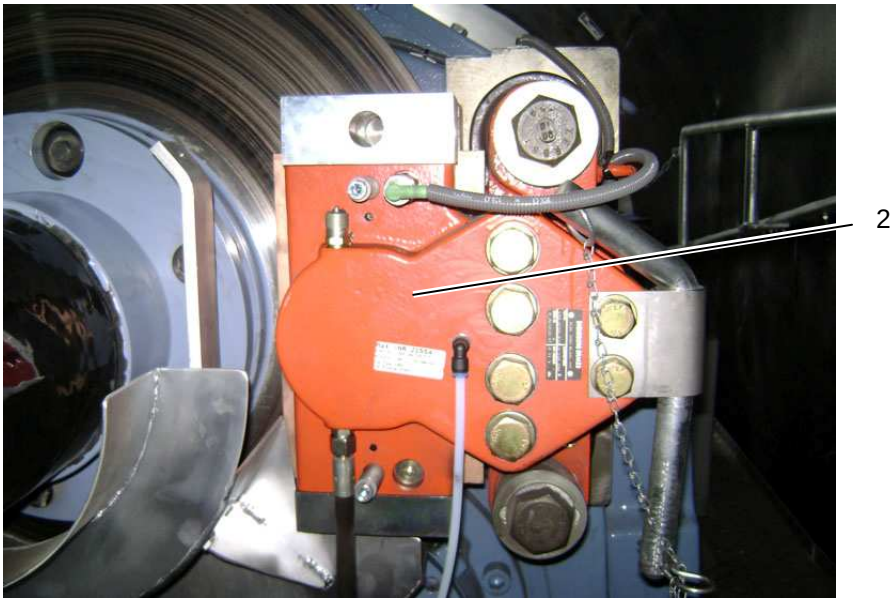



Fig. 6.11.6 – 2 Rotor holding brake

3. Check the entire rotor holding brake (2) for leaking oil.

**DANGER Danger due to high pressure. The pressure of the hydraulic system needs to be released prior to commencing the work. Wear protective goggles and acid-proof gloves.**

4. Resolve smaller leaks by tightening the screw connections.
5. Clean these screw connections and check whether the leak has been repaired during the maintenance.
6. Resolve the cause of leaks.
7. If the brake disk has been soiled with grease or oil, start by determining and resolving the cause of the soiling.
8. Perform the maintenance sections from chapters 6.11.2 "Checking that the brake disk is free from grease and oil" and 6.11.5 "Changing the brake pads".
9. Remove escaped oil and clean the system.


Fig. 6.11.6 – 3 Leak oil bottle

10. Check the leak oil bottle (3) (below the machine base).

**Note:** Leak oil bottles (3) that have been filled with oil are an indication of defective seals or worn brake calipers. In that case, observe the attached manufacturer documentation Svendborg Brakes BSAK 3000 for replacing the brake calipers.

11. Empty the leak oil bottle (3) into the waste oil container and place it back in the mount if applicable.
12. Reinstall the cover (1) of the rotor holding brake.

## 6.11.7 Performing the functional wear signaling mechanism test

Manufacturer: SVENDBORG BRAKES – BSAK 3000

**Directive:**


Fig. 6.11.7 – 1 Wear signaling mechanism

1. Release and disconnect the plug (1) of the wear signaling mechanism (2).

**Note:** The functional test of the wear signaling mechanism (2) is performed by means of the REguard Control B.

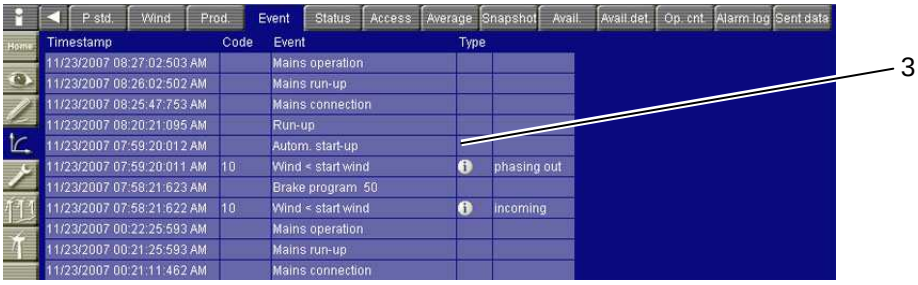



Fig. 6.11.7 – 2 REguard Monitoring

2. REguard Monitoring: Select Reports menu → Events menu (ref. operating manual).

The wear signaling mechanism (2) is functional if the following values are displayed in the table (3):

| | |
|---|---|
| Timestamp: | Current date and time |
| No.: | 2000 |
| Event: | Brake pads worn |
| | Incoming |

3. Reconnect the plug (1) to the wear signaling mechanism (2) and tighten it.
4. Now the table (3) of the REguard Monitoring needs to contain a new entry which is characterized by the fact that "Incoming" is replaced with "Phasing out".
5. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

## 6.11.8 Inspecting the screw connection between the brake calipers and the gearbox

Manufacturer: SVENDBORG BRAKES – BSAK 3000

**Required tools / operating and auxiliary means:**

- Hydraulic power screwdriver
- No. 55 plug insert

**Directive:**

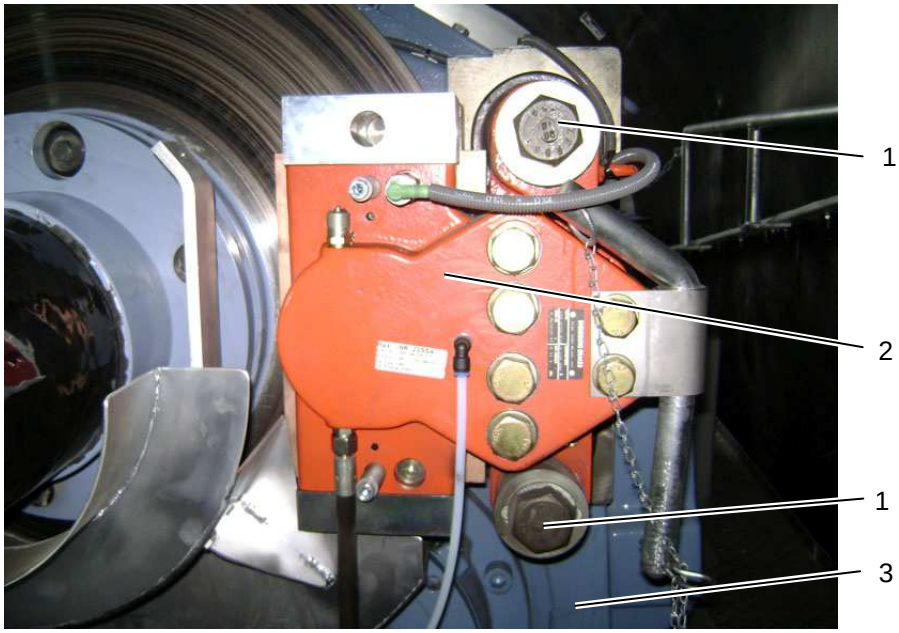



Fig. 6.11.7 – 1 Wear signaling mechanism

**DANGER** **Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver! Observe the safety notices by the manufacturer.**

1. Check the screw connection (1) between the brake calipers (2) and the gearbox (3) with a torque as detailed in the service booklet.

# 6.12 Coupling

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.12.1 Examining the condition of the stacks of laminations

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- No. 13 ring spanner
- Flashlight
- Digital camera

**Directive:**

1. Engage the rotor holding brake (ref. operating manual).


Fig. 6.12.1 – 1 Cover of the rotor holding brake

2. Remove the cover (1) of the rotor holding brake.
3. Put the cover (1) to the side.


Fig. 6.12.1 – 2 Cover of the coupling

4. Remove the cover (2) of the coupling.
5. Put the cover (2) to the side.

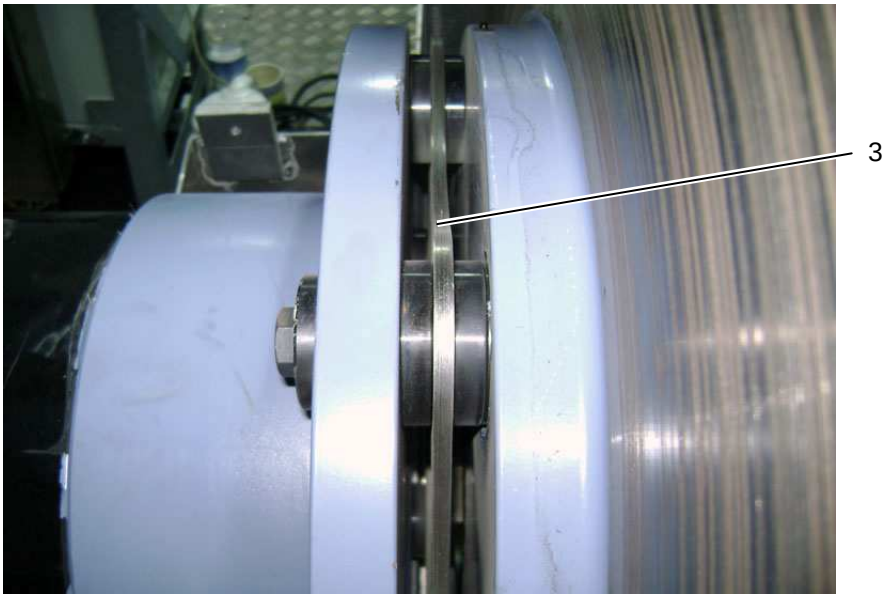



Fig. 6.12.1 – 3 Stack of laminations

**NOTICE** **Danger of severe system damage due to a defective coupling. If individual laminations or entire lamination strands have been broken, the stack of laminations (3) needs to be replaced and the alignment of the generator needs to be checked. In case of doubt, deactivate the wind turbine.**

6. Release any engaged rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

7. Check the circumference of both stacks of laminations (3) for tears in the varnish, deformations, or cracks.

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

8. Release the rotor holding brake until the previously inaccessible section of the stacks of laminations (3) becomes visible; after that, immediately engage the rotor holding brake again.
9. Document defects in the service booklet.
10. Re-install the cover of the rotor holding brake (1) and the cover of the coupling (2).

## 6.12.2 Checking the overload markings

Manufacturer: Flender

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- No. 13 ring spanner
- Flashlight
- Digital camera
- Soap suds

**Directive:**

1. Engage the rotor holding brake (ref. operating manual).


Fig. 6.12.2 – 1 Cover of the rotor holding brake

2. Remove the cover (1) of the rotor holding brake.
3. Put the cover (1) to the side.


Fig. 6.12.2 – 2 Cover of the coupling

4. Remove the cover (2) of the coupling.
5. Put the cover (2) to the side.

**Note:** The load-limiting device frictionally transmits the torque of the wind turbine. The coupling slips in case of brief occurrences of overload. An arrow and a "0" (5) and (6) each that exactly face each other are stamped into the outer diameter of the slip bushing (3) and the flange (4).


Fig. 6.12.2 – 3 Slip bushing with markings

6. Release any engaged rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

7. Release the rotor holding brake (ref. operating manual) in order to ensure that the coupling may be turned in such a manner that the markings (5) and (6) may be viewed without obstructions. Re-engage the rotor holding brake after that.

**Note:** In case of an overload, the slip bushing (3) slips with regard to the flange (4) in the direction indicated by the arrow (7).

8. If the marking (5) has been offset by more than 300° from the marking (6), notify the service.
9. In that case, use an Edding to make a new slip marking on the slip bushing (3) as well as the flange (4) and add the current date.
10. Re-install the cover (1) of the rotor holding brake and the cover (2) of the coupling.

## 6.12.3 Checking the condition of the insulation pipe

Manufacturer: Flender

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- No. 13 ring spanner
- Flashlight
- Digital camera

**Directive:**

1. Engage the rotor holding brake (ref. operating manual).


Fig. 6.12.3 – 1 Cover of the rotor holding brake

2. Remove the cover (1) of the rotor holding brake.
3. Put the cover (1) to the side.


Fig. 6.12.3 – 2 Cover of the coupling

4. Remove the cover (2) of the coupling.
5. Put the cover (2) to the side.

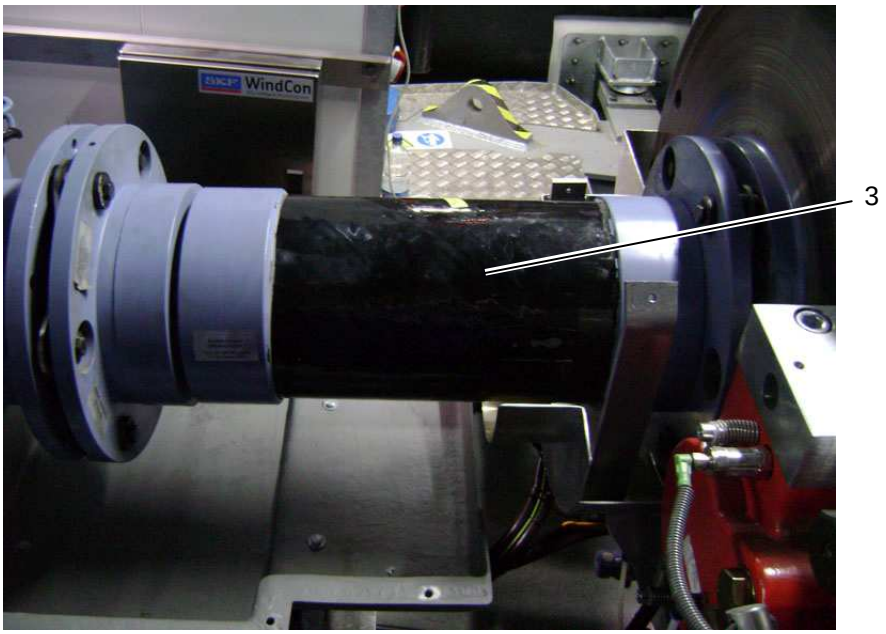



Fig. 6.12.3 – 3 Insulation pipe of the coupling

6. Release any engaged rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).
7. Inspect the circumference of the insulation pipe (3).

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

8. Release the rotor holding brake (ref. operating manual) until the previously inaccessible section of the insulation pipe becomes visible; after that, immediately engage the rotor holding brake again.

9. Clean soilings with soap suds – never use cleaning agents that contain solvents!
10. Re-install the cover (1) of the rotor holding brake and the cover (2) of the coupling.

### 6.12.4 Coupling Radex-N 190 (EON) manufacturer KTR drawing No. 408134 for MM70 / MM82A

Not applicable.

### 6.12.5 Coupling Radex-N 190 (EON) manufacturer KTR drawing No. 415810 for MM70 / MM82A / MM82B

Not applicable.

### 6.12.6 Coupling ARC-6 KZN 410-6 (EON) manufacturer Flender-Atec (drawing No. ARC 06-0410-1000) for MM70 / MM82A

Not applicable.

### 6.12.7 Coupling ARC-6 KRZN 410-6 (EON) manufacturer Flender-Atec (drawing No. ARC 06-0410-1002) for MM82B

Not applicable.

### 6.12.8 Coupling ARC-6 KRZN 410-6 (EON) manufacturer Flender-Atec (drawing No. ARC 06-0410-1003) for MM70 / MM82A

Not applicable.

## 6.12.9 Coupling ARC-6 KRZN 410-6 (EON) manufacturer Flender-Atec (drawing No. ARC 06-0410-1007) for MM70 / MM82A

Not applicable.

## 6.12.10 Coupling ARC-6 KRZN 410-6 (EON) manufacturer Flender-Atec (drawing No. ARC 06-0410-1006) for MM82B / MM92

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- Torque wrench (for 310 Nm)
- No. 13, No. 19, and No. 24 box nut
- No. 19 ring insert
- No. 13 ring spanner
- Loctite
- Digital camera

**Directive:**

1. Engage the rotor holding brake (ref. operating manual).


Fig. 6.12.10 – 1 Cover of the rotor holding brake

2. Remove the cover (1) of the rotor holding brake.
3. Put the cover (1) to the side.


Fig. 6.12.10 – 2 Cover of the coupling

4. Remove the cover (2) of the coupling.
5. Put the cover (2) to the side.
6. Engage the rotor holding brake.

**Note:** The following chapters 6.12.10.1 – 6.12.10.3 should be completed consecutively.

7. After that, re-install the cover (1) of the rotor holding brake and the cover (2) of the coupling.

### 6.12.10.1 Tightening the screw connection between the coupling hub and the sensor disk

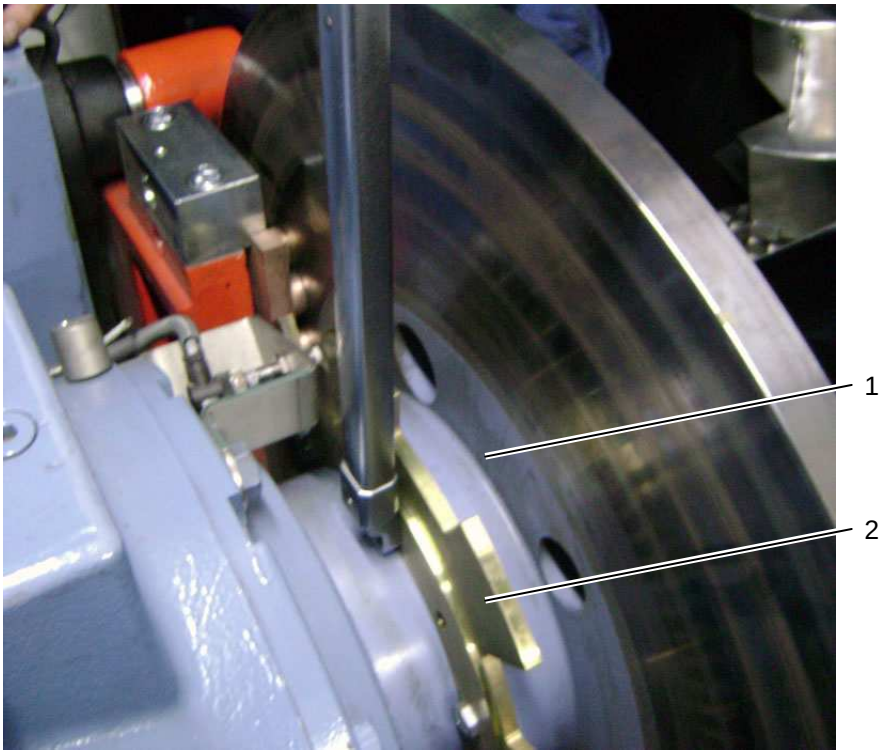



Fig. 6.12.10.1 – 1 Checking the screw connection between the sensor disk and the coupling hub

1. Check the 6 screws of the connection between the sensor disk (2) and the coupling hub (1) on the gearbox side with a torque as detailed in the service booklet.
2. Make screws that are difficult to access more easily accessible by turning the rotor.
3. Release any engaged rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

4. Release the rotor holding brake and let the rotor turn; after that, immediately re-engage the rotor holding brake.

### 6.12.10.2 Tightening the screw plugs and the clamping screws of the stacks of laminations

**NOTICE Danger due to incorrectly pre-loaded screw connections. The screw plugs (3) and the clamping screws (1) are arranged in an alternating manner on the stacks of laminations (2) (ref. fig. 6.12.10.2 – 1 and 2) and will be tightened with different torque values!**


Fig. 6.12.10.2 – 1 Coupling

1. Tighten 6 screw plugs (3) at each stack of laminations (2) with a torque as detailed in the service booklet.
2. Tighten 6 clamping screws (1) at each stack of laminations (2) with a torque as detailed in the service booklet.
3. If a screw connection is particularly loose, remove the screws, apply Loctite 243, and tighten the screws with a torque as detailed in the service booklet.
4. Make screws that are difficult to access more easily accessible by turning the rotor.

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

5. Release the rotor holding brake and let the rotor turn; after that, immediately re-engage the rotor holding brake.

### 6.12.10.3 Tightening the slip hub connection of the generator clamping set

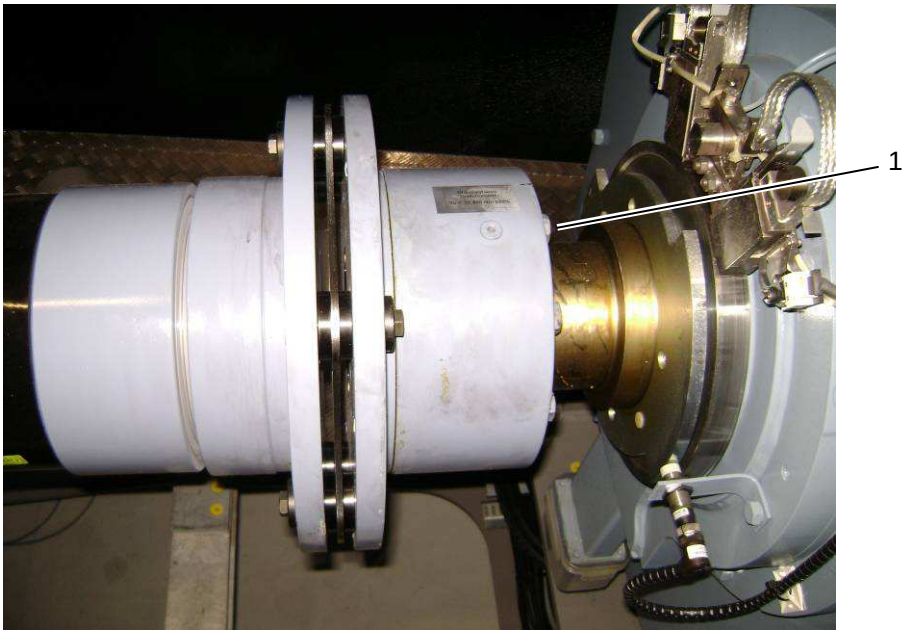



Fig. 6.12.10.3 – 1 Coupling on the generator side

1. Tighten 9 screws (1) with a torque as detailed in the service booklet.

# 6.13 Generator

**⚠ WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.13.1 Terminal box – general controls

**Directive for the outside inspections:**


Fig. 6.13.1 – 1 Stator terminal box (left hand: VEM; right hand: Winergy)


Fig. 6.13.1 – 2 Rotor terminal box (left hand: VEM; right hand: Winergy)

1. Visual inspection of the stator terminal box (1), the rotor terminal box (3), and the heating box (2) for damage and cracks.
2. Clean the terminal boxes if applicable.

## 6.13.2 Checking the grounding connection

### 6.13.2.1 Checking the grounding connection for a tight fit

**Required tools / operating and auxiliary means:**

- No. 13 ring spanner

**Directive:**

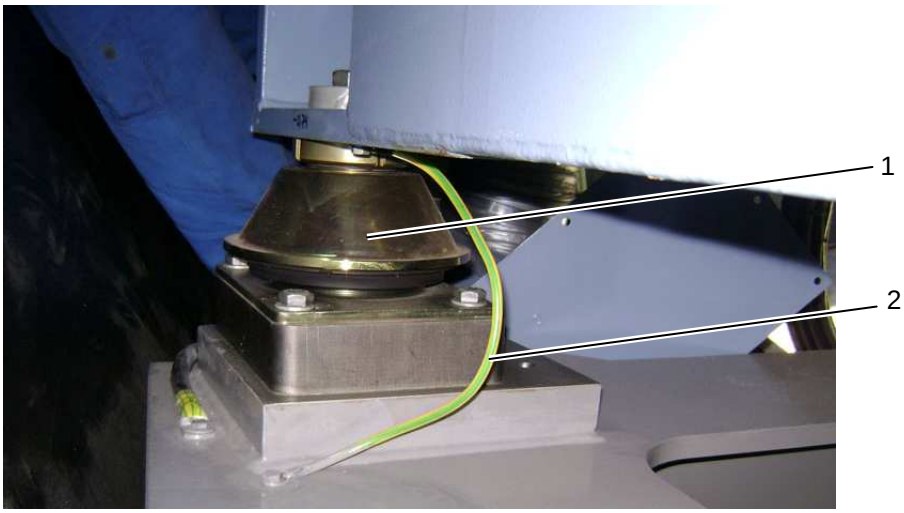



Fig. 6.13.2.1 – 1 Generator base (VEM and WInergy)

1. Check the grounding connection (2) at the four generator bases (1) for a tight fit and tighten them if necessary.


Fig. 6.13.2.1 – 2 Grounding strap (left hand) and grounding cable (right hand)

2. Check all grounding straps (3) and grounding cables (4) of the generator and of the connected components for a tight fit and tighten them if necessary.

### 6.13.2.2 Checking the grounding brushes on the rotor side

**Requirements**

- Engage the rotor lock (ref. operating manual)
- Keep the rotor holding brake closed (ref. operating manual)

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- No. 13 ring spanner
- No. 10 Allen wrench plug insert
- Sliding gauge
- Emery cloth (Grit 180) and double sided adhesive tape (if needed)
- Set of grounding brushes according manufacturer instruction (if needed)
- Ethyl alcohol (if needed)
- Non-fraying cloth

**Directive:**

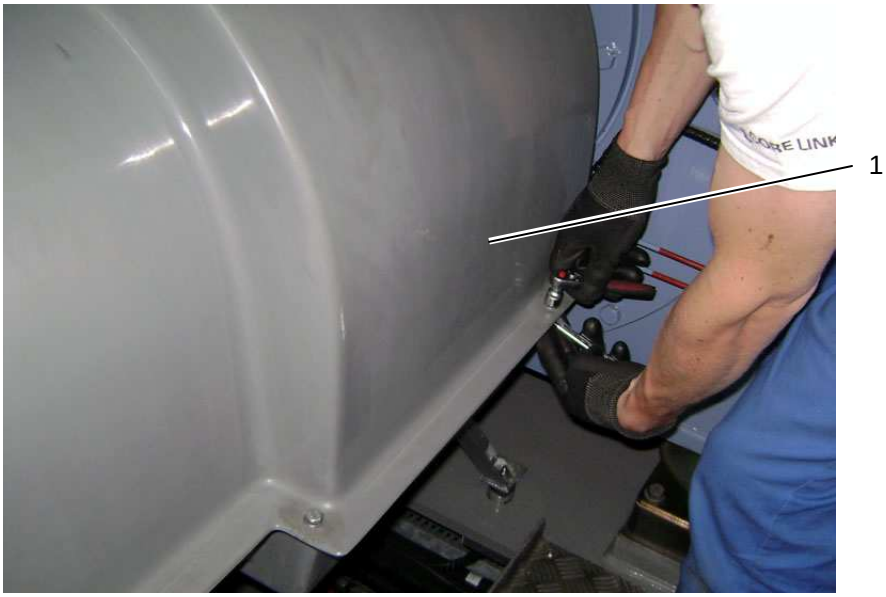



Fig. 6.13.2.2 – 1 Cover of the coupling

1. Remove the cover (1) of the coupling.
2. Put the cover (1) to the side.

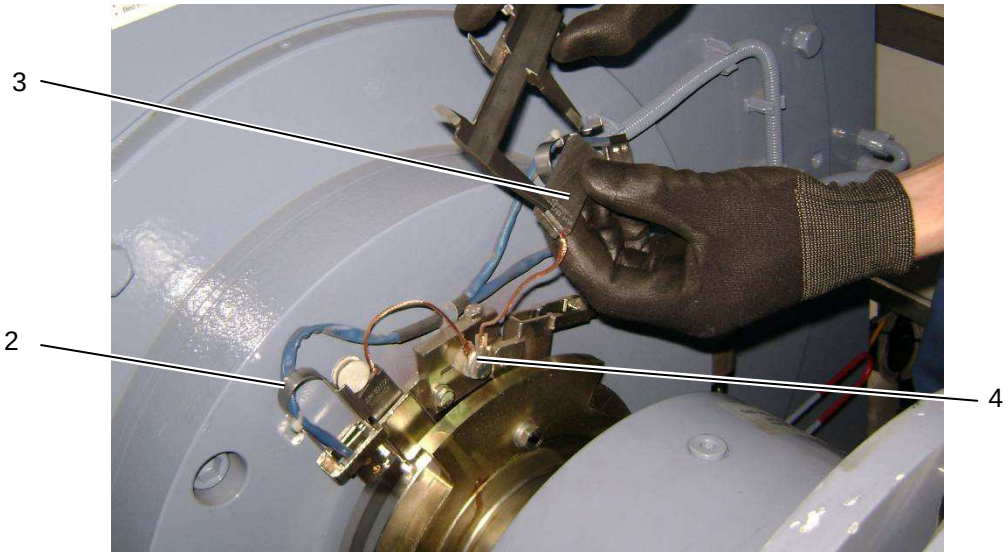



Fig. 6.13.2.2 – 2 Measuring the length of the grounding brushes (example: VEM)


Fig. 6.13.2.2 – 3 Grounding brushes (Winergy)

3. Remove the spring clamps (2) and the grounding brushes (3).
4. Measure the length of the grounding brushes (3) at the lowest point of the radius (brush length actual).
5. Calculate the average wear of the grounding brushes

Length of the new grounding brushes = Brush length new (ref. service booklet).

The durability is the time period that the grounding brushes have been used for.

$$\text{Average wear} = \frac{\text{Brush length new} - \text{Brush length actual}}{\text{Durability}}$$

6. Use the average wear to estimate whether the length of the grounding brushes will be sufficient until the next maintenance interval.

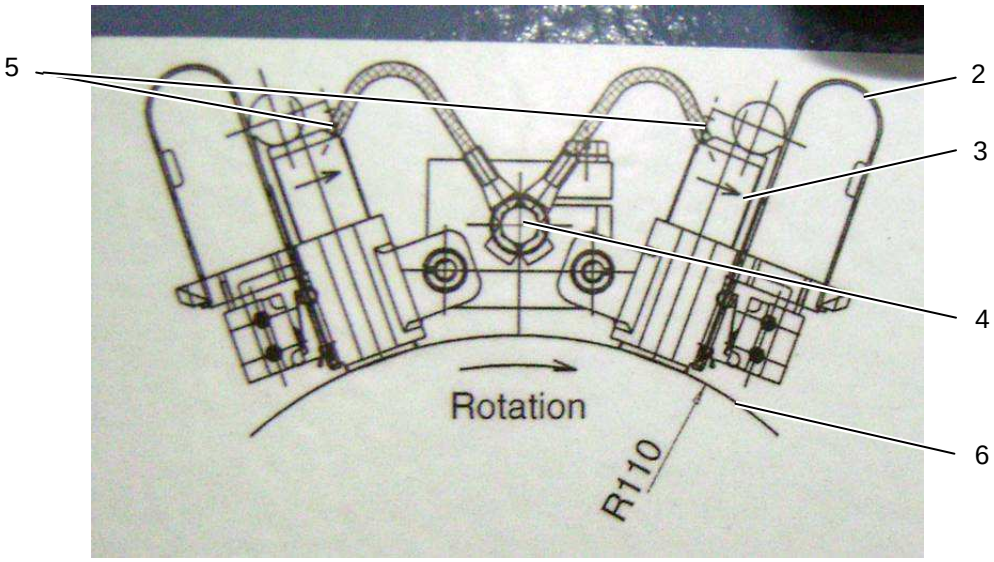



Fig. 6.13.2.2 – 4 Note at the VEM-generator

**If the grounding brushes are still long enough**:

7. Re-insert the grounding brushes into the mount (the arrow on the grounding brush (3) needs to point in the direction of the rotation of the generator).
8. Re-attach the spring mount (2) and consequently clamp the grounding brushes.

**If the grounding brushes are not long enough**:

**Note:** The grounding brushes have been pre-ground at the factory; however, according to the instructions provided by the manufacturer, they need to be ground in for an optimum contact to the grinding surface (VEM: at least 80%; Winergy: at least 90%).

9. Release the screw connection (4) of the worn grounding brushes.
10. Remove the worn grounding brushes and dispose of them in the proper manner.
11. Use double-sided adhesive tape to attach fine emery cloth to the contact surface (6) of the grounding brushes.
12. Ensure that the ends of the emery cloth overlap in the direction of rotation.
13. Insert a new set of brushes; in that context, ensure that the connection cords (5) of the grounding brushes are arranged as shown in fig. 6.13.2.2-4 (VEM) and fig. 6.13.2.2-3 (Winergy).
14. Disengage the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components**

15. Release the rotor holding brake.

**Isolated operation of the wind turbine**

16. REguard Monitoring: Select Parameters menu → Control → General.
17. "Run-up speed 2": Document the parameter setting.
18. Reset "Run-up speed 2" to no more than 1000 rpm.
19. "Generator connection": Document the parameter setting.
20. Increase "Generator connection" to 1800 rpm.
21. REguard Monitoring: Select Parameters menu → System → General → Status codes.
22. Disable status code 65.
23. Perform a RESET of the wind turbine (ref. operating manual) and consequently initiate the isolated operation of the wind turbine with the modified parameters.

**Grinding in the grounding brushes**

24. Wait for a while, then stop the wind turbine.
25. Engage the rotor holding brake.
26. Remove the spring clamps (2) and the grounding brushes (3).
27. If the grounding brushes have not been ground as stipulated, restart the wind turbine and continue with section 24.
28. If the grounding brushes have been ground in correctly, restart the wind turbine and continue with section 29.
29. Clean the grounding brushes with a clean non-fraying cloth of residue.
30. Remove the emery cloth and the double-sided adhesive tape.
31. Remove the residue of the adhesive tape with ethyl alcohol (observe the safety notices provided by the manufacturer).
32. Re-insert the grounding brushes and clamp them by means of the spring element.
33. Re-install the cover of the coupling.

**Terminating the isolated operation**

34. REguard Monitoring: Select Parameters menu → Control → General.
35. Reset "Run-up speed 2" to the previous value.
36. Reset "Generator connection" to the previous value.
37. REguard Monitoring: Select Parameters menu → System → General → Status codes.
38. Enable status code 65 again.
39. Perform a RESET of the wind turbine (ref. operating manual); after that, immediately stop the wind turbine.

### 6.13.2.3 Checking the grounding brushes in the slip ring space

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 13 box nut
- No. 13 ring spanner
- No. 10 Allen wrench plug insert
- Sliding gauge
- Emery cloth (Grit 180) and double sided adhesive tape (if needed)
- Set of grounding brushes according manufacturer instruction (if needed)
- Ethyl alcohol (if needed)
- Non-fraying cloth

**Requirements:**

- Engage the rotor lock (ref. operating manual)
- Keep the rotor holding brake closed (ref. operating manual)

**Directive:**

**Note:** This maintenance section needs to be performed together with chapter 6.13.8 "Cleaning the slip ring space". All additional safety notices are described there. In addition, chapter 6.13.9.3 "Measuring the bearing insulation resistance" may be performed simultaneously.

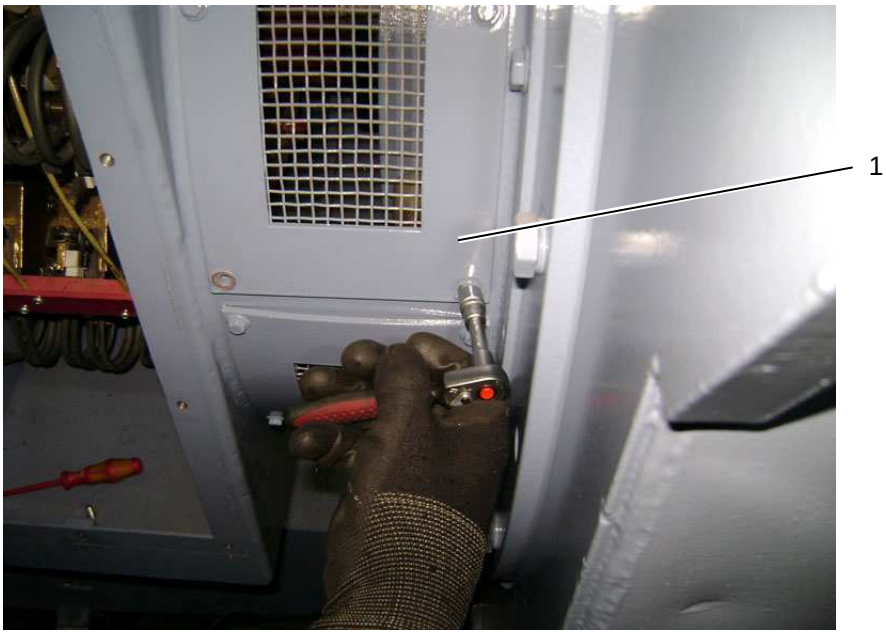



Fig. 6.13.2.3 – 1 Cover of the grounding brush space (VEM)


Fig. 6.13.2.3 – 2 Cover of the slip ring space (Winergy)

1. Remove the cover (1) of the grounding brush space (VEM) respectively of the slip ring space (Winergy).
2. Put the cover to the side.

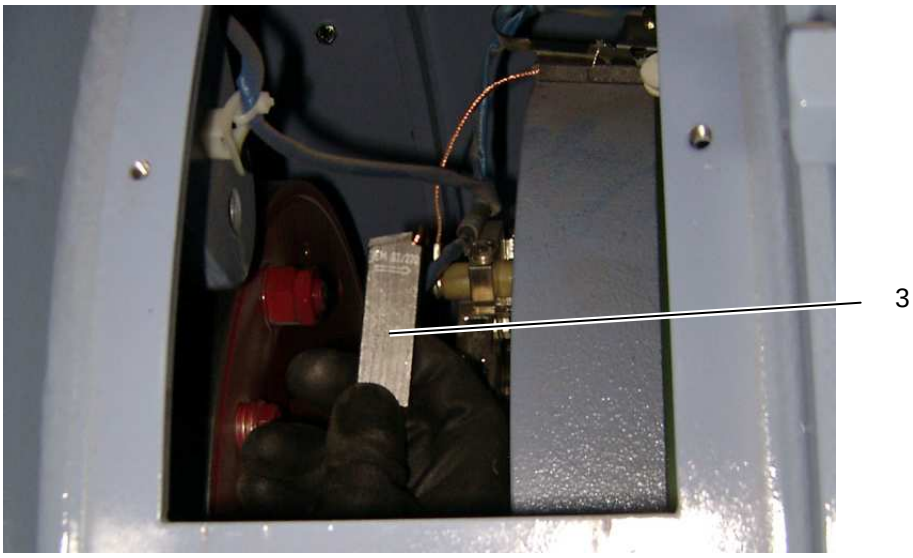



Fig. 6.13.2.3 – 3 Measuring the length of the grounding brushes (example: VEM)

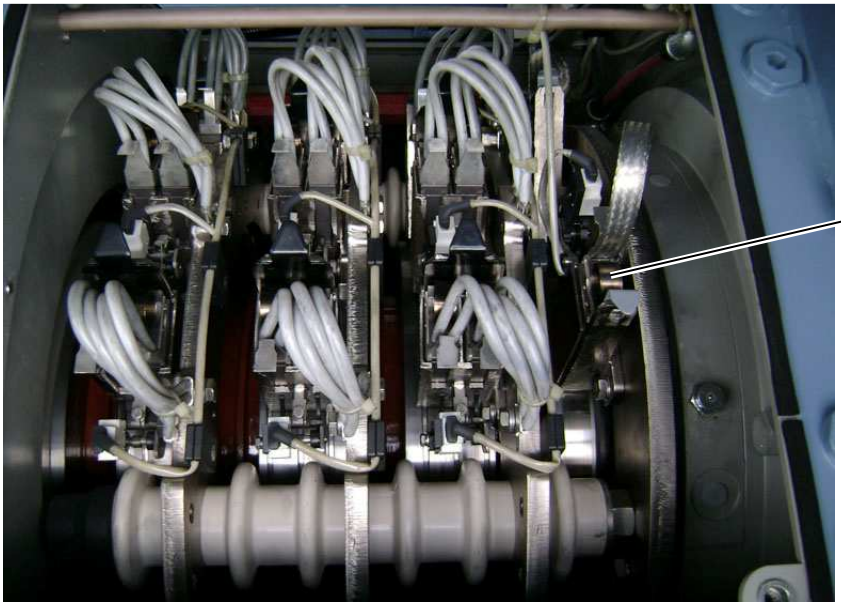



Fig. 6.13.2.3 – 4 Slip ring space (Winergy)

3. Remove the spring clamps (2) and the grounding brushes (3).
4. Measure the length of the grounding brushes (3) at the lowest point of the radius (brush length actual).
5. Calculate the average wear of the grounding brushes.

Length of the new grounding brushes = Brush length new (ref. service booklet).

The durability is the time period that the grounding brushes have been used for.

$$\text{Average wear} = \frac{\text{Brush length new} - \text{Brush length actual}}{\text{Durability}}$$

6. Use the average wear to estimate whether the length of the grounding brushes will be sufficient until the next maintenance interval.

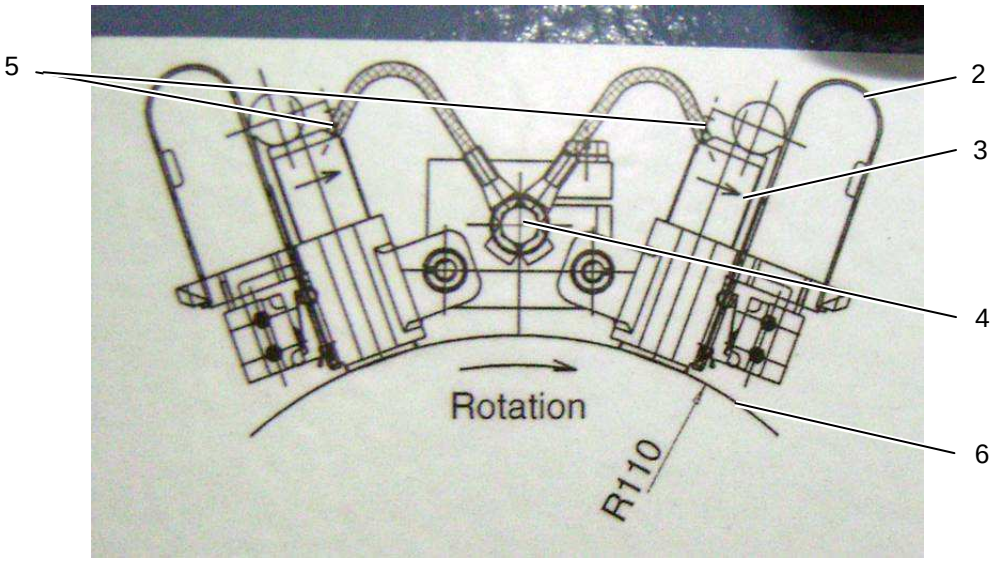



Fig. 6.13.2.3 – 5 Note at the VEM-generator

**If the grounding brushes are still long enough**:

7. Re-insert the grounding brushes into the mount (the arrow on the grounding brush (3) needs to point in the direction of the rotation of the generator).
8. Re-attach the spring mount (2) and consequently clamp the grounding brushes.

**If the grounding brushes are not long enough**:
**Note:** The grounding brushes have been pre-ground at the factory; however, according to the instructions provided by the manufacturer, they need to be ground in for an optimum contact to the grinding surface (VEM: at least 80%; Winergy: at least 90%).

9. Release the screw connection (4) of the worn grounding brushes.
10. Remove the worn grounding brushes and dispose of them in the proper manner.
11. Use double-sided adhesive tape to attach fine emery cloth to the contact surface of the grounding brushes.
12. Ensure that the ends of the emery cloth overlap in the direction of rotation.
13. Insert a new set of brushes; in that context, ensure that the connection cords (5) of the grounding brushes are arranged in a proper manner.
14. Disengage the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

15. Release the rotor holding brake.

**Isolated operation of the wind turbine**

16. REguard Monitoring: Select Parameters menu → Control → General.
17. "Run-up speed 2": Document the parameter setting.
18. Reset "Run-up speed 2" to no more than 1000 rpm.
19. "Generator connection": Document the parameter setting.
20. Increase "Generator connection" to 1800 rpm.
21. REguard Monitoring: Select Parameters menu → System → General → Status codes.
22. Disable status code 65.
23. Perform a RESET of the wind turbine (ref. operating manual) and consequently initiate the isolated operation of the wind turbine with the modified parameters.

**Grinding in the grounding brushes**

24. Wait for a while, then stop the wind turbine.
25. Engage the rotor holding brake.
26. Remove the spring clamps (2) and the grounding brushes (3).

27. If the grounding brushes have not been ground in to 80%, restart the wind turbine and continue with section 24.
28. If the grounding brushes have been ground in correctly, restart the wind turbine and continue with section 29.
29. Clean the grounding brushes with a clean non-fraying cloth of residue.
30. Remove the emery cloth and the double-sided adhesive tape.
31. Remove the residue of the adhesive tape with ethyl alcohol (observe the safety notices provided by the manufacturer).
32. Insert the grounding brushes and clamp them by means of the spring element.
33. Reinstall the cover (1) of the grounding brush space.

**Terminating the isolated operation**

34. REguard Monitoring: Select Parameters menu → Control → General.
35. Reset "Run-up speed 2" to the previous value.
36. Reset "Generator connection" to the previous value.
37. REguard Monitoring: Select Parameters menu → System → General → Status codes.
38. Enable status code 65 again.
39. Perform a RESET of the wind turbine (ref. operating manual); after that, immediately stop the wind turbine.

## 6.13.3 Checking the cable connections for a tight fit

**Required tools / operating and auxiliary means:**

- Channel-lock pliers

**Directive:**

**DANGER Risk of life due to high voltages. Do not open the stator and rotor terminal boxes!**


Fig. 6.13.3 – 1 Stator terminal box (left hand: VEM; right hand: Winergy)


Fig. 6.13.3 – 2 Rotor terminal box (left hand: VEM; right hand: Winergy)


Fig. 6.13.3 – 3 Cable connections at the stator terminal box

1. Check the cable connections (4) at the stator terminal box (1), the rotor terminal box (3), and the heating box (2) for a tight fit.
2. Tighten the cable connections if needed.

## 6.13.4 Checking the proximity sensors

**Requirements:**

- Engage the rotor holding brake (ref. operating manual)

**Required tools / operating and auxiliary means:**

- 2 pcs. No. 24 jaw wrench
- Flashlight

**Directive:**

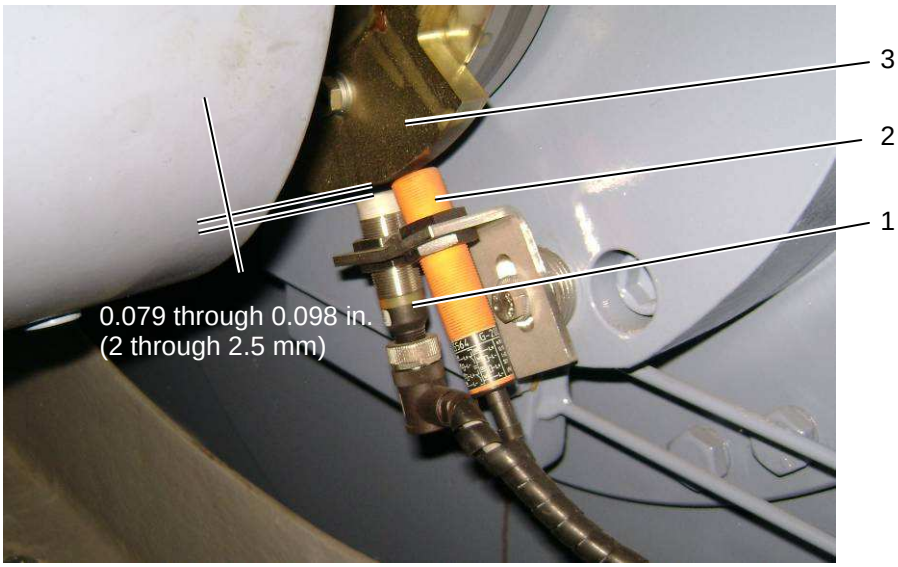



Fig. 6.13.4 – 1 Proximity sensors

**Note:** The proximity sensor (1) submits the generator speed to the REguard Control B. The proximity sensor (2) transmits the generator speed for the oscillation control.

1. Check the distance of the proximity sensors to the sensor disk (3) (nominal distance: 0.079 – 0.098 in. (2 - 2.5 mm)).
2. If the value deviates from the nominal distance, release the proximity sensors, adjust them to the correct nominal distance, and tighten them again.
3. Check the function of the proximity sensor (1) via the REguard Monitoring.


6.13.4 – 2 REguard Monitoring

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

4. Release the rotor holding brake (ref. operating manual).
5. REguard Monitoring: Select Monitoring menu → Gen. → Measured values. A value needs to be displayed in the field "Generator speed".
6. Engage the rotor holding brake (ref. operating manual).

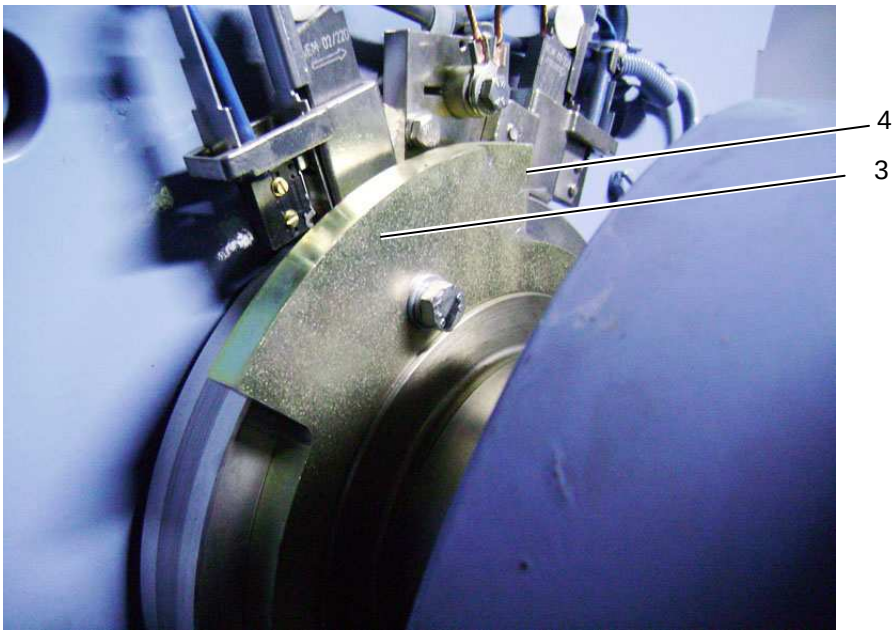



Fig. 6.13.4 – 3 Sensor disk

**NOTICE The function of the proximity sensors is ensured only if the edges (4) of the sensor disk (3) have not been damaged. Never subject the sensor disk to force.**

7. Check the edges (4) of the sensor disk (3) for damage (dents, grooves).
8. Document defects in the service booklet.

## 6.13.5 Checking the sensor system, the cables, and the plug connections

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

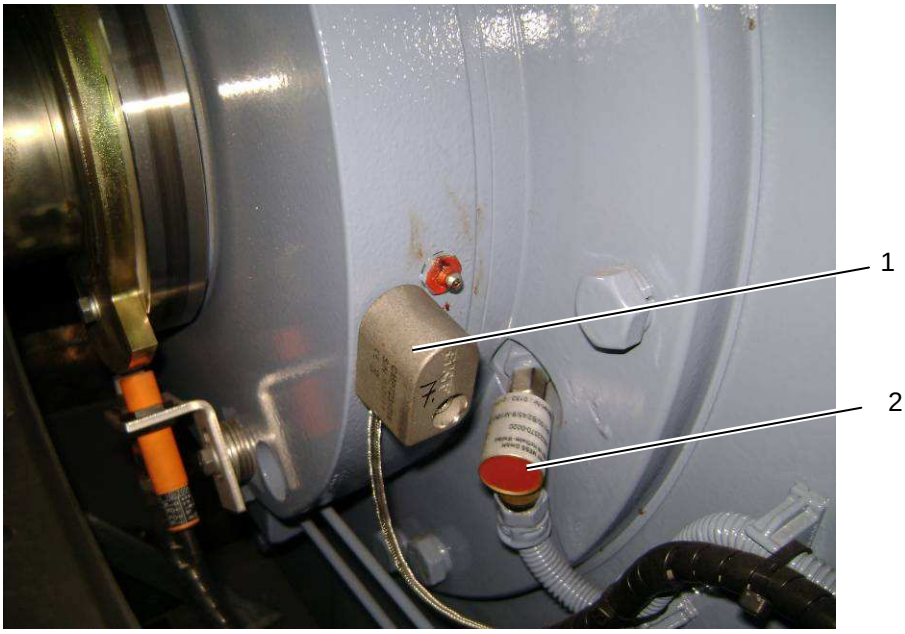



Fig. 6.13.5 – 1 Oscillation sensor (1) and temperature sensor (2) at the A bearing of the VEM-generator

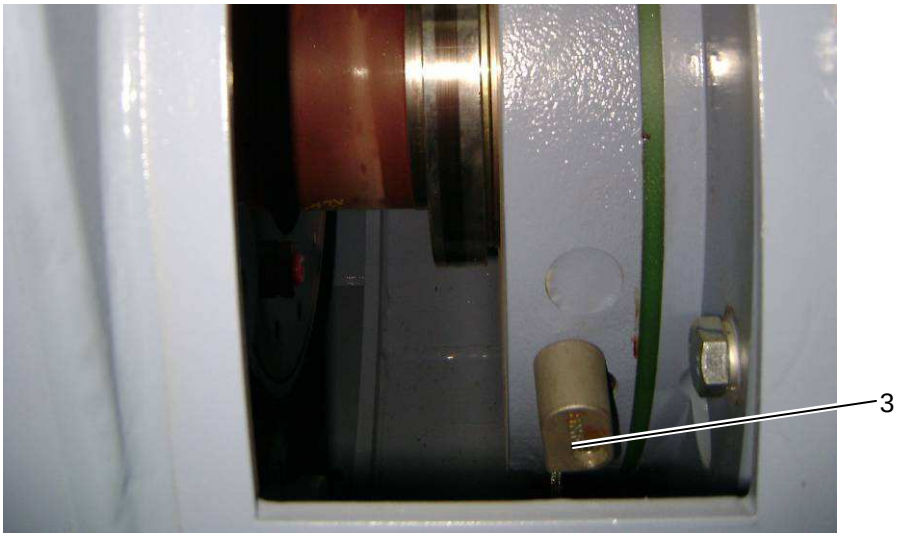



Fig. 6.13.5 – 2 Oscillation sensor (3) at the B bearing of the VEM-generator

1. Check the oscillation sensor (3) for a tight fit during maintenance section chapter 6.13.2.3 "Checking the grounding brushes in the slip ring space"
2. Check all sensors, cables, and plug connections at the generator

**Note:** The operating manual contains an overview of the sensor system.

3. Rectify defects and document them in the service booklet

## 6.13.6 Lightning protection mechanism

### 6.13.6.1 Inspecting the lightning protection mechanism of the stator

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 8 Allen wrench plug insert
- No. 17 box nut

**Directive:**


Fig. 6.13.6.1– 1 Lightning protection box stator (left hand: VEM; right hand: Winergy)

1. Remove the cover of the lightning protection box (1).
2. Safely put the screws to the side.

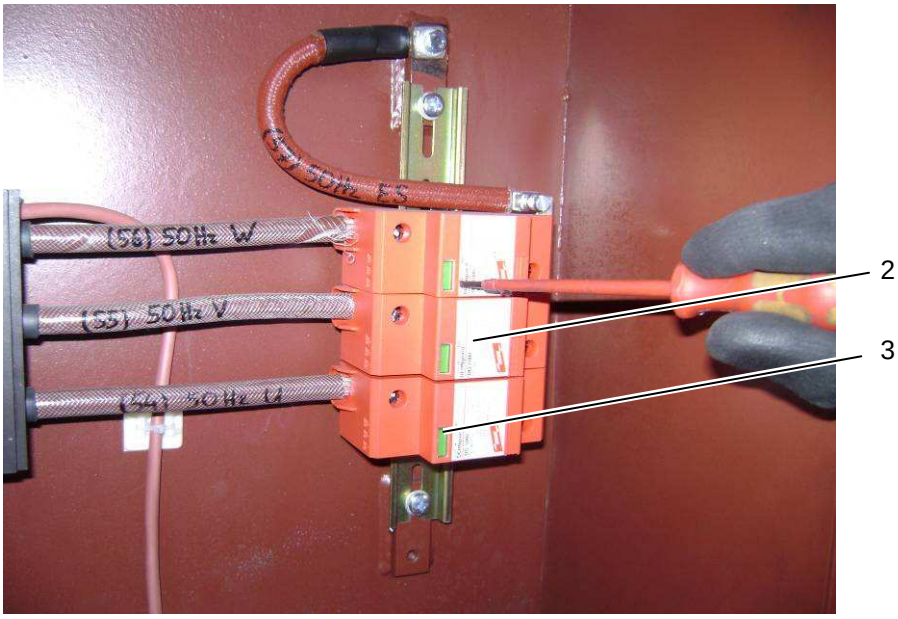



Fig. 6.13.6.1 – 2 Surge protection of the stator

3. Check the surge protection elements (2).

**Note:** If the control panel (3) is green, the surge protection element has not been triggered.

4. If the control panel is red, replace the surge protection element.
5. Perform an insulation resistance measurement in order to exclude damage to the windings of the stator (ref. chapter 6.13.9.2).

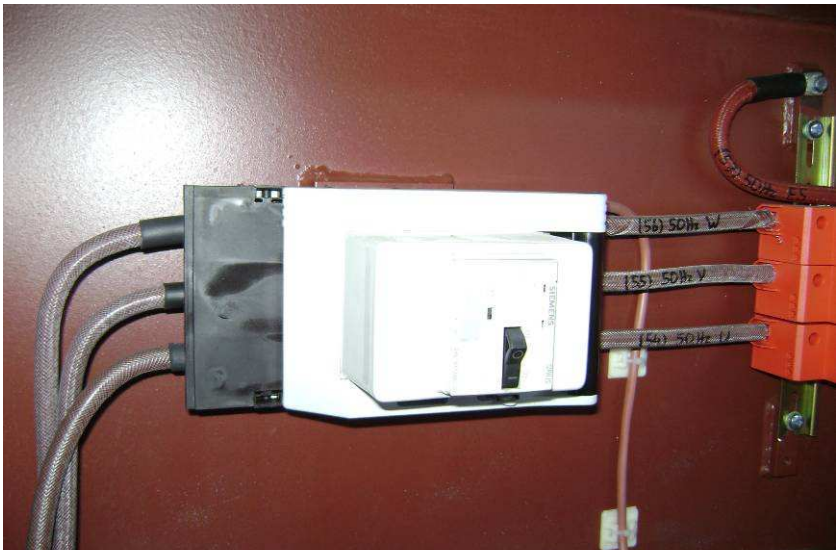



Fig. 6.13.6.1 – 3 Circuit breaker

6. Visual inspection of all components and inspection of the connections for a tight fit.
7. Reinstall the cover of the lightning protection box (1).
8. Document defects in the service booklet.

### 6.13.6.2 Inspecting the lightning protection mechanism of the rotor

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 8 Allen wrench plug insert
- No. 17 box nut

**Directive:**


Fig. 6.13.6.2 – 1 Lightning protection box rotor (left hand: VEM; right hand: Winergy)

1. Remove the cover of the lightning protection box (1).
2. Safely put the screws to the side.


Fig. 6.13.6.2 – 2 Surge protection of the rotor

3. Check the surge protection elements (2).

**Note:** If the control panel (3) is green, the surge protection element has not been triggered.

4. If the control panel is red, replace the surge protection element.
5. Perform an insulation resistance measurement in order to exclude damage to the windings of the rotor (ref. chapter 6.13.9.3)


Fig. 6.13.6.2 – 3 Circuit breakers

6. Visual inspection of all components and inspection of the connections for a tight fit.
7. Reinstall the cover of the lightning protection box (1).
8. Document defects in the service booklet.

## 6.13.7 Inspecting the carbon brushes and the brush holders in the slip ring space

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 10 box nut
- Dust mask
- Industrial vacuum cleaner with fine dust filter
- Disposable gloves or new gloves
- Clean, non-fraying cloths
- Oil and grease-free brush, glass brush
- Force gauge (measuring range 2 – 5 lbf. (10 – 20 N))
- Emery cloth (Grit 180) and double sided adhesive tape (if needed)
- Set of grounding brushes according manufacturer instruction (if needed)
- Ethyl alcohol (if needed)

**Directive:**

**Note:** This maintenance section should ideally only be performed after a generator standstill of four hours in order to ensure that the insulation test may be performed following the removal of the carbon brushes. An excessive temperature of the generator falsifies the measured values.

1. Engage the rotor lock (ref. operating manual).

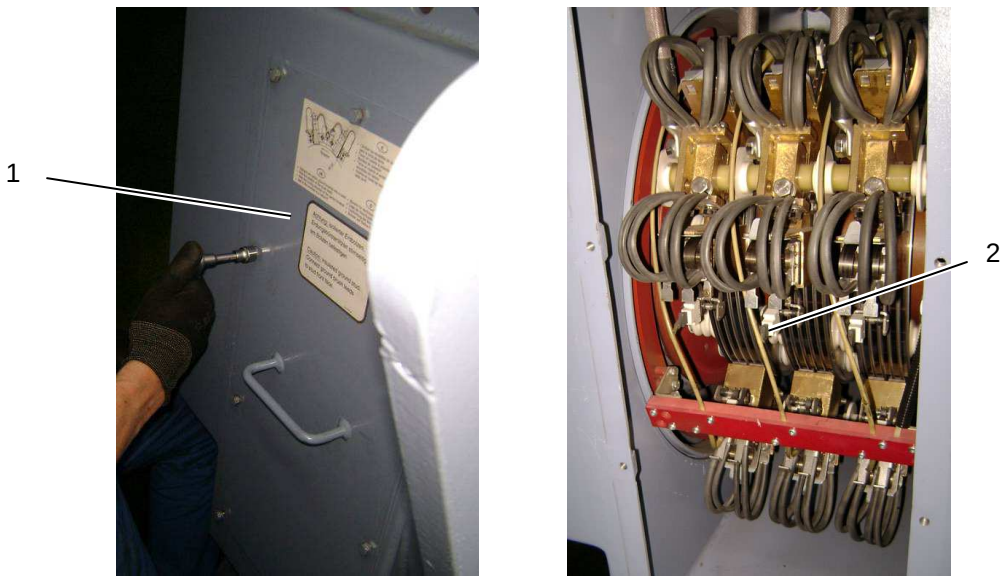



Fig. 6.13.7– 1 Cover slip ring space (1) and slip ring space (2) VEM

**⚠ CAUTION Danger due to fine dust. Wear a dust mask and use an industrial vacuum cleaner with a fine dust filter.**

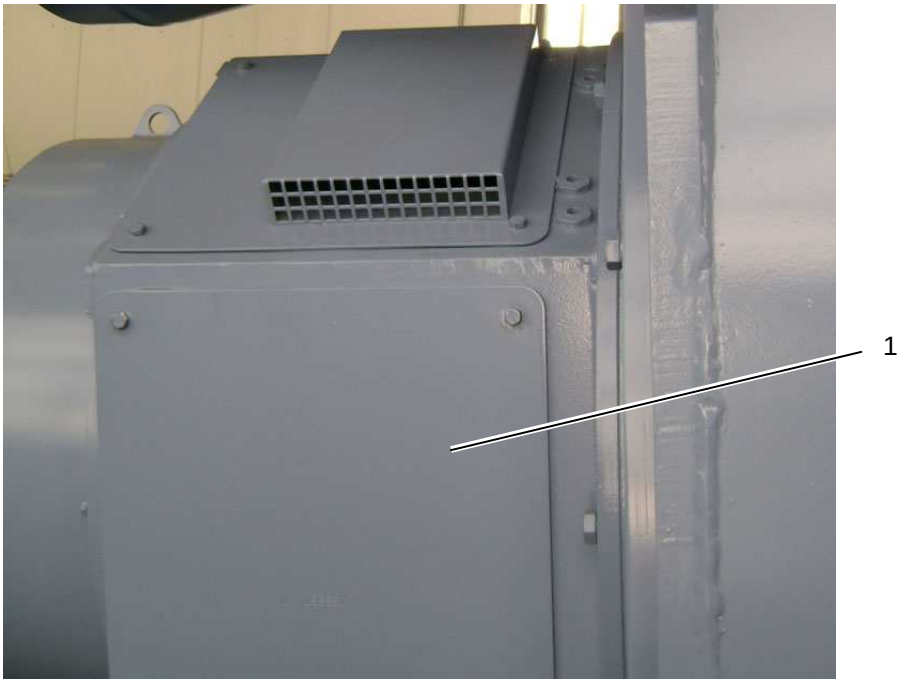



Fig. 6.13.7 – 2 Cover of slip ring space (Winergy)

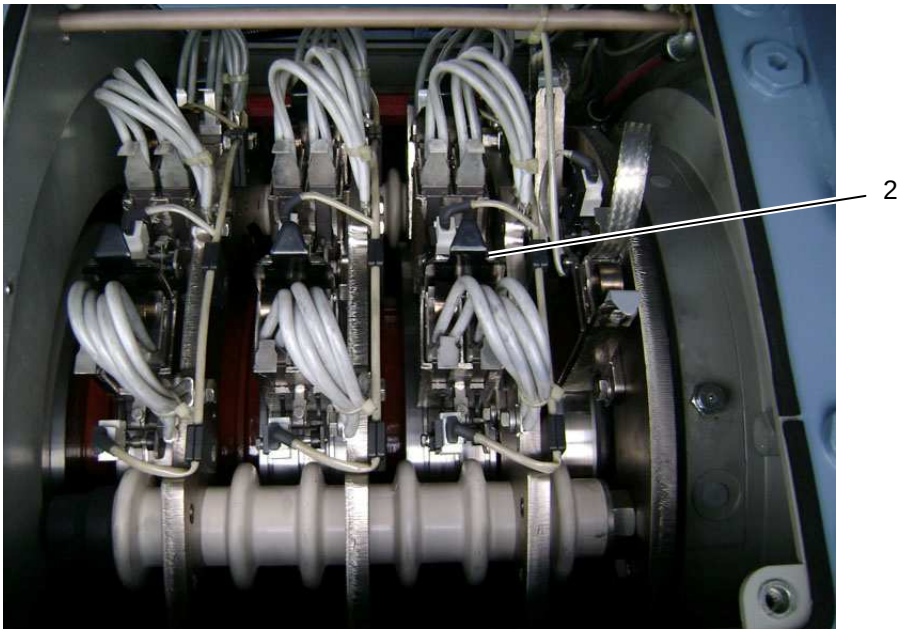



Fig. 6.13.7 – 3 Slip ring space (Winergy)

2. Remove the cover (1) of the slip ring space.
3. Safely put the cover (1) to the side.
4. Evaluate the degree of soiling of the slip ring space (2) immediately after removing the cover (1) (severe, medium, or minor soiling) and enter your findings in the service booklet.
5. Thoroughly vacuum the slip ring space (2) with the industrial vacuum cleaner.

6. Use a glass brush to remove deposits at inaccessible positions while simultaneously operating the vacuum cleaner

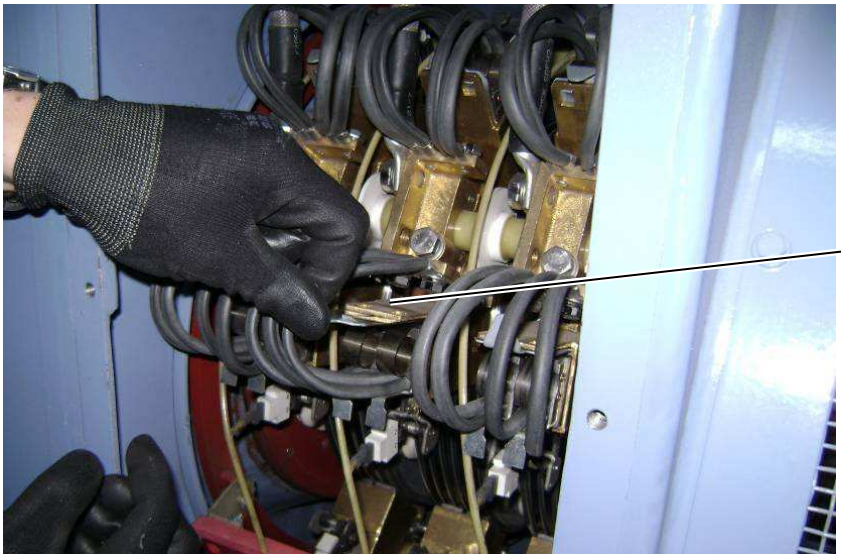



Fig. 6.13.7 – 4 Removing the carbon brushes (example: VEM)

7. Remove the reel tape (3) and subsequently the carbon brush (4).

**Inspecting the brush holder box:**

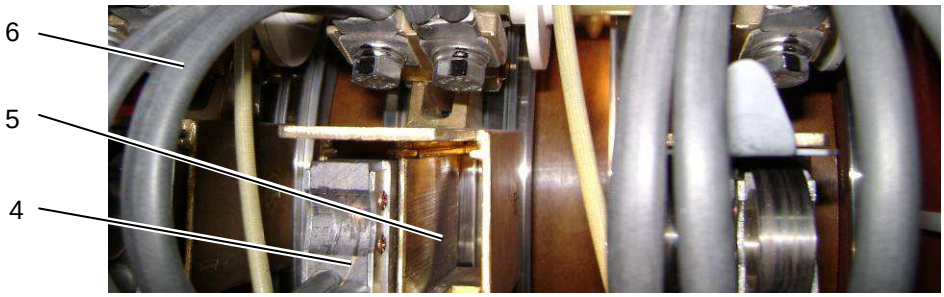



Fig. 6.13.7 – 5 Brush holder box (example: VEM)

8. Inspect the interior surfaces of the brush holder box (5).
9. Carefully grind off current burns in the brush holder box (5).
10. Release deposited dust particles with a brush and vacuum them out.
11. Check the entire screw connection including the connection cords (6) for a good contact and a tight fit.

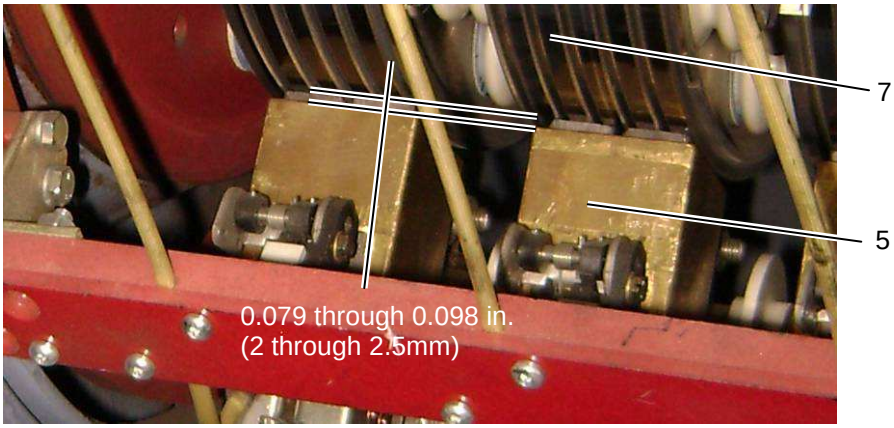



Fig. 6.13.7 – 6 Brush holder box and slip ring (example: VEM)

12. Check the distance between the lower edge of the brush holder box (5) and the slip ring (7) (nominal distance: 0.079. – 0.098 in. (2 - 2.5 mm)).
13. In case of an unusually high wear or an asymmetric brush contact area, check the dimensional accuracy of the reel tape and the brushes.

**Determining the brush contact pressure**

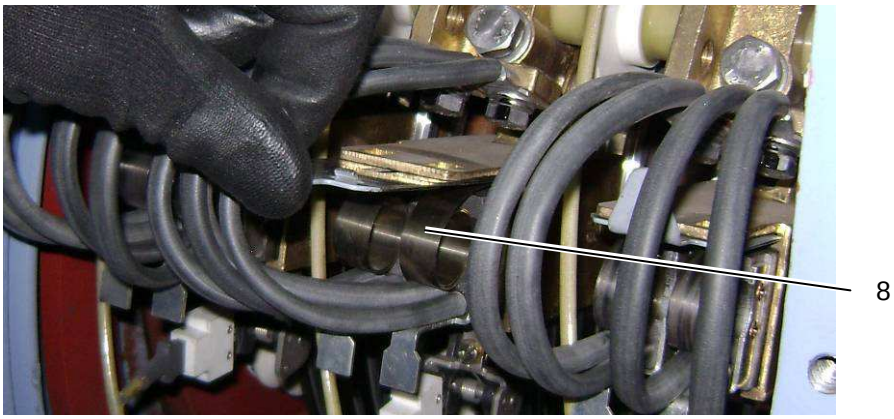



Fig. 6.13.7 – 7 Reel tape (example: VEM)

14. Determine the brush contact pressure which is generated by means of the spring (8) of the reel tape with the help of a force gauge.
15. Determine the brush contact pressure for each spring and document it in the service booklet.

**Note:** The brush contact pressure needs to range from 18.6 to 24 kPa. This corresponds to a nominal elasticity value between 3.37 and 4.3 lbf. (15 and 19.2 N) for a carbon brush contact surface of 1.574 in. x 0.787 (40 mm x 20 mm).

16. Replace the brush holder if this elasticity or this brush contact pressure is no longer reached.
17. Mark the spring type (reel tape or hold-down) in the service booklet.

### Measuring the carbon brush length


Fig. 6.13.7 – 8 Measuring the length of the carbon brush (example: VEM)

18. Measure the length of each individual carbon brush (4) (brush length actual) and document them in the service booklet.
19. Calculate the average wear of the carbon brushes.

Length of the new grounding brushes = Brush length new (ref. service booklet).

The durability is the time period that the grounding brushes have been used for.

$$\text{Average wear} = \frac{\text{Brush length new} - \text{Brush length actual}}{\text{Durability}}$$

20. Use the average wear to estimate whether the length of the carbon brushes will be sufficient until the next maintenance interval.

Minimum length of the carbon brushes: Ref. service booklet

21. Measure the insulation resistance of the rotor winding (ref. chapter 6.13.9.1)

### Checking for a triggered wear signal

22. Check whether the wear signal of the carbon brushes is displayed at the REguard Control B.


Fig. 6.13.7 – 9 REguard Monitoring

23. REguard Monitoring: Select Monitoring menu → Gen. → Digital inputs. The control dot to the right of "Gen. brushes worn out" must be lit green (9).

**Evaluating the condition of the slip rings**

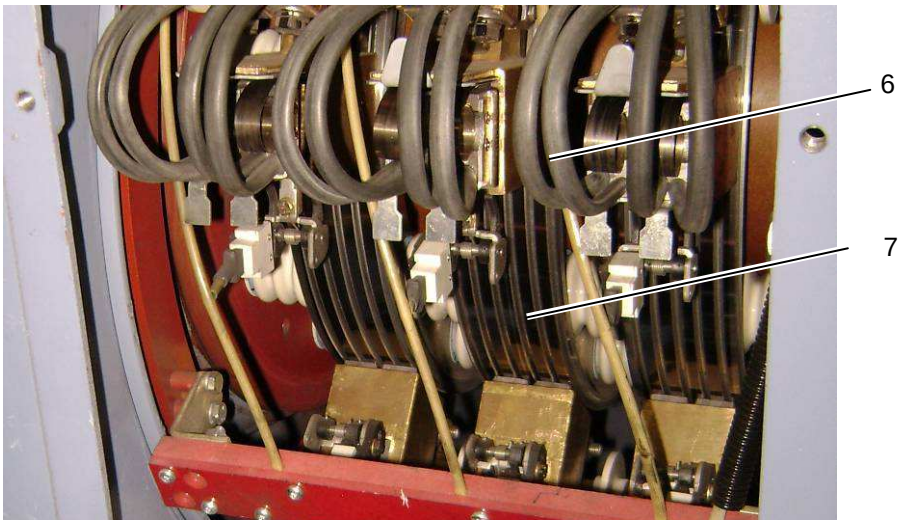



Fig. 6.13.7 – 10 Slip rings (example: VEM)

24. Measure the run-in of the slip ring (7) and document it in the service booklet.
25. Evaluate the alignment of the carbon brushes (4) at the slip ring and document it in the service booklet.
26. Evaluate the look of the contact surface of the slip rings (7) in accordance with the specification detailed in the service booklet and enter your findings in the service booklet.

**If the length of the carbon brushes is sufficient until the next maintenance:**

27. Once again thoroughly clean all elements of the slip ring space (2).
28. Plug the carbon brushes (4) and the reel tapes (3) back to their original places; ensure that the connection cord (6) is not twisted (VEM: fig. 6.13.7–7; Winergy: fig. 6.13.7-12)).

29. Re-attach the cover (1) of the slip ring space.

**If the length of the carbon brushes is insufficient until the next maintenance or the wear signal "Gen. brushes worn out" has already been active prior to beginning this maintenance work:**

**Note:** The carbon brushes have been pre-ground at the factory; however, according to the instructions provided by the manufacturer, they need to be ground in for an optimum contact to the grinding surface (VEM: at least 80%; Winergy: at least 90%).

**Note:** New carbon brushes absolutely must correspond to the specifications in the list of spare parts provided by the manufacturer (brush brand and dimensions).

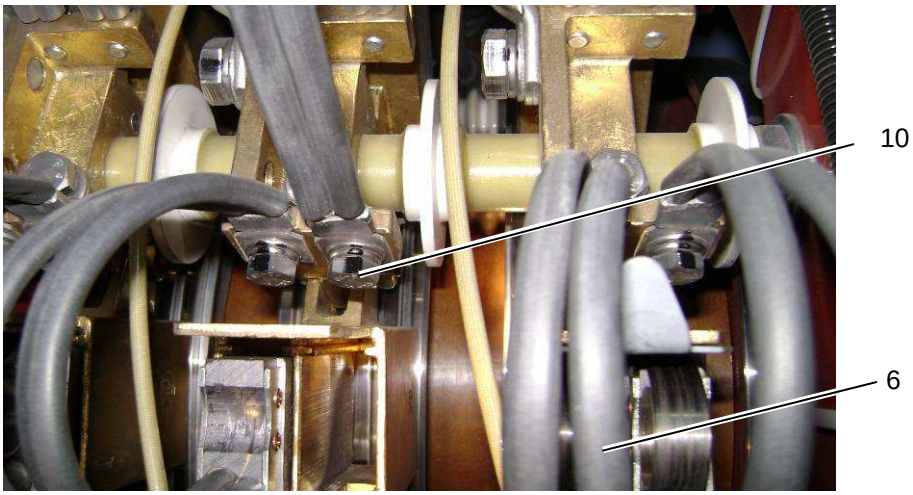



Fig. 6.13.7 – 11 Screw connection of the carbon brushes (VEM)

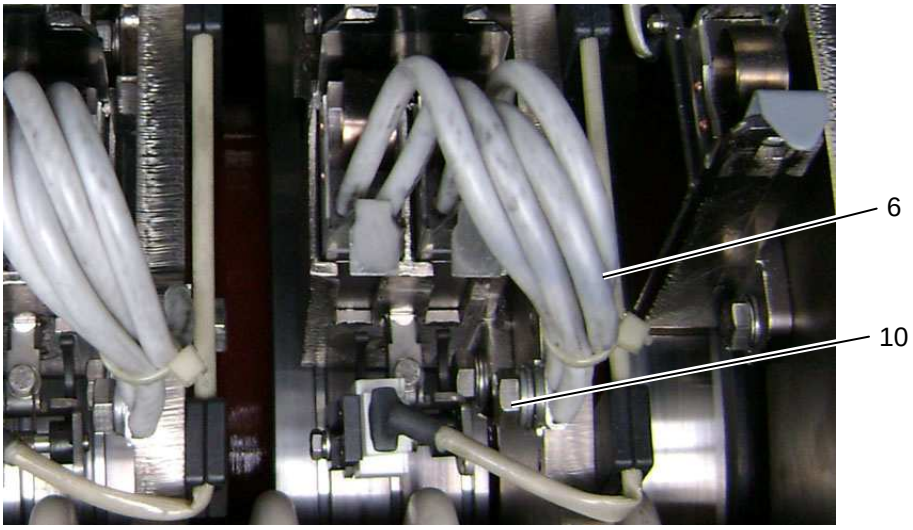



Fig. 6.13.7 – 12 Screw connection of the carbon brushes (Winergy)

30. Remove the screw connections (10) of all carbon brushes (4), remove the carbon brushes, and dispose of them in the proper manner.
31. Use double-sided adhesive tape to attach fine emery cloth to the slip rings (7).

32. Ensure that the ends of the emery cloth overlap in the direction of rotation.
33. Tighten the new carbon brushes. In that context, ensure that the connection cord (8) is not twisted during the insertion (VEM: fig. 6.13.7 – 7; Winergy: fig. 6.13.7-12).
34. Disengage the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

35. Release the rotor holding brake.

**Isolated operation of the wind turbine**

36. REguard Monitoring: Select Parameters menu → Control → General.
37. "Run-up speed 2": Document the parameter setting.
38. Reset "Run-up speed 2" to no more than 1000 rpm.
39. "Generator connection": Document the parameter setting.
40. Increase "Generator connection" to 1800 rpm.
41. REguard Monitoring: Select Parameters menu → System → General → Status codes.
42. Disable status code 65.
43. Perform a RESET of the wind turbine (ref. operating manual) and consequently initiate the isolated operation of the wind turbine with the modified parameters.

**Grinding in the carbon brushes**

44. Wait for a while, then stop the wind turbine.
45. Engage the rotor holding brake.
46. Remove the reel tapes (3) and the carbon brushes (4).
47. Check whether the contact surfaces have been ground in as stipulated (properly run-in carbon brushes exhibit a shiny contact surface).
48. If the carbon brushes have not been ground in yet, re-insert the carbon brushes as well as the brush holder and repeat the grind-in procedure (steps 43 through 47).
49. If the carbon brushes have been ground in, clean all brush holders and carbon brushes one more time with a non-fraying, soft cloth.
50. Use a glass brush to carefully remove emery crystals from the contact surface of the carbon brushes (4) and inspect the contact surface for any remaining foreign objects.
51. Thoroughly clean the slip ring space (2) one more time.
52. Remove the emery cloth and the double-sided adhesive tape.
53. Remove the residue of the adhesive tape with ethyl alcohol (observe the safety notices provided by the manufacturer) and a non-fraying cloth.
54. Insert the carbon brushes and the reel tapes in the manner detailed above.

**⚠ DANGER Risk of life due to high voltages. With the exception of the direct maintenance, the cover of the slip ring space always needs to be closed.**

55. Reinstall the cover (1) of the slip ring space (2).

**Terminating the isolated operation**

56. REguard Monitoring: Select Parameters menu → Control → General.
57. Reset "Run-up speed 2" to the previous value.
58. Reset "Generator connection" to the previous value.
59. REguard Monitoring: Select Parameters menu → System → General → Status codes.
60. Enable status code 65 again.
61. Perform a RESET of the wind turbine (ref. operating manual); after that, immediately stop the wind turbine.

## 6.13.8 Cleaning the slip ring space

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 10 box nut
- Dust mask
- Industrial vacuum cleaner with fine dust filter
- Disposable gloves or new gloves
- Oil, grease, and lint-free cloths
- Oil and grease-free brush, glass brush

**Directive:**

**Note:** Perform this maintenance section together with maintenance section 6.13.7 "Inspecting the carbon brushes and the brush holders in the slip ring space".

1. Engage the rotor lock (ref. operating manual).

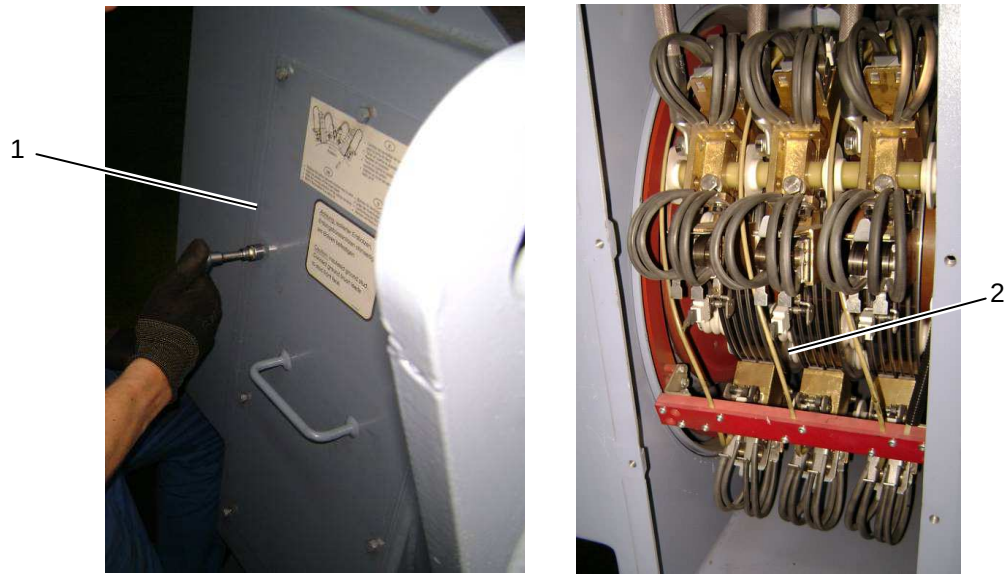



Fig. 6.13.8 – 1 Cover (1) slip ring space and slip ring space (2) VEM

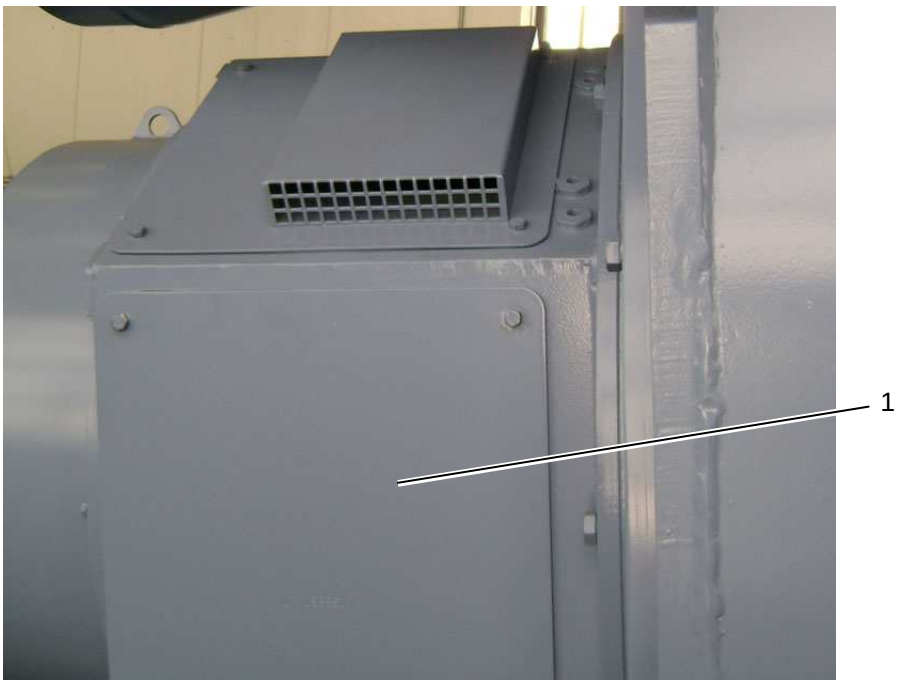



Fig. 6.13.8 – 2 Cover slip ring space (Winergy)

2. Remove the cover (1) of the slip ring space.

**⚠ CAUTION Danger due to fine dust. Wear a dust mask and use an industrial vacuum cleaner with a fine dust filter.**

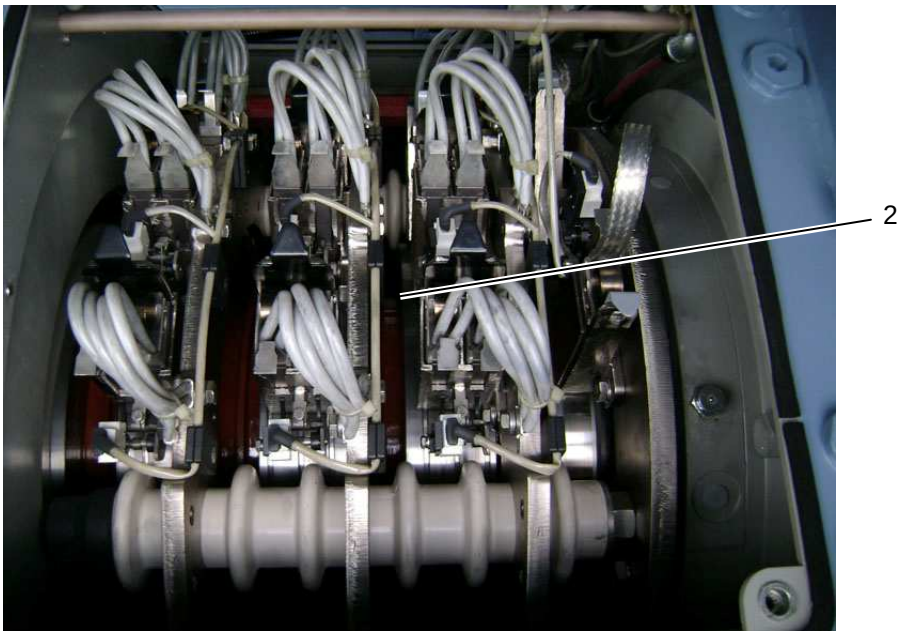



Fig. 6.13.8 – 3 Slip ring space (Winergy)

3. Thoroughly vacuum the slip ring space (2) with the industrial vacuum cleaner.
4. Use a glass brush to remove deposits at inaccessible positions while simultaneously operating the vacuum cleaner.
5. Subsequently clean with oil and grease-free as well as non-fraying cloths.

**DANGER Risk of life due to high voltages. With the exception of the direct maintenance, the cover of the slip ring space always needs to be closed.**

6. Reinstall the cover (1) of the slip ring space.

## 6.13.9 Insulation resistance

### 6.13.9.1 Measuring the insulation resistance of the rotor winding

**Required tools / operating and auxiliary means:**

- Multimeter

**Directive:**

**Note:** This maintenance section may only be started after the generator has been in standstill for four hours. An excessive temperature of the generator falsifies the measured values.

**Note:** This maintenance section needs to be performed while performing the maintenance work in chapter 6.13.7. The required preparations are described there.

**Requirement:**


Fig. 6.13.9.1 – 1 Slip ring space (example: VEM)

- All carbon brushes (1) have been removed from their mounts.
- The rotor lock has been engaged (ref. operating manual).

**Directive:**

**⚠ CAUTION Danger due to fine dust. Wear a dust mask.**

**NOTICE Risk of converter damage. Completely bypass the generator.**

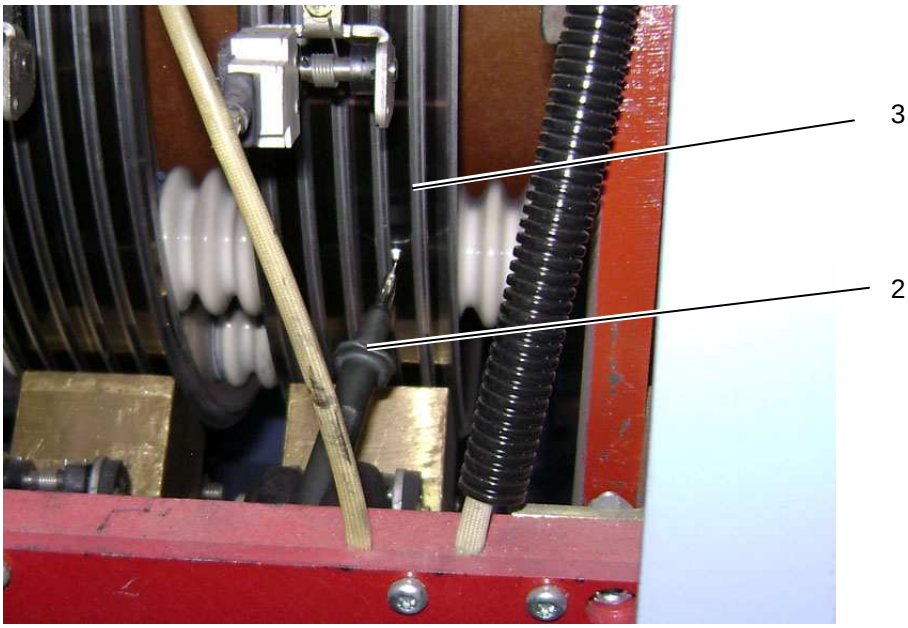



Fig. 6.13.9.1 – 1 Measuring the insulation resistance (example: VEM)

1. Connect the multimeter in an electrically conducting manner to the generator housing.
2. Adjust the test voltage as detailed in the service booklet.
3. Lift the carbon brushes off the generator housing.
4. Connect the measuring tip (2) of the multimeter to the slip ring (3).
5. Determine the measurement and document it in the service booklet.
6. Compare the measured value to the nominal value. If the measured value is less than the nominal value, notify the service control room and document the deviation in the service booklet.
7. Disconnect the multimeter.
8. Continue with maintenance section 6.13.7 "Inspecting the carbon brushes and the brush holders in the slip ring space".

### 6.13.9.2 Measuring the insulation resistance of the stator winding

**Required tools / operating and auxiliary means:**

- Multimeter
- Ratchet with extension
- No. 17 box nut
- No. 8 Allen wrench plug insert
- Torque wrench
- No. 24 box nut

**Directive:**

**Note:** This maintenance section may only be started after the generator has been in standstill for four hours. An excessive temperature of the generator falsifies the measured values.

**Note:** Perform this maintenance section together with maintenance section 6.13.16 "Checking the power cable stator terminal box screws".

1. Engage the rotor lock (ref. operating manual).

**NOTICE** **Risk of converter damage. Completely bypass the generator.**


Fig. 6.13.9.2 – 1 Stator terminal box (left hand: VEM; right hand: Winergy)

2. Remove the cover of the stator terminal box (1).
3. Put the cover to the side.


Fig. 6.13.16 – 2 Stator power cable (example: VEM)

4. Disconnect all power cables (2) of the stator.

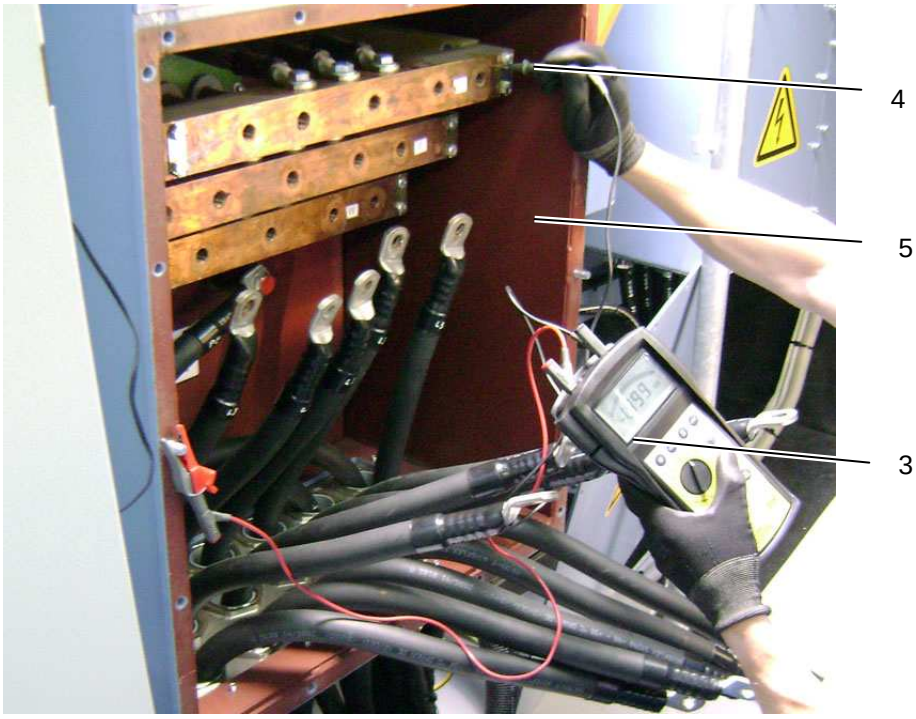



Fig. 6.13.9.2 – 3 Measuring the insulation resistance (example: VEM)

5. Connect the multimeter (3) in an electrically conducting manner to the stator terminal box (5).
6. Adjust the test voltage as detailed in the service booklet.
7. Connect the measuring tip (4) of the multimeter.
8. Determine the measurement and document it in the service booklet.

9. Compare the measured value to the nominal value. If the measured value is less than the nominal value, notify the service control room and document the deviation in the service booklet.
10. Disconnect the multimeter.
11. Reconnect the power cable and tighten it with a torque as detailed in the service booklet.
12. Replace the cover of the stator terminal box and install it.

### 6.13.9.3 Measuring the bearing insulation resistance

**Required tools / operating and auxiliary means:**

- Multimeter
- Ratchet with extension
- No. 13 box nut
- No. 13 ring spanner
- No. 10 Allen wrench plug insert
- Sliding gauge

**Directive:**

**Note:** This maintenance section may only be started after the generator has been in standstill for four hours. An excessive temperature of the generator falsifies the measured values.

**Note:** This maintenance section needs to be performed together with chapter 6.13.8 "Cleaning the slip ring space". The required preparations are described there.

1. Engage the rotor lock (ref. operating manual).
2. Keep the the rotor holding brake closed (ref. operating manual).

**NOTICE** **Risk of converter damage. Completely bypass the generator.**

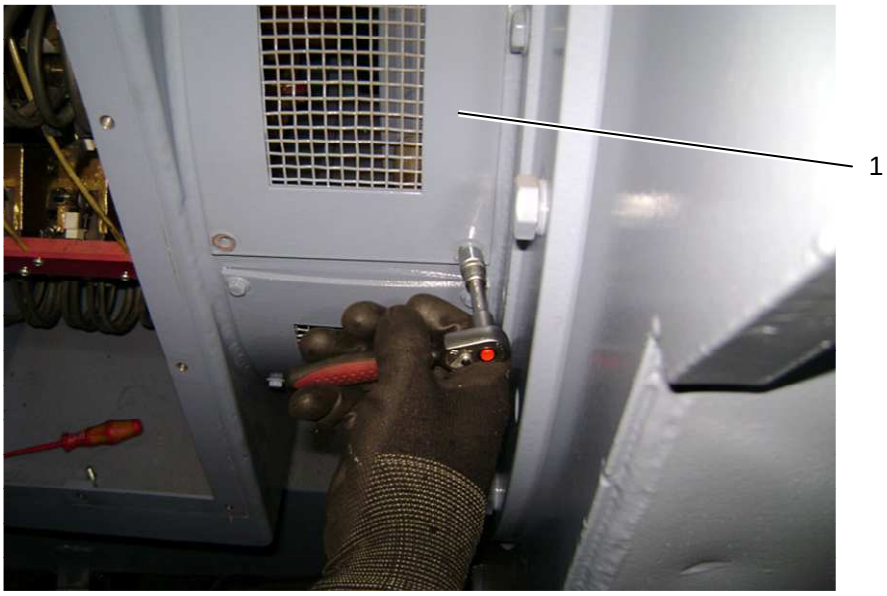



Fig. 6.13.9.3 – 1 Cover of the grounding brush space (VEM)

Fig. 6.13.9.3 – 2 Cover slip ring space (Winergy)

**⚠ CAUTION Danger due to fine dust. Wear a dust mask.**

3. Remove the cover (1) of the grounding brush space (VEM) respectively of the slip ring space (Winergy).
4. Put the cover (1) to the side.

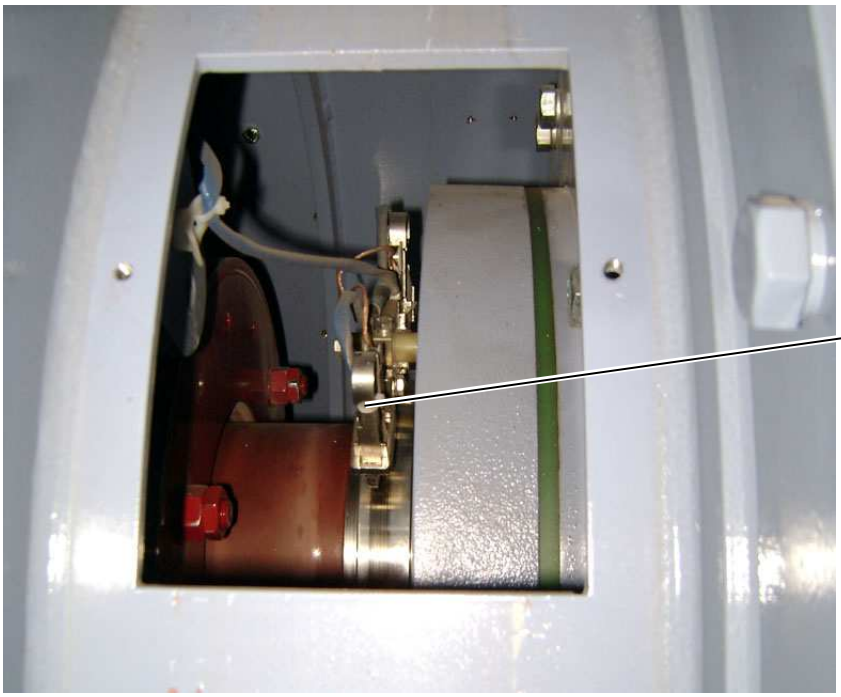



Fig. 6.13.9.3 – 3 Grounding brushes (VEM)

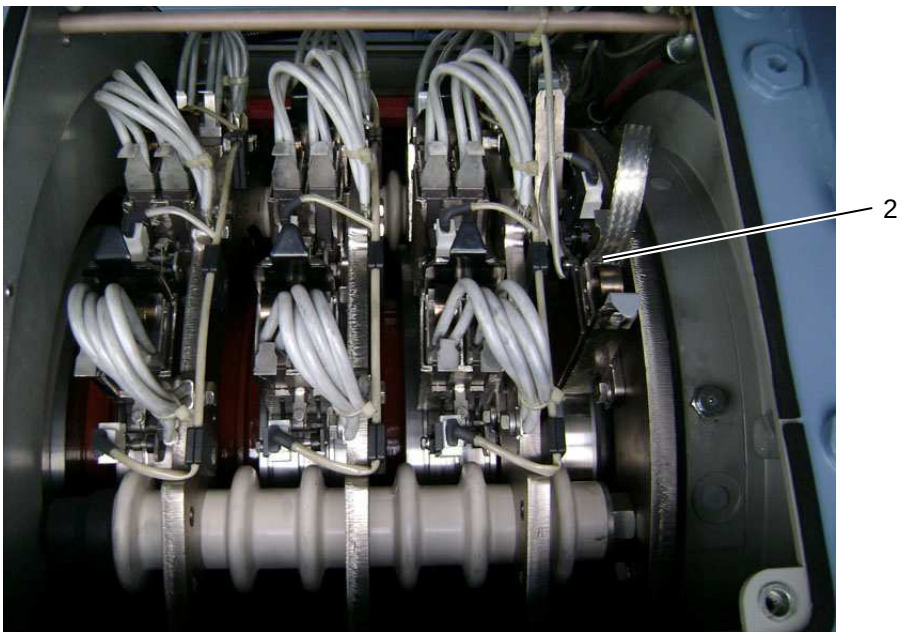



Fig. 6.13.9.3 – 4 Slip ring space (Winergy)

5. Remove the grounding brushes (2).
6. Remove the grounding brushes on the D side (at the B bearing) of the generator (ref. chapter 6.13.2.2 "Checking the grounding brushes on the rotor side").
7. Connect the multimeter in an electrically conducting manner to the generator housing.
8. Adjust the test voltage as detailed in the service booklet.

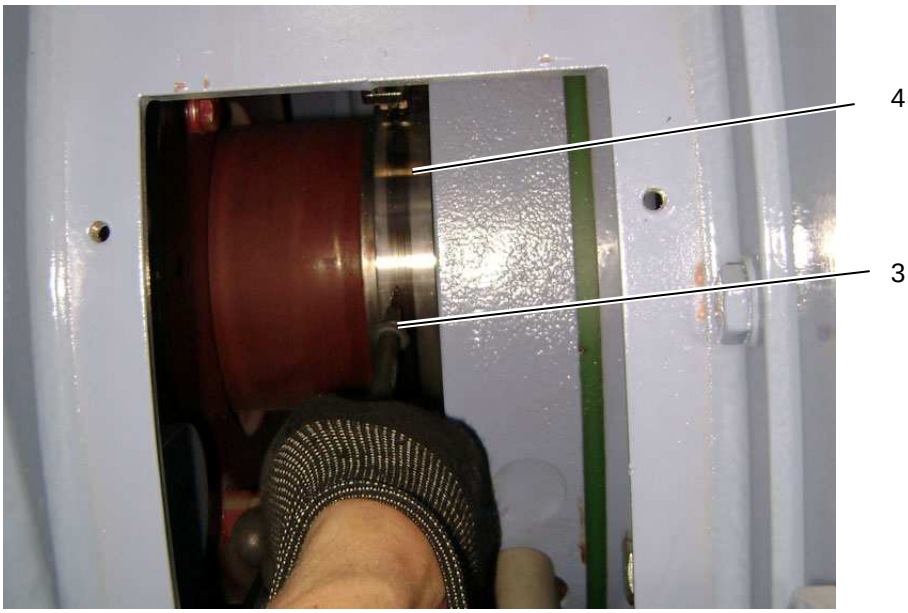



Fig. 6.13.9.3 – 3 Measuring the insulation resistance (example: VEM)

9. Connect the measuring tip (3) of the multimeter to the slip ring (4).
10. Determine the measurement and document it in the service booklet.

11. Compare the measured value to the nominal value. If the measured value is less than the nominal value, notify the service control room and document the deviation in the service booklet.
12. Disconnect the multimeter.
13. Re-insert the grounding brushes at both bearings.
14. Reinstall the cover of the grounding brush space respectively of the slip ring space.
15. Reinstall the cover of the coupling (ref. chapter 6.13.2.2 "Checking the grounding brushes on the rotor side").

## 6.13.10 Cleaning the filter box and replacing the filter mats

**Required tools / operating and auxiliary means:**

- Dust mask
- Industrial vacuum cleaner with fine dust filter
- Gloves
- Filter mat
- Trash bag

**Directive:**

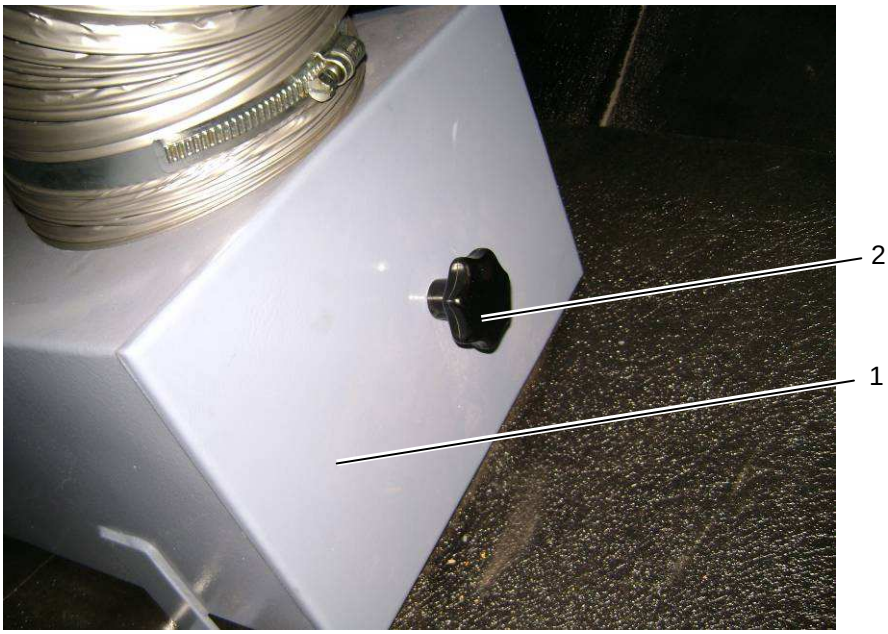



Fig. 6.13.10 – 1 Cover slip ring space (example: VEM)

**⚠ DANGER Risk of life due to fall: Never access the deck crane area while the crane hatch is open. Never subject the crane hatch to a load exceeding 330 lb (150 kg) on an area of 7.8 in. x 0.78 in. (0.2m x 0.2m).**

1. Release the knob (2) and remove the cover of the filter box (1).

**⚠ CAUTION Danger due to fine dust. Wear a dust mask and use an industrial vacuum cleaner with a fine dust filter.**

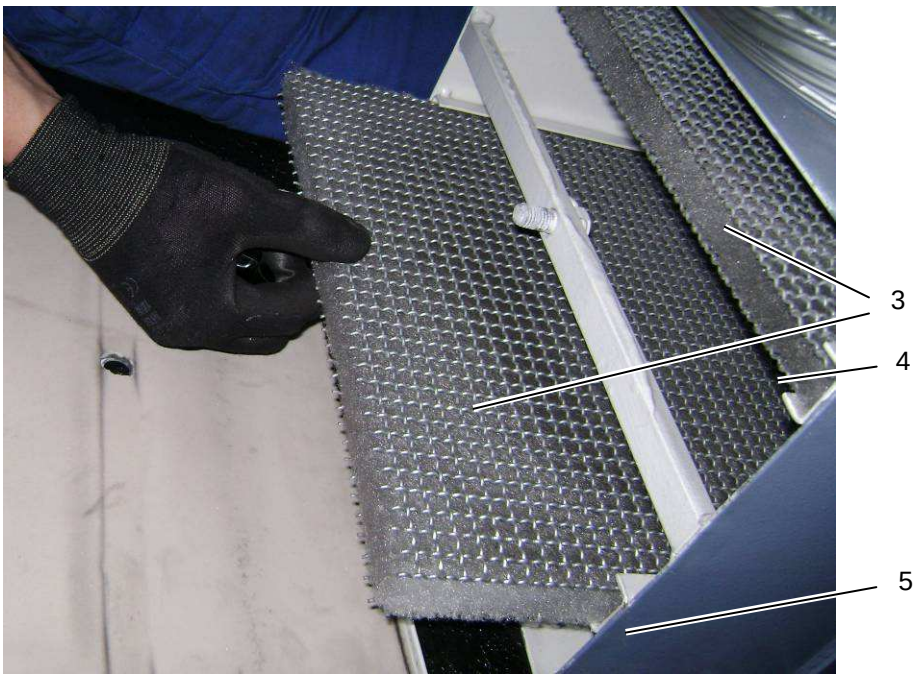



Fig. 6.13.10 – 2 Slip ring space (example: VEM)

2. Carefully remove the filter mats (4) together with the grid (3).
3. Remove the grid and seal the filter mats in an air-tight manner in plastic bags; in that context, disperse as little dust as possible.
4. Clean the filter box by means of the industrial vacuum cleaner.
5. Vacuum the grid.
6. Place the grid on a new filter mat and trim new filter mats along the grid.
7. Place the filter mats (4) between two grids (3) each.
8. Slide the filter mats together with the grids into the slots (4).
9. Replace the cover of the filter box (1) and tighten it with the knob (2).
10. Vacuum the working area.
11. Close the barrier of the crane hatch section.
12. Dispose of the filter mats in the proper manner.

## 6.13.11 Outside ventilator and exhaust air channel

### 6.13.11.1 Inspecting the outside ventilator

**Required tools / operating and auxiliary means:**

- Screwdriver, insulated

**Directive:**

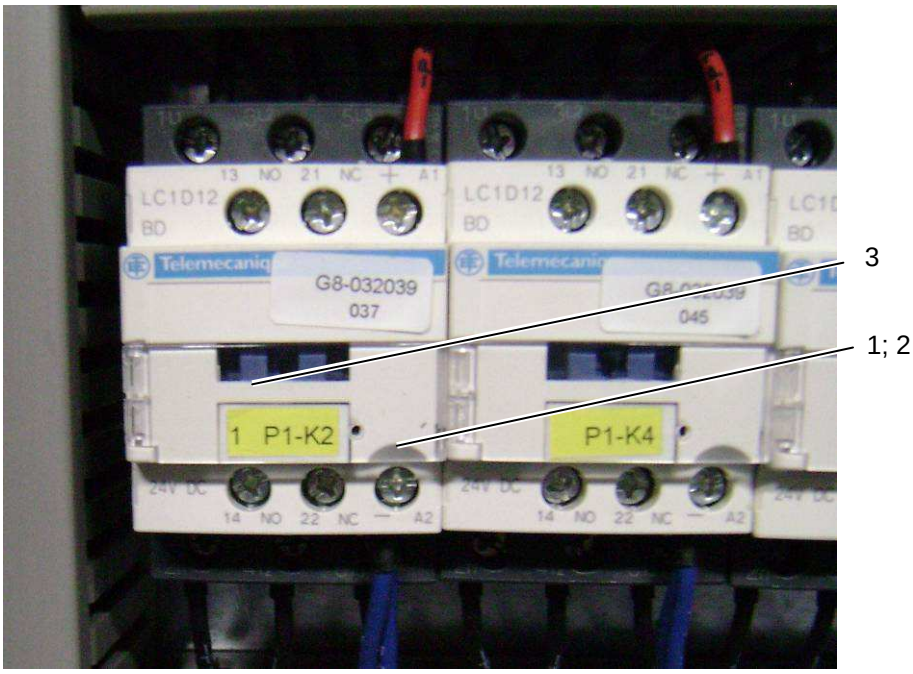



Fig. 6.13.11.1 – 1 Switch generator ventilator in the top box

1. Open the plastic cover (2) of the first switch "Generator ventilator …" (1).
2. Trigger the switch by means of the screwdriver (3).
3. The ventilator motor needs to start up.
4. Remove the screwdriver and close the plastic cover.
5. Perform steps 1 through 4 for all other available ventilators.

## 6.13.11.2 Checking the exhaust air channel

**Required tools / operating and auxiliary means:**

- Screwdriver, insulated

**Directive functional test outside ventilator:**

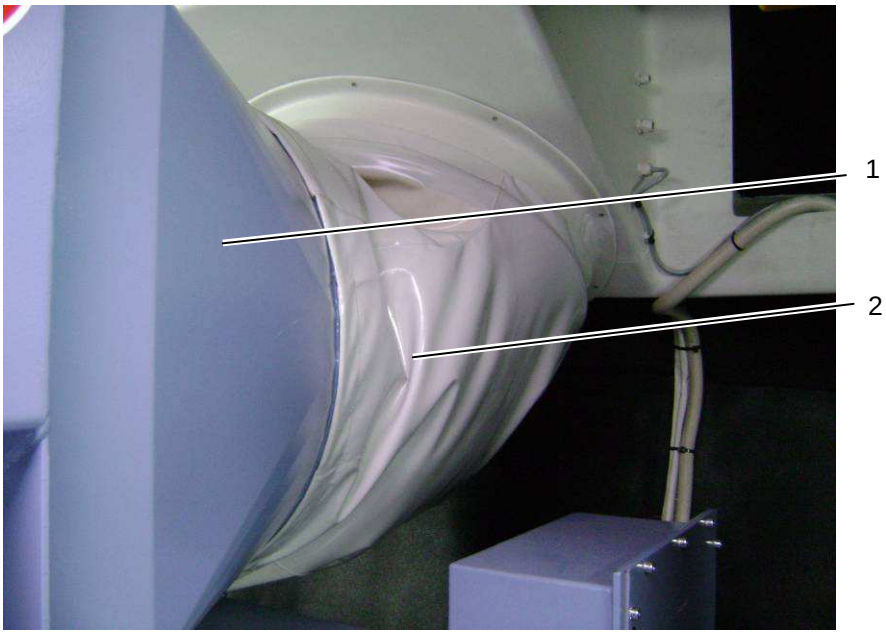



Fig. 6.13.11.2 – 1 Exhaust air channel (example VEM)

**DANGER Risk of life due to fall: Never access the deck crane area while the crane hatch is open. Never subject the crane hatch to a load exceeding 330 lb (150 kg) on an area of 7.8 in. x 0.78 in. (0.2m x 0.2m).**

1. Examine the molded exhaust air channel component (1) and the flexible hose (2) for damage.
2. Close smaller cracks in the flexible hose with fabric tape.
3. Degrease the surrounding of the crack before that.
4. Remove soilings.

## 6.13.12 Performing a visual inspection of the rotary pulse sensor

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

**DANGER Risk of life due to fall: Never access the deck crane area while the crane hatch is open. Never subject the crane hatch to a load exceeding 330 lb (150 kg) on an area of 7.8 in. x 0.78 in. (0.2m x 0.2m).**

**Note:** This maintenance section only consists of a visual inspection. Special tools and extensive instructions are required for the alignment of the rotary impulse sensor. Only document noticeable problems.

**NOTICE Risk of system damage. The rotary impulse sensor is an exactly aligned component. Never subject it to force.**

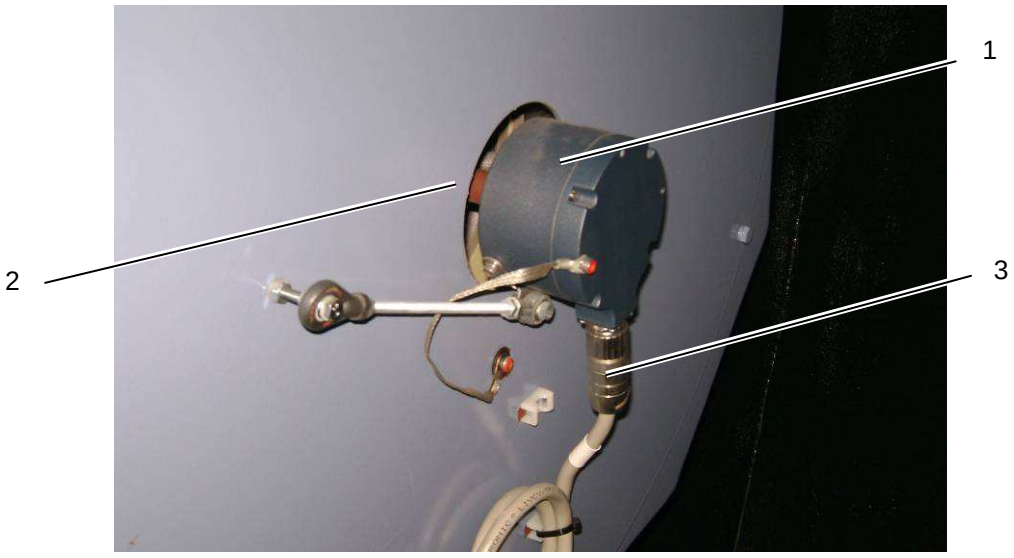



Fig. 6.13.12 – 1 Rotary impulse sensor

1. Check the rotary impulse sensor (1) and the torque support (2) for a tight fit.
2. Disengage the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).
3. Check the cable connections for a tight fit.

**WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

4. Release the rotor holding brake.
5. Check the balance of the rotary impulse sensor.

6. Document irregularities in the service booklet.
7. Re-engage the rotor holding brake.
8. Engage the rotor lock (ref. operating manual).

## 6.13.13 Checking the screw connection between the generator and the generator base

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 36 box nut with limited height

**Directive:**


Fig. 6.13.13 – 1 Generator base

1. Check the screws (3) of the connection between the generator (1) and the generator base (2) with a torque as detailed in the service booklet.
2. Repeat the step for the three other generator bases.

## 6.13.14 Checking the screw connection between the generator base and the machine base

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 24 box nut

**Directive:**

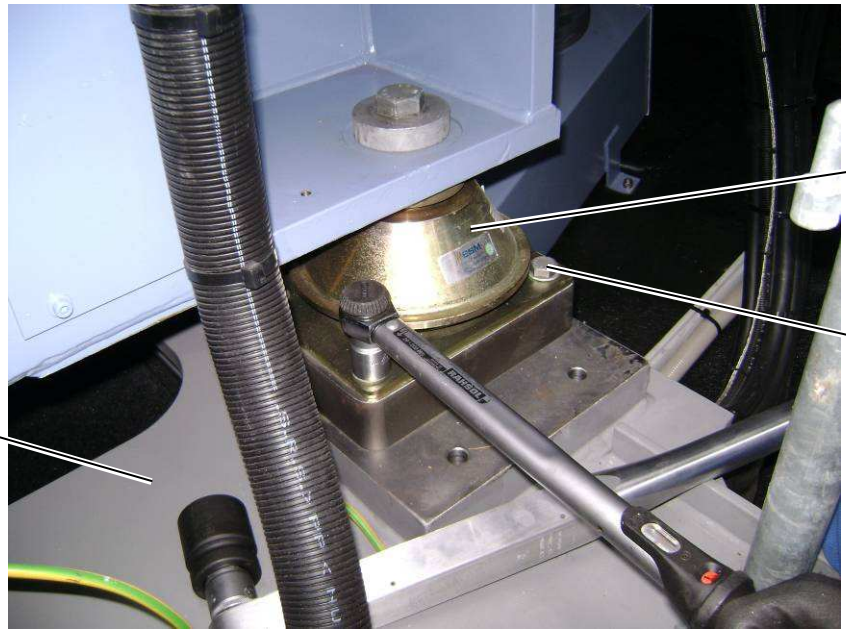



Fig. 6.13.14 – 1 Generator base

1. Check the screws (3) of the connection between the generator base (1) and the machine base (2) with a torque as detailed in the service booklet.
2. Repeat the step for the three other generator bases.

## 6.13.15 Checking the power cable stator terminal box screws

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 17 box nut
- No. 8 Allen wrench plug insert
- Torque wrench
- No. 24 box nut

**Directive:**

**Note:** This maintenance section may be performed together with chapter 6.13.9.2 "Measuring the insulation resistance of the stator winding".


Fig. 6.13.15 – 1 Stator terminal box (left hand: VEM; right hand: Winergy)

1. Remove the cover (1) of the stator terminal box.
2. Put the cover (1) to the side.


Fig. 6.13.15 – 2 Stator power cable (example: VEM)

3. Check all screws (3) of the power cables (2) with a torque as detailed in the service booklet.
4. Replace the cover (1) of the stator terminal box and install it.

## 6.13.16 Lubricating the bearing

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 10 box nut
- Grease gun with approx. 9 oz. (250 g) of lubrication grease in accordance with the type label

**Directive:**

**Note:** Only re-lubricate while the generator is running.

1. Disengage the rotor lock while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).
2. Release the rotor holding brake while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).

**Note:** Fresh lubrication grease provided by the manufacturer needs to be stored for at least 6 weeks in order to avoid bleeding occurrences. The lubrication grease needs to be clean and stored in a temperature-controlled environment.


Fig. 6.13.16 – 1 Grease nipple on the N side (A-bearing) of the VEM-generator


Fig. 6.13.16 – 2 Grease nipple on the N-side (A-bearing) of the Winergy-generator

3. Clean the grease nipple (1).
4. Attach the grease gun to the grease nipple (1) on the D side (A bearing) of the generator and press approximately 3 – 4 oz. (80-120g) of lubrication grease in accordance with the type label via multiple strong strokes into the bearing.
5. Remove the grease gun again.
6. Clean the grease nipple (1).


Fig. 6.13.16 – 3 Grease pusher on the N side (A-bearing) of the VEM-generator

7. ONLY VEM: Pull out the grease pusher (2) and push it back in multiple times.
8. ONLY VEM: Remove excessive lubrication grease from the grease pusher and dispose of it in the proper manner.
9. ONLY VEM: Re-insert the grease pusher (2) and push it all the way in.


Fig. 6.13.17 – 4 Grease container on the N-side (A-bearing) of the Winergy-generrator

10. ONLY WINERGY: Clear the grease container (3) and dispose of it in the proper manner, if needed.

**DANGER Risk of life due to fall: Never access the deck crane area while the crane hatch is open. Never subject the crane hatch to a load exceeding 330 lb (150 kg) on an area of 7.8 in. x 0.78 in. (0,2m x 0,2m).**

11. Open the barrier of the crane hatch section


Fig. 6.13.16 – 5 Pushing lubrication grease in on the N side (B-bearing) of the VEM-generator

12. Clean the grease nipple (4).

13. Attach the grease gun (6) to the grease nipple (4) on the N side (B bearing) of the generator and press approximately 3 – 4 oz. (80 -120 g) of lubrication grease in accordance with the type label via multiple strong strokes into the bearing.
14. Remove the grease gun (6) again.
15. Clean the grease nipple (4).
16. Disconnect the grease pusher (5).

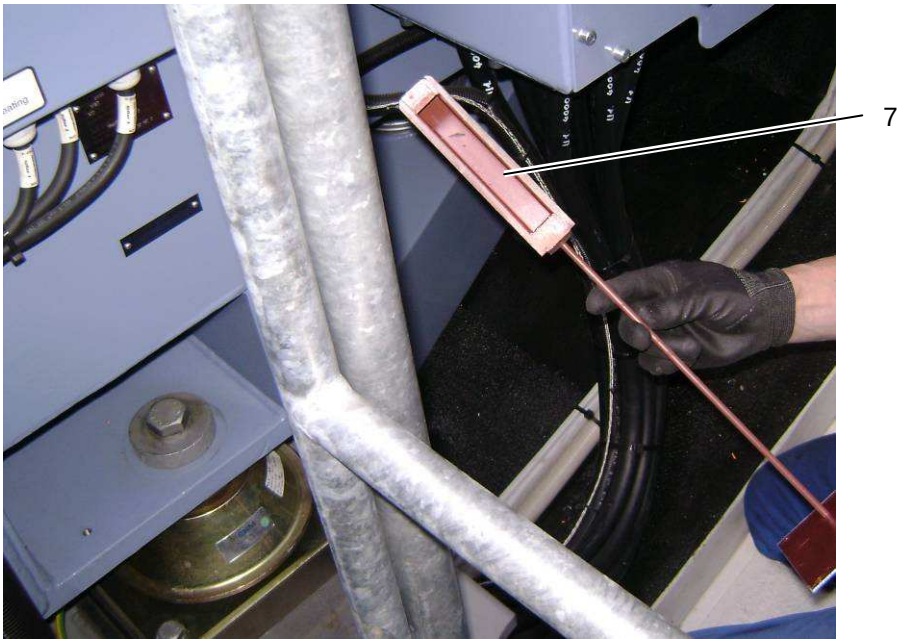
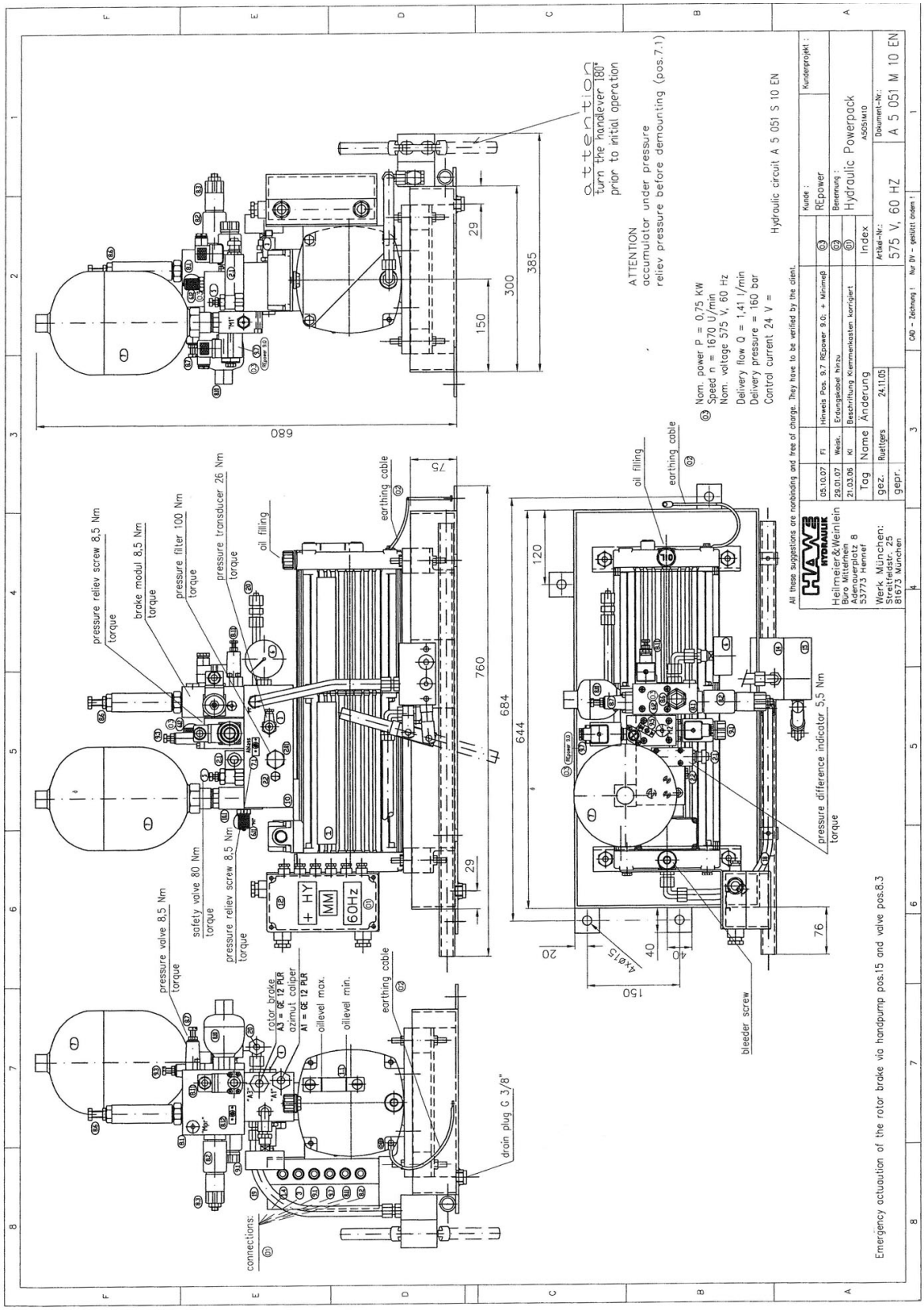



Fig. 6.13.16 – 6 Grease pusher on the N side (B-bearing) of the VEM-generator

17. ONLY VEM: Pull out the grease pusher (7) and push it back in multiple times.
18. ONLY VEM: Remove excessive lubrication grease from the grease pusher and dispose of it in the proper manner.
19. ONLY VEM: Push the grease pusher all the way back in.
20. ONLY VEM: Tighten the grease pusher.
21. ONLY WINERGY: Clean the grease container (as 3) and dispose of it in the proper manner, if needed.
22. Close the barrier of the crane hatch section.
23. Dispose of lubrication grease and soiled cloths in the proper manner.

# 6.14 HAWE hydraulic aggregate



**⚠ WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

**⚠ CAUTION**

**Risk of fall while descending into the yaw area.The ladder to the yaw area does not reach to the platform.**

- Wear protective equipment and descend with care in order to avoid injuries.

**⚠ CAUTION**

**Risk of fall due to unstable foothold in the yaw area.**

- Ensure the safe placement of the step-ladder.
- Keep both feet on the step-ladder while working.

## 6.14.1 Checking the oil level

**Directive:**

1. Release the rotor holding brake while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual).
2. Descend to the yaw area.

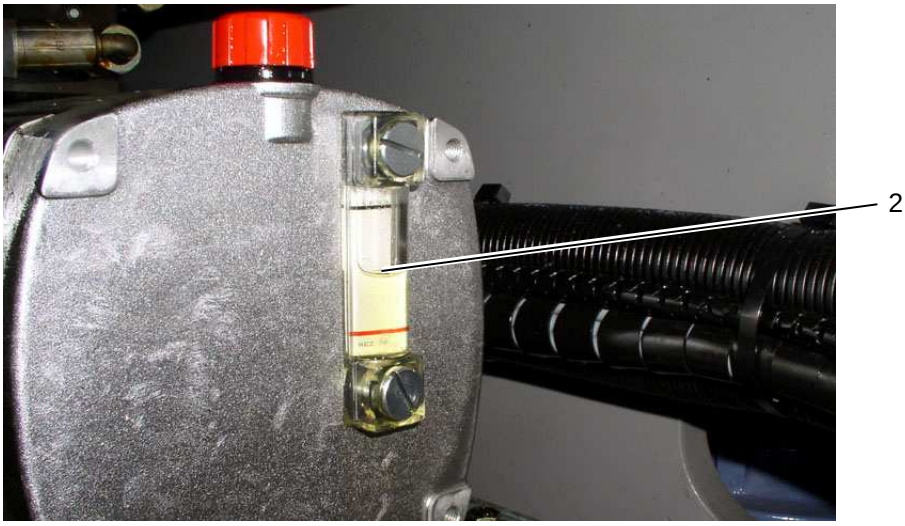



Fig. 6.14.1 – 1 Level indicator

3. Check the oil level; the oil level should be displayed in the middle of the level indicator (2).

## 6.14.2 Performing an oil change

**Required tools / operating and auxiliary means:**

- No. 5 and No. 8 Allen wrench
- Approx. 5 gal. (20 liters) of fresh oil in accordance with the oil card at the hydraulic aggregate
- Canister pump with a long hose
- Waste oil canister (approx. 5 gal. (20 liters))
- Hose for G 3/8" stub (approx. length of 6.5 ft. (2 m))
- Hose bracket or cable tie
- Absorptive cloths
- Fat-solving cleaning agent
- Oil filter (in accordance with the list of spare parts)

**Directive:**

**Draining the oil**

1. Set the motor circuit switch of the hydraulic pump in the top box to STOP.
2. Descend to the yaw area

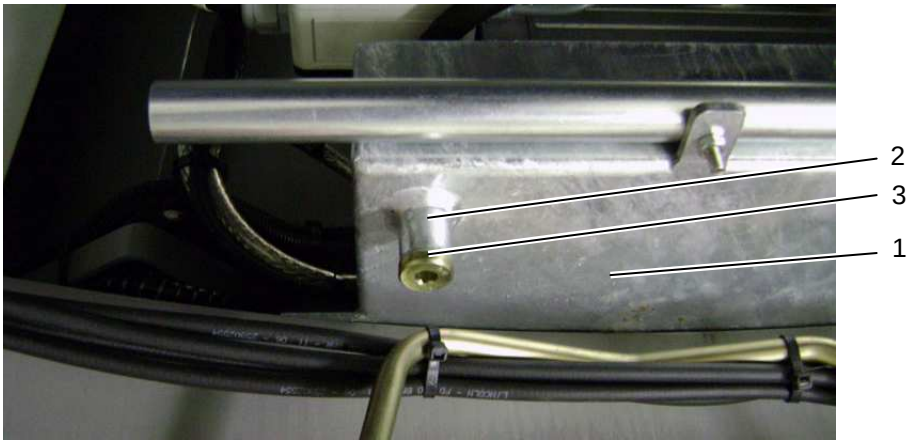



Fig. 6.14.2 – 1 Oil pan of the hydraulic aggregate

3. Remove the oil drain screw (3) at the oil pan (1).
4. Attach the hose by means of a cable clamp or a cable tie at the stub (2).
5. Insert the hose into a 5 gal. (20 liter) waste oil canister.

**DANGER Danger due to high pressure (2320 lb/in²); (160 bar). The pressure of the hydraulic system needs to be released prior to commencing the work. Observe the following directives. Wear protective goggles and acid-proof glove.**

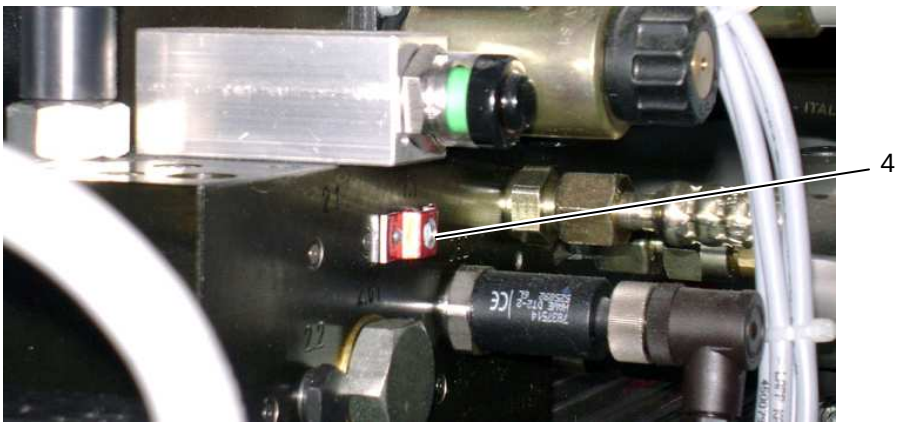



Fig. 6.14.2 – 2 Drain valve 7.1

6. Release the system pressure via drain valve 7.1 (4).

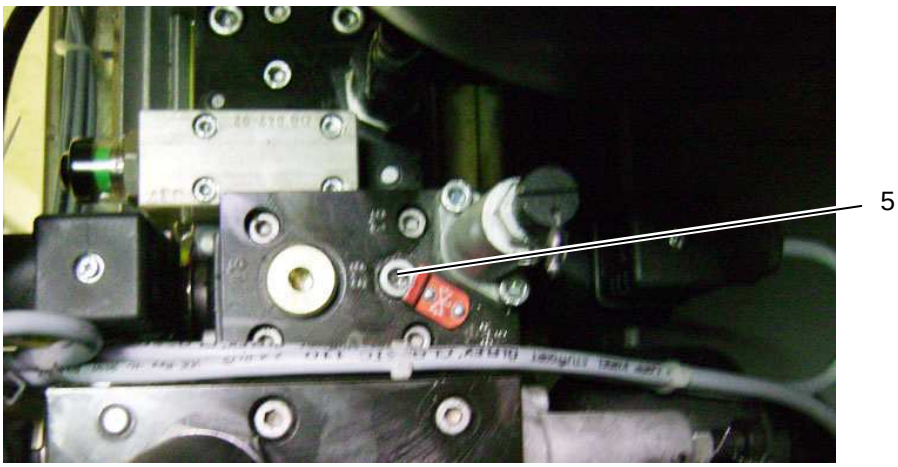



Fig. 6.14.2 – 3 Drain valve 9.5

7. Release the residual pressure via drain valve 9.5 (5).

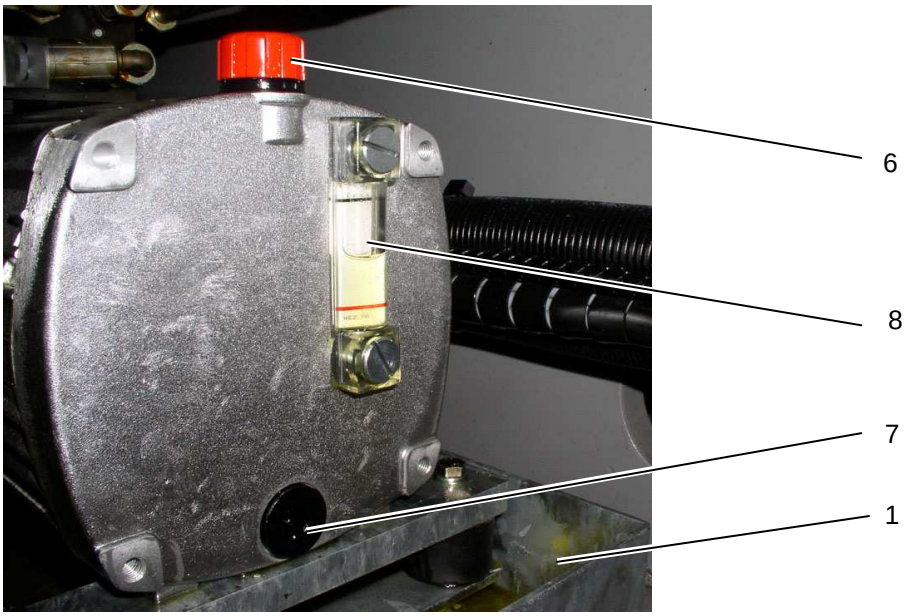



Fig. 6.14.2 – 4 Oil intake stub and oil drain

8. Remove the red cover (6) of the oil intake stub.
9. Remove the oil drain screw (7).
10. Drain the waste oil.
11. Replace the oil filter (ref. chapter 6.14.4 "Replacing the oil filter").
12. Insert and tighten the oil drain screw (7).
13. Fill in approx. 4 gal. (15 liters) of fresh oil in accordance with the oil card until the oil level is displayed in the middle of the level indicator.
14. Close valves 7.1 (4) and 9.5 (5).
15. Set the motor circuit switch of the hydraulic pump to START.
16. Perform a RESET of the wind turbine (ref. operating manual); after that, immediately perform a manual stop of the wind turbine.

**Note:** It may be necessary to perform the RESET of the wind turbine multiple times.

**Flushing the rotor holding brake and removing the air:**

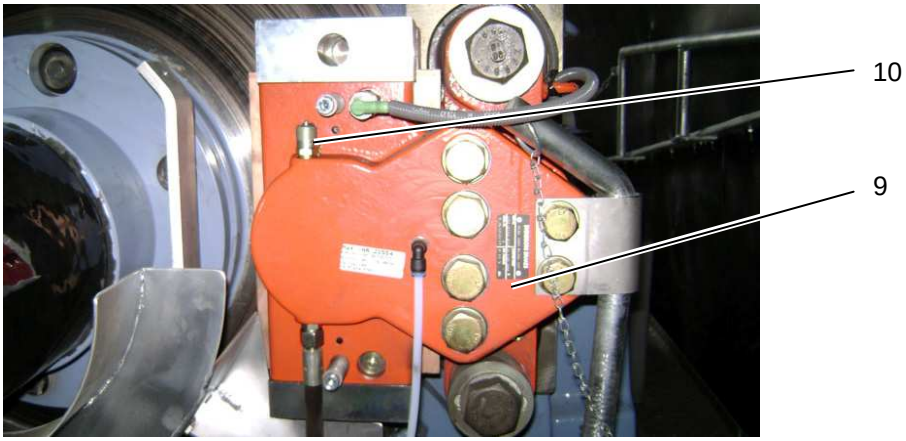



Fig. 6.14.2 – 5 Rotor holding brake

17. Remove the cover of the pressure connection (10) of the rotor holding brake (9).
18. Insert the pressure hose into a waste oil canister.
19. Connect the pressure hose to the pressure connection (10).
20. Activate the rotor holding brake.
21. Drain the oil.
22. If the hydraulic aggregate starts up during the flushing procedure, remove the pressure hose and wait until the hydraulic aggregate stops again.
23. Release the rotor holding brake.
24. Descend to the yaw area
25. Check the oil level at the hydraulic aggregate (ref. chapter 6.14.1 "Checking the oil level")
26. In case of an insufficient oil level, remove the red cover of the oil intake stub (6) and refill oil until the oil level is displayed in the middle of the level indicator (8).

**Note:** If the oil level of the hydraulic aggregate has dropped below the minimum value during the flushing procedure, the safety chain deactivates the wind turbine. In that case, perform a RESET of the wind turbine; after that, immediately perform a manual stop of the wind turbine.

27. Re-attach the cover (6) of the oil intake stub.
28. Return to the machine base.
29. Reconnect the pressure hose at the rotor holding brake (9) to the pressure connection (10).
30. Repeat steps 20 through 29 until the drained oil is both clean and without air bubbles.
31. Disconnect the pressure hose.
32. Re-attach the cover of the pressure connection (12).
33. Descend with the pressure hose and the waste oil canister into the yaw area.

### Flushing the yaw brakes and removing the air


Fig. 6.14.2 – 6 Pressure connection at the yaw brake

34. Release the cover of the pressure connection (12) of the yaw brake (11) which is arranged directly upstream of the return line to the hydraulic aggregate.
35. Insert the pressure hose into the waste oil canister.
36. Connect the pressure hose to the pressure connection (12) of the yaw brake (11).
37. Drain the oil.
38. If the hydraulic aggregate starts up during the flushing procedure, remove the pressure hose and wait until the hydraulic aggregate stops again.
39. Release the rotor holding brake.
40. Check the oil level at the hydraulic aggregate.
41. In case of an insufficient oil level, remove the red cover of the oil intake stub (6) and refill oil until the oil level is displayed in the middle of the level indicator (8).
42. Re-attach the cover (6) of the oil intake stub.

43. Reconnect the pressure hose at the yaw brake (11) to the pressure connection (12).
44. Repeat steps 37 through 43 until the drained oil is both clean and without air bubbles.
45. Disconnect the pressure hose.
46. Re-attach the cover of the pressure connection (12).
47. After that, refill more fresh oil via the oil intake stub until the oil level is displayed in the middle of the level indicator.
48. Tighten the cover (6) on the oil intake stub.
49. Clean the hydraulic aggregate and the oil pan.
50. Remove the hose from the oil drain stub (2) of the oil pan (1) and put it to the side.
51. Re-tighten the oil drain screw (3) at the oil pan (1).
52. Close the waste oil canister.
53. Clean the working area.

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

54. Dispose of waste oil and soiled cloths in the proper manner

## 6.14.3 Checking the oil filter

**Required tools / operating and auxiliary means:**

- No. 5 Allen wrench

**Directive:**

1. Descend to the yaw area

**Note:** The pressure differential display (2) of the oil filter (pressure filter) needs to be inspected while the pump is running.

2. Release pressure via drain valve 7.1 (1) until the hydraulic aggregate switches on.
3. Close drain valve 7.1.

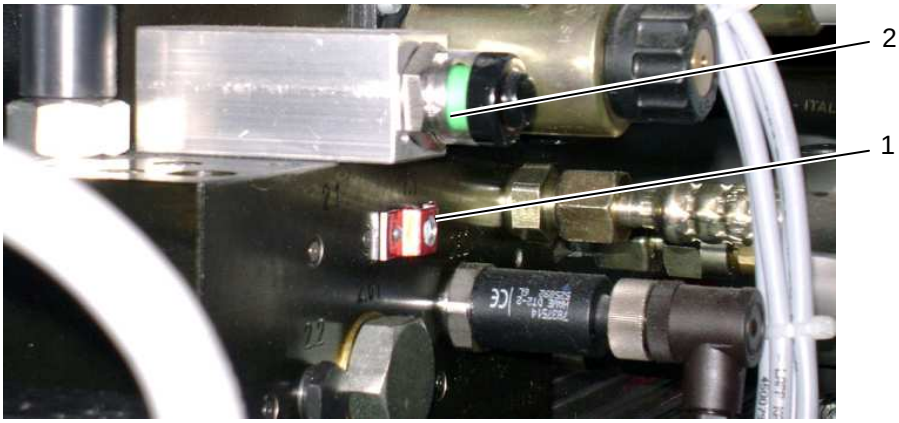



Fig. 6.14.3 – 1 Drain valve 7.1 and pressure differential display

4. The pressure differential display needs to remain green while the hydraulic aggregate operates.
5. If the pressure differential display turns red, the oil filter will need to be replaced (ref. chapter 6.14.4 "Changing the oil filter").

## 6.14.4 Changing the oil filter

**Required tools / operating and auxiliary means:**

- No. 27 ring spanner
- Torque wrench
- No. 27 box nut
- Oil filter and gasket (if needed) in accordance with the list of spare parts provided by the manufacturer
- Cloths

**Directive:**

1. Set the motor circuit switch of the hydraulic pump in the top box to STOP.
2. Descend to the yaw area.

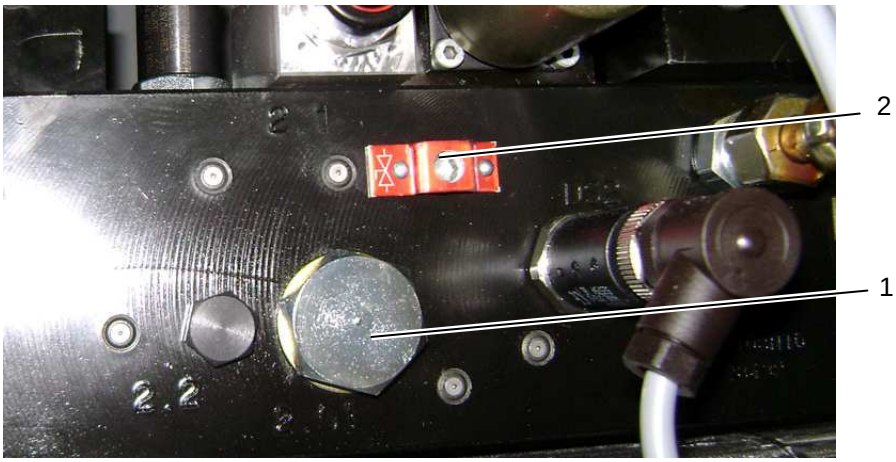



Fig. 6.14.4 – 1 Oil filter (pressure filter) drain valve 7.1

**DANGER Danger due to high pressure (2320 lb/in²); (160 bar). The pressure of the hydraulic system needs to be released prior to commencing the work. Observe the following directives. Wear protective goggles and acid-proof gloves.**

3. Release the system pressure via drain valve 7.1 (2).

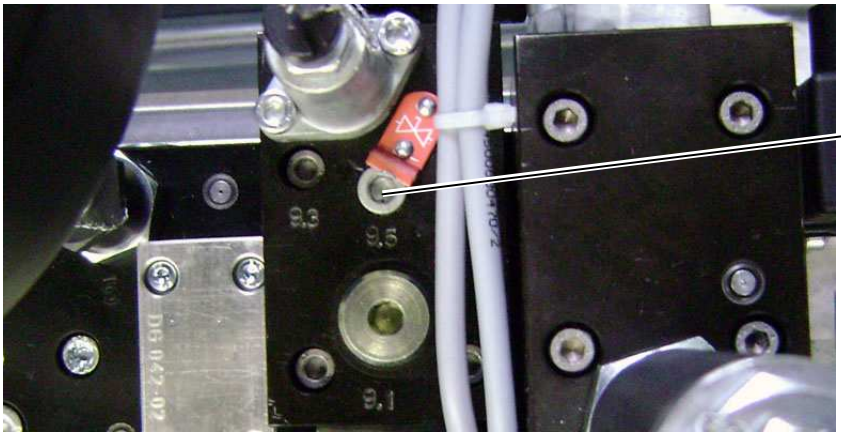



Fig. 6.14.4 – 2 Drain valve 9-5

4. Release the residual pressure via drain valve 9.5 (3).
5. Release the screw connection (1) and remove the covered oil filter.
6. Dispose of the oil filter in the proper manner.
7. Replaced damaged seals.
8. Insert a new oil filter.
9. Tighten the screw connection (1) (torque 73.75 lb-ft (100 Nm)).
10. Close valves 7.1 (2) and 9.5 (3).
11. Clean the working area.

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

12. Set the motor circuit switch of the hydraulic pump in the top box to START.
13. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

## 6.14.5 Checking the hydraulic aggregate for leaking oil

**Required tools / operating and auxiliary means:**

- Grease-solving cleaning agent
- Cloths

**Directive:**

1. Descend to the yaw area

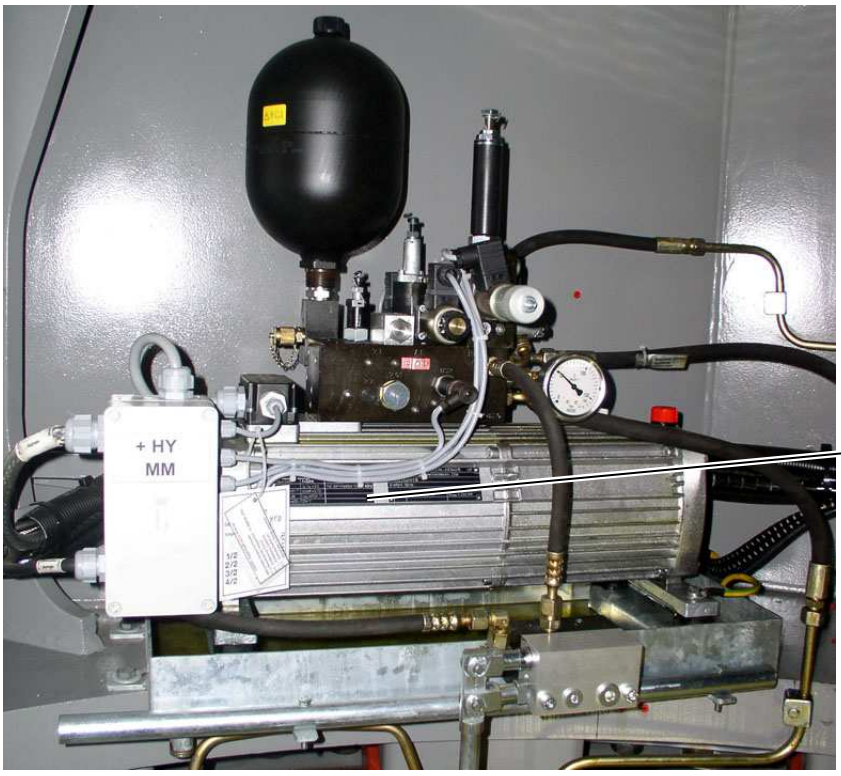



Fig. 6.14.5 – 1 Hydraulic aggregate

2. Check the hydraulic aggregate (1) for leaking oil.
3. If leaking oil is present, release the pressure first.

GEFAHR **Danger due to high pressure (2320 lb/in²); (160 bar). The pressure of the hydraulic system needs to be released prior to commencing the work. Observe the following directives. Wear protective goggles and acid-proof gloves.**

4. Release the pressure via drain valve 7.1 (2).

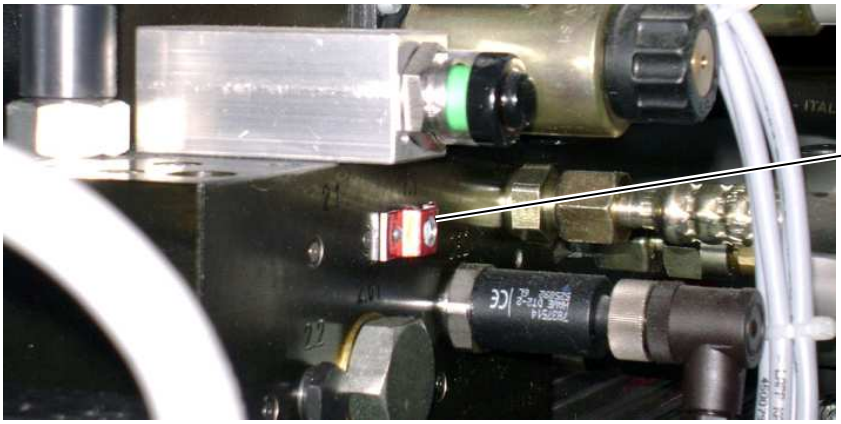



Fig. 6.14.5 – 2 Drain valve 7.1

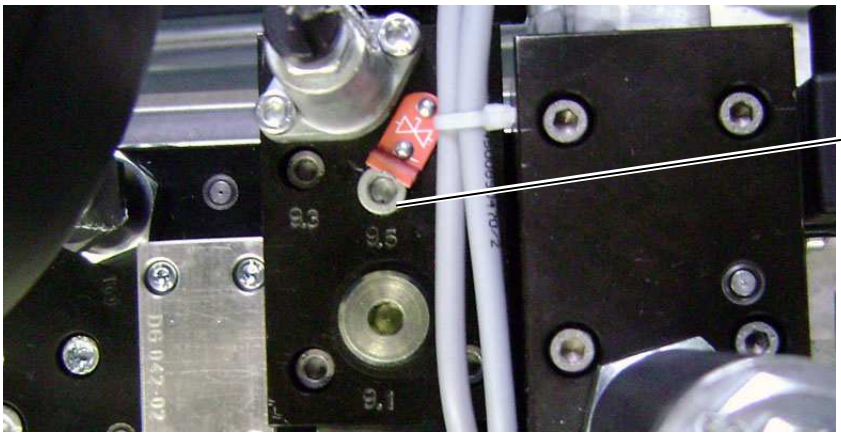



Fig. 6.14.5 – 3 Drain valve 9.5

5. Release the residual pressure via drain valve 9.5 (3).
6. Seal the systems.
7. Re-tighten the screw connections. Ref. chapter 6.14 for the tightening torques of the screw connection for the components. "HAWE hydraulic aggregate".
8. Close valves 7.1 (2) and 9.5 (3).
9. Dispose of soiled cloths in the proper manner.
10. Clean the working area.

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

## 6.14.6 Inspecting the ventilation filter

**Required tools / operating and auxiliary means:**

- none

**Directive:**

1. Descend to the yaw area


**Note:** The cover (1) of the oil intake stub is simultaneously used as ventilation of the hydraulic system.

2. Check the cover for damage.
3. Replace it if needed.

## 6.14.7 Inspecting the system pressure tank

### 6.14.7.1 Performing a visual inspection

**Required tools / operating and auxiliary means:**

- none

**Directive:**

1. Descend to the yaw area

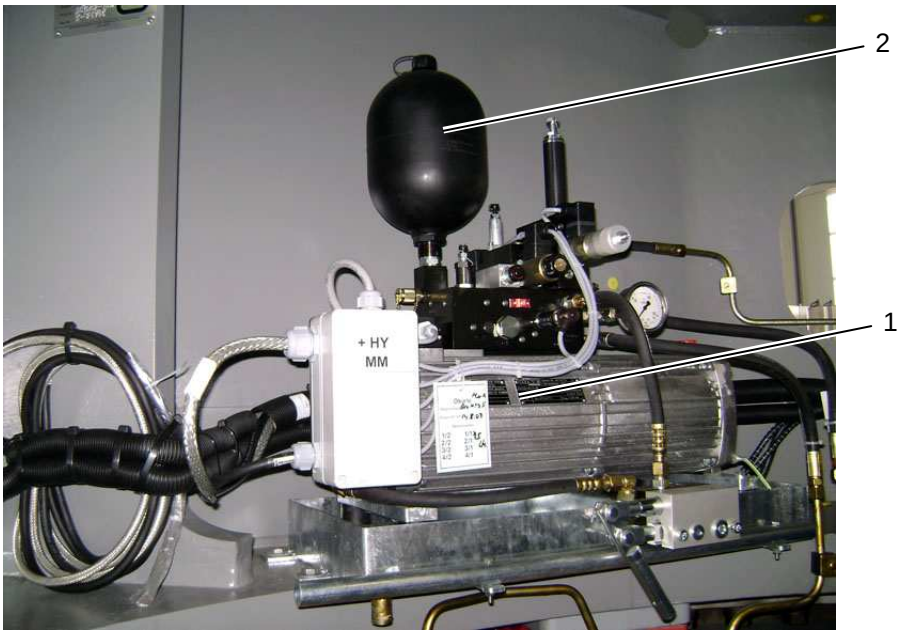



Fig. 6.14.7 – 1 HAWE hydraulic aggregate

2. Perform a visual inspection of the system pressure tank (2) of the hydraulic aggregate (1).
3. The system pressure tank needs to be replaced in case of visible damage on the outside (ref. chapter 6.14.7.4 "Replacing the system pressure tank").

### 6.14.7.2 Checking the gas charging pressure of the system pressure tank

**Required tools / operating and auxiliary means:**

- Pressure gauge
- No. 5 Allen wrench

**Directive:**

1. Set the motor circuit switch of the hydraulic pump in the top box to STOP.
2. Descend to the yaw area.


Fig. 6.14.7.2 – 1 Connecting the pressure gauge

3. Remove the cover of the pressure measurement connection (3).
4. Connect the pressure gauge (2) to the pressure measurement connection (3) in order to measure the gas charging pressure of the system pressure tank (1).

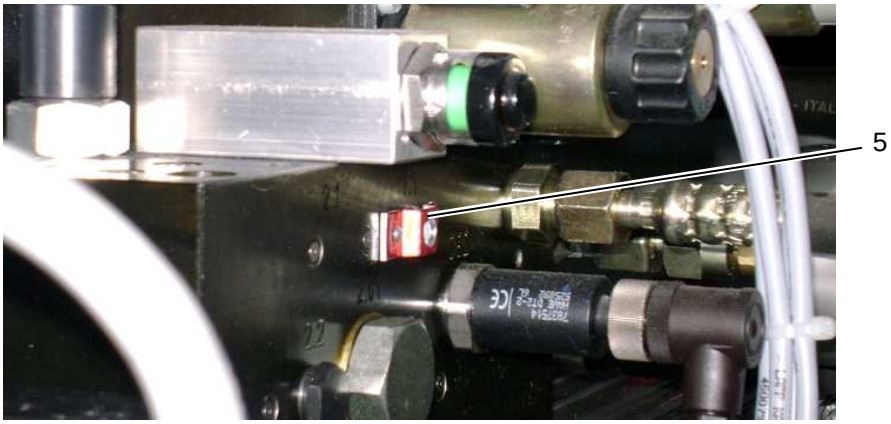



Fig. 6.14.7.2 – 1 Drain valve 7.1

5. Slowly reduce the pressure via drain valve 7.1 (5); in that context, continuously monitor the display (4) of the pressure gauge (2).

**Note:** The measurement initially needs to drop slowly, then rapidly. The measurement that is displayed just prior to the sudden drop in pressure is the gas charging pressure.

6. Document the retrieved value in the service booklet.
7. Close drain valve 7.1 (5) again.
8. Disconnect the pressure gauge (2).
9. Reconnect the cover of the pressure measurement connection (3).
10. If the gas charging pressure does not correspond to the nominal value (ref. service booklet), continue with chapter 6.14.7.3 "Increasing the gas charging pressure".
11. If the gas charging pressure corresponds to the nominal value (ref. service booklet), set the motor circuit switch of the hydraulic pump in the top box to START.
12. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

### 6.14.7.3 Increasing the gas charging pressure of the system pressure tank

**Required tools / operating and auxiliary means:**

- Filling mechanism
- Nitrogen tank
- No. 5 and No. 6 Allen wrench
- Jaw wrench

**Directive:**

**Note:** The cooperation of two service technicians is a mandatory requirement for this maintenance section.

1. Set the motor circuit switch of the hydraulic pump in the top box to STOP.

First service technician:

2. Place the nitrogen tank on the machine base and secure it against falling over.
3. Open the inspection cover above the HAWE hydraulic aggregate.

**⚠ DANGER Danger of explosion. Never use oxygen!**

**⚠ DANGER The nitrogen tank is under substantial pressure! If the pressure in the nitrogen tank exceeds the permissible pressure in the system pressure tank, a pressure relief valve will need to be used during filling.**

Second service technician:

4. Descend to the yaw area


Fig. 6.14.7.3 – 1 HAWE hydraulic aggregate

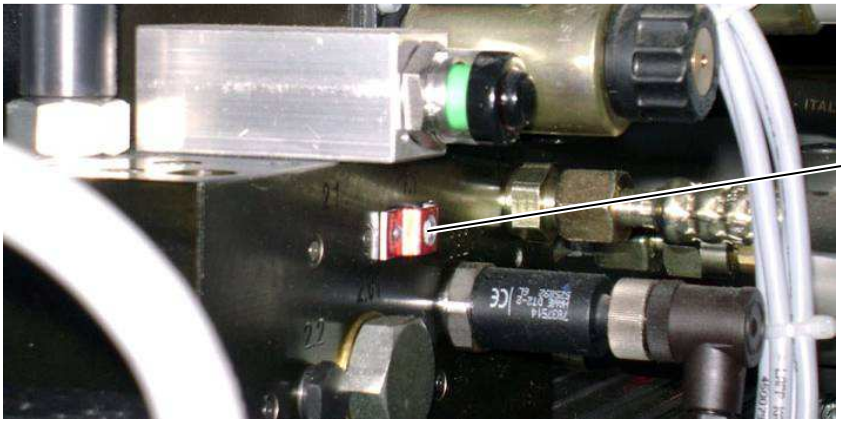



Fig. 6.14.7.3 – 2 Drain valve 7.1

**DANGER Danger due to high pressure (2320 lb/in²); (160 bar). The pressure of the hydraulic system needs to be released prior to commencing the work. Observe the following directives. Wear protective goggles and acid-proof gloves.**

5. Release the pressure via drain valve 7.1 (3).

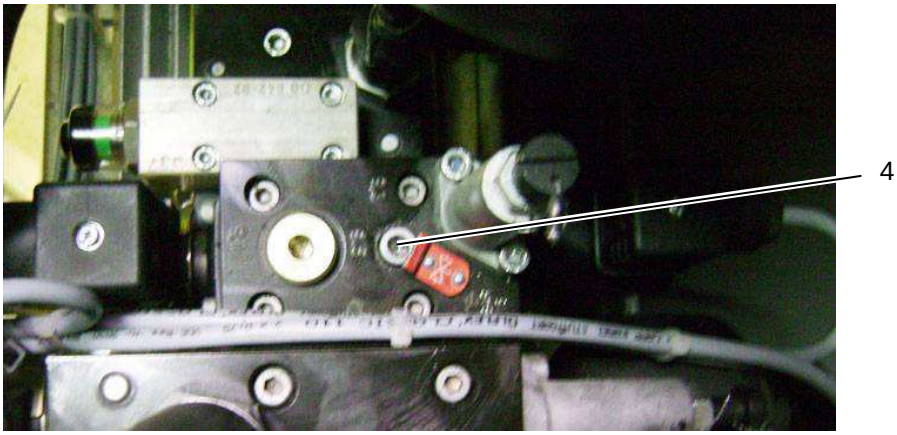



Fig. 6.14.7.3 – 3 Drain valve 9.5

6. Release the residual pressure via drain valve 9.5 (4).

**DANGER The system pressure tank (1) is under substantial pressure. Do not release the valve screw (6)!**


Fig. 6.14.7.3 – 4 System pressure tank

7. Remove the cap (2) from the system pressure tank (1).
8. Just slightly loosen the valve screw (6) located underneath the cap (2) with the No. 6 Allen wrench, do not remove it under any circumstances!

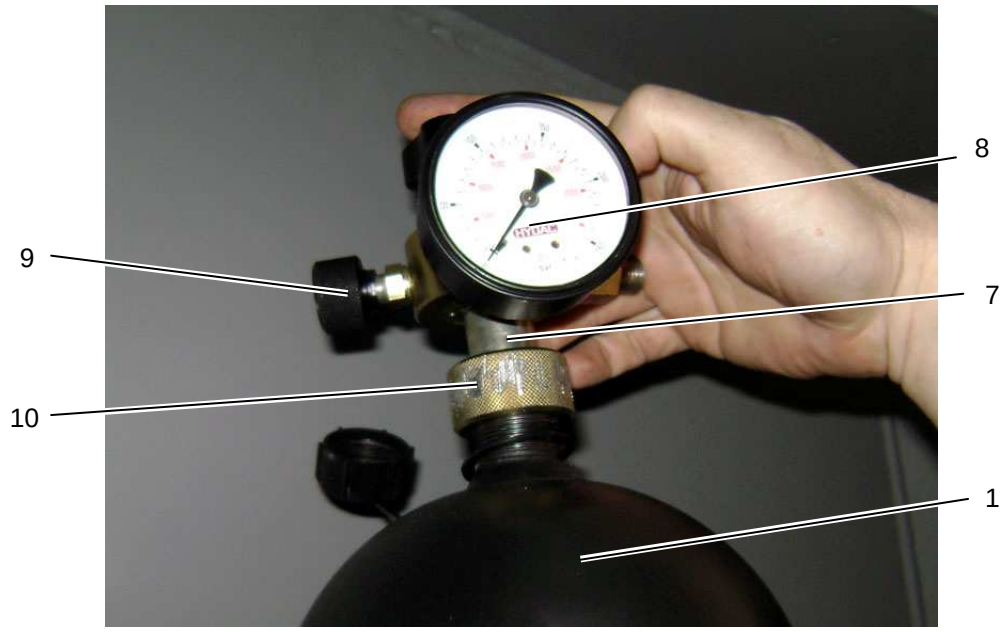



Fig. 6.14.7.3 – 5 Filling mechanism

9. Ensure that the drain valve (9) has been closed prior to connecting the filling mechanism (7).
10. Attach the filling mechanism (7) to the system pressure tank (1) and position it in such a manner that the manometer (8) may be viewed with ease.
11. Manually tighten the knurled thumb screw (10).


Fig. 6.14.7.3 – 6 Attaching the filling hose

12. Connect the filling hose (11) to the filling mechanism (7) by tightening the screw connection (12).
13. If the gas valve is open, close it by turning the hand valve (13) clockwise.

First service technician:

14. Connect the other end of the filling hose (11) to the nitrogen tank.
15. Slowly open the valve of the nitrogen tank and immediately close it again.
16. Repeat opening and closing the valve of the nitrogen tank per the instructions by the second service technician.

Second service technician:

17. Instruct the first service technician to open and close the valve of the nitrogen tank.


Fig. 6.14.7.3 – 7 Filling mechanism

18. Open the gas valve by turning the hand valve (13) counter-clockwise.
19. Continuously monitor the manometer (8).
20. If the gas charging pressure as detailed in the service booklet has been reached, close the valve by turning the hand valve (14) again.

**Note:** The final gas charging pressure is only reached after a temperature equalization of approx. 15 minutes.

21. Wait 15 minutes, subsequently re-measure the gas charging pressure with the manometer (8).
22. If the gas charging pressure does not correspond to the nominal value as detailed in the service booklet, repeat sections 15 through 21.

**⚠ DANGER Danger due to high pressure. Release the system pressure prior to removing the filling hose!**

23. Open the knurled thumb screw (9) and consequently release the pressure.
24. If the squealing sound is no longer audible, remove the filling hose (11).
25. Release the knurled thumb screw (10) and remove the filling mechanism (7).
26. Re-tighten the hexagon socket screw (6) of the system pressure tank
27. Reconnect the cap (2).


Fig. 6.14.7.3 – 8 Labeling the system pressure tank

28. Document the date and the gas charging pressure on the system pressure tank in order to facilitate determining whether the system pressure tank has lost pressure in the context of the next maintenance.
29. Set the motor circuit switch of the hydraulic pump in the top box to START.

## 6.14.8 Checking the condition of the hose lines, pipes, and screw connections

**Required tools / operating and auxiliary means:**

- Tools as required for the respective repair
- Flashlight

**Directive:**

1. Set the motor circuit switch of the hydraulic pump in the top box to STOP
2. Descend to the yaw area

**DANGER Danger due to high pressure (2320 lb/in²); (160 bar). The pressure of the hydraulic system needs to be released prior to commencing the work. Observe the following directives. Wear protective goggles and acid-proof gloves.**

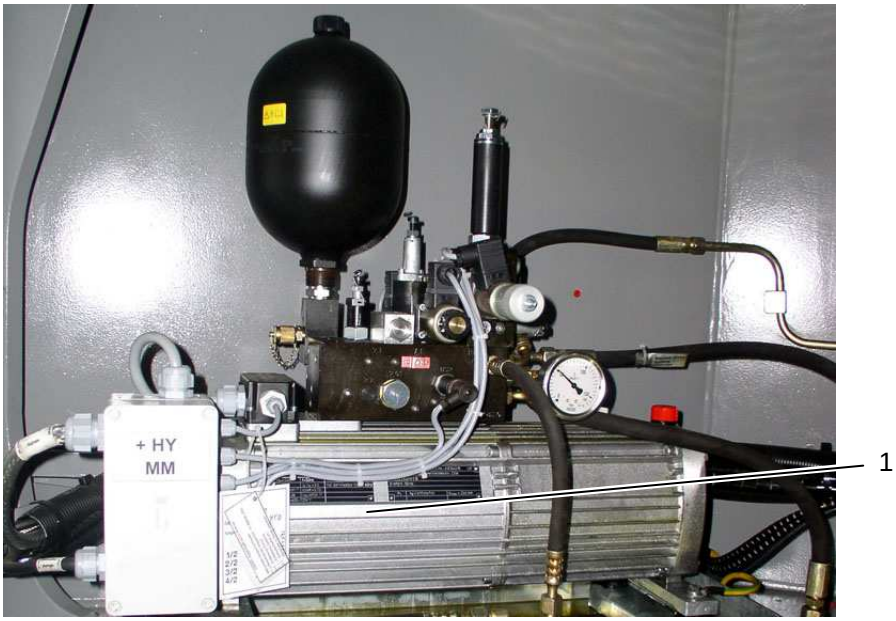



Fig. 6.14.8 – 1 Hydraulic aggregate

3. Inspect all hose lines for damage.
4. Check the screw connections for a tight fit, re-tighten if applicable (tightening torque in accordance with 6.14 HAWE hydraulic aggregate).
5. Examine the condition of the pipes.

**In case of determining defective components**

6. Release the pressure via drain valve 7.1 (2).

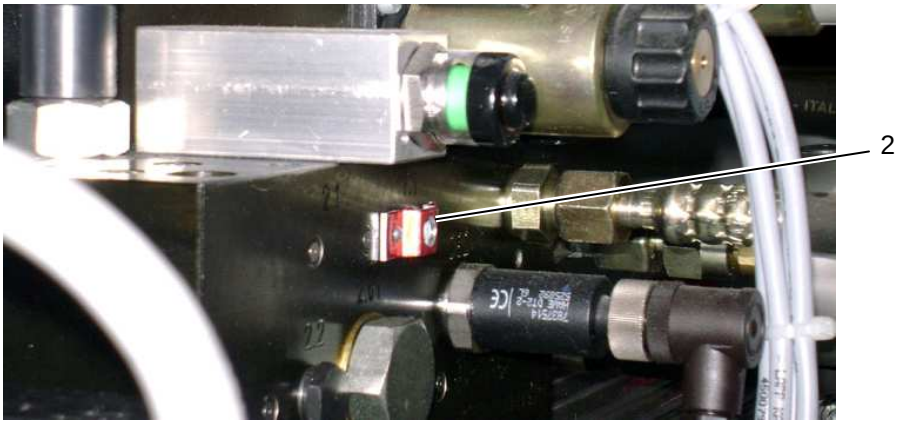



Fig. 6.14.8 – 2 Drain valve 7.1

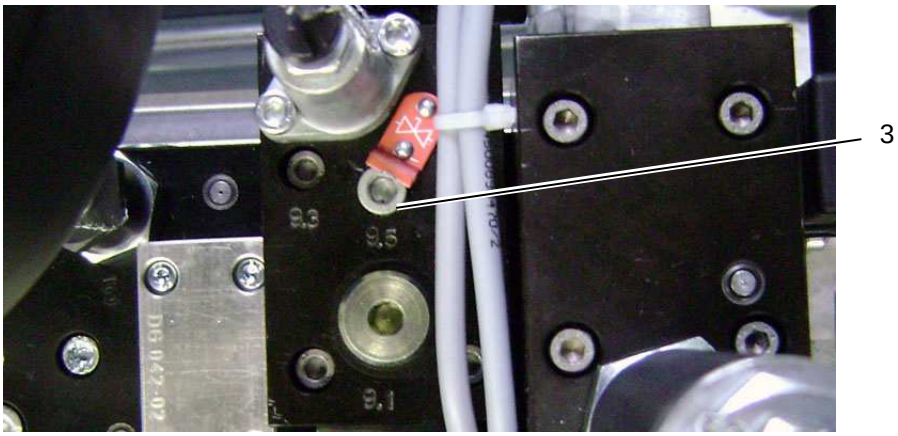



Fig. 6.14.8 – 3 Drain valve 9-5

7. Release the residual pressure via drain valve 9.5 (3).
8. Replace the components.
9. Close valves 7.1 and 9.5 again.
10. Clean the working area.

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

11. Dispose of soiled cloths in the proper manner.
12. Set the motor circuit switch of the hydraulic pump to START.
13. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

## 6.14.9 Checking the oil level sensor

**Required tools / operating and auxiliary means:**

- Insulated screwdriver

**Directive:**

1. Set the motor circuit switch of the hydraulic pump in the top box to STOP.
2. Descend to the yaw area

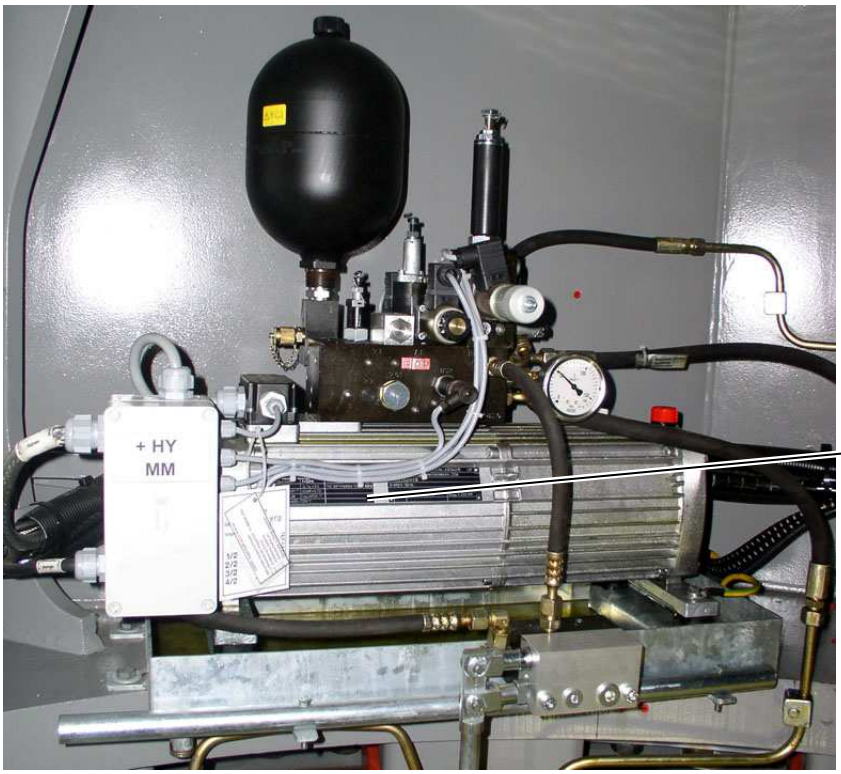



Fig. 6.14.9 – 1 Hydraulic aggregate

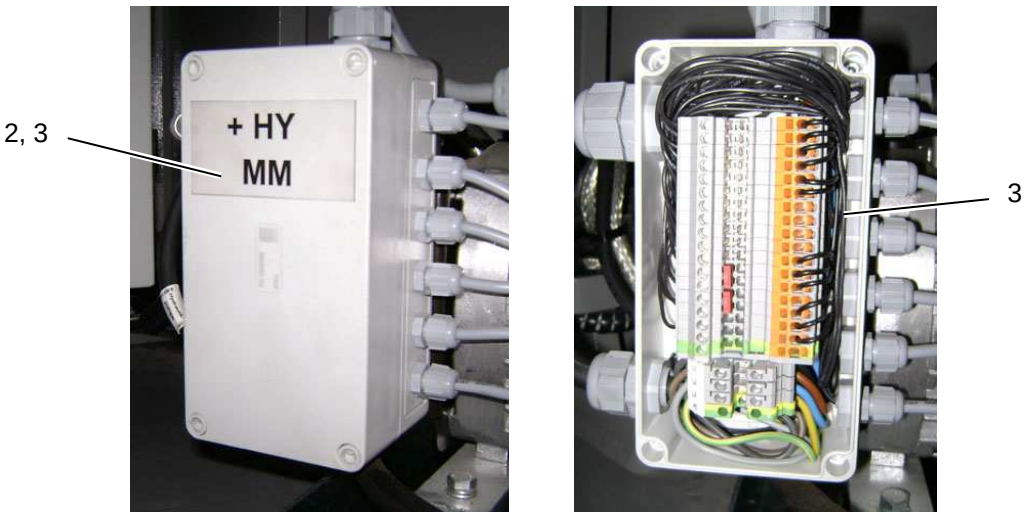



Fig. 6.14.9 – 2 Terminal box of the hydraulic aggregate

3. Remove the cover (2) of the terminal box (3).
4. Determine the cable number of the oil level sensor in the circuit diagram.
5. Disconnect the respective cable.
6. REguard Monitoring: Select Reports menu → Events menu.


Fig. 6.14.9 – 3 REguard Monitoring

7. The following values need to be included in the table.

| | |
|---|---|
| Timestamp | Current date and time |
| No.: | 5550 |
| Event | Low hydraulic oil level |
| | Incoming |

8. Return to the yaw area.
9. Reconnect the cable.
10. Reinstall the cover (2) of the terminal box (3).
11. Now the Events menu needs to contain a new entry which is characterized by the fact that "Incoming" is replaced with "Phasing out".
12. Set the motor circuit switch of the hydraulic pump in the top box to START.
13. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

## 6.14.10 Checking the activation and deactivation points of the pressure sensor

**Directive:**

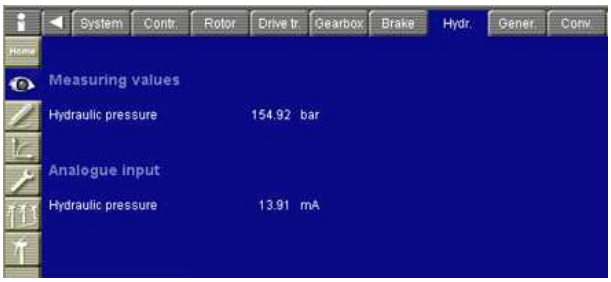



Fig. 6.14.10 – 1 REguard Monitoring

1. REguard Monitoring: Select Monitoring menu → Hydraulic → Measured values.
2. Determine the hydraulic pressure.


Fig. 6.14.10 – 2 Switch "Close brake" at the top box

3. Repeatedly close and open the rotor holding brake via the switch at the top box while taking the activities of other service personnel and the wind conditions into consideration (ref. operating manual) in order to reduce the pressure at the brake.
4. Monitor the display for the hydraulic pressure (3) at the same time.
5. If the hydraulic aggregate activates in an audible manner, determine the hydraulic pressure at the panel of the REguard control B and enter it under $p_{ein}$ in the service booklet.
6. If the hydraulic aggregate deactivates in an audible manner, determine the hydraulic pressure and enter it under $p_{aus}$ in the service booklet.
7. Ref. service booklet for the nominal activation and deactivation points of the pressure sensor.

## 6.14.11 Checking the pressure level of the pressure-limiting valve of the yaw drive

**Required tools / operating and auxiliary means:**

- Pressure gauge

**Directive:**

**Note.** The cooperation of two service technicians is required for this maintenance section.

First service technician

1. Descend to the yaw area

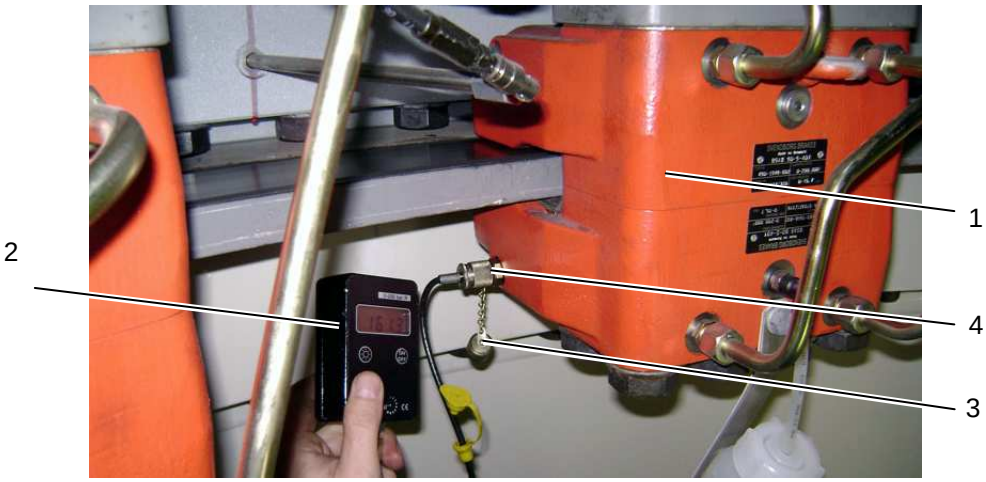



Fig. 6.14.11 – 1 Yaw brake

2. Remove the cover (3) of the pressure measurement connection (4) of a yaw brake (1).
3. Connect the pressure gauge (2), the full brake pressure is loaded.
4. Instruct the second service technician to manually turn the yaw bearing.

**⚠ WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

Second service technician:

5. Following the instructions by the first service technician, manually turn the yaw bearing via at the top box or at the panel of the Regurard Control B and stop it with .

First service technician:

6. Determine the residual pressure at the pressure gauge while the yaw bearing is being turned.
7. Instruct the second service technician to stop.
8. Enter the measurement in the service booklet (ref. service booklet for the nominal value).

## 6.14.12 Checking the pressure level of the pressure-limiting valve of the rotor holding brake

(50 Hz model)

**Required tools / operating and auxiliary means:**

- Pressure gauge

**Directive:**


Fig. 6.14.12 – 1 Rotor holding brake

1. Remove the cover (3) of the pressure measurement connection (2) of the rotor holding brake (1).
2. Connect the pressure gauge (2).
3. Engage the rotor holding brake while taking the activities of other service personnel into consideration (ref. operating manual).
4. Determine the brake pressure at the pressure gauge and enter it in the service booklet.

## 6.14.13 Checking the pressure level of the pressure-limiting valve of the rotor holding brake

60 Hz model

Ref. chapter 6.14.12 "Checking the pressure level of the pressure-limiting valve of the rotor holding brake – 50 Hz model).

The only difference is the nominal brake pressure value (ref. service booklet).

## 6.14.14 Brake storage of the rotor holding brake

### 6.14.14.1 Checking the brake storage

**Required tools / operating and auxiliary means:**

- Pressure gauge

**Directive:**

**Note:** The cooperation of two service technicians is required for this maintenance section.

First service technician:

1. Descend to the yaw area.


Fig. 6.14.14.1 – 1 Brake storage of the rotor holding brake

2. Perform a visual inspection of the brake storage.
3. Document defects in the service booklet.

**Note:** Ref. chapter 6.14.14.2 "Replacing the brake storage" for replacements of the brake storage.

4. Instruct the second service technician to engage the rotor holding brake.

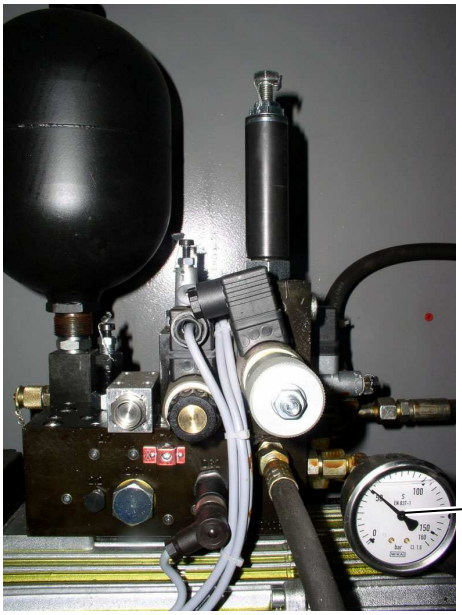



Fig. 6.14.14.1 – 2 Hydraulic aggregate

Second service technician:

5. Manually engage the rotor holding brake via the top box.

First service technician:

6. Monitor the manometer (2) and check the pressure build-up.

**Note:** The pressure in the rotor brake should slowly (approx. within 1-2 seconds) build up to the nominal value (ref. service booklet).

7. Instruct the second service technician to release the rotor holding brake.

Second service technician:

8. Release the rotor holding brake

First service technician:

9. Monitor the manometer (2), the pressure should slowly drop.
10. If the pressure suddenly drops, the brake storage is no longer working correctly and will need to be replaced (ref. chapter 6.14.14.2 "Replacing the brake storage").

#### 6.14.14.2 Replacing the brake storage

**Directive:**

- Replace the brake storage every 10 years
- The directive will be provided at a later time

## 6.14.15 Replacing the yaw module

**Directive:**

- Replace the yaw module for a major overhaul after 3 years.
- Yaw modules will be preset after a major overhaul.
- The directive will be provided at a later time.

## 6.14.16 Inspecting the electrical connections and cables

**Required tools / operating and auxiliary means:**

- Insulated screwdriver

**Directive:**

1. Set the motor circuit switch of the hydraulic pump in the top box to STOP.
2. Descend to the yaw area.

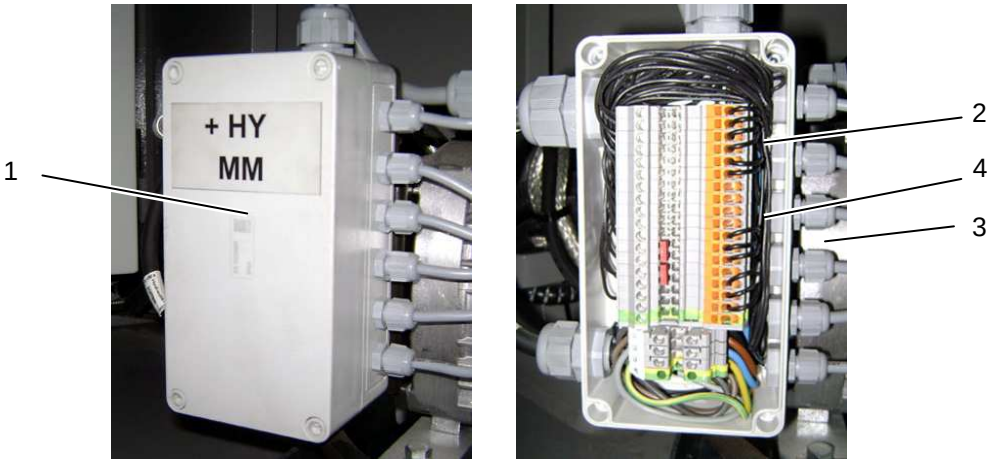



Fig. 6.14.16 – 1 Terminal box hydraulic aggregate

3. Remove the cover of the terminal box (1).
4. Check all cables (2) for a tight fit, re-insert them in the spring-loaded clamps (4) if applicable.
5. Check the PG screw connections (3) for a tight fit, tighten if applicable.
6. Inspect all cables for damage.
7. Replace the cover of the terminal box (1) and tighten it.
8. Set the motor circuit switch of the hydraulic pump to START.
9. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

# 6.15 Anemometer, vane, obstacle lighting

**⚠ WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.15.1 Checking the grounding connection of the weather mast

**Directive:**

**⚠ DANGER Risk of life due to fall: Never access the deck crane area while the crane hatch is open. Never subject the crane hatch to a load exceeding 330 lb (150 kg) on an area of 7.8 in. x 0.78 in. (0,2m x 0,2m).**

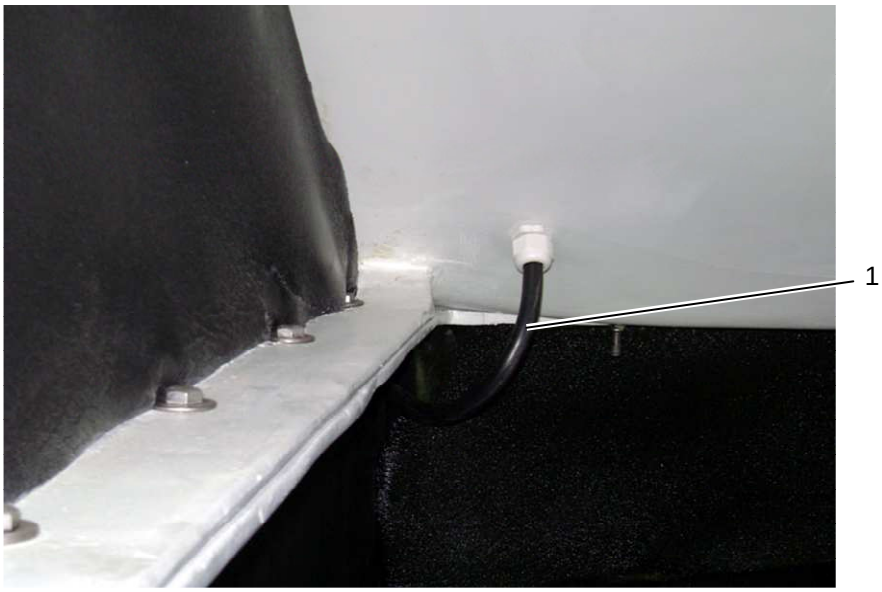



Fig. 6.15.1 – 1 Grounding connection of the weather mast

1. Check the cable grommet of the grounding connection (1) in the rear nacelle area for a tight fit; tighten if applicable.

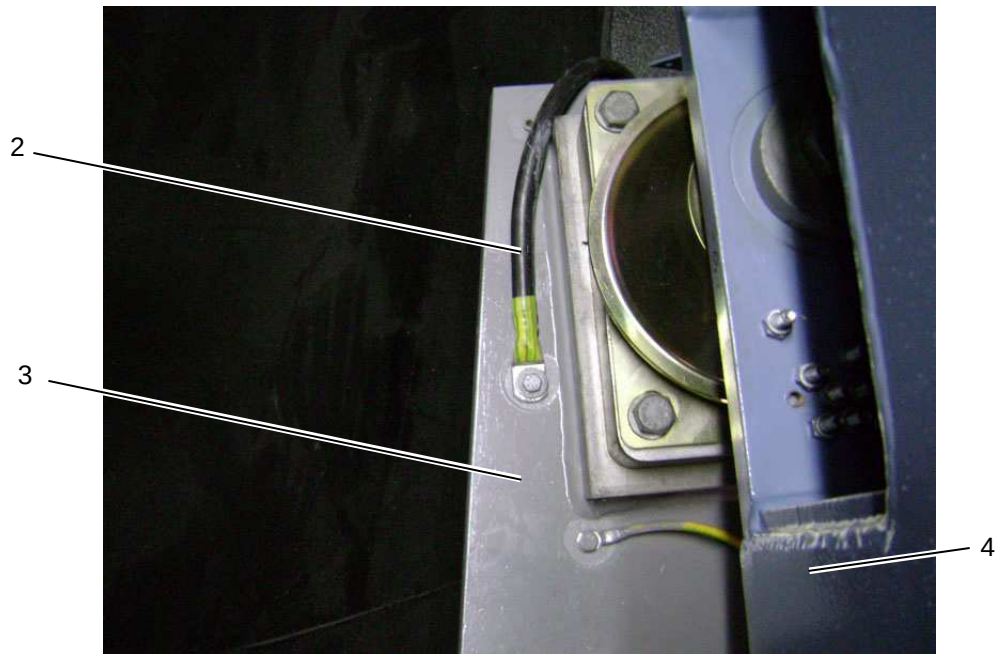



Fig. 6.15.1 – 2 Grounding connection of the weather mast at the machine base

2. Check the grounding connection (2) of the weather mast in the range of the generator (4) at the machine base (3) for a tight fit, tighten if applicable.

## 6.15.2 Checking the condition and the attachment of the anemometer

**Directive:**

**Note:** Perform all maintenance sections in chapter 6.15 consecutively.

1. Secure the inspection hatch via both turning knobs against falling closed.

**DANGER Risk of life due to fall. Observe the safety notices in chapter 5!**


Fig. 6.15.2 – 1 Anemometer at the weather mast

2. Check the ease of movement of the cups (2) of both anemometers (1).
3. Check both anemometers (2) for a tight fit at the weather mast (3), tighten if applicable.
4. Upon returning to the nacelle, fold the ladder back again and secure it against movements.

## 6.15.3 Checking the condition and the attachment of the vane

**Directive:**

**Note:** Perform all maintenance sections in chapter 6.15 consecutively.

1. Secure the inspection hatch via both turning knobs against falling closed.

**DANGER Risk of life due to fall. Observe the safety notices in chapter 5!**

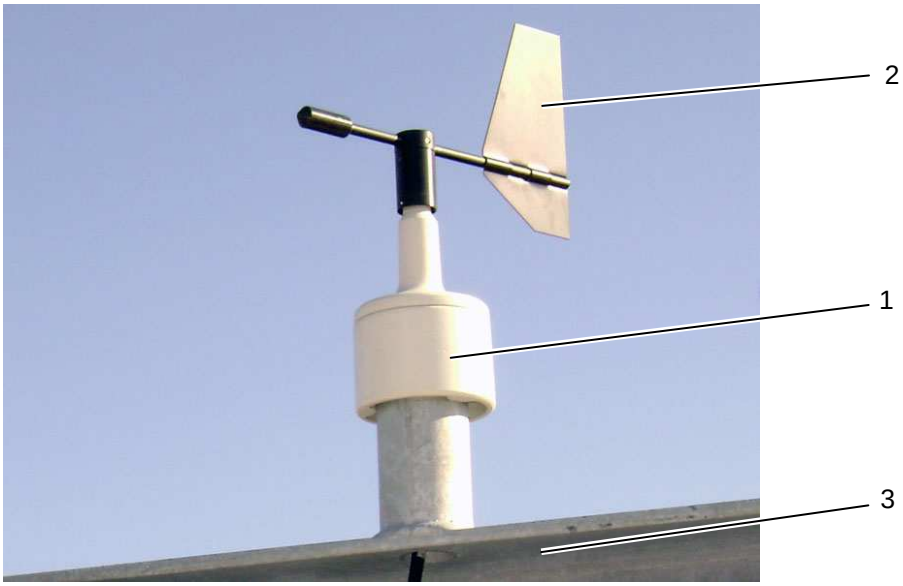



Fig. 6.15.3 – 1 Vane at the weather mast

2. Check the ease of movement of the vane (2).
3. Replace a damaged vane (2) (observe the vane alignment).
4. Check the tight fit of the mount (1) at the weather mast (3), tighten if applicable.
5. Upon returning to the nacelle, fold the ladder back again and secure it against movements.

## 6.15.4 Checking the north alignment of the wind turbine

### Directive

The alignment of the wind turbine to the north is completed in the context of the commissioning of the wind turbine. More exact details as to which object the wind turbine was homed in on are available in the return sheet "Wind turbine alignment".

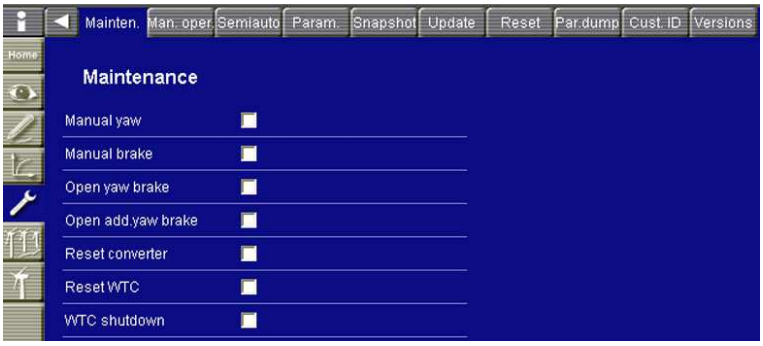



Fig. 6.15.4 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).

**DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

2. Manually move the wind turbine by means of or to the nacelle position 0° and stop it with .
3. Descend to the yaw area.

**CAUTION Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform. Wear protective equipment and descend with care in order to avoid injuries.**

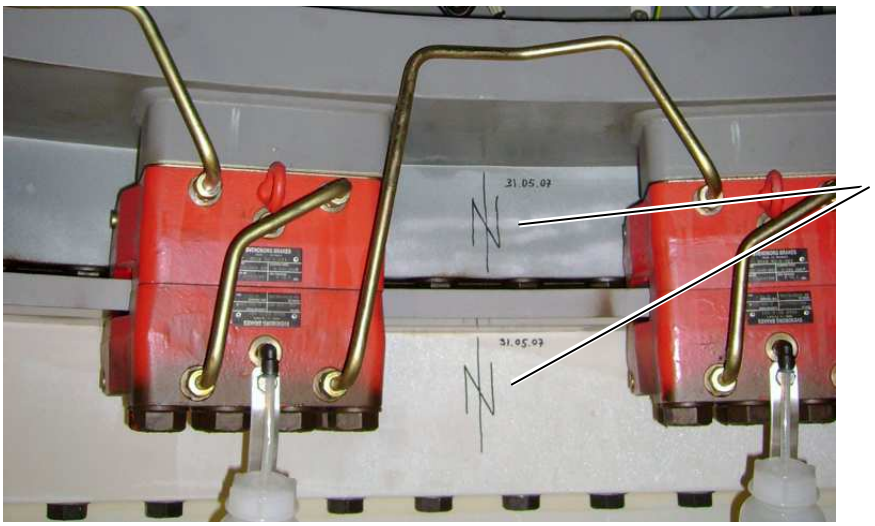



Fig. 6.15.4 – 2 North indication in the yaw area

4. Check the markings (1) for conformity.
5. Document deviations in the service booklet.
6. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

## 6.15.5 Inspecting the condition of the cables

**Directive:**

**Note:** Perform all maintenance sections in chapter 6.15 consecutively.

1. Secure the inspection hatch via both turning knobs against falling closed.

**DANGER Risk of life due to fall. Observe the safety notices in chapter 5!**


Fig. 6.15.5 – 1 Weather mast (3)

2. Check the cables of the anemometers (1) and the vane (2) for damage.
3. Upon returning to the nacelle, fold the ladder back again and secure it against movements.

## 6.15.6 Inspecting the heating anemometer

**Directive:**

**Note:** Perform all maintenance sections in chapter 6.15 "Anemometer, vane, obstacle lighting" consecutively.


Fig. 6.15.6 – 1 REguard Monitoring

1. REguard Monitoring: Select Maintenance menu → Maintenance → Maintenance.
2. Activate the menu entries "Manual" and "ON/OFF".

**DANGER Risk of life due to fall. Observe the safety notices in chapter 5!**

3. While observing the safety instructions detailed above, climb to the nacelle roof after approx. 5 minutes.

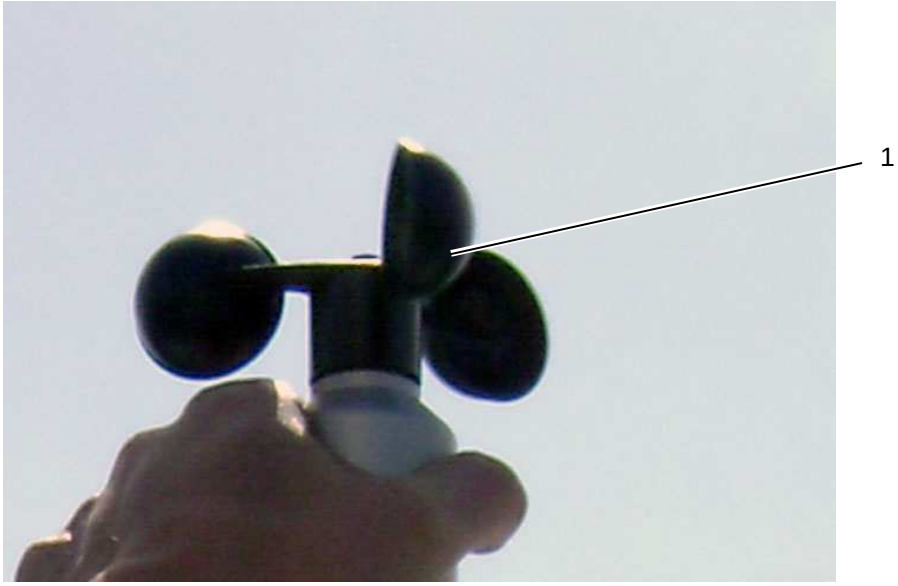



Fig. 6.15.6 – 2 Anemometer

4. Manually check whether one of the two anemometers (1) warms up.

**Note:** Only one of the two anemometers is heated. In the winter, different measurements by the two anemometers provide an indication of possible ice formations at the wind turbine.

5. Upon returning to the nacelle, fold the ladder back again and secure it against movements.
6. Once again select the menu entries "Manual" and "ON/OFF" in order to deactivate them.

## 6.15.7 Checking the obstacle lighting

**Required tools / operating and auxiliary means:**

- Black adhesive tape

**Directive**

**Performing a functional test lamps:**

1. Secure the inspection hatch via both turning knobs against falling closed.

**⚠ DANGER Risk of life due to fall. Observe the safety notices in chapter 5!**


Fig. 6.15.7 – 1 Dimming sensor of the obstacle lighting

2. Cover the dimming sensor (1) at the weather mast (2) with black adhesive tape.


Fig. 6.15.7 – 2 Obstacle lighting

3. Check whether both obstacle lighting systems (3) are activated.
4. Check the entire circumference as to whether all lamps (4) are lit.
5. Replace defective lamps.

**Testing the rechargeable battery mode:**

6. Keep the dimming sensor (1) covered.
7. Set the motor circuit switch obstacle lighting in the top box to STOP.
8. The lamps need to remain lit.
9. If the lamps are not lit, also refer to the directive "Performing a visual inspection switching cabinet".

**Performing a visual inspection switching cabinet:**

10. Set the motor circuit switch obstacle lighting in the top box to STOP

**⚠ CAUTION Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform. Wear protective equipment and descend with care in order to avoid injuries.**

11. Descend to the yaw area.

**⚠ CAUTION Risk of fall due to unstable foothold in the yaw area. Ensure the safe placement of the step-ladder. Keep both feet on the step-ladder while working.**


Fig. 6.15.7 – 3 Switching cabinet obstacle lighting

**⚠ DANGER Risk of life due to high voltages. Observe the safety notices in chapter 5.**

12. Open the switching cabinet obstacle lighting (6).

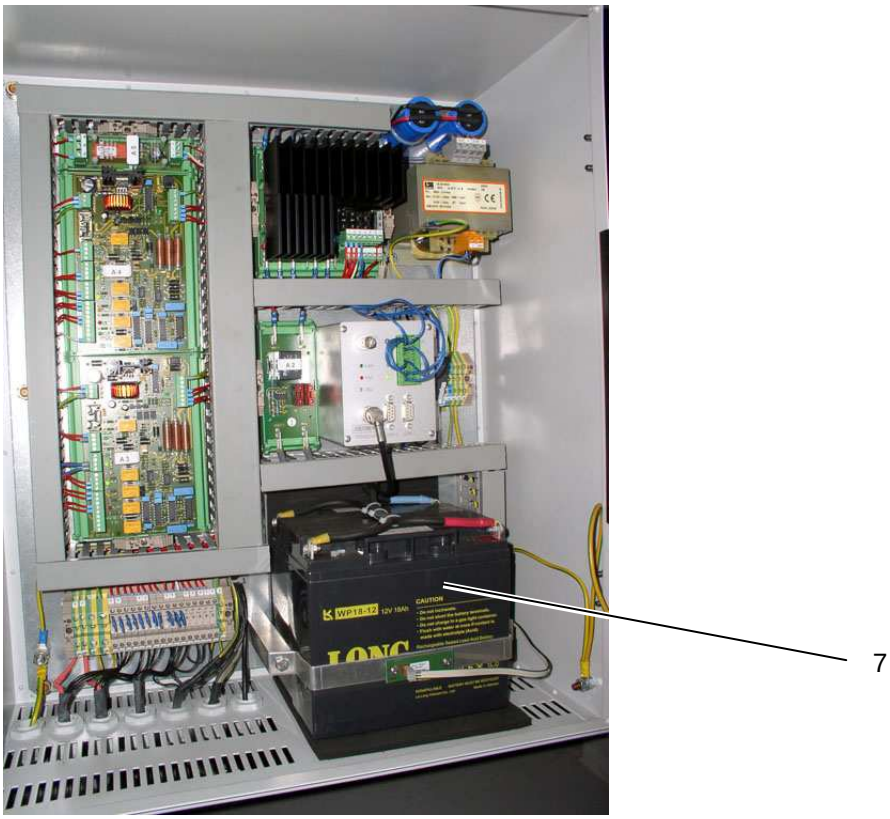



Fig. 6.15.7 – 4 Switching cabinet obstacle lighting

13. Perform a visual inspection of the rechargeable batteries (7) and the other components of the switching cabinet.
14. If the rechargeable battery mode of the obstacle lighting is non-functional, measure the voltage of the rechargeable batteries.
15. Replace defective rechargeable batteries.
16. Check the tight fit of the cables, clamp down if needed.
17. Examine the components for defects.
18. Document defects in the service booklet.
19. Close and secure the switching cabinet cover.
20. Set the motor circuit switch obstacle lighting in the top box to START.

**⚠ DANGER Risk of life due to fall. Observe the safety notices in chapter 5!**

21. Return to the nacelle roof.
22. Remove the adhesive tape from the dimming sensor.
23. After leaving the nacelle roof, fold the ladder back again secure it against movements.

# 6.16 Yaw brakes

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

**CAUTION**

**Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform.**

- Wear protective equipment and descend with care in order to avoid injuries.

**CAUTION**

**Risk of fall due to unstable foothold in the yaw area.**

- Ensure the safe placement of the step-ladder.
- Keep both feet on the step-ladder while working.

## 6.16.1 Checking that the brake disk is free from grease and oil

**Required tools / operating and auxiliary means:**

- Brake cleaner

**Directive:**

**Note:** The cooperation of two service technicians is mandatory for this maintenance section. This maintenance section may be performed together with chapter 6.16.2 "Checking the surface of the brake disk".

First service technician:

1. Descend to the yaw area.

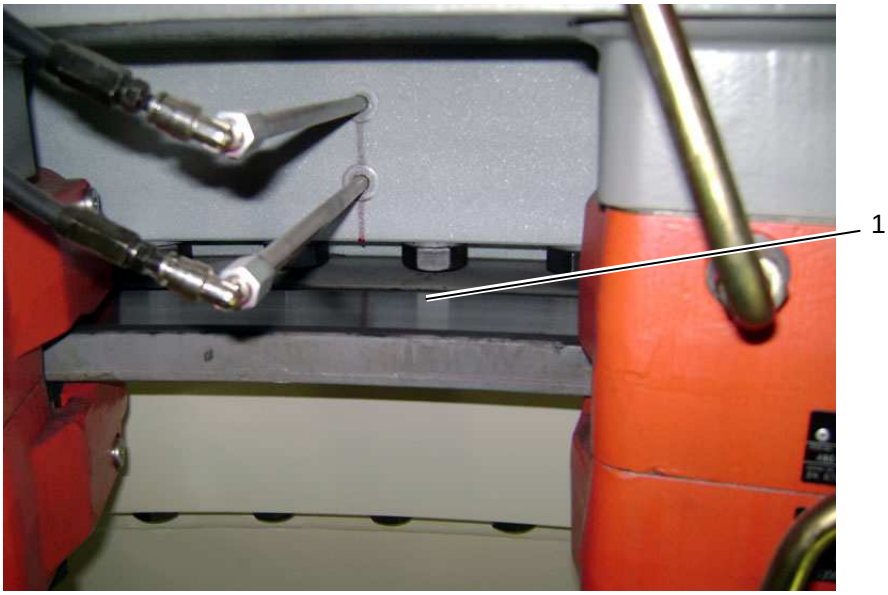



Fig. 6.16.1 – 1 Brake disk yaw

2. Examine whether the surface of the brake disk (1) is free from oil and grease on both sides.

**NOTICE** **Danger of system damage due to a soiled brake disk: The brake effect of a brake disk soiled with oil is greatly reduced or cancelled. It is absolutely necessary to determine the cause of the soiling with oil prior to installing the new brake pads.**

3. If the brake pads have been soiled with oil, they must be replaced (ref. chapter 6.16.4 "Changing brake pads".
4. Clean the brake disk in sections and on both sides with brake cleaner.
5. To that end, instruct the second service technician to manually turn the yaw bearing.

Second service technician:


Fig. 6.16.1 – 2 REguard Monitoring

**DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

6. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).
7. After the instruction by the first service technician:
   Manually move the yaw bearing via the panel of the REguard Control B with or at the top box and stop it with .

First service technician:

**WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

8. Clean the section of the brake disk (1) which has not been cleaned yet.
9. Instruct the second service technician to move the yaw bearing again if needed.
10. REguard Monitoring: Deactivate "Manual yaw" (1) in the Maintenance menu.

## 6.16.2 Checking the surface of the brake disk

**Required tools / operating and auxiliary means:**

- Digital camera

**Directive:**

**Note:** The cooperation of two service technicians is mandatory for this maintenance section. This maintenance section may be performed together with 6.16.1 "Checking that the brake disk is free from grease and oil".

First service technician:

1. Descend to the yaw area.

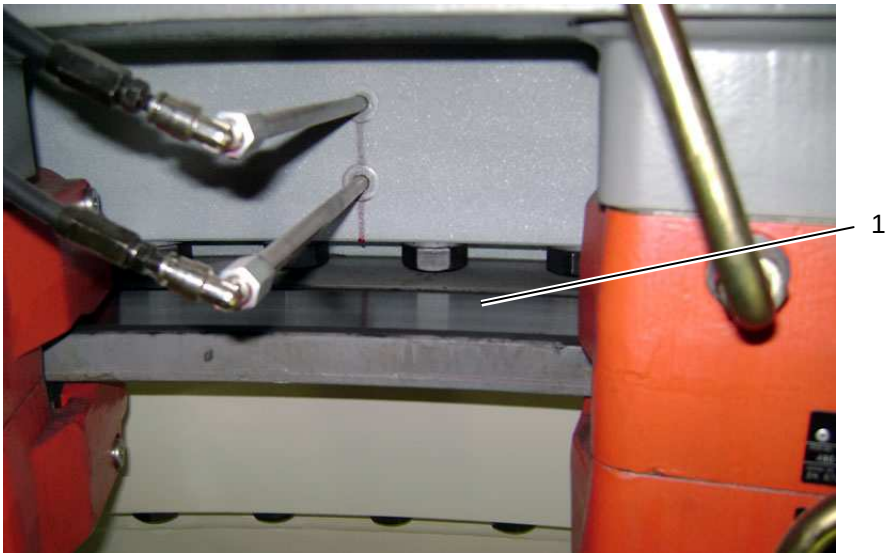



Fig. 6.16.2 – 1 Brake disk yaw

2. Examine the surface of the brake disk (1) for grooves, cracks, and chippings on both sides and in sections.
3. To that end, instruct the second service technician to manually turn the yaw bearing.
4. Document defects in the service booklet.

Second service technician:


Fig. 6.16.2 – 2 REguard Monitoring

**DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

5. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).
6. After the instruction by the first service technician:
   Manually move the yaw bearing via the panel of the REguard Control B with or at the top box and stop it with .

First service technician:

**WARNING Risk of contusions due to rotating system components. Do not reach into rotating system components.**

7. Inspect the newly accessible section of the brake disk (1).
8. Document defects in the service booklet.
9. Instruct the second service technician to move the yaw bearing again if needed.
10. REguard Monitoring: Deactivate "Manual yaw" (1) in the Maintenance menu.

## 6.16.3 Inspecting the brake pad surface and the brake pad thickness

**Required tools / operating and auxiliary means:**

- Hydraulic power screwdriver (ref. safety notice following section 9)
- No. 41 box nut, No. 19 jaw wrench
- Grinding means
- Fresh oil in accordance with the oil card at the hydraulic aggregate
- Collection container for draining oil
- Clean gloves, protective goggles
- Brake cleaner
- Grease-solving cleaning agent and cloths
- Industrial vacuum cleaner

**Directive:**

**Preparations**

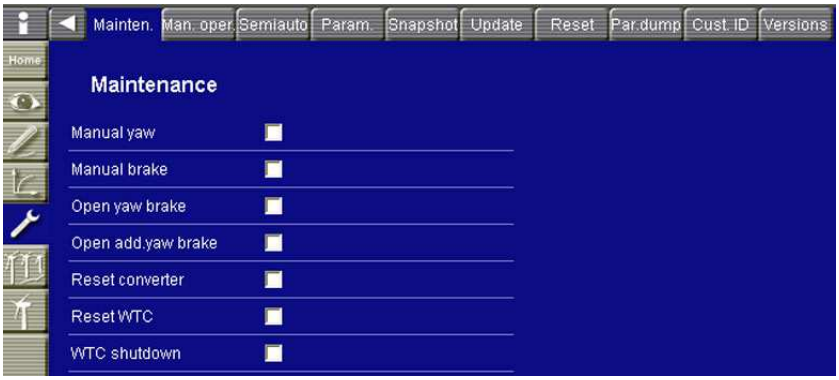



Fig. 6.16.3 – 1 REguard Monitoring

**DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).
2. Set the motor circuit switch of the hydraulic pump in the top box to STOP.
3. Descend to the yaw area.

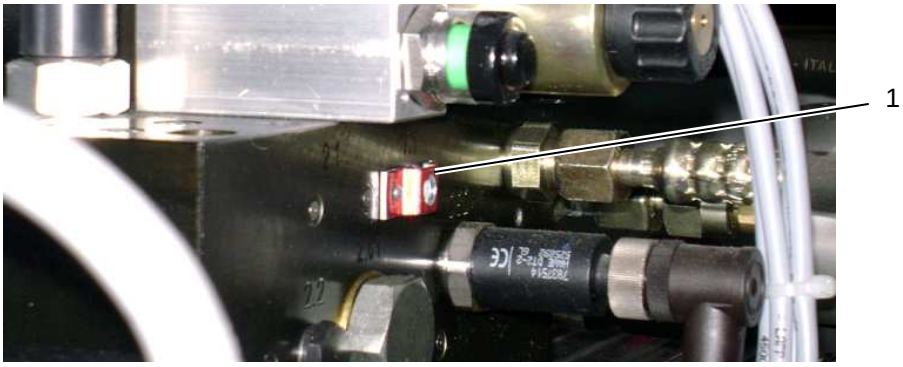



Fig. 6.16.3 – 2 Drain valve 7.1

**DANGER** **Danger due to high pressure (2320 lb/in²); (160bar). The pressure of the hydraulic system needs to be released prior to commencing the work. Observe the following directives. Wear protective goggles and acid-proof gloves.**

4. Release the system pressure via drain valve 7.1 (1) at the hydraulic aggregate.

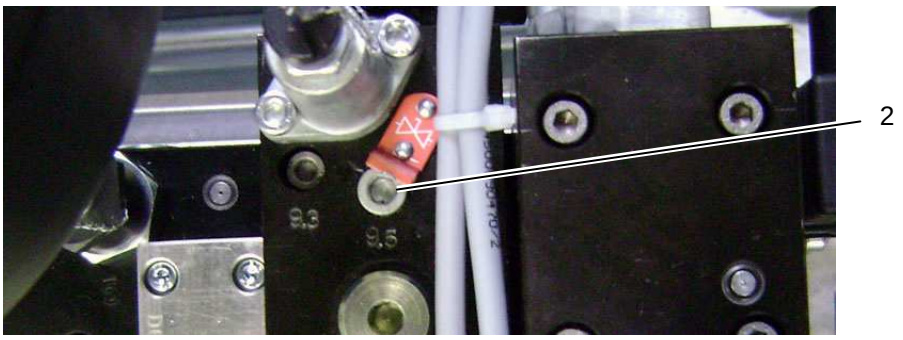



Fig. 6.16.3 – 3 Drain valve 9.5

5. Release the residual pressure via drain valve 9.5 (2) at the hydraulic aggregate.

**Disassembling the yaw brake**

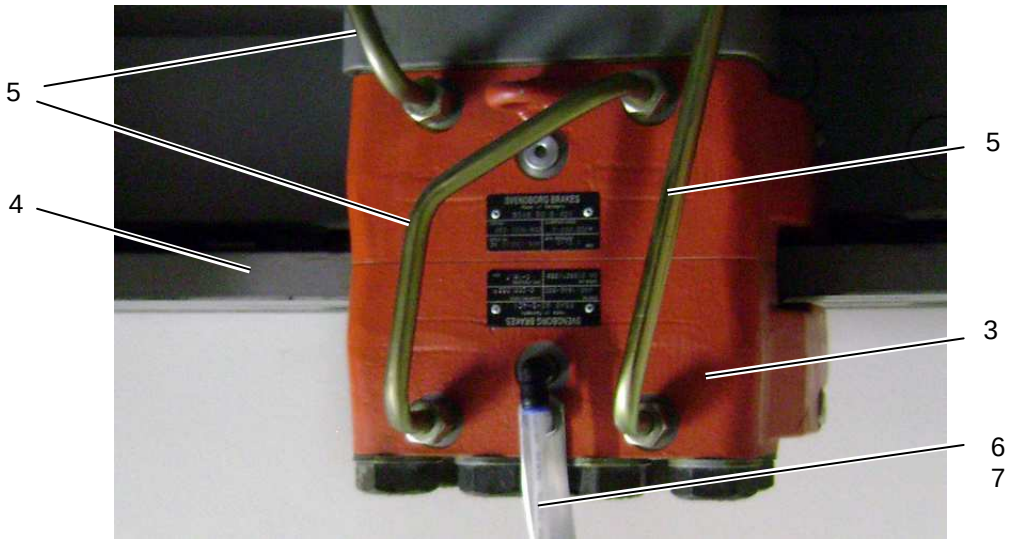



Fig. 6.16.3 – 4 Hydraulic lines of the yaw brakes

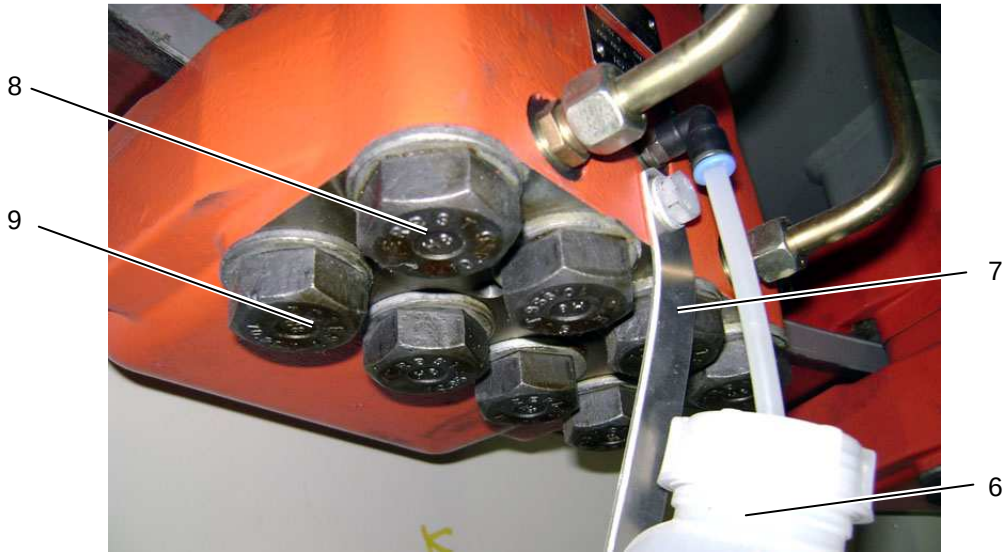



Fig. 6.16.3 – 5 Yaw brake

6. Remove the leak oil bottle (6) with the hose.
7. Disconnect the mount (7) of the leak oil bottle.
8. Remove the hydraulic lines (5).

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

9. Collect draining oil.

**⚠ WARNING Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!**

10. Only loosen one (8) of the eight screws, remove the remaining seven screws (9).

**Note:** The weight of a yaw brake including the brake pads amounts to 170 lb. (77 kg).

11. Turn the yaw brake away from the brake disk (4) in its entirety, the loosened screw (8) serves as pivotal point.
12. Put on clean gloves in order to prevent soiling the brake pads with oil.


Fig. 6.16.3 – 6 Brake pads

13. Remove the brake pads (10).
14. Push the piston of the yaw brake back into the yoke.
15. Examine the brake pad surface for grooves, chippings, and soilings with oil.
16. Brake pads that have been soiled with oil must be replaced.

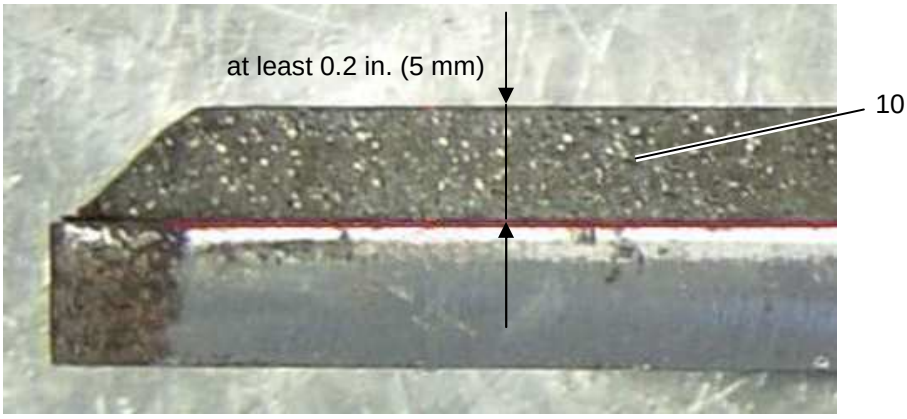



Fig. 6.16.3 – 7 Cross-section of a brake pad

17. Measure the brake pad thickness and enter the measured value in the service booklet.
18. If the brake pad thickness (without the carrier plate) is less than or equal to 0.2 in. (5 mm), the brake pads need to be replaced.

**NOTICE** **Severe reduction of the brake effect due to brake pads that have been soiled with oil. New brake pads need to remain in the packaging as long as possible in order to protect them against soiling and contact with oil. If grease or oil soils the brake pad, the brake pad may no longer be used.**

19. Remove brake dust by means of an industrial vacuum cleaner from the yaw brake (3).
20. Remove any soilings with oil.
21. Clean the sections of the brake disk (4) with brake cleaner (observe the safety notices provided by the manufacturer).
22. Insert the reusable or the new brake pads (10) with the pad side facing the brake disk into the brake calipers.
23. Turn back the yaw brake (3).
24. If needed, lubricate the screws (8) and (9) with Molykote and slightly start tightening them in the first step.
25. After that, increase the tightening torque for each screw in steps to the nominal value as detailed in maintenance section chapter 6.16.8.
26. Reinstall the hydraulic lines (5).
27. Install the mount (7) for the leak oil bottle.
28. Insert the leak oil bottle (6) and connect the hose.
29. Clean the yaw brake and the working area.

**⚠ CAUTION** **Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

30. Repeat steps 6 through 29 for all other yaw brakes (3).

**Refilling oil**

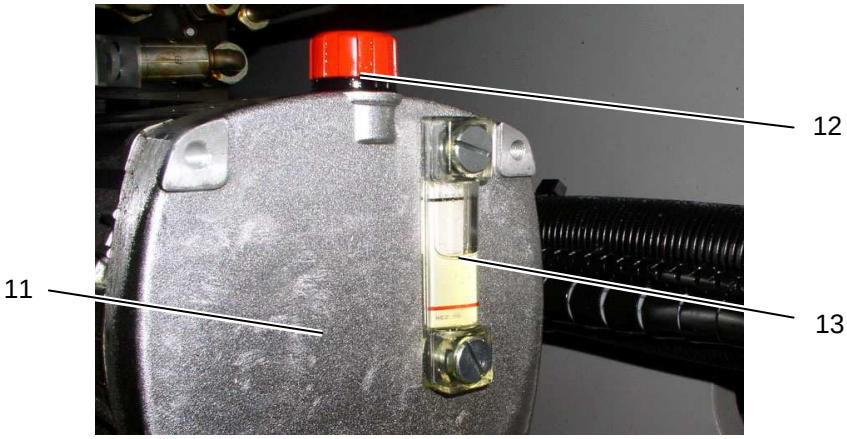



Fig. 6.16.3 – 8 Hydraulic aggregate

31. Remove the cover of the oil intake stub (12).
32. Fill fresh oil in accordance with the oil card at the hydraulic aggregate (11) into the oil intake stub (10) until the oil level is displayed in the middle of the level indicator (13).
33. Close valves 7.1 (1) and 9.5 (2).
34. Set the motor circuit switch of the hydraulic pump in the top box to START.
35. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

**Note:** It may be necessary to perform the RESET of the wind turbine multiple times.

**Removing the air from the yaw brakes**


Fig. 6.13.7 – 9 Pressure connection at the yaw brake

36. Release the cover of the pressure connection (14) of the yaw brake which is arranged directly upstream of the return line to the hydraulic aggregate.
37. Insert the pressure hose into the waste oil canister.

38. Connect the pressure hose to the pressure connection (14) of the yaw brake (3).
39. Drain the oil.
40. If the hydraulic aggregate starts up during the flushing procedure, remove the pressure hose and wait until the hydraulic aggregate stops again.
41. Release the rotor holding brake.
42. Check the oil level at the hydraulic aggregate.
43. In case of an insufficient oil level, remove the red cover of the oil intake stub (12) and refill oil until the oil level is displayed in the middle of the level indicator (13).
44. Re-attach the cover (12) of the oil intake stub.
45. Reconnect the pressure hose at the yaw brake (3) to the pressure connection (14).
46. Repeat steps 38 through 44 until the drained oil is both clean and without air bubbles.
47. Disconnect the pressure hose.
48. Re-attach the cover of the pressure connection (14).
49. After that, refill more fresh oil via the oil intake stub until the oil level is displayed in the middle of the level indicator.
50. Tighten the cover (12) on the oil intake stub.
51. Clean the hydraulic aggregate and the oil pan.
52. Close the waste oil canister.
53. Clean the working area.

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

54. Embed the new brake pads in accordance with the manufacturer instructions that are enclosed with the brake pads.
55. REguard Monitoring: Deactivate "Manual yaw" (1) in the Maintenance menu.
56. Dispose of old brake pads, waste oil, and soiled cloths in the proper manner.

## 6.16.4 Changing brake pads

This maintenance section is described in chapter 6.16.3. There you may simply skip measuring and inspecting the old brake pads.

### 6.16.5 Inspecting the yaw brakes for squeaking noises

**Note:** Squeaking noises are generally caused by glass formations at the brake pad surface; these are resolved by sanding down these glass formations or replacing the brake pads.

The associated directives are provided in chapter 6.16.3.

Add the following maintenance steps after the removal of the brake pads:

Examine the brake pads for glass formations (hardened spots).

1. Place the affected brake pad in a vice (e.g. in the service vehicle).

**⚠ WARNING Risk of injury. Always place brake pads in a vice prior to grinding. Wear eye and hearing protection. Always keep the protective cover of the angle grinder installed.**

2. Grind off existing glass formations by means of an angle grinder with a serrated disk.
3. The grinding process may not cause the brake pad thickness to drop below the minimum.
4. Continue with the work in chapter 6.16.3 after the grinding process.

## 6.16.6 Performing a visual inspection of the yaw brakes and a check for leaking oil

**Required tools / operating and auxiliary means:**

- No. 19 jaw wrench
- Grease-solving cleaning agent and cloths

**Directive:**

1. Set the motor circuit switch of the hydraulic pump in the top box to STOP.
2. Descend to the yaw area.


Fig. 6.16.6 – 1 Hydraulic lines of the yaw brakes

3. Check the yaw brakes (1) for damage and leaking oil.
4. Clean the yaw brakes if necessary.
5. Tighten the screw connections (3) of the hydraulic lines (2).

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

6. Clean the working area if necessary.
7. Set the motor circuit switch of the hydraulic pump in the top box to START.
8. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.
9. Dispose of soiled cloths in the proper manner.

## 6.16.7 Leaking oil

### 6.16.7.1 Checking the leak oil bottles

**Directive:**

1. Descend to the yaw area.

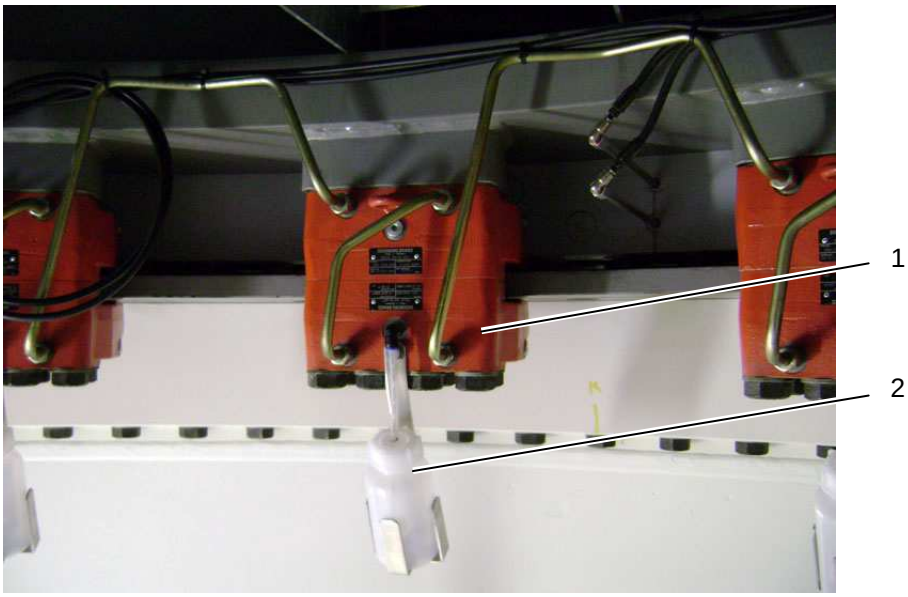



Fig. 6.16.7.1 –1 Leak oil bottles of the yaw brakes

2. Check the leak oil bottles (2) of the yaw brakes (1).
3. If there are larger quantities of leaking oil, the seals will need to be replaced at the brake calipers of the yaw brake.

**Note:** Replacing the seals poses extensive requirements with regard to the cleanliness of the working area. This is due to the fact that inclusions of dirt and dust greatly reduce the durability of the seals. These requirements are not fulfilled at a wind turbine.

4. Completely remove the affected yaw brake and replace it with a new one (ref. maintenance section chapter 6.16.7.2 "Replacing the yaw brake").
5. Clean the working area if necessary.

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

6. Dispose of soiled cloths in the proper manner.

### 6.16.7.2 Replacing the yaw brake

**Required tools / operating and auxiliary means:**

- New yaw brake in accordance with the list of spare parts provided by the manufacturer
- Hydraulic power screwdriver (ref. safety notice in section 9)
- No. 41 box nut
- No. 19 jaw wrench
- Fresh oil in accordance with the oil card at the hydraulic aggregate
- Collection container for draining oil
- Clean gloves
- Brake cleaner
- Grease-solving cleaning agent and cloths

**Directive:**

**Note:** The cooperation of two service technicians is a mandatory requirement for this maintenance section.

1. Set the motor circuit switch of the hydraulic pump in the top box to STOP.
2. Lower the new yaw brake to the yaw area (the weight of a yaw brake without brake pads amounts to 120 lb. (55 kg).
3. Both service technicians need to descend to the yaw area.

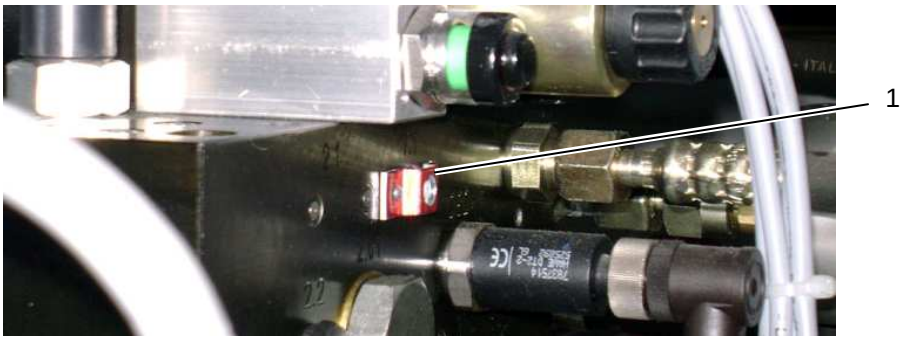



Fig. 6.16.7.2 – 1 Drain valve 7.1

**⚠ DANGER Danger due to high pressure (2320 lb/in²); (160bar). The pressure of the hydraulic system needs to be released prior to commencing the work. Observe the following directives. Wear protective goggles and acid-proof gloves.**

4. Release the system pressure via drain valve 7.1 (1) at the hydraulic aggregate.

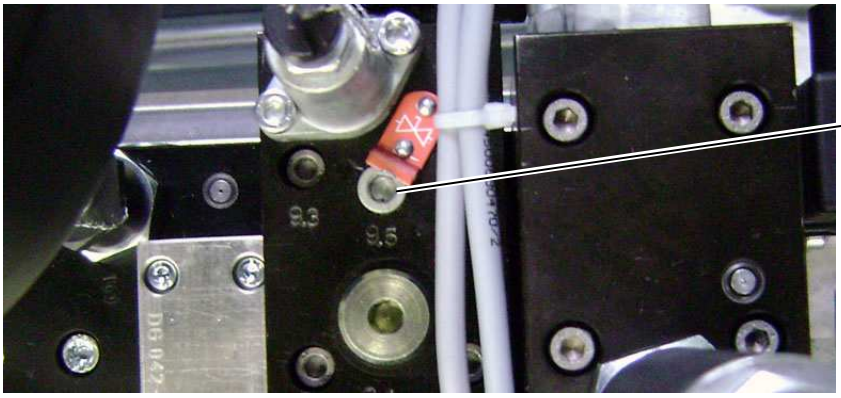



Fig. 6.16.7.2 – 2 Drain valve 9.5

5. Release the residual pressure via drain valve 9.5 (2) at the hydraulic aggregate.


Fig. 6.16.7.2 – 3 Hydraulic lines of the yaw brakes

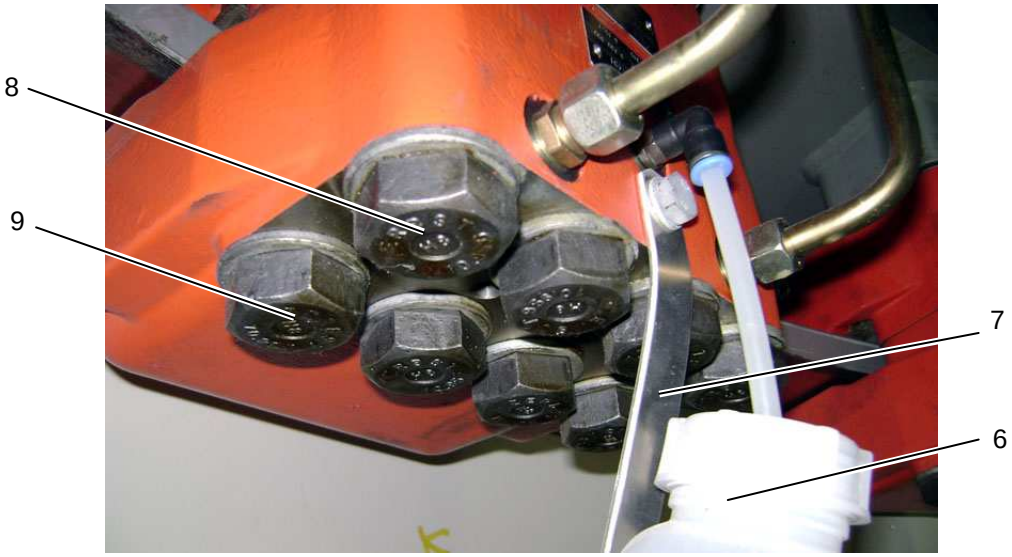



Fig. 6.16.7.2 – 4 Yaw brake

6. Remove the leak oil bottle (6).
7. Disconnect the mount (7) of the leak oil bottle.
8. Remove the hydraulic lines (5).
9. Collect draining oil.

**DANGER** **Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!**

10. Only loosen one (8) of the eight screws, remove the remaining seven screws (9).

**Note:** The weight of a yaw brake including the brake disks amounts to 170 lb. (77 kg).

11. Turn the yaw brake (3) away from the brake disk (4) in its entirety, the loosened screw (8) serves as pivotal point.

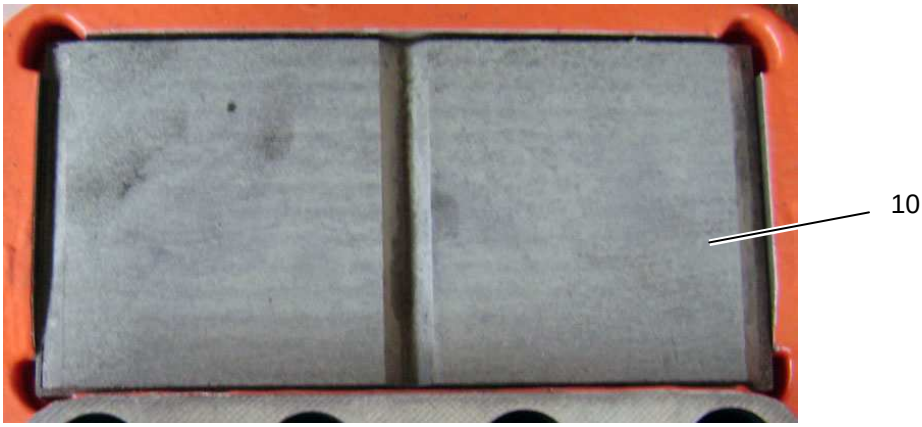



Fig. 6.16.7.2 – 5 Brake pads

12. Remove and inspect the brake pads (10).

**NOTICE** **Danger due to brake pads that have been soiled with oil. Severe reduction of the brake effect due to brake pads that have been soiled with oil. Brake pads that have been soiled with oil must be replaced with new brake pads.**

13. If the brake pads have not been soiled with oil, measure the brake pad thickness and enter the measurement in the service booklet.

**Note:** If the brake pad thickness without the carrier plate is less than or equal to 0.2 in. (5 mm), the brake pads need to be replaced.

14. Make sure that the two brake calipers of the yaw brake (3) may not fall down after releasing the last screw (8).
15. Support the yaw brake (3) and release the last screw (8).
16. Put down the brake calipers of the yaw brake (3) and drain the remaining oil.
17. Clean both sides of the brake disk (4) with brake cleaner (observe the safety notices provided by the manufacturer).

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

18. Clean the working area.

**NOTICE Severe reduction of the brake effect due to brake pads that have been soiled with oil. New brake pads need to remain in the packaging as long as possible in order to protect them against soiling and contact with oil. If grease or oil soils the brake pad, the brake pad may no longer be used.**

19. Start by attaching both brake calipers of the new yaw brake (3) with a single screw (8).
20. Insert the brake pads with the pad side facing the brake disk into the brake calipers.
21. Turn the yaw brake in the direction of the brake disk.
22. If needed, lubricate the threads of the screws (9) with Molykote and slightly start tightening them in the first step.
23. After that, increase the tightening torque for each screw in steps to the nominal value as detailed in maintenance section chapter 6.16.8.
24. Reinstall the hydraulic lines (5).
25. Install the mount (7) for the leak oil bottle.
26. Insert and connect the leak oil bottle (6).
27. Clean the yaw brake and the working area.

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

**Refilling oil**

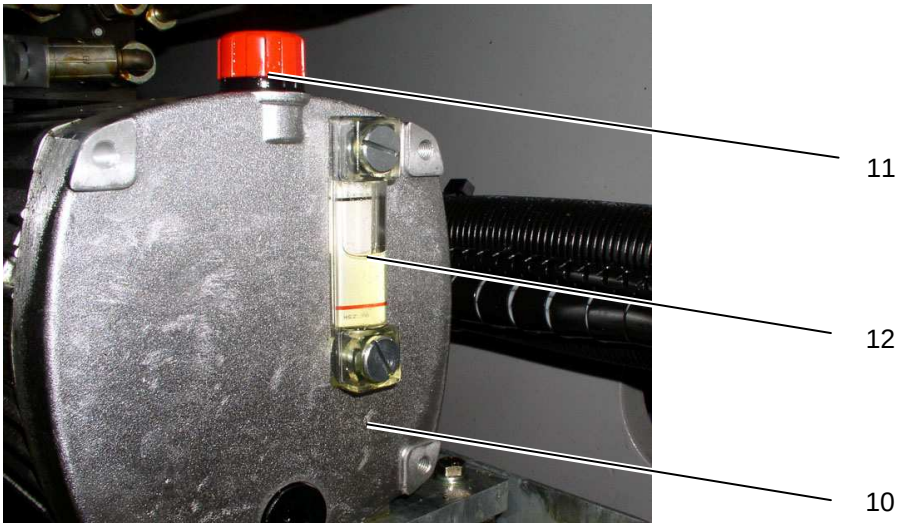



Fig. 6.16.7.2 – 6 Hydraulic aggregate

28. Remove the cover of the oil intake stub (11).
29. Fill fresh oil in accordance with the oil card at the hydraulic aggregate (10) into the oil intake stub (11) until the oil level is displayed in the middle of the level indicator (12).

30. Close valves 7.1 (1) and 9.5 (2).
31. Set the motor circuit switch of the hydraulic pump in the top box to START.
32. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

**Note:** It may be necessary to perform the RESET of the wind turbine multiple times.

### Removing the air from the yaw brakes


Fig. 6.16.7.2 – 7 Pressure connection

33. Release the cover of the pressure connection (13) of the yaw brake which is arranged directly upstream of the return line to the hydraulic aggregate.
34. Insert the pressure hose into the waste oil canister.
35. Connect the pressure hose to the pressure connection (14) of the yaw brake (3).
36. Drain the oil.
37. If the hydraulic aggregate starts up during the flushing procedure, remove the pressure hose and wait until the hydraulic aggregate stops again.
38. Release the rotor holding brake.
39. Check the oil level at the hydraulic aggregate.
40. In case of an insufficient oil level, remove the red cover of the oil intake stub (12) and refill oil until the oil level reaches the middle of the level indicator (13)
41. Re-attach the cover (12) of the oil intake stub.
42. Reconnect the pressure hose at the yaw brake (3) to the pressure connection (14).
43. Repeat steps 35 through 41 until the drained oil is both clean and without air bubbles.

44. Disconnect the pressure hose.
45. Re-attach the cover of the pressure connection (13).
46. After that, fill in more fresh oil via the oil intake stub (11) until the oil level is displayed in the middle of the level indicator (12).
47. Tighten the cover of the oil intake stub (11).
48. Clean the hydraulic aggregate (10).
49. Close the waste oil canister.
50. Clean the working area.

**⚠ CAUTION** **Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

51. Embed the new brake pads in accordance with the manufacturer instructions that are enclosed with the brake pads.
52. REguard Monitoring: Deactivate "Manual yaw" (1) in the Maintenance menu.
53. Dispose of the yaw brake, old brake pads, waste oil, and soiled cloths in the proper manner.

## 6.16.8 Checking the screw connection between the yaw brake and the machine base

**Required tools / operating and auxiliary means:**

- Hydraulic power screwdriver (ref. safety notice following section 4)
- No. 41 box nut

**Directive:**

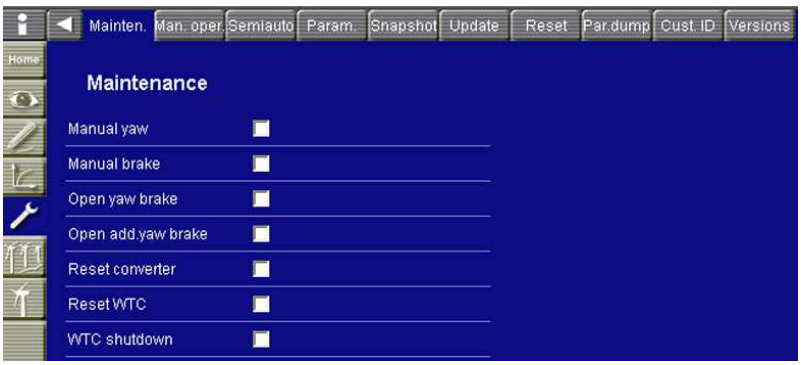



Fig. 6.16.8 – 1 REguard Monitoring

**DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).
2. Descend to the yaw area.

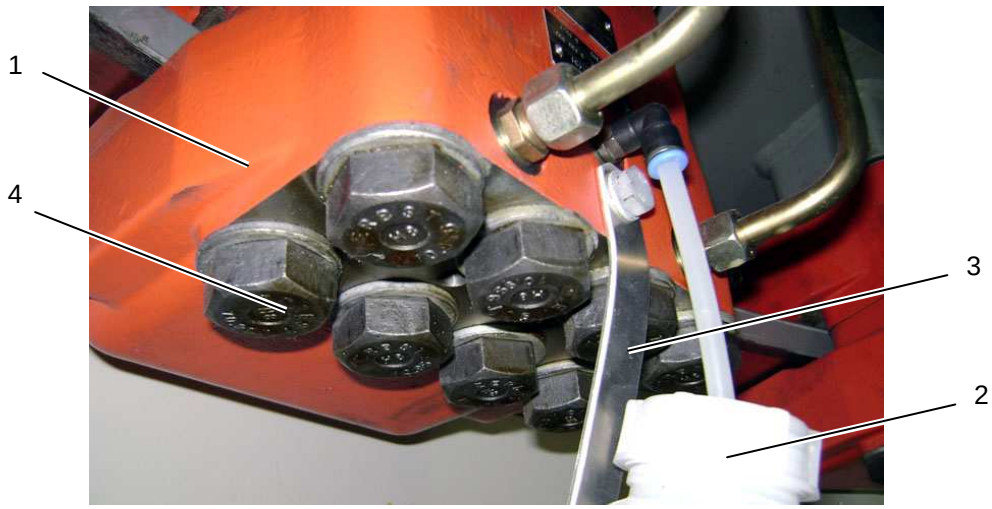



Fig. 6.16.8 – 2 Yaw brake

3. Remove the leak oil bottle (2) with the hose.
4. Remove the mount (3) of the leak oil bottle.

**⚠ DANGER Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!**

5. Check the screws (4) with the hydraulic power screwdriver and a tightening torque in accordance with the service booklet.
6. Install the mount (3) of the leak oil bottle.
7. Insert the leak oil bottle (2) and connect the hose.
8. Repeat steps 3 through 7 for the other yaw brakes (1).
9. Clean the working area.

**⚠ CAUTION Risk of fall due to the floor area being soiled with oil. Thoroughly clean the entire working area.**

10. Reselect "Manual yaw" to deactivate it again.

# 6.17 Yaw bearing

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

**CAUTION**

**Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform.**

- Wear protective equipment and descend with care in order to avoid injuries.

**CAUTION**

**Risk of fall due to unstable foothold in the yaw area.**

- Ensure the safe placement of the step-ladder.
- Keep both feet on the step-ladder while working.

## 6.17.1 Performing the functional test 360°

**Directive:**

**Note:** This maintenance section may also be performed together with the maintenance section chapter 6.18.5 "Cam switch of the cable twist".


Fig. 6.17.1 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).

**⚠ DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

2. Manually move the yaw bearing via the panel of the REguard Control B with or at the top box and stop it with .
3. When selecting the direction of rotation of the yaw bearing, it must be ensured that the permissible angle of twist of the cables will not be exceeded.
4. Reselect "Manual yaw" (1) to deactivate it again.

## 6.17.2 Inspecting the condition of the outer seal

**Required tools / operating and auxiliary means:**

- Digital camera if necessary
- Cloths
- Grease-solving cleaning agent
- Molykote
- Brush

**Directive:**

**Note:** Perform this maintenance section together with the maintenance sections chapter 6.17.3 "Inspecting the condition of the gearing", chapter 6.17.4 "Checking the soiling of the gearing", and chapter 6.17.7 "Lubrication condition of the gearing".

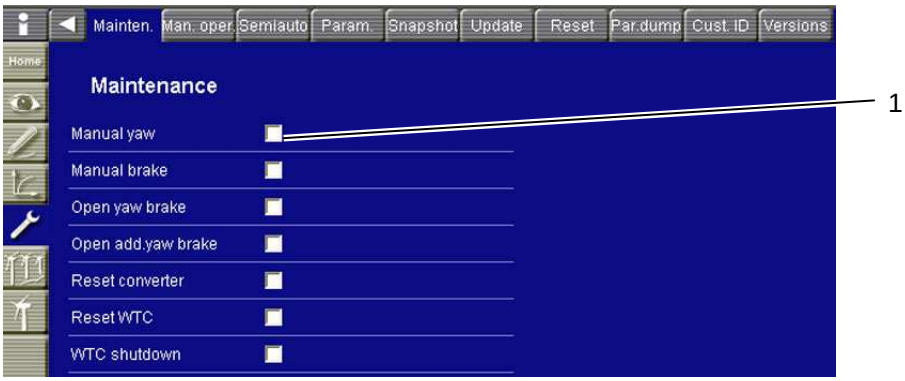



Fig. 6.17.2 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).


Fig. 6.17.2 – 2 Access to the hub

**DANGER Descend to the access area to the hub only if no signal sounds upon opening the access door (2).**

**CAUTION Danger due to spatial tightness and rough surfaces. Wear all protective clothing in order to avoid injuries.**

2. Descend to the hub access.


Fig. 6.17.2 – 3 Yaw gearing

**Note:** The outer seal of the yaw bearing is not directly visible. However, if the track (3) of the grounding brushes (4) is soiled with Molykote, this indicates a damaged seal or excessive pressure in the yaw bearing (ref. chapter 6.17.6 "Inspecting the self-lubrication system").

3. Document severe soiling in the service booklet (maintenance section 6.17.2).
4. Clean soilings (maintenance section 6.17.2).
5. Inspect the gearing (5) for corrosion and wear (maintenance section 6.17.3).

6. Check the soiling of the gearing (5) (maintenance section 6.17.4).
7. If rough dirt particles are included in the grease, clean the gearing (5) and re-lubricate it with Molykote (maintenance section 6.17.4).
8. Remove operating and auxiliary means from the area of rotation.
9. Return to the machine base.

**DANGER Danger due to rotating system components. Never be present in the outer yaw area while the yaw bearing is turned.**

10. Manually turn the yaw bearing in coordination with other service technicians via the panel of the REguard Control B approx. 30°with or and stop it with .
11. Check the angle of rotation via "Nacelle position" or "Angle of twist" (ref. fig. 6.17.2 – 1).
12. Return to the hub access and inspect as well as clean the next section.
13. Repeat maintenance steps 3 through 12 until the entire gearing has been inspected and cleaned.

**NOTICE Damage at the gearing is possible if objects get wedged in the gearing.**

14. Remove all tools as well as auxiliary and operating means from the working area after completing the work.
15. Reselect "Manual yaw" to deactivate it again.
16. Dispose of soiled cloths in the proper manner.

**Note:** The following steps only apply to maintenance section 6.17.2.

17. Descend to the yaw area.

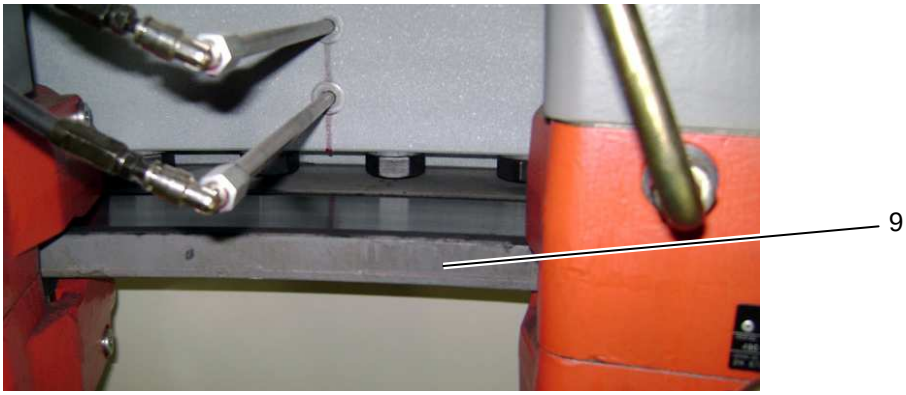



Fig. 6.17.2 – 3 Brake disk

**Note:** The inner seal of the yaw bearing is also not directly visible. However, if a brake disk (9) is soiled with Molykote, this indicates a damaged seal or excessive pressure in the yaw bearing (ref. chapter 6.17.6 "Inspecting the self-lubrication system").

18. Clean soilings.

**NOTICE** **Danger due to brake pads that have been soiled with oil. If soilings with Molykote are also visible on the brake disk of the yaw brakes, the brake pads will need to be replaced and the entire brake area will need to be degreased (ref. maintenance section 6.16.4 "Changing brake pads").**

19. Dispose of soiled cloths in the proper manner.

## 6.17.3 Inspecting the condition of the gearing

**Directive:**

This maintenance section is described in chapter 6.17.2 "Inspecting the condition of the outer seal".

## 6.17.4 Checking the soiling of the gearing

**Directive:**

This maintenance section is described in chapter 6.17.2 "Inspecting the condition of the outer seal".

## 6.17.5 Inspecting the lightning protection mechanism

**Directive**:

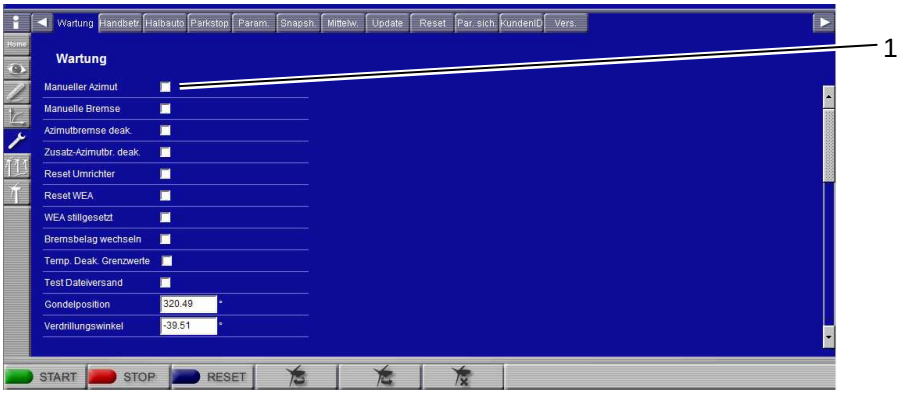



Fig. 6.17.5 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).

**⚠ DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

Fig. 6.17.5 – 2 Access to the hub

**⚠ DANGER Descend to the access area to the hub only if no signal sounds upon opening the access door.**

**⚠ CAUTION Danger due to spatial tightness and rough surfaces. Wear all protective clothing in order to avoid injuries.**

2. Descend to the hub access.

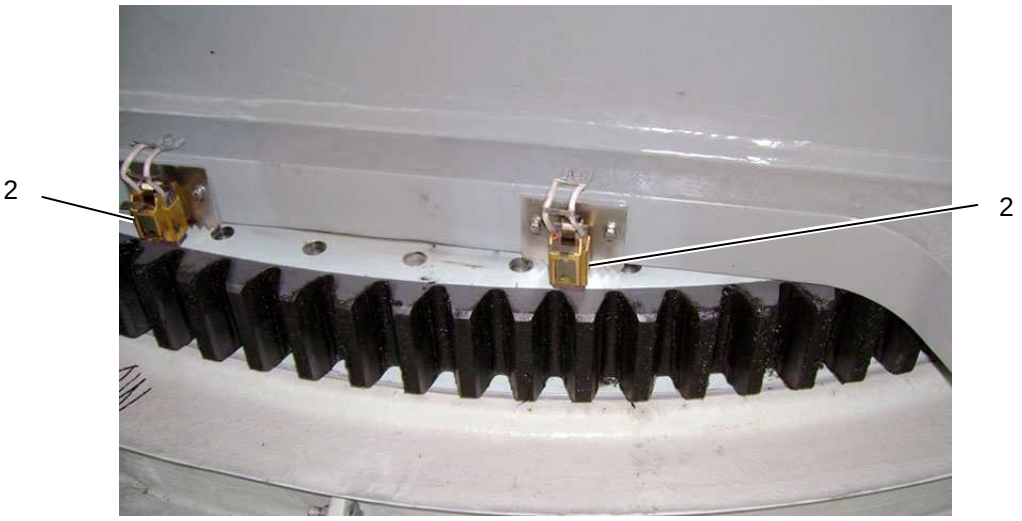



Fig. 6.17.5 – 3 Lightning protection mechanism


Fig. 6.17.5 – 4 Lightning protection mechanism

3. Remove the spring-loaded clamp (3).
4. Evaluate the elasticity of the spring, replace if necessary.
5. Remove the grounding brush (4).
6. Measure the length of the grounding brush (4).
7. If the length of the grounding brush is less than or equal to 0.8 in. (20 mm), replace the grounding brush.
8. To that end, release the screw connection (5), remove the grounding brush, and replace it with a new one.
9. Repeat steps 4 through 8 for the second lightning protection mechanism.
10. Remove all tools as well as auxiliary and operating means from the working area after completing the work.
11. Reselect "Manual yaw" to deactivate it again.

## 6.17.6 Inspecting the self-lubrication system

**Required tools / operating and auxiliary means:**

- Lubrication grease in accordance with the specifications at the lubrication system
- Grease gun
- Flat-headed screwdriver

**Directive:**

1. Descend to the yaw area.


Fig. 6.17.6 – 1 Self-lubrication system yaw bearing

2. In case of insufficient lubrication grease consumption, check as to whether the red pin (3) protrudes from the pressure valve; this would indicate a block of the lubrication line.
3. In that case, resolve the block of the lubrication line.

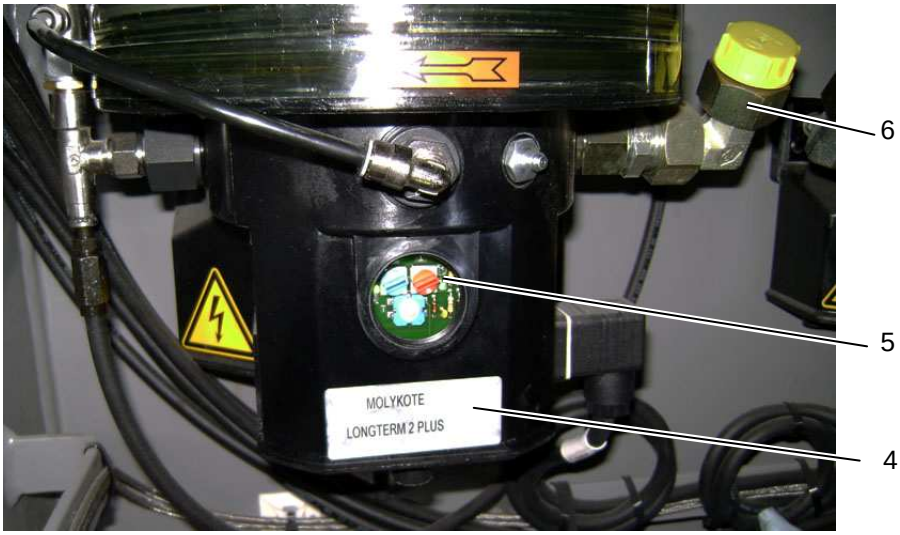



Fig. 6.17.6 – 2 Self-lubrication system

4. Also check the control of the pump in case of deviating grease consumption.
5. To that end, remove the cross-shaped cover which protects the control (5).


Fig. 6.17.6 – 3 Control of the pump

6. Use the flat-headed screwdriver to set the blue adjustment disk (6) to F.
7. Use the flat-headed screwdriver to set the red adjustment disk (7) to 7.
8. Re-attach the cross-shaped cover.

### Refilling lubrication grease

9. Release the screw connection of the lubrication stub (6).
10. Remove the lubrication stub.
11. Clean the threading.

12. Manually tighten the grease gun to the lubrication stub.
13. Support the lubrication stub while pressing in the lubrication grease in order to prevent breaking out of the plastic enclosure of the self-lubrication system.
14. Press in lubrication grease until the maximum filling mark has been reached at the lubrication grease container (1).
15. Disconnect the grease gun (3).
16. Clean the threading.
17. Re-attach and tighten the lubrication stub (2).

## 6.17.7 Checking the function of the self-lubrication system

**Required tools / operating and auxiliary means:**

- Screwdriver

**Directive:**

**Note:** Perform this maintenance section together with the maintenance sections 6.17.2 "Inspecting the condition of the outer seal", 6.17.3 "Inspecting the condition of the gearing", and 6.17.4 "Checking the soiling of the gearing".

1. Descend to the yaw area.


Fig. 6.17.7 – 1 Self-lubrication system

2. Check the function of the self-lubrication system by activating the push-button (2) at the pump (1) → The pump needs to start up.
3. Re-attach the cross-shaped cover.

## 6.17.8 Checking the screw connection between the yaw bearing and the machine base

**Required tools / operating and auxiliary means:**

- Hydraulic power screwdriver (ref. safety notice following section 5)
- No. 41 box nut
- Edding

**Directive:**

**Note:** The cooperation of two service technicians is required for this maintenance section.

First service technician:

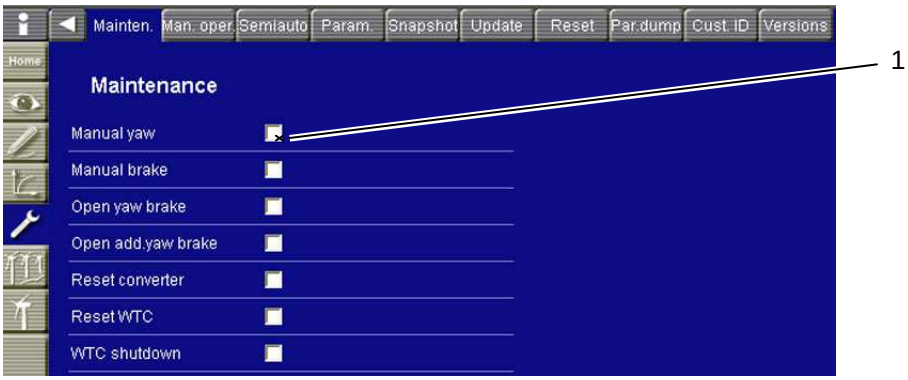



Fig. 6.17.8 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).

**⚠ WARNING** Risk of injury and severe damage due to activating the wind direction adjustment while working with the hydraulic power screwdriver. "Manual yaw" (1) must be activated under all circumstances!

Second service technician:

2. Descend to the yaw area.

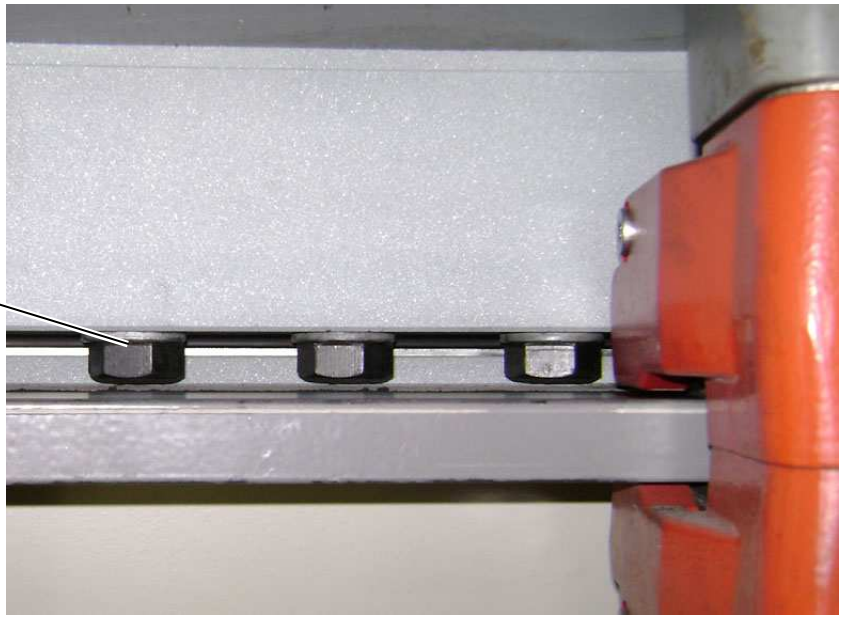



Fig. 6.17.8 – 2 Screw connection between the yaw bearing and the machine base


Fig. 6.17.8 – 3 Brake disk of the yaw brake

3. Position the screw heads (2) of the screw connection between the yaw bearing and the machine base in such a manner that they are visible in the center of the perforations (4) of the brake disk (3).
4. To that end, instruct the first service technician to manually turn and stop the yaw bearing.

First service technician:

5. Manually move the yaw bearing via the panel of the REguard Control B with or at the top box and stop it with upon receiving the respective instructions from the second service technician.

Second service technician:

**DANGER** **Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!**

6. Check the screws (2) with the hydraulic power screwdriver and a tightening torque in accordance with the service booklet.
7. Mark the checked screws with an Edding.
8. Repeat maintenance steps 2 through 6 until all screws have been checked.

First service technician:

9. Reselect "Manual yaw" (1) to deactivate it.

First or second service technician:

10. Touch up varnish chippings in accordance with the HEMPEL Repair procedure (ref. attachment).

## 6.17.9 Checking the screw connection between the tower head and the yaw bearing

**Required tools / operating and auxiliary means:**

- Hydraulic power screwdriver
- No. 41 box nut
- Edding

**Directive:**

1. Descend to the yaw area.

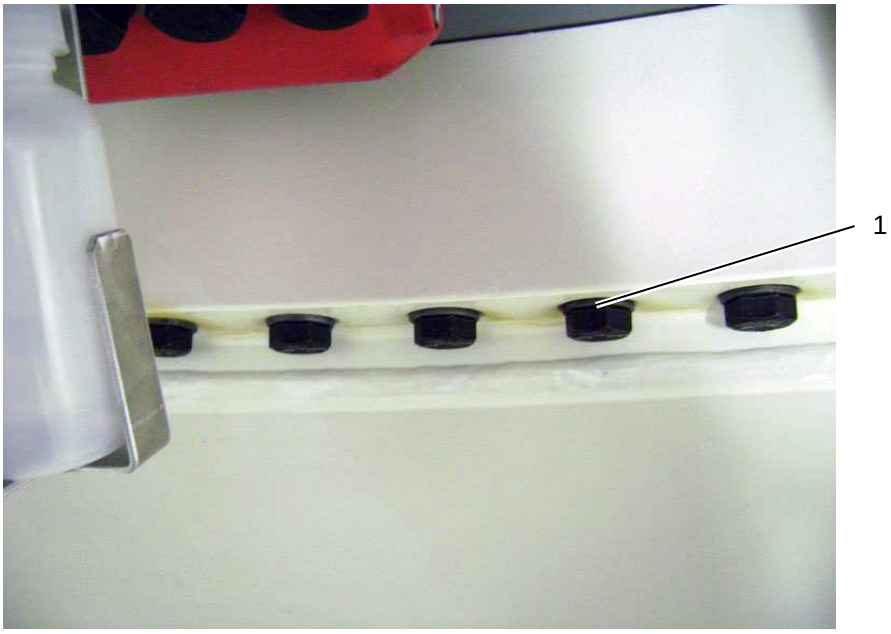



Fig. 6.17.9 – 1 Screw connection between the yaw bearing and the tower head

**DANGER Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!**

2. Check the screws (1) with the hydraulic power screwdriver and a tightening torque in accordance with the service booklet.
3. Mark the checked screws with an Edding.

# 6.18 Yaw adjustment mechanism

**⚠ WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.18.1 Checking the oil level

**Directive:**

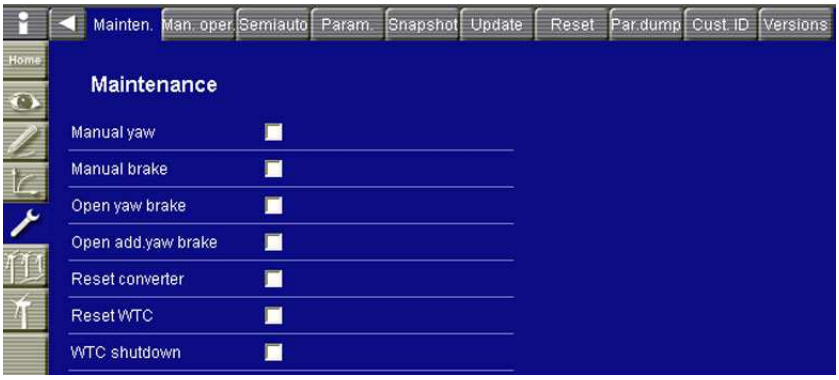



Fig. 6.18.1 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).
2. Engage the rotor lock (ref. operating manual).

**⚠ DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

**⚠ CAUTION Danger due to spatial tightness and rough surfaces. Wear all protective clothing in order to avoid injuries.**


Fig. 6.18.1 – 2 Access to the hub

**DANGER** **Descend to the access area to the hub only if no signal sounds upon opening the access door (1).**


Fig. 6.18.1 – 3 Yaw drives

3. Descend to the yaw drives (2).
4. Check the oil level of all four yaw gearboxes (2), the level indicator (3) should be ¾ filled.

**NOTICE** **Damage at the gearing is possible if objects get wedged in the gearing.**

5. Remove all tools as well as auxiliary and operating means from the working area after completing the work.
6. Reselect "Manual yaw" to deactivate it again.

## 6.18.2 Performing an oil change

**Required tools / operating and auxiliary means:**

- No. 8 Allen wrench
- Canister pump
- 4 times 5 gal. (20 liters) of oil in accordance with the type label on the yaw gearbox
- Collection container for waste oil
- Cloths
- Grease-solving cleaning agent

**Directive:**

**Note:** This maintenance section should be performed at operating temperature in order to ease draining and filling the oil.


Fig. 6.18.2 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).
2. Engage the rotor lock (ref. operating manual)

**⚠ DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

**⚠ CAUTION Danger due to spatial tightness and rough surfaces. Wear all protective clothing in order to avoid injuries.**


Fig. 6.18.2 – 2 Access to the hub

**DANGER** **Descend to the access area to the hub only if no signal sounds upon opening the access door (1).**

3. Descend to the yaw drives.

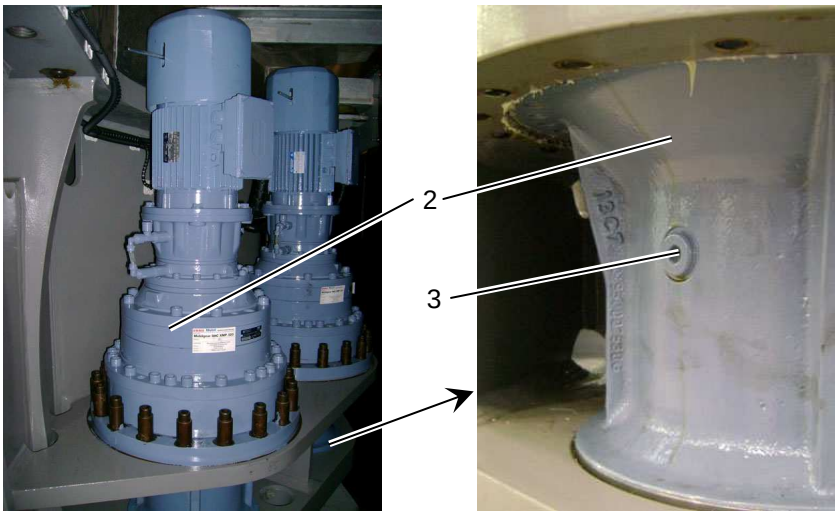



Fig. 6.18.2 – 3 Yaw gearbox

**CAUTION** **Risk of burns due to hot gearbox oil. Wear oil-proof gloves and protective goggles.**

4. Remove the oil drain screw (3) of the yaw gearbox (2).
5. Collect draining oil (approx. 5 gal. (20 liters)) as much as possible.
6. Re-insert the oil drain screw.
7. Clean the working area.
8. Dispose of waste oil and soiled cloths in the proper manner.


Fig. 6.18.2 – 4 Oil intake stub

9. Remove the oil intake screw (4).
10. Use a canister pump to fill in 5 gal. (20 liters) of oil until the level indicator (5) is ¾ filled.


Fig. 6.18.2 – 5 Yaw gearbox (upper view)

11. Clean the working area.
12. Dispose of waste oil and soiled cloths in the proper manner.
13. Repeat steps 4 through 12 at the other yaw gearboxes.

**NOTICE** **Damage at the gearing is possible if objects get wedged in the gearing.**

14. Remove all tools as well as auxiliary and operating means from the working area after completing the work.
15. Reselect "Manual yaw" to deactivate it again.

### 6.18.3 Checking the e-motors for noise

**Directive:**

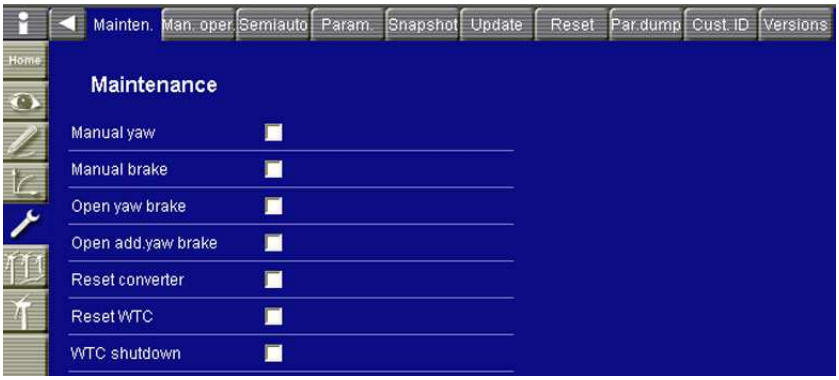



Fig. 6.18.3 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).

**DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

2. Manually move the yaw bearing via the panel of the REguard Control B with or at the top box and stop it with
3. In that context, check for unusual noises of the electric motors.
4. Describe noticeable problems in the service booklet.
5. Reselect "Manual yaw" to deactivate it again.

## 6.18.4 Testing the proximity sensors

**Directive:**

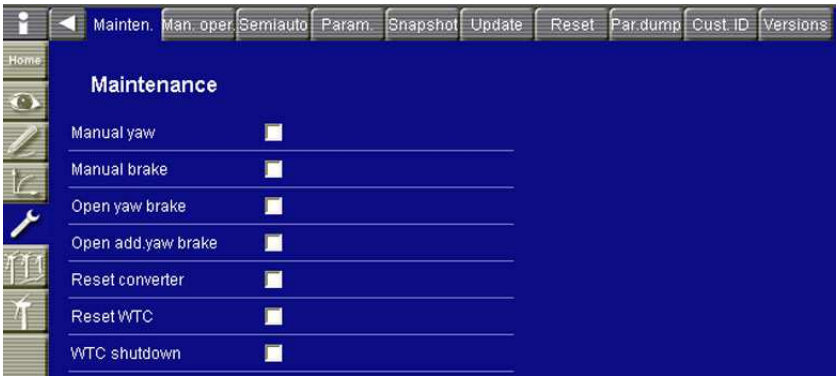



Fig. 6.18.4 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).

**DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

2. Manually move the yaw bearing via the panel of the REguard Control B with and at the top box and stop it with .
3. The values for "Nacelle position" and "Cable twist" need to change

**DANGER Danger due to rotating yaw drives. Ensure that nobody activates the manual yaw during the following maintenance.**

**CAUTION Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform. Wear protective equipment and descend with care in order to avoid injuries.**

4. Descend to the yaw area.

**CAUTION Risk of fall due to unstable foothold in the yaw area. Ensure the safe placement of the step-ladder. Keep both feet on the step-ladder while working.**

**Note:** The proximity sensors may be accessed via the inspection opening on the right next to the hydraulic aggregate. Ensure dependable footing during the testing and adjusting procedures.

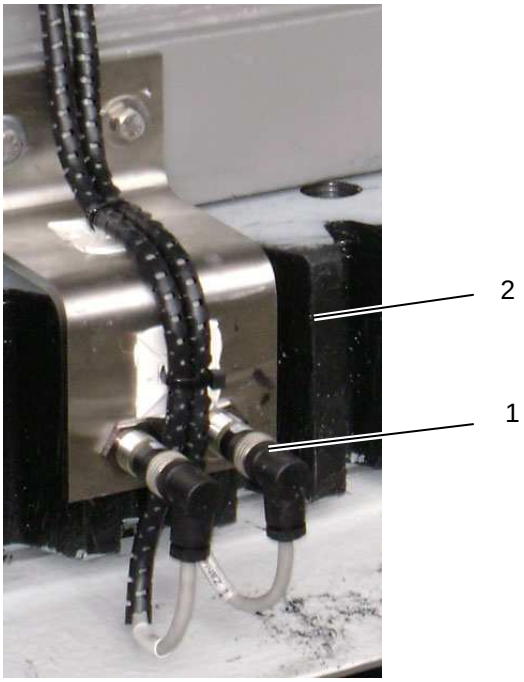



Fig. 6.18.4 – 2 Proximity sensors at the yaw cog wheel

5. Check the distance between the proximity sensors (1) and the gearing (2) by means of the feeler gauge (nominal size up to 0.098 in. (2.5 mm)).
6. Release the screw connection of the proximity sensors in case of a deviation from the nominal distance.
7. Adjust the proximity sensors to the nominal distance.
8. Re-tighten the screw connection.
9. Remove all tools from the working area.
10. Reselect "Manual yaw" to deactivate it again.

## 6.18.5 Cam switch cable twist – checking the function

**Directive:**


Fig. 6.18.5 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).

**⚠ DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

2. Manually move the yaw bearing via the panel of the REguard Control B with  and  at the top box until the controller stops the yaw drives.


Fig. 6.18.5 – 2 REguard Monitoring

**⚠ DANGER Danger due to incorrectly adjusted cam switch. All protection functions are deactivated while moving the yaw bearing via the switches. It is paramount that the angle of twist is monitored during the turning procedure! It may not exceed 50° more than the triggering angle of the REguard Control B!**

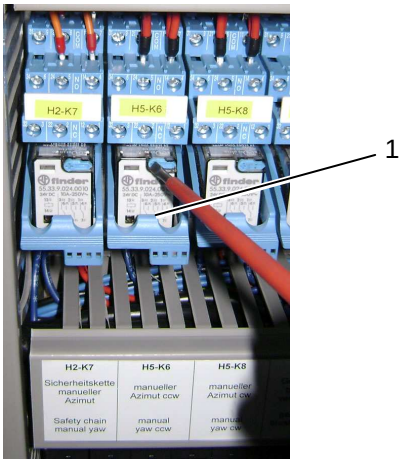



Fig. 6.18.5 – 3 Switches manual yaw

3. After that, continue moving the yaw bearing via the switch manual yaw (1) cw or ccw until

- the control point to the right of "Cable twisted CW" or "Cable twisted CCW" lights up or
- the maximum triggering angle of the controller + 50° is reached.

4. If the cam switch does not trigger on time, it will need to be re-adjusted.
5. If the cam switch is properly adjusted, the safety chain will be triggered and brake program 200 will be activated.
6. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.
7. Turn the yaw bearing in the opposite direction and repeat steps 2 through 6.
8. Reselect "Manual yaw" to deactivate it again.

## 6.18.6 Inspecting the seal

**Directive:**

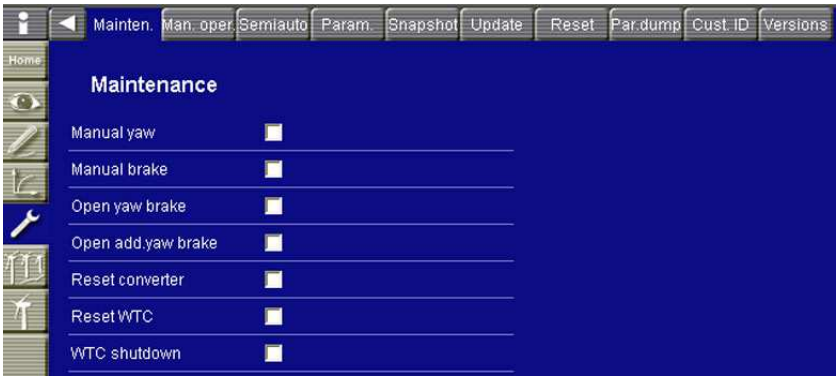



Fig. 6.18.6 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).
2. Set the motor circuit switch of the yaw drives in the top box to STOP.

**⚠ DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

**⚠ CAUTION Danger due to spatial tightness and rough surfaces. Wear all protective clothing in order to avoid injuries.**

The seals need to be inspected if oil has escaped in the range of the flange.

**⚠ CAUTION The e-motor (1) of a yaw drive weighs approx. 135 lb. (60kg). Do not lift by hand. Use a chain hoist.**

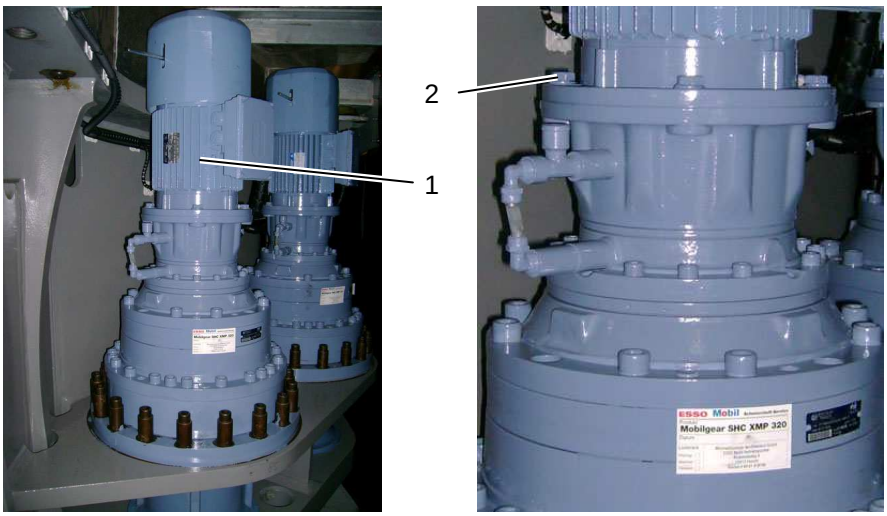



Fig. 6.18.6 – 2 Yaw gearbox

3. Disconnect the Harting plug from the e-motor.
4. Depending on the attachment type of the cables, ensure that the e-motor has sufficient clearance for movements and the cables will not be damaged.
5. Attach the round loop to the e-motor (1).
6. Connect the end of the chain hoist to the round loop and reliably attach the suspension of the chain hoist.
7. Release the screw connections (2).
8. Slowly lift up the e-motor (1) until the seal may be accessed in an unobstructed manner.
9. Remove the old seal.
10. Carefully mount the new seal with the help of the plastic bushing and the soft mallet.
11. Damaged seals need to be replaced.
12. Slowly lower the e-motor and place it on the gearbox (3) in a perfectly fitting manner.
13. Tighten the screw connection.
14. Renew the released cable ties.
15. Reconnect and secure the Harting plug.
16. Set the motor circuit switch of the yaw drives in the top box to START.
17. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.
18. Reselect "Manual yaw" to deactivate it again.

## 6.18.7 Checking the screw connection between the yaw gearbox and the machine base

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 14 Allen wrench plug insert

**Directive:**

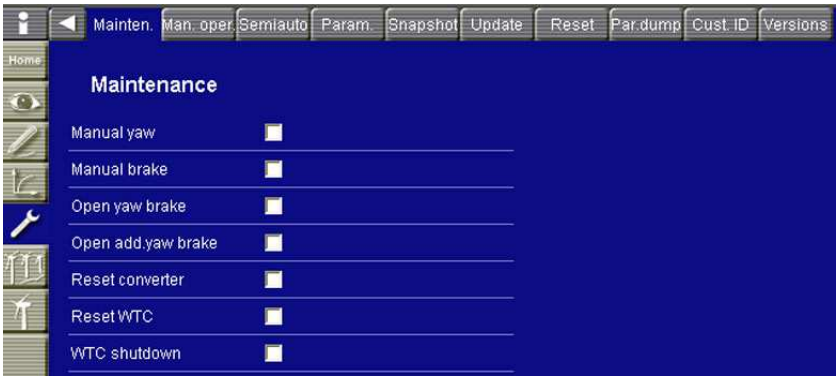



Fig. 6.18.7 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).

**DANGER Risk of life due to rotating yaw drives. Ensure that nobody is present in the outer yaw area during manual movements of the yaw bearing.**

**CAUTION Danger due to spatial tightness and rough surfaces. Wear all protective clothing in order to avoid injuries.**

2. Engage the rotor lock (ref. operating manual).

Fig. 6.18.7 – 2 Access to the hub

**DANGER** **Descend to the access area to the hub only if no signal sounds upon opening the access door (1).**

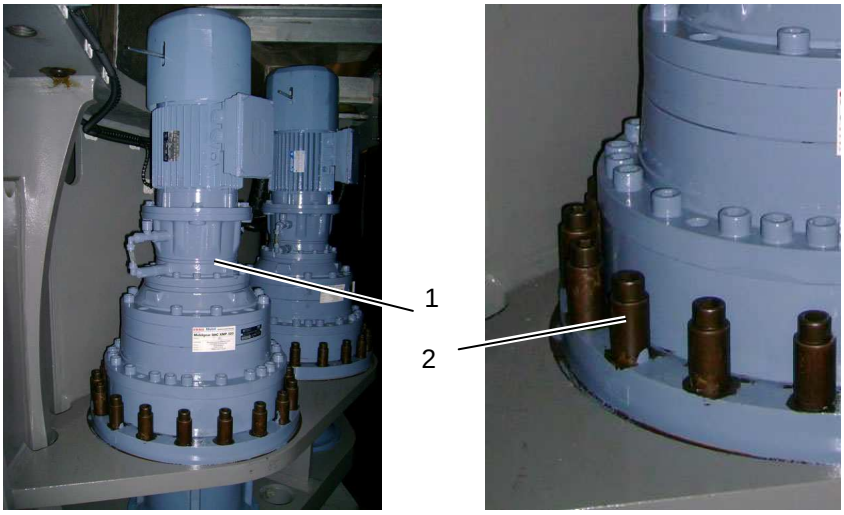



Fig. 6.18.7 – 3 Yaw drives

3. Check the screws (2) of all four yaw drives (1) with a torque as detailed in the service booklet.

**NOTICE** **Damage at the gearing is possible if objects get wedged in the gearing.**

4. Remove all tools as well as auxiliary and operating means from the working area after completing the work.
5. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.
6. Reselect "Manual yaw" to deactivate it again.

# 6.19 Chain hoist

**⚠ WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.19.1 Inspecting the test instruction protocol

**Directive:**

Chain hoists need to be inspected by an authorized person on an annual basis. In that context, this person completes a test instruction protocol which is available in the tower base of the wind turbine.

1. Check whether the test instruction protocol has been completed in full and whether the test interval has been observed.

## 6.19.2 Inspecting the condition of the chain bag

**Directive:**

**⚠ DANGER Risk of life due to fall: Never access the deck crane area while the crane hatch is open. Never subject the crane hatch to a load exceeding 330 lb (150 kg) on an area of 7.8 in. x 0.78 in. (0,2m x 0,2m).**

**⚠ CAUTION Operation by service personnel only, and only while the rotor is slowed down. Do not exceed the maximum load capacity of 550 lb. (250 kg) (ref. operating manual).**

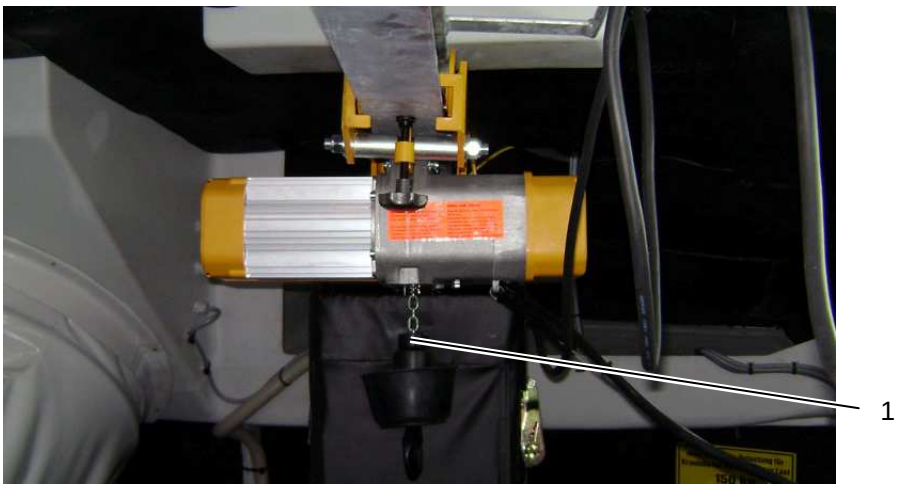



Fig. 6.19.2 – 1 Deck crane

1. Release the locking wheel (1) of the deck crane.
2. If the locking wheel (1) is difficult to turn, lubricate the threading.
3. Pull the deck crane in the direction of the nacelle center.
4. Secure the deck crane by means of the locking wheel (1).


Fig. 6.19.2 – 2 Chain bag

5. Inspect the chain bag (2) for damage.
6. Inspect the holding belt (3) for damage.
7. Replace damaged chain bag.
8. Document defects in the service booklet.
9. Move the deck crane back and lock it again.

## 6.19.3 Checking the function and the general condition

**Directive:**

**DANGER Risk of life due to fall. Put on the entire PPE and secure against fall prior to opening the crane hatch and prior to activating the deck crane (ref. chapter 5).**

**CAUTION Operation by service personnel only, and only while the rotor is slowed down. Do not exceed the maximum load capacity of 550 lb. (250kg) (ref. operating manual).**

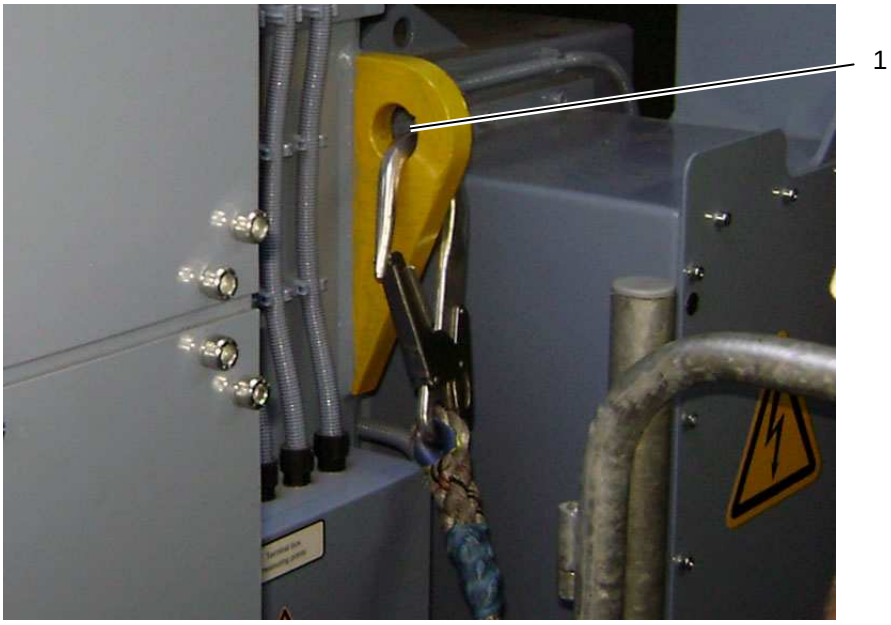



Fig.6.19.3 -1 Attachment point for work in the area of the crane hatch

1. Secure at the attachment point (1).
2. Center the deck crane above the crane hatch.

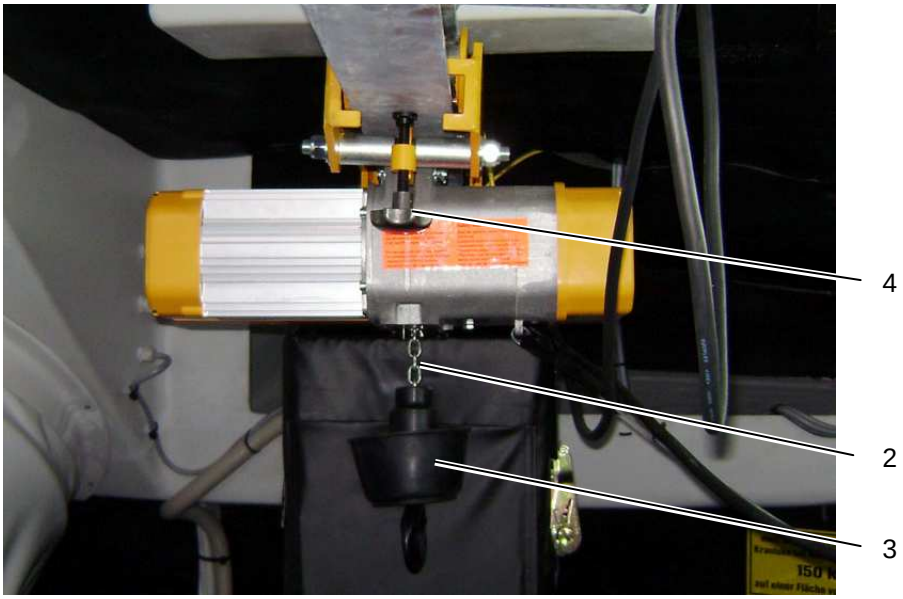



Fig. 6.19.3 – 2 Chain hoist

3. Secure the deck crane by means of the locking wheel (4).
4. Open the crane hatch.


Fig. 6.19.3 – 3 Switching unit

5. Activate the switching unit and fully release the chain (2) with the crane hook (3).
6. Perform a visual inspection of the chain during the release.
7. Remove rough soilings.
8. If the chain (2) is poorly lubricated, stop the chain hoist.
9. Lubricate the sections of the chain with chain grease.
10. Activate the deck crane again.
11. Document defects in the service booklet.
12. Close the crane hatch.

## 6.19.4 Examining the condition of the chain

**Directive:**

Ref. maintenance section 6.19.1 "Inspecting the test instruction protocol" and 6.19.2 "Checking the function and the general condition".

# 6.20 Wiring / electrical system / general condition of the nacelle

**⚠ WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.20.1 Top box

### 6.20.1.1 Checking the screw connections for a tight fit

**Directive:**

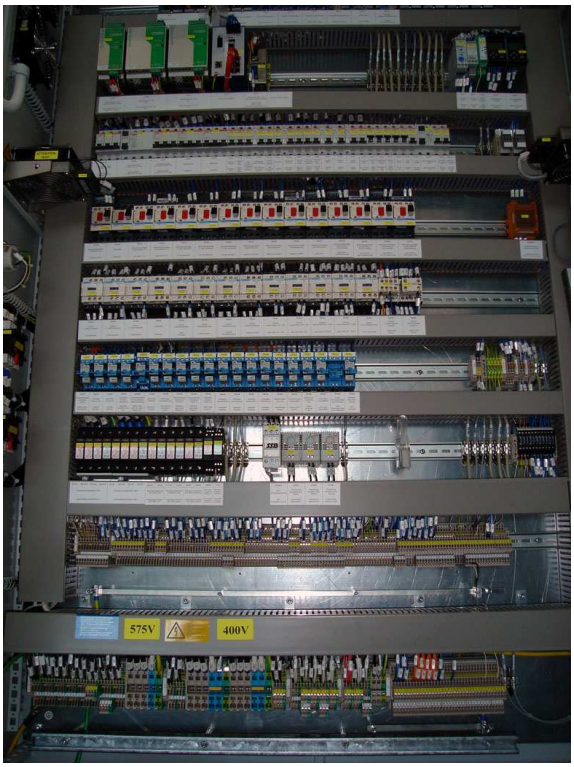



Fig. 6.20.1.1 – 1 Top box

Check all screw and cable connections for a tight fit.

1. Test control elements at random.

### 6.20.1.2 Checking the surge protection elements

**Directive:**

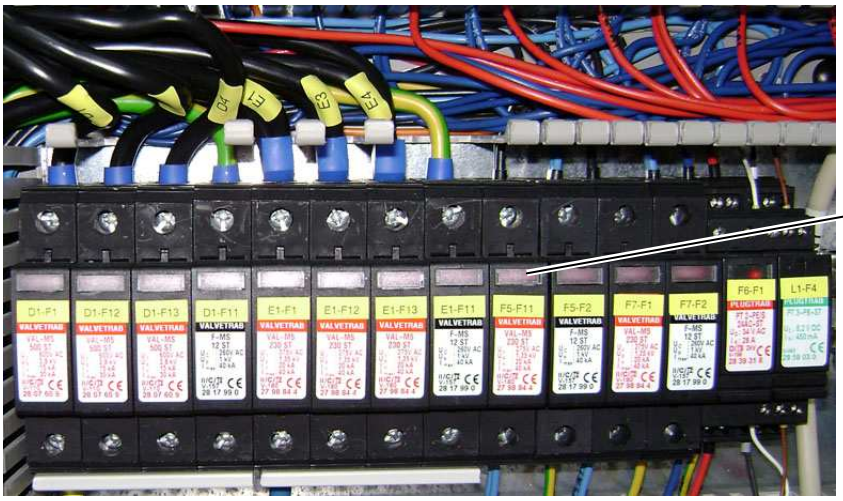



Fig. 6.20.1.2 – 1 Surge protection elements

1. Check the surge protection elements (1). If the surge protection has been triggered, the control panel (1) will be shaded red.
2. In that case, replace the triggered surge protection element (ref. parts list e-circuit diagram in the top box).

### 6.20.1.3 Testing the function of the speed monitoring system

**Requirements:**

1. The rotor lock has been released (ref. operating manual)
2. The rotor holding brake has been released (ref. operating manual)

**Directive:**

**⚠ WARNING Only perform this maintenance step with the reduced values specified in the service booklet and during an average wind speed of no more than 10 m/s.**


Fig. 6.20.1.3 – 1 Rhein speedometer relay

Identification of the operating elements of the Rhein speedometer relay:

| | |
|---|---|
| 1 | Buttons for programming |
| 2 | Display of the current value |
| 3 | Relay 2 |
| 4 | Relay 1 |
| 5 | Switching threshold for relay 1 |
| 6 | Switching direction for relay 1 |
| 7 | Switching direction for relay 2 |
| 8 | Measuring unit |

**Settings for the relay H6-K4 rotor speed:**

3. Reduce the preset value for the maximum permissible rotor speed of 20 rpm to 3 rpm.
4. To that end, push the PROG button at the relay and adjust the value via the buttons for the programming (1).
5. After that, select OK.
6. The safety chain needs to trigger and brake program 200 needs to start as soon as the rotor reaches the speed of 3 rpm (ref. panel of the RE-guard control B).
7. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.
8. Reset the rotor speed in the manner detailed in sections 2 and 3 to 20 rpm at the relay H6-K4.
9. Document the result under maintenance section 6.20.1.6 in the service booklet.

**Settings for the relay H6-K2 rotor speed:**

10. Reduce the preset value for the maximum permissible gearbox speed of 1950 rpm to 300 rpm at relay 2.
11. To that end, push the PROG button at the relay and adjust the value via the buttons for the programming (1).
12. After that, select OK.

**Note:** The safety chain needs to trigger and brake program 200 needs to start as soon as the gearbox reaches the speed of 300 rpm (ref. panel of the REguard control B).

13. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.
14. Reset the rotor speed in the manner detailed in sections 9 and 10 to 1950 rpm at the relay H6-K2.
15. Document the result under maintenance section 6.20.1.6 in the service booklet.

### 6.20.1.4 Checking the function of the ventilators and the heating

**Directive:**

**DANGER** **Risk of life due to high voltages. Observe the safety notices in chapter 5**


Fig. 6.20.1.4 – 1 Thermostats

- Thermostats switching cabinet ventilator (1) (blue lettering)
- Thermostat switching cabinet heating (2) (red lettering)

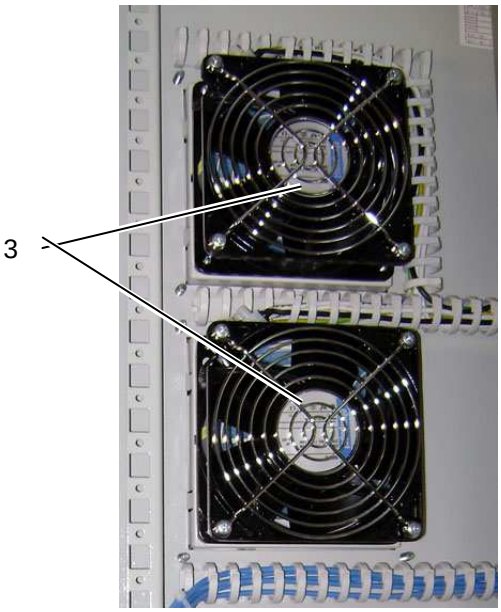



Fig. 6.20.1.4 – 2 Ventilator


Fig. 6.20.1.4 -3 Heating

1. Successively reduce the temperature set for the switching cabinet ventilator (3) at the thermostats (1) in a noticeable manner by turning the adjustment disk. The ventilators need to start up.
2. Reset the temperature values to the nominal values again (also refer to the circuit diagram).
3. Noticeably increase the temperature set for the switching cabinet heating (4) at the thermostat (1) by turning the adjustment disk.

**⚠ CAUTION The heating will become very hot. Do not touch.**

4. Wait a while, then check the heat radiation of the heating units.
5. Reset the temperature value to the nominal value again (also refer to the circuit diagram).

### 6.20.1.5 Checking the function of the protection elements and settings

**Directive:**

1. Calibrate the parameter values of the components with the parameter values specified in the circuit diagram.

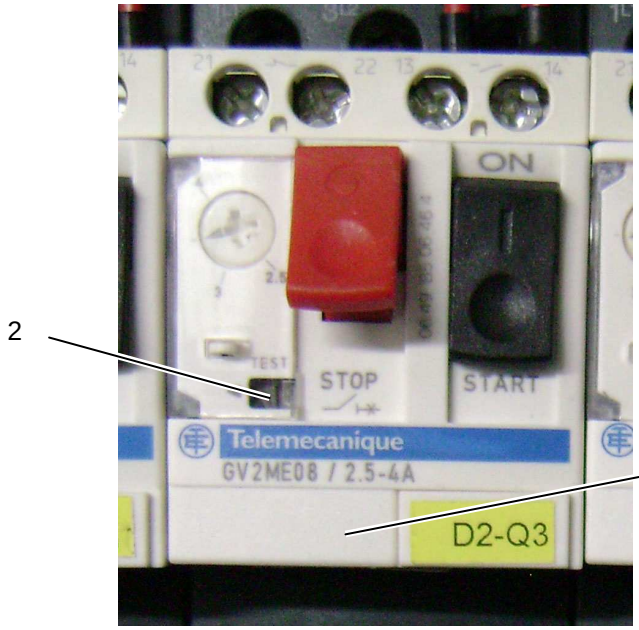



Fig. 6.20.1.5 – 1 Motor-circuit switch

2. Check the function of the motor-circuit switch (1) by triggering the TEST switch (2).
3. Reset the motor-circuit switch to START.
4. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

### 6.20.1.6 Checking the sensor system

**Directive:**

**⚠ WARNING Activate the EMERGENCY STOP pushbutton in hazardous situations, to protect against restarts of the wind turbine during maintenance work, or to test the function of the EMERGENCY STOP pushbutton only (ref. operating manual for a description of the function of the EMERGENCY STOP pushbuttons).**

**EMERGENCY STOP pushbutton at portable switching unit**


Fig. 6.20.1.6 – 1 Portable switching unit

1. Activate the EMERGENCY STOP pushbutton (2) at the portable switching unit (1).


Fig. 6.20.1.6 – 2 REguard Monitoring

**Note:** The safety chain must trigger brake program 200. The green control lamp (3) to the right of "FB emergency stop nacel." needs to turn on in the display.

2. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.
3. Turn the EMERGENCY STOP pushbutton back out.
4. Document the result of the test in the service booklet.

**Emergency stop pushbutton at the top box**

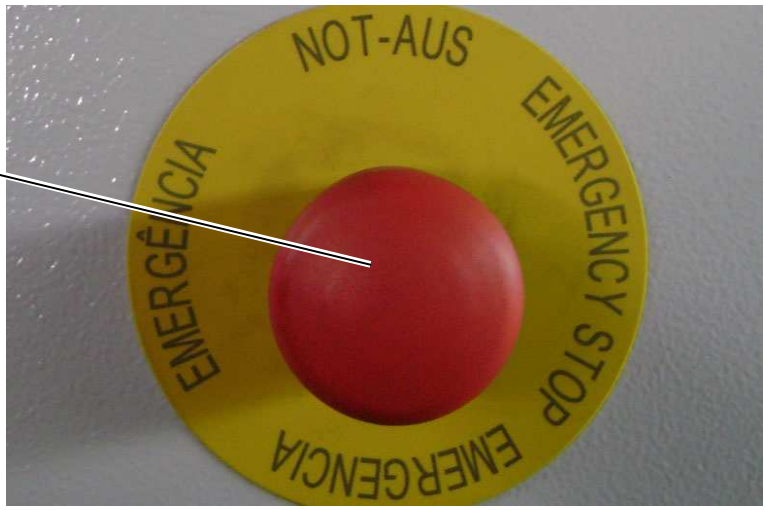



Fig. 6.20.1.6 – 3 Emergency stop pushbutton at the top box

5. Activate the EMERGENCY STOP pushbutton (4) at the top box.


Fig. 6.20.1.6 – 4 REguard Monitoring

**Note:** The safety chain must trigger brake program 200. The green control lamp (5) to the right of "FB emergency stop TopBox" needs to turn on in the display.

6. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.
7. Turn the EMERGENCY STOP pushbutton back out.
8. Document the result of the test in the service booklet.

### Testing the vibration switch

Fig. 6.20.1.6 – 5 Hatch to the section below the machine base

(Floor plate in the coupling area has already been removed)

**⚠ CAUTION Risk of head injuries. Wear a bump cap.**

9. Release the floor plate and put it to the side.

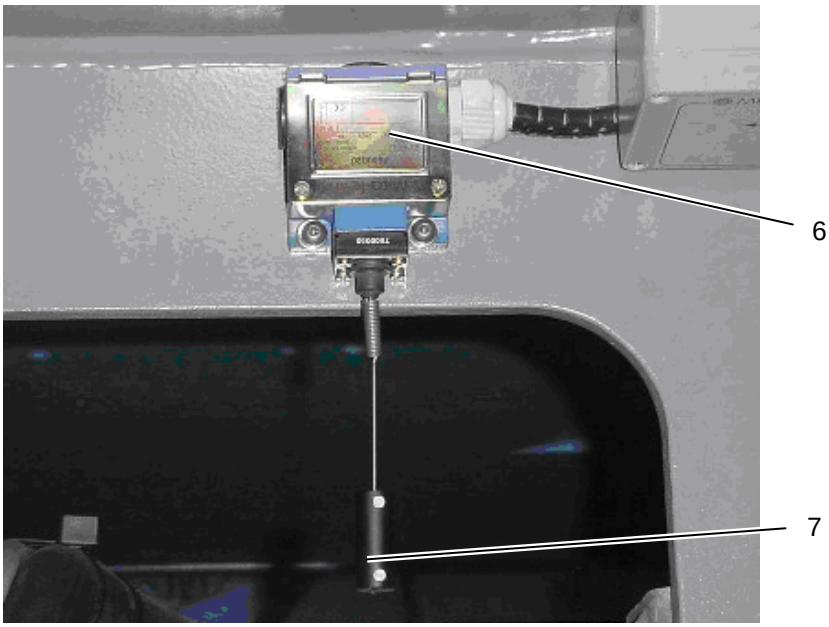



Fig. 6.20.1.6 – 6 Vibration switch

10. Trigger the vibration switch (6) by moving the weight (7).

**Note:** The safety chain must trigger brake program 200.

11. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.

12. Document the result of the test in the service booklet.

**Note:** Perform maintenance section 6.20.2.2 "Checking the oscillation sensor at the machine base" and 6.20.2.3 "Checking the vibration switch at the machine base" immediately afterwards.

13. Tighten the floor plate again.

**Testing the overspeed switch rotor**

Ref. chapter 6.20.1.3 "Testing the function of the speed monitoring system".

**Testing the overspeed switch generator**

Ref. chapter 6.20.1.3 "Testing the function of the speed monitoring system".

**Inspecting the self test**


Fig. 6.20.1.6 – 7 RESET pushbutton at the top box

14. Activate the RESET pushbutton (8) at the top box.

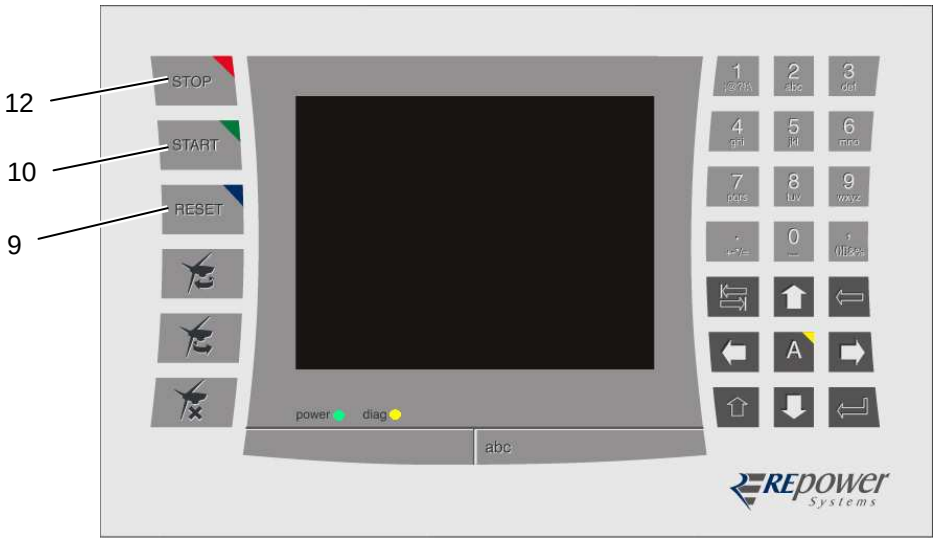



Fig. 6.20.1.6 – 8 Panel of the REguard Control B

15. Select RESET (9) at the panel of the REguard Control B.
16. After that, select START (10) at the panel of the REguard Control B. "System OK" will be displayed on the display after the successful self test.
17. After that, stop the wind turbine again by pushing the STOP button (11).

## 6.20.2 Sensors

### 6.20.2.1 Checking the oscillation sensor at the gearbox support

**Required tools / operating and auxiliary means**

- Ratchet
- No. 10 box nut

**Directive:**

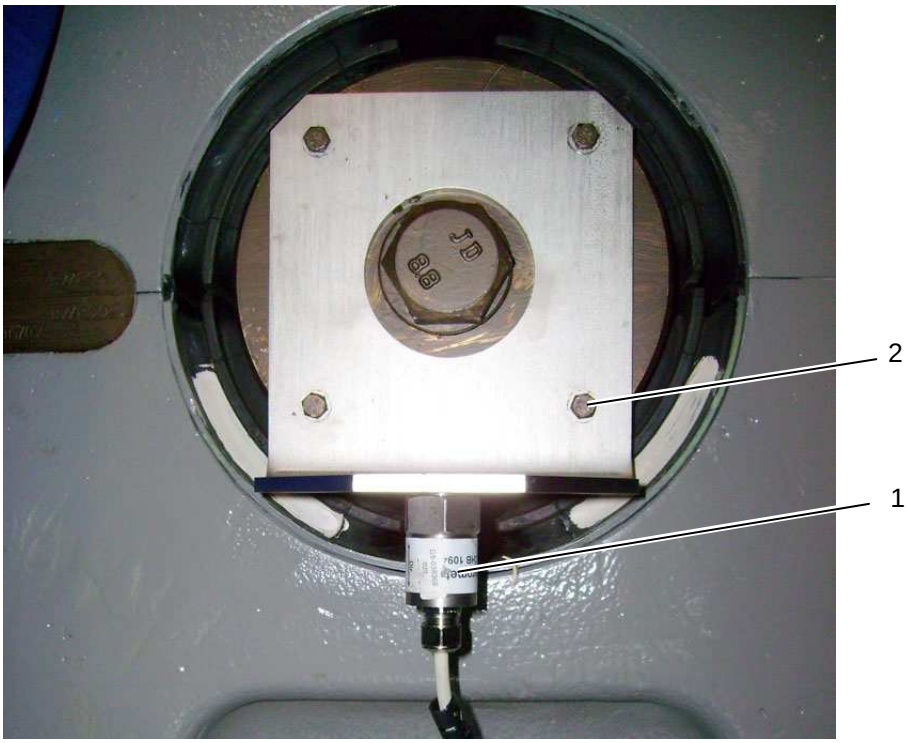



Fig. 6.20.2.1 – 1 Oscillation sensor at the gearbox support

1. Re-tighten the screw connection (2) of the mount of the oscillation sensor (1).
2. Check the oscillation sensor (1) for a tight fit.
3. Check the cable connections (1) for their tight fit and damage.

### 6.20.2.2 Checking the oscillation sensor at the machine base

**Required tools / operating and auxiliary means**

- Flat-headed screwdriver
- Flashlight

**Directive:**

**Note:** Perform this maintenance section together with 6.20.1.6 "Checking the vibration switch".


Fig. 6.20.2.2 – 1 Oscillation sensor at the machine base

1. Manually tighten the screw connection (2) of the oscillation sensor (1) at the machine base (3).
2. Perform a visual inspection of the electrical connection.
3. Check the cable connections for their tight fit and damage.
4. Activate brake program 200 and check the display contents.
5. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B

**Note:** Perform maintenance section 6.20.2.3 "Checking the vibration switch at the machine base" immediately afterwards.

### 6.20.2.3 Checking the vibration switch at the machine base

**Required tools / operating and auxiliary means**

- Flat-headed screwdriver
- Flashlight

**Directive:**

**Note:** Perform this maintenance section following 6.20.2.2 "Checking the oscillation sensor at the machine base".


Fig. 6.20.2.3 – 1 Vibration switch at the machine base

1. Manually tighten the screw connections (2) of the vibration switch (1) at the machine base (4).
2. Perform a visual inspection of the electrical connection.
3. Check the cable connections for their tight fit and damage.
4. Check the attachment of the weight (3).
5. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B

## 6.20.3 Inspecting the shadow cast module

**Directive:**


Fig. 6.20.3 – 1 Switching cabinet of the shadow cast module

**Note:** The switching cabinet (1) of the shadow cast module is installed in the tower base of a single wind turbine of the entire wind farm. A manual is located at the switching cabinet of the shadow cast module.

**NOTICE** **Never remove the face plate of the switching cabinet, otherwise all warranty claims will be void!**

1. Check the time (always use winter time!) only if the shadow cast module has not been equipped with a DCF module.


Fig. 6.20.3 – 2 Sensor of the shadow cast module

**Note:** The sensors (2) of the shadow cast module are directly attached to the tower, in particular at a height of approximately 2.5 m.

**⚠ CAUTION** **Risk of fall. Ensure the safe placement of the step-ladder.**

2. Carefully clean the sensor housing cover with a soft and moist cloth.

## 6.20.4 Inspecting the cables

**Directive:**

**DANGER Risk of life due to fall: Never access the deck crane area while the crane hatch is open. Never subject the crane hatch to a load exceeding 330 lb (150 kg) on an area of 7.8 in. x 0.78 in. (0,2m x 0,2m).**

**CAUTION Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform. Wear protective equipment and descend with care in order to avoid injuries.**

1. Inspect all cables which have not been checked yet in the context of the individual component inspection as well as their arrangement in the nacelle.
2. Look for damage, resolve any damage if possible, e.g. by fitting a repair collar.

**NOTICE If cable insulation has broken, repairs are no longer permitted. These cables must be replaced. Inform the service control room and obtain additional information.**

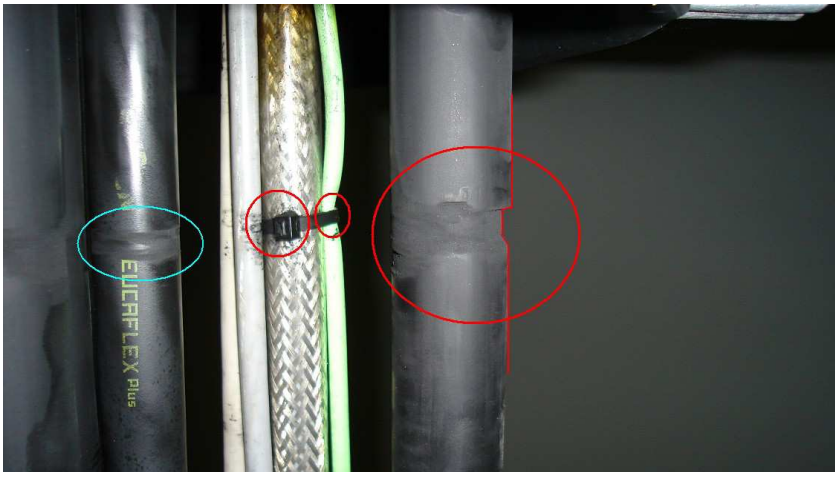



Fig. 6.20.4 – 1 Pictures of possible damage

## 6.20.5 Inspecting the suspension and attachment of the cables

**Directive:**

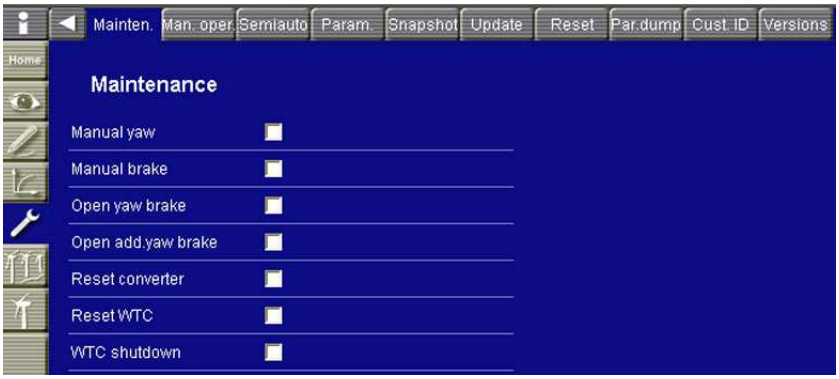



Fig. 6.20.5 – 1 REguard Monitoring

1. REguard Monitoring: select Maintenance menu → Maintenance → Maintenance; activate „Manual yaw“ and inform other service personnel to that effect (ref. operating manual).

**⚠ DANGER Ensure that nobody is present in the range of the yaw drives during movements of the yaw bearing.**

2. Manually move the yaw bearing via the panel of the REguard Control B with the buttons or at the top box to the angle of twist 0°(2) and stop it with .
3. Reselect "Manual yaw" to deactivate it again:

Fig. 6.20.5 – 2 Cables in the upper tower segment

4. Inspect the suspension and the attachment of the cables.

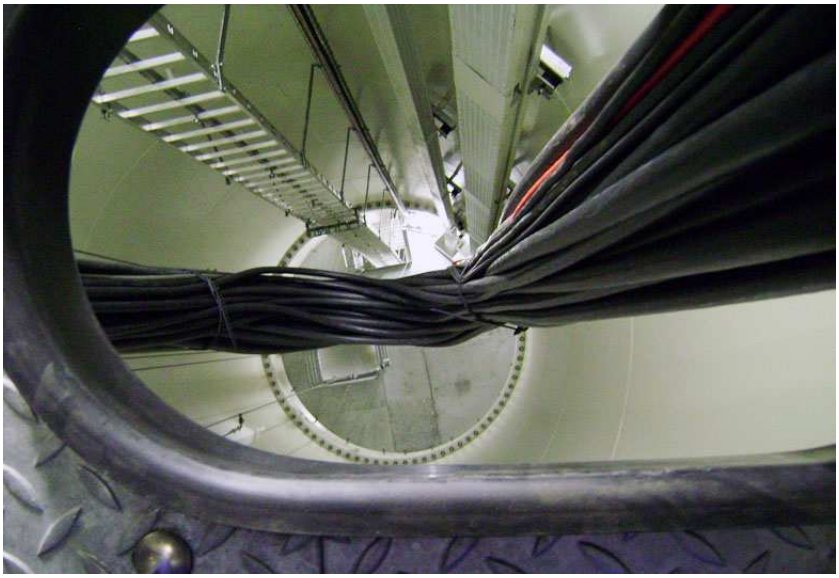


Fig. 6.20.5 – 3 Free-hanging cables

5. Check that the cable strand is untwisted at the 0° angle of twist.

## 6.20.6 Inspecting the nacelle lighting

**Directive:**

**⚠ DANGER Risk of life due to fall: Never access the deck crane area while the crane hatch is open. Never subject the crane hatch to a load exceeding 330 lb (150 kg) on an area of 7.8 in. x 0.78 in. (0.2m x 0.2m).**

**⚠ CAUTION Risk of fall while descending into the yaw area. The ladder to the yaw area does not reach to the platform. Wear protective equipment and descend with care in order to avoid injuries.**

1. Check all lamps of the nacelle.
2. Replace defective lighting means.

## 6.20.7 Inspecting the fire extinguishers in the nacelle

**Directive:**

**Note:** Fire extinguishers need to be inspected by an authorized person every two years. Two fire extinguishers are located in the nacelle.


Fig. 6.20.7 -1 Fire extinguishers

1. Use the data on the fire extinguishers (1) to determine when the next inspection of the fire extinguishers will need to be performed.
2. Enter the determined date in the service booklet.
3. Perform a visual inspection of the condition of the fire extinguishers.
4. Document complaints in the service booklet.

## 6.20.8 Inspecting the first aid kit in the nacelle

**Directive:**


Fig. 6.20.8 -1 First aid kit

1. Check the first aid kit by means of the packing slip in the first aid kit for completeness.
2. Check the expiration dates of the contents.
3. Document complaints in the service booklet.

## 6.20.9 Inspecting the lifting / rescue device

**Directive:**


Fig. 6.20.9 -1 Rescue device

1. Check the box (1) of the rescue device for damage.
2. Inspect the anti-tamper seal (2).


Fig. 6.20.9 -2 Sticker on the rescue device

3. Compare the date of manufacture (3) with the inspection data (4) and enter it under 6.24.5 in the service booklet.
4. Document complaints in the service booklet.

## 6.20.10 Inspecting the grounding connection of the switching cabinets and the load-bearing beam

**Directive:**


Fig. 6.20.10 – 1 Top box door

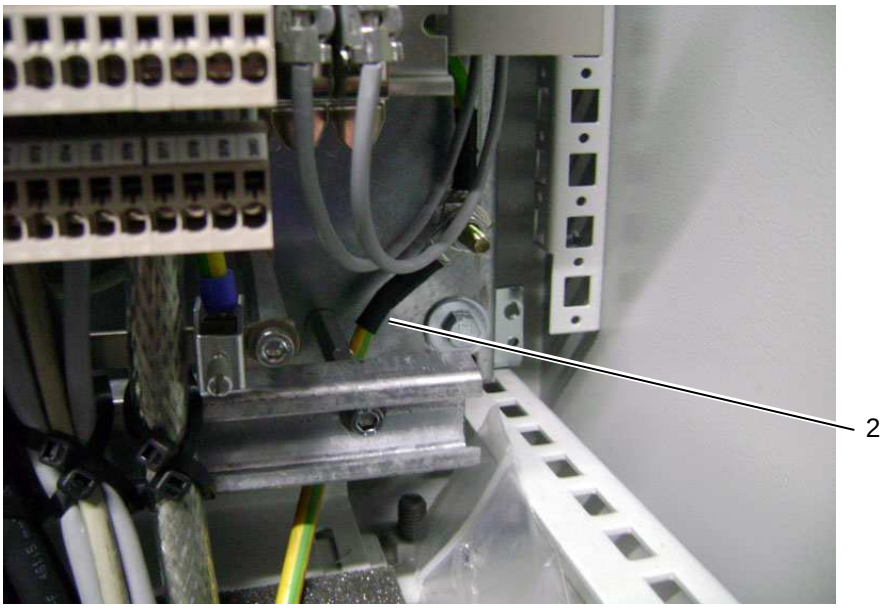



Fig. 6.20.10 – 2 Top box (inside)

**DANGER Risk of life due to fall: Never access the deck crane area while the crane hatch is open. Never subject the crane hatch to a load exceeding 330 lb (150 kg) on an area of 7.8 in. x 0.78 in. (0.2m x 0.2m).**

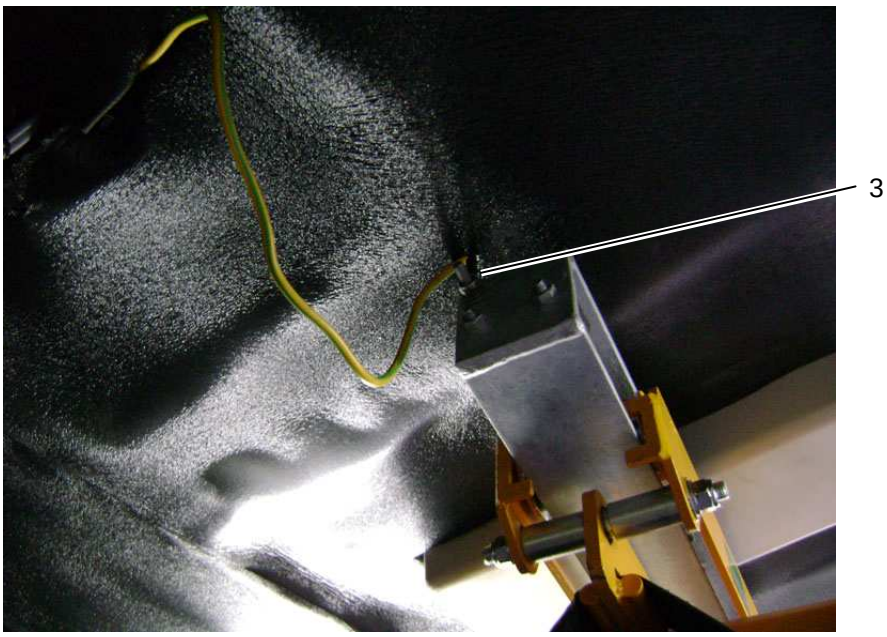



Fig. 6.20.10 – 3 Grounding connection of the load-bearing beam

1. Check the grounding connection of the switching cabinets (2), the switching cabinet doors (1), and the load-bearing beam (3) for a tight fit, tighten if applicable.

## 6.20.11 Checking the condition of the nacelle

**Directive:**

Prior to exiting the nacelle:

Clean the nacelle

2. Remove the trash
3. Secure loose components
4. Close all hatches and covers

**Complete the following steps:**

5. Release the rotor lock (ref. operating manual)
6. Set the parameters of the REguard Control B to standard
7. Release the status codes
8. Set the service switch to "0"
9. Activate the power supply pitch
10. Check whether the deck crane is up and secured
11. Reset the active status and log out

# 6.21 Tower (fittings)

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.21.1 Checking the ladder and runner rail mounts

**Required tools / operating and auxiliary means:**

- Ratchet
- Box nuts (size in accordance with the ladder manufacturer)

**Directive:**

**Note:** Perform this maintenance section together with 6.24.3 "Checking the lighting" and 6.21.8.1 "Performing a visual inspection of the conductor rails".

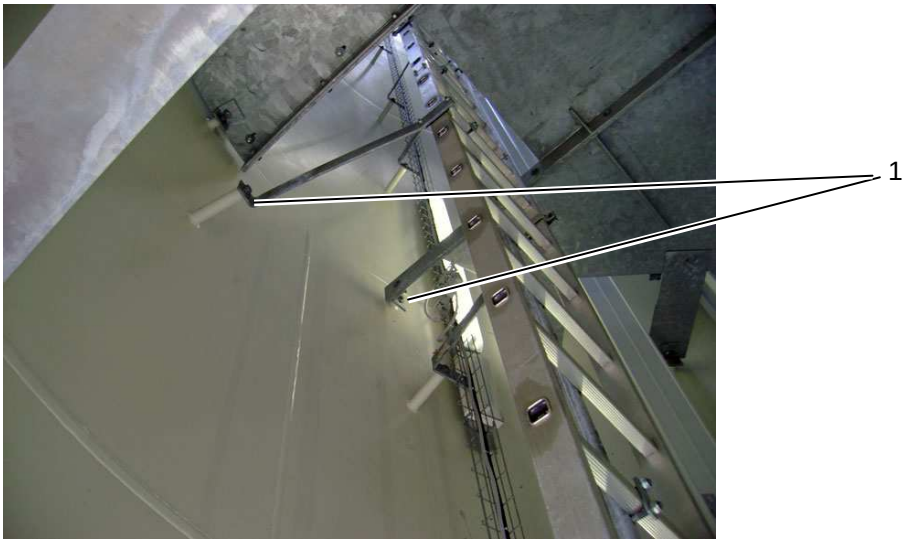



Fig. 6.21.1 – 1 Ladder in the tower

1. Check all screw connections of the ladder (1) under load (e.g. while descending).
2. Tighten loose screw connections.

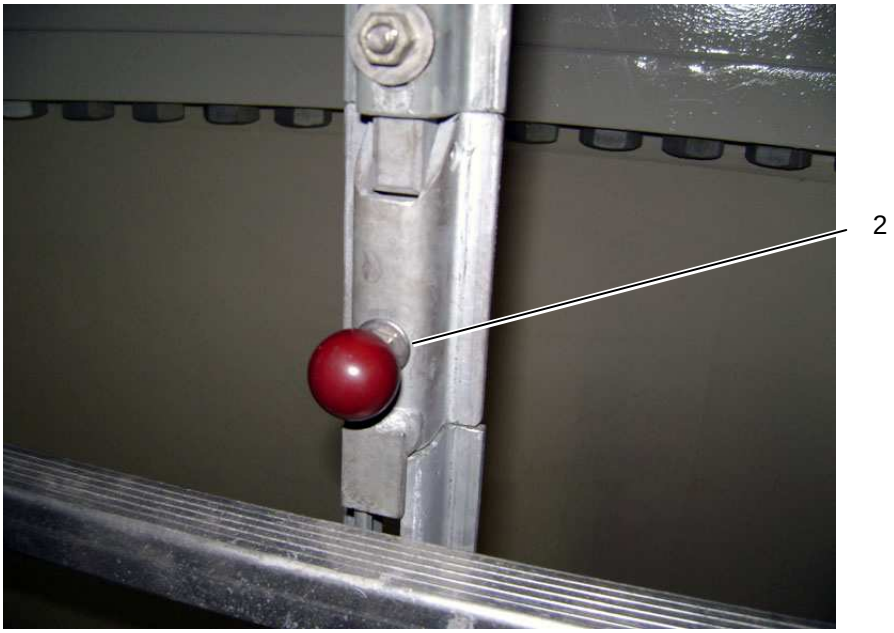



Fig. 6.21.1 – 2 Locking mechanism at the runner rail

3. Check as to whether the locking mechanism (2) engages properly

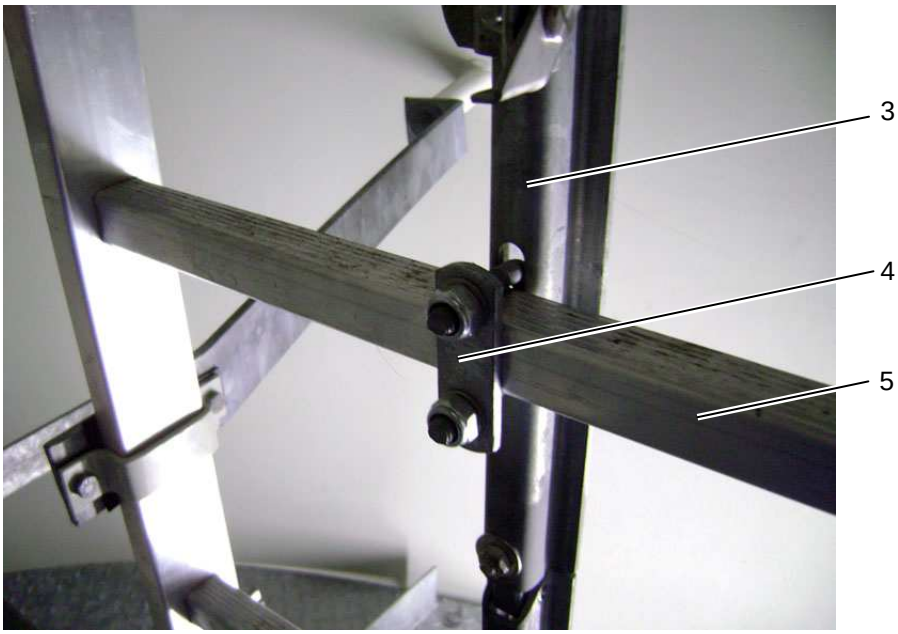



Fig. 6.21.1 – 3 Attachment of the runner rail

4. Ensure that two meeting runner rail segments (3) are secured by means of brackets (4) at the closest ladder rung (5).

## 6.21.2 Checking cables and lines

**Directive:**

1. Visually inspect all cables and lines in the tower for the proper arrangement and damage.
2. Document damage in the service booklet.

Examples:

Fig. 6.21.2 – 1 Cable in the tower

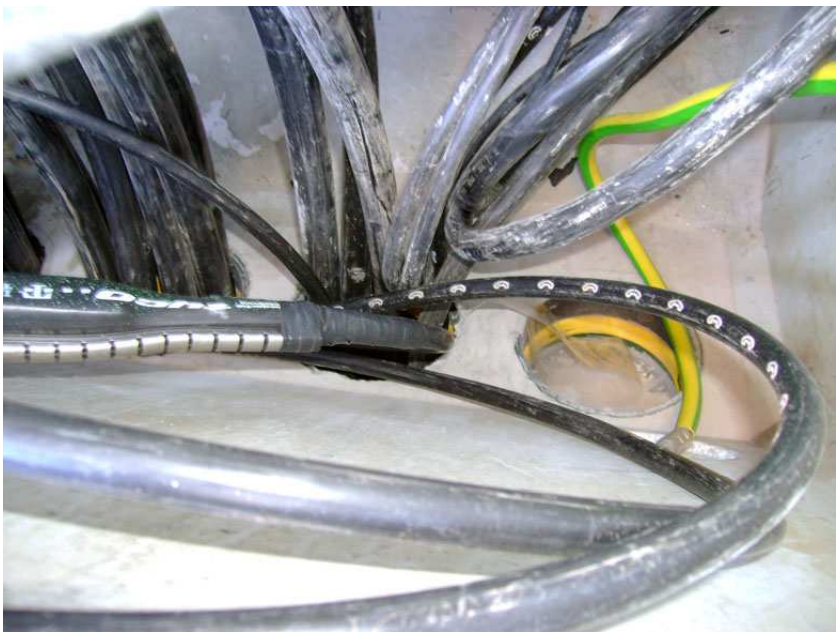


Fig. 6.21.2 – 2 Cable in the tower base

Fig. 6.21.2 -3 Grounding cable in the tower base

## 6.21.3 Checking the lighting

The inspection of the interior lighting is described in 6.24.3 "Checking the lighting".

The inspection of the emergency lighting is described in 6.24.4 "Checking the emergency lighting".

**Directive for checking the exterior lighting:**

**⚠ CAUTION Risk of fall. Ensure the safe placement of the step-ladder.**


Fig. 6.21.3 – 1 Outside lamp

1. Cover the dimming sensor (2) of the exterior lighting (1). The exterior lighting (1) needs to switch on.
2. Replace defective lighting means.

## 6.21.4 Checking the ladder and the platform for soiling

**Directive:**

**Note:** Perform this maintenance section together with 6.21.1 "Checking the ladder and runner rail mounts".


Fig. 6.21.4 – 1 Ladder

1. Check the ladder (1) and the platforms (2) at the end of a tower segment for soiling.
2. Remove soilings.
3. Remove grease soilings with a degreasing cleaning agent and cloths.
4. Dispose of soiled cloths in the proper manner.

## 6.21.5 Checking the door, the door lock, and the hinges

**Directive:**

**Note:** Perform this maintenance section together with 6.21.7 "Checking the door filter mat".

Fig. 6.21.5 – 1 Door and door lock (example 1)

Fig. 6.21.5 – 2 Door lock (example 2)

1. Check the ease of movement of the door.
2. Check whether the door seal rests against the entire door area.
3. Lubricate and/or adjust the hinges if applicable.
4. Check whether the door lock closes in an easy and reliable manner, oil if necessary.
5. Document defects in the service booklet.

## 6.21.6 Documenting the inspection date of the harness

**Directive:**

Fig. 6.21.6 – 1 Harness (examples)

Fig. 6.21.6 – 2 Holding rope (example)

Fig. 6.21.6 – 3 Fall absorber (example)

1. Check for damage. Enter the inspection date (on the back of the harness) in the context of maintenance section 6.24.25 "Entering inspection data of the safety mechanisms in the service booklet".
2. Harnesses that no longer meet the requirements need to be disabled, e.g. by cutting the belts.
3. Document defects in the service booklet.

## 6.21.7 Checking the door filter mat

**Directive:**

**Note:** Perform this maintenance section together with 6.21.5 "Checking the door, the door lock, and the hinges".


Fig. 6.21.7 – 1 Door (example 1)

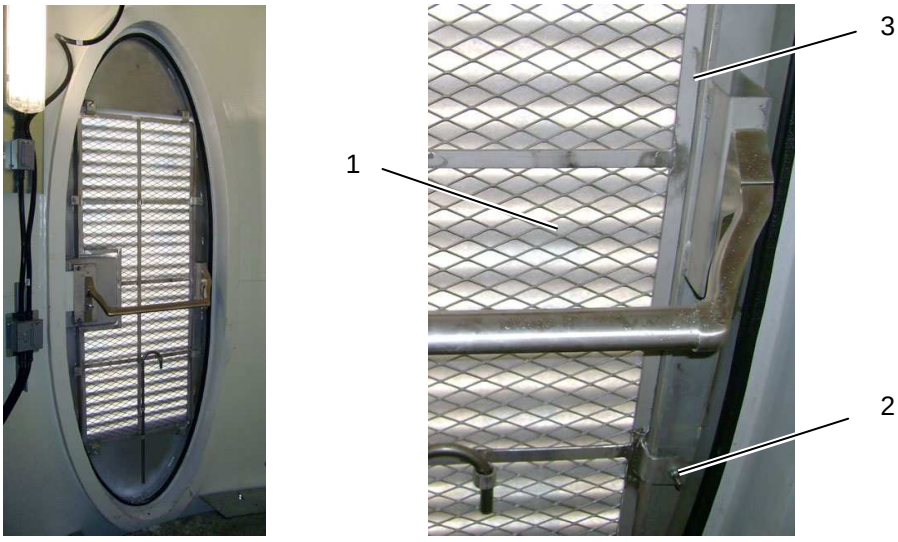



Fig. 6.21.7 – 1 Door (example 2)

1. Check the door filter mat (1).
2. In case of damage, release the screws (2) of the frame (3).
3. Trim a new door filter mat to size and place it in the frame.
4. Re-attach the frame to the door.

## 6.21.8 Rail system

### 6.21.8.1 Performing a visual inspection

**Directive:**

**Note:** Perform this maintenance section together with 6.21.1 "Checking the ladder and runner rail mounts" and 6.24.3 "Checking the lighting".


Fig. 6.21.8.1 – 1 Conductor rails

1. Check the entire length of the conductor rails (1) for noticeable problems, deformations, discolorations.

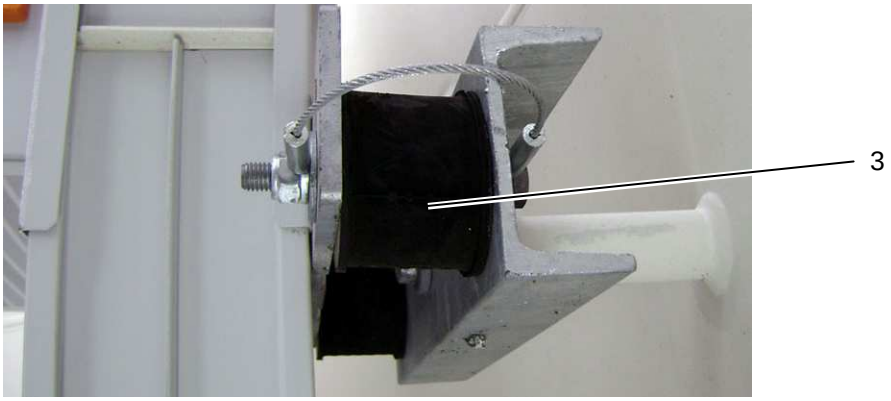



Fig. 6.21.8.1 – 2 Connection between the conductor rail and the tower

2. Perform a visual inspection of the elastomer bearings (3) for cracks, strippings, and other noticeable problems.
3. Visually inspect the grounding of the conductor rails (2).
4. Document defects in the service booklet.

### 6.21.8.2 Measuring the insulation resistance of the rotor rail incl. the power cables

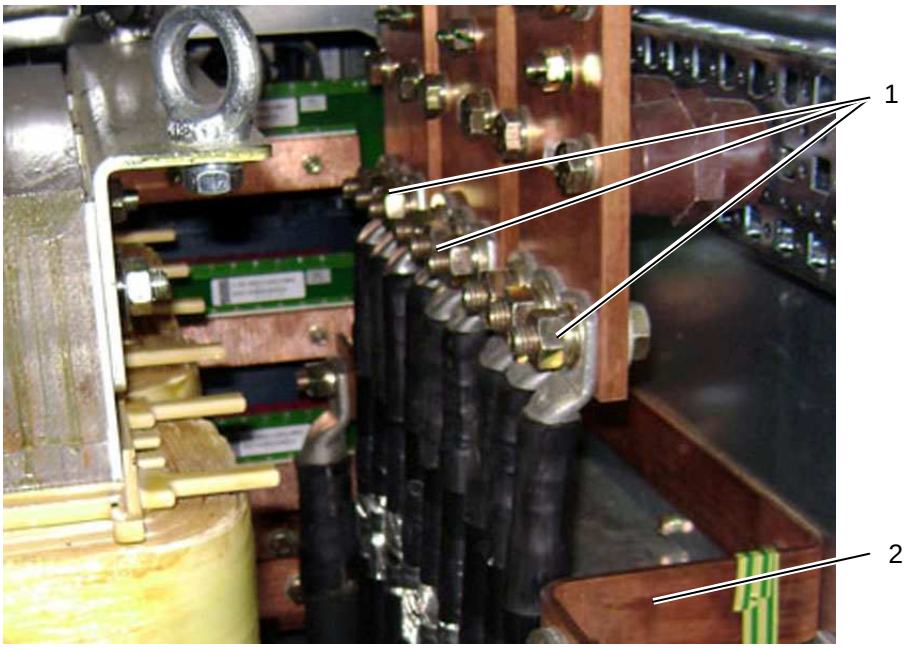



Fig. 6.21.8.2 – 1 Rotor connections in the converter cabinet

**NOTICE** **The lines need to be disconnected in the rotor connection cabinet in the nacelle and in the converter cabinet in the tower base prior to the measurement!**

1. Set the range selection switch of the testing device Unitest Telaris to a testing range of 1000 V.
2. Connect the black testing tip to PE (2).
3. Connect the red testing tip to an individual line (1).
4. Activate the testing device Unitest Telaris by pushing the "Start" button and start the testing procedure.
5. Switch the line (1) and restart the testing device Unitest Telaris by means of the "Start" button.
6. Document the test results in the service booklet.
7. Reconnect the lines after the measurements (observe the tightening torque).

### 6.21.8.3 Measuring the insulation resistance of the stator rail incl. the power cables


Fig. 6.21.8.3 – 1 Insulation measurement of the stator lines

**NOTICE** **The lines need to be disconnected in the stator connection cabinet in the nacelle prior to the measurement! The circuit breakers need to be removed in the tower base.**

1. Set the range selection switch of the testing device Unitest Telaris (fig. 3.4.2.1, 1) to a testing range of 1000 V.
2. Connect the black testing tip (1) to PE.
3. Connect the red testing tip (2) to an individual line.
4. Activate the testing device Unitest Telaris (3) by pushing the "Start" button and start the testing procedure.
5. Switch the line and restart the testing device Unitest Telaris by means of the "Start" button.
6. Document the test results in the service booklet.

## 6.21.9 Checking the power cable rotor terminal box screws (tower head)

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 10 box nut
- No. 18 ring spanner
- Torque wrench with extension
- No. 19 box nut

**Directive:**

**Note:** Perform this maintenance section together with 6.21.13 "Checking the attachment of the power cables" and 6.21.14 "Checking the cable connections".


Fig. 6.21.9 – 1 Rotor (1) and stator terminal box (2)

1. Release the cover of the rotor terminal box (1) and put the cover to the side.
2. Verify that power is disconnected.


Fig. 6.21.9 – 2 Rotor terminal box

3. Check all screws (3) of the rotor power cables (4) with a torque as detailed in the service booklet.
4. Replace the cover of the rotor terminal box and tighten it.

## 6.21.10 Checking the power cable stator terminal box screws (tower head)

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 10 box nut
- No. 18 ring spanner
- Torque wrench with extension
- No. 19 / 24 box nut

**Directive:**

**Note:** Perform this maintenance section together with 6.21.13 "Checking the attachment of the power cables" and 6.21.14 "Checking the cable connections".

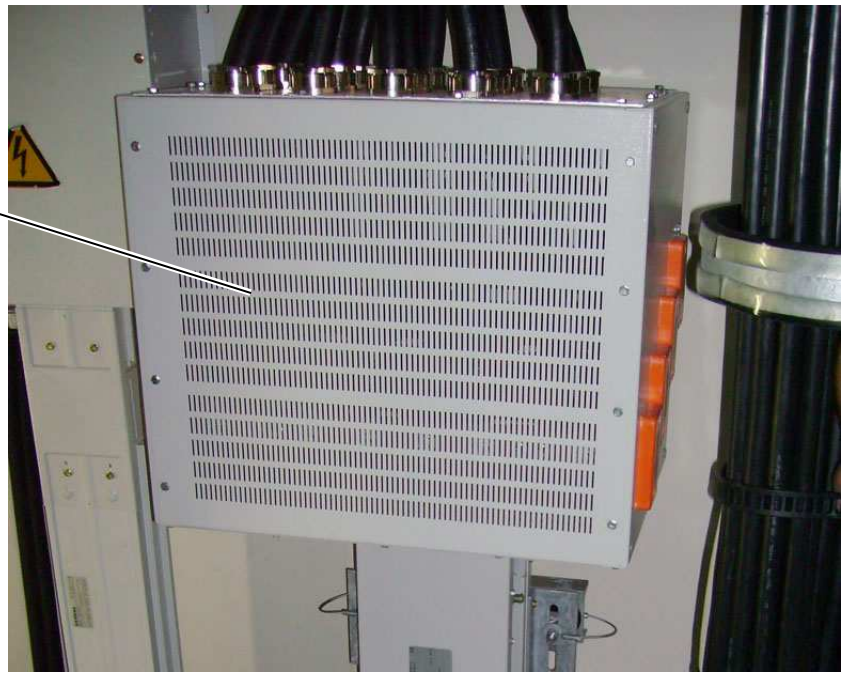



Fig. 6.21.10 – 1 Stator terminal box

1. Release the cover of the stator terminal box (1) and put the cover to the side.
2. Verify that power is disconnected


Fig. 6.21.10 – 2 Stator power cable

3. Check all screws (2) of the power cables (3) with a torque as detailed in the service booklet.
4. Replace the cover of the stator terminal box and tighten it.

## 6.21.11 Checking the power cable rotor terminal box screws (tower base)

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 10 box nut
- No. 18 ring spanner
- Torque wrench with extension
- No. 19 box nut

**Directive:**

**⚠ CAUTION Risk of fall. Ensure the safe placement of the step-ladder. Keep both feet on the step-ladder while working.**

**Note:** Perform this maintenance section together with 6.21.13 "Checking the attachment of the power cables" and 6.21.14 "Checking the cable connections".


Fig. 6.21.11 – 1 Rotor (1) and stator terminal box (2)

1. Release the cover of the rotor terminal box (1) and put the cover to the side.
2. Verify that power is disconnected

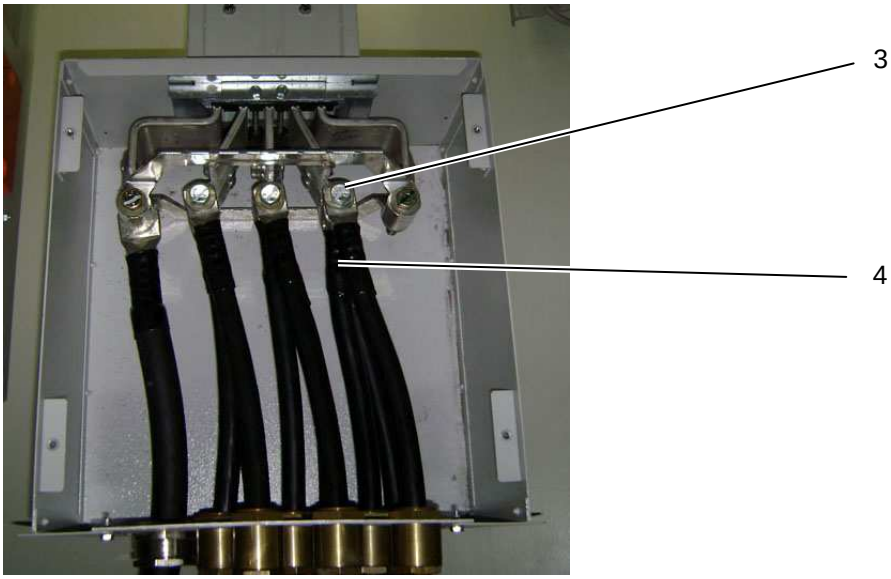



Fig. 6.21.11 – 2 Rotor power cable

3. Check all screws (3) of the power cables (4) with a torque as detailed in the service booklet.
4. Replace the cover of the rotor terminal box and tighten it.

## 6.21.12 Checking the power cable rotor terminal box screws (tower base)

**Required tools / operating and auxiliary means:**

- Ratchet with extension
- No. 10 box nut
- No. 18 ring spanner
- Torque wrench with extension
- No. 19 / 24 box nut

**Directive:**

**⚠ CAUTION Risk of fall. Ensure the safe placement of the step-ladder. Keep both feet on the step-ladder while working.**

**Note:** Perform this maintenance section together with 6.21.13 "Checking the attachment of the power cables" and 6.21.14 "Checking the cable connections".


Fig. 6.21.12 – 1 Rotor (1) and stator terminal box (2)

1. Release the cover of the stator terminal box (2) and put the cover to the side.
2. Verify that power is disconnected


Fig. 6.21.12 – 2 Stator power cable

3. Check all screws (3) of the power cables (4) with a torque as detailed in the service booklet.
4. Replace the cover of the stator terminal box and tighten it.

## 6.21.13 Checking the attachment of the power cables

**Directive:**

**⚠ CAUTION Risk of fall. Ensure the safe placement of the step-ladder. Keep both feet on the step-ladder while working.**

**Note.** Perform this maintenance section together with 6.21.9 through 6.21.12 "Checking the power cables" and 6.21.14 "Checking the cable connections".

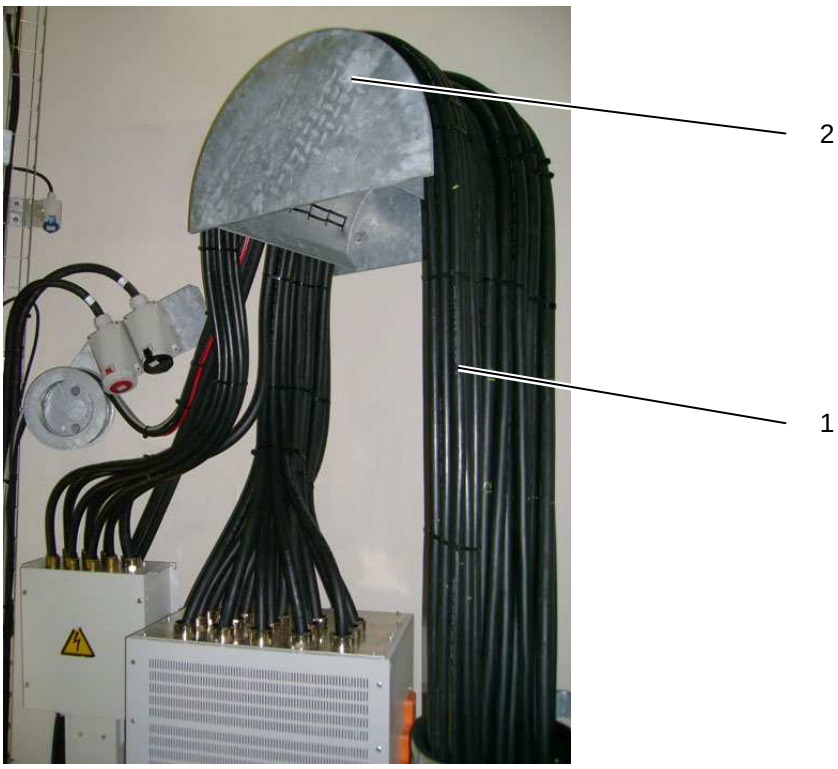



Fig. 6.21.13 – 1 Suspension of the power cables in the tower head

1. Check the mounts between the power cables (1).


Fig. 6.21.13 – 2 Cable mount

2. Check the attachment of the power cables (1) at the cable mount (2).


Fig. 6.21.13 – 3 Power cable in the tower base

3. Check the attachment of the power cables (3) in the tower base.

Fig. 6.21.13 – 4 Power cable in the foundation area

4. Check the attachment of the power cables in the foundation area.

## 6.21.14 Checking the cable connections

**Required tools / operating and auxiliary means:**

- Channel-lock pliers

**Directive:**

**⚠ CAUTION Risk of fall. Ensure the safe placement of the step-ladder. Keep both feet on the step-ladder while working.**

**Note.** Perform this maintenance section together with 6.21.9 through 6.21.12 "Checking the power cables" and 6.21.13 "Checking the attachment of the power cables".

Fig. 6.21.14 – 1 Cable connections rotor and stator terminal box in the tower head

Fig. 6.21.14 – 2 Cable connections rotor and stator terminal box in the tower base

1. Check the cable connections at the rotor and stator terminal boxes in the tower head and the tower base for a tight fit.
2. Tighten the cable connections if applicable.

## 6.21.15 Checking the tower grounding connections

**Directive:**

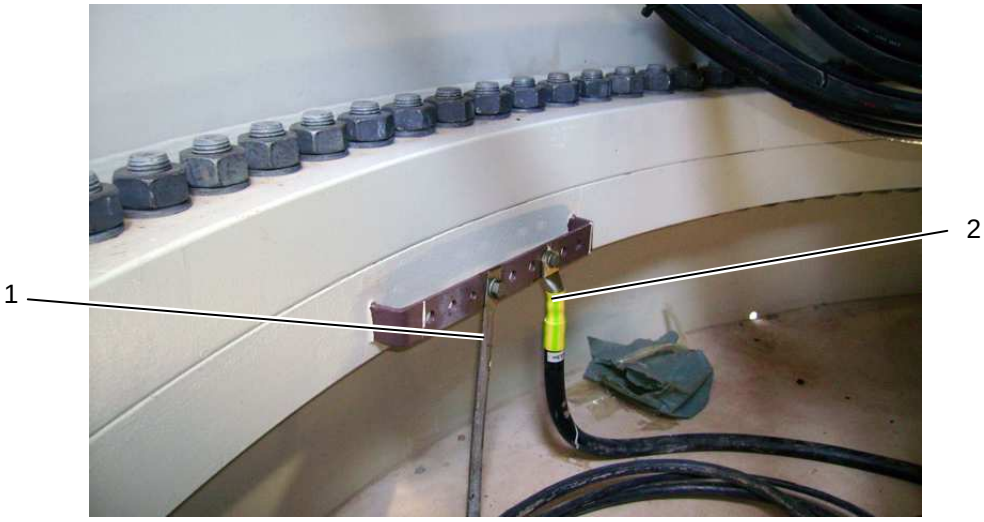



Fig. 6.21.15 – 1 Foundation and tower grounding connection

1. Check the grounding connection (1) of the foundation for a tight fit and damage.
2. Check the tower grounding connection (2) for a tight fit and damage.
3. Tighten loose connections.
4. Document damage in the service booklet.

## 6.21.16 Elevator systems and ascent supports

### 6.21.16.1 Elevator systems

**Required tools / operating and auxiliary means:**

- Graphite-free grease
- Brush
- Ring spanner

**Directive:**


Fig. 6.21.16.1 – 1 Elevator systems (left: manufacturer Hailo; right PowerClimber)

**DANGER Risk of life due to fall. Elevator systems may only be operated in the proper manner following instructions.**

**Note:** Tests may only be performed by individuals that possess the applicable proficiency certificate issued by the company which manufactured the elevator system.

The following activities may be realized by service personnel:

1. Check the motor and the gearbox for unusual noise.
2. Test the block stop function.
3. Test the emergency descent.

**Note:** The manufacturer documents are available in the elevator system.


Fig. 6.21.16.1 – 2 Ropes

**DANGER** **Risk of life due to fall. Ensure personal protection (ref. chapter 5) for all work.**

**CAUTION** **Risk of injury due to points of rupture at the ropes. Do not touch the ropes with the bare hands. Use the brush.**

4. Check the ropes (1) for damage.
5. Utilizing a brush, lightly oil the ropes with graphite-free oil.


Fig. 6.21.16.1 – 3 Rope guide

6. Check the screw connections of the rope guide (2)
7. Check for the presence of the notice sign "PPE and rescue device must be carried" at the basket.
8. Document defects in the service booklet. In case of doubt: Shut down the elevator system.

**Note:** The replacement of the drive unit is realized by the manufacturer of individuals authorized by the manufacturer.

## 6.21.16.2 Ascent supports

**Directive:**

**Note:** Tests may only be performed by individuals that possess the applicable proficiency certificate issued by the company which manufactured the elevator system.

**Note:** The manufacturer documentation is available in the wind turbine.

The following activities may be realized by service personnel:

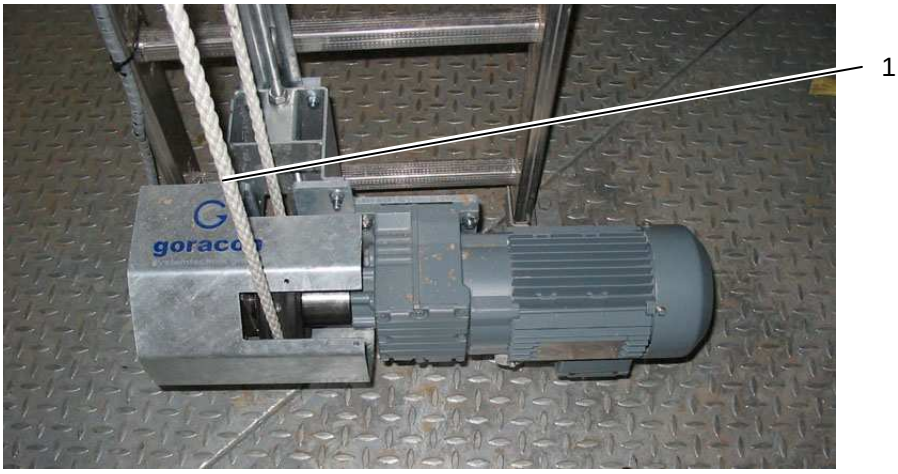



Fig. 6.21.16.2 – 1 Ascent support manufacturer Goracon

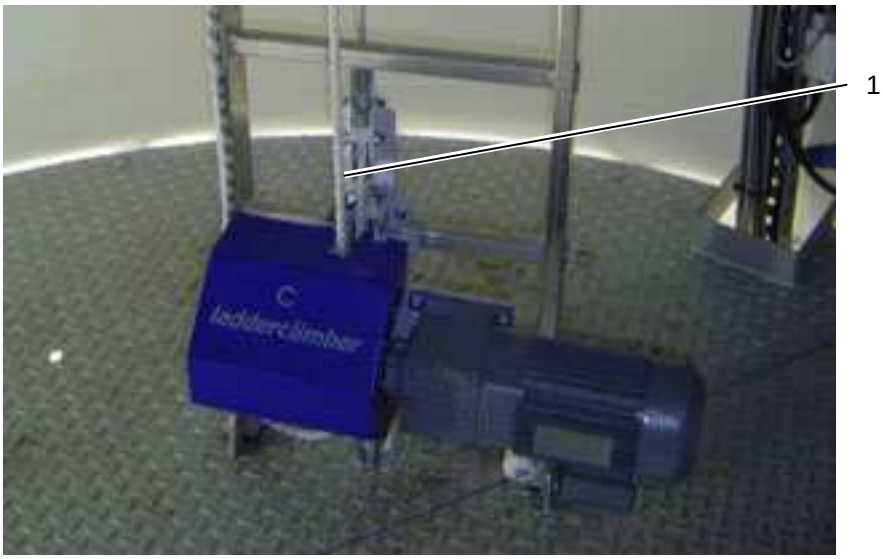



Fig. 6.21.16.2 – 2 Ascent support Ladderclimber by the manufacturer Goracon

1. Check the rope (1) for damage during an empty run; in that context, pay particular attention to the splice point.

**Note:** Perform this test prior to each use of the ascent support.

2. In case of damage: Shut down the ascent support and commission the replacement of the rope.
3. Check for unusual noise of the motor and gearbox during the rope test.
4. Document defects in the service booklet. In case of doubt: Shut down the ascent support.

# 6.22 Tower (hull and flanges)

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.22.1 Checking the welding seams

**Required tools / operating and auxiliary means:**

- Flashlight
- Digital camera

**Directive:**


Fig. 6.22.1 – 1 Tower

1. Perform a visual inspection of all welding seams (1) in the tower. In that context, pay particular attention to paint chippings.
2. Document defects including the tower segment in the service booklet.

## 6.22.2 Checking the flange connections

**Required tools / operating and auxiliary means:**

- Flashlight
- Digital camera

**Directive:**

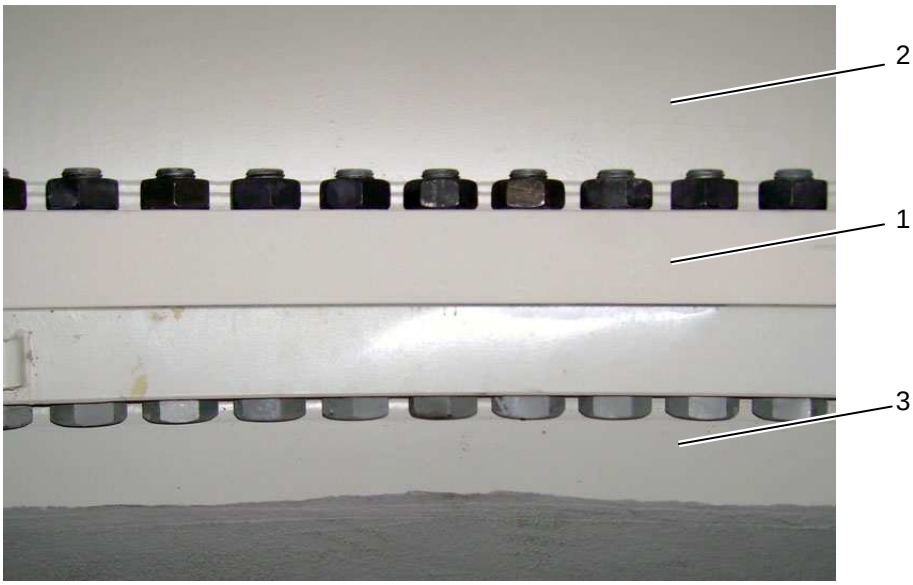



Fig. 6.22.2 – 1 Tower flange

1. Perform a visual inspection of all flange connections (1) of the tower. In that context, check for rust spots and gaps between the flanges.
2. Document defects including the associated tower segments (2) and (3) in the service booklet.

### 6.22.3 Tower nominal height 65 m for MM70

### 6.22.4 Tower nominal height 65 m for MM70

### 6.22.5 Tower nominal height 65 m for MM70

### 6.22.6 Tower nominal height 55 m for MM70

### 6.22.7 Tower nominal height 59 m for MM82

### 6.22.8 Tower nominal height 59 m for MM82

### 6.22.9 Tower nominal height 69 m for MM82

### 6.22.10 Tower nominal height 69 m for MM82

### 6.22.11 Tower nominal height 69 m for MM82

### 6.22.12 Tower nominal height 80 m for MM82

### 6.22.13 Tower nominal height 80 m for MM82

### 6.22.14 Tower nominal height 100 m for MM82

### 6.22.15 Tower nominal height 100 m for MD77, MM82/92

These towers are not relevant for USA.

# 6.22.16 Tower nominal height 262 ft. (80 m); wind zone III; MM92

This tower is not relevant for USA.

# 6.22.17 Tower nominal height 262 ft. (80 m); wind zone III; MM92 (USA)

## 6.22.17.1 Connector flange

**Required tools / operating and auxiliary means:**

- Hydraulic power screwdriver
- No. 70 plug attachment

**Directive:**

**DANGER Hydraulic power screwdrivers operate with an extremely high pressure and very high torque values. Work with hydraulic power screwdrivers may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic power screwdriver. Observe the safety notices by the manufacturer!**

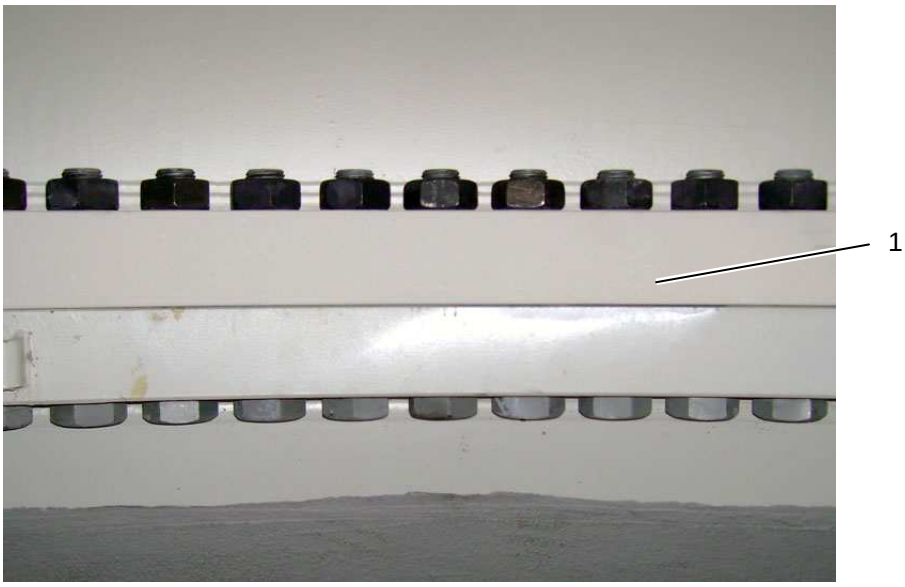



Fig. 6.22.16 – 1 Flange

1. Check all screws of all flanges (1) of the tower by means of the hydraulic power screwdriver with a torque as detailed in the service booklet.

## 6.22.17.2 Foundation flange

**Required tools / operating and auxiliary means:**

- Hydraulic screw tightening mechanism

**Directive:**

**DANGER** **Hydraulic aggregates operate with extremely high pressure. Work with hydraulic tools may only be performed by individuals that have been trained and authorized by the manufacturer of the hydraulic tool. Observe the safety notices by the manufacturer!**


Fig. 6.22.19 – 1 and 2 Anchor bolt at the foundation flange (1)

1. Attach the plug attachment (4) to the anchor bolt (2) and the nut (3).
2. Attach the locknut (5) to the anchor bolt (2).


Fig. 6.22.19 – 3 Tightening the anchor bolt

3. Connect the hydraulic hose (6).

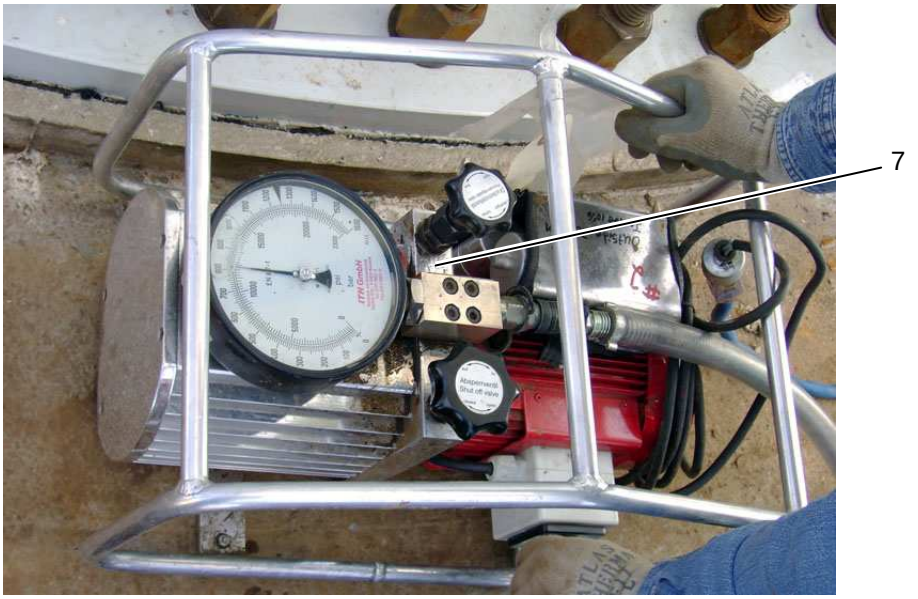



Fig. 6.22.19 – 4 Hydraulic aggregate

4. Activate the hydraulic aggregate (7) and build up the pressure that corresponds to the preload force as detailed in the service booklet.
5. Check the nut of the extended anchor bolt by means of the ratchet and tighten it if required (ref. fig. 6.22.19 – 3).

**NOTICE** **Danger due to loose screw connections. If one of the tested screws is loose, all screw connections of the foundation flange will need to be tested - even if the service booklet specifies a smaller quantity.**

6. Release the pressure at the hydraulic aggregate (7) and deactivate the hydraulic aggregate.

7. Release the nut (5) from the plug attachment (4) and remove the plug attachment.
8. Repeat steps 1, 2, and 4 through 7 at all required anchor bolts on the inside and outside of the tower.
9. Remove the hydraulic hose (6).

## 6.22.18 Tower nominal height 328 ft. (100 m) for MM92

This tower is not relevant for USA.

## 6.22.19 All towers MM92

**Directive:**


Fig. 6.22.18 – 1 Yaw area

1. Perform a visual inspection at the head flange (1). In that context, pay attention to paint chippings at the welding seam

# 6.23 Controller / converter / transformer station


**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.23.1 Checking the function of the heater / ventilator of the converter

**Required tools / operating and auxiliary means:**

- Flat-headed screwdriver

**Directive:**


Fig. 6.23.1 – 1 Sample photographs thermostats

1. Successively modify the parameter values (1) of the individual thermostats (2) in the converter cabinet in order to activate the ventilators and/or the heaters in the converter cabinet.

**⚠ CAUTION Risk of contusions due to rotating system components. Do not reach into rotating system components.**

**⚠ CAUTION Risk of burns due to hot system components. Do not reach into hot system components.**

**NOTICE Restore the correct parameter values of the thermostats after the functional test in order to avoid malfunctions.**

2. Adjust the parameter values of the thermostats in accordance with the list of settings for protective and functional equipment from the circuit diagram of the converter.

## 6.23.2 Not used

## 6.23.3 Maintaining the converter in accordance with the manufacturer instructions

**Directive:**

Ref. manufacturer instructions for the maintenance of the converter

## 6.23.4 Performing a general visual inspection

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

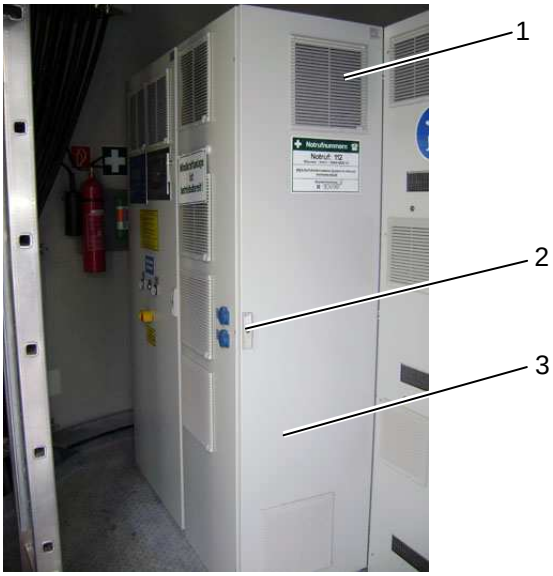



Fig. 6.23.4 – 1 Inspecting the converter cabinet

1. Check the covers (1), locking mechanisms (2), and doors (3) of the converter cabinet for missing components (e.g. screws).

## 6.23.5 Checking the failure current protection

**Directive:**


Fig. 6.23.5 – 1 Failure current protection switch

1. Deactivate the wind turbine.
2. Push the test button (1). The failure current protection switch (6) needs to trigger.
3. Push the lever (3) up. The failure current protection is restored.
4. Push the test button (2). The failure current protection switch (5) needs to trigger.
5. Push the lever (4) up. The failure current protection is restored.
6. Perform steps 2 through 4 for all failure current protection switches at the converter.

**Note:** The wind turbine may now be restarted.

## 6.23.6 Testing the uninterruptible power supply (UPS)

**Directive:**


Fig. 6.23.6 – 1 Testing the UPS

1. Push the test button at the UPS (1) if available (as an alternative, it is also possible to deactivate the grid voltage via the motor circuit switch).
2. Wait approx. 6 minutes.
3. Keep the grid voltage deactivated until the UPS deactivates on its own.
4. Reactivate the grid voltage one minute after the deactivation of the UPS.

**Note:** The wind turbine should automatically start up without interference.

## 6.23.7 Adjusting the voltage measurement

**Directive:**


Fig. 6.23.7 – 1 Transformer unit for the voltage measurement

1. Access the respective Monitoring menu in the REguard Control B and check the values.
2. If the values are incorrect, access the Parameters menu and modify the respective parameters.
3. Re-check the values in the Monitoring menu.
4. Repeat the procedure until the values in the Monitoring menu correspond to the nominal values.

## 6.23.8 Checking the circuit breaker

**Directive:**


Fig. 6.23.8 – 1 Checking the circuit breaker

1. Perform a visual inspection at the circuit breaker (1).
2. Document the readout of the counter for the realized switches (read out the counter (2) directly at the switch).
3. Notify the REpower service in case of noticeable problems (e.g. traces of smoke residue).

## 6.23.9 Checking the power cables rotor (L1 – L3)

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 19 box nut

**Directive:**


Fig. 6.23.9 – 1 Checking the power cables rotor (L1 – L3)

**DANGER Risk of life due to high voltages. Complete the present as well as the following five chapters in direct succession!**

1. Deactivate the wind turbine.
2. Deactivate the voltage at the converter.
3. Open the converter door (rear).
4. Perform a visual inspection of all screw connections (1).
5. Check all screw connections (1) for tightness. To that end, successively check each screw connection with a torque as detailed in the service booklet.
6. Continue with chapter 6.23.10 "Checking the power cable rotor (PE)"

## 6.23.10 Checking the power cable rotor (PE)

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 24 box nut

**Directive:**

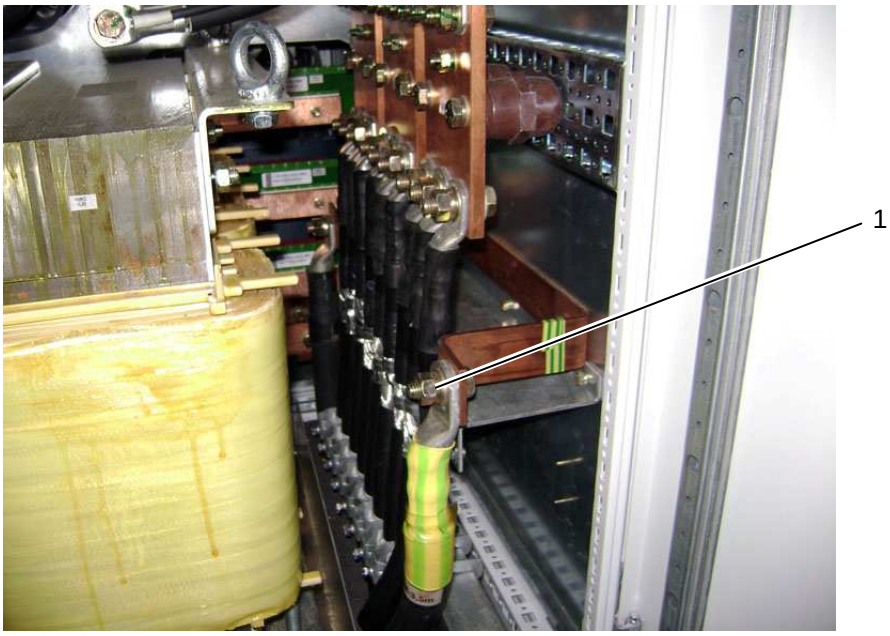



Fig. 6.23.10 – 1 Checking the power cable rotor (PE)

**DANGER Risk of life due to high voltages. It is necessary to start with chapter 6.23.9!**

1. Perform a visual inspection of the screw connection (1).
2. Check the screw connection (1) for tightness. To that end, check the screw connection (1) with a torque wrench as detailed in the service booklet.
3. Close the converter door.
4. Continue with chapter 6.23.11 "Checking the power cables stator (L1 – L3)"

## 6.23.11 Checking the power cables stator (L1 – L3)

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 24 box nut

**Directive:**


Fig. 6.23.11 – 1 Checking the power cables stator (L1 – L3)

**DANGER Risk of life due to high voltages. It is necessary to start with chapter 6.23.9!**

1. Open the converter door (front).
2. Remove the protective grid against touch (already removed here).
3. Perform a visual inspection of all screw connections (1) (rear 3 bus bars).
4. Check all screw connections (1) for tightness. To that end, successively check each screw connection with a torque as detailed in the service booklet.
5. Continue with chapter 6.23.12 "Checking the power cable stator (PE)"

## 6.23.12 Checking the power cable stator (PE)

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 24 box nut

**Directive:**


Fig. 6.23.12 – 1 Checking the power cable stator (PE)

**DANGER Risk of life due to high voltages. It is necessary to start with chapter 6.23.9!**

1. Perform a visual inspection of the screw connection (1).
2. Check the screw connection (1) for tightness. To that end, check the screw connection with a torque as detailed in the service booklet.
3. Continue with chapter 6.23.13 "Checking the transformer cables (L1 – L3)"

## 6.23.13 Checking the transformer cables (L1 – L3)

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 24 box nut

**Directive:**


Fig. 6.23.13 – 1 Checking the transformer cables (L1 – L3)

**DANGER** **Risk of life due to high voltages. It is necessary to start with chapter 6.23.9!**

1. Perform a visual inspection of all screw connections (1) (front 3 bus bars).
2. Check all screw connections (1) for tightness. To that end, successively check each screw connection with a torque as detailed in the service booklet.
3. Continue with chapter 6.23.14 "Checking the transformer cable (PE)"

## 6.23.14 Checking the transformer cable (PE)

**Required tools / operating and auxiliary means:**

- Torque wrench
- No. 24 box nut

**Directive:**


Fig. 6.23.14 – 1 Checking the transformer cable (PE)

**DANGER** **Risk of life due to high voltages. It is necessary to start with chapter 6.23.9!**

1. Perform a visual inspection of the screw connection (1).
2. Check the screw connection (1) for tightness. To that end, check the screw connection with a torque as detailed in the service booklet.
3. Attach the protective grid against touch.

**Note:** The wind turbine may now be restarted.

## 6.23.15 Checking the cable connections (PG or M)

**Directive:**

1. Check the screw connections for a tight fit.

## 6.23.16 Checking the transformer station

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

Fig. 6.23.16 – 1 Checking the transformer station


Fig. 6.23.16 – 2 Checking the transformer station

1. Perform a visual inspection of the transformer station (general condition, ventilator grid, vandalism).
2. Check for cable damage due to small animals (e.g. rats, mice).
3. Check for water in the transformer station.

## 6.23.17 Checking the terminal bars

**Required tools / operating and auxiliary means:**

- Flashlight

**Directive:**

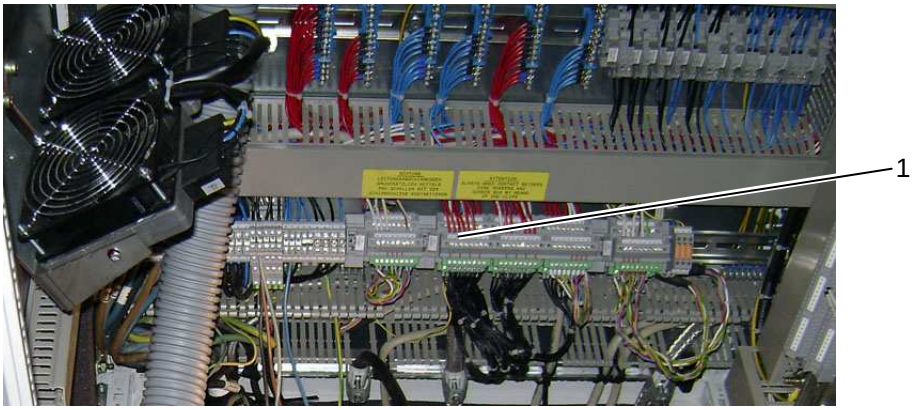



Fig. 6.23.17 – 1 Checking the terminal bars (example converter switching cabinet)

1. Check the cables for a tight fit in the terminal bars, re-tighten if applicable.
2. Perform a visual inspection, e.g. for discolorations.

# 6.24 Safety functions


**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

## 6.24.1 Performing a self test

**Directive:**

The performance of the self test of the control is described in chapter 6.20.1.6 "Checking the sensor system".

## 6.24.2 Checking the EMERGENCY STOP push-button at the tower base

**Directive:**

**⚠ WARNING Activate the EMERGENCY STOP pushbutton in hazardous situations, to protect against restarts of the wind turbine during maintenance work, or to test the function of the EMERGENCY STOP pushbutton only. Refer to the operating manual for a description of the function of the EMERGENCY STOP pushbuttons.**


Fig. 6.24.2 – 1 EMERGENCY STOP pushbutton at the converter switching cabinet

1. Activate the EMERGENCY STOP pushbutton (1) at the converter switching cabinet in the base of the tower.


Fig. 6.24.2 – 2 REguard Monitoring

**Note:** The safety chain must trigger brake program 200. The green control lamp (2) to the right of "FB emergency stop conv." needs to turn on in the display.

2. Turn the EMERGENCY STOP pushbutton back out.
3. Perform a RESET of the safety chain (ref. operating manual); subsequently activate the STOP button at the panel of the REguard control B.
4. Document the result of the test in the service booklet.

## 6.24.3 Checking the lighting

**Directive:**

**Note:** Perform this maintenance section together with 6.21.1 "Checking the ladder / runner rail mounts" and 6.21.8.1 "Performing a visual inspection of the conductor rails".


Fig. 6.24.3 – 1 Tower lighting

1. Activate the lighting in the entrance area of the tower base.
2. Check all lamps (1) of the tower.
3. Replace defective lighting means.

## 6.24.4 Checking the emergency lighting

**Directive:**


Fig. 6.24.4 – 1 Tower lighting

1. Deactivate the power supply in the tower base.
2. Comprehensively check the emergency lighting (1) of the tower.
3. Replace defective lighting means.
4. Reactivate the power supply.

### 6.24.5 Entering inspection data of the safety mechanisms in the service booklet

**Directive:**

1. Enter the date of the next fire extinguisher inspection (nacelle and tower) by an authorized person (ref. chapter 6.20.7 "Checking the fire extinguisher in the nacelle").
2. Enter the date of the next inspection of the harness by an authorized person (ref. chapter 6.21.6 "Checking the harness").
3. Enter the expiration dates of the first aid kits (nacelle and tower) (ref. chapter 6.20.8 "Checking the first aid kit in the nacelle").
4. Enter the date of the next inspection of the lifting/rappelling device by an authorized person (ref. chapter 6.20.9 "Checking the lifting/rappelling device / rescue device").
5. Enter the date of the next inspection of the ladder and the climbing protection by an authorized person (ref. chapter 6.21.1 "Checking the ladder / runner rail mounts").

# 6.25 Cleaning the wind turbine

**DANGER**

**Risk of life while accessing the rotor hub.**

- Move the rotor blade to the V position and engage the rotor lock (ref. operating manual) prior to accessing the hub.
- Activate the service switch and remove the key (ref. operating manual).
- Keep the rotor holding brake closed (ref. operating manual).

**WARNING**

**Obey all safety instructions to avoid injury or property damage.**

- General instructions and regulations in chapter 5.
- Instructions and regulations in this chapter.
- State, local, and OSHA safety regulations.
- Safety signs.

**CAUTION**

**Danger due to spatial tightness and rough surfaces in the rotor hub.**

- Wear all protective clothing in order to avoid injuries.

## 6.25.1 Cleaning the wind turbine and performing the waste disposal

**Directive:**

1. Clean all soilings that have been caused by the maintenance work.
2. Clean the nacelle (ref. chapter 6.20.11 "Checking the condition of the nacelle").
3. Clean the rotor hub.
4. Clean ladders and platforms; in that context, particularly remove oil and grease residues in order to avoid the slipping risk.
5. Dispose of waste, waste oil, waste grease, soiled cloths, exchanged components etc. in the proper manner.

## 6.25.2 Checking paint coats

**⚠ CAUTION**

**Risk of respiratory illnesses.**

- Respirator masks must be worn in case of forming dust, escaping gas, varnishing work, GRP work, and work at the slip ring unit.

**Directive:**

1. Check all paint coats (ref. 6.1.4 "Performing the check for corrosion") and perform touch-up work if applicable.

**⚠ DANGER** **Only touch up paint coat damage that may be accessed without danger. Always ensure personal safety.**

2. Touch up the paint coat in accordance with the HEMPEL Repair procedure (ref. attachment).

# 6.26 Foundation

## 6.26.1 Checking the condition of the gap between the tower and the foundation

**Directive:**

Fig. 6.26.1 – 1 Tower base


Fig. 6.26.1 – 2 Transition foundation – tower

1. Check the gap (2) between the tower (1) and the foundation (3).
2. Document cracks in the seal, deformations, traces of rust, and other irregularities in the service booklet.

## 6.26.2 Checking the foundation for cracks

**Directive:**


Fig. 6.26.2 – 1 Tower base

1. Check the foundation (1) for cracks.
2. Document cracks and other damage in the service booklet.

## 6.26.3 Checking the grounding connection of the foundation

**Directive:**

Fig. 6.26.3 – 1 Grounding connection of the foundation

1. Check for the existence of a grounding protocol (in the tower base).
2. Enter the date of the most current grounding protocol in the service booklet.

## 6.26.4 Checking the water drain holes

**Directive:**


Fig. 6.26.4 – 1 Water drain hole (outside)


Fig. 6.24.4 – 2 Water drain hole (inside)

1. Check the water drain holes (1).
2. If water enters from the outside, seal the inside and the outside of the water drain holes with Sikaflex white.

# 6.27 Surrounding of the wind turbine

## 6.27.1 Performing a visual inspection

**Directive:**

Fig. 6.27.1 – 1 Surrounding of the wind turbine

1. Check the entire surrounding of the wind turbine for damage, vandalism, and other noticeable problems.
2. Document damage and noticeable problems in the service booklet.

# 7 APPENDIX

A Service booklet

B Maintenance Instruction for Frequency Converter Systems

C HEMPEL Repair procedure, onshore standard REpower

D SVENDBORG BRAKES

E Summery of Proper Gearbox Handling

# APPENDIX A

REpower Systems AG

Service Manual / Booklet

Documents-No.: T-2.1-GP.WA.02-A-C-EN

# APPENDIX B

Maintenance Instruction for Frequency Converter Systems

Documents-No.: P-1.1-EL.UM.10-A-E-EN

# APPENDIX C

HEMPEL Repair Specification Wind turbine Sections Onshore Standard, REPOWER

Product Data: HEMPELS`S URETHANE 5595U

Product Data: HEMPELS´S URETHANE 5595D

Product Date: HEMPELS´S EPOXY 376US

## Repair Specification Wind turbine Sections - Onshore Standard, REPOWER

## INTERIOR TREATMENT

**Original paint specification:**
Original specification carried out in work shop after cleaning and abrasive blasting to Sa. 2½ in accordance to ISO 8501-1.

| | | |
|---|---|---|
| HEMPADUR ZINC 17360 | 50 | µm dry film thickness |
| HEMPADUR 47140/ 4588/ Hempel's Epoxy 376US | 150 | µm dft. |
| **Total** | **200** | **µm dft.** |

**Repair procedure:**
Oil and grease to be removed by emulsion cleaning. Entire area to be washed off by high pressure fresh water cleaning . Minor damages **up to 100 cm²** are cleaned mechanically to St.3 according to ISO 8501-1. Avoid damaging of existing surface profile. Larger areas are blasted to Sa. 2½ according to ISO 8501-1. Transitions to solid existing paint system to be sanded smooth. An area of the intact HEMPADUR 47140/ 4588/ 376US around the damage is rugged with sandpaper in order to secure good adhesion.

Minor damages cleaned mechanically to min. St. 3 to be stripe coated with:
HEMPEL'S ZINC PRIMER 16490/ Hempel's 174DE to min. 50 µm dft.

Larger damages blasted to Sa. 2½ to be stripe coated with:
HEMPADUR ZINC 17360 to min. 50 µm dft, alternatively HEMPADUR ZINC 15360/-3.

For both primer coats it is very important that the transition area to existing coat must be kept at an absolute minimum.

All damages to be stripe coated with:
HEMPADUR HI-BUILD 47140/ 4588/ 376US to min. 150 µm dft, total 200µm dft.

In the case that damages are only inflicting second coat, the areas have to be washed and degreased. Sanding to solid coat with good adhesion. Transitions to solid existing paint system to be sanded smooth. An area of the intact HEMPADUR 47140/ 4588 around the damaged area to be roughened with sandpaper in order to secure good adhesion.

Stripe coat with:
HEMPADUR HI-BUILD 47140/ 4588/ 376US to min. 100-150 µm dft, total 200µm dft.

**General remarks:**
Provided the products are applied by brush, several applications must be expected in order to achieve the specified dft. Usage of airless spray application the specified dft can be achieved by one coat.

***During repair the steel temperature has to be at least 3°C above the dew point temperature. Pay attention to condensation when the humidity is high.***

***Please take note that repairs are always visible, and if not carried out correctly also weak elements in the paint system. Thus to achieve a corrosion- and cosmetically good result, it is vital to exercise the utmost care, with the cleaning as well as the application.***

## Repair Specification Wind turbine Sections - Onshore Standard, REPOWER

## EXTERIOR TREATMENT

**Original paint specification:**
Original specification carried out in work shop after cleaning and abrasive blasting to Sa. 2½ (Sa 3 on metallized areas) in accordance to ISO 8501-1:

| | | |
|---|---|---|
| HEMPADUR ZINC 17360 | 50 | µm dft |
| HEMPADUR HI-BUILD 47140/4588/ 376US | 150 | µm dft |
| HEMPATHANE 55214/ 55210/55610/ 5595D/ 5595U | 80 | µm dft. |
| **Total** | **280** | **µm dft.** |

**Repair procedure:**
Oil and grease to be removed by emulsion cleaning. Entire area to be washed off by high pressure fresh water cleaning . Minor damages **up to 100 cm²** are cleaned mechanically to St.3 according to ISO 8501-1. Avoid damaging of existing surface profile. Larger areas are blasted to Sa. 2½ according to ISO 8501-1. Transitions to solid existing paint system to be sanded smooth.

Minor damages cleaned mechanically to min. St. 3 to be stripe coated with:
HEMPEL'S ZINC PRIMER 16490/ Hempel's 174DE to min. 50 µm dft.

Larger damages blasted to Sa. 2½ to be stripe coated with:
HEMPADUR ZINC 17360 to min. 50 µm dft. (Alternatively HEMPADUR ZINC 15360/-3)**.**

For both primer coats it is very important that the transition area to existing coat must be kept at an absolute minimum.

All damages to be stripe coated with:
HEMPADUR HI-BUILD 47140/4588 to min. 180 µm dft, total min. 230 µm dft.
HEMPATHANE TOPCOAT 55214/ 55210/55610/ 5595D/ 5595U to min. 50 µm dft, total 280 µm dft.

In the case that damages are **not** inflicting the first layer the areas have to be washed and degreased. Sanding to solid coat with good adhesion. Transitions to solid existing paint system to be sanded smooth.

Stripe coat with:
HEMPADUR HI-BUILD 47140/ 4588 to 100- 180µm dft, total min. 230µm dft.
HEMPATHANE TOPCOAT 55214/ 55210/ 55610/ 5595D/ 5595U to 50 µm dft, total 280 µm dft.

Damages on flanges:
Damages e.g. wear from dummy flanges or lifting gear, to be grinded or scraped to a smooth surface. Keep at least a minimum of surface roughness by using a coarse disc sander. Touch up with HEMPADUR ZINC 15360/-3/19840 (Grey) or HEMPEL'S ZINC PRIMER 16490 or 174DE. The touched up areas should be reduced to a minimum.

**General remarks:**
Provided the products are applied by brush, several applications must be expected in order to achieve the specified dft. Usage of airless spray application the specified dft can be achieved by one coat.

***During repair the steel temperature has to be at least 3°C above the dew point temperature. Pay attention to condensation when the humidity is high.***

***Please take note that repairs are always visible, and if not carried out correctly also weak elements in the paint system. Thus to achieve a corrosion- and cosmetically good result, it is vital to exercise the utmost care, with the cleaning as well as the application.***

# HEMPEL'S URETHANE 5595U

BASE 5595U with CURING AGENT 931US

**Description:**

HEMPEL'S URETHANE 5595U is a high gloss, two-component, aliphatic polyurethane enamel with excellent gloss and colour retention. It is resistant to water, impact, and abrasion. Easy to clean.

Minimum temperature for curing is -10°C/14°F.

**Recommended use:**

As a deluxe finishing coat for protection of structural steel in severely corrosive environment where light-fastness and gloss retention are required.

**Service temperatures:**

Maximum, dry: 120°C/248°F.

**Availability:**

For sale in North America only.

**PHYSICAL CONSTANTS:**

| | | |
|---|---|---|
| Colours/Shade Nos.: | White/10000* | Gray/01290* |
| Finish: | High gloss | High gloss |
| Volume solids: | 63% | 63% |
| Theoretical spreading rate: | 13.7 m²/litre - 50 microns<br>505 sq.ft./US gallon - 2 mils | 13.7 m²/litre - 50 microns<br>505 sq.ft./US gallon - 2 mils |
| Flash point: | 27°C/81°F | 27°C/81°F |
| Specific gravity: | 1.3 kg/litre - 10.8 lbs/US gallon | 1.3 kg/litre -10.8 lbs/US gallon |
| Surface dry: | 4 (approx.) hrs at 20°C/68°F *(ISO 1517)* | 4 (approx.) hrs at 20°C/68°F *(ISO 1517)* |
| Dry to touch: | 8 (approx.) hours at 20°C/68°F | 8 (approx.) hours at 20°C/68°F |
| Fully cured: | 7 days at 20°C/68°F | 7 days at 20°C/68°F |
| V.O.C.: | 312 g/litre - 2.6 lbs/US gallon<br>According to US EPA Method 24. | 312 g/litre - 2.6 lbs/US gallon |

**Other shades according to assortment list.*

*The physical constants stated are nominal data according to the HEMPEL Group's approved formulas. They are subject to normal manufacturing tolerances and where stated, being standard deviation according to ISO 3534-1. Further reference is made to "Explanatory Notes" in the HEMPEL Book.*

**APPLICATION DETAILS:**

| | | |
|---|---|---|
| Mixing ratio for 5595U: | Base 5595U : Curing agent 931US<br>4 : 1 by volume | |
| Application method: | Airless spray | Brush |
| Thinner (max. vol.): | 821US (5%) | 821US (5%) |
| Pot life: | 2 hours (20°C/68°F) | |
| Nozzle orifice: | .017"-.019" | |
| Nozzle pressure: | 150 bar/2200 psi<br>*(Airless spray data are indicative and subject to adjustment)* | |
| Cleaning of tools: | THINNER 08080 or 821US | |
| Indicated film thickness, dry: | 50 microns/2 mils *(See REMARKS overleaf)* | |
| Indicated film thickness, wet: | 100 microns/4 mils | |
| Overcoating interval, min: | See REMARKS overleaf | |
| Overcoating interval, max: | See REMARKS overleaf | |

**Safety:**

Handle with care. Before and during use, observe all safety labels on packaging and paint containers, consult HEMPEL Material Safety Data Sheets and follow all local or national safety regulations. Avoid inhalation, avoid contact with skin and eyes, and do not swallow. Take precautions against possible risks of fire or explosions as well as protection of the environment. Apply only in well ventilated areas.

Issued: August 2003

**2. HEMPEL'S URETHANE 5595U**

**APPLICATION AND CURING CONDITIONS:**

The surface must be completely clean and dry at the time of application, and its temperature must be above the dew point to avoid condensation. Minimum temperature for curing is -10°C/14°F. At the freezing point and below, be aware of the risk of ice on the surface which will hinder the adhesion. High humidity and/or condensation during application and the following 16 hours (20°C/68°F) may adversely affect the film formation.

In confined spaces provide adequate ventilation during application and drying.

**PRECEDING COAT:**

HEMPADUR® HI-BUILD 45150, HEMPADUR® 4563U or according to specification.

**SUBSEQUENT COAT:**

None.

**REMARKS:**

Film thickness:

May be specified in another film thickness than indicated depending on purpose and area of use. This will alter spreading rate and may influence drying time and overcoating interval. Normal range is 40-60 microns/1.5-2.5 mils.

Overcoating and drying/curing time:

**Physical data versus temperatures:**

| | | | | | | |
|---|---|---|---|---|---|---|
| Surface temperature | | 14°F | 32°F | 50°F | 68°F | 86°F |
| Dry to touch, approx. | | 3 days | 36 hours | 16 hours | 8 hours | 6 hours |
| Resist condensing humidity/ light showers after*: | | (7 days) | 3 days | 32 hours | 16 hours | 12 hours |
| Fully cured, 70% RH | | (2 months) | 32 days | 14 days | 7 days | 5 days |
| Overcoating interval, overcoating with 5595U | Min | 6 days | 3 days | 32 hours | 16 hours | 12 hours |
| | Max* | None | None | None | None | None |

**A completely clean surface is mandatory to ensure intercoat adhesion especially at long overcoating intervals. Any dirt, oil, and grease has to be removed, e.g. with suitable detergent. Salts to be removed by fresh water hosing. To check an adequate quality of the surface cleaning, a test patch is recommended before actual overcoating.**

Notes:

Curing Agent 931US is sensitive to moisture. Store in a dry place and keep the can tightly closed until use. Open curing agent cans with caution as overpressure might exist. Even small traces of water in the mixed paint will reduce the pot-life and result in film defects.

**HEMPEL'S URETHANE 5595U is for professional use only.**

**ISSUED:**

August 2003
HEMPEL (USA) INC.

# HEMPEL'S URETHANE 5595D

BASE 5595D with CURING AGENT 931US

**Description:**

HEMPEL'S URETHANE 5595D is a two-component, semi-gloss, aliphatic polyurethane enamel with excellent gloss and color retention. It is resistant to water and light abrasion. Easy to clean.
Minimum temperature for curing is -10°C/14°F.

**Recommended use:**

As a deluxe finishing coat for protection of structural steel in severely corrosive environments, where light-fastness and gloss-retention are required.

**Service temperatures:**

Maximum, dry: 140°C/284°F.

**Availability:**

Subject to confirmation.

**PHYSICAL CONSTANTS:**

| | |
|---|---|
| Colors/Shade No.: | Grey/11150 |
| Finish: | Semi-gloss |
| Volume solids, %: | 65 ± 1 |
| Theoretical spreading rate: | 12.6 $m^2$/liter - 50 microns<br>505 sq. ft/US gallon - 2 mils |
| Flash point: | 27°C/81°F |
| Specific gravity: | 1.4 kg/liter - 11.4 lbs./US gallon |
| Surface dry: | 2 (approx.) hrs at 20°C/68°F |
| Dry to touch: | 4 (approx.) hours at 20°C/68°F |
| Fully cured: | 7 days at 20°C/68°F |
| V.O.C.: | 272 g/litre - 2.3 lbs/US gallon *(US EPA Method 24)*<br>288 g/litre - 2.4 lbs/US gallon |

*The physical constants are subject to normal manufacturing tolerances.*
*Further reference is made to "Explanatory Notes" in The HEMPEL Book.*

**APPLICATION DETAILS:**

| | | |
|---|---|---|
| Mixing ratio for 5595D: | Base 5595D : Curing Agent 931US<br>4 : 1 by volume | |
| Application method: | Airless spray | Brush |
| Thinner (max. vol.): | 821US (5%) | 821US (5%) |
| Pot life: | ½ hour (20°C/68°F) | |
| Nozzle orifice: | .017"-.019" | |
| Nozzle pressure: | 150 bar/2200 psi<br>*(Airless spray data are indicative and subject to adjustment)* | |
| Cleaning of tools: | HEMPEL'S THINNER 821US | |
| Indicated film thickness, dry: | 50 microns/2 mils *(see REMARKS overleaf)* | |
| Indicated film thickness, wet: | 100 microns/4 mils | |
| Overcoating interval, min: | See REMARKS overleaf | |
| Overcoating interval, max: | See REMARKS overleaf | |

**Safety:**

Handle with care. Before and during use, observe all safety labels on packaging and paint containers, consult HEMPEL Material Safety Data Sheets and follow all local or national safety regulations. Avoid inhalation, avoid contact with skin and eyes, and do not swallow. Take precautions against possible risks of fire or explosions as well as protection of the environment. Apply only in well ventilated areas.

**HEMPEL'S URETHANE 5595D**

APPLICATION and CURING CONDITIONS:
The surface must be completely clean and dry at the time of application, and its temperature must be above the dew point to avoid condensation. Minimum temperature for curing is -10°C/14°F. At the freezing point and below, be aware of the risk of ice on the surface which will hinder the adhesion. High humidity and/or condensation during application and the following 16 hours (20°C/68°F) may adversely affect the film formation.
In confined spaces, provide adequate ventilation during application and drying.

PRECEDING COAT:
According to specification.

SUBSEQUENT COAT:
None.

REMARKS:
Film thicknesses:
May be specified in another film thickness than indicated depending on purpose and area of use. This will alter spreading rate and may influence drying time and overcoating interval. Normal range is 40-60 microns/1.6-2.4 mils.

Overcoating and drying/curing time:

| **Physical data versus temperatures:** | | | | | | |
|---|---|---|---|---|---|---|
| Surface temperature | | 14°F | 32°F | 50°F | 68°F | 86°F |
| Dry to touch, approx. | | 3 days | 36 hours | 16 hours | 8 hours | 6 hours |
| Resist condensing humidity/ light showers after: | | 7 days | 3 days | 32 hours | 16 hours | 12 hours |
| Fully cured, 70% RH | | 2 months | 32 days | 14 days | 7 days | 5 days |
| Overcoating interval when overcoating with 5595D | Min | 6 days | 3 days | 32 hours | 16 hours | 12 hours |
| | Max | None | None | None | None | None |

**A completely clean surface is mandatory to insure intercoat adhesion, especially at long overcoating intervals. Any dirt, oil, and grease has to be removed, e.g. with suitable detergent. Salts to be removed by fresh water hosing. To check an adequate quality of the surface cleaning, a test patch is recommended before actual overcoating.**

Note:
CURING AGENT 931US is sensitive to moisture. Store in a dry place and keep the can tightly closed until use. Open curing agent cans with caution as overpressure might exist. Even small traces of water in the mixed paint will reduce the pot-life and result in film defects.

**HEMPEL'S URETHANE 5595D is for professional use only.**

ISSUED BY:
HEMPEL (USA), Inc. - 5595D11150US002

# HEMPEL'S EPOXY 376US

BASE 376U9 with CURING AGENT 972US

**Description:**

HEMPEL'S EPOXY 376US is a high-solids, two-component, high-build, polyamine-cured, epoxy paint especially designed for application by heavy-duty plural component, airless spray equipment. Components will need to be heated up to approximately 105°F to 110°F for good atomization.

**Availability:**

For sale in North America only.

**PHYSICAL CONSTANTS:**

| | |
|---|---|
| Color/Shade no.: | Grey/12170 *(see Remark overleaf)* |
| Finish: | Semi-gloss |
| Volume solids, %: | 96.5 ± 1 |
| Theoretical spreading rate: | 6.43 $m^2$/liter - 150 microns<br>258 sq. ft/US gallon - 6 mils |
| Flash point: | Base 376U9: >93.3°C/200°F<br>Curing Agent 972US: Between 61°C/142°F and 93.3°C/200°F |
| Specific gravity: | 1.70 kg/liter - 14.2 lbs/US gallon, for Grey shade<br>1.68 kg/liter - 14.0 lbs/US gallon, for other shades |
| Dry to touch: | 7 (approx.) hours at 20°C/68°F |
| Fully cured: | 7 days at 20°C/68°F |
| V.O.C.: | 76 g/litre - 0.6 lbs/US gallon *(US EPA Method 24)* |

*The physical constants are subject to normal manufacturing tolerances.*
*Further reference is made to "Explanatory Notes" in The HEMPEL Book.*

**APPLICATION DETAILS:**

| | |
|---|---|
| Mixing ratio for 376US: | Base 376U9 : Curing agent 972US<br>3 : 1 by volume |
| Application method: | Heavy-duty plural component airless spray  Brush (touch-up only) |
| Thinner: | Do not dilute |
| Pot life: | 15 minutes (20°C/68°F) |
| Nozzle orifice: | .019"-.021" |
| Nozzle pressure: | 250 bar/3625 psi<br>*(Airless spray data are indicative and subject to adjustment)* |
| Cleaning of tools: | HEMPEL'S TOOL CLEANER 99610 |
| Indicated film thickness, dry: | 6 mils/150 microns (see REMARKS overleaf) |
| Indicated film thickness, wet: | 6.1 mils/155 microns |
| Recoat interval, min: | 3 hours (20°C/68°F) *for PU's* |
| Recoat interval, max: | 3 days (20°C/68°F) |

**Safety:**

Handle with care. Before and during use, observe all safety labels on packaging and paint containers, consult HEMPEL Material Safety Data Sheets, and follow all local or national safety regulations. Avoid inhalation, avoid contact with skin and eyes, and do not swallow.  Take precautions against possible risks of fire or explosions as well as protection of the environment. Apply only in well-ventilated areas.

**HEMPEL'S EPOXY 376US**

| | |
|---|---|
| SURFACE PREPARATION: | **New steel:** Remove oil, grease, etc. with suitable detergent. Remove salt and other water-soluble contaminants by high-pressure fresh water cleaning. Abrasive blasting to SSPC-SP 10, "Near-White Blast Cleaning". For temporary protection, if required, use a suitable shopprimer. All damage of shopprimer and contamination from storage and fabrication should be thoroughly cleaned prior to final painting. For repair and touch up, use HEMPEL'S EPOXY 376US.<br>**Repair:** Remove oil, grease, etc. with suitable detergent. Remove salt and other water-soluble contaminants by high-pressure fresh water cleaning. Clean damaged areas thoroughly by power tool cleaning to SSPC-SP 3 (minor areas) or by abrasive blasting to SSPC-SP 10. Feather edges to sound, intact paint, and touch-up to full film thickness. |
| APPLICATION CONDITIONS: | Use only where application and curing can proceed at temperatures above 5°C/41°F. The temperature of the paint should preferably be below 25°C/77°F. Apply only on a clean and dry surface with a temperature at least 3°C/5°F above the dew point to avoid condensation. Relative humidity max 85%. |
| APPLICATION EQUIPMENT: | HEMPEL'S EPOXY 376US, being high viscous material, requires special measures to be taken during application. Spray application can only be carried out with plural component, airless equipment with proportioning pump adjusted to mixing ratio 3:1. Please consult a specific Equipment Manufacturer for more details on obtaining the correct mix ratio. |
| PRECEDING and SUBSEQUENT COAT: | None, or according to specification. |
| REMARKS: | |
| Service Temperatures: | The natural tendency of epoxy coatings to become more sensitive to mechanical damage and chemical exposure at elevated temperatures is reflected in this product. |
| Film thicknesses: | May be specified in other film thicknesses than indicated depending on purpose and area of use. This will alter spreading rate and may influence drying time and recoating interval. Normal range dry is 6-8 mils/ 150-200 microns. |
| Color: | With the way it is being produced, this product is more prone to yellowing (color change) than any other epoxy products. |
| Recoating: | In confined spaces provide adequate ventilation during application and drying.<br>Recoating interval will normally apply in connection with touch-up of too low dry film thickness. Consult HEMPEL for further advice.<br>Before recoating after exposure in contaminated environment, clean the surface thoroughly by high-pressure fresh water hosing and allow to dry. If the maximum overcoating interval is exceeded, roughening of the surface is necessary to ensure adhesion. |
| Disclaimer: | Any reference to a company standard or specification in this Technical Product Data sheet shall not be construed as a recommendation by that company to purchase. |
| Note: | **HEMPEL'S EPOXY 376US is for professional use only.** |
| ISSUED BY: | HEMPEL (USA), Inc. - 376US12170US001 |

***This Product Data Sheet supersedes those previously issued. For definition and scope, see "Explanatory Notes" in The HEMPEL Book. Data, specifications, directions, and recommendations given in this data sheet represent only test results or experience obtained under controlled or specially defined circumstances. Their accuracy, completeness, or appropriateness under the actual conditions of any intended use of the products herein must be determined exclusively by the Buyer and/or User. The products are supplied and all technical assistance is given subject to HEMPEL's GENERAL CONDITIONS OF SALES, DELIVERY, AND SERVICE unless otherwise expressly agreed in writing. The Manufacturer and Seller disclaim, and Buyer and/or User waive all claims involving any liability, including but not limited to negligence, except as expressed in said GENERAL CONDITIONS for all results, injury, or direct or consequential losses or damages arising from the use of the products as recommended above, on the overleaf, or otherwise. Product data are subject to change without notice and become void five years from the date of issue.***

# APPENDIX D

SVENDBORG BRAKES

Manufacturer instructions for the brake pads.

**Brake pads**
The pads for the brakes are either packed in a separate plastic bag in order to protect them from contamination or mounted in the brake by delivery. Do not assemble the pads until after the disc has been cleaned. Avoid contaminating the pads with oil. Even a small amount of oil can reduce the friction coefficient considerably.

In case of contamination;
It is not possible to clean organic pads without degrading the material and in case of contamination they might have to be replaced.
Sintermetal pads can be cleaned with benzine.

A label showing the article No. is enclosed with all pads. This should be mounted onto the brake, next to the name plate for future reference.
The surface must be cleaned very carefully in order to obtain a good adherence.

When putting into service or changing brake pads, the brake pads should always be bedded / worn in so that maximum braking torque is obtained.

**Asbestosfree:**
All pads are asbestos free and certified. If a certificate is needed, please make a request for this.

**Pad retraction springs:**
If the brake or pads are equipped with pad retraction springs please tighten the bolts according to the table.

| Bolts for pad retraction springs | | |
|---|---|---|
| Bolt size | Torque | |
| | Lubricated MoS2 | Dry & Oiled |
| M5 | 4 Nm | 5 Nm |
| M8 | 15 Nm | 19 Nm |
| M10 | 20 Nm | 27 Nm |
| M12 | 40 Nm | 52 Nm |
| "Lubricated" is based on Molykote – MoS2 | | |



**SVENDBORG BRAKES A/S**
5882 Vejstrup, Denmark Tel: +45 63 25 52 55 Fax: +45 62 28 22 18
Web: www.svendborg-brakes.dk



SVENDBORG BRAKES

**Temperature sensors:**
If the brake pad is equipped with temperature sensors, please make sure that the wire does not break during assembly. If equipped with thread-mounted sensors please remove these from the old pads and re-use.

**Bedding in of the brake pads:**
To obtain the rated coefficient of friction between the pad and the disc brake, and to ensure the pad surface is aligned to the disc, it is essential that the pads are bedded to the disc surface.
The coefficient of friction may drop by approx. 20% when not bedded in. This can be done by making a series of load-tests with increasing load or speed until sufficient coefficient of friction is achieved.
If the brake disc is new the time of bedding in will be longer because the disc also has to be bedded in. Always use new pads with a new disc. Never use used pads with a new disc.

**Organic pads:**
Organic pads can normally be bedded in by driving the disc through the pads with a minimum of 25% of the rated clamping force applied, or if that is not possible by making a series of activations with increased load or increased speed.

**Sintermetal pads:**
The process for sintermetal pads is the same as for organic pads, but with a slightly higher clamping force when bedding in – approx. 40% of the rated clamping force applied.

During the process of "bedding in", the disc temperature should be monitored to ensure that the disc does not overheat.



**SVENDBORG BRAKES A/S**
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FOR-102 rev2

# APPENDIX E

REpower Systems AG

Summery of Proper Gearbox Handling

Documents-No.: M-1.1-TS.GT.00-A-B-EN

*Extended Frequency Range*

*[MM/60Hz/USA]*

# Product Description

**REpower Systems AG**
**Alsterkrugchaussee 378**
**22335 Hamburg**

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**Fax: +49 - 40 - 539307 - 37**

**www.repower.de**



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**Possible work procedures shown in this product description comply with German and the REpower's own safety provisions and regulations. The national laws of other countries may provide for further safety specifications.**
**It is essential that all precautionary measures, both project- and country-specific, be strictly complied with. It is the duty of each customer to inform itself, implement and observe these measures.**
**The applicability and validity of the relevant legal and/or contractual provisions, the technical guidelines, DIN standards and other comparable regulations is not excluded by the contents or demonstrations contained in product description. Moreover these provisions and regulations shall continue to apply without any limitation.**

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## Table of Contents

## Applicable Documents

**The following documents are mentioned within this document without being subject matter of this product description.**

| Title | Document no. |
|---|---|
| REpower MM92 [60Hz] | PD-2.6-WT.WT.01-A-*-EN |
| | |
| | |

*** Depending on the project specific selection of REpower products the respective documents will appear in each case as separate amendments of the contract in their actual version.**

## List of Abbreviations and Units

| Abbreviation/Unit | Description |
|---|---|
| WEC | Wind Energy Converter<br>(equal to Wind Turbine Generator System [WTGS]) |
| p.u. | per unit |
| LV | low voltage (nominal grid voltage $\leq$ 1 kV) |
| MV | medium voltage (nominal grid voltage > 1 kV and < 60 kV) |
| HV | high voltage (nominal grid voltage $\geq$ 60kV) |
| $U_{WEC}$ | voltage |
| $U_N$ | rated voltage |
| $P_N$ | rated active power |
| $P_{WEC}$ | active power |
| $Q_{WEC}$ | reactive power |
| t | time |

# 1 Introduction

**This document describes the REpower product** *Extended Frequency Range***. The product** *Extended Frequency Range* **is part of the REpower Grid Products.**

**REpower offers a variety of modular Grid Products which can be added to the standard wind turbine or wind farm configuration to meet the site specific customer and operator requirements.**

# 2 Feature Definition

**The product** *Extended Frequency Range* **enables the REpower wind turbine to operate within an extended frequency range without disconnection from the grid.**

**The REpower wind turbine stays connected to the grid even if the grid frequency at grid side changes between 59.4 Hz and 60.6 Hz and the voltage is within the permissible voltage range.**

**Additionally the REpower wind turbine will not trip within the frequency and related time limits as described at Figure 1. During this time the voltage has to be close to nominal voltage.**

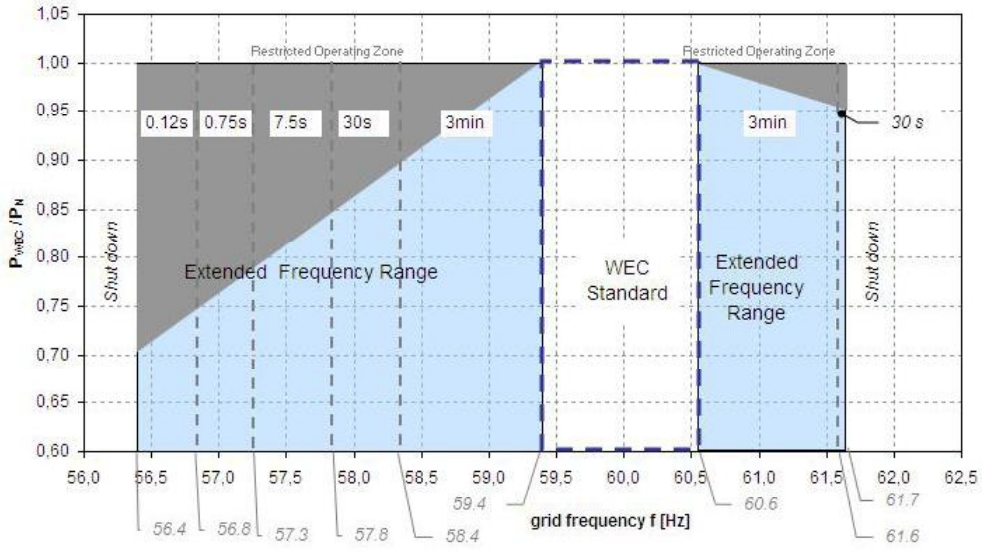


**Figure 1:** *Extended Frequency Range* **of REpower wind turbine**

**The standard grid protection settings for minimum and maximum frequency are adjustable parameters which can be set within the frequency range described at Figure 1.**

**Within the Restricted Operating Zone in Figure 1 a power reduction is possible and in extreme situations a disconnection of the wind turbine from the grid may occur.**

**Under worst case conditions the production of reactive power can be affected.**

# 3 Scope of Supply

## 3.1 Hardware & Software

**WEC components to realise this product are in the scope of supply of REpower Systems.**

## 3.2 Installation & Commissioning

**REpower is responsible to set up the product during commissioning.**

**The product scope does not include additional tests.**

*Fault Ride Through ZERO*

*[MM/60Hz/USA]*

# Product Description

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## Applicable Documents

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| Title | Document no. |
|---|---|
| REpower MM92 [60Hz] | PD-2.6-WT.WT.01-A-*-EN |
| | |
| | |

*** Depending on the project specific selection of REpower products the respective documents will appear in each case as separate amendments of the contract in their actual version.**

## List of Abbreviations and Units

| Abbreviation/Unit | Description |
|---|---|
| FRT | Fault Ride Trough |
| WEC | Wind Energy Converter<br>(equal to Wind Turbine Generator System [WTGS]) |
| p.u. | per unit |
| LV | low voltage (nominal grid voltage $\leq$ 1 kV) |
| MV | medium voltage (nominal grid voltage > 1 kV and < 60 kV) |
| HV | high voltage (nominal grid voltage $\geq$ 60kV) |
| $U_{WEC}$ | voltage |
| $U_N$ | nominal voltage |
| $P_N$ | nominal active power |
| $P_{WEC}$ | active power |
| $Q_{WEC}$ | reactive power |
| t | time |

# 1 Introduction

**This document describes the REpower product** *Fault Ride Through ZERO***. The product** *Fault Ride Through ZERO* **is part of the REpower Grid Products.**

**REpower offers a variety of modular Grid Products which can be added to the standard wind turbine or wind farm configuration to meet the site specific customer and operator requirements.**

# 2 Feature Definition

**The product** *Fault Ride Through ZERO* **enables the REpower wind turbine to stay grid connected during short-term symmetrical and asymmetrical line faults.**

**In case of symmetrical voltage drops down to approximately 0% of nominal voltage of the affected phases at MV side of the WEC transformer, the wind turbine will remain grid connected without interrupting the energy production[1] if the voltage stays above the orange line, see Figure 1.[2] The WEC will also remain grid connected in case of asymmetrical faults.**

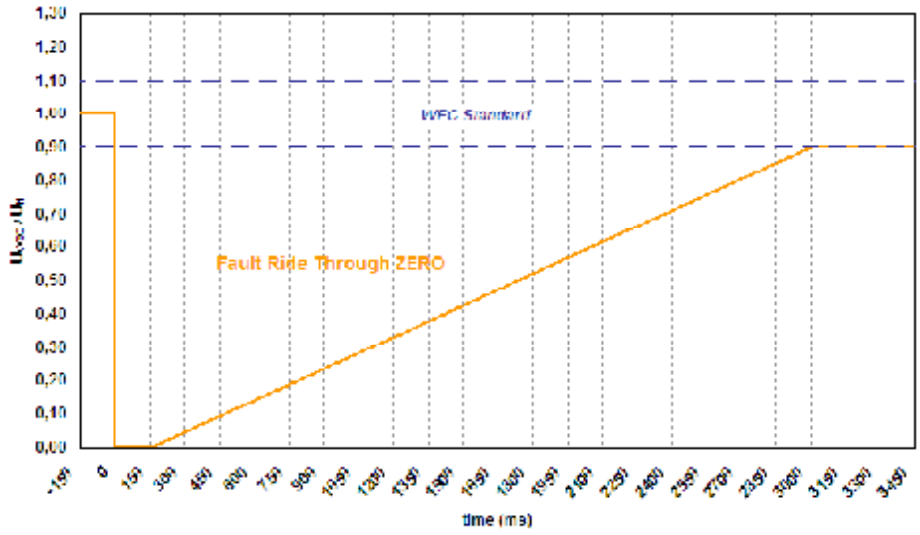


**Figure 1: Example Fault Ride Through ZERO**

**1 Outside of the steady state voltage range power output of WEC may be affected and the WEC may operate in a mode without controlled energy production.**

**2 The parameters above the orange line can be adjusted to achieve different requirements, e.g. WECC proposal (90% in 1750 ms).**

**In extreme situations a disconnection of the wind turbine from the grid may occur.**

# 3 Scope of Supply

## 3.1 Hardware & Software

**WEC components to realise this product are in the scope of supply of REpower Systems.**

## 3.2 Installation & Commissioning

**REpower is responsible to set up the product during commissioning.**

**The product scope does not include additional tests.**

*Over Voltage Ride Through*

*[MM/60Hz/USA]*

# Product Description

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## Table of Contents

## Applicable Documents

**The following documents are mentioned within this document without being subject matter of this product description.**

| Title | Document no. |
|---|---|
| REpower MM92 [60Hz] | PD-2.6-WT.WT.01-A-*-EN |
| | |
| | |

*** Depending on the project specific selection of REpower products the respective documents will appear in each case as separate amendments of the contract in their actual version.**

## List of Abbreviations and Units

| Abbreviation/Unit | Description |
|---|---|
| WEC | Wind Energy Converter<br>(equal to Wind Turbine Generator System [WTGS]) |
| LV | low voltage (nominal grid voltage $\leq$ 1 kV) |
| MV | medium voltage (nominal grid voltage > 1 kV and < 60 kV) |
| HV | high voltage (nominal grid voltage $\geq$ 60kV) |
| p.u. | per unit |
| $U_{WEC\ i}$ | voltage |
| $U_N$ | rated voltage |
| $P_N$ | rated active power |
| $P_{WEC\ i}$ | active power |
| $Q_{WEC\ i}$ | reactive power |
| t | time |
| OVRT | Over Voltage Ride Through |

# 1 Introduction

**This document describes the REpower product** *Over Voltage Ride Through***. The product** *Over Voltage Ride Through* **is part of the REpower Grid Products.**

**REpower offers a variety of modular Grid Products which can be added to the standard wind turbine or wind farm configuration to meet the site specific customer and operator requirements.**

# 2 Feature Definition

**The product** *Over Voltage Ride Through* **enables the REpower wind turbine to continue operation undamaged in case of short-term over voltage events in the grid, see Figure 1. Equipped with the product** *Over Voltage Ride Through* **the REpower wind turbine will only trip if the voltage of the wind turbine exceeds:**

- **110% of nominal voltage for 5000 ms**
- **120% of nominal voltage for 2000 ms**
- **125% of nominal voltage for 800 ms**
- **130% of nominal voltage instantaneously**

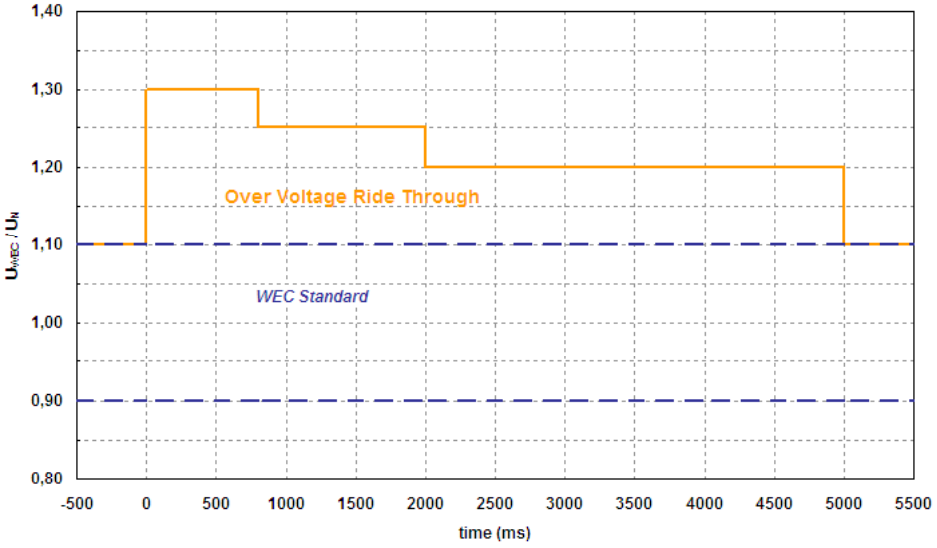



**Figure 1:** *Over Voltage Ride Through*

**In exceeding high voltage situations parts of the WEC may be damaged.**

**Asymmetrical over voltage events are not covered with this product.**

**Under worst case conditions the production of reactive power can be affected and/or a disconnection of the wind turbine from the grid may occur.**

# 3 Scope of Supply

## 3.1 Hardware & Software

**WEC components to realise this product are in the scope of supply of REpower Systems.**

## 3.2 Installation & Commissioning

**REpower is responsible to set up the product during commissioning.**

**The product scope does not include additional tests.**

**EXHIBIT G**
**RATE SCHEDULE**

| RATES: | REGULAR | OVERTIME | HOLIDAY |
|---|---|---|---|
| Hi-Voltage Labor | $/hr. | $/hr. | $/hr. |
| Field Labor | $/hr. | $/hr. | $/hr. |
| Office Labor (if necessary) | $/hr. | $/hr. | $/hr. |
| **Services, Parts & Materials**: | | | |
| Travel | Cost | | |
| Meals, Hotels, Subsistence | Cost | | |
| Purchase of Equipment, Materials, or Spare Parts for Cost Reimbursable Services | Cost | | |
| Work Subcontracted | Cost Plus Administrative Fee of [%] | | |

**Notations:**

1. Overtime and Holiday work constituting Reimbursable Expenses will be performed only by mutual agreement between O&M Contractor and Owner, except when necessary to address an Emergency and subject to the requirements of Section 4.1(d)(viii) and Section 4.6.
2. Regular work hours for purposes of this Schedule shall mean Normal Business Hours.
3. All work performed pursuant to a call-out outside of Normal Business Hours shall have a four (4) hour minimum charge billed at the Overtime or Holiday rates, as applicable.

**EXHIBIT H**
**EVENT CODE ALLOCATION TABLE**

| Event Code Number | Description | Allocation |
|---|---|---|
| 77 | Reduced power transformer 2024 [P] reduced trafo | Manufacturer |
| 100 | Safety chain open 10 Safety chain open | Manufacturer |
| 110 | Emergency stop topbox 16 Emer.stop cont.panel | Manufacturer |
| 111 | Emergency stop nacelle 92 Emer. stop nacelle | Manufacturer |
| 115 | Emergency stop converter 1404 Freq.conv. emer.stop | Manufacturer |
| 200 | Service 7 Turbine is serviced | Manufacturer |
| 205 | Servicemode pitch | Manufacturer |
| 210 | Manual brake 451 Manual brake | Manufacturer |
| 220 | Noise opt. operating mode active 1 | Environmental |
| 225 | Noise opt. operating mode active 2 | Environmental |
| 250 | Update active! | Normal Operation |
| 305 | Brake control 424 Brake control | Manufacturer |
| 308 | Max. braking time BP20 | Manufacturer |
| 310 | Max. braking time BP50 431 B50 brake time > max | Manufacturer |
| 320 | Max. braking time BP52 495 B52 brake time>max. | Manufacturer |
| 325 | Max. braking time BP60 494 B60 brake time>max. | Manufacturer |
| 330 | Rpm window | Manufacturer |
| 332 | Max. braking time BP170 | Manufacturer |
| 335 | Max. braking time BP180 490 B180 brake time>max. | Manufacturer |
| 340 | Max. braking time BP190 491 B190 brake time>max. | Manufacturer |
| 350 | Max. braking time BP200 434 B200 brake time>max. | Manufacturer |
| 360 | Timeout systemtest 1 1540 T.out selftest no. 1 | Normal Operation |
| 365 | Timeout systemtest 2 | Normal Operation |
| 370 | Timeout systemtest 3 | Normal Operation |
| 400 | Manual operation 26 Manual operation | Manufacturer |
| 402 | Semi automatic operation | Manufacturer |
| 405 | Stop manual operation | Manufacturer |
| 410 | Test brake program 200 | Normal Operation |
| 412 | Test brake program 190 | Normal Operation |
| 414 | Test brake program 180 | Normal Operation |
| 415 | Test brake program 170 | Normal Operation |

| | | |
|---|---|---|
| 416 | Test brake program 75 | Normal Operation |
| 418 | Test brake program 60 | Normal Operation |
| 420 | Test brake program 52 | Normal Operation |
| 422 | Test brake program 50 | Normal Operation |
| 424 | Test brake program 20 | Normal Operation |
| 450 | Repeating error BP50 | Manufacturer |
| 455 | Repeating error BP52 | Manufacturer |
| 460 | Repeating error BP60 | Manufacturer |
| 465 | Repeating error BP75 | Manufacturer |
| 468 | Repeating error BP170 | Manufacturer |
| 470 | Repeating error BP180 | Manufacturer |
| 475 | Repeating error BP190 | Manufacturer |
| 480 | Repeating error BP200 | Manufacturer |
| 513 | TimeOut bridging limit switch | Manufacturer |
| 515 | Pitch limit switches 1130 Pitch endstop switch | Manufacturer |
| 516 | Pitch limit switch 1 1906 Pitch endstop 1 500ms 52 X 0 0 0 0 ms | Manufacturer |
| 517 | Pitch limit switch 2 1908 Pitch endstop 2 | Manufacturer |
| 518 | Pitch limit switch 3 1909 Pitch endstop 3 | Manufacturer |
| 520 | Overload axis 1 1150 Pitch 1 current>max | Manufacturer |
| 525 | Overload axis 2 1151 Pitch 2 current>max | Manufacturer |
| 530 | Overload axis 3 1152 Pitch 3 current>max | Manufacturer |
| 535 | Current measurement axis 1 1153 Pitch 1 current err. | Manufacturer |
| 540 | Current measurement axis 2 1154 Pitch 2 current err. | Manufacturer |
| 545 | Current measurement axis 3 1155 Pitch 3 current err. | Manufacturer |
| 550 | Pitch current asymmetry 1156 Pitch(M)current asym 2s 52 X 0 0 0 0 ms | Manufacturer |
| 555 | Pitch angle deviation 1113 Pitch angle diff. | Manufacturer |
| 564 | Bladeangle implausible | Manufacturer |
| 565 | Max.windspeed bladeangle 258 Pitch angle>max.wind | Environmental |
| 566 | Pitch too slow BP50 | Manufacturer |
| 567 | Pitch too slow BP52 | Manufacturer |
| 568 | Pitch too slow BP60 | Manufacturer |
| 569 | Pitch too slow BP75 | Manufacturer |
| 570 | Pitch too slow BP180 | Manufacturer |
| 576 | Pitch too slow BP170 | Manufacturer |
| 577 | Pitch too fast BP170 | Manufacturer |

| | | |
|---|---|---|
| 581 | Setpoint >meas. 1 | Normal Operation |
| 582 | Setpoint >meas. 2 | Normal Operation |
| 583 | Setpoint >meas. 3 | Normal Operation |
| 600 | Max. temp. motor axis 1 1147 Pitch motor temp. 1 | Manufacturer |
| 605 | Max. temp. motor axis 2 1148 Pitch motor temp. 2 10s 52 455 X 0 20 0 10 | Manufacturer |
| 610 | Max. temp. motor axis 3 1149 Pitch motor temp. | Manufacturer |
| 628 | Max. temp. pitch motor PTC 1199 Pitch(M) sub2 temp. 10s 52 455 X 0 20 0 | Manufacturer |
| 630 | Overload fan pitch motor 1173 Th.rel.pitch(M) fan | Manufacturer |
| 635 | Overload pitch motor 1,2,3 1174 Th.rel.pitch(M)rot. | Manufacturer |
| 636 | Overload pitch motor 1 1916 Th.rel.pitch(M)rot.1 | Manufacturer |
| 637 | Overload pitch motor 2 1917 Th.rel.pitch(M)rot.2 | Manufacturer |
| 638 | Overload pitch motor 3 1918 Th.rel.pitch(M)rot.3 | Manufacturer |
| 645 | Spinnerbox version implausible | Manufacturer |
| 650 | Pitch controller communication error | Manufacturer |
| 652 | Pitch controller initialisation error | Manufacturer |
| 656 | Error pitch converter 1 1910 Pitch ctrl. error 1 | Manufacturer |
| 657 | Error pitch controller 2 1911 Pitch ctrl. error 2 | Manufacturer |
| 658 | Error pitch controller 3 1912 Pitch ctrl. error 3 | Manufacturer |
| 660 | Limit switches | Manufacturer |
| 665 | Pitch error 1161 Pitch error | Manufacturer |
| 666 | PitchBox temp to low | Environmental |
| 670 | Max. pitch speed encoder A 1163 Pitch motor rpm high | Manufacturer |
| 672 | Max. pitch speed encoder B | Manufacturer |
| 675 | Pitchmeas.sys. 1><2 1166 Pitchmeas.sys. | Manufacturer |
| 681 | Limit switch er | Manufacturer |
| 682 | Limit switch er | Manufacturer |
| 683 | Limit switch er | Manufacturer |
| 685 | Timeout e.on-run | Manufacturer |
| 687 | Power failure pitch | Manufacturer |
| 690 | Pitch run-away (SpinnerBox ver.=3) | Manufacturer |
| 692 | Pitch run-away (SpinnerBox ver.=4) | Manufacturer |
| 700 | Batt. undervoltage/overvoltage 57 Batt. voltage stop | Manufacturer |
| 710 | Battery test 95 Battery test | Normal Operation |
| 711 | Battery monitoring axis 1 | Normal Operation |
| 712 | Battery monitoring axis 2 | Normal Operation |

| | | |
|---|---|---|
| 713 | Battery monitoring axis 3 | Normal Operation |
| 714 | Battery monitoring test interval | Normal Operation |
| 715 | Battery charge cycle pitch-system 1175 Pitch bat. charger | Manufacturer |
| 716 | Battery charge cycle axis 1 error | Manufacturer |
| 717 | Battery charge cycle axis 2 error -- -- *1min 0 455 X 0 20 0 30s | Manufacturer |
| 718 | Battery charge cycle axis 3 error | Manufacturer |
| 720 | Pitch battery charge cycle 1176 Pitch bat.chargecyc. | Manufacturer |
| 725 | Battery voltage axis 1 1182 Batt.voltage 1 stop | Manufacturer |
| 730 | Battery voltage axis 2 1184 Batt.voltage 2 stop | Manufacturer |
| 735 | Battery voltage axis 3 1186 Batt.voltage 3 stop | Manufacturer |
| 775 | Pitch heating mode | Environmental |
| 776 | Timeout pitch heating mode | Environmental |
| 780 | Error bridging startup | Manufacturer |
| 785 | Error brake resistor CHP | Manufacturer |
| 786 | Signal bridging startup + CHP | Manufacturer |
| 800 | Rotor tacho defective 302 (R) tacho defect | Manufacturer |
| 801 | Rotor sensor A defective | Manufacturer |
| 802 | Rotor sensor B defective | Manufacturer |
| 805 | High rotor speed 311 Rotor overspeed | Manufacturer |
| 810 | Maximum rotor speed 317 Rotor overspeed max. | Manufacturer |
| 815 | Rotor overspeed 320 WP2035 (R) overspeed | Manufacturer |
| 820 | Rotating direction rotor 321 Rotating direc.rotor | Manufacturer |
| 850 | Error lubrication pump pitch -- -- 10s 0 X 0 20 0 30s | Manufacturer |
| 1005 | Drivetrain oscillation z level 1 1558 WP4084#2 CH1 level 1 | Manufacturer |
| 1015 | Drivetrain oscillation z level 2 1564 WP4084#2 CH1 level 2 | Manufacturer |
| 1050 | Drivetrain oscillation | Manufacturer |
| 1055 | Max. drivetrain oscillation | Manufacturer |
| 1120 | 4-20mA drivetrain position encoder | Manufacturer |
| 1125 | 4-20mA drivetrain oscillation z-axis | Manufacturer |
| 1130 | Acceleration detector drivetrain | Manufacturer |
| 1200 | High temp. rotorbearing 1713 (R) bearing temp. | Manufacturer |
| 1210 | Max. temp. rotorbearing 1714 (R) bear. temp. stop | Manufacturer |
| 1212 | PT100 rotorbearing defect | Manufacturer |
| 1217 | Error measuring temp. rotorbearing | Manufacturer |

| | | |
|---|---|---|
| 1310 | Overload lubrication rotorbearing 1244 (R)bear.lubric.th.r. | Manufacturer |
| 1320 | Manual operation lubrication rotorbearing | Manufacturer |
| 1500 | High oil pressure gear 1337 Gear oil press. high | Manufacturer |
| 1510 | Low oil pressure gear 1306 Gear oil press. low | Manufacturer |
| 1515 | Error measuring pressure gear pump | Manufacturer |
| 1520 | 4-20mA pressure gear pump | Manufacturer |
| 1525 | 4-20mA pressure inlet gear | Manufacturer |
| 1530 | Error measuring pressure inlet gear | Manufacturer |
| 1550 | Missing gear oil 1355 Missing gear oil | Manufacturer |
| 1552 | Gear oil warm up | Normal Operation |
| 1555 | Gear heating enabled | Normal Operation |
| 1557 | Gear heating enabled (CCV-option) | Normal Operation |
| 1558 | Timeout gearoil heating routine active (CCV-option) | Manufacturer |
| 1560 | Manual operation fan gear | Manufacturer |
| 1565 | Manual operation gear heating | Manufacturer |
| 1570 | Manual operation gear oil pump | Manufacturer |
| 1575 | Manual operation gear bypass filter | Manufacturer |
| 1600 | High gear speed 310 Gear overspeed 0 ms 75 X 0 0 0 0 ms | Manufacturer |
| 1605 | Gear overspeed 319 WP2035 (G) overspeed 0 ms 200 X 240 0 0 0 ms | Manufacturer |
| 1610 | Maximum gear speed 328 Gear overspeed max. 0 ms 200 X 240 0 0 0 ms | Manufacturer |
| 1620 | Implausible gear speed -- -- 100ms 52 X 0 0 0 0 ms | Manufacturer |
| 1625 | Implausible gear speed leap -- -- 0 ms 52 X 0 0 0 0 ms | Manufacturer |
| 1630 | Disc filter adaption implausible -- -- 0 ms 52 X 0 0 0 0 ms | Manufacturer |
| 1700 | High temp. gear bearing 1 1323 Gear bearing temp. 1 10s 0 455 X 0 20 0 10s | Manufacturer |
| 1705 | Max. temp. gear bearing 1 1324 Gear bear.temp.1stop 10s 52 X 0 0 0 0 ms | Manufacturer |
| 1707 | PT100 gear bearing 1 defect -- -- 10ms 52 455 X 0 20 0 15min | Manufacturer |
| 1708 | Error measuring temp. gear bearing | Manufacturer |
| 1710 | High temp. gear bearing 2 1325 Gear bearing temp. 2 | Manufacturer |
| 1715 | Max. temp. gear bearing 2 1326 Gear bear.temp.2stop | Manufacturer |

| | | |
|---|---|---|
| 1717 | PT100 gear bearing 2 defect | Manufacturer |
| 1718 | Error measuring temp. gear bearing 2 | Manufacturer |
| 1720 | High gear oil temperature 1327 Gear oil temp. high | Environmental |
| 1725 | Low gear oil temperature 1328 Gear oil temp. low | Environmental |
| 1727 | PT100 gear oil sump defect | Manufacturer |
| 1728 | Error measuring temp. gear oil sump | Manufacturer |
| 1729 | PT100 inlet gear defect | Manufacturer |
| 1738 | Error measuring temp. inlet gear -- -- *0 ms 0 455 X 0 20 0 5min | Manufacturer |
| 1800 | Overload gear oil pump 1332 Gear oil(P)therm. | Manufacturer |
| 1810 | Overload gear heating 920 Gearheat.therm.relay | Manufacturer |
| 1815 | Overload fan oil cooler gear 919 Gear fan therm.relay | Manufacturer |
| 1825 | Overload gear bypass filter 1345 Th.relay sec.filter | Manufacturer |
| 1855 | Gear bypass filter choked 1310 Gear sec.filt.choked | Normal Operation |
| 1860 | Oil filter gear choked 1339 Gear oil fil.1 chok. | Normal Operation |
| 1920 | Particle sensor defect | Manufacturer |
| 1922 | Particle Gear Alarm 10min | Manufacturer |
| 1924 | Particle Gear Alarm 24h | Manufacturer |
| 1926 | Particle Gear Alarm Total | Manufacturer |
| 2000 | Brake pads worn 415 Brake pads worn | Manufacturer |
| 2010 | Replace brake pads 416 Replace brake pads | Manufacturer |
| 2050 | Brake closed in operation 1833 Brake closed | Manufacturer |
| 2100 | Feedback brake 1 429 (B) feedback | Manufacturer |
| 2110 | Feedback brake 2 455 (B) feedback 2 | Manufacturer |
| 2350 | Disc brake cooling down | Environmental |
| 2500 | Maximum generator speed 312 (G) overspeed 0 ms 75 X 0 0 0 0 ms | Manufacturer |
| 2510 | Generator speed implausible 300 (G) tacho defect | Manufacturer |
| 2515 | Implausible generatorspeed leap | Manufacturer |
| 2550 | Overload generator fan 1 918 Fan(G)ext.term.relay | Manufacturer |
| 2600 | High temp. gen. bearing 1 526 (G) bearing 1 temp. | Manufacturer |
| 2605 | Max. temp. gen. bearing 1 527 (G)bear.1 temp. stop | Manufacturer |
| 2607 | PT100 gen. bearing 1 defect | Manufacturer |
| 2608 | Error measuring temp. gen. bearing 1 | Manufacturer |

| | | |
|---|---|---|
| 2610 | High temp. gen. bearing 2 528 (G) bearing 2 temp. | Manufacturer |
| 2615 | Max. temp. gen. bearing 2 529 (G)bear.2 temp. stop | Manufacturer |
| 2617 | PT100 gen. bearing 2 defect | Manufacturer |
| 2618 | Error measuring temp. gen. bearing 2 | Manufacturer |
| 2650 | Overload generator fan 2 936 (G)fan 2.term. relay | Manufacturer |
| 2655 | Overload generator fan 3 | Manufacturer |
| 2660 | Thermistor generator 510 Thermistor G1 stator | Manufacturer |
| 2665 | High stator temperature 513 G1 stator temp. | Manufacturer |
| 2670 | Max. temp. stator 514 G1 stator temp. stop | Manufacturer |
| 2672 | PT100 stator temperature defect -- -- 10ms 52 455 X 0 20 0 15min | Manufacturer |
| 2673 | Error measuring temp. stator | Manufacturer |
| 2675 | Overload generator heating | Manufacturer |
| 2710 | Generator power too high 530 (G) power too high | Manufacturer |
| 2800 | Max. power peak 550 (G) peak power max. | Manufacturer |
| 2805 | Wear filter is blocked 553 (G)Wear filter | Manufacturer |
| 2810 | Serivce generator brushes 554 (G)Brushes worn | Manufacturer |
| 2815 | Service wear filter 555 (G)Wear filter stop | Manufacturer |
| 2900 | Manual operation generator heating | Manufacturer |
| 2910 | Manual operation generator fan 1 | Manufacturer |
| 2920 | Manual operation generator fan 2 | Manufacturer |
| 2930 | Manual operation generator fan 3 | Manufacturer |
| 2950 | Lightning protection defect 602 Lightning prot. def | Manufacturer |
| 3000 | Frequency converter not ready 1401 Freq.conv. not ready | Manufacturer |
| 3050 | Frequency converter speed windows | Manufacturer |
| 3090 | Frequency converter spare protection | Manufacturer |
| 3110 | Frequency converter error 1409 Freq. conv. error | Manufacturer |
| 3120 | Frequency converter overspeed 1411 Freq.conv.overspeed | Environmental |
| 3125 | Timeout ready for connection 651 Cut in | Environmental |
| 3130 | Timeout grid synchronisation 1415 Freq.conv. | Environmental |
| 3140 | Frequency converter operation range | Environmental |
| 3150 | Maximum temperature converter inlet | Environmental |
| 3160 | Cables overload 1693 Cable overload | Manufacturer |
| 3162 | Cables overload stop 1694 Cable overload stop | Manufacturer |
| 3200 | Frquency converter temp. low 1602 Freq.conv.temp.low | Manufacturer |
| 3205 | PT100 converter inlet temperature defect | Manufacturer |

| | | |
|---|---|---|
| 3208 | Error measuring temp. converter inlet | Manufacturer |
| 3210 | Frequency converter load rejection 1644 Freq.conv.parallel | Manufacturer |
| 3220 | Reduced power converter 1792 [P] reduced conv. | Manufacturer |
| 3225 | Limit reactive power converter | Manufacturer |
| 3250 | No power 1688 No power | Manufacturer |
| 3255 | Converter power too high | Normal Operation |
| 3260 | Converter power too low | Normal Operation |
| 3265 | Converter torque setpoint | Normal Operation |
| 3320 | 4-20mA torque converter | Manufacturer |
| 3330 | 4-20mA conv. generator speed | Manufacturer |
| 3340 | Parameter setting implausible | Manufacturer |
| 3400 | UPS warning 1762 UPS Warning | Manufacturer |
| 3410 | UPS error | Manufacturer |
| 3420 | UPS buffertime too short | Manufacturer |
| 3500 | Autoreclosure/deactivation 102 Phase drop | Utility |
| 3530 | High voltage - Level 1 110 Voltage high | Utility |
| 3531 | High voltage - Level 2 | Utility |
| 3535 | Low voltage - Level 1 111 Voltage low | Utility |
| 3536 | Low voltage - Level 2 | Utility |
| 3537 | Transient grid error 128 Transient grid error | Utility |
| 3540 | High frequency - Level 1 120 Frequency high | Utility |
| 3541 | High frequency - Level 2 | Utility |
| 3543 | High frequency - P reduction | Utility |
| 3545 | Low frequency - Level 1 121 Frequency low | Utility |
| 3546 | Low frequency - Level 2 -- -- 0 ms 170 468 10 20 0 3min | Utility |
| 3547 | Critical frequency 134 Critical frequency | Utility |
| 3548 | Low frequency - P reduction | Utility |
| 3550 | Phase angle 130 L1-L2-L3 12 | Utility |
| 3555 | Current asymmetry 601 Current asymmetry | Utility |
| 3560 | Voltage asymmetry | Utility |
| 3570 | Grid error 156 Grid error | Utility |
| 3590 | Overvoltage | Utility |
| 3591 | Transient voltage peak | Utility |
| 3650 | Power-up relay 73 Power-up relay | Manufacturer |
| 3750 | Grid measuring implausible | Manufacturer |
| 3800 | Circuit breaker 600 Main switch off | Manufacturer |
| 3805 | Max. transformer temp. 2022 Trafo temp.stop | Manufacturer |
| 3810 | Medium voltage off 2023 Medium Voltage off *30min 170 X 10 0 0 0 ms | Manufacturer |

| | | |
|---|---|---|
| 3820 | Supply circuit breaker off-state 150 Trafo switch tripped | Manufacturer |
| 3830 | Supply curcuit breaker earthed | Manufacturer |
| 3835 | Cable panel breaker open | Manufacturer |
| 3840 | SF6 boiler pressure low 1695 SF6-Pressure low | Manufacturer |
| 3855 | Failure NH-fuses | Manufacturer |
| 3860 | Maintenance NH-fuses | Manufacturer |
| 3870 | Overload transformer fan outlet air | Manufacturer |
| 3875 | Overload transformer fan inlet air | Manufacturer |
| 3920 | Reactive compensation system defect | Manufacturer |
| 4000 | High temperature nacelle 30 Nacelle temp. | Environmental |
| 4020 | Max. temperature nacelle 31 Nacelle temp. stop | Environmental |
| 4022 | PT100 temperature nacelle defect -- -- 10ms 0 455 X 0 10 0 1h | Manufacturer |
| 4023 | Error measuring temp. nacelle | Manufacturer |
| 4100 | Vibration 5 Vibration | Manufacturer |
| 4500 | Tower resonance time 205 Tower resonance time | Manufacturer |
| 4510 | Tower oscillation Y level 1 1539 WP4084#1 CH1 level 1 | Manufacturer |
| 4520 | Tower oscillation X level 1 1555 WP4084#1 CH2 level 1 | Manufacturer |
| 4530 | Tower oscillation Y level 2 1556 WP4084#1 CH1 level 2 | Manufacturer |
| 4540 | Tower oscillation X level 2 1557 WP4084#1 CH2 level 2 | Manufacturer |
| 4565 | System fault accel. sensor 1 | Manufacturer |
| 4585 | 4-20mA tower oscillation Y-axis | Manufacturer |
| 4587 | 4-20mA tower oscillation X-axis | Manufacturer |
| 4588 | Oscillation encoder tower | Manufacturer |
| 4600 | PT100 temp. bottom box defect | Manufacturer |
| 4605 | Fehler Messung Temp. Bodenbox | Manufacturer |
| 5000 | Breakdown obstacle light 1561 Flight warn.ligh.out | Manufacturer |
| 5100 | Service obstacle light 1569 Flight warn.ligh.def | Manufacturer |
| 5500 | High hydraulic pressure 1223 (H)sys. press. high | Manufacturer |
| 5510 | Low hydraulic pressure 1224 (H)sys. press. low | Manufacturer |
| 5520 | 4-20mA hydraulic pressure | Manufacturer |
| 5550 | Low hydraulic oil level 1201 (H) oil level low | Manufacturer |
| 5600 | Overload hydraulic pump 1207 (H)motor therm.relay | Manufacturer |
| 5700 | Max. operation time hydraulic 1213 (H) oper.time > max. | Manufacturer |

| | | |
|---|---|---|
| 5710 | Min. operation time hydraulic 1214 (H) oper.time < min. | Manufacturer |
| 5720 | Brake Accumulator Defect | Manufacturer |
| 5750 | Manual operation hydraulic pump | Manufacturer |
| 5760 | Flushing hydraulic oil | Manufacturer |
| 5770 | Hand-Flushing hydraulic oil | Manufacturer |
| 6000 | Overload electr. yaw brake 747 Yaw(B) therm. relay 1s 52 X 240 20 0 0 ms | Manufacturer |
| 6005 | Overload yaw motor 1&3 750 Yaw(M)therm.relay1+3 | Manufacturer |
| 6010 | Overload yaw motor 2&4 751 Yaw(M)therm.relay2+4 | Manufacturer |
| 6100 | Rotating direction yaw 742 Yaw sensor A/B | Manufacturer |
| 6110 | Yaw sensor defect 730 Yaw sensor defect | Manufacturer |
| 6115 | Yaw sensor A defect | Manufacturer |
| 6116 | Yaw sensor B defect | Manufacturer |
| 6200 | Cable autounwind 715 Cable auto unwind | Manufacturer |
| 6210 | Max. cable twistangle 722 Cable twisted | Manufacturer |
| 6300 | Yaw error 700 Error by yawing | Manufacturer |
| 6350 | Check nacelle position! | Manufacturer |
| 6360 | Implausible nacelle position | Manufacturer |
| 6400 | Manual yaw brake | Manufacturer |
| 6410 | Manual yaw | Manufacturer |
| 6500 | Windspeeds not conformable 220 W.speed nonidentical | Manufacturer |
| 6510 | Anemometer 1 defect 224 Wind gauge R out | Manufacturer |
| 6515 | 4-20mA anemometer 1 | Manufacturer |
| 6520 | Anemometer 2 defect 225 Wind gauge L out 2min | Manufacturer |
| 6525 | 4-20mA anemometer 2 | Manufacturer |
| 6530 | Anemometer defect 226 Wind gauge defect | Manufacturer |
| 6540 | Anemometer frosted 210 Anemom. iced over 20s 52 X 0 20 10 *1d | Environmental |
| 6600 | Wind direction not conformable 221 W.direc.nonidentical | Environmental |
| 6610 | Vane frosted 21 | Environmental |
| 6620 | Vane defect 218 Wind vane defect | Manufacturer |
| 6625 | Control vane! | Manufacturer |
| 6630 | 4-20mA vane 1 | Manufacturer |
| 6632 | Adjust windvane 1 | Manufacturer |
| 6635 | 4-20mA vane 2 | Manufacturer |
| 6637 | Adjust windvane 2 | Manufacturer |

| | | |
|---|---|---|
| 6700 | Shadow casting 1568 Shadow casting | Environmental |
| 6750 | Manual operation meteorology heating | Environmental |
| 7001 | Task runtime failure | Manufacturer |
| 7002 | Task runtime failure 5ms | Manufacturer |
| 7003 | Task runtime failure 10 ms | Manufacturer |
| 7004 | Task runtime failure grid measuring | Utility |
| 7005 | Division by zero 39 Division by zero | Manufacturer |
| 7008 | Reboot required | Manufacturer |
| 7011 | Params loading active | Manufacturer |
| 7012 | Manual snapshot | Manufacturer |
| 7013 | Alarm call test 38 Alarm call test | Manufacturer |
| 7030 | Control flag implausible | Manufacturer |
| 7050 | PT100 TopBox defect | Manufacturer |
| 7055 | Error measuring temperature TopBox | Manufacturer |
| 7085 | Comm. error switch top box | Manufacturer |
| 7090 | Comm. error switch bottom box | Manufacturer |
| 7325 | Time synchronisation failure (SNTP error) | Manufacturer |
| 7400 | High CPU temperature | Environmental |
| 7401 | Max. temperature CPU | Environmental |
| 7402 | CPU Failure RTC | Manufacturer |
| 7403 | CPU Accumulator NVRAM | Manufacturer |
| 7404 | CPU Memory Error | Manufacturer |
| 7420 | PLC-module FM 211 1/4 | Manufacturer |
| 7425 | PLC-module DI 232 1/5 | Manufacturer |
| 7430 | PLC-module DI 232 1/6 | Manufacturer |
| 7435 | PLC-module DO 232 1/7 | Manufacturer |
| 7440 | PLC-module PTAI 1/8 | Manufacturer |
| 7445 | PLC-module CNT 204 / HT 1/9 | Manufacturer |
| 7450 | PLC-module AIO 288 1/10 | Manufacturer |
| 7455 | PLC-module FS 211/ N 2/1 | Manufacturer |
| 7460 | PLC-module CM 202 2/2 | Manufacturer |
| 7465 | PLC-module DIO 216 2/3 | Manufacturer |
| 7470 | PLC-module AIO 288 2/4 | Manufacturer |
| 7475 | PLC-module AO 208 2/5 | Manufacturer |
| 7480 | PLC-module DI 232 2/6 | Manufacturer |
| 8000 | Park master stop 99 Parkmasterstop | |
| 8100 | No park communication 1007 No park communication. | Owner |
| 8105 | Parkmaster operation failed | |
| 8200 | REguard grid station snapshot | |
| 8400 | Error communication PM | Manufacturer |

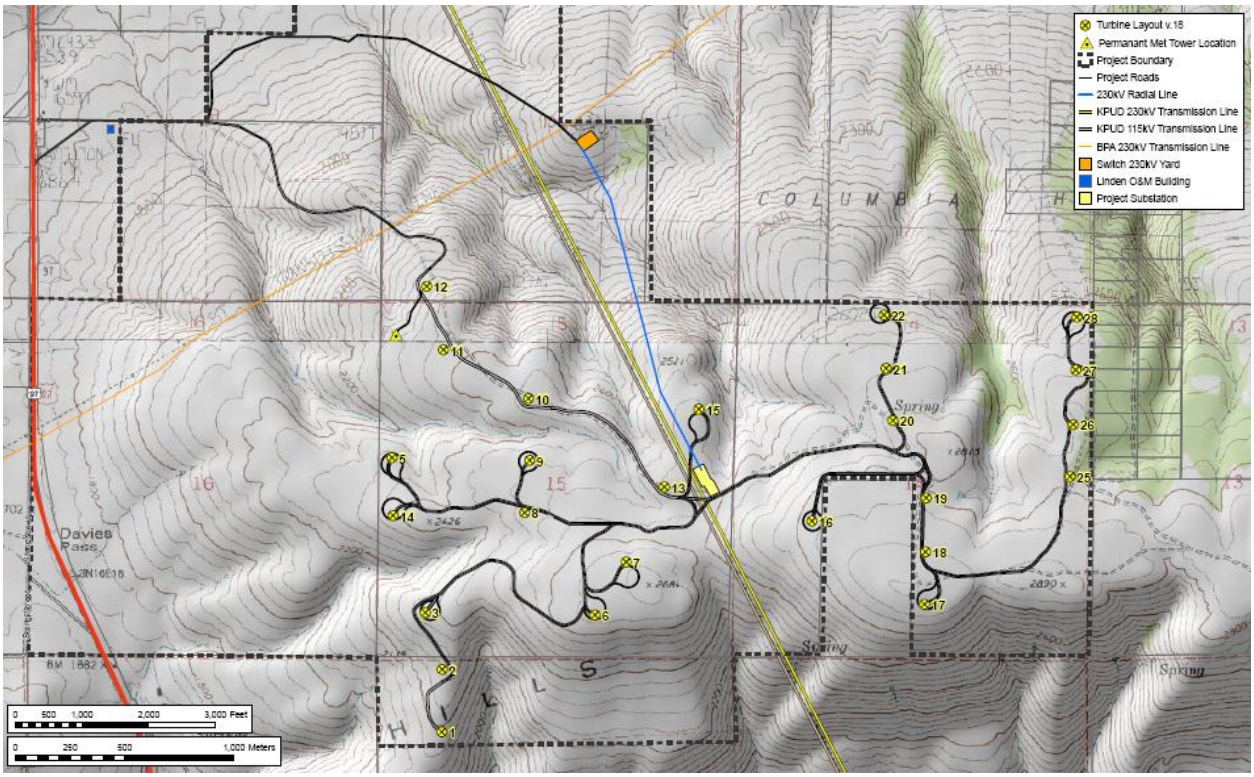
| | | |
|---|---|---|
| 9210 | EVU-Stop 135 EU-stop | |
| Clear | Clearance | |
| COM | Loss of Communication | Owner |
| Maint | Maintenance | Manufacturer |
| Net | Netcom | Owner |
| Rep | Repair | Manufacturer |
| TowerNoCom | Cannot connect to tower to determine fault | Owner |
| TowerNoLog | Cannot connect to tower to determine fault | Owner |
| VIS | Loss of Visibility | Owner |

**EXHIBIT I**
**WIND PLANT SITE**

**LINDEN RANCH WIND PROJECT**

THE LINDEN RANCH WIND PROJECT (PROJECT) IS A WIND GENERATION FACILITY WITH A NAMEPLATE CAPACITY OF 50 MW, LOCATED IN KLICKITAT COUNTY IN SOUTH CENTRAL WASHINGTON, APPROXIMATELY 4.5 MILES SOUTHEAST OF THE CITY OF GOLDENDALE, EAST OF HIGHWAY 97. THE PROJECT SITS ON A RIDGE AT AN ELEVATION OF APPROXIMATELY 2700 FEET OVERLOOKING THE COLUMBIA RIVER.

THE PROJECT SITE CONSISTS OF TWENTY-FIVE WIND TURBINES, APPROXIMATELY TEN MILES OF ROADS, FOUNDATIONS, A COLLECTOR STATION, A ONE MILE 230 KV TRANSMISSION LINE, ONE METEOROLOGICAL TOWER, SWITCHYARD (OWNED BY THE KLICKITAT PUBLIC UTILITY DISTRICT - KPUD) AND AN OPERATING AND MAINTENANCE BUILDING.




THE PROJECT HAS TWENTY-FIVE (25) SENVION (FORMERLY REPOWER) MM92 2.0 MW WIND TURBINE GENERATORS. EACH TURBINE IS A THREE BLADED, UPWIND, HORIZONTAL-AXIS WIND TURBINE WITH A ROTOR DIAMETER OF APPROXIMATELY 92.5 METERS. THE TURBINE ROTOR AND THE NACELLE ARE MOUNTED ON TOP OF A TUBULAR TOWER GIVING A ROTOR HUB HEIGHT OF APPROXIMATELY 80 METERS. THE NACELLE CONTAINS THE ELECTRICAL GENERATING EQUIPMENT. THE MAXIMUM HEIGHT OF THE TURBINES IS APPROXIMATELY 127 METERS WHEN A ROTOR BLADE IS AT THE TOP OF ITS ROTATION.

THE WIND FARM HAS A 230/34.5 KV LINDEN COLLECTION SUBSTATION THAT INCLUDES A 64 MVA MAIN TRANSFORMER, TWO 9.6 MVAR CAPACITOR BANKS, TWO +/- 4 MVAR DVAR UNITS AND RELATED SWITCHGEAR. THE LINDEN COLLECTION SUBSTATION CONNECTS TO KPUD'S NEW LINDEN 230 KV SWITCHYARD VIA A LINDEN OWNED ONE MILE 230 KV RADIAL TRANSMISSION LINE. POINT OF INTERCONNECTION IS AT A SWITCHYARD LOCATED IN THE FACILITY THAT IS OWNED BY KPUD. THE KPUD SWITCHYARD IS THEN CONNECTED TO KPUD'S EXISTING EE CLOUSE SUBSTATION VIA A 230 KV TRANSMISSION LINE. THE EE CLOUSE SUBSTATION IS THEN CONNECTED TO BONNEVILLE POWER ADMINISTRATION'S

(BPA) HARVALUM SUBSTATION. THE POINT OF DELIVERY IS AT BPA'S HARVALUM SUBSTATION.

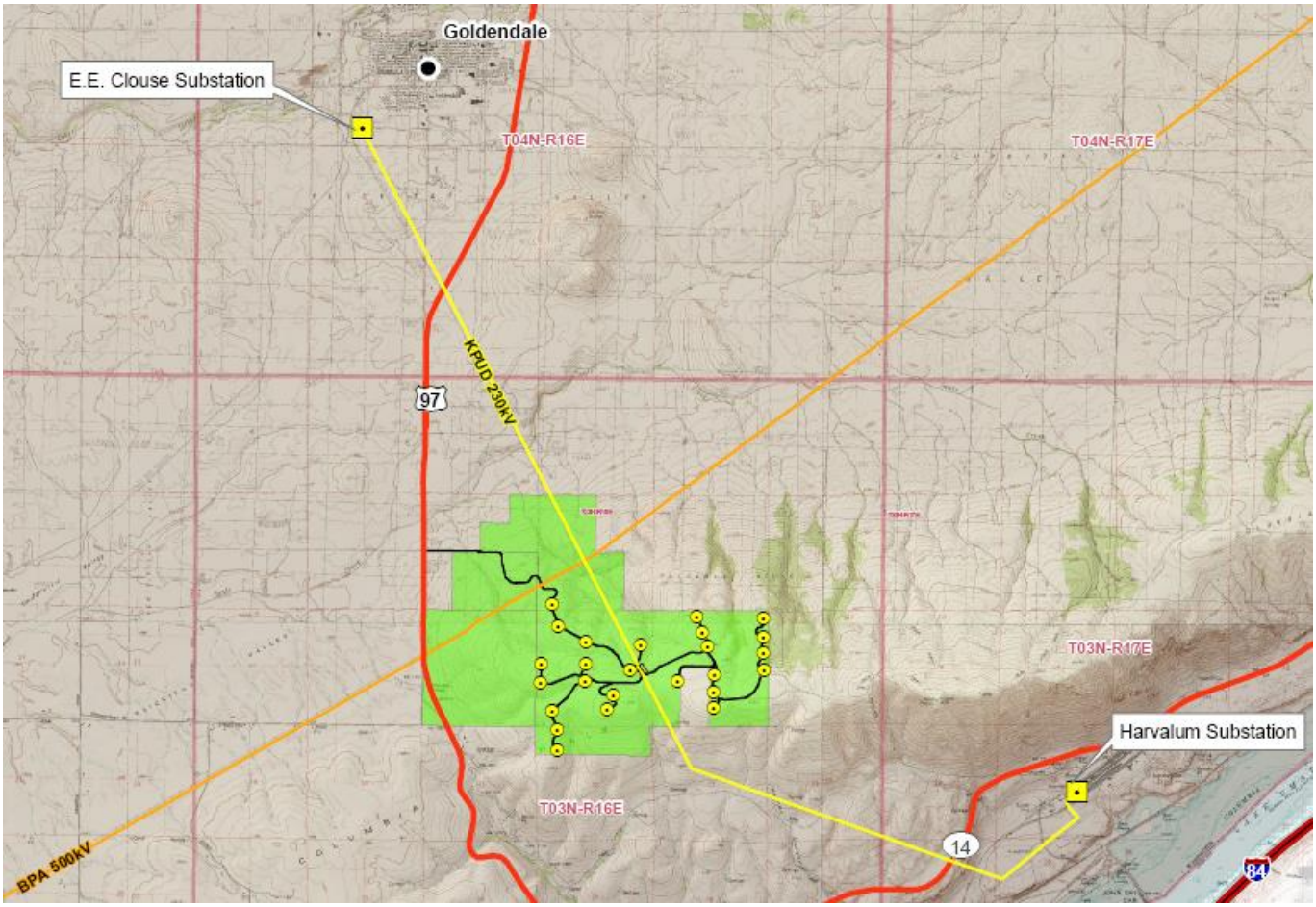


**EXHIBIT J**
**REQUIREMENTS OF PROJECT AGREEMENTS**

**REAL PROPERTY AGREEMENTS**

**1. Triple L Wind Amended and Restated Wind Turbine Project Lease Agreement dated August 28, 2009 (Main Project Lease)**

- Take any measures as may be reasonably necessary to perform under this Agreement in a manner that avoids contributing to soil erosion on the Wind Plant Site.

**2. Department of Natural Resources Wind Power Development Lease No. 60-079358 dated November 1, 2008, as amended by the First Amendment dated September 9, 2009 (Access Road Lease)**

- Do not undertake or suffer any activity to be conducted upon the Wind Plant Site which constitutes a nuisance or which is a threat to the health or welfare of the general public.

- Cut no timber owned by the State of Washington (the "State") and do not remove State-owned valuable material without prior written consent of the State.

- Take all reasonable precautions within O&M Contractor's scope of work to protect the Wind Plant Site from fire, and make every reasonable effort to report any fire to the appropriate authorities.

- Prevent the accumulation of debris or refuse on the Wind Plant Site. Prevent the accumulation of equipment parts or "bone yards" on the Wind Plant Site.

- Repair all damage to improvements, other than Wind Plant improvements, on the Wind Plant Site that are caused by O&M Contractor or its Subcontractors, which is in excess of that which O&M Contractor or its Subcontractors would cause through normal and prudent use of the property for the operation of the Wind Plant. Take all reasonable precautions to protect State-owned crops and trees.

- Keep and maintain the WECs and areas of the O&M Facility utilized by O&M Contractor in good order and repair and safe condition for the safe conduct of any activities or enterprises conducted therein, and keep and maintain the whole of the land, including all improvements in a clean, sanitary and attractive condition.

- Do not destroy any land survey corner monuments and reference points (including but not limited to corner markers, witness objects, or line markers) without prior written approval from the State.

**3. Department of Natural Resources Wind Power Development Lease No. 60-079461 dated September 1, 2006, as amended by the First Amendment dated September 9, 2009 (Buffer Parcel Only)**

- Do not undertake or suffer any activity to be conducted upon the Wind Plant Site which constitutes a nuisance or which is a threat to the health or welfare of the general public.

- Take all reasonable precautions within O&M Contractor's scope of work to protect the Wind Plant Site and improvements from fire, and make every reasonable effort to report any fire to the appropriate authorities.

- Prevent accumulation of debris and refuse on the Wind Plant Site, and prevent the accumulation of equipment parts or "bone yards" on the Wind Plant Site.

- Take all reasonable precautions to protect State-owned crops and trees.

- Do not make or allow to be made any filling in of the Wind Plant Site or any deposit of rock, earth, ballast, refuse, garbage, waste matter, chemical, biological or other wastes, hydrocarbons, any other pollutants, or other matter within or upon the Wind Plant Site, except as approved in writing by the State, or unless permitted as a permitted use. Remove all unapproved fill material, refuse, garbage, wastes and all of the abovementioned material.

- Keep and maintain the WECs and areas of the O&M Facility utilized by O&M Contractor in good order and repair and safe condition for the safe conduct of any activities or enterprises conducted therein, and keep and maintain the whole of the Wind Plant Site, including all improvements, in a clean, sanitary and attractive condition. Unused equipment must be removed from the Wind Plant Site within 3 months of last date of use.

- Do not destroy any land survey corner monuments and reference points (including but not limited to corner markers, witness objects, or line markers) without prior written approval from the State.

**TRANSMISSION AND INTERCONNECTION AGREEMENTS**

**1. Balancing Authority Area Services Agreement with Bonneville Power Administration (09TX-14524)**

- If the Wind Plant is disconnected because of Remedial Action Scheme action, do not restore generation until approval is given by the Bonneville Power Administration Dispatcher and Owner or BOP Contractor provides approval to O&M Contractor. Bonneville will give approval to restore when conditions permit.

- Assist Owner, as requested by Owner within O&M Contractor's scope of work, in complying with other requirements of Bonneville Power Administration.

**RENEWABLE ENERGY EXCHANGE AGREEMENT**

- By 5:00 PM Pacific Prevailing Time each day, provide to Owner a non-binding forecast (in a format agreed upon by Owner) of the expected mechanical availability for each WEC for the following day.

- Provide notice to Owner of the occurrence of any event or the existence of any circumstance that is likely to affect the mechanical availability of a WEC, promptly after becoming aware of such event or circumstance.

**TURBINE SUPPLY & COMMISSIONING CONTRACT AND TOWERS AGREEMENT**

- Act as a communication facilitator between Owner and the manufacturing division of WEC Manufacturer with respect to all obligations of WEC Manufacturer thereunder.

**EXHIBIT K**
**O&M CONTRACTOR REPRESENTATIVE**
**OWNER REPRESENTATIVE**

**O&M CONTRACTOR REPRESENTATIVE**

[_____]

**OWNER REPRESENTATIVE**

**Los Angeles Department of Water and Power,**
**as Operating Agent**
[_____]

**EXHIBIT L**
**PROACTIVE MAINTENANCE QUOTE**

1. Scope of Work. [*to be inserted*].

2. Quote Price: $[*to be inserted*].

3. Payment Schedule: [*to be inserted*].

4. Project Schedule. [*to be inserted*].

5. Performance Bond; Payment Bond. In connection with the Proactive Maintenance, O&M Contractor shall furnish a performance bond and a payment bond, in each case, equal to one hundred present of the Quote Price. Each such bond shall be in a form reasonably acceptable to Owner and consistent with any Applicable Law.

6. Warranties. In addition to the Services Warranty set forth in Article 14 (Warranties and Guarantees), O&M Contractor provides the following warranties with respect to any Parts provided as part of the Proactive Maintenance: [*to be inserted*].

7. Additional Insurance. In addition to the requirements set forth in Article 17 (Insurance), during the performance of the Proactive Maintenance, O&M Contractor will maintain the following additional coverages: [*to be inserted*].

8. PWA Requirements. In performing the Proactive Maintenance, O&M Contractor will comply with the Prevailing Wage and Apprenticeship Requirements set forth in Attachment 1 hereto.

9. Termination. Owner will have the right to terminate O&M Contractor's performance of Proactive Maintenance, in its entirety or with respect to some but not all of the WECs, at any time for its convenience, which termination shall be effective upon the O&M Contractor's receipt of written notice of termination from Owner. In such case, Owner will pay O&M Contractor for Proactive Maintenance (including any Parts and Services) provided up to the date of termination.

10. Terms and Conditions. Except to the extent expressly set forth in this Exhibit L, the terms and conditions of the Agreement will apply to the Proactive Maintenance work.

Attachment 1
Prevailing Wage and Apprenticeship Requirements

O&M Contractor acknowledges that the Proactive Maintenance work is subject to the prevailing wage and apprenticeship requirements described in Internal Revenue Code (the "Code") Sections 45(b)(7) and 45(b)(8) or 45Y(g)(9) and 45Y(g)(10) with respect to a production tax credit, or Sections 48(a)(10) and 48(a)(11) or 48E(d)(3) and 48E(d)(4) with respect to the investment tax credit, IRS Notice 2022-61, and those rules promulgated and published by Treasury Decision 9998 at 89 Fed Reg 53184 (June 25, 2024) as corrected at 89 Fed Reg 66560 (Aug. 16, 2024), as may be amended, modified, or supplemented (the "Prevailing Wage and Apprenticeship Requirements").

(a) General. O&M Contractor will comply with the Prevailing Wage and Apprenticeship Requirements applicable to Proactive Maintenance Services and without limiting the foregoing, the following provisions shall apply:

(i) Prevailing Wages. All laborers and mechanics employed by O&M Contractor or any Subcontractor performing alterations or repairs shall be paid wages not less than the prevailing wage in effect on the Effective Date of this Agreement; provided, that compliance with this clause (a)(i) shall take into account any corrections and penalties for under-payments described in the Prevailing Wage and Apprenticeship Requirements and paid by O&M Contractor (or if paid by Owner, then reimbursed by O&M Contractor).

(ii) Apprenticeships. To the extent applicable during the performance of Proactive Maintenance, with respect to construction, alteration or repair work performed by O&M Contractor's laborers and mechanics, O&M Contractor shall ensure that (A) the percentage of the total labor hours of such work that is performed by qualified apprentices as defined in the Code is at least equal to fifteen percent (15%); (B) any work described in clause (a)(ii) hereof satisfies the applicable apprentice-to-journeyworker ratios of the applicable registered apprenticeship program that is sponsoring the qualified apprentices; and (C) if O&M Contractor or any Subcontractor employs four (4) or more individuals to perform such work, O&M Contractor or the applicable Subcontractor employs one (1) or more qualified apprentices to perform such work; provided, that compliance with this clause (a)(ii) shall take into account O&M Contractor's satisfaction of the good faith effort exception described in the Code Section 45(b)(8)(D)(ii) and the Prevailing Wage and Apprenticeship Requirements (the "Good Faith Effort Exception"). For purposes of establishing O&M Contractor's satisfaction of the Good Faith Effort Exception, O&M Contractor shall provide written documentation reasonably satisfactory to Owner demonstrating that, in accordance with the Prevailing Wage and Apprenticeship Requirements, (x) O&M Contractor submitted a written request for qualified apprentices from a registered apprenticeship program and (y) either (I) such request was denied for reasons other than the failure of O&M Contractor to comply with the established standards and requirements of such registered apprenticeship program, or (II) such registered apprenticeship program failed to respond to such request within five (5) business days after the date on which such registered apprenticeship program received such request, and (z) O&M Contractor continued to make an additional request within three hundred and sixty-five (365) days after each denial or failure to respond to the previous request. For clarification, the placed in service date for each WEC shall be the date on which all of the following have occurred: (1) necessary permits and licenses for operating have been obtained; (2) all critical tests necessary for proper operation have been performed; (3) the WEC has been placed in the control of Owner; (4) the WEC has been synchronized with the transmission grid; and (5) daily operation of the WEC has begun.

(b) Records. O&M Contractor shall contract with a nationally recognized public accounting firm or professional payroll compliance recording firm or other nationally recognized professional organization (the "Agent") to directly collect, maintain, review and audit O&M Contractor and Subcontractor records sufficient to demonstrate compliance with the Prevailing Wage and Apprenticeship Requirements.

(i) Records. O&M Contractor and O&M Contractor's Subcontractors shall each maintain true, accurate, and complete records as required under the Prevailing Wage and Apprenticeship Requirements, to demonstrate its compliance with clause (a), including, in respect of clause (a)(i), employer name and address, applicable wage determination, employee name, employee identification numbers of laborers and mechanics and qualified apprentices who performed construction work on the Wind Plant, the classifications of work they performed, their hours worked in each classification, and the wage rates paid for the work, and in respect of clause (a)(ii), records demonstrating the percentage of labor hours performed by qualified apprentices, apprentice-to-journeyworker ratios achieved, or O&M Contractor's satisfaction of the Good Faith Effort Exception, as applicable (the "O&M Contractor Records"). O&M Contractor shall require its Subcontractors to meet the applicable analogous recordkeeping requirements for the Wind Plant as those described in this clause (b)(i). However, O&M Contractor or O&M Contractor's Subcontractors shall in no event be required to share or disclose personal identifiable information or confidential information (including tax returns) directly with Owner.

(ii) PWA Agent Report. O&M Contractor and its Subcontractors shall each provide O&M Contractor Records directly to the Agent (excluding any personal identifiable information) for the Agent's review and verification of their continuing compliance with the Prevailing Wage and Apprenticeship Requirements. O&M Contractor shall cause Agent to provide the first report to Owner within three (3) months after O&M Contractor's or a Subcontractor's employees are first deployed on site and at the end of each month thereafter, each such report a "PWA Agent Report." Each PWA Agent Report shall provide a summary of the Agent's findings, including any wage or apprentice hour noncompliance and corrective actions made by O&M Contractor or its Subcontractors to cure the noncompliance. The PWA Agent Report shall include employer name and address, employee identification numbers or names of laborers and mechanics who performed laborer and mechanic work on the Wind Plant, classifications of work each employee performed, hours worked in each classification, applicable wage determination and wage rates paid for their work. With respect to qualified apprentices, the PWA Agent Report shall include records demonstrating the percentage of labor hours performed by qualified apprentices, apprentice-to-journeyworker ratios achieved, any required ratio corrective actions and O&M Contractor's or Subcontractor's satisfaction of the Good Faith Effort Exception, as applicable. The PWA Agent Report shall exclude any individual's personal identifiable information or actual hourly wage and benefits information paid to laborers and mechanics that may be greater than the applicable prevailing wage and benefits. PWA Agent Reports may be made available to any taxing authority or other party identified by Owner for purposes of (1) confirming compliance with the Prevailing Wage and Apprenticeship Requirements, or (2) curing any violation of the Prevailing Wage and Apprenticeship Requirements as specified in clause (d) Indemnity.

(iii) Records review. Owner shall, within thirty (30) days of receiving each PWA Agent Report, provide O&M Contractor written comments identifying in good faith any errors, omissions, or other concerns related to such records or O&M Contractor's performance of its obligations under this sub-clause including any commercially reasonable corrective actions Owner reasonably believes are warranted, which O&M Contractor shall review and incorporate or implement at its sole discretion.

(iv) Record Retention. O&M Contractor and its Subcontractors shall each separately maintain O&M Contractor Records for four (4) years after the end of the Term; provided, that if Owner provides written notice to O&M Contractor of a Tax Proceeding (as defined in paragraph (d)) is ongoing, O&M Contractor shall maintain O&M Contractor Records until Owner notifies O&M Contractor that there is a final resolution with respect to such Tax Proceeding. Owner may elect to receive all O&M Contractor Records at the end of the Term.

(c) Cooperation.

(i) Change in Requirements. In the event of a change in U.S. Federal income tax law, issuance of temporary, proposed, or final Treasury regulations, or the issuance of other guidance by the Treasury Department or Internal Revenue Service ("IRS") that is binding on such agencies and can be relied on by taxpayers generally, in each case after the Effective Date and with respect to the Prevailing Wage and Apprenticeship Requirements described herein, O&M Contractor shall comply with such changed regulations or guidance and the Parties agree to provide reasonable cooperation and assistance to amend the provisions of this Section to address such revised requirements, even if the revised requirements are less stringent than stated in this Section. If O&M Contractor, acting reasonably, is unable to comply with such change, it will notify Owner within ninety (90) days of issuance of such changed regulations or guidance.

(ii) Audits. Owner shall promptly notify O&M Contractor in writing when it receives from the IRS any written determination of non-compliance with the requirements described in this Section. The Parties agree to provide reasonable cooperation and assistance in connection with an audit or examination undertaken by the IRS in connection with the Wind Plant's satisfaction of the Prevailing Wage and Apprenticeship Requirements; provided, that O&M Contractor or its Subcontractors shall in no event be required to share or disclose O&M Contractor Records or confidential information (including tax returns) with Oner or any party other than the IRS. No representation or warranty is made by O&M Contractor as to qualification of any part of the Wind Plant for any U.S. Federal production tax credit or investment tax credit other than with respect to the records delivered under clause (b) hereof.

(iii) Labor classifications and wage rates. If Appendix 1 is to include laborers or mechanics for which no prevailing wage determination or labor classification has been published by the Secretary of Labor as of the date of this Contract, Seller shall, as promptly as possible (in any event no later than ninety (90) days before any relevant work begins by Seller or any of its subcontractors on the Facility) and in accordance with applicable law (including IRS Notice 2022-61, 2022-52 I.R.B. 560 (Nov. 30, 2022), as such notice may be amended, modified, or supplemented), request such relevant wage determinations and labor classifications from the Department of Labor ("DOL"); provided, that following receipt of such wage determinations and labor classifications from the DOL, Purchaser shall process any relevant Change Orders by Seller relating to such wage determinations and labor classifications if it results in an increase in laborers' and mechanics' prevailing wage rates or additional apprentice hours. If Purchaser instructs Seller that a Seller's labor classification is exempt from having to pay prevailing wages, Seller will not be responsible for any penalties, fines, wage corrections or additional apprentice hour requirements if it is later determined that such labor classification should not have been exempt from prevailing wages or apprenticeship requirements.

(d) Indemnity. O&M Contractor shall indemnify and hold harmless Owner from the failure by O&M Contractor to satisfy its obligations under clause (a) or clause (b). Owner shall

notify O&M Contractor of any audit, investigation, or written information request from the IRS (a "Tax Proceeding") relating to the Wind Plant's satisfaction of the Prevailing Wage and Apprenticeship Requirements within fifteen (15) days of receiving such request, provided that failure by Owner to notify O&M Contractor of a Tax Proceeding as set forth in this sentence shall not relieve O&M Contractor of its obligations pursuant to this paragraph (d) to the extent O&M Contractor is not prejudiced by such failure. Owner shall provide O&M Contractor reasonable opportunity to (i) review and comment on any written submissions of Owner to be made to the IRS in respect of such Tax Proceeding and (ii) take such actions as the IRS may in writing expressly permit to cure any proposed disqualification, if any. The Parties agree to cooperate in good faith to cure any failure or potential failure to satisfy the Prevailing Wage and Apprenticeship Requirements.