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Assembly Instructions

Nacelle pre-assembly and assembly

E-115 EP3 Wind Energy Converter

Prototype

ENERCON
ENERGY FOR THE WORLD

Publisher

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The revision table refers to the source document of this translation. Not all revisions may have been translated.

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Applicable documents

The titles of the documents listed are either the title of the version in the original language or a rough translation of the title. The document no. stated refers to the original language version in each case.

Document no.	Document
BMA-D0181626	Gebrauchsanweisung Gestell Vormontage E-101/E-115 (E-101/E-115 pre-assembly frame equipment instructions)
BMA-D0337117	Gebrauchsanleitung Adapter für Ausklinkvorrichtung Rotorblatt E115-1 (Gebrauchsanleitung Adapter für Ausklinkvorrichtung Rotorblatt E115-1 (E115-1 rotor blade release device adapter operating instructions))
D0663514	Betriebsanleitung Montageschuhe Rotornabe EP3 (EP3 hub mounting devices operating manual)
GA-D0407038	Gebrauchsanleitung Transportgestell Generatorhälfte 50t (Generator half-section 50t transport frame operating manual)
GA-D0584202	Gebrauchsanleitung Ablagewanne Rotorblatt E-115 (E-115 rotor blade deposit tray operating manual)
GA-D0673171	Gebrauchsanleitung Montagegestell Rotornabe (Hub assembly frame operating manual)
TD-des-10-de-xx-10-003	Betriebsanleitung Sicherheitssteigleiter LMB® (Operating manual for LMB® safety ladder)
TD-des-10-de-xx-15-005	Betriebsanleitung Bolzen für E-115-Rotorblatt-Handling (Betriebsanleitung Bolzen für E-115-Rotorblatt-Handling (E-115-1 rotor blade handling bolt operating manual))
TD-des-10-de-xx-15-031	Betriebsanleitung Lastaufnahme Statorhälfte-50-t (Operating manual for 50 t stator half lifting accessory)
TD-des-10-de-xx-17-113	Betriebsanleitung Hebevorrichtung Generator E-115 EP3 (E-115 EP3 generator lifting device operating manual)
TD-des-10-ger-xx-15-021	Betriebsanleitung Ausklinkvorrichtung Rotorblatt E-101 (E-101 rotor blade release device operating manual)
TD-des-10-ger-xxx-13-020	Bedienungsanleitung Elebia Lasthaken (Bedienungsanleitung Elebia Lasthaken (Operating instructions for the Elebia load hook))
TD-esc-07-ger-xxx-13-007	Reparaturanweisung Farbreparaturen (Repair instructions for paint damage)
TD-esc-08-de-xx-12-003	Generelle Informationen und Tätigkeiten zum Anlagenaufbau und Großkomponententausch (General information and activities for WEC assembly and replacement of major components)
TD-esc-08-de-xx-14-014	Generelle Informationen zu Verschraubungswerkzeugen (General information on tightening tools)

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Table of contents

1 General 1
1.1 About this document 1
1.2 Related Documents 2
1.3 Text and layout conventions 3

2 Safety 4
2.1 Explanations 4
2.1.1 Explanation of safety instructions 4
2.1.2 Explanation of safety instructions 4
2.1.3 Explanation of embedded safety warnings 5
2.1.4 Indicating risk levels 5
2.1.5 Symbols used in this document 6
2.2 Qualifications 7
2.3 Personal protective equipment (PPE) 7
2.3.1 Always use required PPE in a danger zone 7
2.3.2 PPE for special situations 8
2.3.3 Personal fall protection system (PFPS) 8
2.4 Safety instructions 10
2.4.1 General hazards 10
2.4.2 Mechanical hazards 11
2.4.3 Electrical hazards 12
2.4.4 Other hazards 13

3 Introduction to nacelle pre-assembly and assembly 14

4 Machine house pre-assembly 16
4.1 Overview of machine house pre-assembly 16
4.2 Machine house pre-assembly warning notices 17
4.3 Machine house 18
4.3.1 Positioning the assembly frame 18
4.3.2 Disassembling transport straps 18
4.3.3 Attaching the machine house 19
4.3.4 Setting down the machine house on the assembly frame 19
4.3.5 Installing the machine house ladder 20
4.3.6 Bolting yaw bearing threaded bolts 20
4.4 Machine house casing 20
4.4.1 Lowering and bolting the lower machine housing casing 20
4.4.2 Installing the rear basement ladder 20
4.4.3 Installing connectors for the machine housing lower casing 20

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4.5 Anemometer supports 21
4.5.1 Installing anemometer supports 21

5 Pre-assembling the generator 22
5.1 Generator pre-assembly overview 22
5.2 Generator pre-assembly warning notice 23
5.3 Generator stator 25
5.3.1 Preparing stator half-sections 25
5.3.2 Positioning stator half-sections 25
5.3.3 Bolting the stator half-sections 27
5.3.4 Connecting the PE cable 30
5.3.5 Connecting the rotor lock hoses 31
5.3.6 Connecting rear generator casing to separation points 31
5.3.7 Installing generator fans on separation points 31
5.3.8 Installing the fitted parts on the stator separation point 32
5.3.9 Installing lateral generator casing on separation points 32
5.4 Roof unit 32
5.4.1 Installing the landing platform 32
5.4.2 Installing the beacon lights 32
5.4.3 Installing anemometer supports 33
5.5 Generator rotor 33
5.5.1 Preparing rotor sections 33
5.5.2 Positioning the rotor halves 33
5.5.3 Bolting P2 rotor halves 34
5.5.4 Bolting P3 rotor halves 37
5.5.5 Installing PE cable 37
5.5.6 Connecting rotor bridges 37
5.5.7 Install air guide assembly and enclosure at the separation points 40
5.5.8 Installing generator casing on the front 41
5.6 Installing rotor in stator 41
5.6.1 Preparing the rotor 41
5.6.2 Preparing the stator 41
5.6.3 Preparing the lifting device 41
5.6.4 Installing lifting device on rotor bearing unit 42
5.6.5 Placing rotor into stator 42
5.6.6 Bolting the rotor bearing unit to the stator support 42

6 Rotor head pre-assembly 44
6.1 Overview of rotor head pre-assembly 44
6.2 Safety warnings for rotor head pre-assembly 45

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6.3 Rotor head 46
6.3.1 Positioning the assembly frame 46
6.3.2 Setting down the rotor head onto the assembly frame 46
6.3.3 Removing transport supports 47
6.3.4 Installing hub threaded bolts 47
6.4 Rotor head casing 47
6.4.1 Pre-assembling blade pipe extensions 47
6.4.2 Installing blade pipe extensions 47

7 Rotor blade pre-assembly 48
7.1 Pre-assembly overview of rotor blades 48
7.2 Rotor blade pre-assembly warning notice 49
7.3 Outer rotor blade preparation 50
7.3.1 Placing a deposit tray underneath the outer blade 50
7.3.2 Removing the separating flange frame of the outer rotor blade 51
7.3.3 Preparing the outer blade separating flange 52
7.3.4 Checking protrusion of expansion bolts 53
7.4 Inner rotor blade preparation 53
7.4.1 Placing the deposit tray underneath the inner blade 53
7.4.2 Preparing the inner blade separating flange 54
7.5 Installing outer rotor blade on inner rotor blade 54
7.5.1 Checking the centring pins and centring holes 54
7.5.2 Attaching the outer blade for hoisting 55
7.5.3 Slewing outer blade towards inner blade 59
7.5.4 Pre-tightening outer and inner blade 61
7.5.5 Setting down the rotor blade 63
7.5.6 Tensioning outer and inner blade 63
7.5.7 Installing the lightning protection cable 64
7.6 Rotor blade 66
7.6.1 Mounting the blade skirts 66
7.6.2 Installing the Velcro seal on the separation point 68
7.6.3 Removing the stickers on the separation point 72

8 Pre-assembly of rotor blades on rotor head 74
8.1 Warning signs for pre-assembly of rotor blades on rotor head 74
8.2 Rotor head preparation 76
8.2.1 Preparing the blade adapter flange 76
8.2.2 Positioning excavator mats and deposit trays 76
8.2.3 Connecting the pitch installation aid 76
8.3 Preparing the rotor blades 77

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8.3.1 Preparing rotor blade flange ... 77
8.3.2 Installing round sling for manual lever hoist ... 77
8.3.3 Attaching guide ropes to rotor blade ... 78
8.3.4 Rigging the rotor blade ... 80
8.3.5 Removing rotor blade tip from transport frame ... 85
8.4 First rotor blade ... 85
8.4.1 Hoist first rotor blade and move into position ... 85
8.4.2 Fastening first rotor blade ... 87
8.4.3 Set down and unhook the rotor blade ... 88
8.4.4 Assembling ladders and blade adapter step guards ... 89
8.4.5 Installing the lifting eye cover ... 89
8.4.6 Installing roller lightning conductor ... 91
8.4.7 Installing the lightning protection cable ... 92
8.5 Second rotor blade ... 92
8.5.1 Hoisting second rotor blade and moving into position ... 92
8.5.2 Bolting second rotor blade ... 92
8.5.3 Unhooking second rotor blade ... 92
8.5.4 Assembling ladders and blade adapter step guards ... 93
8.5.5 Installing the lifting eye cover ... 93
8.5.6 Installing the roller lightning conductor ... 93
8.5.7 Installing the lightning protection cable ... 93
8.6 Third rotor blade ... 94
8.6.1 Hoist the third rotor blade and move into position ... 94
8.6.2 Bolting third rotor blade ... 94
8.6.3 Unhooking third rotor blade ... 94
8.6.4 Assembling ladders and blade adapter step guards ... 94
8.6.5 Installing the lifting eye cover ... 94
8.6.6 Installing the roller lightning conductor ... 97
8.6.7 Installing the lightning protection cable ... 97

9 Machine house assembly ... 98
9.1 Overview of machine house assembly ... 98
9.2 Safety warnings for machine house installation ... 99
9.3 Nacelle power supply ... 101
9.3.1 Positioning the installation aids ... 102
9.3.2 Connecting the nacelle installation aid ... 102
9.3.3 Preparing the initial rotation of the nacelle ... 104
9.4 Machine house ... 105
9.4.1 Attaching the machine house ... 105
9.4.2 Hoisting the machine house and setting it down on the tower ... 105

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9.4.3 Carrying out the gap measurement yaw bearing – tower ... 106
9.4.4 Installing tower gap cover ... 116
9.4.5 Bolting machine house and tower together ... 116
9.5 Finishing steps ... 117
9.5.1 Mounting the cable support ... 117
9.5.2 Installing grease collecting ring ... 118
9.5.3 Greasing the yaw gear rim ... 119

10 Generator installation ... 122
10.1 Overview of generator installation ... 122
10.2 Safety warnings for generator installation ... 123
10.3 Generator ... 125
10.3.1 Rigging the generator with the lifting device ... 125
10.3.2 Aligning the generator ... 125
10.3.3 Installing the rear transport cover at the back ... 125
10.3.4 Hoisting the generator and moving it into position ... 125
10.3.5 Bolting the stator support to the main carrier ... 126
10.3.6 Removing the lifting device ... 127
10.3.7 Installing the top transport cover at the back; installing the safety ladder ... 127
10.4 Rotor lock and trapped key interlock system ... 127
10.4.1 Connecting rotor lock hydraulic unit ... 127
10.4.2 Removing and installing the transport lock for the rotor lock ... 128
10.4.3 Setting and releasing the rotor lock ... 130

11 Installing the rotor head with rotor blades ... 134
11.1 Overview of installing the rotor head with rotor blades ... 134
11.2 Warning signs for installing the rotor head with rotor blades ... 135
11.3 Rotor head ... 137
11.3.1 Preparing connecting flanges and fits ... 137
11.3.2 Detaching the sixth spinner section ... 137
11.3.3 Rigging the rotor head ... 137
11.3.4 Installing the guide ropes ... 140
11.3.5 Turning rotor blades into the feathered position ... 140
11.3.6 Aligning the rotor head ... 141
11.3.7 Hoisting the rotor head and moving it into position ... 142
11.3.8 Bolting the hub to the rotor bearing unit ... 142
11.3.9 Disassembling lifting equipment ... 143
11.3.10 Removing the guide ropes ... 144
11.4 Rotor head casing ... 145
11.4.1 Installing the sixth spinner section ... 145

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11.5 Slip ring unit 146
11.5.1 Installing the slip ring unit support 146
11.5.2 Disassembling transport adapter 146
11.6 Electromechanical brake 147
11.6.1 Checking release clearance 147
11.6.2 Adjusting release clearance 148

12 Finishing steps 153
12.1 Perform a visual inspection and cleaning work 153
12.2 Releasing the rotor lock 153
12.3 Leaving the WEC 154

Appendix 155
Torque table 155

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List of abbreviations

DIN	Deutsches Institut für Normung e.V. (German institute for standardisation)
EIP	Instructed person (electrically)
GRP	Glass-fibre Reinforced Plastic
ISO	International Organization for Standardization
Load application rib (LAR)	Load application rib
PE	Polyethylene
PE	Protective earth (PE conductor)
PFPS	Personal fall protection system
TSI	Technical Service Info System
WEC	Wind energy converter

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1 General

1.1 About this document

These instructions are intended for installation technicians.

These instructions describe all activities to be carried out for the pre-assembly and installation of the nacelle for the wind energy converter (WEC):

- E-115 EP3

These instructions may only be used for the WEC type specified here.

Procedures

The structure of this document defines the sequence of the work to be performed. Some activities can be performed concurrently.

Perform work steps in accordance with the instructions below so as to ensure a consistent quality standard for all WECs.

Figures

The photos/figures in this document serve as illustrations and may differ from the actual components.
Components in the illustrations may be highlighted using colour. This colour may vary from the original colour of the component.

Up-to-dateness

The actual equipment of the WEC may differ from the explanations and illustrations in this document due to the latest technological changes. Any changes not included by the date this document was released will be published as technical documents in the TSI database.

Point of contact

The Technical Service Dispatch is the contact partner for all comments or clarification of uncertainties.

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1.2 Related Documents

These instructions must always be used in conjunction with the related documents:

General information and activities for WEC assembly

General information that applies to more than one particular WEC type and general activities that are assumed to be known during WEC assembly and are not explained in greater detail in these instructions, e.g. cleaning flange surfaces, setting up the winches etc., are summarised in document “General information and activities for WEC assembly and replacement of major components” and must be observed:

See document: TD-esc-08-de-en-12-003 “Generelle Informationen und Tätigkeiten zum Anlagenaufbau und Großkomponententausch” (General information and activities for WEC assembly and replacement of major components)

General information on tightening tools

The document “General information on tightening tools” contains information on bolted joints, torque-controlled tightening procedures and hydraulic pre-tensioning; torque tables, pressure tables and overviews of hydraulic torque wrenches, tensioning cylinders and hydraulic units, and this document must be adhered to:

See document: TD-esc-08-de-xx-14-014 “Generelle Informationen zu Verschraubungswerkzeugen” (General information on tightening tools)

Operating manual and instruction for use

Technical data, safety instructions and other information on aids and equipment are provided in the corresponding operating manuals by the manufacturers. The applicable manufacturer documentation is explicitly referenced in each respective work step. The manufacturer’s documentation must be observed.

Missing documents

Documents which are not available can be accessed via the TSI database or requested from the relevant Technical Service Dispatch.



An overview of all documents referred to in these instructions is provided at the beginning.

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1.3 Text and layout conventions

Representation of additional notes



Additional notes for better understanding have a background with grey lines and are identified by this symbol.

✓ Identifies a prerequisite for the subsequent action steps.

1. (Numbering) indicates lists or work steps, depending on context.
   Identifies instructions in safety instructions.

➥ Identifies the expected result of an action.

- Identifies level one bullet points.
  - Identifies level two bullet points.

Italics Identifies names of objects and messages where a literal rendition is required, as well as quoted headings.

"Quotation marks" These identify text portions that are meant to stand out from the body text, such as quotations, special technical terms and document titles.

Boldface Apart from headings and marginal text, identifies other important text portions or single words requiring special emphasis.

`Code` typeface Denotes textual messages on displays generated by the software; example:

- The status message `Turbine operational` is displayed.

Cross references Refer to section headings and to tables and figures.

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2 Safety

Staying on a construction site and in/on a wind energy converter and installing wind energy converters present risks. To ensure safe working conditions, observe all safety instructions in these assembly instructions.

In addition, the local accident prevention regulations and general safety regulations for the specific area of application must be observed.

The documentation of the installed components and the work equipment used must also be observed.

2.1 Explanations

In these instructions, a distinction is made between general safety instructions and specific safety warnings. The following explains the details of these safety instructions and safety warnings and their distinguishing factors as well as the safety instructions that apply to this document.

2.1.1 Explanation of safety instructions

Safety instructions refer to general hazards that apply to all activities described in this document.

Type and source of hazard

Consequences of non-compliance

⇨ Measure to avoid danger

Safety instructions describe the type or source of danger, the consequences of ignoring the instructions and how to avoid the danger.

Safety instructions are neither highlighted by a signal word nor by a hazard symbol, nor are they colour-coded.

The safety instructions can be found in the Safety Instructions section.

2.1.2 Explanation of safety instructions

The document presents the safety warnings immediately together with the impending danger.

⚠ DANGER



Source of danger

Consequences of non-compliance

⇨ Measures to avoid the danger

All safety warnings in this document are clearly marked and highlighted with coloured borders. Safety warnings are preceded by a symbol and a signal word. The signal word indicates the extent of the

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hazard. Furthermore, the safety warnings describe the source of danger, the consequences of non-compliance, and how to avoid the danger.

2.1.3 Explanation of embedded safety warnings

Embedded safety warnings appear in this document immediately before a work step involving the impending danger.

⚠ DANGER! Type and source of danger. Measures to avoid the danger

Embedded safety warnings describe the type or source of danger and how to avoid the danger. Embedded safety warnings are preceded by a signal word. The signal word indicates the degree of danger.

2.1.4 Indicating risk levels

Safety warnings contain signal words which indicate the severity of the danger. Safety warnings are also colour-coded according to the respective hazard level.

The definitions of the signal words and their colour coding are listed below.

DANGER:

⚠ DANGER



Indicates an imminently dangerous situation which, if not avoided, will result in severe injury or death.

WARNING:

⚠ WARNING



Indicates a potentially dangerous situation which, if not avoided, may result in severe injury or death.

CAUTION:

⚠ CAUTION



Indicates a potentially dangerous situation which, if not avoided, may result in minor or moderate injury.

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NOTICE:

NOTICE

Indicates a potentially dangerous situation which, if not avoided, may result in property damage.

2.1.5 Symbols used in this document

The hazard symbols used in these instructions conform to European standards (DIN, ISO). The meaning of the symbols is explained in the table below.

If you come across any unknown symbols in the course of work, contact Technical Service Dispatch to ask for their meaning and the required measures and conduct!


Warning of hazard spot


Risk of falling from height


Risk of crushing


Risk of falling objects


Risk of suspended loads


Warning of noise


Warning for floor-level obstacles


Hazard from pointed objects

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Risk of property damage

Important and useful information

2.2 Qualifications

The following requirements apply to the staff performing assembly operations:

- Basic requirements for entering the wind energy converter mentioned in the operating manual
- Qualification as electrically instructed person according to DIN EN 50110-1 (when outside of the scope of DIN EN 50110-1, observe the regulations set out there)
- Training appropriate for the respective job (e.g. technical training in mechanical systems)
- Valid ENERCON health and safety training
- If other requirements apply at the place of installation, these must also be observed.

2.3 Personal protective equipment (PPE)

Various hazards may be present on the construction site, in the danger zone of the wind energy converter (rotor diameter x 0.5), and in the wind energy converter itself. They may lead to serious injuries or death. Therefore:

- Always wear protective equipment as described below.
- Always use protective equipment when entering the danger zone.
- Do not wear rings, necklaces or other jewellery.
- Observe the signs posted in the wind energy converter and on work equipment concerning the use of personal protection equipment.

2.3.1 Always use required PPE in a danger zone



Head protection

To protect the head from falling objects and from impact when falling or when working in cramped conditions. Design according to EN 397 or EN 12492 or ANSI Z89.1.



Foot protection

Protection against foot injuries caused by objects or contact with heat/ chemical substances.

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High-visibility vest

For wear over work clothes to make persons more visible.



Safety goggles

To protect eyes from small falling objects, dirt particles and flying sparks.

2.3.2 PPE for special situations



Protective clothing

Form-fitting clothing with low tear resistance, with tight sleeves and without any projecting parts. Primarily used to protect against entanglement in rotating machine parts. Wear work clothes including electric arc protection when working on the electrical system.



Hand protection

Protection against hand injuries caused by objects or contact with heat/chemical substances.



Ear protection

Protection against hearing damage caused by loud noise.



Personal fall protection system

Prevents falls from more than negligible heights.



Respiratory protection

Protection against toxic substances in the air

2.3.3 Personal fall protection system (PFPS)

When ascending in the tower, climbing onto the nacelle roof, or accessing any other area where there is a risk of falling, the use of the personal fall protection system in addition to the aforementioned protection equipment is mandatory.

The PFPS consists of the following components:

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Fig. 1: Overview of a personal fall protection system

1	Safety harness EN 361, CSA Z357.1	3	Guided-type fall arrester with rigid anchor line (must have been approved for use with safety ladder) EN 353-1, CSA Z259.2.1
2	2x lanyard with shock-absorbing lanyard EN 354, EN 355, CSA Z259.11		

Notes on use

Personal fall protection systems (PFPS) that are defective or used improperly provide only limited protection, or none at all.

- All users must have been trained in the proper use of their PFPS.
- Before each use, perform a visual and functional check of the PFPS.
- Never use a PFPS if it is defective.
- Have PFPS checked regularly by an authorised body.
- Do not use any PFPS whose inspection is overdue – turn it in for inspection.

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2.4 Safety instructions

All technicians at the construction site must adhere to the health and safety regulations. Any questions regarding the health and safety regulations should be addressed to the Safety and Health Construction Coordinator (SHCC).

2.4.1 General hazards

Improper conduct in or around the wind energy converter

Death or serious injury

- ⇨ Observe the health and safety regulations of ENERCON.
- ⇨ Follow all relevant ENERCON instructions for safe use as well as the manufacturers' operating manuals and instructions.
- ⇨ Should the safety standards of the respective country be more stringent than those required by ENERCON, the national regulations apply.

Tripping and slipping

Severe injury

- ⇨ Look out for steps, unevenness, and objects in the work area.
- ⇨ Remove any loose objects from walkways.
- ⇨ Immediately clean any surfaces soiled by oil and/or grease.
- ⇨ Dry off any wet surfaces.

Falling from height

Death or serious injury

- ⇨ Use PFPS according to regulations.
- ⇨ Secure yourself to a designated anchorage point whenever there is a risk of falling from height.

Use of country-specific special vehicles (mini-dumpers, mini-excavators, etc.)

Death or serious injury

- ⇨ When using country-specific special vehicles, observe the applicable laws and regulations.

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2.4.2 Mechanical hazards

Crushing between components

Death or severe injury

- ⇨ Always raise, slew and lower the components with special caution.
- ⇨ Do not place any body parts in the gaps between components.
- ⇨ Do not reach into the intermediate spaces or between flanged surfaces.
- ⇨ Use appropriate tools (mounting lever, etc.) or guide ropes for aligning components.
- ⇨ Secure the components against swinging.

Sharp edged and pointed components

Cuts and abrasions

- ⇨ Wear protective gloves.
- ⇨ Exercise special care when working in the vicinity of sharp edges and corners.

Colliding with components

Severe head injuries

- ⇨ Wear suitable hard hat.
- ⇨ Warn other workers after installing components at head height.
- ⇨ Use barrier tape to cordon off components that protrude into walkways, or take other measures to highlight their presence.

Working with tightening tools

Death or severe injury

- ⇨ Follow the instructions in the document TD-esc-08-en-xx-14-014 “Generelle Informationen zu Verschraubungswerkzeugen” (General information on tightening tools).

Noise when operating impact wrenches and impact tools

Hearing damage

- ⇨ Wear ear protection.
- ⇨ Warn other workers of the noise.

Falling objects

Death or serious injury

- ⇨ Always wear a hard hat inside and near wind energy converters.
- ⇨ Secure tools, materials and other loose objects to prevent them from falling.
- ⇨ When working at a height, ensure that no one is standing/working under the area where work is being done.

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Falling suspended loads

Death or severe injury

- ⇨ Do not stand or work under suspended loads.
- ⇨ Move loads under supervision only.
- ⇨ Set down all suspended loads before leaving the work area.

Improper use of lifting tackle/accessories

Death or serious injury

- ⇨ Ensure that the lifting tackle and lifting accessories are appropriate for the relevant object.
- ⇨ Lifting tackle and lifting accessories may only be used by appropriately instructed personnel. A short training is provided by the foreman and must be documented.
- ⇨ Perform a thorough visual inspection of all lifting tackle and lifting accessories each time before use.
- ⇨ Lifting tackle and lifting accessories that are defective or whose inspection labels have expired must be taken out of service. These must then be clearly labelled as unusable (e.g. with a red "STOP" label).
- ⇨ Ensure that all unauthorised persons have left the danger zone before hoisting a load.
- ⇨ Do not use improvised lifting tackle or lifting accessories.
- ⇨ Contact Technical Service Dispatch if you have any questions or problems relating to the lifting tackle or lifting accessories.

2.4.3 Electrical hazards

Electric current

Death or serious injury

- ⇨ Follow the 5 safety rules.
- ⇨ Only skilled electricians are allowed to access and disconnect medium-voltage rooms and low-voltage rooms.
- ⇨ Switching operations must only be carried out by switching authorised persons.
- ⇨ Instructed persons (electrically) may only work in the areas for which they have received specific training.

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2.4.4 Other hazards

Handling substances that are harmful to human health or allergenic (sensitising)

Poisoning, injury, allergies

- ⇨ Wear suitable protective gloves according to the glove plan, protective clothing and safety goggles.
- ⇨ Avoid breathing in substances. Work only in well-ventilated rooms or use respiratory protection.
- ⇨ Follow all safety, storage and processing instructions provided by the respective manufacturer.
- ⇨ Observe the material safety data sheets for the individual substances.
- ⇨ Observe the latest applicable instructions for the safe use of hazardous substances.

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3 Introduction to nacelle pre-assembly and assembly

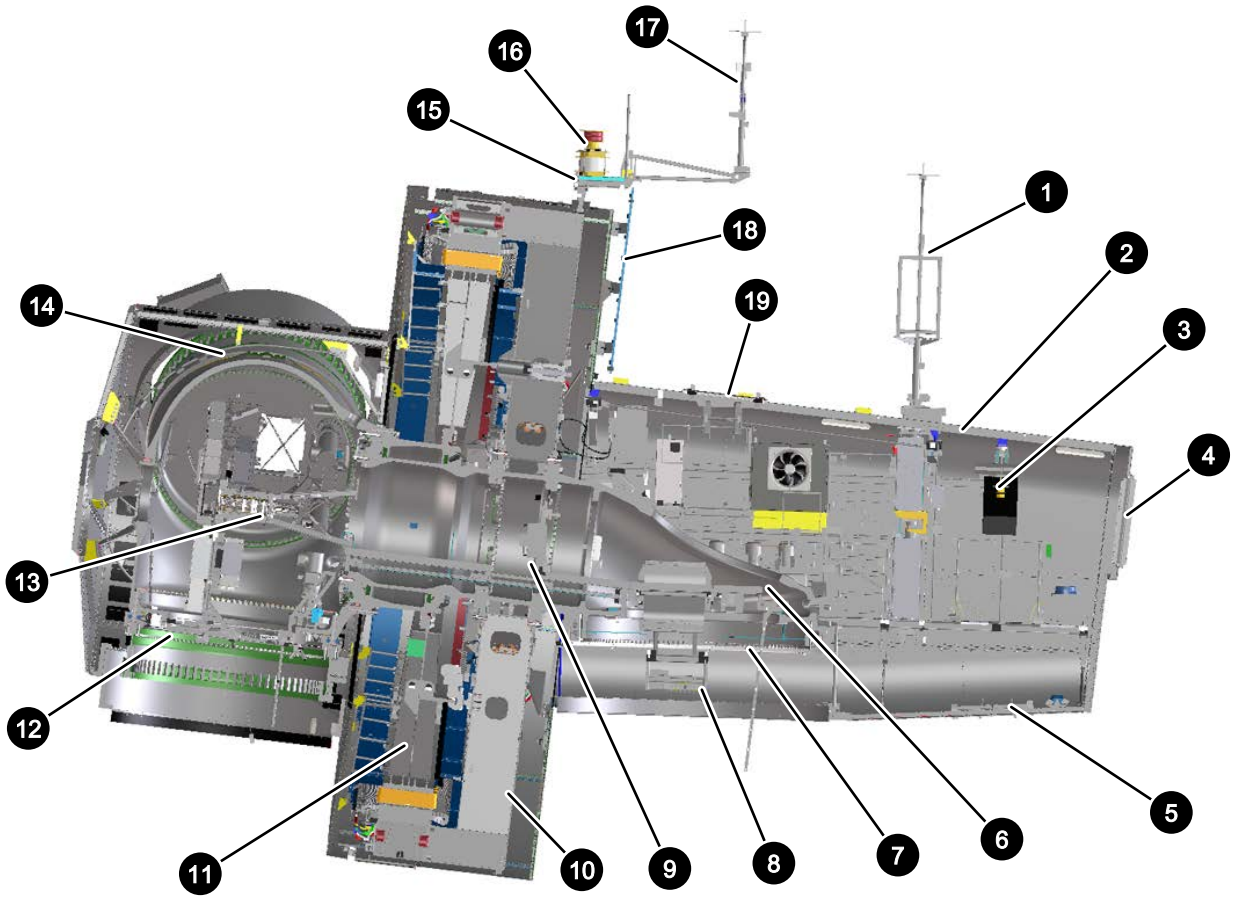


Fig. 2: Nacelle cross-section E-115 EP3

1	Anemometer support (backup)	2	Machine house casing	3	Chain winch
4	Demister segments	5	Winch hatch	6	Main carrier
7	Yaw bearing	8	Cable support	9	Stator support
10	Generator stator	11	Generator rotor	12	Blade flange bearings
13	Slip ring unit	14	Blade adapter	15	Roof unit
16	Beacon light	17	Anemometer support	18	Generator ladder
19	Roof hatch				

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The E-115 EP3 nacelle consists of:

- Machine house
- Generator
- Rotor head
- Rotor blades

Due to the dimensions of the E-115 EP3, the nacelle is supplied to the construction site in several individual parts and has to be assembled on site.

These instructions describe pre-assembly and assembly of the individual components. The activities may be performed simultaneously in some cases.

Machine house

The machine house consists of the main carrier, the yaw bearing with motors, and the machine house casing. The lower machine house casing is lowered from the transport position and bolted.

The machine house is set down on the upper tower flange and bolted onto the tower following a gap measurement.

Generator

The generator consists of the two-part generator stator, the three-part generator rotor, the rotor bearing unit and the roof unit with anemometer supports and beacon lights.
The stator halves are assembled on the ground. The roof unit is installed on the upper stator half. The rotor bearing unit is installed in the middle rotor segment in the factory. The lateral segments of the generator rotor are installed on the middle rotor segment on the ground. The pre-assembled generator rotor with rotor bearing unit is inserted in the pre-assembled stator.

Before installation on the machine house, the generator needs to be aligned using 2 cranes. After being aligned, the generator is raised with the main crane to in front of the machine house and bolted to the main carrier.

Rotor blades

The split rotor blades consist of an inner rotor blade and an outer rotor blade. The outer rotor blades are installed on the inner rotor blades on the ground.

Rotor head and rotor blades

The rotor head consists of hub, blade adapters with blade flange bearings and rotor head casing. The rotor head stands on the rotor head flange for pre-assembling. The blade pipes are mounted on the rotor head casing. The rotor blades are mounted on the rotor head. The rotor blades are lined with shells.

The rotor head with mounted rotor blades is erected by 2 cranes and raised by one crane to the height of the generator. The hub is bolted to the rotor bearing unit.

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4 Machine house pre-assembly

4.1 Overview of machine house pre-assembly

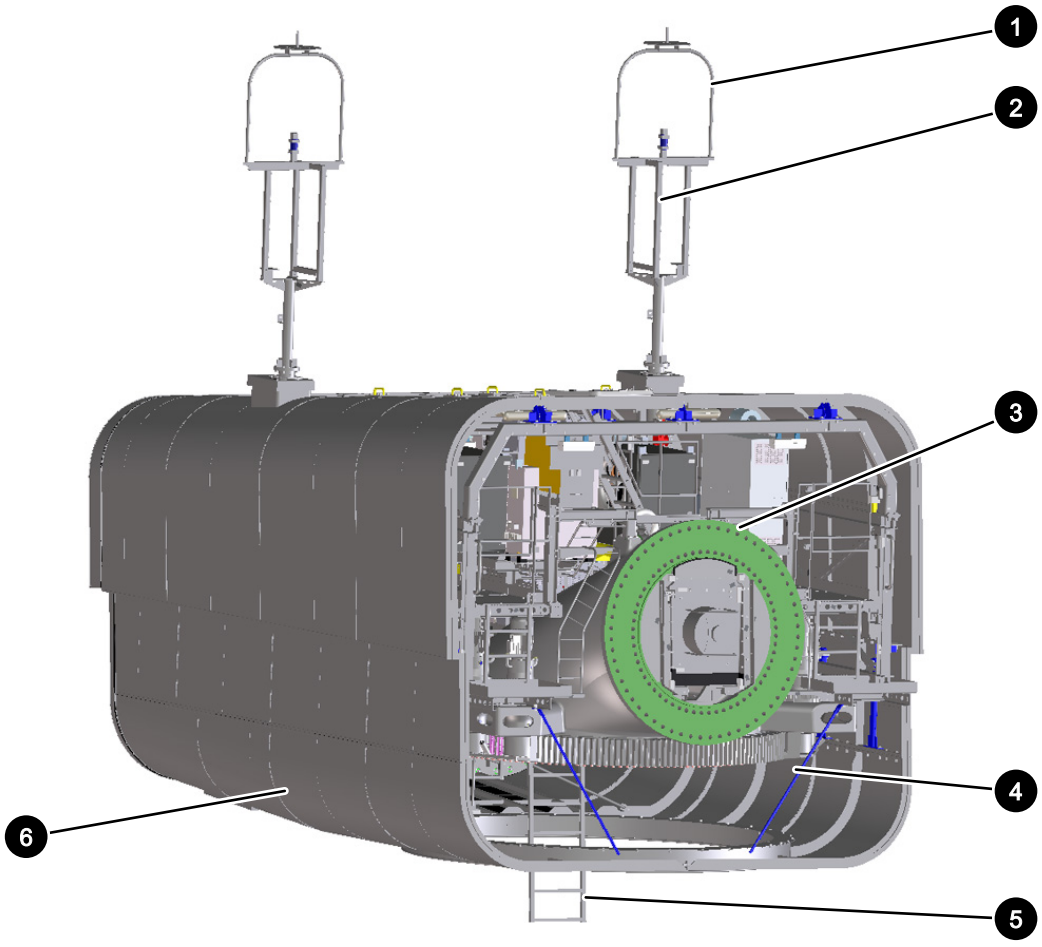


Fig. 3: Overview of machine house pre-assembly

1	Anemometer support	2	Wind mast
3	Main carrier	4	Connection to machine house casing
5	Main carrier ladder	6	Lower machine house casing

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4.2 Machine house pre-assembly warning notices

In addition to the basic safety instructions in ch. 2.4, p. 10, also observe the following basic safety instructions during pre-assembly of the machine house:

⚠ DANGER



Falling from the nacelle

Death or severe injury

- ⇨ Use **two protection systems** when working on top of the nacelle. In combination with your PFPS, use **either**:
  - 2x Fallstop BK (SAP 110933)
  - 1x Fallstop BK (SAP 110933) and 1x fall arrest block (SAP 123833)
- ⇨ Secure yourself to a designated anchorage point whenever there is a risk of falling from height.

⚠ WARNING



Kicking-back and swinging lifting accessories

Severe crushing injuries and bruising

- ⇨ Do not release tensioned lifting accessories from the components.
- ⇨ If possible, always lower the lifting tackle to the ground before releasing it.
- ⇨ If multiple items of lifting tackle are used then always release them one after another.
- ⇨ Lifting accessories attached at an angle must be carefully guided to a vertical position after being released and must not be allowed to swing free.

⚠ CAUTION



Extreme noise when bolting casing segments

Hearing damage

- ⇨ Wear ear protection.
- ⇨ Warn other workers before starting bolting work.

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4.3 Machine house

4.3.1 Positioning the assembly frame



Fig. 4: Pre-assembly frame

The pre-assembly frame (SAP 517642) is used to set down the machine house during pre-assembly. Further technical information is provided in the manufacturer's operating manual.

⇨ See document: BMA-D0181626 "Gebrauchsanweisung Gestell Vormontage E-101/E-115" (E-101/E-115 pre-assembly frame equipment instructions)

1. Positioning 4 excavator mats in the assembly frame's installation position according to the current construction site specification.

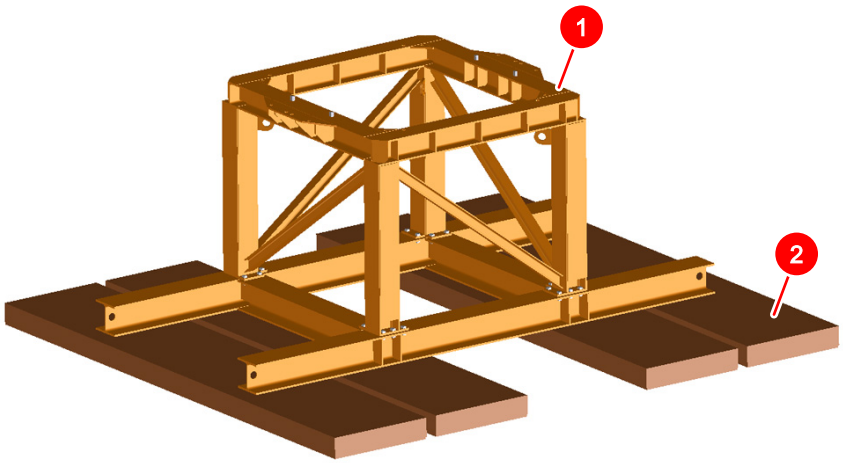


Fig. 5: Assembly frame positioned on excavation mats

1	Assembly frame	2	Excavator mats

2. Set down the assembly frame on the excavator mats according to the figure (fig. 5, p. 18).
3. Align the assembly frame using a spirit level and shim if required.

See also

[〉 18]

4.3.2 Disassembling transport straps

1. Remove transport straps from the main carrier flange.
2. Install the lids on the rear machine house, in front of the rear transport straps.

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4.3.3 Attaching the machine house

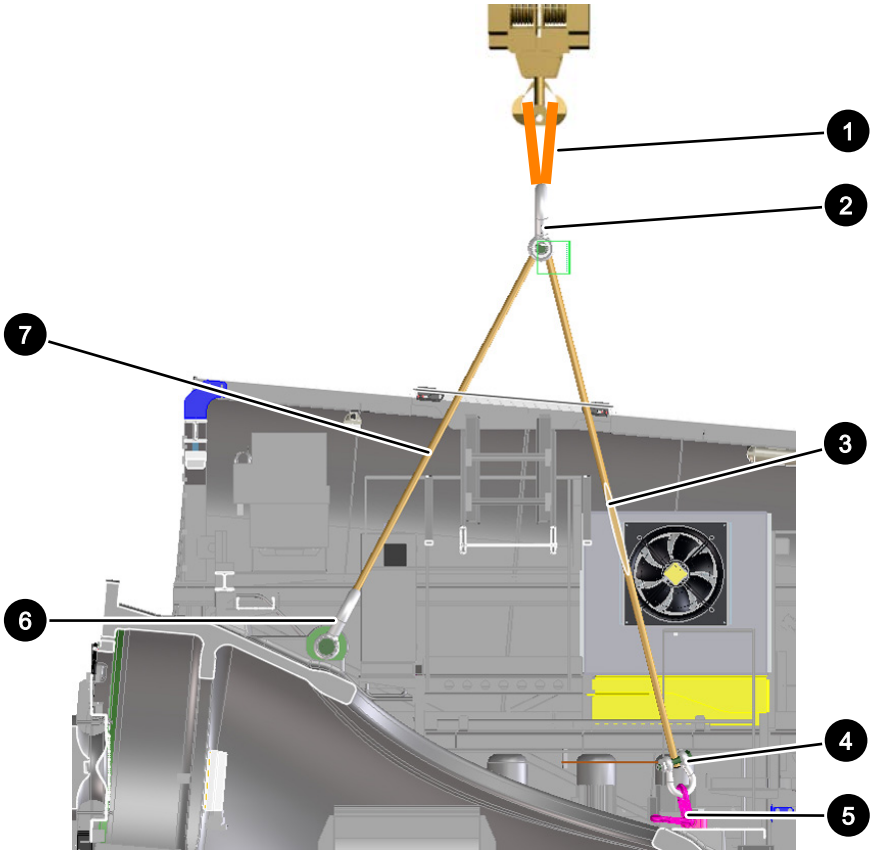


Fig. 6: Attaching the machine house

1	Sling for double crane hook min. lifting capacity 50 t (with double hook)	2	55-t shackle
3	2x 15-t round slings (3 m)	4	2x 35-t shackles
5	2x M48-VLBG swivel hoist rings	6	55-t shackle
7	30-t round sling (2.2 m)		

1. Open the nacelle hatch.
2. Unhook the nacelle roof ladder and place to one side.
3. Attach the machine house for hoisting according to the illustration.

4.3.4 Setting down the machine house on the assembly frame

1. Slew the machine house over the assembly frame.
2. Align the machine house such that the side outriggers of the assembly frame are to the left and right of the machine house.
3. Set the machine house down onto the assembly frame.
4. Below the main carrier, fasten the main carrier transport frame to the assembly frame using 8x M24x70 bolt kits.
5. Tighten the fasteners to a **special torque of 100 Nm**.

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6. Unhook the main carrier from the crane.

4.3.5 Installing the machine house ladder

1. Hook the machine house ladder into the holders underneath the machine house.
2. Install the PE cable on the ladder.

4.3.6 Bolting yaw bearing threaded bolts

1. Clean the yaw bearing flange and check that the surface is even using a try square (SAP 18083).
2. Guide the threaded bolts into the drill holes on the yaw bearing flange. Observe the minimum depth of engagement of 1.5 x bolt diameter.

4.4 Machine house casing

4.4.1 Lowering and bolting the lower machine housing casing

1. Attach 4 750-kg chain hoists to the side guides of the machine housing lower casing.
2. Clamp the chain hoists slightly.
3. Remove transport bolts from the machine housing lower casing.
4. Evenly set the machine housing lower casing down using chain hoists until the lower casing flanges and the upper casing lie on top of each other. Make sure that the machine housing lower casing is not tilted out of line.
5. Fasten the lower casing to the upper casing and tighten the fasteners to the required torque.
6. Connect bolt connections on the lateral guides and tighten them to the required torque.

4.4.2 Installing the rear basement ladder

1. Position basement ladder underneath the machine housing platform and assemble it until hand-tightened.
2. Tighten the fasteners to the required torque, see *Torque table*, p. 155.

4.4.3 Installing connectors for the machine housing lower casing

1. Hand-tighten the front, middle, and rear connectors of the machine housing casing.
2. Tighten all fasteners to the required torque, see *Torque table*, p. 155.

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4.5 Anemometer supports

4.5.1 Installing anemometer supports

✓ Telescopic masts are in the lowered transport position.

1. Attach the first anemometer support and lift it onto the machine housing roof.
2. Set down the anemometer support onto the flange of the telescopic mast.
3. Bolt the anemometer support to the telescopic mast.
4. Install the second anemometer support on the second telescopic mast.
5. Tighten all fasteners to the required torque, see *Torque table*, p. 155.



Anemometer supports on the machine housing roof are not equipped with wind measuring units. Anemometer supports serve as a backup for the anemometer supports on the generator.

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5 Pre-assembling the generator

5.1 Generator pre-assembly overview

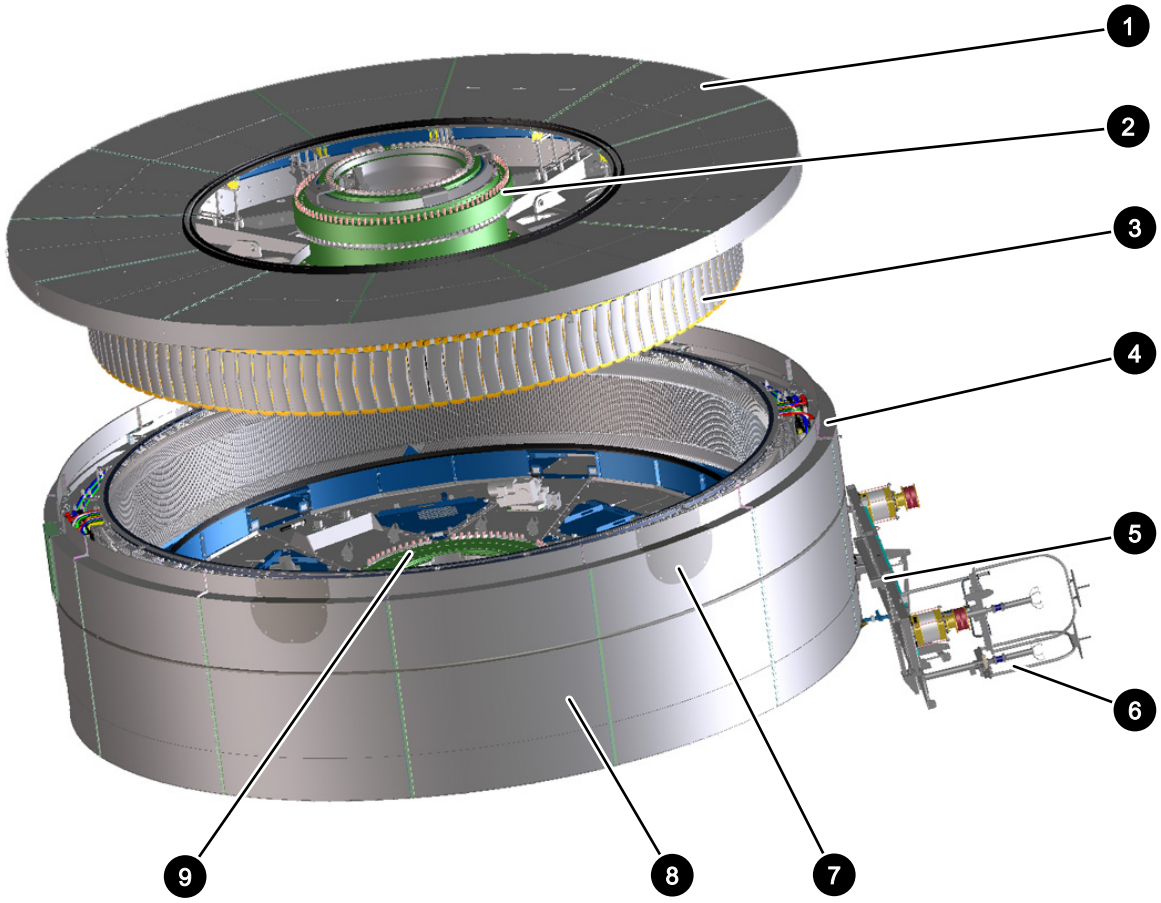


Fig. 7: Overview of generator pre-assembly

1	Front generator casing	2	Rotor bearing unit
3	Pole shoes	4	Generator casing jacket
5	Roof unit	6	Anemometer supports
7	Jacket section cover	8	Separation point casing section
9	Stator support		

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5.2 Generator pre-assembly warning notice

In addition to the basic safety instructions in ch. 2.4, p. 10, also observe the following basic safety instructions during pre-assembly of the generator:

⚠ DANGER



Working with the hydraulic torque wrench

Death or severe injury

- ⇨ Hydraulic torque wrenches may only be operated by persons who have received proper training and are familiar with the unsupervised use of the device.
- ⇨ Wear safety goggles.
- ⇨ Wear protective gloves.
- ⇨ Only the person working with the tool may use the remote control.

⚠ WARNING



Danger of tripping and falling at openings below the packing film

Severe injury

- ⇨ Do not step on yielding surfaces when walking on packed components.
- ⇨ Do not step on the holes and openings underneath the packaging foil and label these areas if necessary.

⚠ WARNING



Kicking-back and swinging lifting accessories

Severe crushing injuries and bruising

- ⇨ Do not release tensioned lifting accessories from the components.
- ⇨ If possible, always lower the lifting tackle to the ground before releasing it.
- ⇨ If multiple items of lifting tackle are used then always release them one after another.
- ⇨ Lifting accessories attached at an angle must be carefully guided to a vertical position after being released and must not be allowed to swing free.

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⚠ CAUTION



Extreme noise when bolting casing segments

Hearing damage

⇨ Wear ear protection.

⇨ Warn other workers before starting bolting work.

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5.3 Generator stator

5.3.1 Preparing stator half-sections

1. Using the labels on the packaging of the stator halves, ensure that one stator half P1 (12 o'clock half) and one stator half P2 (6 o'clock) are present.
2. Using the serial numbers, check that the stator halves present match.
3. Open the packaging of the stator halves at the disconnection points and open at the load suspension devices. The remaining area of the stator half-sections remains packed for the time being.
4. Make sure that the holes and flange surfaces are clean.

5.3.2 Positioning stator half-sections



Fig. 8: Stator half-section lifting accessory

The stator half-section lifting accessory (SAP 597918) is used for transporting and rigging a stator half-section. The lifting accessory is comprised of a left and right lifting accessory.
Further technical information is provided in the manufacturer's operating manual.

⇨ See document: TD-des-10-de-xx-15-031 "Betriebsanleitung Lastaufnahme Statorhälfte-50-t" (Operating manual for 50 t stator half lifting accessory)



Fig. 9: Generator half-section 50t transport frame

The generator half-section 50t transport frame (SAP 606959) is used for transporting and storing a generator stator half-section. During pre-assembly of the stator, the stator half-sections are bolted to one another on the transport frames.
Additional technical data may be found in the manufacturer's operating manual.

⇨ See document: GA-D0407038 "Gebrauchsanleitung Transportgestell Generatorhälfte 50t" (Generator half-section 50t transport frame operating manual)

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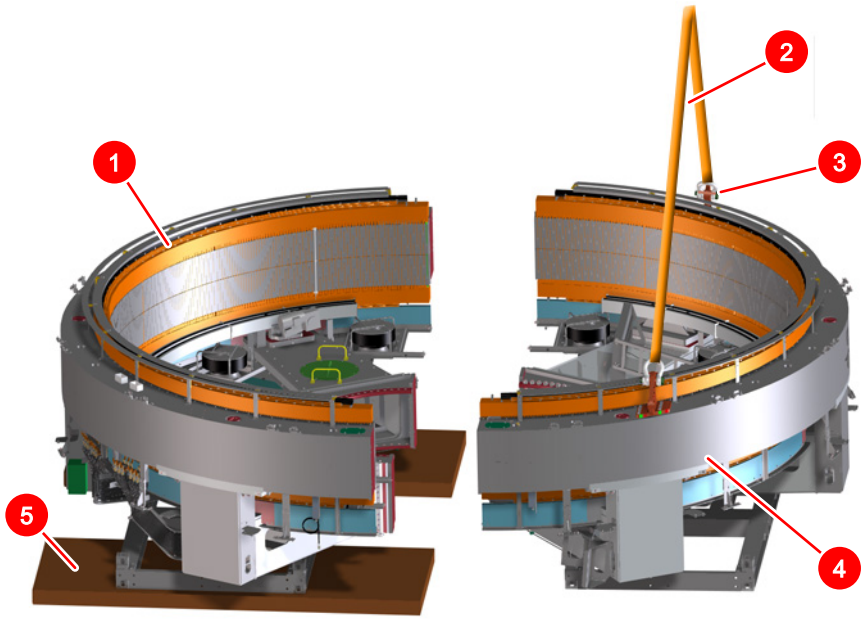


Fig. 10: Positioning the stator halves

1	12 o'clock stator half section	4	6 o'clock stator half section
2	2x 40-t round slings (8 m)	5	Excavator mats
3	2x stator half-section lifting tackle with shackle		

1. Spread out enough excavator mats at the installation position of the first stator half.
2. Attach lifting tackle to the first rotor half-section according to the overview (fig. 10, p. 26) and lower it onto the excavator mats.
3. Ensure that the stator half-section is aligned horizontally.
4. Remove the lifting accessory from the first stator half-section.
5. Rig the second rotor half as shown in the overview (fig. 10, p. 26).

The stator half-sections must be aligned horizontally and without offset at the flange surfaces so that they can be bolted without tension.

6. Slew the second stator half in front of the first stator half and align the flange surfaces with each other.
7. Correct the height of the second stator half-section if necessary so that the flange surfaces are flush.

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5.3.3 Bolting the stator half-sections

NOTICE

Incorrect procedure when bolting the stator half-sections

Stator halves sliding to one another and/or formation of an eccentric air gap

- ⇨ Always maintain the specified assembly order of the centre bolts and bolt connections.
- ⇨ Make sure that the length of the centre bolts is sufficient for the bolt connection.
- ⇨ Do not unhook the second stator half-section out of the crane until the bolt connections of the stator half-sections have been bolted fully to the required torque.

1. If the hand hole covers are present on the stator ring, remove them.
2. Lightly grease the centre bolts with MoS2 multipurpose grease.
3. On the separating flanges, lightly grease the large drill holes for the centre bolts with MoS2 multipurpose grease. Make sure that grease does not enter the flange surfaces.

Installing centre bolts

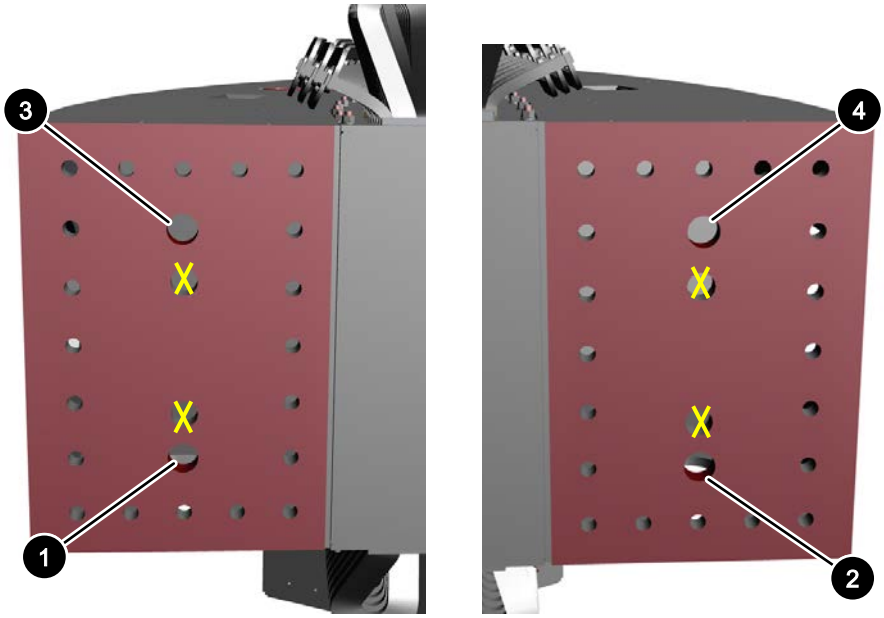


Fig. 11: Assembly sequence for stator ring centre bolts

1-4	Assembly sequence

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4. On the connecting flanges of the **stator ring**, insert centre bolts from the lower stator half to the upper stator half in the large drill holes.

> Centre bolts do not fit in the smaller drill holes positioned centrally inside (yellow X). No bolt connections need to be inserted in these drill holes.

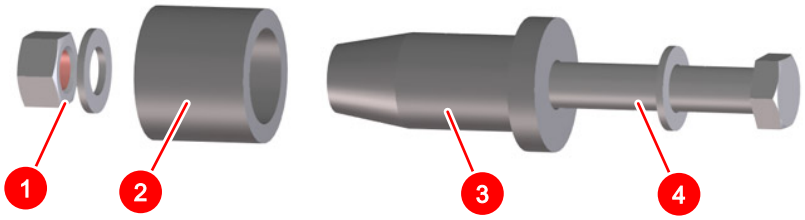


Fig. 12: Overview of centre bolt fasteners

1	Nut and washer	3	Centre bolt
2	Centring sleeve	4	Bolt and washer

5. Produce M24 bolt connections on the centre bolts using the centring sleeves according to the overview (fig. 12, p. 28).
6. Tighten the M24 bolt connections on the centre bolts one after another, in the specified sequence, with a torque of **40 Nm** until they cannot be tightened any more, and the gap between the separating flanges is evenly closed.
7. Once the gap between the separating flanges has closed completely, tighten the centre bolt M24 fasteners in the specified sequence with a torque of 790 Nm.
8. Insert the M24 fasteners in the remaining drill holes, but do not tighten yet.

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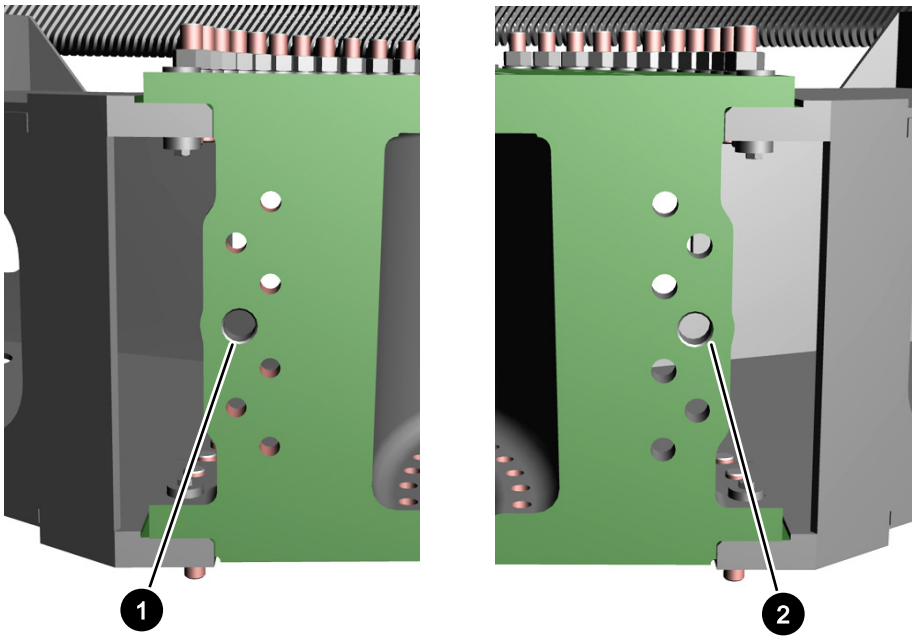


Fig. 13: Assembly sequence for stator support centre bolts

1-2	Assembly sequence

9. On the connecting flanges of the **stator support**, insert centre bolts from the unthreaded side in the large drill holes.
10. Produce M24 bolt connections on the centre bolts using the centring sleeves according to the overview (fig. 12, p. 28).
11. Tighten the M24 bolt connections on the centre bolts one after another, in the specified sequence, with a torque of **40 Nm** until they cannot be tightened any more, and the gap between the separating flanges is evenly closed.
12. Once the gap between the separating flanges has closed completely, tighten the centre bolt M24 fasteners in the specified sequence with a torque of 790 Nm.
13. Bolt M36 threaded bolts into the remaining drill holes. Observe the minimum depth of engagement of 1.5 x bolt diameter.

Check offset of stator halves

14. At the flange surfaces, check the alignment of the stator half-sections to one another using a H bracket. There must be no offset at the flanges between the stator half-sections.

Result	Work step
There is no offset.	Continue with *Bolting the stator half-sections*, p. 30.

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Result	Work step
There is offset at the flange surfaces.	■ Make sure that the centre bolts have been installed with the correct length. ■ Make sure that the gap between the stator ring halves flanges and the stator carrier halves is completely closed. ■ Contact Technical Service Dispatch.

Bolting the stator half-sections

15. Tighten the M24 bolt connections on the stator ring connecting flanges **crosswise** to the required torque.
16. Tighten the M36 bolt connections on the stator support connecting flanges one after another from the inside out to the required torque.
    ↳ The stator halves are now fully bolted.
17. Put enough excavator mats and, if necessary, scantlings underneath the second stator half.
18. Set down the stator half.
19. Remove the lifting accessories from the second stator half.
20. Install the hand hole covers on the stator ring and tighten the fasteners to the required torque.

5.3.4 Connecting the PE cable

The PE cables are pre-installed on one side on the stator half-sections.

1. On the stator separation points, clear the holes and the contact surfaces of the earthing points of paint using a wire brush if necessary and clean with Rivolta M.T.X. 60 Forte (SAP 553183).
2. Spray the cleaned contact surfaces with Rivolta F.L.G. GT-2 (SAP 514100).
3. Mount the PE cables on the earthing points opposite of the second stator half and tighten with the special torque **60 Nm**.
4. Spray the tightened fasteners with Rivolta F.L.G GT-2.

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5.3.5 Connecting the rotor lock hoses

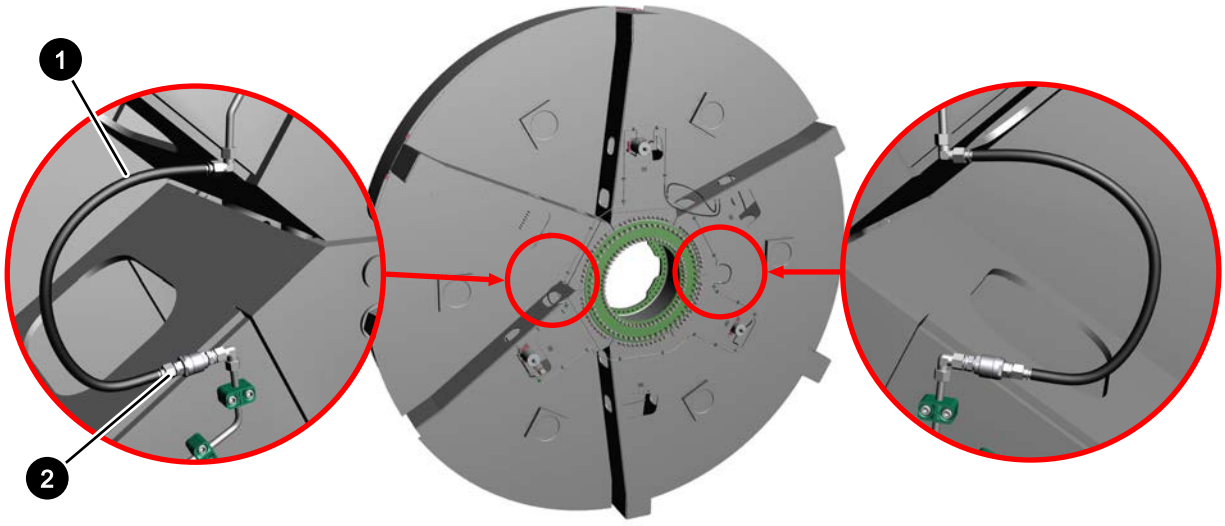


Fig. 14: Overview of the rotor lock hoses

1	Hose	2	Coupling

1. Loosen the hoses preassembled on one side of the rotor lock at the stator separation points on the machine-house side.
2. Make sure that couplings on hoses and pipes are clean.
3. Attach hose couplings to the pipes. The couplings latch with an audible click.

5.3.6 Connecting rear generator casing to separation points

1. Mount connector supports at the separation points of the generator stator.
2. Install bracket connectors.
3. Connect the connectors to the rear generator casing.
4. Bolt the rear generator casing together and to the bracket.

5.3.7 Installing generator fans on separation points

1. Position generator fans underneath the stator separation points.
2. Position the crane hook above the first separation point.
3. Hook suitable round slings for lifting the fan into the crane hook and guide them from above through the opening in the stator.
4. Hook the fan onto the crane hook.
5. Lift the fan to the installation position and bolt it to the stator.
6. Bolt the plates of the generator enclosure together.
7. Tighten all fasteners to the required torque, see *Torque table*, p. 155.

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8. Install the generator fan at the second separation point as well.

5.3.8 Installing the fitted parts on the stator separation point

1. Bolt air guide assembly frames together at the separation points.
2. Install the door plate on the rotor head at the 3 o'clock separation point.
3. Install the door plate on the rotor head at the 9 o'clock separation point.
4. Installing cover plates at separation points
5. Install generator enclosure seals at the separation points.
6. Install the air deflector plates at the stator ring separation points.
7. Attach the seals to the air deflector plates.
8. Tighten all fasteners to the required torque, see *Torque table*, p. 155.

5.3.9 Installing lateral generator casing on separation points

1. Position generator casing segments at the separation points. Make sure that the sealing cords between the segments do not slide.
2. Bolt separation point segments to the already pre-assembled generator casing. There are 5 holes left in the area ofthe stator ring.
3. Produce bolt connections to the rear generator casing.
4. Tighten all fasteners to the required torque, see *Torque table*, p. 155.

5.4 Roof unit

5.4.1 Installing the landing platform

1. Install the roof unit platform at the 12 o'clock position of the generator.
2. Tighten the fasteners to the required torque, see *Torque table*, p. 155.

5.4.2 Installing the beacon lights

Installing daytime beacon lights

1. Position the daytime beacon lights on the beacon carrier at the specified installation positions. The couplings for the connecting cables must be facing the rear.
2. Insert the connecting cables on the couplings of the daytime beacon lights and secure them.

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3. Bolt the daytime beacon lights with the beacon carrier.

Installing nighttime beacon lights

4. Place the nighttime beacon lights onto the 4 threaded bolts on the top of the daytime beacon lights.
5. Plug in the connecting cables underneath the nighttime beacon lights and secure them.
6. Lubricate the threaded bolts with a thin layer of white all-round paste.
7. Hand-tighten the nighttime beacon lights.
8. Tighten the fasteners to the required torque, see *Torque table*, p. 155.
9. Lay the connecting cable and secure to the beacon carrier with as many cable ties as needed.

5.4.3 Installing anemometer supports

1. Install supports of the wind measuring units on the platform hinges.
2. Fold down the supports and secure them to the platform with a sufficient number of lashing straps.
3. Install anemometer supports on the supports.
4. Fold down anemometer supports and secure them on supports with a sufficient number of lashing straps.

5.5 Generator rotor

5.5.1 Preparing rotor sections

1. Open the packaging of the rotor half-sections at the connecting flanges. The remaining rotor halves surfaces remain packaged.
2. Make sure that the holes and flange surfaces are clean.

5.5.2 Positioning the rotor halves

1. Spread out enough excavator mats at the installation position of the generator rotor.
2. Set down the middle P1 rotor half on the excavator mats.
3. Ensure that the rotor half-sections are aligned horizontally.

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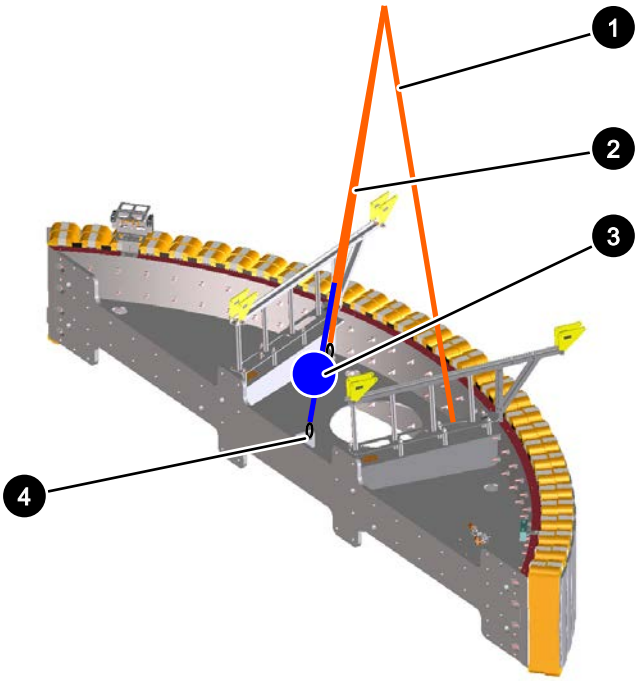


Fig. 15: Rigged rotor half

1	2x 4-t round slings (4 m)	2	1x 4-t round sling (3 m)
3	3-t chain hoist	4	3x 9.5-t shackles

4. Rig the lateral P2 rotor half for hoisting.
5. Slew the lateral P2 rotor half in front of the P1 rotor half flange marked with P2, and align the flange surfaces so that they face each other.

The rotor half-sections must be aligned horizontally with one another and without offset at the flange surfaces so that they can be bolted together without tension.

5.5.3 Bolting P2 rotor halves

NOTICE

Incorrect procedure when bolting the rotor half-sections

Rotor halves sliding towards one another and/or formation of an eccentric air gap

- ⇨ Always maintain the specified assembly sequence of the centre bolts and bolt connections.
- ⇨ Make sure the correct centre bolts are used.
- ⇨ Do not unhook the second rotor half-section out of the crane until the bolt connections of the rotor half-sections have been bolted fully to the required torque.

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1. Lightly grease the centre bolts with MoS2 multipurpose grease.
2. On the separating flanges, lightly grease the large drill holes for the centre bolts with MoS2 multipurpose grease. Make sure that grease does not enter the flange surfaces.

Installing centre bolts

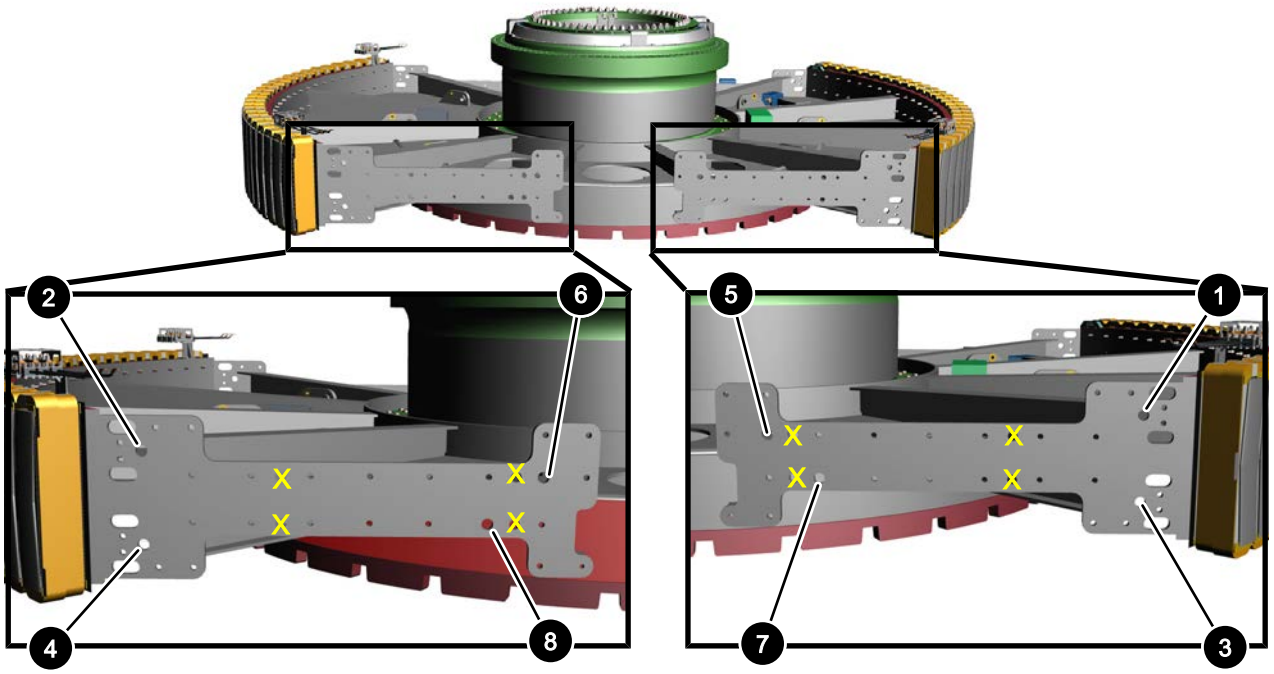


Fig. 16: Rotor centre bolts installation position

1-8	Centre bolt assembly sequence

3. Insert the centre bolts from the middle rotor part P1 outwards into the large drill holes on the rotor connecting flanges in accordance with the specified assembly sequence.

Centre bolts do not fit in the smaller drill holes (yellow X). No bolt connections need to be inserted in these drill holes.

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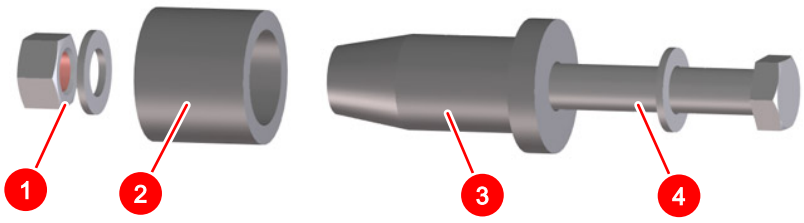


Fig. 17: Overview of centre bolt fasteners

1	Nut and washer	3	Centre bolt
2	Centring sleeve	4	Bolt and washer

4. Install the centre bolt M24 fasteners as shown in the overview (fig. 17, p. 36).
5. Tighten the M24 bolt connections on the centre bolts one after another, in the specified sequence, with a torque of **40 Nm** until they cannot be tightened any more, and the gap between the separating flanges is evenly closed.
6. Once the gap between the separating flanges has closed completely, tighten the centre bolt M24 fasteners in the specified sequence with a torque of 790 Nm.
7. Insert the M24 fasteners in the remaining drill holes, but do not tighten yet.

Bolting the rotor halves

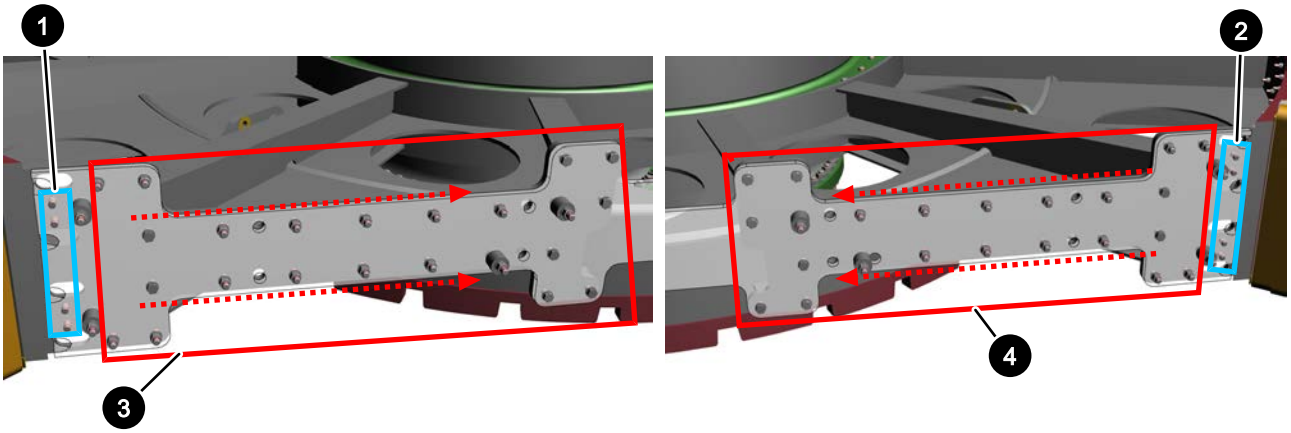


Fig. 18: Rotor halve separating flange with bolt connections

1-4	Assembly sequence for bolt connections on separating flange

8. Tighten the outer vertical M24 bolt connections from the top down to a torque of 790 Nm.
9. Tighten the horizontal M24 bolt connections on the connecting flanges from the outside inwards to a torque of 790 Nm.

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5.5.4 Bolting P3 rotor halves

1. Position the P3 rotor half on the middle rotor half according to ch. 5.5.2, p. 33.
2. Bolt P3 rotor half according to ch. 5.5.3, p. 34.

5.5.5 Installing PE cable

The PE cables are pre-installed on one side on the rotor half-sections.

1. At the rotor separation points, clear the holes and the contact surfaces of the earth points of paint with a wire brush if necessary and clean with Rivolta M.T.X. 60 Forte (SAP 553183).
2. Spray the cleaned contact surfaces with Rivolta F.L.G. GT-2 (SAP 514100).
3. Mount the PE cables on the earthing points opposite of the other rotor half-section and tighten to the special torque of **60 Nm**.
4. Spray the tightened fasteners with Rivolta F.L.G GT-2.

5.5.6 Connecting rotor bridges

There are 3 rotor bridges in total. Rotor bridges establish electrical connection between the rotor halves.

NOTICE

Damage to fasteners on rotor bridges when using impact wrenches

Property damage

⇨ Hand-tighten the fasteners using the hand ratchet **only**.

⇨ Use a manual torque wrench to tighten fasteners to the required torque of **60 Nm**.

⇨ When tightening the fasteners counter-tighten them with a spanner.

NOTICE

Damage to rotor bridges due to improper installation of busbars

Property damage

⇨ Clean the connection surfaces for installation of the busbars and apply corrosion protection using the lubricant “RIVOLTA F.L.G. GT-2 400 ml (fully-synthetic multi-temperature grease)”.

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Preparing rotor bridges

1. Check to ensure that the rotor bridge is installed in the correct position and tightened to the required torque.
2. Fold the connecting cables clamped into the clamps onto the other rotor half.
3. Clean the electrical connecting surfaces of the busbars using steel wool and remove any paint or resin residue.
4. Spray a coat of Rivolta lubricant on the cleaned surfaces on both sides.

Installing connecting cables

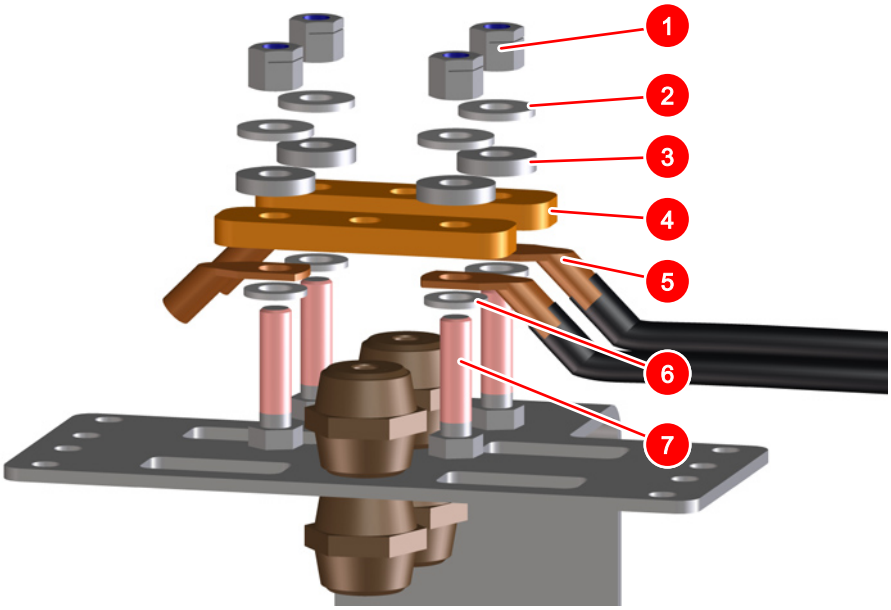


Fig. 19: Cable lug fasteners on top busbars

1	Nut ESN H130 M12x175 R60 HDG ALCOA® (SAP 79471)	2	Conical spring washer DIN 6796 12x29x03 mech.galv. (SAP 27297)
3	Washer 13x30x6 300HSFG HDG (SAP 105980)	4	Copper busbar (SAP 591897)
5	Cable lug (SAP 592977)	6	Washer ISO 7089 12 300HSFG HDG (SAP 105149)
7	Hexagon bolt ISO 4017 M12x045 8.8HDG (SAP 103239)		

5. Position each connecting cable with the cable lug on the busbar opposite.
6. Install the connecting cables with the specified screwing scheme on the busbar.
7. Tighten the fasteners to a special torque of **60 Nm**.

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Installing busbars

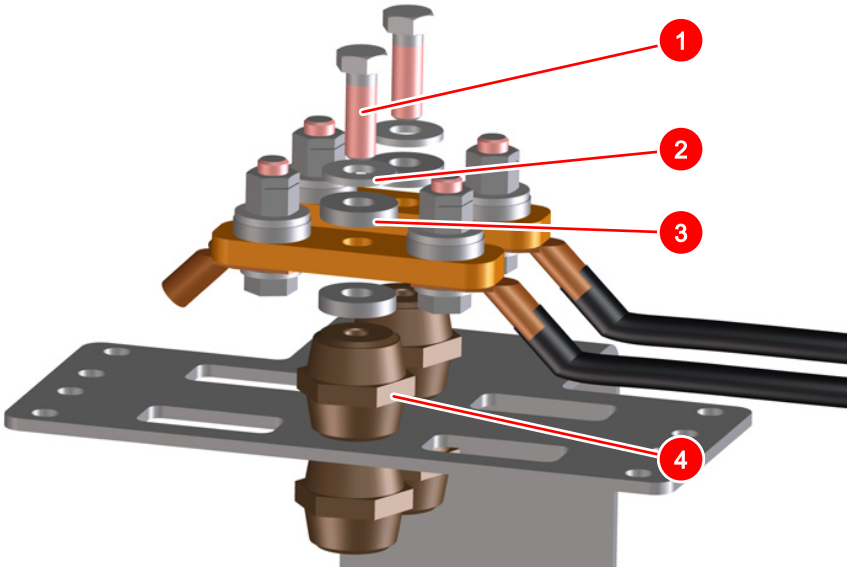


Fig. 20: Busbar fastening with cast resin insulators

1	Hexagon bolt ISO 4017 M12x035 8.8HDG (SAP 107264)	2	Conical spring washer DIN 6796 12x29x03 (SAP 27297)
3	Washer ISO 7089 12 300HSFG HDG (SAP 105149)	4	Cast resin insulator (SAP 49865)

8. Position the top and bottom busbars on the cast resin insulators as shown on the illustration and hand-tighten them.
9. Tighten the fasteners to a special torque of **60 Nm**.

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Mounting strain relief device on support

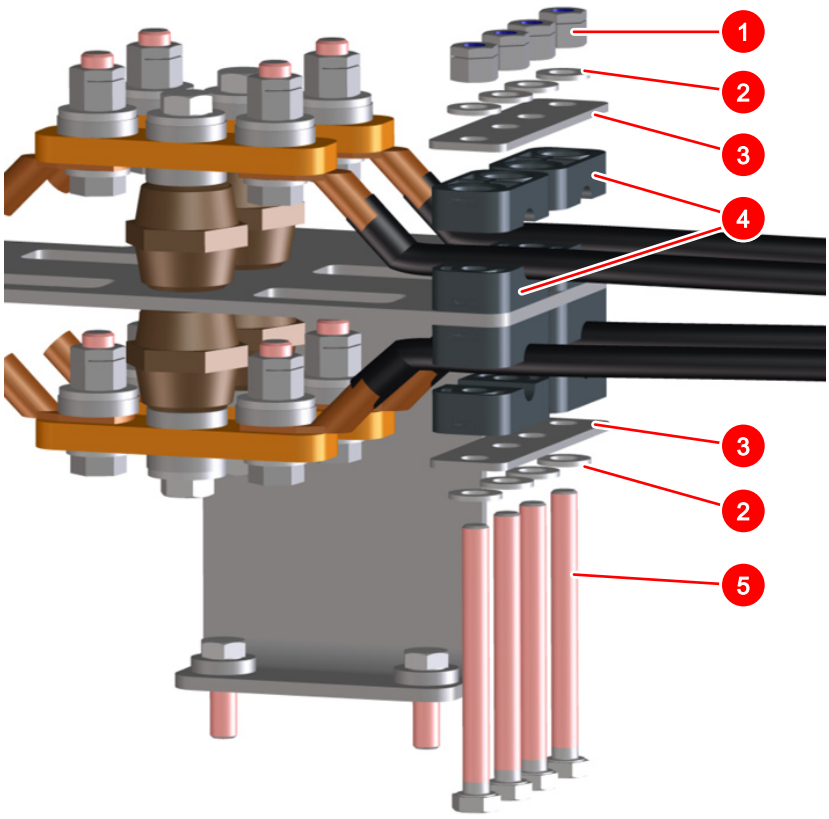


Fig. 21: Strain relief device fastener to support

1	Nut ESN H130 M10x150 R60 HDG ALCOA® (SAP 79470)	2	Washer ISO 7089 10 300HSFG HDG (SAP 24283)
3	Connector clamps (SAP 580414)	4	Clamp, Stauff DIN 3015 (SAP 592189)
5	Hexagon bolt ISO4014 M10x100 8.8HDG (SAP 105279)		

10. Position and hand-tighten the 3 clamps (for strain relief device on the connecting cables) on the rotor bridge support as shown on the illustration.

5.5.7 Install air guide assembly and enclosure at the separation points

1. Install air deflector plates at the generator rotor separation points on the generator rotor.
2. Install enclosure sealing plates on the machine-house side separation points of the generator rotor.

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5.5.8 Installing generator casing on the front

1. Position the generator casing segments on the generator rotor connectors.
2. Bolt the casing sections together until hand-tightened, and bolt them at the connectors.
3. Align the casing sections if necessary.
4. Tighten all fasteners to the required torque, see *Torque table*, p. 155.
5. Rivet the casing sections together on the lateral overlap plates.

5.6 Installing rotor in stator

5.6.1 Preparing the rotor

1. Unwrap the rotor completely.
2. Remove all transport protection caps from the rotor brake disk.

5.6.2 Preparing the stator

1. If the generator tarpaulin is present, remove it.
2. Remove any remaining pieces of transport packaging from the stator windings.
3. Ensure that the stator windings are clean.
4. Make sure the rotor brakes are fully open.
5. Check that the locking bolts have been inserted in by ¼ of the bolt length at the factory.
6. If the bolts are completely extended, retract them by approx. ¼ of their length.

5.6.3 Preparing the lifting device



Fig. 22: Generator lifting device

The lifting device for generator E-115 EP3 (SAP 678021) is used in generators with a rotor bearing unit for inserting the generator rotor into the generator stator. The lifting device can also be used to raise and install the generator.
Further technical information is provided in the manufacturer's operating manual.

⇨ See document: TD-des-10-de-xx-17-113 "Betriebsanleitung Hebevorrichtung Generator E-115 EP3" (E-115 EP3 generator lifting device operating manual)

1. Prepare the lifting device for operation according to the operating manual.

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5.6.4 Installing lifting device on rotor bearing unit

1. Rig the lifting device for lifting according to the corresponding operating manual.
2. Set down the lifting device onto the rotor bearing unit.
3. Bolt the lifting device to the rotor bearing unit according to the operating manual.

5.6.5 Placing rotor into stator

1. Attach the rotor for lifting according to the lifting device operating manual.
2. Lift the rotor and raise it above the stator.
3. Orient the rotor such that the 12 o'clock markings on the rotor and stator are aligned.

⚠ DANGER! Risk of crushing! Do not enter the danger zone while lowering the rotor and do not insert any body parts between the components.

4. Slowly lower the rotor into the stator. Make sure that the pole shoes of the rotor do not hit the air guide assembly or the windings of the stator.
5. During the lowering procedure, make sure that
   - The air gap plates slide into the air gap between the rotor and the stator,
   - The brake disk slides between the brake pads of the electromechanical brakes,
   - The locking bolts slide into slots of the brake disk.

5.6.6 Bolting the rotor bearing unit to the stator support

Bolting the fasteners inside

1. Bolt and hand-tighten hexagon nuts with washers onto the threaded bolts of the bolt connection between the stator support and the rotor bearing unit in the stator support.

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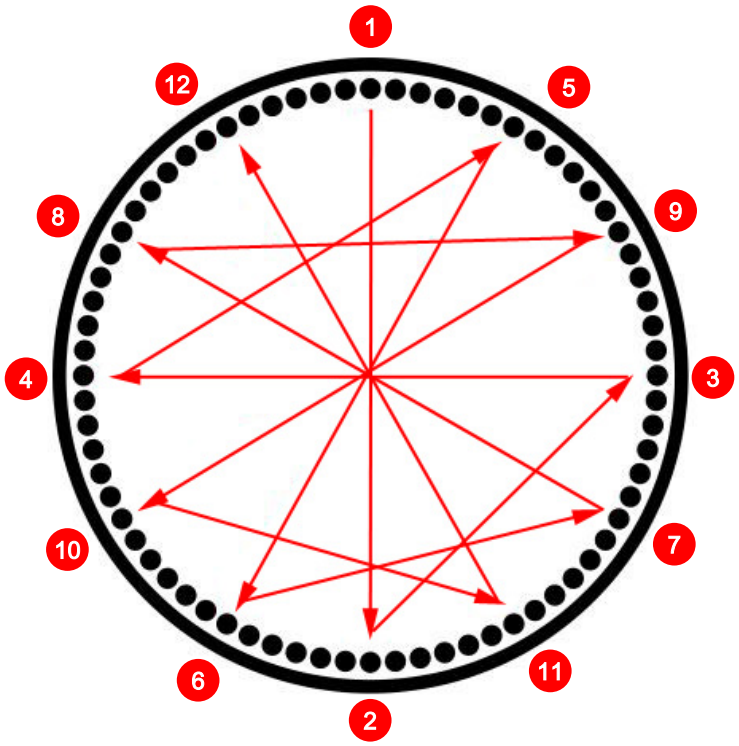


Fig. 23: Crosswise fastening sequence

2. Tighten the bolt connections crosswise at 12 positions to 30 % of the required torque; see *Torque table*, p. 155.
3. Tighten 12 pre-tightened bolt connections to 100 % of the required torque.
4. Tighten the remaining bolt connections around the perimeter to 100 % of the required torque; see torque table.
5. Continue bolting around the perimeter until the nuts can be turned no further when tightened with the required torque.

Bolting external fasteners

6. Bolt and hand-tighten hexagon nuts with washers onto the outer threaded bolts of the bolt connection between the rotor bearing unit and the stator support in the stator support between the rotor and stator.
7. Tighten the bolt connections crosswise at 12 positions to 30 % of the required torque; see *Torque table*, p. 155.
8. Tighten the bolt connections around the perimeter to 100 % of the required torque; see torque table.
9. Continue bolting around the perimeter until the nuts can be turned no further when tightened with the required torque.

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6 Rotor head pre-assembly

6.1 Overview of rotor head pre-assembly

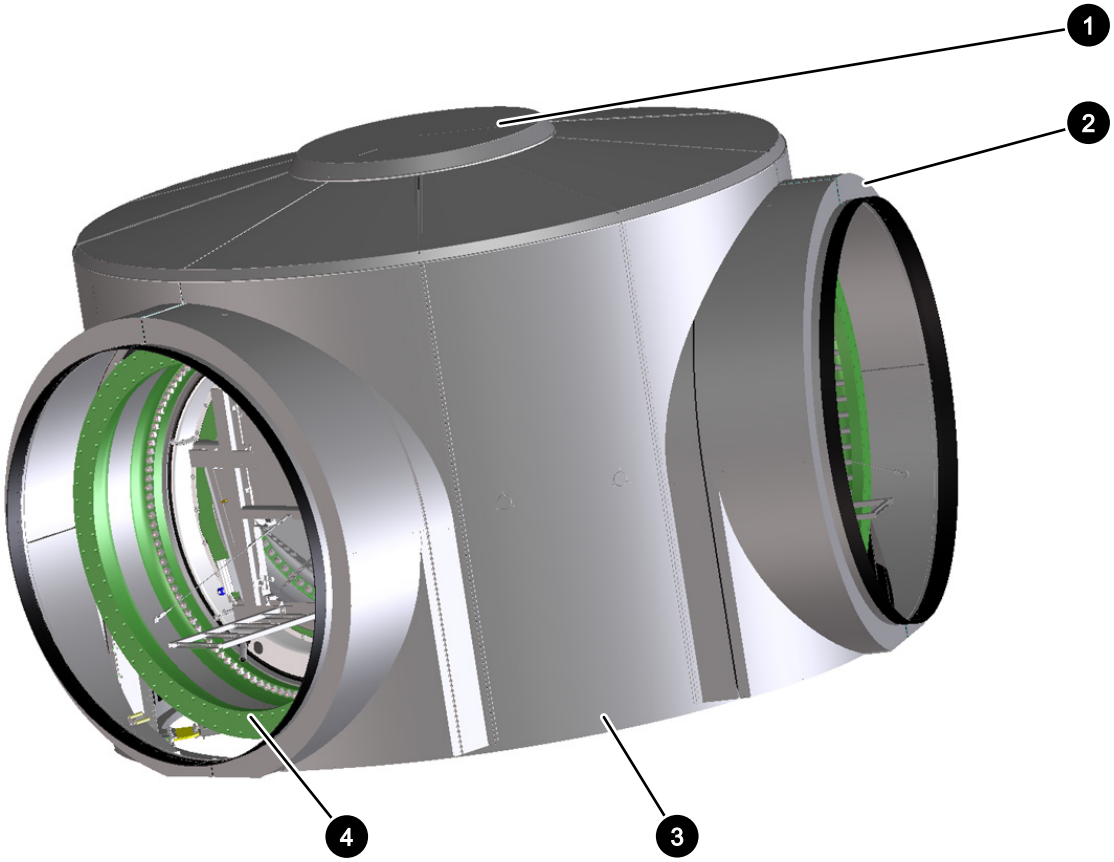


Fig. 24: Overview of rotor head pre-assembly

1	Rotor head cap	2	Blade pipe extension
3	Sixth spinner section	4	Blade adapter

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6.2 Safety warnings for rotor head pre-assembly

In addition to the basic safety instructions in ch. 2.4, p. 10, also observe the following safety warnings during pre-assembly of the rotor head:

⚠ WARNING



Overturning of casing sections

Death or serious injury

- ⇨ Support the casing sections during assembly.
- ⇨ Assemble the casing sections on solid ground (e.g. excavator mats) with protective supports.
- ⇨ In the case of strong wind, turn the largest surfaces of the casing sections away from the wind and provide additional tensioning for the casing sections if necessary.

⚠ WARNING



Kicking-back and swinging lifting accessories

Severe crushing injuries and bruising

- ⇨ Do not release tensioned lifting accessories from the components.
- ⇨ If possible, always lower the lifting tackle to the ground before releasing it.
- ⇨ If multiple items of lifting tackle are used then always release them one after another.
- ⇨ Lifting accessories attached at an angle must be carefully guided to a vertical position after being released and must not be allowed to swing free.

⚠ CAUTION



Extreme noise when bolting casing segments

Hearing damage

- ⇨ Wear ear protection.
- ⇨ Warn other workers before starting bolting work.

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6.3 Rotor head

6.3.1 Positioning the assembly frame

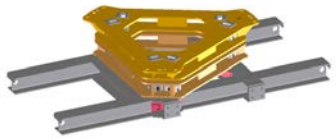


Fig. 25: Hub E-115 EP3 assembly frame

The hub E-115 EP3 assembly frame (SAP 676431) is used to set down the rotor head during pre-assembly.
Additional technical data can be found in the manufacturer's operating manual.

⇨ See document: GA-D0673171 "Gebrauchsanleitung Montagegestell Rotornabe" (Hub assembly frame operating manual)

1. Make sure all twistlocks on the assembly frame are closed.
2. Place the assembly frame on a level, firm surface according to the current construction site specification. If necessary, lay out sufficient excavator mats underneath the bottom frame.
3. Use a spirit level to make sure that the assembly frame is straight.

6.3.2 Setting down the rotor head onto the assembly frame

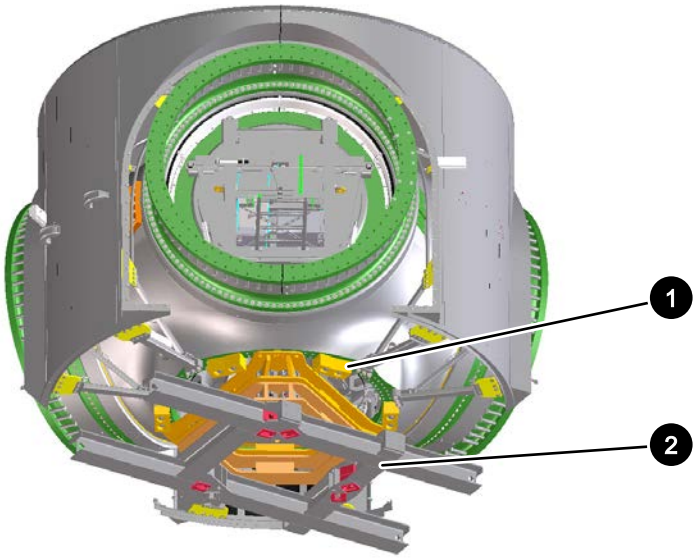


Fig. 26: Rotor head onto the assembly frame

1	Transport support	2	Assembly frame

1. Attach the rotor head for hoisting.
2. Lift the rotor head over the assembly frame and align such that the blade connections are positioned above the outriggers of the assembly frame.
3. Set the rotor head down onto the assembly frame.
4. Bolt the rotor head to the assembly frame using a sufficient number of bolt connections.

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6.3.3 Removing transport supports

1. Remove transport supports from the hub flange.

6.3.4 Installing hub threaded bolts

1. Clean the hub flange and check that the surface is even using a try square (SAP 18083).
2. Carefully remove any irregularities using a surface scraper.
3. Screw the threaded bolts into the threaded holes on the hub flange. Observe the minimum depth of engagement of 1.5 x bolt diameter.

6.4 Rotor head casing

6.4.1 Pre-assembling blade pipe extensions

3 blade pipe extensions must be preassembled.

1. Position a left blade pipe extension and a right blade pipe extension next to each other.
2. Bolt the blade pipe extensions to the flanges. Position shim plates with seals between the flanges.
3. Tighten all fasteners to the required torque, see *Torque table*, p. 155.
4. Make sure the seal is correctly installed on the flange of the blade pipe extension.

6.4.2 Installing blade pipe extensions

1. Make 12-mm holes at the top of the blade pipe extension, one on the left side and one on the right side.
2. Install an M12 swivel hoist ring on each of the drill holes.
3. Rig the blade pipe extension for lifting by means of swivel hoist rings.
4. Move the blade pipe extension in front of the first blade pipe on the rotor head casing.
5. Bolt the blade pipe and the blade pipe extension together.
6. Tighten all fasteners to the required torque, see *Torque table*, p. 155.
7. Remove the swivel hoist rings.
8. Seal the drill holes with the supplied stoppers.
9. Seal the stoppers with permanently flexible sealant.
10. Mount the remaining blade pipe extensions as well.

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7 Rotor blade pre-assembly

7.1 Pre-assembly overview of rotor blades

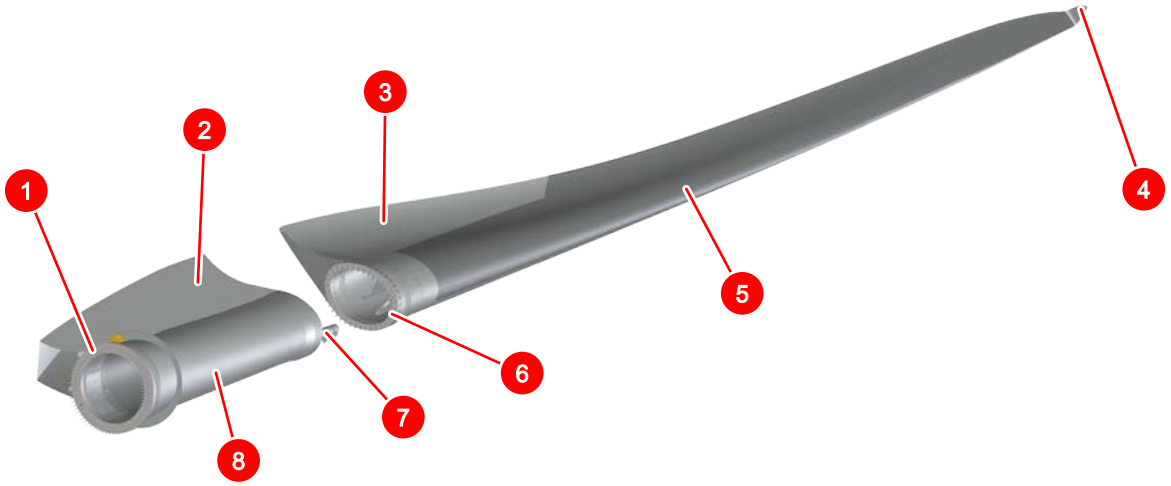


Fig. 27: Overview of E-115 rotor blade

1	Rotor blade flange	5	Outer blade
2	Inner rotor blade spoiler	6	Separating flange of outer rotor blade
3	Outer rotor blade spoiler	7	Separating flange of inner rotor blade
4	Blade tip	8	Inner blade

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7.2 Rotor blade pre-assembly warning notice

In addition to the basic safety instructions in ch. 2.4, p. 10, also observe the following basic safety instructions during pre-assembly of the rotor blades:

⚠ DANGER



Working with a bolt tensioning cylinder

Death or severe injury

- ⇨ The bolt tensioning cylinder may only be operated by persons who have received proper training and are familiar with the unsupervised use of the device.
- ⇨ Make sure a valid training certificate is available.
- ⇨ Wear safety goggles.
- ⇨ Wear protective gloves.
- ⇨ Before using the pretensioning force method, check by hand to determine whether the nut has been tightened on the respective threaded rod. Make sure that the threaded bolt does not turn or settle when the bolt tensioning cylinder is put on.

⚠ DANGER



Swinging of rotor blade during installation

Fatal crush injuries

- ⇨ Do not reach between the flanges.

⚠ CAUTION



Rotor blades with trailing edge serrations

Stab injuries

- ⇨ Do not remove the edge protection on the trailing edge serrations until just before the rotor blade hoist.
- ⇨ Block off the danger zone if no edge protection is present.
- ⇨ Exercise particular care when working near the trailing edge serrations.

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7.3 Outer rotor blade preparation

7.3.1 Placing a deposit tray underneath the outer blade

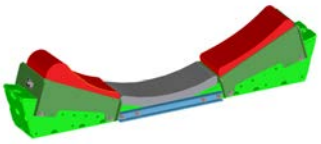


Fig. 28: E-115 rotor blade deposit tray

The outer blade deposit tray (SAP 659124) is used to set down and to support the outer and inner blade in the separating flange area.
Additional technical data can be found in the manufacturer's operating manual.

⇨ See document: GA-D0584202 "Gebrauchsanleitung Ablagewanne Rotorblatt E-115" (E-115 rotor blade deposit tray operating manual)

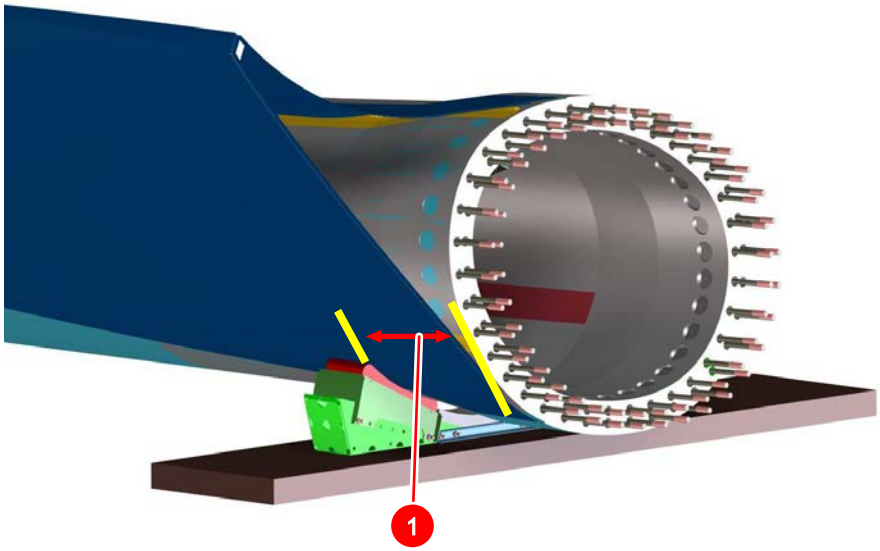


Fig. 29: Outer blade in deposit tray

1	Distance 870 mm

1. Place a deposit tray and a sufficient number of excavator mats underneath the outer blade at a distance of 870 mm from the separating flange. The separating flange frame must not touch the ground.

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7.3.2 Removing the separating flange frame of the outer rotor blade

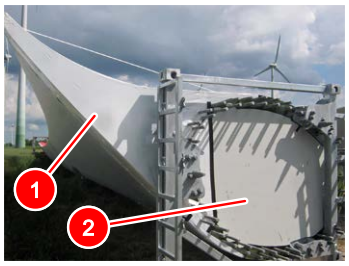


Fig. 30: Overview of separating flange of outer rotor blade

1	Protective film on spoiler	2	Transport protection cover

1. Remove the transport protection cover and the protective film from the separating flange.

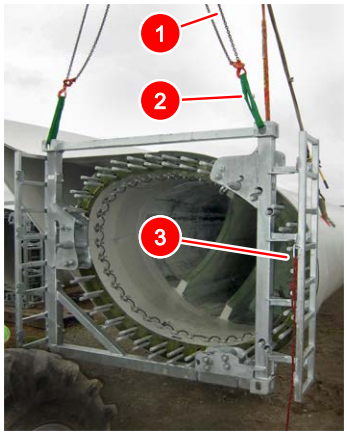


Fig. 31: Separating flange frame attached

1	Chain sling	3	Guide rope
2	2 t round sling (1 m)		

2. Attach lifting tackle to the separating flange frame according to the illustration (fig. 31, p. 51) for hoisting.

Use the auxiliary crane or the telescopic handler to attach the separating flange transport frame.

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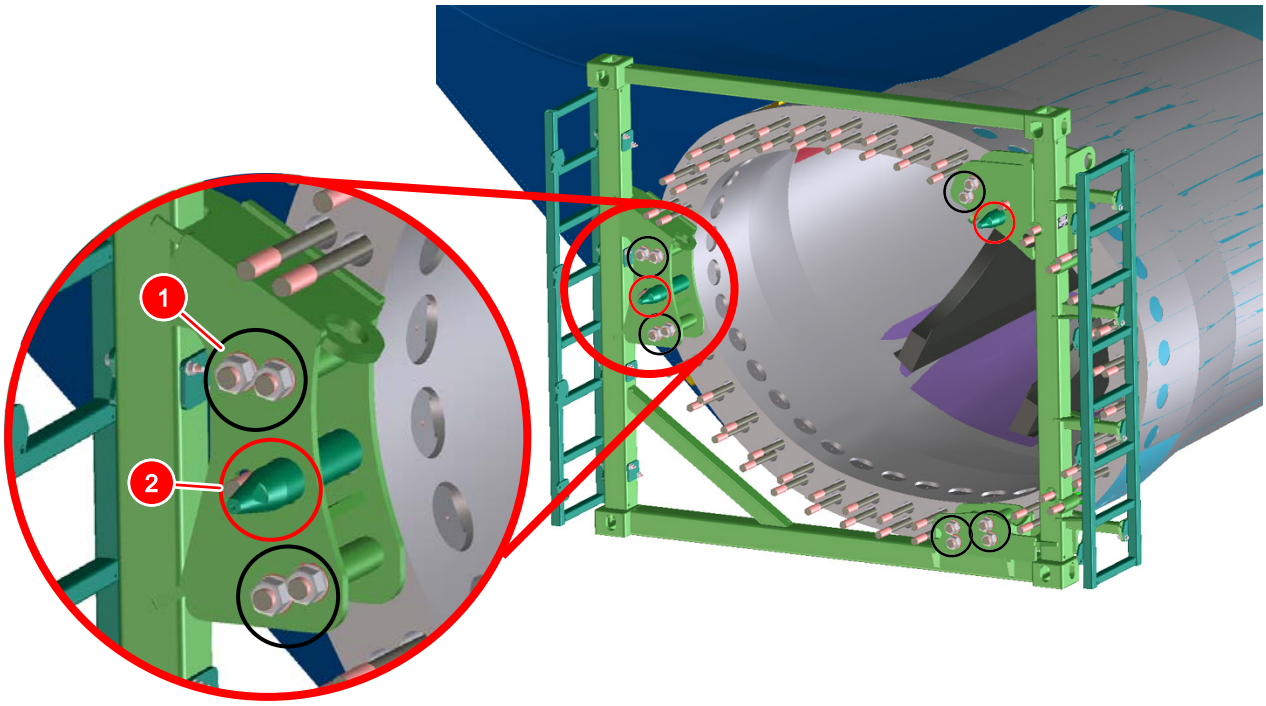


Fig. 32: Overview of the separating flange frame

1	Lock nuts (black)	2	Centre bolts (red)

3. Remove the lock nuts and washers from the separating flange frame.

> The centre bolts protect the threaded bolts. Do not remove them until after the separating flange frame has been dismantled.

⚠ DANGER! Risk of crushing: During disassembly of the separating flange frame, do not reach between the separating flange frame and the separating flange.

4. Slowly pull the separating flange frame from the threaded bolts and move it away.
5. Remove the centre bolts.

7.3.3 Preparing the outer blade separating flange

1. Ensure that the flange surface is clean and flat.
2. Make sure the blade bolts are undamaged.
3. Ensure that the blade bolts are clean.

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7.3.4 Checking protrusion of expansion bolts

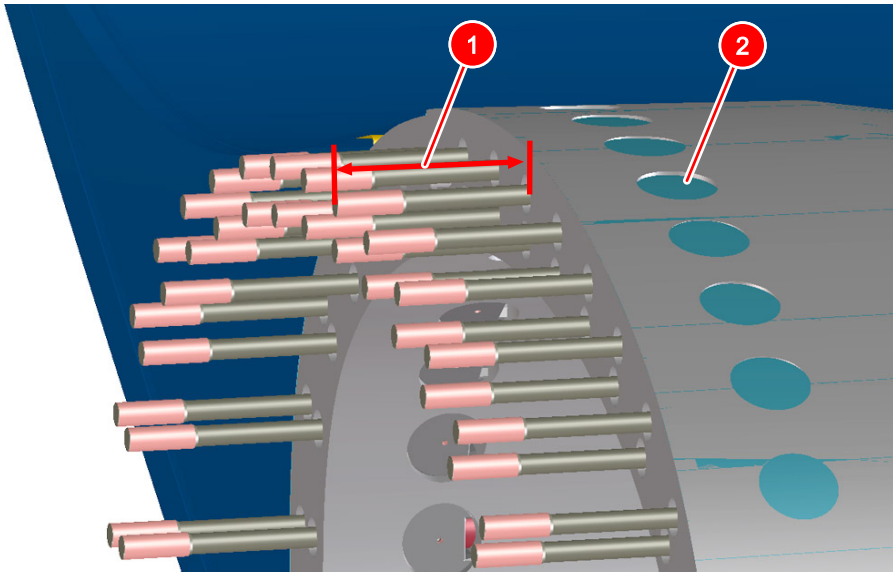


Fig. 33: Expansion bolts on the outer rotor blade

1	Protrusion of expansion bolt	2	Cross bolt

1. Measure the protrusion of the centring pins on the outer blade separating flange. The target value must be 291 mm with a tolerance of -3 mm and +4 mm.
2. If the thread protrusion is outside the tolerance, screw the expansion bolt into the cross bolt or unscrew it out of the cross bolt with a torque of **200 Nm** ± 15 Nm.
3. If the thread protrusion of the expansion bolts cannot be corrected, contact the relevant Technical Service Dispatch.

7.4 Inner rotor blade preparation

7.4.1 Placing the deposit tray underneath the inner blade

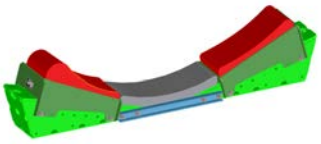


Fig. 34: E-115 rotor blade deposit tray

The outer blade deposit tray (SAP 659124) is used to set down and to support the outer and inner blade in the separating flange area.
Additional technical data can be found in the manufacturer's operating manual.

⇨ See document: GA-D0584202 "Gebrauchsanleitung Ablagewanne Rotorblatt E-115" (E-115 rotor blade deposit tray operating manual)

1. Place a rotor blade deposit tray and a sufficient number of excavator mats underneath the inner blade on the separating flange so that the separating flange is at a 90° angle. The shell must be at least 870 mm from the separating flange so that the separating flange does not become damaged.

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7.4.2 Preparing the inner blade separating flange

1. Ensure that the flange surface is clean and flat.

7.5 Installing outer rotor blade on inner rotor blade

7.5.1 Checking the centring pins and centring holes

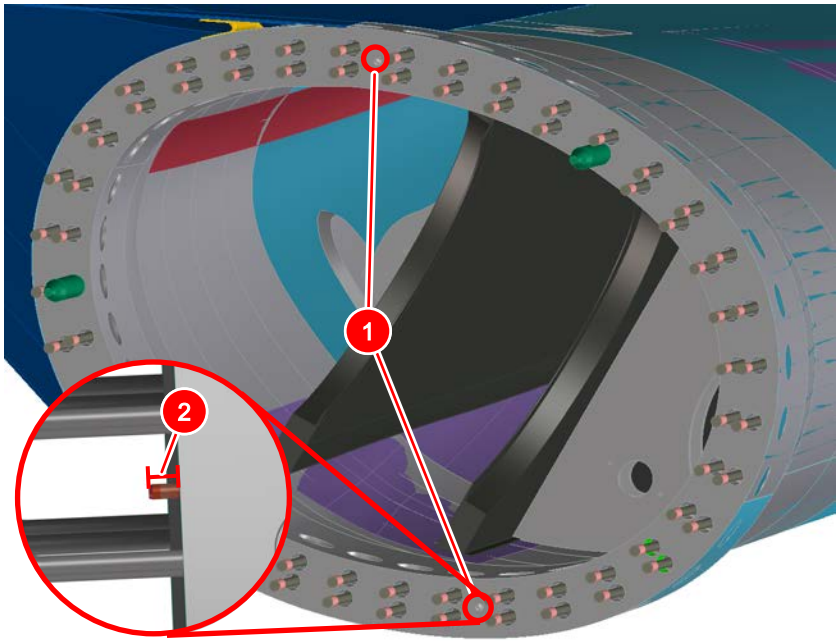


Fig. 35: Overview of separating flange of outer rotor blade

1	Position of the centring pins	2	Centring pin length

1. Measure the length of the two centring pins on the outer blade separating flange.

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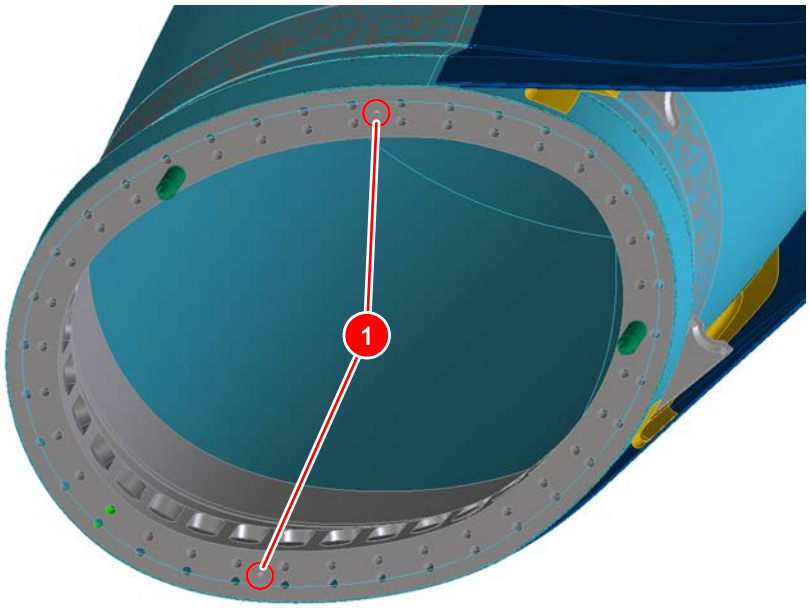


Fig. 36: Overview of separating flange of inner rotor blade

1	Position of the centring holes

2. Measure the depth of the two centring holes on the inner blade separating flange.
3. If the centring pins are longer than the centring holes are deep, bore the centring holes with a drill bit (Ø13 mm).

7.5.2 Attaching the outer blade for hoisting

The outer blade must be rigged to 2 cranes.

Installing release devices



Fig. 37: Rotor blade release device

The rotor blade release device (SAP 520513) is used for attaching and releasing rotor blades with a load application rib (LAR) during assembly and disassembly. The release device can also be inserted into a release device adapter on the separating flange during the pre-assembly.
Further technical information is provided in the manufacturer's operating manual.

⇨ See document: TD-des-10-de-xx-15-021 “Betriebsanleitung Ausklinkvorrichtung Rotorblatt E-101” (E-101 rotor blade release device operating manual)

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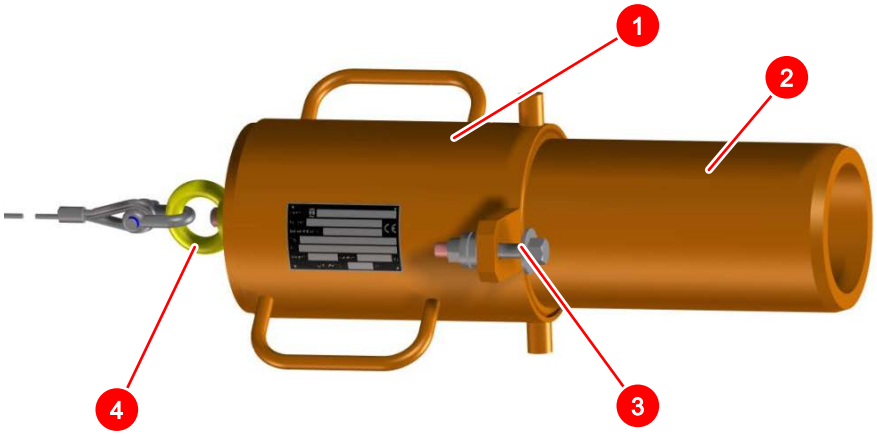


Fig. 38: Release device with pin in front end position

1	Guide tube	3	Bolt connection
2	Bolt	4	Lifting eye nut

1. Ensure that the bolt of the release device is in the front end position.
2. Insert the bolt of the release device to the limit stop into the lower opening of the load application rib (LAR) in the outer rotor blade, the guide tube must point towards the blade flange.

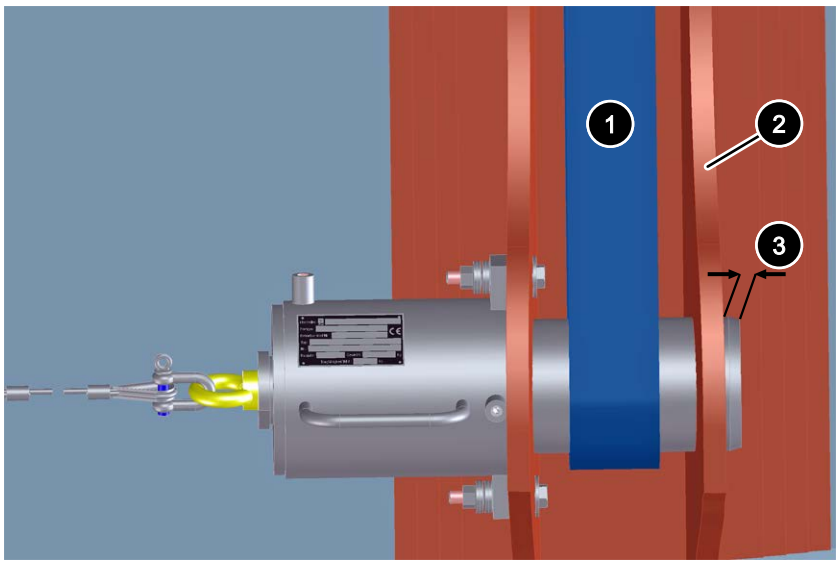


Fig. 39: Overview of release device bolt

1	Round sling	3	Bolt protrusion min. 10 mm
2	Load application rib		

3. Measure the protrusion of the bolt at the end of the LAR.
4. If the bolt has a protrusion < 10 mm, consult the Technical Service Dispatch office in charge.

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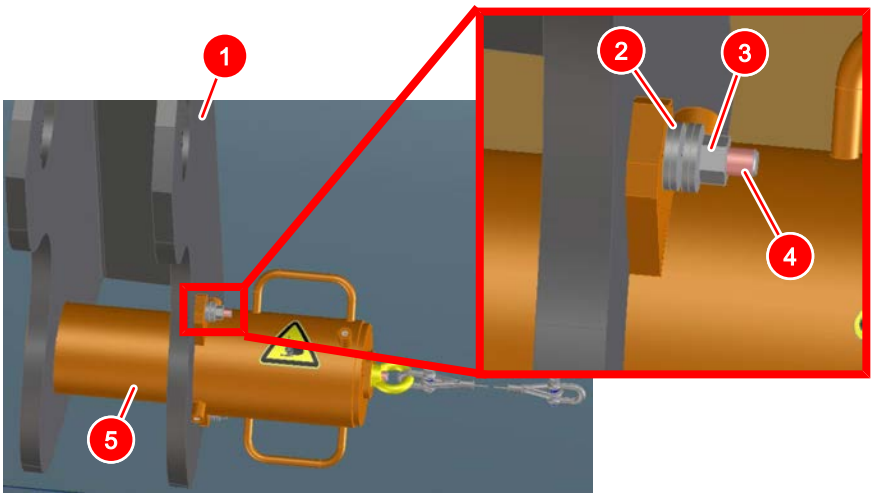


Fig. 40: Release device installed on load application rib

1	Load application rib	4	Hexagon bolt
2	4x conical spring washer	5	Pin
3	Hexagon nut		

5. Fasten the release device to the LAR using the bolts, hexagon nuts, washers and conical spring washers supplied. Place the conical spring washers so that they are opposite each other.
6. Tighten the hexagon nuts until the conical spring washers are compressed to 15 mm.
7. Check whether the release device has been properly installed in the LAR of the inner rotor blade during pre-assembly of the rotor blade.
8. Install the second release device on the adapter for the release device in the inner rotor blade in accordance with the previous worksteps.

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Attaching the outer blade at flange

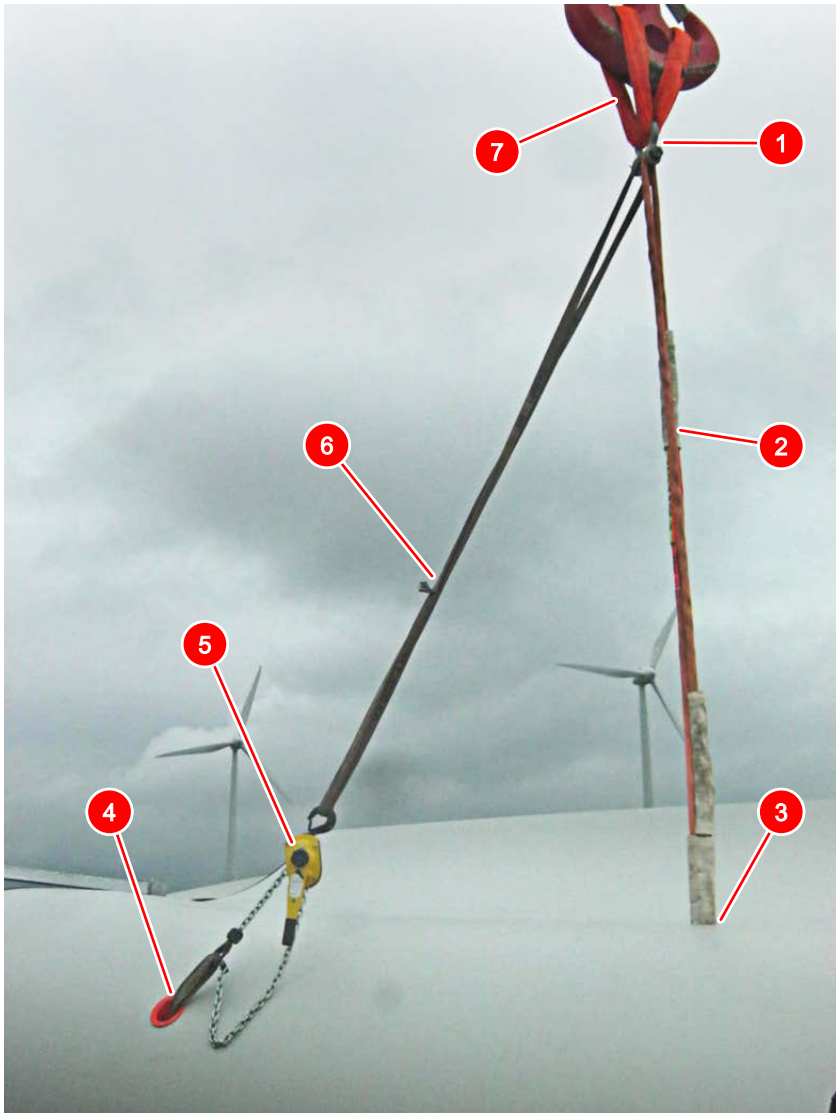


Fig. 41: Outer blade rigged

1	25-t shackle	2	20-t round sling MagnumX (5 m) with NoCut round sling protection
3	Tip-side lifting point	4	4-t round sling (4 m) with NoCut round sling protection
5	3-t chain hoist	6	4-t round sling (3 m)
7	15-t round sling (2 m), looped		

9. Pull the protective tubing over the round slings.
10. Guide the 4-t round sling through the lifting point at the flange.
11. Guide the 20-t round sling through the tip-side lifting point.
12. In the rotor blade, pull the lifting eye nuts to pull the pins fully out of the release devices.

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13. Position the round slings between the load application rib and the adapter for the release device.
14. Push the lifting eye nuts to insert the release device pins through the ends of the round sling. Move the pins into the end position.
15. Pull lightly on the lifting eye nuts to ensure that the bolts have latched in the end position.
16. Position the protective tubing in such a way that it is inside the lifting eyes.
17. Hook the remaining lifting accessories to the outer blade as shown in the figure.

Attaching the outer blade on the blade tip side

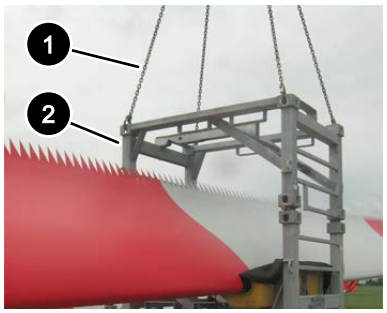


Fig. 42: Rigged tip frame

1	4-leg lifting chain	2	Tip frame

18. Hang a long 4-leg lifting chain with sufficient lifting capacity on the auxiliary crane hook.
19. Put the hooks of the lifting chain into the corner fittings of the tip frame.

7.5.3 Slewing outer blade towards inner blade

1. Lift the outer rotor blade and carefully move it into position in front of the separating flange of the inner rotor blade.
2. If present, remove the deposit tray from underneath the inner blade.

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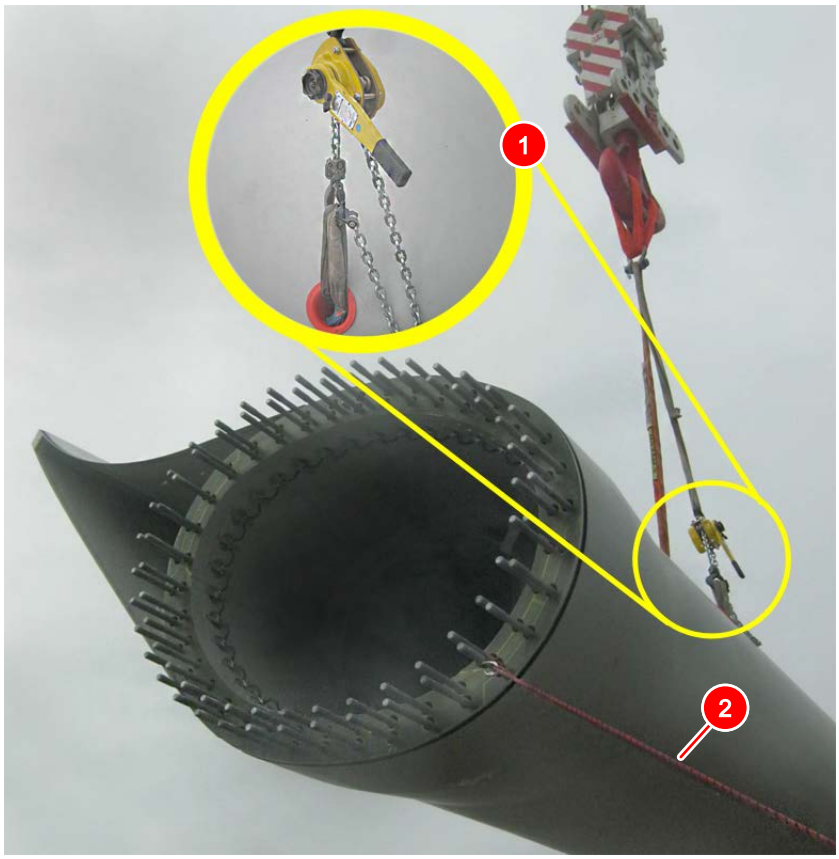


Fig. 43: Outer blade raised

1	3-t chains or manual lever hoist	2	Guide cable

3. Ensure that the lightning conductor cable cannot get trapped between the separating flanges.

⚠ DANGER! Risk of crushing: Do not reach between the separating flanges. Use only the appropriate tools for aligning the blade parts.

4. Slowly slew the inner blade in front of the separating flange of the outer blade.

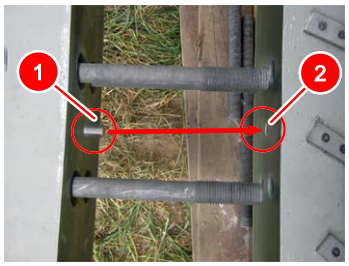


Fig. 44: Positions of centring pin and centring drill hole

1	Centring pin of outer blade	2	Centring drill hole of outer blade

5. If the separating flanges are not at 90° angles and parallel to one another or the outer blade is twisted relative to the inner blade, use the manual lever hoist to align, lower or raise the outer blade.
   ↪ The centring pins are located exactly in front of the centring drill holes.

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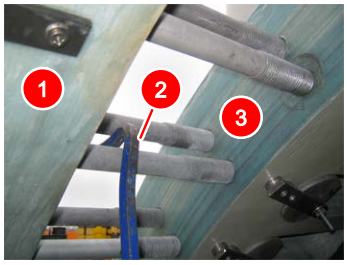


Fig. 45: Overview of separating flange between inner and outer blade

1	Separating flange of inner rotor blade
2	Crowbar
3	Separating flange of outer rotor blade

6. Move the outer blade close to the inner blade and guide the threaded bolts into the holes. If necessary, use a crowbar to guide the threaded bolts into the holes.

7.5.4 Pre-tightening outer and inner blade

✓ The outer rotor blade has been positioned on the inner blade.

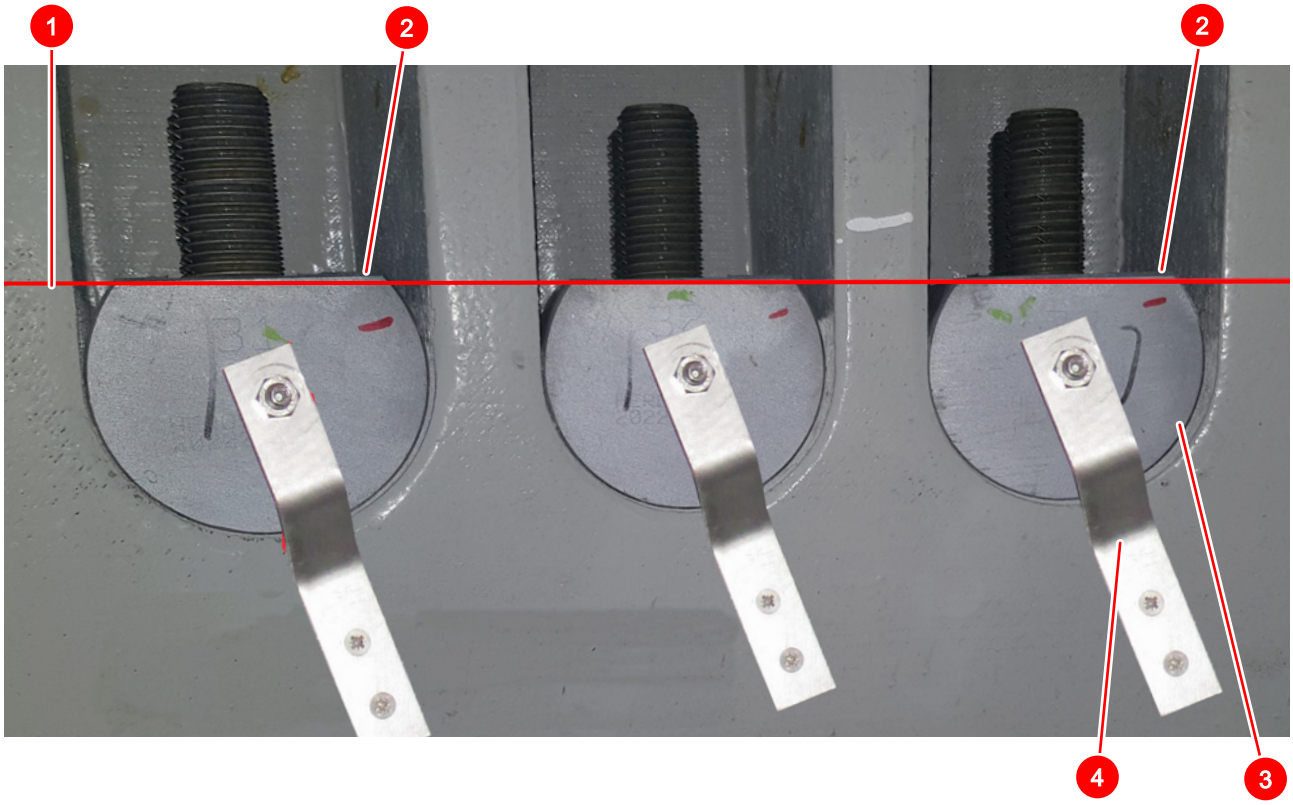


Fig. 46: Overview of cross dowels

1	Axle	3	Cross dowel
2	Twisting	4	Metal strips

1. Check that all cross dowels are twisted inside the pocket.
2. Loosen the twisted cross dowel on the metal strips, but do not remove it.
3. Align the twisted cross dowels using an assembly lever. Make sure that external pocket covers are not damaged.
4. Bolt the loosened metal strips snug-tight.

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Twisted cross dowels may cause the bolt tensioning cylinder to tilt and jam when tightening the bolt connections during assembly or maintenance. Jammed bolt tensioning cylinders can only be removed from the bolt connections with great effort.

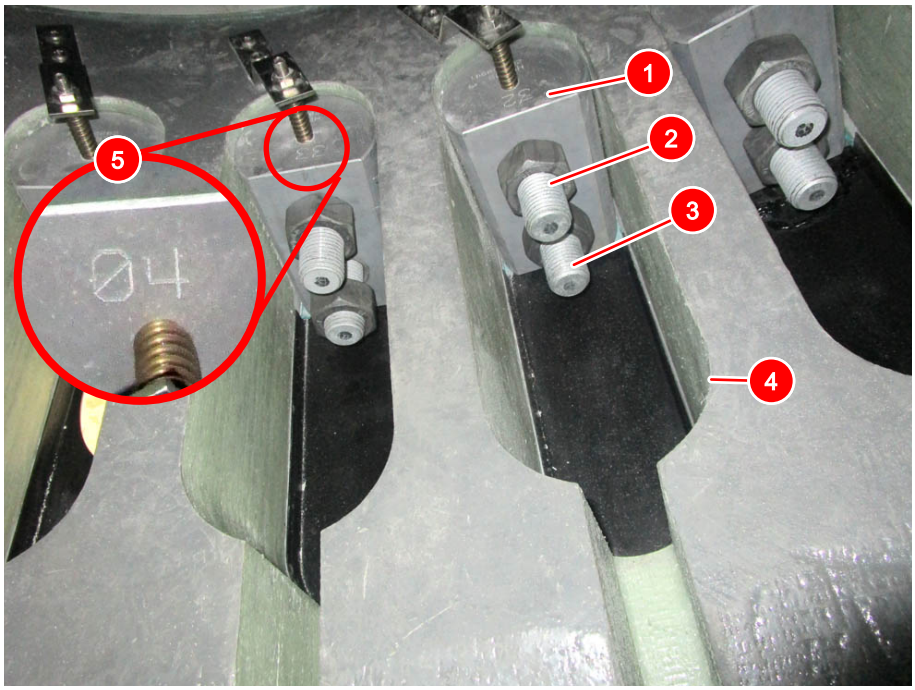


Fig. 47: Separation point pocket positions

1	Cross bolt	4	Recess at corner of module
2	Inner pins	5	Position of pocket numbering
3	Outer pins		

5. Screw the nuts manually onto the blade bolts at the inner blade – outer blade separation point on the inner ring and outer ring **without** washers.
6. In the pockets, label eight cross bolts **in a crosswise sequence**, e.g. cross bolt no.: 6, 23, 15, 31, 10, 26, 13 and 33.
7. Tighten the fasteners on the labelled cross bolts **in a crosswise sequence** to a preliminary torque of **250 Nm**. Observe the gap between the inner and outer blades while doing this.
8. Tighten the bolt connections **in a crosswise sequence** using a torque of **250 Nm** until the gap is fully closed and the bolt connections cannot be tightened further.
9. Tighten the remaining bolt connections to a preliminary torque of **250 Nm** in a clockwise sequence.

↪ The rotor blade is now pre-bolted and can be unhooked from the crane.

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After pre-tightening, the outer blade and inner blade must be tightened to their final preload within **7 days**.

7.5.5 Setting down the rotor blade

1. Slowly lay down the rotor blade and make sure that the tip frame sits securely on the excavator mats. There must be no deposit underneath the inner blade.
2. Ensure that the rotor blade lies correctly in the deposit tray underneath the outer blade. The deposit tray must be positioned 870 mm behind the separating flange.
3. Detach the rotor blade from the crane.
4. Disassemble the release devices in the rotor blade.

7.5.6 Tensioning outer and inner blade

✓ The inner and outer blades are pre-bolted.

NOTICE

Falling tools or materials when tensioning the fasteners of the separating flange

Damage to elongated hole covers in inner blade

⇨ When working on the upper elongated holes, cover the lower elongated holes.

⇨ Be careful when placing the tightening tools and the bolt tensioning cylinder in the lower elongated holes.

To prevent the cross bolts from twisting in the pockets, the bolt connections are tensioned using the tensioning cylinder to the final preload force in four steps.

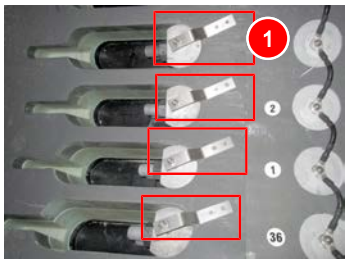
⚠ DANGER! Tensioning cylinders may only be operated by trained personnel.

1. Tension the **inner bolt ring** bolt connections in a clockwise sequence with **200 kN**.
2. Tension the **outer bolt ring** bolt connections in a clockwise sequence with **200 kN**.
3. Tension the **inner bolt ring** bolt connections in a clockwise sequence with **415 kN**.
4. Tension the **outer bolt ring** bolt connections in a clockwise sequence with **400 kN**.

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Removing metal strips

✓ The rotor blade is completely tensioned.



1	Metal strips

5. Remove the metal strips from the cross dowels.
6. Unscrew the threaded bolts from the cross dowels.

Fig. 48: Cross dowels with metal strips

7.5.7 Installing the lightning protection cable

The lightning protection cable is on the separating flange of the inner rotor blade between cross bolt 7 and cross bolt 8.

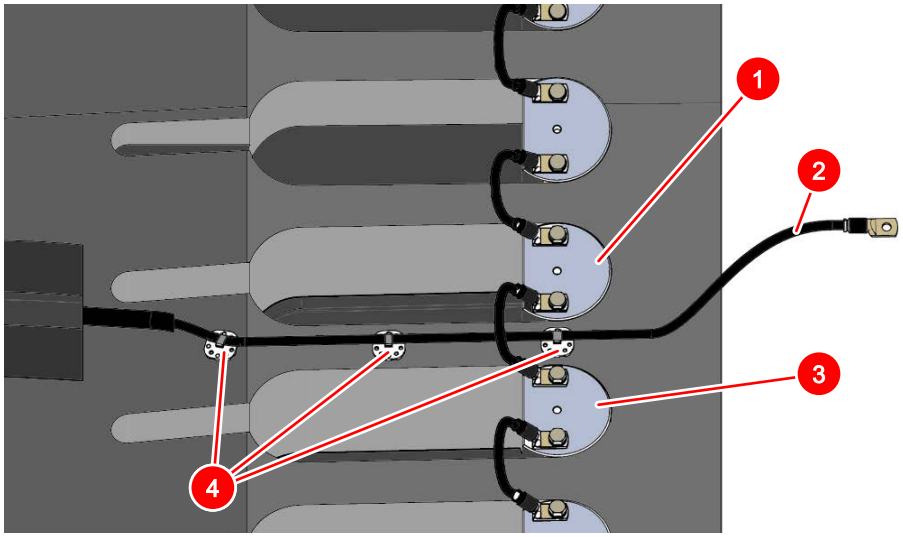


Fig. 49: Lightning protection cable layout on the separation point of the inner rotor blade

1	Cross bolt 7	3	Cross bolt 8
2	Lightning protection cable	4	Cross connectors

1. Check on the lightning protection cable whether the cable is secured to the cable clamp with cable ties.
2. If no cable ties are attached, secure the lightning protection cable to the cable clamp with cable ties.

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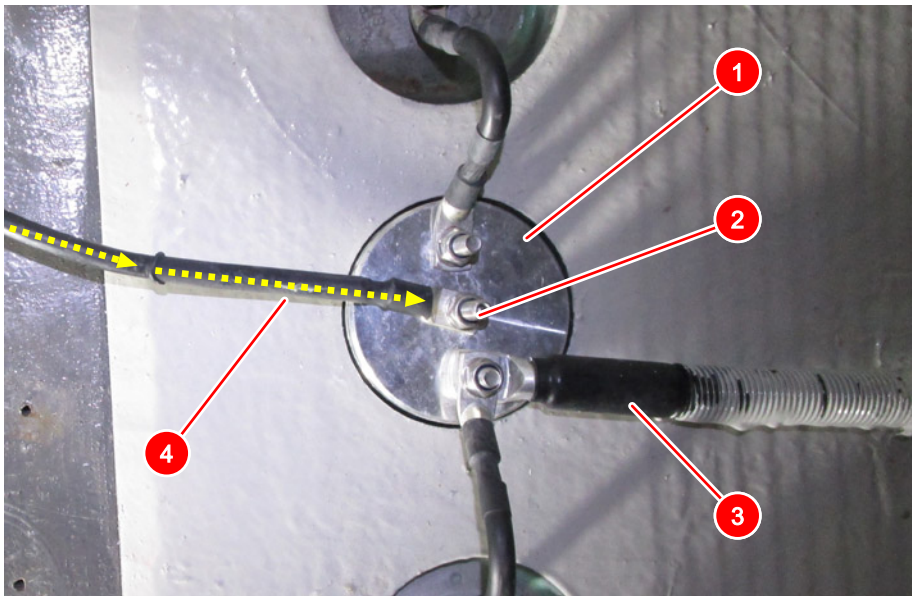


Fig. 50: Overview of lightning protection connections, outer rotor blade

1	Cross bolt with connection for lightning protection	3	Outer rotor blade lightning protection cable
2	Lightning protection cable connection	4	Inner rotor blade lightning protection cable

3. Release the pre-mounted nut and washer at the lightning conductor cable connection on the outer blade.
4. Fit the lightning conductor cable to the connection on the outer blade using the cable lug.
5. Bolt the lighting conductor cable in position using the washer and nut and tighten to the specified torque, see torque table *Torque table*, p. 155.

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7.6 Rotor blade

7.6.1 Mounting the blade skirts

Installing the blade skirt

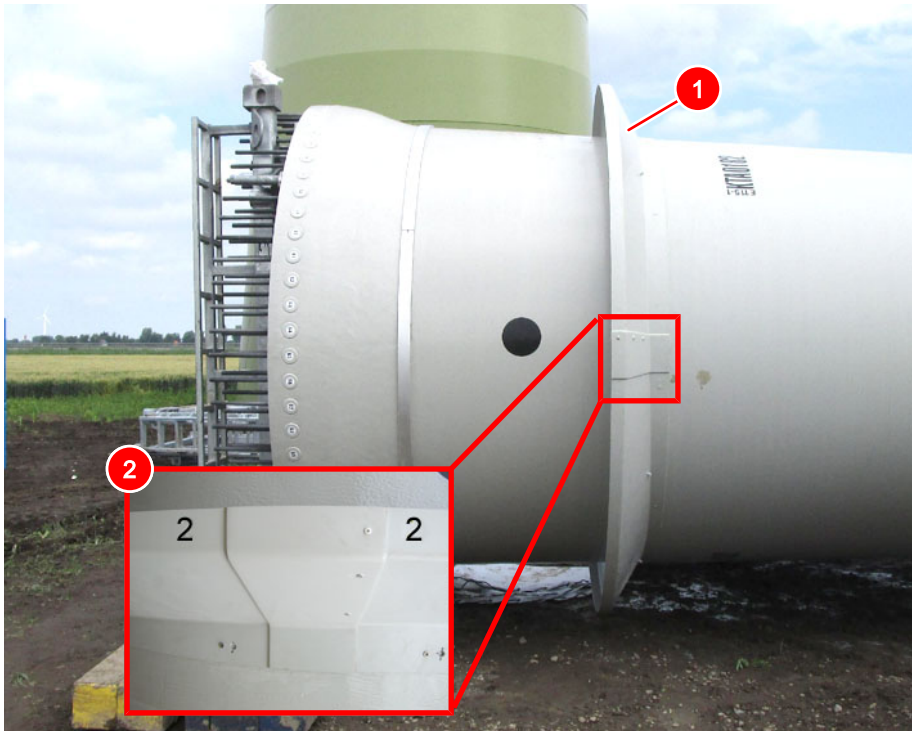


Fig. 51: Blade skirt overview

1	Blade skirt	2	Separation point with overlap and numbering

The blade skirt components can be secured and aligned with lashing straps for easy assembly on the rotor blade before being bolted.

1. Move the blade skirt components to the mounting position. Note the numbering of the blade skirts at the overlaps.
   - No. 1 to No. 1
   - No. 2 to No. 2
   - No. 3 to No. 3
2. Ensure that the blade skirt sections overlap correctly.
3. Bolt the blade skirt sections together at the overlaps.
4. Align the holes in the blade skirt congruent to the holes in the rotor blade.
5. Mount the blade skirt on the rotor blade using 6.4x38 self-tapping screws and washers.

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Align the blade skirt

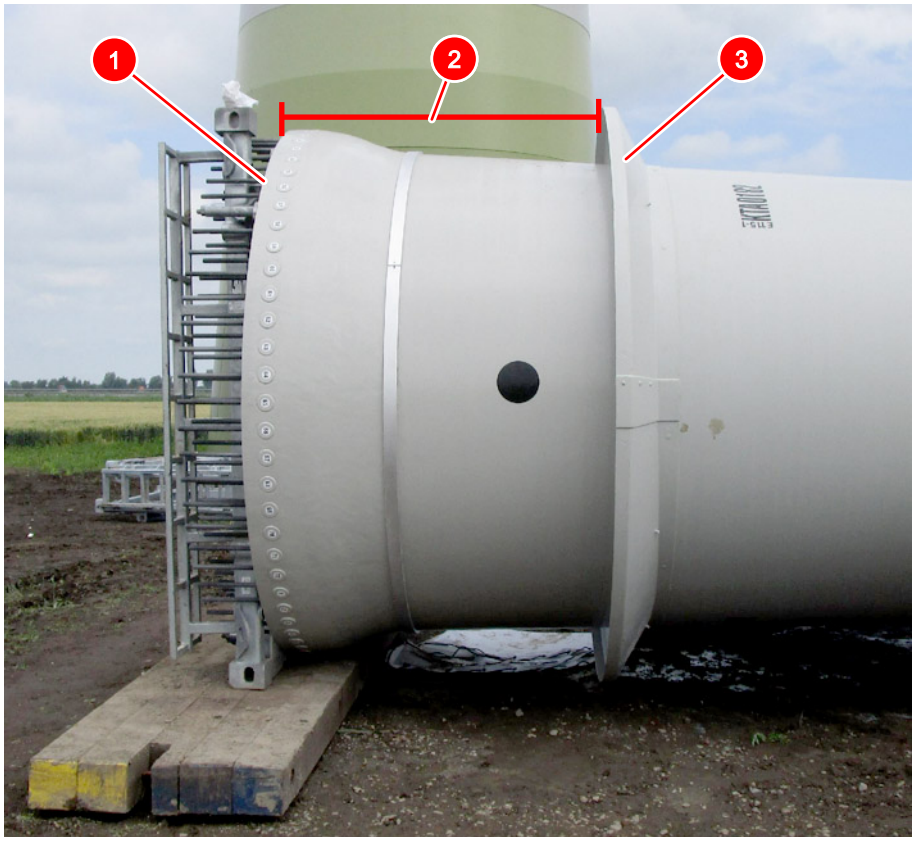


Fig. 52: Distance between the blade skirt and rotor blade flange

1	Rotor blade flange	3	Blade skirt
2	Distance 491 mm ±5 mm		

6. Measure the distance of the blade skirt around the entire circumference of the rotor blade flange. The distance must be 491 mm ±5 mm or else the blade skirt will chafe on the rotor head casing while in operation.
7. If the distance is outside the tolerance, align the blade skirt with the elongated holes.
8. Tighten the blade skirt to the required torque, see *Torque table*, p. 155.

Sealing the blade skirt



Fig. 53: Blade skirt in place and sealed

If the blade skirts are not flush with the rotor blade and a gap is therefore formed, the gap must be bridged using a PE sealing cord (SAP 17554).

9. Seal the gap between the blade skirt and rotor blade and the screwed connections with the sealant supplied.

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7.6.2 Installing the Velcro seal on the separation point

The Velcro seal must be installed on the rotor blade separation point between the rotor blade spoilers to close the gap between the spoilers. Velcro strips are pre-assembled on the rotor blade in the factory, and need to be attached to the Velcro seal.

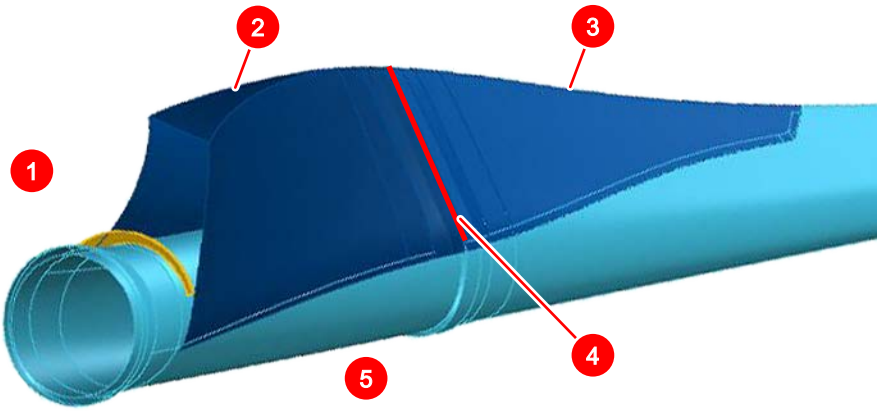


Fig. 54: Overview of E-115-1 TES/spoiler

1	Suction face	4	Velcro seal
2	Segment 1 (flange)	5	Pressure face
3	Segment 2 (tip)		

Preparing the Velcro strips

1. Visually check the Velcro strips on the rotor blade.
2. If the Velcro surfaces are frozen, use a hot-air gun to melt the ice. Take care that the heat does not damage the Velcro strips. Otherwise, it becomes impossible to install the Velcro seal.
3. If the Velcro strips are soiled, use a vacuum cleaner or compressed air to clean them.

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Preparing Velcro seal

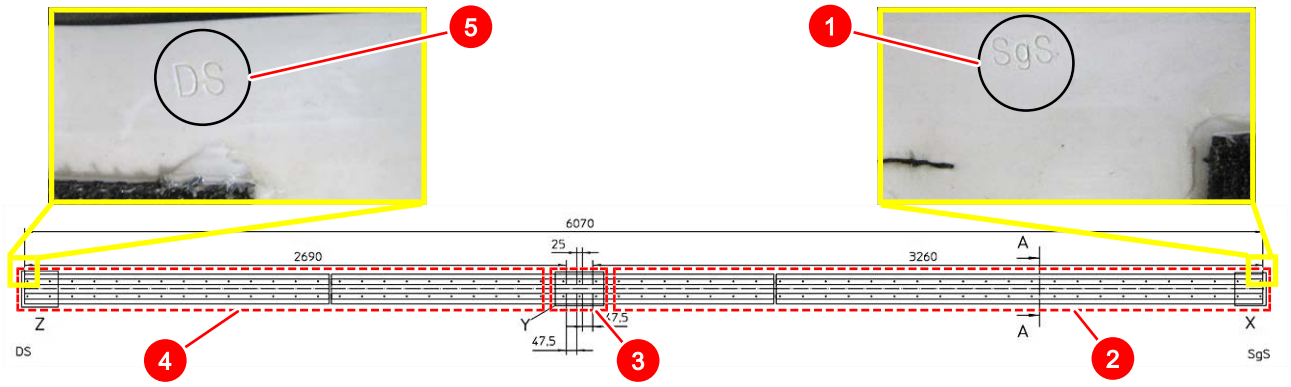


Fig. 55: E115-1 (length: 6070 mm, SAP 137750) spoiler velcro seal overview

1	Position of suction face marking	4	Velcro seal, suction face (3260 mm long)
2	Velcro seal, pressure face (2690 mm long)	5	Position of pressure face marking
3	Trailing edge velcro seal		

4. Check whether the Velcro strips are perforated in regular intervals on the Velcro seal.



Fig. 56: Punching holes in the Velcro seal

5. If the Velcro seal is not perforated, use a hole punch (SAP 144005) to punch Ø-3-mm holes in the Velcro seal; space them about 10 cm apart.

Press Velcro seal on the rotor blade

⚠ WARNING



Danger of slipping or falling from the rotor blade during assembly of the Velcro seal

Severe injury

- ⇨ Use your PFPS in accordance with its intended use.
- ⇨ Secure a fall arrest block in the crane hook.
- ⇨ Dry wet surfaces before stepping on them.

6. Align the Velcro seal so the pressure side (DS) and suction side (SgS) labels on the Velcro seal are correctly placed on the pressure side and suction side of the rotor blade.

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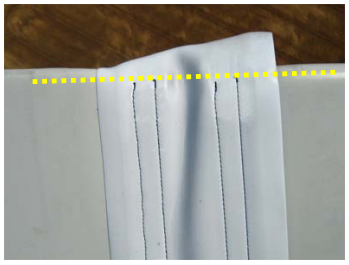


Fig. 57: Lay Velcro seal on the trailing edge

7. Place the Velcro seal against the trailing edge so that the start of the sewn-in Velcro strip is flush with the edge.

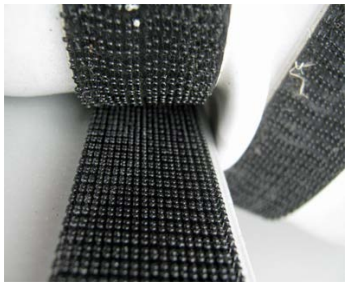


Fig. 58: Match up Velcro strips along the entire length

8. Match up and close the Velcro seal starting from the trailing edge towards the rotor blade joint. Make sure that the Velcro strips are perfectly matched up on top of each other.



Fig. 59: Press down on the Velcro seal

9. Push down on the Velcro strips with the press-on roller (SAP 143964) so that they are firmly pressed together. Repeatedly check that the Velcro strips are properly aligned; correct the alignment if necessary.
   ↪ The Velcro seal makes firm contact with the Velcro strips.



Fig. 60: Correctly connected Velcro strips

10. Make sure the Velcro strips make proper contact.

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Gluing the Velcro seal

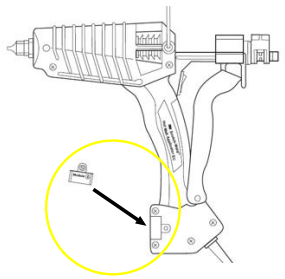


Fig. 61: Hot glue gun overview

The temperature of the hot glue gun (SAP 143958) has five different temperature modules. Temperature module 4 must be used with the hot melt glue (SAP 143965).

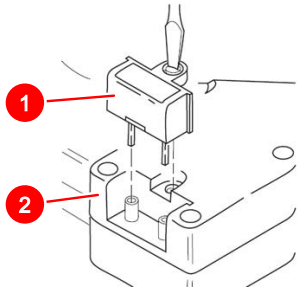


Fig. 62: Inserting temperature module

1	Temperature module	2	Insert at bottom of handle

11. Insert temperature module 4 into the slot at the bottom of the handle.
12. Tighten the slotted screw to fasten the temperature module.

⚠ WARNING

Hot-melt glue and hot parts of hot glue gun

Burns

⇨ Always wear safety goggles and protective gloves when working with hot-melt glue.



Fig. 63: Inserting hot glue gun into the hole

13. Insert the hot glue gun about 3 mm into a hole on the Velcro seal. Move and twist the hot glue gun slightly back and forth to push the nozzle through the Velcro seal.



Fig. 64: Glue oozing out on side

14. Tilt the hot glue gun slightly so that it points to the edge of the Velcro seal.
15. Pull the hot glue gun back slightly so that the nozzle opening is free and the hot-melt glue can be freely injected into the Velcro joint.
16. Lift the protruding edge of the silicone profile slightly and actuate the hot glue gun until the hot glue oozes out of the side of the Velcro joint.
17. Press down on the glued area using the press-on roller to ensure that the Velcro joint is fully closed.
18. Repeat the work steps for all holes.

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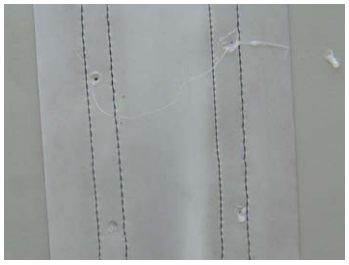


Fig. 65: Glue residue on Velcro seal

19. Allow glue to dry slightly.
20. Remove all glue residue from the Velcro seal.

Additional screwing on of Velcro seal

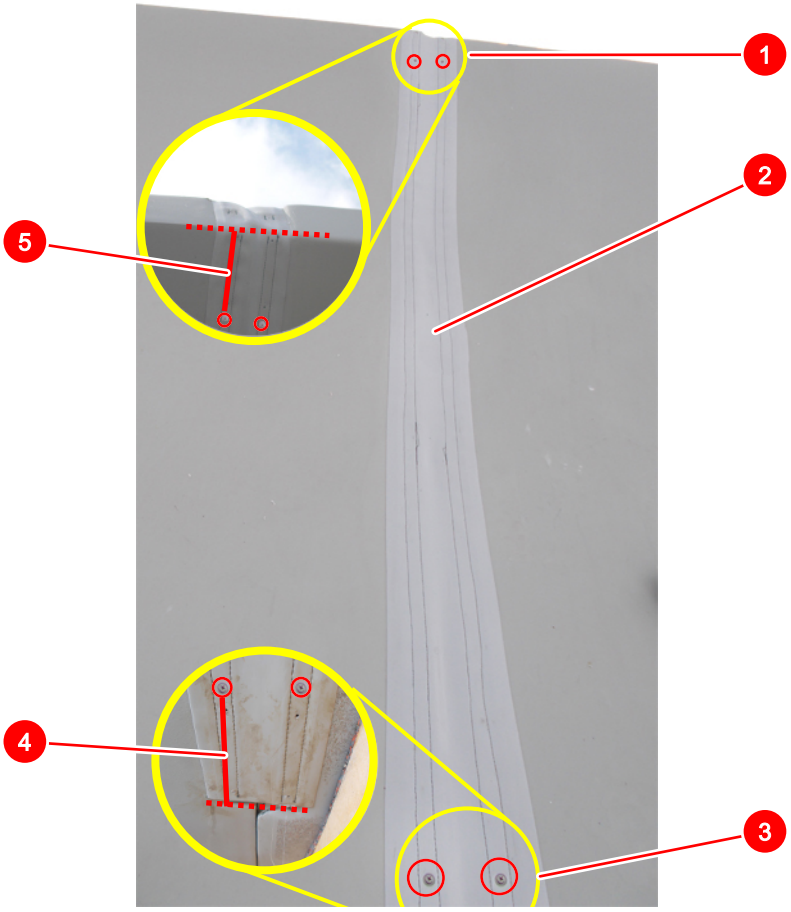


Fig. 66: Velcro seal in place

1	Spax screws near trailing edge	4	Distance 50 mm
2	Velcro seal	5	Distance 100 mm
3	Spax screws at bottom		

21. On the pressure face and suction face, use a total of eight Spax screws to fasten the velcro seal as in figure (fig. 66, p. 72).

7.6.3 Removing the stickers on the separation point

✓ The inner blade is mounted on the outer blade.

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There are several stickers on the separation points of the rotor blades that are no longer required once the rotor blade pre-assembly is complete. The stickers would come loosen during operation and must therefore be removed.

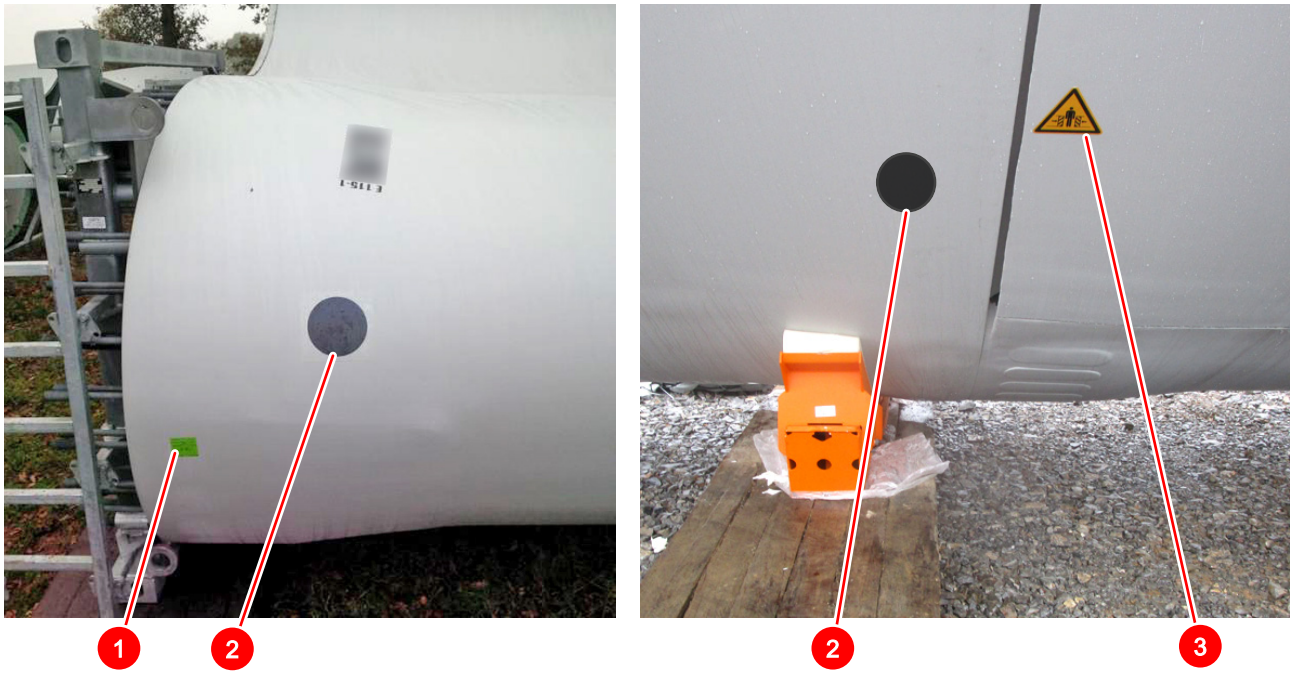


Fig. 67: Label on the separation point

1	QA sticker	3	Warning sticker - risk of crushing
2	Colour code sticker		

1. Remove the following stickers on the outer blade and the inner blade on the separation point:
   - the warning sticker - risk of crushing,
   - the round colour code sticker,
   - the QA sticker.

> The colour code stickers and the warning stickers are mounted on a carrier film and can be removed without tools and cleaning agents.

2. Ensure that the carrier films of the stickers are removed completely.

> The colour code stickers on the rotor blade flange are covered by the blade skirts and do not need to be removed.

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8 Pre-assembly of rotor blades on rotor head

8.1 Warning signs for pre-assembly of rotor blades on rotor head

In addition to the basic safety instructions in the ch. 2.4, p. 10, also observe the following safety warnings for pre-assembly of rotor blades on the rotor head:

⚠ DANGER



Improper conduct when installing the rotor blade

Death or serious injury

- ⇨ Only lift the rigged rotor blade for assembly **without** the transport frame.
- ⇨ Use the guide ropes to prevent the rotor blade from twisting.
- ⇨ Maintain radio contact with all personnel involved.

⚠ DANGER



Tipping the rotor head over during rotor blade assembly

Death or serious injury

- ⇨ Before installing the rotor blades, position deposit trays with excavator mats at the installation positions of the rotor blades.
- ⇨ Position the deposit trays underneath the rotor blade before unhooking the rotor blade.
- ⇨ Always place deposit trays and excavator mats underneath rotor blades.
- ⇨ Do not turn the rotor head during rotor blade assembly.

⚠ DANGER



Swinging of rotor blade during installation

Fatal crush injuries

- ⇨ Do not reach between the flanges.

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⚠ CAUTION



Rotor blades with trailing edge serrations

Stab injuries

- ⇨ Do not remove the edge protection on the trailing edge serrations until just before the rotor blade hoist.
- ⇨ Block off the danger zone if no edge protection is present.
- ⇨ Exercise particular care when working near the trailing edge serrations.

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8.2 Rotor head preparation

8.2.1 Preparing the blade adapter flange

1. Clean the flange faces of the blade adapters.
2. Check the cleaned flange faces for uneven spots and remove any found.

8.2.2 Positioning excavator mats and deposit trays

1. Position 3 excavator mats, stacked on top of each other, in front of each of the 3 blade pipes, at the place where approximately the separating flange is located after rotor blade assembly.
2. Place one outer blade deposit tray on each excavator mat.

8.2.3 Connecting the pitch installation aid

A pitch installation aid is required to turn the blade flange bearings during the WEC assembly.

⚠ DANGER

Working incorrectly with the pitch installation aid

Death or serious injury

⇨ Only electrically instructed persons (EIP) or (electrically) skilled persons may connect the installation aid.

⇨ Do not connect or disconnect the connecting cables unless the *emergency stop button* has been actuated.



Fig. 68: Adapter cable for pitch control

Each blade flange bearing has two pitch motors that turn the bearing.

An adapter cable (SAP 570165) connects the pitch installation aid to the two pitch motors. The installation aid then controls the two pitch motors via this adapter cable.

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Fig. 69: Pitch motor connection point

1. Make sure that the plugs and couplings are clean.
2. Connect one plug of the adapter cable to the coupling of the pitch installation aid.
3. Connect the two plugs of the adapter cable cable to the corresponding coupling of the pitch motors.
4. Secure the connections between plugs and couplings against accidental disconnection.

Each time before turning the hub, the installation aid cables must be disconnected from the pitch motors and returned to the machine house.

8.3 Preparing the rotor blades

8.3.1 Preparing rotor blade flange

1. Check the rotor blade flange surfaces for dirt, rough spots and damage.
2. Clean the flange surfaces as needed.
3. Check the threaded rods for damage and dirt.
4. If the threaded rods are dirty, clean them with a wire brush and cleaning agent as needed.

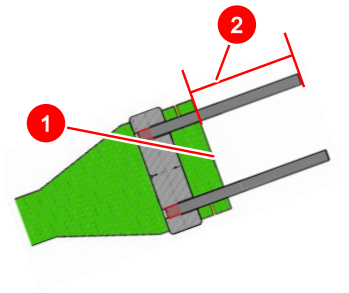


Fig. 70: Rows of bolts at blade connection

1	Blade flange	2	Protruding bolt

5. Check the bolt protrusion of the blade bolts. Ensure that:
   - the blade bolts at the positions 1 & 36 in the inner bolt ring and outer bolt ring protrude by 296.5± 3 mm.
   - All other blade bolts on the inner and outer bolt ring protrude by 282.5 mm ± 3 mm.
6. If any bolts are damaged or out of alignment, or if bolt protrusions are out of tolerance, contact Technical Service Dispatch.

8.3.2 Installing round sling for manual lever hoist

A manual lever hoist has to be inserted between rotor hub and rotor blade in order to be able to pull the rotor blade during assembly towards the rotor hub. An anchorage point needs to be created on the rotor blade for the manual lever hoist.

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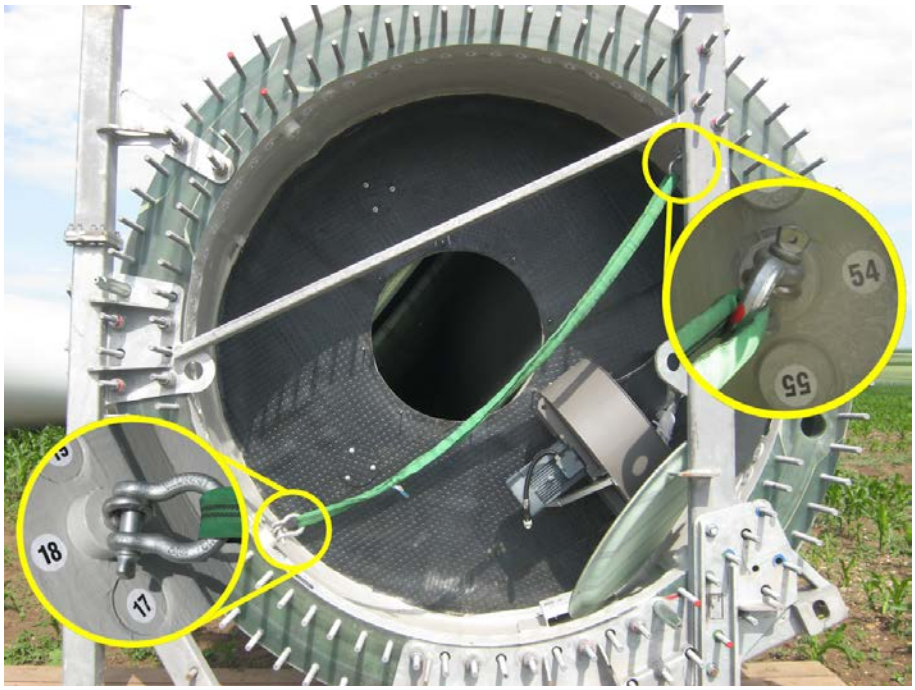


Fig. 71: Round sling attached to protruding cross bolt

1. Insert one M12 eye bolt into each of the threaded holes of two cross bolts protruding on opposite sides.
2. Fasten a 2 t round sling (2 m) between the eye bolts with a 2 t shackle in each case.

↪ During rotor blade assembly, a manual lever hoist can be inserted into the round sling.

8.3.3 Attaching guide ropes to rotor blade

In order to stabilise and steer the rotor blade during installation, guide ropes need to be attached to the rotor blade flange and near the front.

Fastening guide rope to rotor blade flange



Fig. 72: Guide rope fastened to the blade bolt

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1. On the rotor blade flange, attach the guide rope to a blade bolt and pass it several times around the other blade bolts.
2. Make sure that the guide rope will not come off during tightening.

Fastening the guide rope in the blade tip area

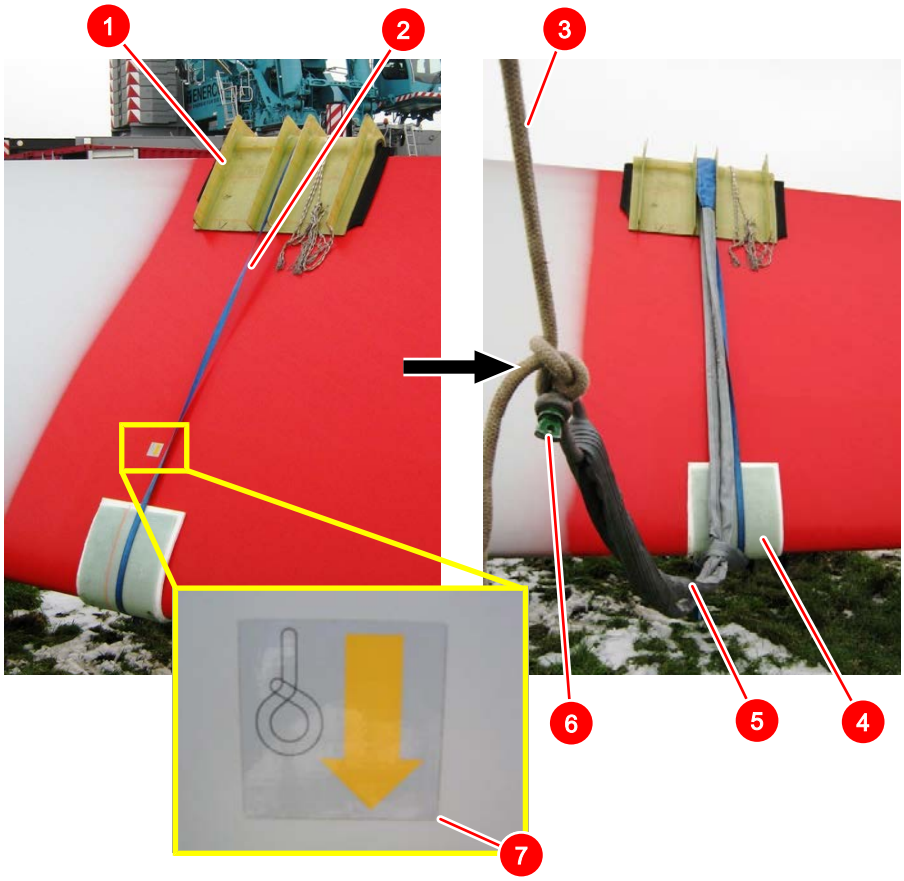


Fig. 73: Protective shells on the rotor blade

1	Trailing edge of blade protective shell	5	4-t round sling (6 m)
2	Lashing strap	6	4.75 shackle
3	Guide cable	7	Mark for installation position of guide rope
4	Leading edge of the blade protective shell		

3. Position the trailing edge of blade protective shell at the marked location on the rotor blade trailing edge. In freezing conditions, put a sheet of plastic underneath the protective shell to make it easier to remove later.
4. Place a sufficiently long lashing strap over the protective shell and guide it around the rotor blade.
5. Position the blade protective shell leading edge under the blade protective shell trailing edge on the rotor blade front edge.

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6. Secure the protective shells to the rotor blade with the lashing strap. Position the lashing strap closure on one of the protective shells so that the rotor blade surface is not damaged.
7. Place a 4-t round sling (6 m) around the rotor blade over the protective shells.
8. Fasten a guide rope with a 4.75-t shackle to the available end of the round sling.

8.3.4 Rigging the rotor blade

Installing adapter for release device



Fig. 74: Release device adapter

The release device adapter (SAP 556587) is needed to create an anchorage point on the separating flange of the E115-1 inner rotor blade for hoisting the inner rotor blade without a separating flange frame or for hoisting the entire rotor blade. A release device (SAP 520513) or a handling bolt (SAP 578317) can be inserted into the adapter.
Further technical specifications are provided in the manufacturer's operating manual.

⇨ See document: BMA-D0337117 "Gebrauchsanleitung Adapter für Ausklinkvorrichtung Rotorblatt E115-1" (Gebrauchsanleitung Adapter für Ausklinkvorrichtung Rotorblatt E115-1 (E115-1 rotor blade release device adapter operating instructions))

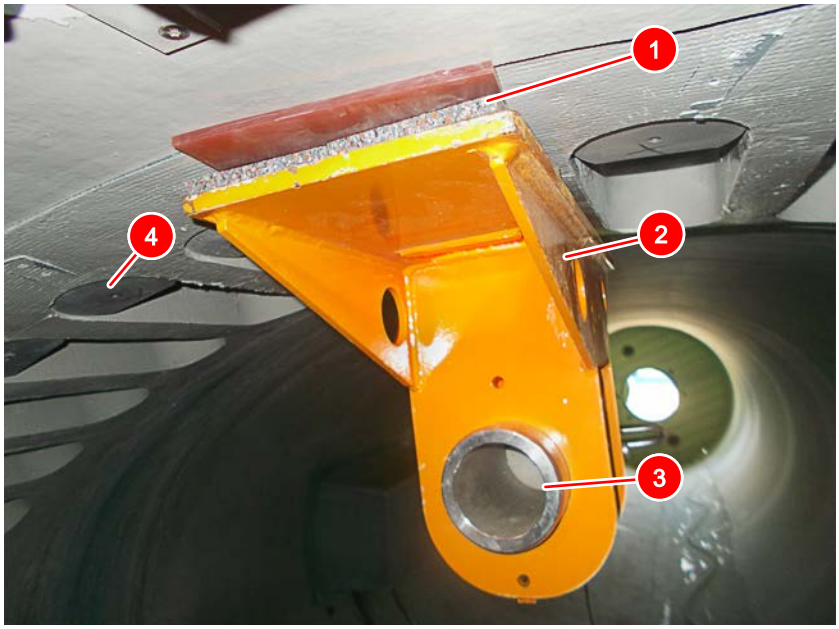


Fig. 75: Adapter for release device installed

1	Rubber mats	3	Release device
2	Release device adapter	4	Cross bolt

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1. Position the adapter for the release device at the anchorage point of the separating flange.

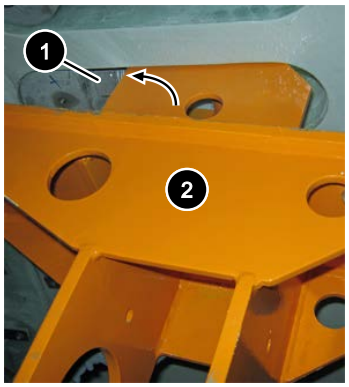


Fig. 76: Fitting the adapter

1	Bolt connections on rotor blade	2	Adapter

2. Tilt the adapter slightly to guide the two holes over the bolt connections of the inner blade.



Fig. 77: Bolt connection of the adapter

3. Outside the rotor blade, use two nuts to hand-tighten the adapter to secure it to the bolt connection of the rotor blade.
4. Use rubber mats to line the gap between adapter and rotor blade in the lengthwise direction.

Installing release devices



Fig. 78: Rotor blade release device

The rotor blade release device (SAP 520513) is used for attaching and releasing rotor blades with a load application rib (LAR) during assembly and disassembly. The release device can also be inserted into a release device adapter on the separating flange during the pre-assembly.
Further technical information is provided in the manufacturer's operating manual.

⇨ See document: TD-des-10-de-xx-15-021 “Betriebsanleitung Ausklinkvorrichtung Rotorblatt E-101” (E-101 rotor blade release device operating manual)

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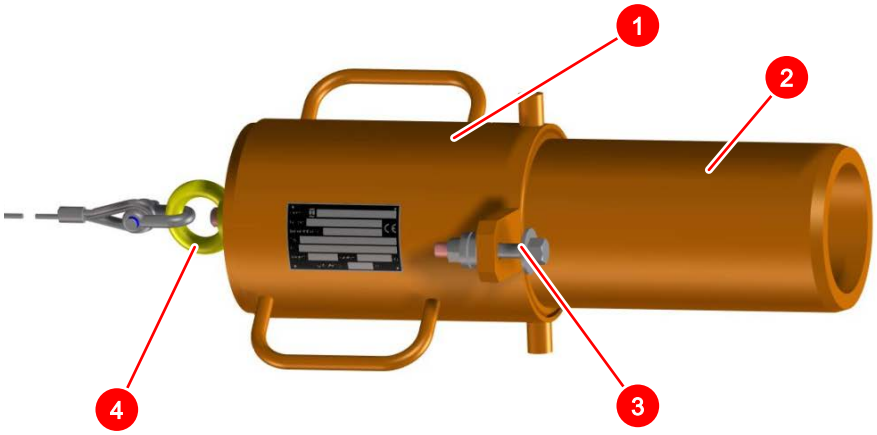


Fig. 79: Release device with pin in front end position

1	Guide tube	3	Bolt connection
2	Bolt	4	Lifting eye nut

5. Ensure that the bolt of the release device is in the front end position.
6. Insert the bolt of the release device to the limit stop into the lower opening of the load application rib (LAR) in the outer rotor blade, the guide tube must point towards the blade flange.

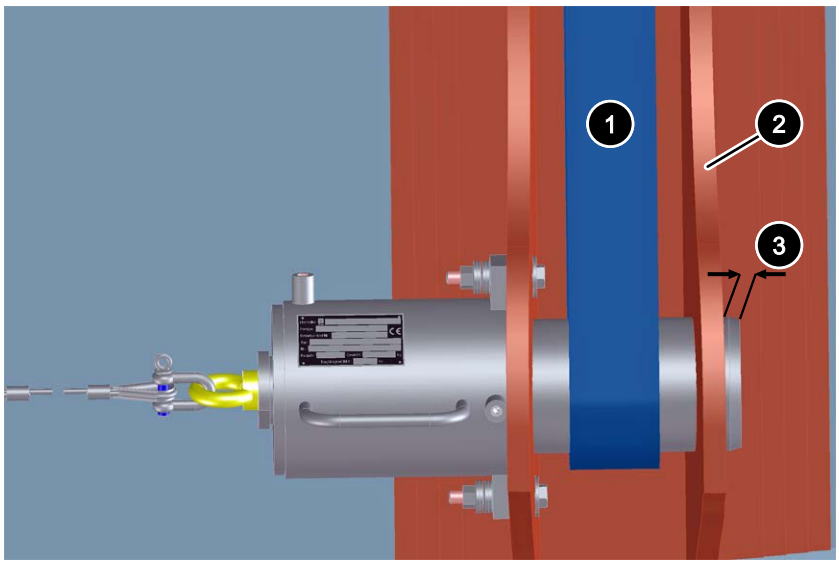


Fig. 80: Overview of release device bolt

1	Round sling	3	Bolt protrusion min. 10 mm
2	Load application rib		

7. Measure the protrusion of the bolt at the end of the LAR.
8. If the bolt has a protrusion < 10 mm, consult the Technical Service Dispatch office in charge.

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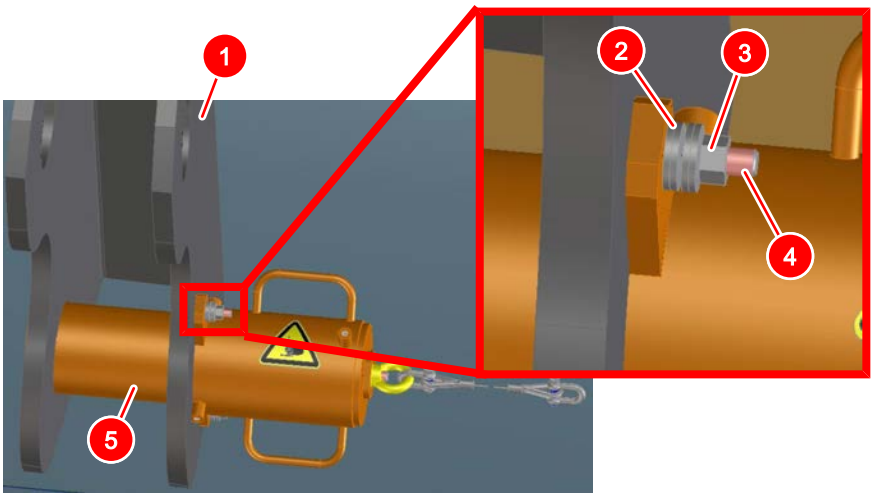


Fig. 81: Release device installed on load application rib

1	Load application rib	4	Hexagon bolt
2	4x conical spring washer	5	Pin
3	Hexagon nut		

9. Fasten the release device to the LAR using the bolts, hexagon nuts, washers and conical spring washers supplied. Place the conical spring washers so that they are opposite each other.
10. Tighten the hexagon nuts until the conical spring washers are compressed to 15 mm.
11. Check whether the release device has been properly installed in the LAR of the inner rotor blade during pre-assembly of the rotor blade.
12. Install the second release device on the adapter for the release device in the inner rotor blade in accordance with the previous worksteps.

Installing pull ropes

The pull ropes need only be installed on rotor blades that will not be unhooked at the 3 o'clock or 9 o'clock position.

13. Shackle the pull ropes to the lifting eye nuts of the release devices.
14. Run the free ends of the pull ropes to the rotor blade flange.
15. Secure the pull ropes to an eye bolt on the blade bolt.

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Attaching rotor blade by means of release devices

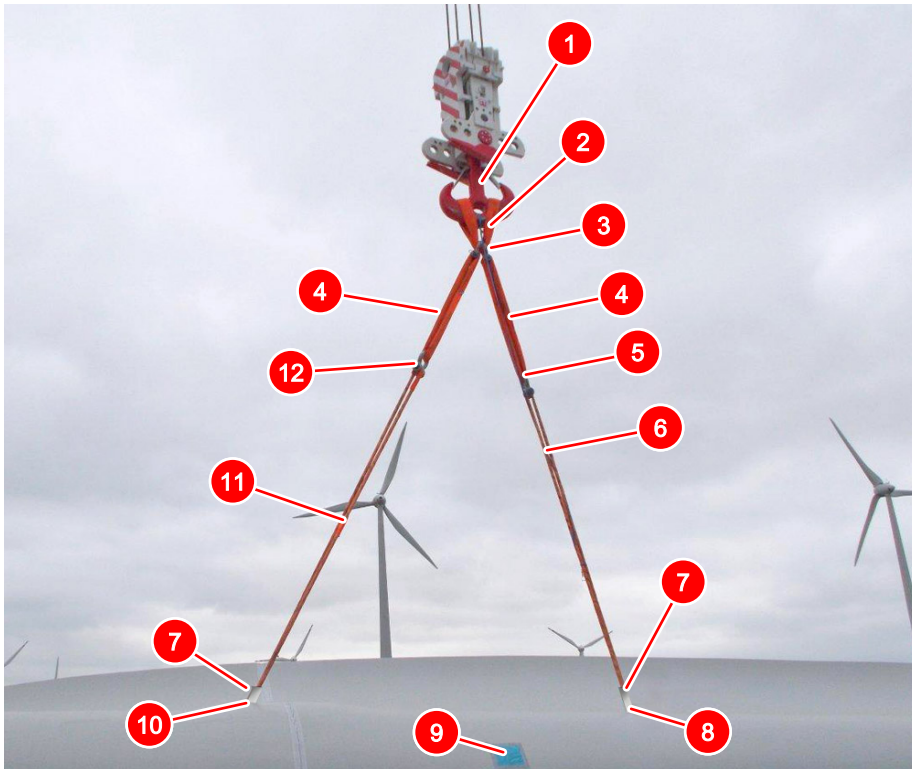


Fig. 82: Rotor blade attached by release device

1	Crane hook	7	Protective tubing for round slings (SAP 141659)
2	30-t round sling (1 m) in U shape as a sling for double crane hook	8	Lifting eye on outer blade
3	1×75-t shackle	9	Middle lifting eye (not used)
4	30-t round sling (1.7 m)	10	Lifting eye of inner blade
5	35-t shackle	11	MagnumX 30-t round sling (5 m)
6	MagnumX 30-t round sling (5 m)	12	25-t shackle

16. Pull the protective tubing over the 30-t MagnumX round slings.
17. Pass the 30-t MagnumX round sling through the lifting eye of the inner blade.
18. Pass the 30-t MagnumX round sling through the lifting eye of the outer blade.
19. In the rotor blade, pull the lifting eye nuts to pull the pins fully out of the release devices.

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Fig. 83: Round sling attached to release device

20. Position the round slings between the load application rib and the adapter for the release device.
21. Push the lifting eye nuts to insert the release device pins through the ends of the round sling. Move the pins into the end position.
22. Pull lightly on the lifting eye nuts to ensure that the bolts have latched in the end position.
23. Position the protective tubing in such a way that it is inside the lifting eyes.
24. Install the remaining lifting accessories for the hoist on the inner blade as shown in the overview (fig. 82, p. 84).

8.3.5 Removing rotor blade tip from transport frame

If present, remove the top frames (export frames).

1. Attach a 4-leg lifting chain to the corner fittings of the top frame.
2. Unlock the twistlocks of the rotor blade frame.
3. Lift the top frame and move it away with the crane.

To detach the lower transport frame, remove the fasteners and the plastic shell.



Fig. 84: Top frame, detached

1	Supports (brackets)

4. Remove the hexagon bolts on both sides of the supports (brackets).
5. Remove the plastic shell.
6. Lift the rotor blade slightly and lash all transport frame parts securely for transport.

8.4 First rotor blade

8.4.1 Hoist first rotor blade and move into position

⚠ DANGER



Swinging of rotor blade during installation

Fatal crush injuries

⇨ Do not reach between the flanges.

1. Carefully move the rotor blade in front of the blade adapter.
2. Use the guide ropes to hold the rotor blade steady.

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3. Position the rotor blade flange in front of the flange of the blade flange bearing; do not yet insert the threaded rods into the holes on the blade flange bearing.
4. Hook the manual lever hoist in the blade adapter into the round sling on the rotor blade flange.
5. Remove the guide rope on the rotor blade flange.

1 pair of threaded rods is missing on the rotor blade flange. 2 holes are missing in the flange of the blade flange bearing. The rotor blade can only be installed if these positions are flush. This prevents incorrect assembly of the rotor blade.

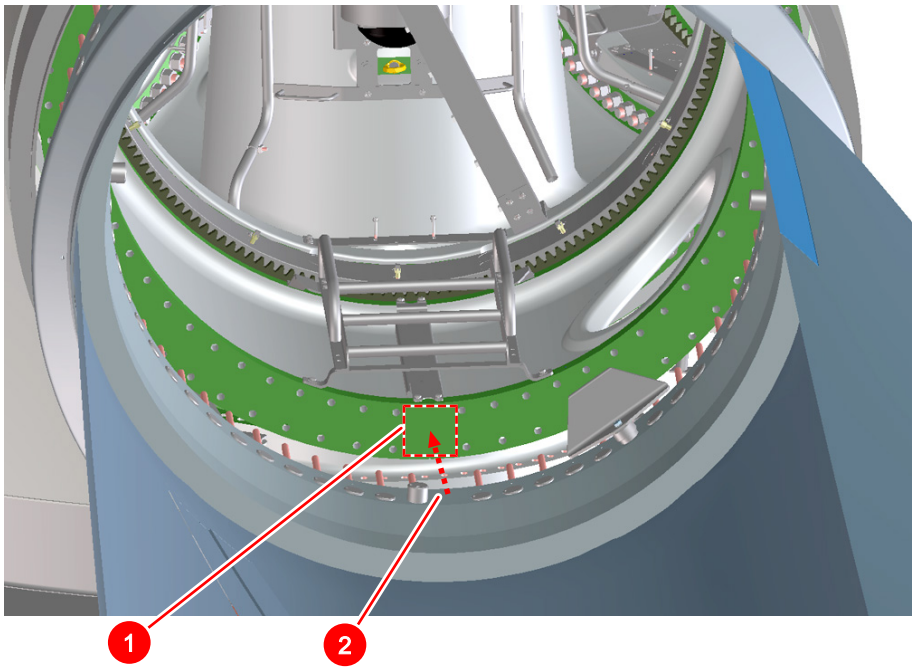


Fig. 85: Overview of rotor blade flange - blade adapter flange

1	Position of unused holes	2	Position of unused threaded rods

6. Check on the blade adapter flange whether the positions of the unused holes are flush with the unused threaded rod pair on the rotor blade.
7. If the positions are not flush, turn the blade flange bearing using the installation aid.

⚠ DANGER! Use the manual lever hoist as an insertion aid only and not for greater tensile force!

8. Move the rotor blade to the blade flange bearing and guide the threaded rods of the rotor blade into the holes of the blade adapter. Use the manual lever hoist to guide the rotor blade.

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8.4.2 Fastening first rotor blade

1. Screw the hexagon nuts and expansion sleeves onto the threaded rods of the inner and outer bolt rings by hand as far as possible.

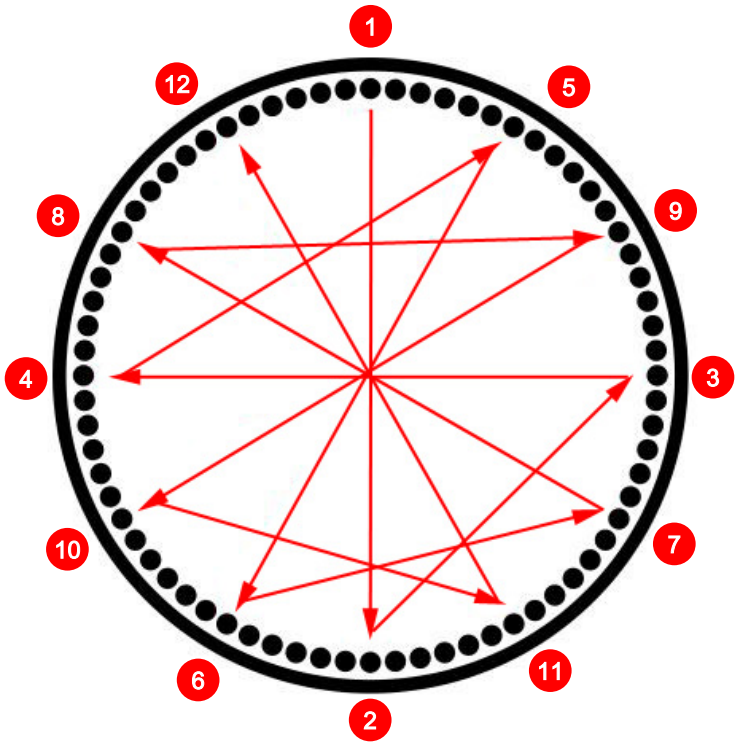


Fig. 86: Diagonal fastening sequence

2. Tighten the bolts of the inner bolt ring at **12** positions in **diagonal succession** to the preliminary torque of **250 Nm**. Observe the gap between blade flange and blade connection unit.
3. Mark the fasteners that have been tightened.
4. Keep tightening the 12 marked bolt connections **in diagonal succession** using a torque of **250 Nm** until the gap has closed and the connections cannot be tightened any further.
5. Tighten the remaining bolt connections of the inner and outer bolt rings to the preliminary torque of **250 Nm**.

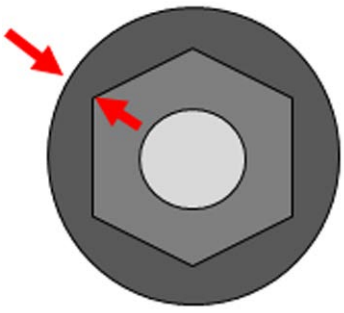


Fig. 87: 0° marking between nut and flange surface of blade adapter

6. Mark an edge on each hexagon nut, then transfer this to the flange of the blade adapter.

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7. Tighten all hexagon nuts on the inner and outer bolt ring in circumferential succession to the final torque of **790 Nm**.

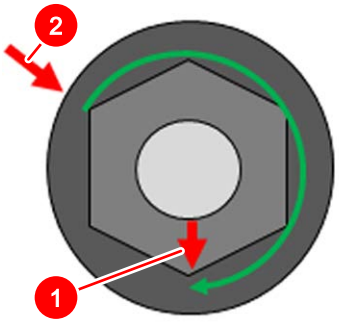


Fig. 88: Positions of markings

1	Marking at 240°	2	Marking at 0°

8. Check the angle of rotation on the marking of the hexagon nuts. If the angle of rotation is less than 240°, the bolt connection is tightened correctly.

An angle of rotation of 240° corresponds to 4 edges of a hexagon nut.

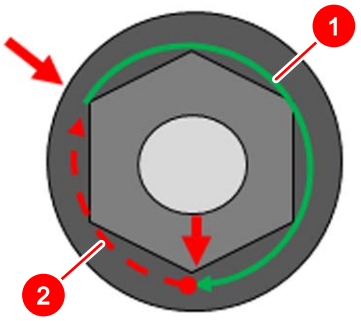


Fig. 89: Permitted angle of rotation

1	Green area: The angle of rotation is OK	2	Red area: The angle of rotation is not OK

9. If the angle is greater than 240°, contact the responsible Technical Service Dispatch.
10. Re-tighten all hexagon nuts a second time round to the final torque of **790 Nm**.

8.4.3 Set down and unhook the rotor blade

✓ The rotor blade is tightened to 85 % torque.

1. Make sure that the deposit tray is positioned underneath the outer blade at a distance of 1 m from the separating flange.
2. Slowly place the rotor blade on the deposit tray.
3. Make sure that the round slings on the rotor blade are without load.

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4. In the rotor blade, pull out the pins from the release devices by pulling on the lifting eye nuts.
5. Make sure that the round slings do not become trapped.
6. Carefully raise the crane hook to pull the round slings out of the rotor blade.
7. Move the pins to the front end position on the release devices.
8. Remove the fasteners of the release devices with the load application ribs.
9. Lock the bolt connections at the release devices.
10. Remove the release devices from the rotor blade.

8.4.4 Assembling ladders and blade adapter step guards

1. In the blade adaptor, install step guards on the load control sensors.
2. Install ladders to the rotor blade.

8.4.5 Installing the lifting eye cover

✓ The rotor blade has been unhooked and the release devices have been removed.

All lifting eyes of rotor blades must be sealed using lifting eye covers (LAR covers).

1. Inside the rotor blade, check the two lifting eyes between the load application ribs of the rotor blade for dirt and clean as needed.

There are 2 versions of lifting eye covers: LAR cover made of GRP with bolt connection (SAP 121689) and LAR cover made from plastic with snap lock (SAP 613840).

Installing the lifting eye cover with bolt connection



Fig. 90: Lifting eye cover with bolt connection

2. Lubricate the threaded bolts of the lifting eye cover lightly using white all-round paste.

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3. Fold in the lifting eye cover so that the cover fits into the attachment hole.
4. Insert the lifting eye cover into the attachment hole from the inside and open out the cover.



Fig. 91: Lifting eye cover installed

5. Centre the lifting eye cover in the attachment hole.
6. Use the bracket and the bolts to fasten the lifting eye cover to the rotor blade and snug-tighten them.

Installing the lifting eye cover with ratchet

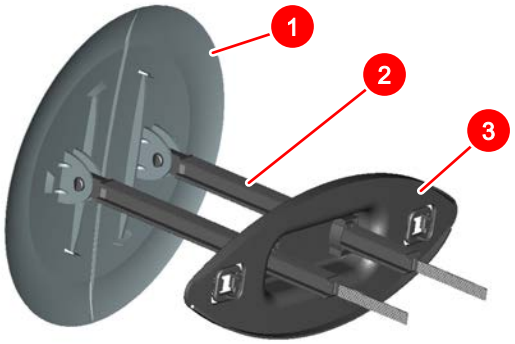


Fig. 92: Lifting eye cover with ratchet

1	Cover	3	Ratchet support
2	Ratchet bar		

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Fig. 93: Lifting eye cover folded in

7. Fold in the lifting eye cover.
8. Guide the lifting eye cover outwards through the attachment hole and secure it on the ratchet bars.
9. Fold out the lifting eye cover.
10. Tighten the lifting eye cover on the ratchet bars until the cover fully covers the attachment hole.



Fig. 94: Ratchet support installed

11. Guide the ratchet support over the two ratchet bars of the cover. The inward curve of the ratchet support must point outwards.
12. Pull the ratchet support towards the cover completely over the ratchet bars until the lifting eye cover is located firmly in the attachment hole.

8.4.6 Installing roller lightning conductor

✓ The rotor blade has been installed.

1. On the blade pipes inside the rotor head, position the first roller lightning conductor on the rotor head casing together with the insulating plate and tighten by hand.

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Fig. 95: Adjusting the rollers

2. Line up the rollers to point towards the centre of the rotor blade's discharge ring.
3. Tighten the fasteners to the required torque, see *Torque table*, p. 155.
4. Make sure that the roller lightning conductor presses tightly against the discharge ring.
5. Adjust the lightning rod such that its tip lies level with the generator discharge ring's centre line at a distance of 10 mm.
6. Bolt on the lightning rod and tighten to the specified torque.
7. Use the installation aid to pitch the rotor blade completely in and out to ensure that the roller lightning conductor functions properly.

8.4.7 Installing the lightning protection cable

1. Route the cable of the discharge box out of the rotor blade if necessary through the boring in the reinforcing ring.
2. Route the cable as far as the connection point on the blade flange of the rotor hub and fasten to the existing paste bases using sufficient cable ties.
3. Clean any paint from the contact surface of the connection point using a wire brush if necessary and with Rivolta M.T.X. 60 Forte (SAP 553182).
4. Spray the cleaned contact surface with Rivolta F.L.G. GT-2 (SAP 514100).
5. Install the cable on the connection point.
6. Spray the tightened fasteners with Rivolta F.L.G GT-2.

8.5 Second rotor blade

8.5.1 Hoisting second rotor blade and moving into position

✓ The first rotor blade is installed on the rotor head.

1. Hoist the second rotor blade to the rotor head as described in ch. 8.4.1, p. 85 and place it into position.

8.5.2 Bolting second rotor blade

1. Bolt the rotor blade as described in ch. 8.4.2, p. 87.

8.5.3 Unhooking second rotor blade

1. Unhook the rotor blade as described in ch. 8.4.3, p. 88.

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8.5.4 Assembling ladders and blade adapter step guards

1. Fit ladders and steps guards in the blade adapter acc. to ch. 8.4.4, p. 89.

8.5.5 Installing the lifting eye cover

1. Install the lifting eye covers as described in ch. 8.4.5, p. 89.

8.5.6 Installing the roller lightning conductor

1. Install the roller lightning conductor as described in ch. 8.4.6, p. 91.

8.5.7 Installing the lightning protection cable

1. Install the lightning protection cable as shown in ch. 8.4.7, p. 92.

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8.6 Third rotor blade

8.6.1 Hoist the third rotor blade and move into position

✓ The first and second rotor blade have been installed on the rotor head.

1. Hoist the third rotor blade to the rotor head as described in ch. 8.4.1, p. 85 and place it into position.

8.6.2 Bolting third rotor blade

1. Bolt the rotor blade as described in ch. 8.4.2, p. 87.

8.6.3 Unhooking third rotor blade

1. Unhook the rotor blade as described in ch. 8.4.3, p. 88.

8.6.4 Assembling ladders and blade adapter step guards

1. Fit ladders and steps guards in the blade adapter acc. to ch. 8.4.4, p. 89.

8.6.5 Installing the lifting eye cover

✓ The rotor blade has been unhooked and the release devices have been removed.

All lifting eyes of rotor blades must be sealed using lifting eye covers (LAR covers).

1. Inside the rotor blade, check the two lifting eyes between the load application ribs of the rotor blade for dirt and clean as needed.



There are 2 versions of lifting eye covers: LAR cover made of GRP with bolt connection (SAP 121689) and LAR cover made from plastic with snap lock (SAP 613840).

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Installing the lifting eye cover with bolt connection



Fig. 96: Lifting eye cover with bolt connection

2. Lubricate the threaded bolts of the lifting eye cover lightly using white all-round paste.
3. Fold in the lifting eye cover so that the cover fits into the attachment hole.
4. Insert the lifting eye cover into the attachment hole from the inside and open out the cover.



Fig. 97: Lifting eye cover installed

5. Centre the lifting eye cover in the attachment hole.
6. Use the bracket and the bolts to fasten the lifting eye cover to the rotor blade and snug-tighten them.

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Installing the lifting eye cover with ratchet

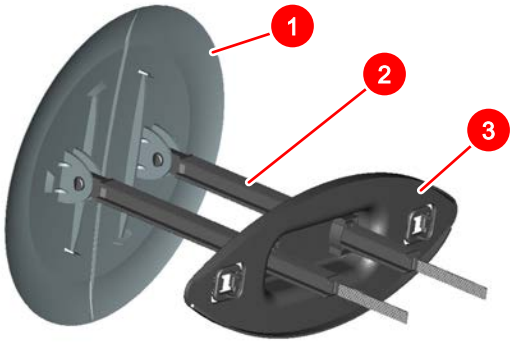


Fig. 98: Lifting eye cover with ratchet

1	Cover	3	Ratchet support
2	Ratchet bar		



Fig. 99: Lifting eye cover folded in

7. Fold in the lifting eye cover.
8. Guide the lifting eye cover outwards through the attachment hole and secure it on the ratchet bars.
9. Fold out the lifting eye cover.
10. Tighten the lifting eye cover on the ratchet bars until the cover fully covers the attachment hole.



Fig. 100: Ratchet support installed

11. Guide the ratchet support over the two ratchet bars of the cover. The inward curve of the ratchet support must point outwards.

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12. Pull the ratchet support towards the cover completely over the ratchet bars until the lifting eye cover is located firmly in the attachment hole.

8.6.6 Installing the roller lightning conductor

1. Install the roller lightning conductor as described in ch. 8.4.6, p. 91.

8.6.7 Installing the lightning protection cable

1. Install the lightning protection cable as shown in ch. 8.4.7, p. 92.

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9 Machine house assembly

9.1 Overview of machine house assembly

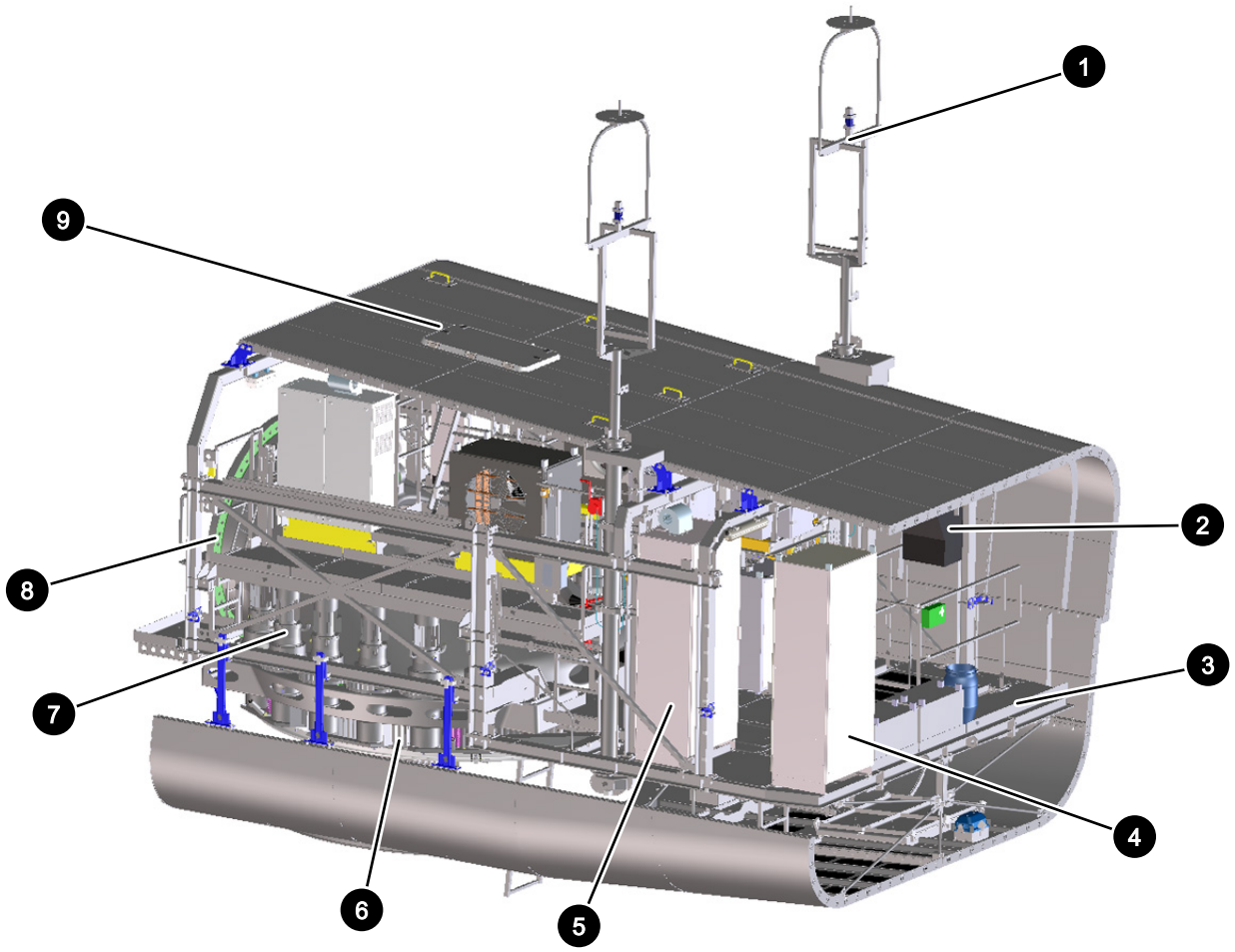


Fig. 101: Overview of machine house installation

1	Anemometer support (backup)	2	Chain winch
3	Machine house platform	4	Nacelle control cabinet
5	Yaw control cabinet	6	Yaw bearing
7	Yaw motors	8	Main carrier flange
9	Nacelle hatch		

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9.2 Safety warnings for machine house installation

In addition to the basic safety instructions in the ch. 2.4, p. 10, also observe the following safety warnings during machine house installation:

⚠ DANGER



Premature unhooking of the machine house

Death or serious injury

⇨ Before unhooking the machine house, make sure that the machine house is tightened snug-tight with 3 nuts in at least 4 positions crosswise (every 90°) (at least 12 nuts in total).

⚠ DANGER



Tools and materials falling through tower gap

Death or severe injury

⇨ Before working on the tower gap in the machine house, install the tower gap cover.

⇨ Ensure that the danger zone below the machine house is clear of people while the tower gap cover is not yet installed.

⚠ DANGER



Working with hydraulic torque wrench, hydraulic unit and hydraulic hoses

Death or serious injury

⇨ Hydraulic equipment may only be operated by persons who are familiar with the devices and have received training in their unsupervised use.

⇨ Always wear safety goggles and protective gloves when working with or on the devices.

⇨ Ensure that all inspection certificates are current. Do not use devices whose inspection certificates have expired.

⇨ For pressure values, refer to the torque table for hydraulic torque wrench cassettes.

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⚠ DANGER



Working with impact wrenches

Death or serious injury

- ⇨ Impact wrenches may only be operated by persons who have received proper training and are familiar with the unsupervised use of the device.
- ⇨ Wear safety goggles.
- ⇨ Wear protective gloves.
- ⇨ Wear ear protection.

⚠ DANGER



Falling from the nacelle

Death or severe injury

- ⇨ Use **two protection systems** when working on top of the nacelle. In combination with your PFPS, use **either**:
  - 2x Fallstop BK (SAP 110933)
  - 1x Fallstop BK (SAP 110933) and 1x fall arrest block (SAP 123833)
- ⇨ Secure yourself to a designated anchorage point whenever there is a risk of falling from height.

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9.3 Nacelle power supply

Installation aids are required for the power supply to the nacelle during the WEC installation. There are two installation aids for the nacelle and one installation aid for the pitch control:

Tab. 1: Overview of installation aid functions

Function	Nacelle installation aid V1 (SAP 509623)	Nacelle installation aid V2 (SAP 521231)	Pitch installation aid V1 (SAP 511350)
Turning the machine house	x		
Activate the rotor brake	x	x	
Operating the chain winch	x	x	
Turning the pitch control			x

Due to the high dead load, the nacelle installation aid V1 and the pitch installation aid V1 must be transported downwards with the chain winch once the installation is complete. The chain winch and the rotor brake are then operated with the installation aid V2.

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9.3.1 Positioning the installation aids

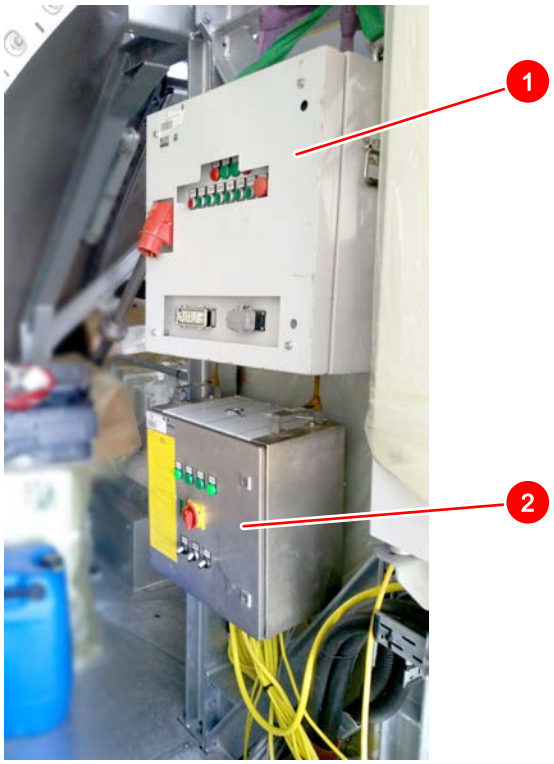


Fig. 102: Positioning the installation aids

1	Pitch installation aid V1	2	Nacelle installation aid V1

1. Position the pitch installation aid beside the nacelle control cabinet in the machine house as per the figure on the right.
2. Position the nacelle installation aid below the pitch installation aid.

The pitch installation aid is connected only after the rotor head is assembled.

9.3.2 Connecting the nacelle installation aid

⚠ DANGER

Electric current

Death or serious injury from electric arcs and electric shocks

⇨ Ensure that the 32A CEE power supply plug for the nacelle installation aid has been disconnected from the power supply before connecting the installation aid to the yaw motors, the rotor brake and the chain winch.

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NOTICE

Insufficient voltage on electromechanical brakes

Damage due to blocking of electromechanical brakes

⇨ While installing the WEC, only 2 of the 3 electromechanical brakes should be operated using the installation aid.

⇨ Remove the power supply cable on one of the electromechanical brakes before braking for the first time using the installation aid.

Connecting yaw motors



Fig. 103: Labelled plug

1. Route the connection cables for the yaw motors from the nacelle installation aid to the relevant yaw motors according to the labelling on the plugs.



Fig. 104: Yaw motor connected

2. Disconnect the plugs of the connection cables on the yaw motors.

After the nacelle installation aid has been used, the disconnected connection cables must be connected again.

3. Connect and secure the plugs of the nacelle installation aid connection cables at the yaw motors.

Connecting the rotor brake

While installing the WEC, the electromechanical brakes may block and thus become damaged. This blockage is due to insufficient power being supplied via the installation aid. To prevent this blockage, only 2 of the 3 electromechanical brakes may be used.

4. Install the connecting cable for the electromechanical brakes from the installation aid to the stator sub-distribution system connection.

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5. Plug the connecting cable into the connection point under the stator sub-distribution system and lock it.
6. Remove the power supply cable in the generator from one of the electromechanical brakes.
7. Secure the power supply cable to the electromechanical brake using an adequate number of cable ties. Ensure the cable does not become damaged while the rotor turns.

Connecting the chain winch

8. Guide the connection cable for the chain winch from the installation aid to the main switch of the chain winch.

After the nacelle installation aid has been used, the disconnected connection cable must be reconnected.

9. Unplug the plug of the power supply cable at the chain winch main switch.
10. Connect and secure the plug of the nacelle installation aid connection cable at the main switch.

9.3.3 Preparing the initial rotation of the nacelle

Long-distance transports and long idle times in combination with moisture can cause the brake pads of the yaw brakes to seize up. In this event the yaw brakes fail to release properly and the affected yaw drives lock up. This can cause major damage to the yaw gear rim. For this reason, verify that the yaw brakes release properly before the **nacelle rotates for the first time**.

⚠ DANGER

Electric current while opening the installation aid

Death or serious injury from electric arcs and electric shocks

⇨ Before opening the nacelle installation aid, make sure that the 32A CEE power plug is unplugged.

The steps described here may only be carried out by (electrically) instructed persons or skilled electricians.

Carrying out preparatory work

1. Switch off the main switch on the nacelle installation aid.
2. Unplug the nacelle installation aid 32A CEE power plug from the power supply.
3. Open the nacelle installation aid.
4. Switch off motor circuit breakers -Q03, -Q04 and -Q05.

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5. Switch on motor circuit breaker -Q02.
6. Close the nacelle installation aid.
7. Attach the nacelle installation aid 32A CEE power plug to the power supply.

Checking the yaw brake function

8. Switch on the main switch on the nacelle installation aid.

NOTICE

Defective yaw brakes

Damage to yaw gear rim

⇨ Stop the nacelle turning immediately if the nacelle and/or one or more fan wheels on the yaw motors are not turning or only with interruptions and contact the responsible Technical Service Dispatch to clarify the subsequent procedure.

9. Activate yawing, left or right. Listen for any unusual noises.
   ↪ The activated yaw motor 1 turns the nacelle into the specified direction; the strain is audible.
   ↪ The fan impeller of all yaw motors turn in the same direction without interruption.
10. Stop yawing.

Finishing steps

11. Switch off the main switch on the nacelle installation aid.
12. Unplug the nacelle installation aid 32A CEE power plug from the power supply.
13. Open the nacelle installation aid.
14. Switch on motor circuit breakers -Q03, -Q04 and -Q05.
15. Close the nacelle installation aid.
16. Attach the nacelle installation aid 32A CEE power plug to the power supply.
17. Switch on the main switch on the nacelle installation aid.

↪ The nacelle can be moved in the required position.

9.4 Machine house

9.4.1 Attaching the machine house

1. Rig the machine house for hoisting according to ch. 4.3.3, p. 19.

9.4.2 Hoisting the machine house and setting it down on the tower

1. Keep raising the crane hook until the lifting accessories are taut.

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2. Under the machine house, remove the bolt connections between the adapter plate and the main carrier.
3. Carefully lift the machine house. The adapter must remain on the frame.
4. Hoist the machine house to its installation position above the tower.
5. Carefully set the machine house down on the top tower flange, guiding the threaded rods through the holes in the tower flange.

⚠ DANGER! Only screw on the lock nuts if the danger zone below the machine house is clear of people. Only install the remaining machine house fasteners after the tower gap cover has been installed.

6. Screw 3 nuts and washers snug-tight onto the machine house's threaded rods in 4 positions in diagonal succession (ever 90°) (at least 12 nuts in total).
7. ↪The machine house can be unhooked.

9.4.3 Carrying out the gap measurement yaw bearing – tower

During assembly of the machine house, the gap needs to be measured between yaw bearing and the top flange of the tower before and after bolting. For this the tower flange is divided into 12 measuring ranges each of 30°. Measuring range no. 1 is located on the right of the longitudinal seam on the topmost tower wall plate. Measurement must be performed clockwise.



To prevent inaccuracies, only one person should perform the gap measurement.

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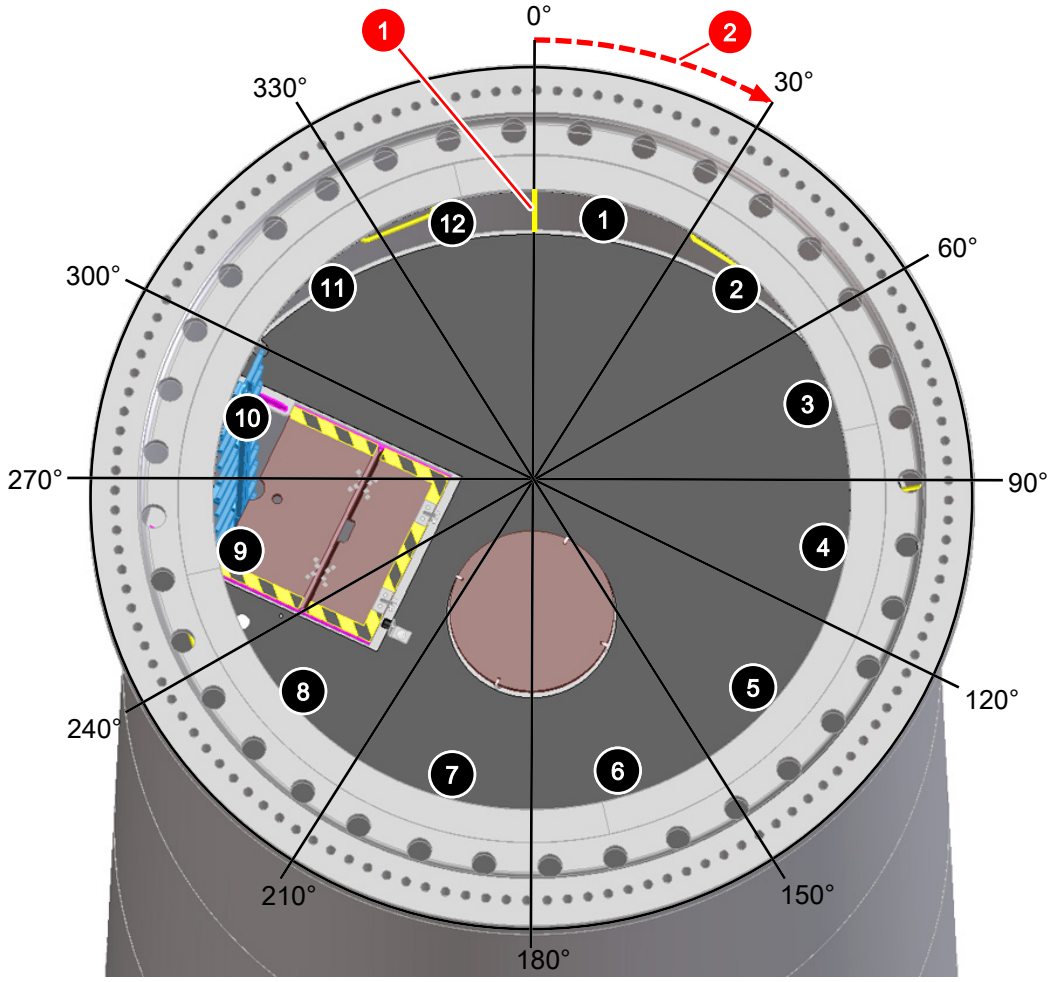


Fig. 105: Measuring ranges top flange tower

1 (red)	Longitudinal seam of the tower wall plate
2 (red)	Measuring direction, clockwise
1-12 (black)	Measuring areas

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Measuring areas

The gap measurement is to be performed on the contact surface of the yaw bearing in 3 measuring areas:

- in the bolting plane,
- on the interior flange edge,
- on the exterior flange edge.

The outer flange starts behind the yaw bearing teeth.

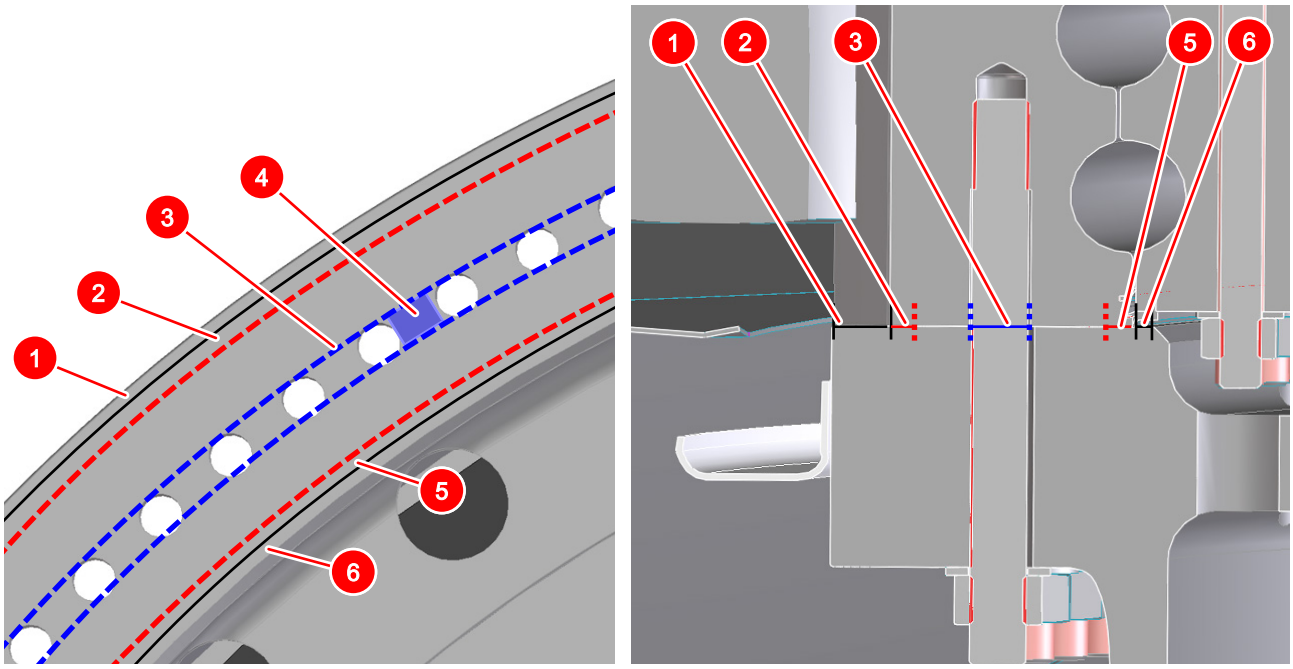


Fig. 106: Top flange tower measuring planes

1	Area under the gear rim	4	Measuring area between threaded bolts
2	Outer edge 10 mm measuring area	5	Inner edge 10 mm measuring area
3	Bolting plane	6	Area in which the bearing is not making contact

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Gap geometry

The following must be measured with each gap measurement:

- the gap width in tangential direction (area on flange perimeter),
- the gap depth in radial direction (area between flange inner edge and flange outer edge),
- the gap height (thickness of the max. feeler gauge that can be inserted).

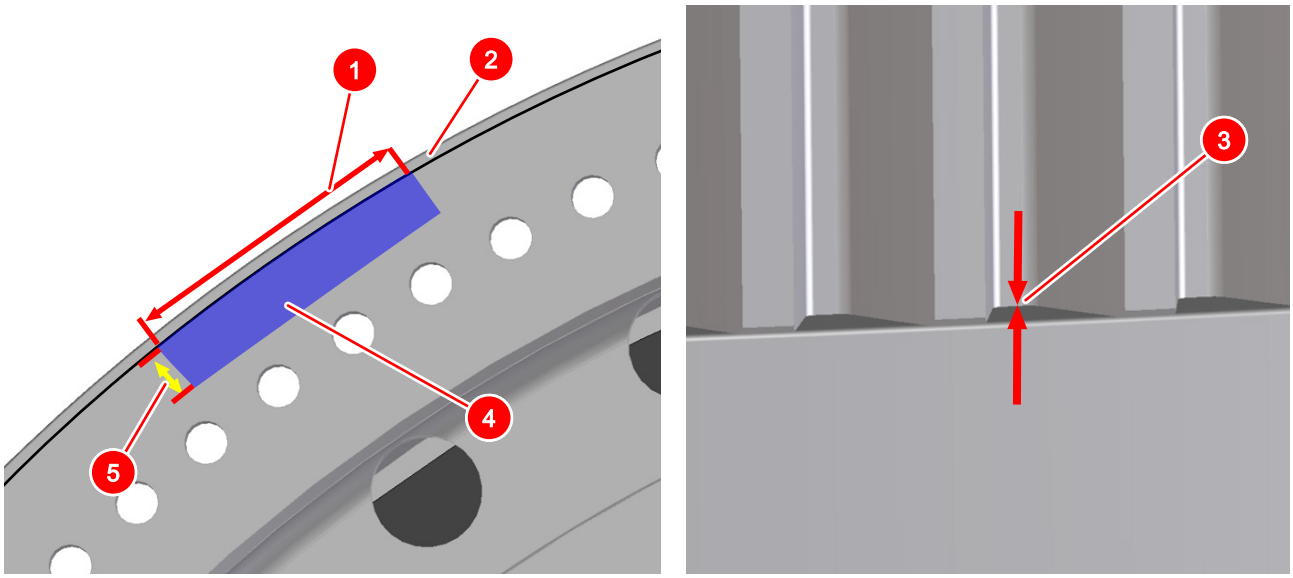


Fig. 107: Gap geometry

1	Gap width	4	Gap area
2	Area of yaw bearing teeth, no contact area	5	Gap depth
3	Gap height		

There is a yaw bearing with a slewing ring bearing between the steel tower and the main carrier. To minimise wear and tear on the yaw bearing, the bearing race support must be as smooth as possible. If this is not ensured, friction will occur in the yaw bearing to a point where bearing races and balls can be damaged irreparably. Measuring the gap serves to determine whether an ENERCON service company needs to shim up the gap between the yaw bearing and tower after assembly.

Gap measurements in the bolting plane at 0 Nm

✓ The machine house has been set down and hand-tightened with a sufficient number of lock nuts.

✓ The bolt connection of the machine house is not tightened = 0 Nm.

1. Turn the machine house via the installation aid briefly to the left and right in order to release any jamming of the bolts.

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2. Measure the gap in each of the 12 measuring areas within the **bolting plane** with a feeler gauge.

Result	Work step
Gap height **≤ 0.2 mm**	■ Only document the largest value measured and the measuring area in the installation log.
Gap height **> 0.2 mm**	■ Raise the machine house and place it on so it is offset at 90°. This step can be repeated up to 3 times. ■ Repeat the gap measurement.

Additional measurement

3. If the gap height is still > 0.2 mm after the machine house has been shifted three times, measure the gap height between all bolts in the bolting plane in the affected measuring range (see fig. 105, p. 107) and in the measuring ranges before and after it.



If several positions have a gap that is outside of tolerance, several areas will have to be measured accordingly.

4. Enter the measured values in the additional log TD-esc-03-de-xx-17-003. Threaded rod 1 is located on the longitudinal seam of the tower wall plate.

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Gap measurement on undamaged inner and outer flange edges at 0 Nm

✓ The flange edge is **undamaged**.

5. On the outer flange edge and the inner flange edge, determine the maximum feeler thickness that can be pushed into the gap to a **depth of 10 mm**.

Result	Item
Gap height **≤ 0.3 mm**	■ Only document the maximum feeler thickness and the measuring range in the installation report.
Gap height **> 0.3 mm**	■ Determine the maximum feeler thickness in each of the 12 measuring ranges and document in the installation report. ■ Measure the gap height in the bolting plane between all bolts in the affected measuring range and in the measuring ranges before and after and enter the measurements in the additional report TD-esc-03-de-xx-17-003.

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Gap measurement on damaged inner and outer flange edges at 0 Nm

✓ The flange edge is **damaged**, but approved (e.g. reconditioned transport damage).

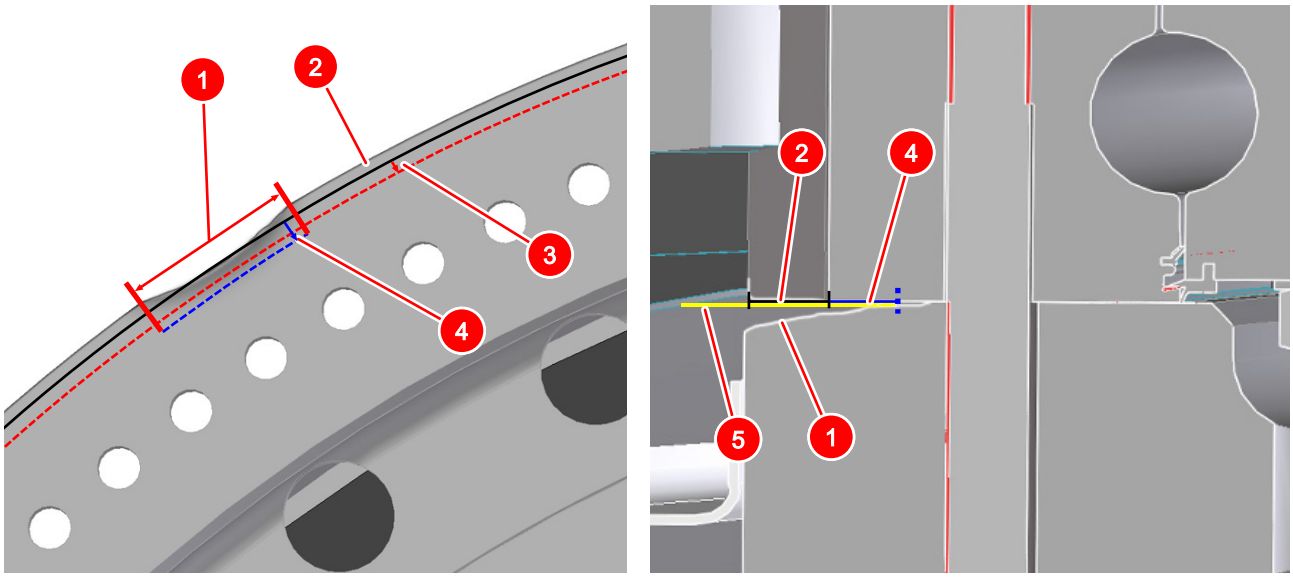


Fig. 108: Damaged flange (based on the example of the outer flange edge)

1	Damaged area	4	Measuring depth 15 mm
2	Area of the yaw bearing toothing, not a contact surface	5	Feeler gauge
3	Measuring depth 10 mm		

6. On the outer flange edge and the inner flange edge, in the damaged areas **only**, determine the maximum feeler thickness that can be pushed into the gap to a depth of **15 mm**. The measurement must be carried out from the theoretical contact area and not the actual contact area.

Result	Item
Gap height **≤ 0.35 mm**	■ Only document the maximum feeler thickness and the measuring range in the report.
Gap height **> 0.35 mm**	■ Determine the maximum feeler thickness in each of the 12 measuring ranges and document in the installation report. ■ Measure the gap height in the bolting plane between all bolts in the affected measuring range and in the measuring ranges before and after

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Result	Item
	and enter the measurements in the additional report TD-esc-03-de-xx-17-003.

Bolting the machine house

7. If the gap values are within the tolerance or all measurements are documented, bolt the machine house in accordance with ch. 9.4.5, p. 116.

Gap measurement at inner and outer flange edges at 100 % torque/ pretensioning force

✓ The flange edge is undamaged.

8. Determine the maximum thickness of the feeler leaf on the outer and inner flange edge that can be inserted 10 mm into the gap.

Result	Work step
Gap height **= 0 mm**	■ In the installation log, enter the value “0” in the first field.
Gap height **> 0 mm**	■ Determine the maximum thickness of the feeler leaf that can be inserted 10 mm into the gap in each of the 12 measuring areas and document this in the installation log. ■ Release the bolt connection in the affected measuring area and the in measuring areas in front of it and behind it and measure the gap height between all bolts then enter it into the additional log TD-esc-03-de-xx-17-003. ■ Tighten the bolt connection to 100 %.

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Gap measurement on the damaged inner and outer flange edges at 100 % torque/preload

✓ The flange edge is **damaged**, but approved (e.g. reconditioned transport damage).

9. On the outer flange edge and the inner flange edge, in the damaged areas **only**, determine the maximum feeler thickness that can be pushed into the gap to a depth of **15 mm**. The measurement must be carried out from the theoretical contact area and not the actual one.

Result	Item
Gap height **= 0.05 mm**	■ Enter the value “0” in the first field in the installation report.
Gap height **> 0.05 mm**	■ Determine the maximum feeler thickness that can be pushed into each of the 12 measuring ranges to a depth of 15 mm and document in the installation report. ■ Measure the gap height in the bolting plane between all bolts in the affected measuring range and in the measuring ranges before and after and enter the measurements in the additional report TD-esc-03-de-xx-17-003. ■ Tighten the bolt connection to 100 %.

10. If the gap is outside the tolerance after bolting, write a defect report with the following information:
    - information that the gap values between the yaw bearing and top flange tower are exceeded,
    - the values that exceed the tolerance (see report),
    - the gap values from the bolting plane at 0 Nm (additional report sent),
    - the Contract Info and Production Info for the steel section 1 taken from the type plate (a clear photo is sufficient).

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Example of a gap measurement

Example:

- 1st measurement in the bolting plane at 0 Nm
  - Result: Largest gap height measured 0.2 mm (within the tolerance) in measuring range 3, in the other measuring ranges gap height < 0.2 mm
- 2nd measurement on the outer edge at 0 Nm
  - Result: Largest gap height measured 0.4 mm (outside the tolerance) in measuring range 3, therefore note down all 12 measuring ranges
- 3rd measurement on the inner edge at 0 Nm
  - Result: No gap present
- 4th measurement on the outer edge at 100 % torque/preload
  - Result: Largest gap height measured 0.1 mm (outside the tolerance) in measuring range 3, therefore note down all measuring ranges and fill out the additional report
- 5th measurement on the inner edge at 100 % torque/preload
  - Result: No gap present

Tab. 2: Example entry in the gap report

Gap (mm) measuring range	1	2	3	4	5	6	7	8	9	10	11	12
with 100 % inside (5th measurement)	0											
with 0 Nm inside (3rd measurement)			0									
with 0 Nm bolting plane (1st measurement)			0.2									
with 0 Nm outside (2nd measurement)	0.1	0.1	0.4	0.3	0.2	0	0	0.2	0	0	0.1	0
with 100 % outside (4th measurement)	0	0	0.1	0	0	0	0	0	0	0	0	0

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Result: In this case, the bolt connection in measuring range 3 and measuring ranges 2 and 4 would have to be loosened again and a gap measurement carried out in the loosened area within the bolting plane. The measuring results must be recorded in the additional report.

Tab. 3: Example entry in the additional report

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
								0	0	0	0	0.1	0	0	0
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
0	0.1	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0	0.1	0	0	0	0
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
0															
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128
129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144

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9.4.4 Installing tower gap cover

1. Put the panels of the tower gap cover on the nacelle neck flange and fasten them.
2. Tighten all fasteners to the required torque, see *Torque table*, p. 155.

9.4.5 Bolting machine house and tower together

1. In the nacelle basement, screw the hexagon nuts with washers onto the threaded bolts of the machine house as far as possible.

⚠ DANGER! Hydraulic torque wrenches may only be operated by trained personnel.

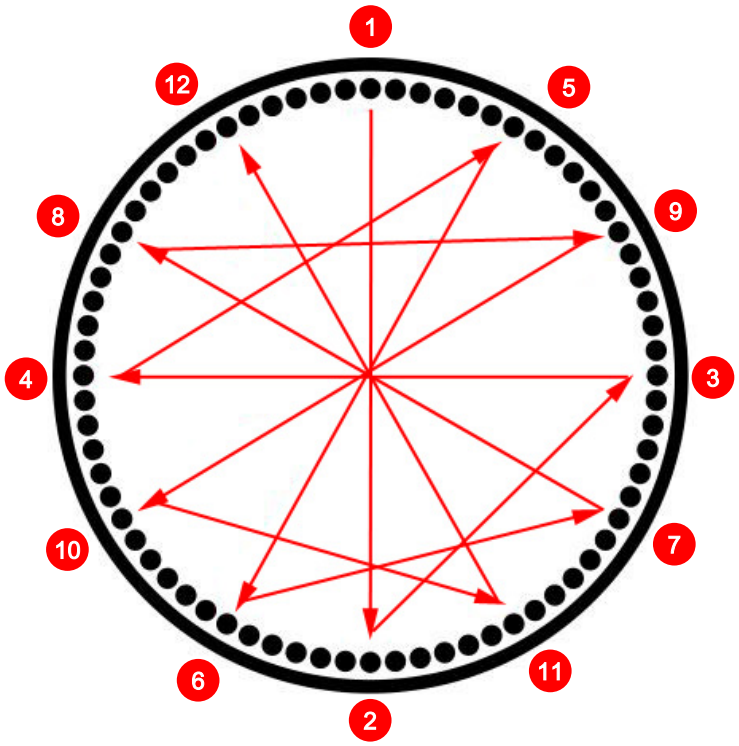


Fig. 109: Crosswise fastening sequence

2. Tighten the bolt connections crosswise at 12 positions to 30 % of the required torque; see *Torque table*, p. 155.
3. Tighten the bolt connections around the perimeter to 100 % of the required torque; see *Torque table*, p. 155.
4. Continue bolting around the perimeter until the nuts can be turned no further when tightened with the required torque.

9.5 Finishing steps

9.5.1 Mounting the cable support

The cable support is supplied with the top steel section of the tower, and is secured in the tower in the transport position.

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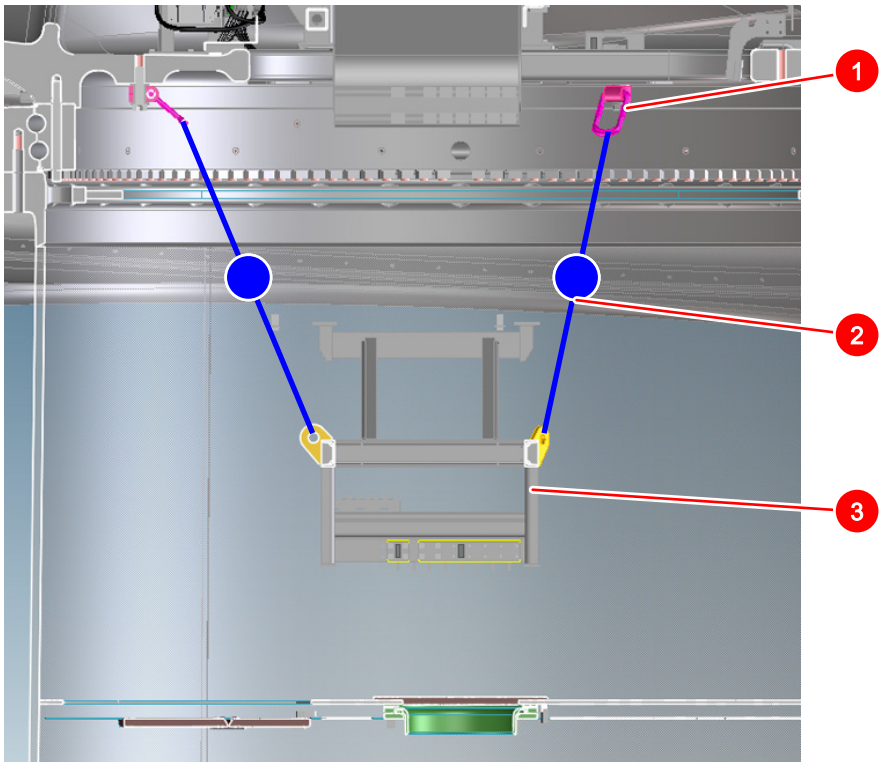


Fig. 110: Attached cable support

1	3x M36 swivel hoist ring	2	3x 1.5-t chain hoist
3	Cable support		

1. Underneath the main carrier, bolt 3 swivel hoist rings into the available threaded holes.
2. Hook 3 chain hoists onto the swivel hoist rings.
3. Remove cable support from the transport position.
4. Hook chain hoists onto the cable support.
5. Lift the cable support to the installation position underneath the main carrier.
6. Bolt the cable support to the main carrier and tighten the bolts to the required torque.

9.5.2 Installing grease collecting ring

1. Below the yaw bearing, put the sections of the grease collecting ring in place on the tower.
2. Plug the sections of the grease collecting ring together and install the fasteners.
3. Put the grease collecting ring into position on the tower and fasten it to the tower.
4. Tighten all fasteners to the required torque, see *Torque table*, p. 155.
5. Seal the gap between the grease collecting ring and tower with sealant.

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9.5.3 Greasing the yaw gear rim

The yaw gear rim is not greased for transport. In order to ensure uniform lubrication of the gear rim during commissioning, the 4 the lubricating pinions of the yaw bearing need to be filled after assembly of the machine house.

Depending on the manufacturer, the lubricating pinions may be installed with or without a protective housing.

1. On the yaw gear rim, check which lubricating pinion version is installed.

Result	Item
Lubricating pinion with protective housing present	Continue with section *Filling the lubricating pinion with protective housing (manufacturer ZS)*, p. 119
Lubricating pinion without protective housing present	Continue with section *Filling the lubricating pinion without protective housing (manufacturer Herion)*, p. 120

Filling the lubricating pinion with protective housing (manufacturer ZS)

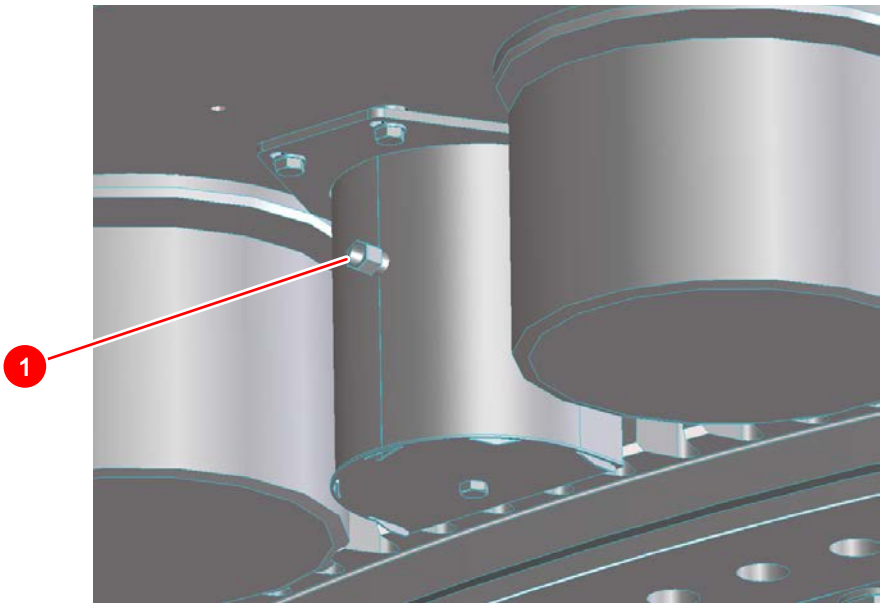


Fig. 111: ZS lubricating pinion

1	Lubricating pinion connection on the protective housing

2. Screw a button head lubricating nipple onto the lubricating point connection of the first lubricating pinion.
3. Connect a manual or cordless grease gun with hose and button head coupler to the button head lubricating nipple.
4. Turn the machine house in one direction and in the process, fill the lubricating pinion evenly with 2 cartridges of grease. The grease cartridges are included in the fastener box.

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5. Make sure that the lubricating pinion applies the grease evenly to the tooth flanks; if necessary, turn the machine house forward and back a few more times.
6. Remove the grease gun and the button head lubricating nipple.
7. Repeat the preceding steps on all remaining lubricating pinions.

Filling the lubricating pinion without protective housing (manufacturer Herion)

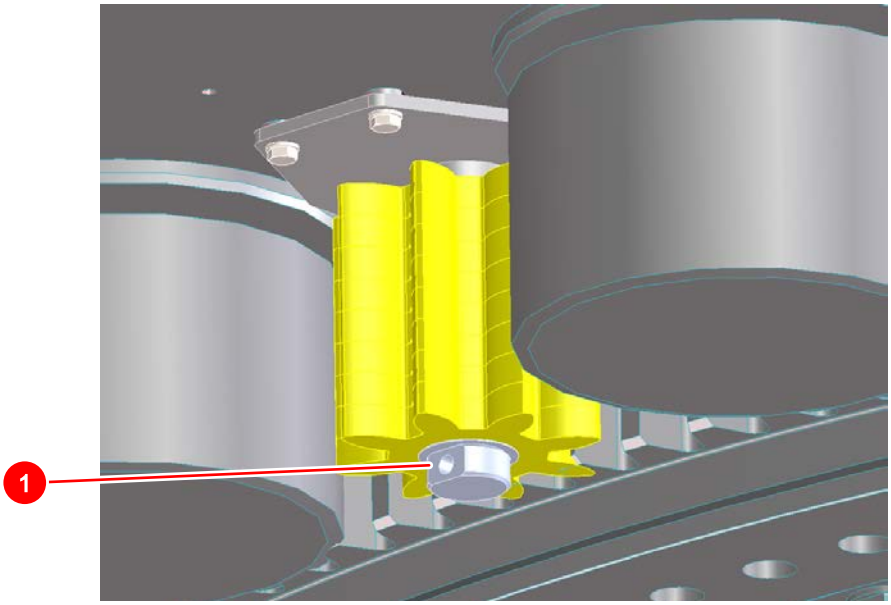


Fig. 112: Herion lubricating pinion

1	Lubrication point connection

The accessories kit with the pipe extensions required for filling is fixed in the machine house on one of the yaw motors.

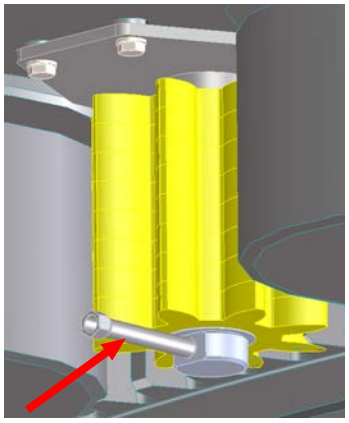


Fig. 113: Lubricating pinion with pipe extension

8. Screw the pipe extension onto the lubricating point connection of the first lubricating pinion.
9. Screw a button head lubricating nipple into the pipe extension.
10. Connect a manual or cordless grease gun with hose and button head coupler to the button head lubricating nipple.
11. Turn the machine house in one direction and in the process, fill the lubricating pinion evenly with 2 cartridges of grease. The grease cartridges are included in the fastener box.
12. Make sure that the lubricating pinion applies the grease evenly to the tooth flanks; if necessary, turn the machine house forward and back a few more times.
13. Remove the grease gun and the button head lubricating nipple.

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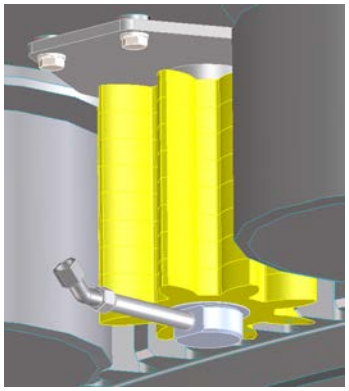


Fig. 114: Lubricating pinion with elbow

14. Screw the elbow from the accessories kit onto the pipe extension.

> The pipe extension and the elbow are required when commissioning the WEC for assembling the lubricators.

15. Repeat the preceding steps on all remaining lubricating pinions.

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10 Generator installation

10.1 Overview of generator installation

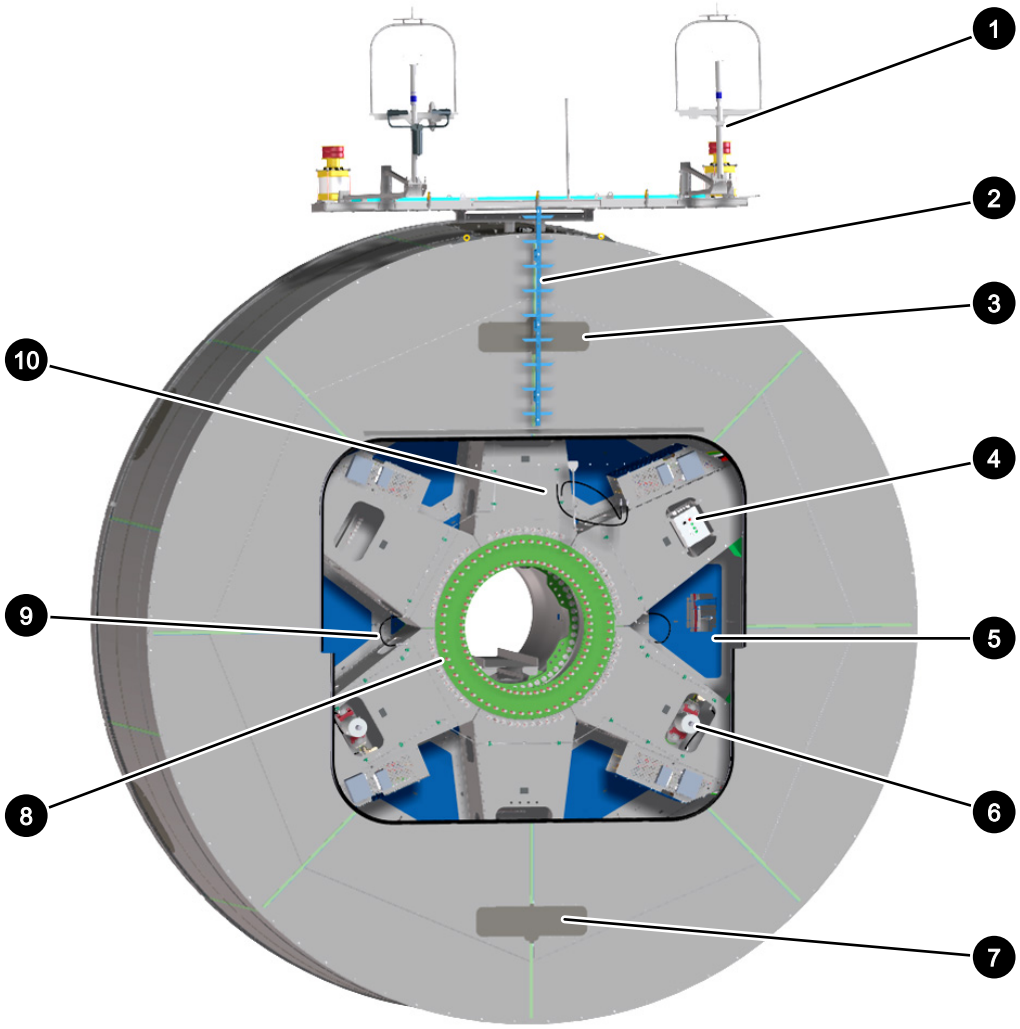


Fig. 115: Overview of generator installation

1	Roof unit	2	Safety ladder
3	Upper rear cover	4	Stator sub-distribution system
5	3 o'clock generator pass	6	Hydraulic cylinder for rotor lock
7	Lower rear cover	8	Stator support
9	Rotor lock hose	10	Rotor lock hydraulic unit connection

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10.2 Safety warnings for generator installation

In addition to the basic safety instructions in ch. 2.4, p. 10, also observe the following safety warnings for generator installation:

⚠ DANGER



Generator installed too early

Death or serious injury

⇨ Before mounting the stator to the machine house, make sure that all bolt connections between the machine house and the tower are snug-tight.

⚠ DANGER



Premature unhooking of generator

Death or serious injury

⇨ Before disconnecting the stator, make sure that the stator's internal bolt connections are tightened crosswise to 100% of the required torque at at least 12 positions, and the external bolt connections at at least 10 positions at the top.

⚠ DANGER



Working with hydraulic torque wrench, hydraulic unit and hydraulic hoses

Death or serious injury

⇨ Hydraulic equipment may only be operated by persons who are familiar with the devices and have received training in their unsupervised use.

⇨ Always wear safety goggles and protective gloves when working with or on the devices.

⇨ Ensure that all inspection certificates are current. Do not use devices whose inspection certificates have expired.

⇨ For pressure values, refer to the torque table for hydraulic torque wrench cassettes.

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⚠ DANGER



Falling from the nacelle

Death or severe injury

⇨ Use **two protection systems** when working on top of the nacelle. In combination with your PFPS, use **either**:

- 2x Fallstop BK (SAP 110933)
- 1x Fallstop BK (SAP 110933) and 1x fall arrest block (SAP 123833)

⇨ Secure yourself to a designated anchorage point whenever there is a risk of falling from height.

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10.3 Generator

10.3.1 Rigging the generator with the lifting device

✓ The lifting device is mounted on the generator.



Fig. 116: Generator lifting device

The lifting device for generator E-115 EP3 (SAP 678021) is used in generators with a rotor bearing unit for inserting the generator rotor into the generator stator. The lifting device can also be used to raise and install the generator.
Further technical information is provided in the manufacturer's operating manual.

⇨ See document: TD-des-10-de-xx-17-113 "Betriebsanleitung Hebevorrichtung Generator E-115 EP3" (E-115 EP3 generator lifting device operating manual)

1. Rig the generator with the lifting device for lifting according to the operating manual.

10.3.2 Aligning the generator

1. Lift and turn the generator using 2 cranes according to the operating manual of the lifting device.

10.3.3 Installing the rear transport cover at the back

1. Lower the erected generator as far as possible.
2. Use guide ropes to keep the generator from twisting.
3. Install the rear transport cover at the back.

10.3.4 Hoisting the generator and moving it into position

✓ The bolt connections between the yaw bearing and the tower are all tightened at least snug-tight.

1. Hoist the generator until it reaches the level of the main carrier. Use guide ropes to steady the generator.
2. Carefully move the generator towards the main carrier.
3. Pass the threaded bolts of the generator into the drill holes on the main carrier flange.
4. Hand-tighten 8 nuts with washers in a **crosswise** pattern onto the threaded bolts to prevent the generator from oscillating.

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10.3.5 Bolting the stator support to the main carrier

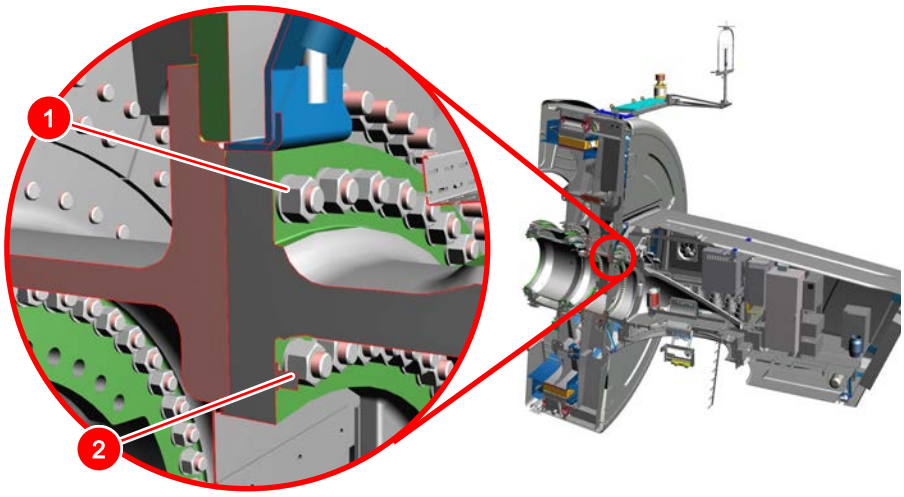


Fig. 117: Bolt connection: stator support – main carrier

1	Outer bolt connection	2	Inner bolt connection

1. In the machine house screw the hexagon nuts with washers onto the threaded rods of the outer stator support bolt connection and in the main carrier onto the threaded rods of the inner stator support bolt connection using washers until they are hand-tightened.

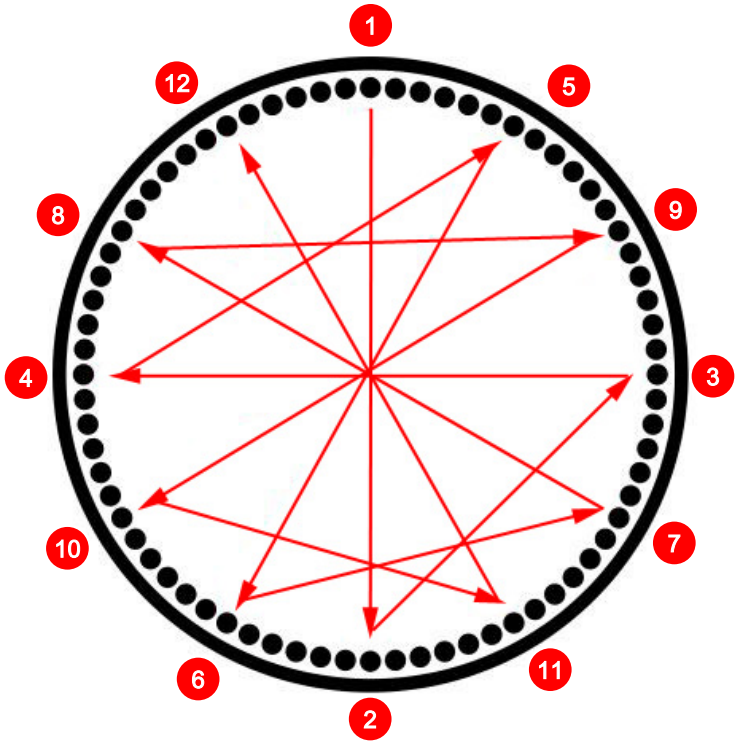


Fig. 118: Crosswise fastening sequence

2. In the main carrier, tighten the bolt connection **using a crosswise pattern** at **12** positions to 30 % of the required torque; see *Torque table*, p. 155.

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3. Tighten 12 pre-tightened bolt connections to 100 % of the required torque.
4. In the machine house, tighten 10 bolt connections on top to 100 % of the required torque.
   ↪ The generator stator can be unhooked from the crane.
5. Tighten bolt connections in the main carrier around the perimeter to 100 % of the required torque; see torque table.
6. Continue bolting around the perimeter until the nuts can be turned no further when tightened with the required torque.
7. In the machine house, tighten the bolt connections around the perimeter to 100 % of the required torque; see torque table.
8. Continue bolting around the perimeter until the nuts can be turned no further when tightened with the required torque.
9. In the main carrier, check the torque of bolt connections and if necessary retighten to the required torque.

10.3.6 Removing the lifting device

1. Remove the lifting device according to the operating manual.

10.3.7 Installing the top transport cover at the back; installing the safety ladder

1. From the machine house roof, install the transport cover at the rear end and on top.
2. Install the safety ladder at the top rear side of the generator. In doing so, observe the manufacturer's operating manual TD-des-10-de-xx-10-003 “Betriebsanleitung Sicherheitssteigleiter LMB®” (Operating manual for LMB® safety ladder).

10.4 Rotor lock and trapped key interlock system

10.4.1 Connecting rotor lock hydraulic unit

✓ Rotor lock hoses are connected at the separation points of the stator, see ch. 5.3.5, p. 31.



The hydraulic hoses have different quick couplings. This helps to clearly identify the connection position.

1. Make sure all hydraulic hoses connectors and hydraulic unit connectors are clean.
2. Perform a visual inspection of the hydraulic hoses. Pay particular attention to the following check items:
   - Oil leaks
   - Kinks
   - Cleanliness of hose couplings

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3. If the connectors of the available hoses do not fit on the hydraulic unit, contact Technical Service Dispatch.
4. Put the ends of the hydraulic hoses onto the hydraulic unit terminals and make sure they latch.
   ↪ A clicking sound indicates a proper latch.
5. If the hydraulic hoses are too short or too long, loosen the oil tray fasteners and move the oil tray forwards or back in the elongated holes.
6. Ensure that the hydraulic hoses are securely in place.
7. Tighten the oil tray fasteners to the required torque.
8. Check that the fasteners between hydraulic unit and oil tray have the required torque; tighten if necessary.

10.4.2 Removing and installing the transport lock for the rotor lock

There are hexagon nuts on the rotor lock's 3 hydraulic cylinders. These are used as transport locks. The hydraulic cylinders are set to a nominal dimension at the factory and then secured with the hexagon nuts.

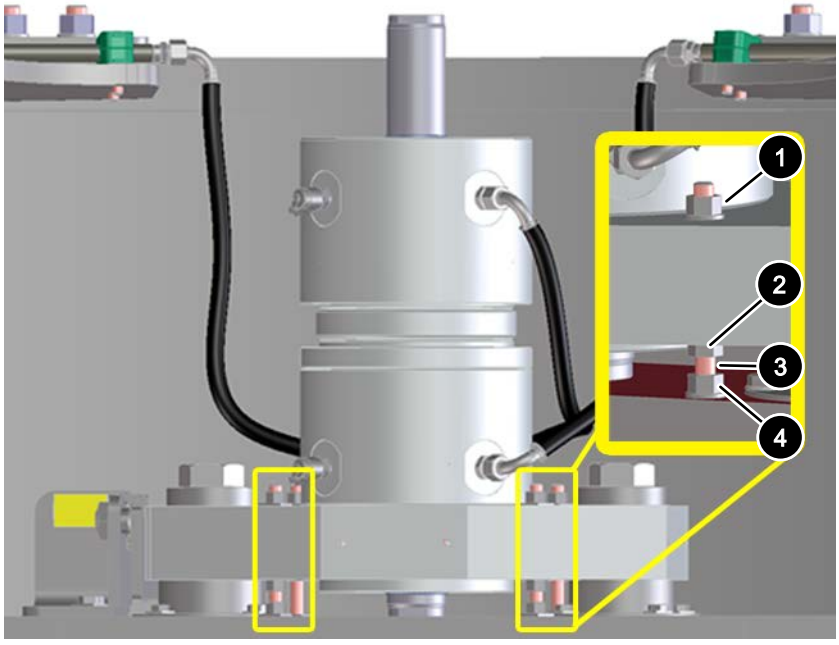


Fig. 119: Overview of hydraulic cylinders in delivery condition

1	Lock nut on machine house side	3	Transport lock’s threaded rod
2	Lock nut on rotor head side	4	Threaded rod’s lock nut

Prior to releasing the rotor lock, you must always unscrew the transport locks. During plant assembly, always reinstall the transport locks on the machine house side after re-engaging the rotor lock. Without the transport locks, the hydraulic cylinders can retract when the rotor lock is engaged, which releases the rotor.

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Unscrewing transport lock

The following steps must be performed every time before engaging the rotor lock.

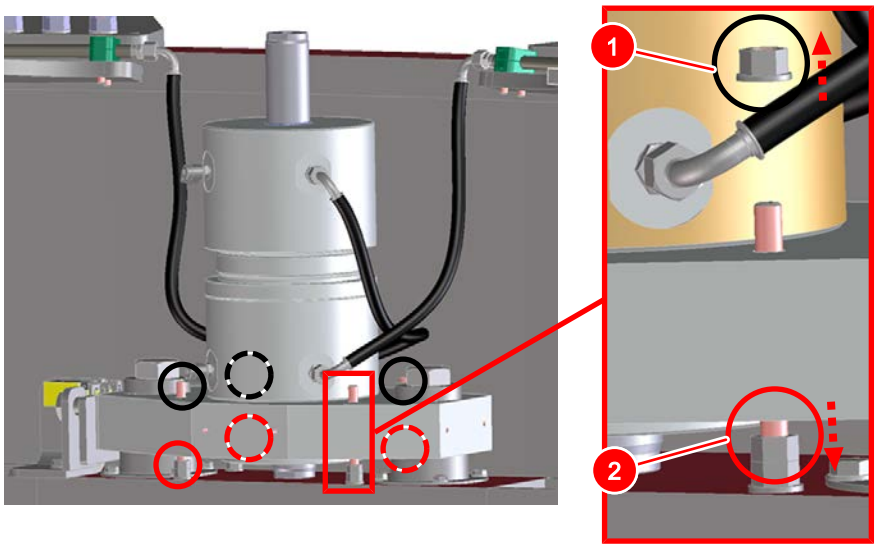


Fig. 120: Removing the hydraulic cylinders' lock nuts

1	Lock nuts on machine house side	2	Lock nuts on rotor head side

1. Remove the lock nuts and washers on the machine house side from the 3 hydraulic cylinders and keep them safe for later use.
2. Counter the lock nuts on the rotor head side against the threaded rods' nuts.

↪ You can now use the rotor lock.

Installing the transport locks

During plant assembly, the following steps must be performed every time after engaging the rotor lock.

✓ Make sure the rotor has been locked.

3. Screw the lock nuts and washers snug-tight onto the threaded rods on the machine house side.

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10.4.3 Setting and releasing the rotor lock

NOTICE

Improper application of rotor lock

Damage to rotor lock and generator

⇨ The rotor lock bolts mesh with the slots in the locking bolts of the rotor.
If the rotor is not stopped correctly at one of these positions, attempting to lock the rotor anyway can cause serious damage to the WEC.

⇨ Do not use the rotor lock/rotor brake at wind speeds greater than 16 m/s over a 10-minute mean.

Releasing the rotor lock



Fig. 121: V1 nacelle installation aid

✓ The power supply to the installation aid is connected.

✓ Indicator light *NETZ OK [GRID OK]* is on.

1. Make sure there are no persons or loose components or tools in the rotor head.
2. Ensure that the rear lock nuts are removed from the hydraulic cylinders of the rotor lock, see ch. 10.4.2, p. 128.
3. Close the generator door.
4. On the trapped key interlock of the generator door, turn the green key and pull it out.
   ↳ The generator door can no longer be opened.
5. On the nacelle converter cabinet, insert the green key into the free slot of the trapped key interlock.
6. Turn the green key.
7. Turn the blue key next to the green key and pull it out.
8. On the rotor lock hydraulic unit, insert the blue key into the slot of the trapped key interlock.
9. Turn the blue key.
   ↳ The valve lever on the hydraulic unit is unlocked.

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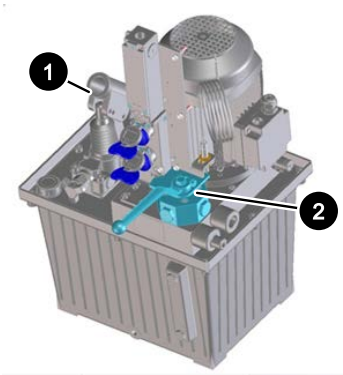


Fig. 122: Hydraulic unit with valve lever set to *Release rotor lock*

1	Hand pump
2	Ball valve

The rotor lock consists of a ball valve and a hand pump.

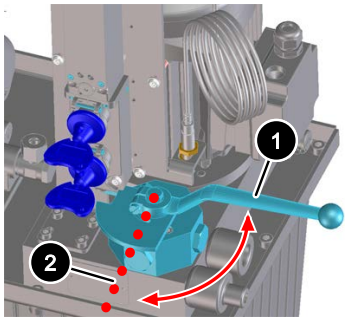


Fig. 123: Positions of ball valve

1	*Set rotor lock* position
2	*Release rotor lock* position

10. To release the rotor lock, move the ball valve lever to the *Release rotor lock* position.
11. Actuate the hand pump until the bolts have moved fully out of the slots.
    ↪ On the stator sub-distribution system (=014), the red *Rotor lock retracted* indicator lights up.
12. Install the rear lock nuts on the hydraulic cylinders of the rotor lock, see ch. 10.4.2, p. 128.

↪ The rotor brake can be released.

Rotor lock guide plate

The rotor lock guide plate helps with finding the exact locking position of the rotor.

If the rotor lock guide plate points to a slot in the brake disk, the rotor is in a proper position for setting the rotor lock.

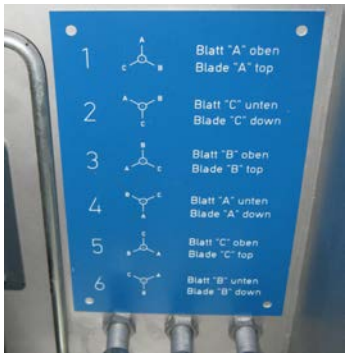


Fig. 124: Pitch position numbers

An overview of the blade positions at various rotor lock positions can be found on the rotor lock. The possible blade positions, e.g. *Blade A down*, are sequentially numbered. These same numbers can be found on the rotor next to the slots.

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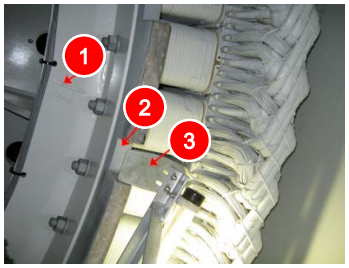


Fig. 125: Rotor lock guide plate

1	Blade position numbers
2	Slot
3	Rotor lock guide plate

Setting the rotor lock

13. Use the *ROTATE NACELLE* rotary switch on the installation aid to turn the nacelle into the wind so that the rotor turns slowly.

> Before the electromechanical brake is used for the first time, the release clearance must be checked and, if necessary, adjusted; see ch. 11.6, p. 147.

14. Actuate the *ELEC BRAKE* rotary switch on the installation aid to engage the electromechanical brake.
    ↪ The brakes close audibly (*Brake on* indicator light is on).
15. Ensure that the rear lock nuts are removed from the hydraulic cylinders of the rotor lock, see ch. 10.4.2, p. 128.
16. To set the rotor lock, set the lever of the ball valve to the *Set rotor lock* position.
17. Turn the *ELEC BRAKE* rotary switch on the installation aid to the right until the electromechanical brakes open. Hold this position.
    ↪ The green *Brake on* indicator light goes out.
18. Watch the rotor lock guide plate and look for the numbers on the rotor through the window. The position for setting the rotor lock is reached once the rotor lock guide plate and the slot for the desired blade position are in line.

> The brake responds with a slight delay. Therefore, actuate the brake shortly before the locking position is reached.

19. Release the rotary switch.
    ↪ The electromechanical brakes engage.
20. Actuate the hand pump until the bolts have moved fully into the slots.
    ↪ The hand pump becomes harder to actuate.
21. Release the electromechanical brakes and continue to work the hand pump. This way, the bolts can centre themselves without resistance inside the slots of the brake disks.
    ↪ On the stator sub-distribution system **all three** *Rotor lock actuated* indicators light up green.
22. Install the rear lock nuts on the hydraulic cylinders of the rotor lock, see ch. 10.4.2, p. 128.

> During WEC installation, the key of the trapped key interlock is not released electrically. For the mechanical release, follow the steps below.

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23. Release the mechanical lock on the trapped key interlock of the hydraulic unit:
    - Fortress Interlocks: Insert the small key into the mechanical lock and turn.
    - Secu M.S.: Remove the safety bolt from the mechanical lock and use an Allen key to release the mechanical lock.
24. Turn the blue key and pull it out.
25. On the nacelle converter cabinet, insert the blue key into the free slot of the trapped key interlock.
26. Turn the blue key.
27. Turn the green key next to the blue key and pull it out.

➥ The generator door can be opened.

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11 Installing the rotor head with rotor blades

11.1 Overview of installing the rotor head with rotor blades

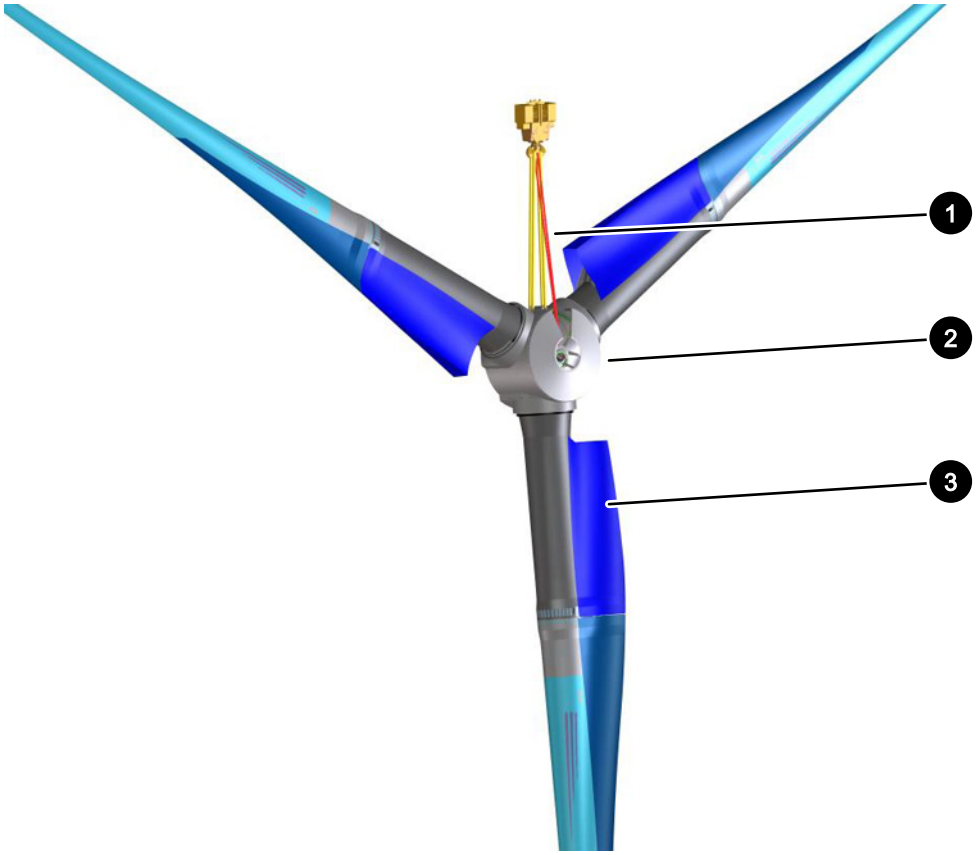


Fig. 126: Overview of rotor head installation

1	Lifting accessories	2	Rotor head
3	Rotor blade A		

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11.2 Warning signs for installing the rotor head with rotor blades

In addition to the basic safety instructions in the ch. 2.4, p. 10, also observe the following safety warnings for installation of rotor hub with rotor blades:

⚠ DANGER



Rotor head installed too early

Death or serious injury.

⇨ Before installing the rotor head, make sure that bolt connections between the main carrier and the tower, the stator support and the main carrier, and the rotor bearing unit and the stator support are fully tightened to the required torque.

⚠ DANGER



Premature unhooking of rotor head with rotor blades

Death or serious injury.

⇨ Before unhooking the rotor head with rotor blades, make sure that bolt connections between the hub and the rotor bearing unit are fully tightened to the required torque.

⚠ DANGER



Crushing due to turning the rotor blade

Death or serious injury

⇨ Make sure no one is in the range of rotation before turning the rotor blade.

⚠ DANGER



Falling from the nacelle

Death or severe injury

⇨ Use **two protection systems** when working on top of the nacelle. In combination with your PFPS, use **either**:

- 2x Fallstop BK (SAP 110933)
- 1x Fallstop BK (SAP 110933) and 1x fall arrest block (SAP 123833)

⇨ Secure yourself to a designated anchorage point whenever there is a risk of falling from height.

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⚠ DANGER



Rotor may idle if not locked

Death or serious injury

- ⇨ Do not work on the rotor brake or on/in the rotor head unless the rotor lock is set.
- ⇨ Do not enter the rotor head unless the rotor lock is set.
- ⇨ Do not use the rotor lock at wind speeds greater than 16 m/s over a 10-minute mean.

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11.3 Rotor head

11.3.1 Preparing connecting flanges and fits

Hub

1. Check hub flange surfaces for dirt and irregularities and clean or machine them as needed.
2. Clean the hub fit.
3. Grease the fit with MoS_2 grease.
4. Make sure that grease does not enter the flange surfaces.

Rotor

5. Check the blade flange surfaces for dirt and irregularities and clean or machine them as needed.
6. Clean the rotor fitting.

11.3.2 Detaching the sixth spinner section

1. Disassemble the sixth spinner section.
2. Disassemble rotor head cap segments underneath.

11.3.3 Rigging the rotor head

The rotor head needs to be lifted with 2 cranes and turned in the installation position. The main crane is attached to the hub. The auxiliary crane is attached to the rotor blade A.

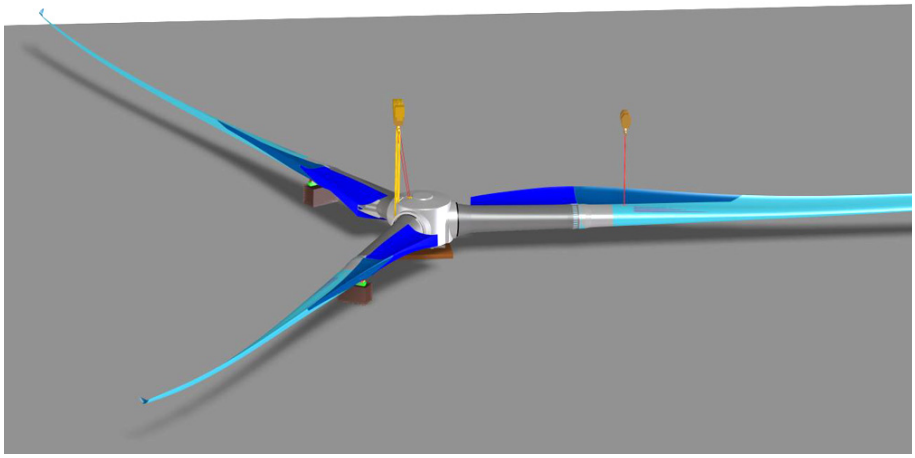


Fig. 127: Attached rotor head with rotor blades

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Attach main crane to hub

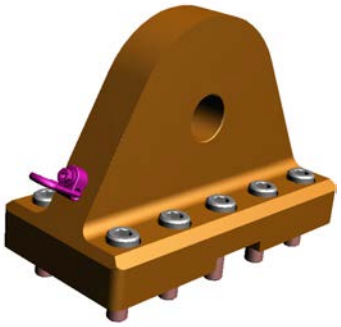


Fig. 128: EP3 hub mounting device

The hub EP3 (SAP 679012) mounting devices are used for turning and hoisting the pre-assembled rotor head. This requires 2 mounting devices including shackles and bolts.

Further technical specifications are provided in the manufacturer's operating manual.

⇨ See document: D0663514 "Betriebsanleitung Montageschuhe Rotornabe EP3" (EP3 hub mounting devices operating manual)

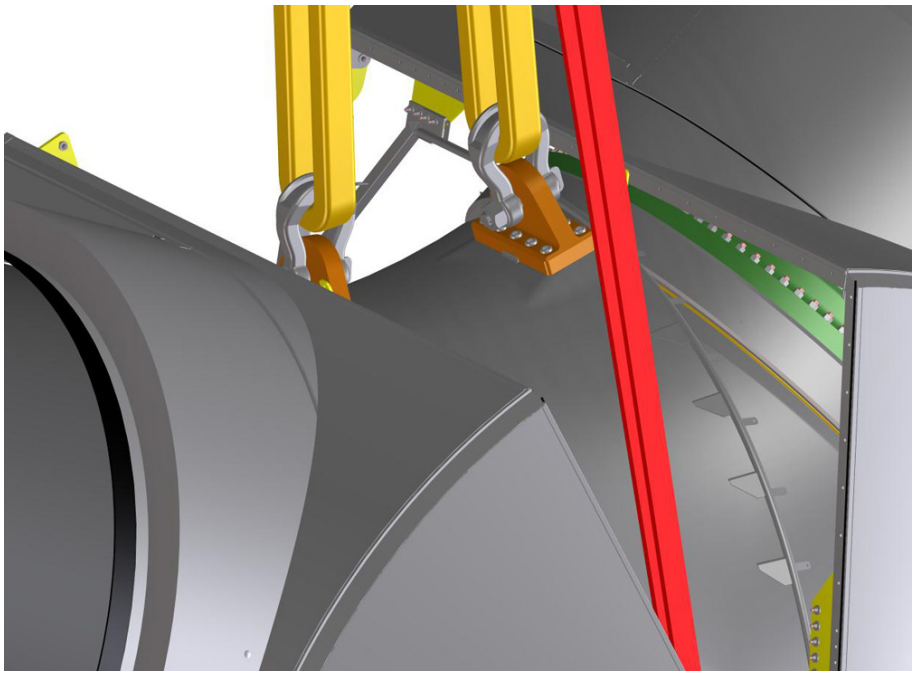


Fig. 129: Mounting devices installed

1. Install mounting devices on the hub according to the relevant operating manual.
2. Tighten mounting device fasteners to a **special torque of 700 Nm**.
3. Hang 2 80-t round slings (4 m, SAP 662520) onto the crane hook.
4. Attach round slings to the mounting devices using 2 75-t shackles (SAP 93159).

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Attach auxiliary crane to rotor blade A

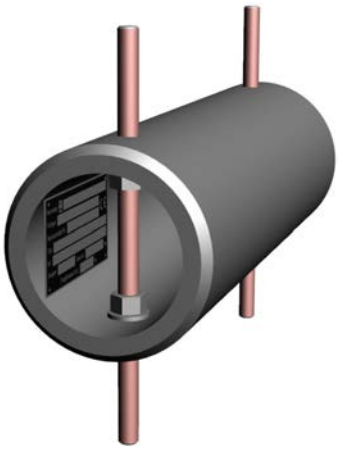


Fig. 130: Bolt for rotor blade handling

The bolt for E-115 rotor blade handling (handling bolt SAP 578317 for short) is used for attaching rotor blades with a load application rib (LAR) when the release device cannot be installed due to an incorrect distance of the LER. The handling bolt can also be inserted into the adapter on the separating flange during pre-assembly of the rotor blades. Further technical information is provided in the manufacturer's operating manual.

⇨ See document: TD-des-10-de-xx-15-005 "Betriebsanleitung Bolzen für E-115-Rotorblatt-Handling" (Betriebsanleitung Bolzen für E-115-Rotorblatt-Handling (E-115-1 rotor blade handling bolt operating manual))



Fig. 131: Automatic load hook

The automatic load hook 20t (SAP 547458) is used to lift components that could not be unhooked after assembly without an additional auxiliary crane. The load hook can be opened and closed via remote control when it is without load.
Further technical specifications are provided in the manufacturer's operating manual.

⇨ See document: TD-des-10-ger-xxx-13-020 "Bedienungsanleitung Elebia Lasthaken" (Bedienungsanleitung Elebia Lasthaken (Operating instructions for the Elebia load hook))

5. Insert the handling bolt into the load application rib of the outer blade of rotor blade A.
6. Hook the automatic load hook into the crane hook.
7. Hang a 30-t round sling (5 m, SAP 143121) onto the automatic load hook.
8. Close the automatic load hook.
9. Pull a round sling protection (SAP 141659) over the free end of the round sling.
10. Lead the round sling through the lifting eye of the rotor blade and hook it into the handling bolt.
11. Make sure the round sling guard is in the lifting eye so that the round sling does not become damaged.
12. Secure the handling bolt in the load application rib in accordance with the relevant operating manual.

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11.3.4 Installing the guide ropes

To be able to stabilise and steer the rotor head during pulling, attach one guide rope to each rotor blade B and C in the front area. The guide ropes are guided with winches.

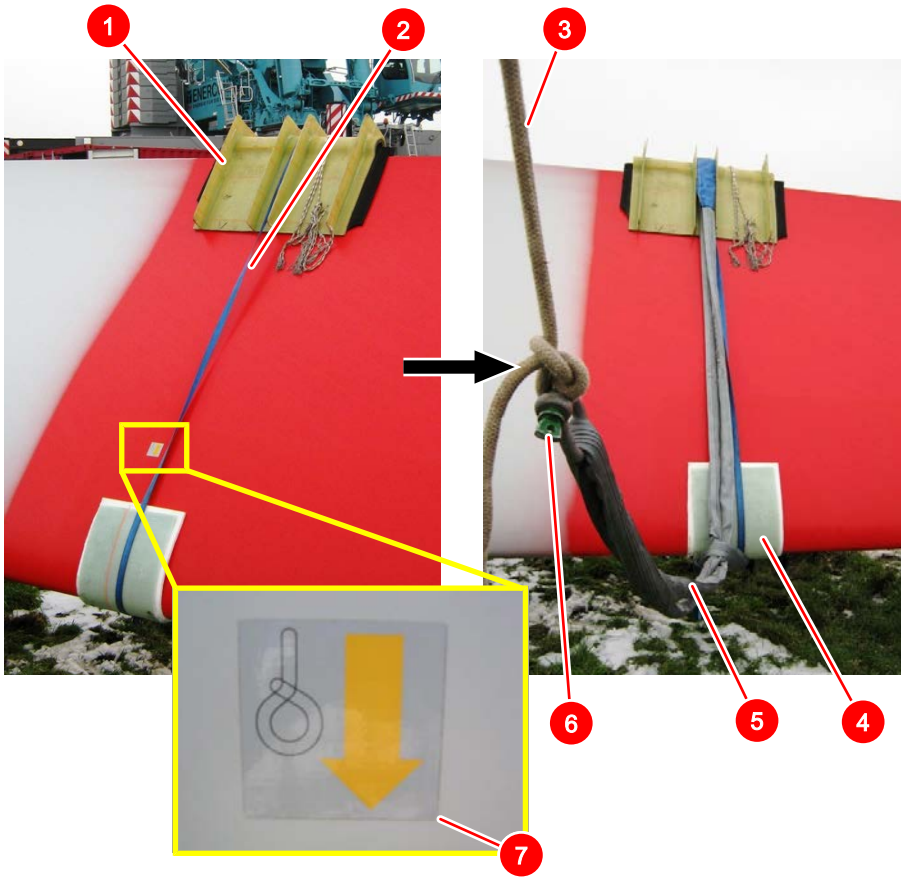


Fig. 132: Protective shells on the rotor blade

1	Trailing edge of blade protective shell	5	4-t round sling (6 m)
2	Lashing strap	6	4.75 shackle
3	Guide cable	7	Mark for installation position of guide rope
4	Leading edge of the blade protective shell		

1. Fasten the guide cables to rotor blades B and C in accordance with the work steps in ch. 8.3.3, p. 78.

11.3.5 Turning rotor blades into the feathered position

To ensure the area exposed to wind on the rotor blade is as small as possible during assembly of the rotor head, turn these to feathered position before lifting the rotor head.

1. Remove bolt connections between the assembly frame and the hub.

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2. Raise the rotor head using main crane and auxiliary crane evenly until the rotor blades can be turned without colliding with the deposit trays.

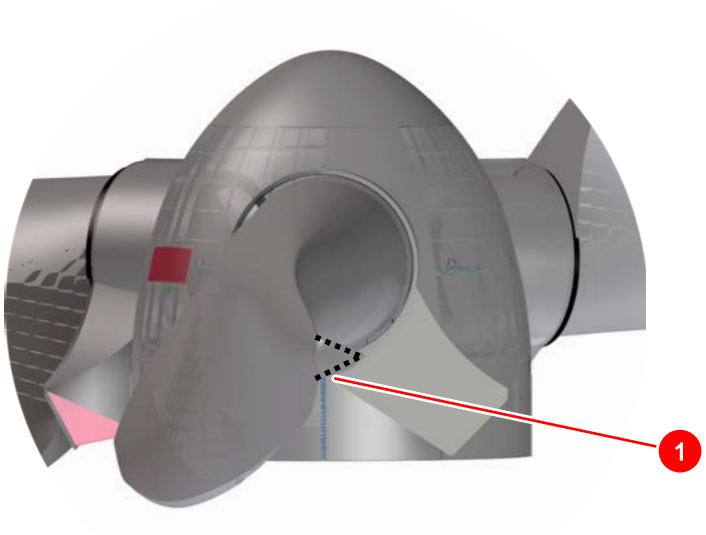


Fig. 133: Rotor blade in feathered position

1	Rotor blade tip

3. Use the pitch installation aid to move the rotor blades into feathered position (90° position) in turn. In doing so, make sure that the trailing edges do not collide with the deposit tray.

➥ The blade tips of the rotor blades are pointing to the right.

11.3.6 Aligning the rotor head

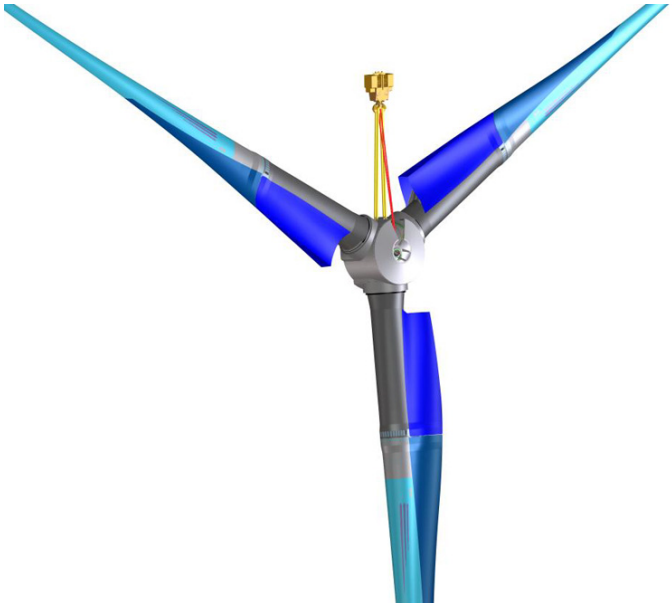


Fig. 134: Turned rotor head

1. Slowly lift the rotor head using the main crane and move it using the auxiliary crane. In doing so guide the rotor head via the guide ropes to the rotor blades.

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2. When the rotor head is upright, stop lifting.
3. Loosen the round sling on the auxiliary crane.
4. Open the automatic load hook and unhook the auxiliary crane.

11.3.7 Hoisting the rotor head and moving it into position

1. Hoist the rotor head to the height of the generator.
2. Move the rotor head to the assembly position, guiding the threaded bolts of the hub flange into the boreholes on the rotor bearing unit.
3. Make sure that the markings on the hub flange and the rotor bearing unit are aligned.
4. In the generator, screw 8 hexagon nuts with expansion sleeves in a crosswise pattern onto the threaded bolts to prevent the rotor head from oscillating.

11.3.8 Bolting the hub to the rotor bearing unit

✓ Bolt connections between the machine house and the tower, the stator support and the main carrier, and the rotor bearing unit and the stator support are tightened to the required torque:

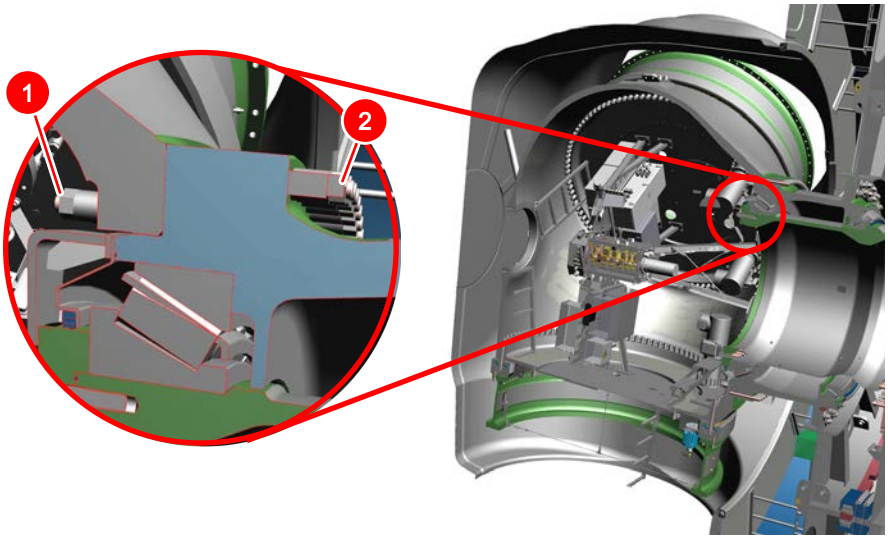


Fig. 135: Bolt connections on hub - rotor bearing unit

1	Inner bolt connections on the rotor head	2	External bolt connections on nacelle side

1. Bolt hexagon nuts with expansion sleeves hand-tight onto the threaded bolts of the outer bolt connections of the hub in the generator.

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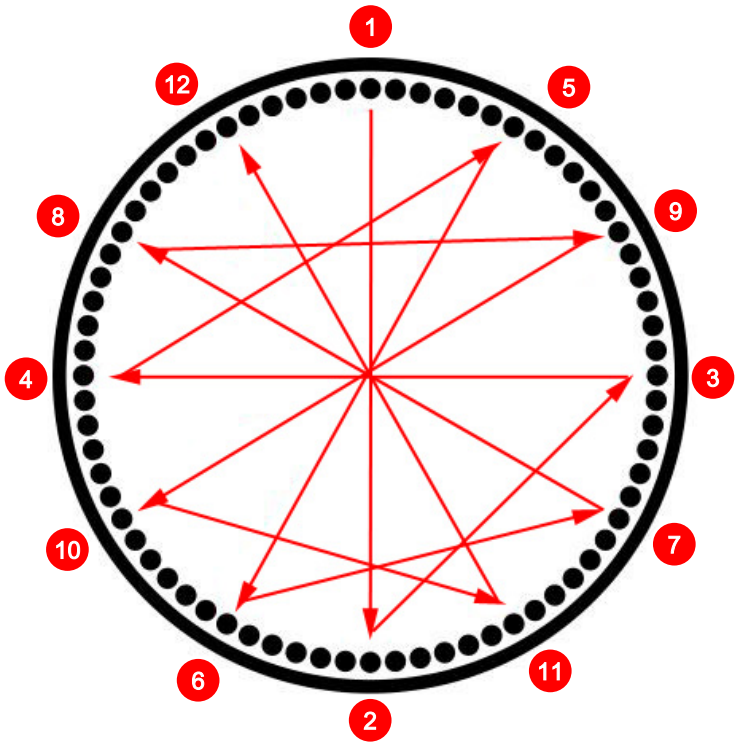


Fig. 136: Crosswise fastening sequence

2. Tighten bolt connections in the generator crosswise at 12 positions to 30 % of the required torque; see *Torque table*, p. 155.
3. Tighten the bolt connections around the perimeter to 100 % of the required torque; see *Torque table*, p. 155.
4. Continue bolting around the perimeter until the nuts can be turned no further when tightened with the required torque.
5. Bolt hexagon nuts with expansion sleeves hand-tight onto the threaded bolts of the inner bolt connections of the hub in the rotor head.
6. Tighten the bolt connections around the perimeter to 100 % of the required torque; see torque table.
7. Continue bolting around the perimeter until the nuts can be turned no further when tightened with the required torque.
8. In the generator, check the torque of bolt connections and if necessary retighten to the required torque.

➥ The rotor head can be unhooked.

11.3.9 Disassembling lifting equipment

1. Loosen bolt connections on the mounting devices.
2. Lower mounting devices to the ground using the lifting equipment.

> The round sling on the rotor blade A can be dismantled only after the installation of the sixth spinner section. For this, the rotor blade must be turned to the 3 o'clock position or the 9 o'clock position.

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11.3.10 Removing the guide ropes

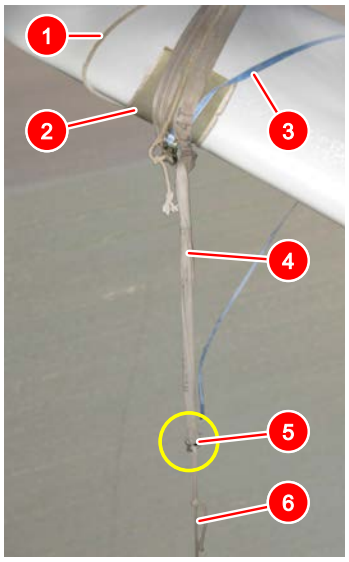


Fig. 137: Overview of guide rope

1	Safety rope for protective shell	4	Round sling
2	Protective shell on leading edge	5	Shackle
3	Lashing strap	6	Guide ropes

1. Hang one 1-t round sling (1 m) onto the crane hook.
2. Use a man basket to reach the guide rope at the front area of the first rotor blade.

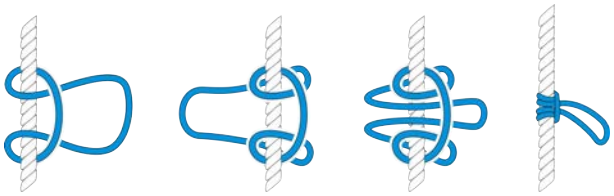


Fig. 138: Prusik knot

3. Fasten a loop strap to the guide rope using a Prusik knot.
4. Attach the guide rope to the man basket using the loop strap.
5. Raise the man basket to relieve the load on the guide rope.

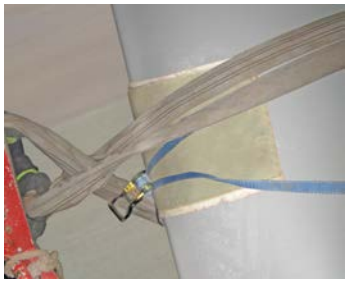


Fig. 139: Removing the round sling

6. Remove the guide rope from the rotor blade and secure it to the round sling on the crane hook.
7. Remove the loop strap between man basket and guide rope.



Fig. 140: Protective shell secured

8. Attach a safety rope to the protective shell.

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Fig. 141: Loosening the lashing strap

9. Put the protective liner from the leading edge into the man basket.
10. Unfasten the lashing strap and put it in the man basket while holding the protective shell in place.
11. Remove the protective shell from the trailing edge and put it into the man basket together with the safety rope.
12. Remove the guide rope on the second rotor blade in accordance with the previous work steps.

If the guide cables cannot be reached due to the main crane hook height being too low, the rotor blades will have to be turned to 3 o'clock position or 9 o'clock position before dismantling the guide ropes. Turning the rotor head is not possible until the sixth spinner section has been assembled.

11.4 Rotor head casing

11.4.1 Installing the sixth spinner section

1. Install the rotor head cap segment on the sixth spinner section.
2. Make 2 12-mm holes on the sixth spinner section.
3. Install an M12 swivel hoist ring on each of the drill holes.
4. Rig the sixth spinner section for hoisting using 2 2-t shackles and 2 4-t round slings (4 m).
5. Raise the sixth spinner section into the opening in the rotor head. Make sure that the sealing cords between the casing sections do not slide.
6. Bolt the sixth spinner section to the connectors and the spinner.

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11.5 Slip ring unit

11.5.1 Installing the slip ring unit support

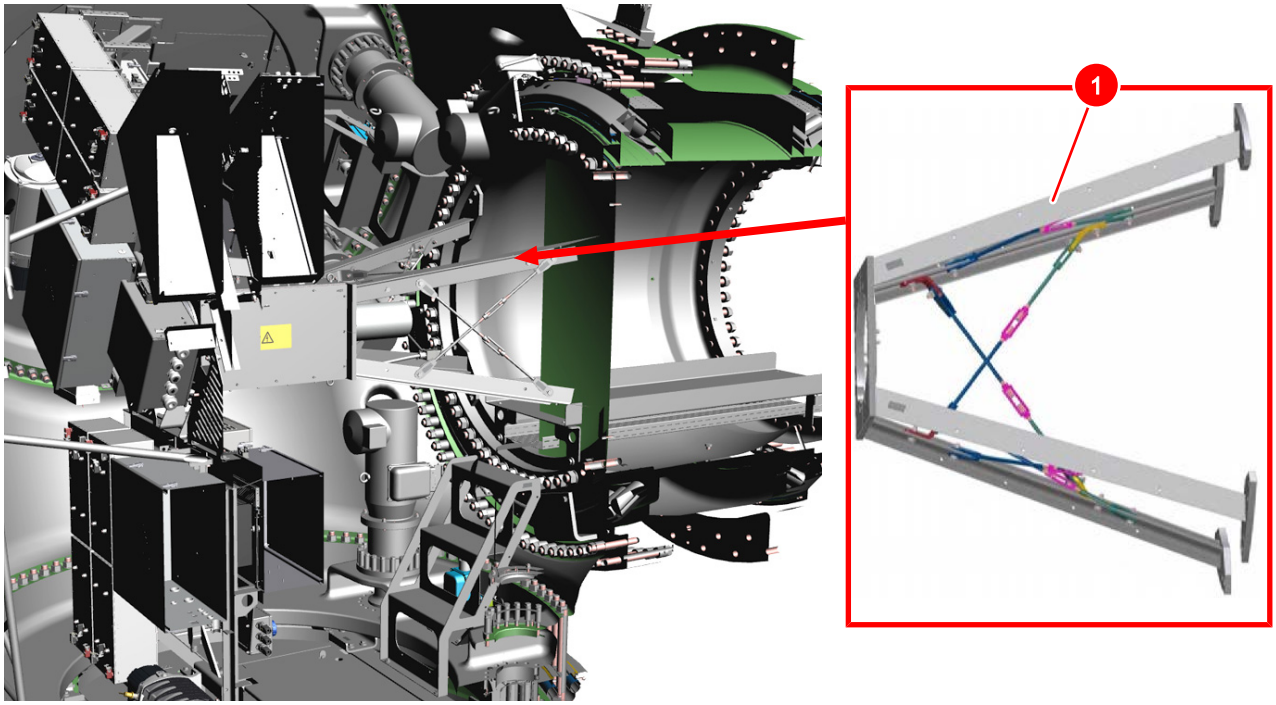


Fig. 142: Slip ring unit support installed

1	Slip ring unit support

1. Install the slip ring unit support between the slip ring unit and the rotor bearing unit.

11.5.2 Disassembling transport adapter

✓ The slip ring unit support is mounted.

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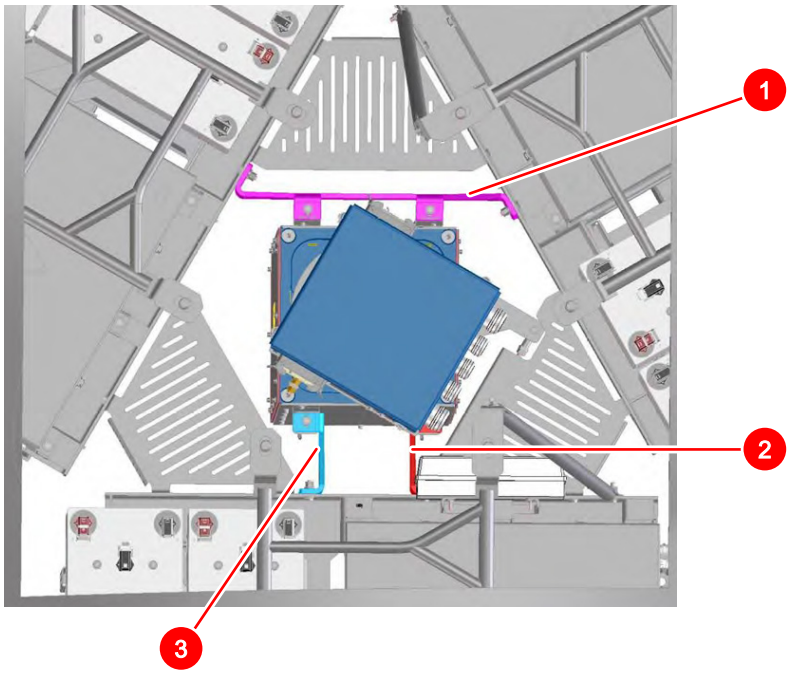


Fig. 143: Slip ring unit transport adapter

1	Transport adapter at the top	2	Bottom left transport adapter
3	Bottom right transport adapter		

1. Remove the transport adapter from the stationary part of the slip ring unit.

11.6 Electromechanical brake

Before the electromechanical brakes are used for the first time, check the release clearance between brake pads and brake disk and, if necessary, adjust it. It is not possible to adjust the release clearance accurately during production.

11.6.1 Checking release clearance

✓ The fastener between rotor – rotor hub has been fully installed and torqued.

✓ Make sure the rotor has been locked.

1. Use the installation aid to release the electromechanical brake.

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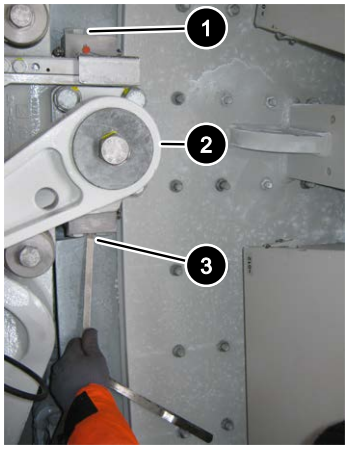


Fig. 144: Checking the electromechanical brake

1	Measuring point 1	3	Measuring point 3
2	Measuring point 2		

2. In the generator, use a feeler gauge to measure the release clearance between brake pad and brake disk of each of the three electromechanical brakes; measure at the 3 points specified in the figure.
3. Make sure that the release clearance on both sides is 2 mm +0.5 mm.
4. If the release clearance is out of tolerance, adjust it as described in ch. 11.6.2, p. 148.

11.6.2 Adjusting release clearance

⚠ DANGER

Automatic brake application

Serious injuries

- ⇨ Secure the brake before resuming automatic operation.
- ⇨ Before operating the brake manually, switch off the Main switch and pull the plug.
- ⇨ Never leave ratchet or Allen key in manual adjustment control.

✓ The check of the release clearance (see ch. 11.6.1, p. 147) has shown that the brakes need to be adjusted.

✓ The installation aid is connected to the stator sub-distribution system.

✓ Make sure the rotor has been locked.

The *brake release* button on the stator sub-distribution system works in 2 stages:

Activating stage 1 opens the brake for as long as the button is held in position. Releasing the button closes the brake.

Actuating the second stage keeps the brake in its current position.

1. On the stator sub-distribution system, press and hold the *Rotor brake release* button until the electromechanical brakes have opened fully.
2. Switch off the main switch on the installation aid. This ensures that the brakes will not close again.
3. Pull the plugs off the brakes.
4. Check which type of brake is installed:

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Result	Work step
Installed brakes: “Hanning & Kahl HEAW 300 T EVO”.	Adjust release clearance as per *Adjusting release clearance for Hanning & Kahl HEAW 300 T EVO*, p. 149.
Installed brakes: “KTR 300 RT”.	Adjust release clearance as per *Adjusting the release clearance for KTR 300 RTD*, p. 151.

Adjusting release clearance for Hanning & Kahl HEAW 300 T EVO

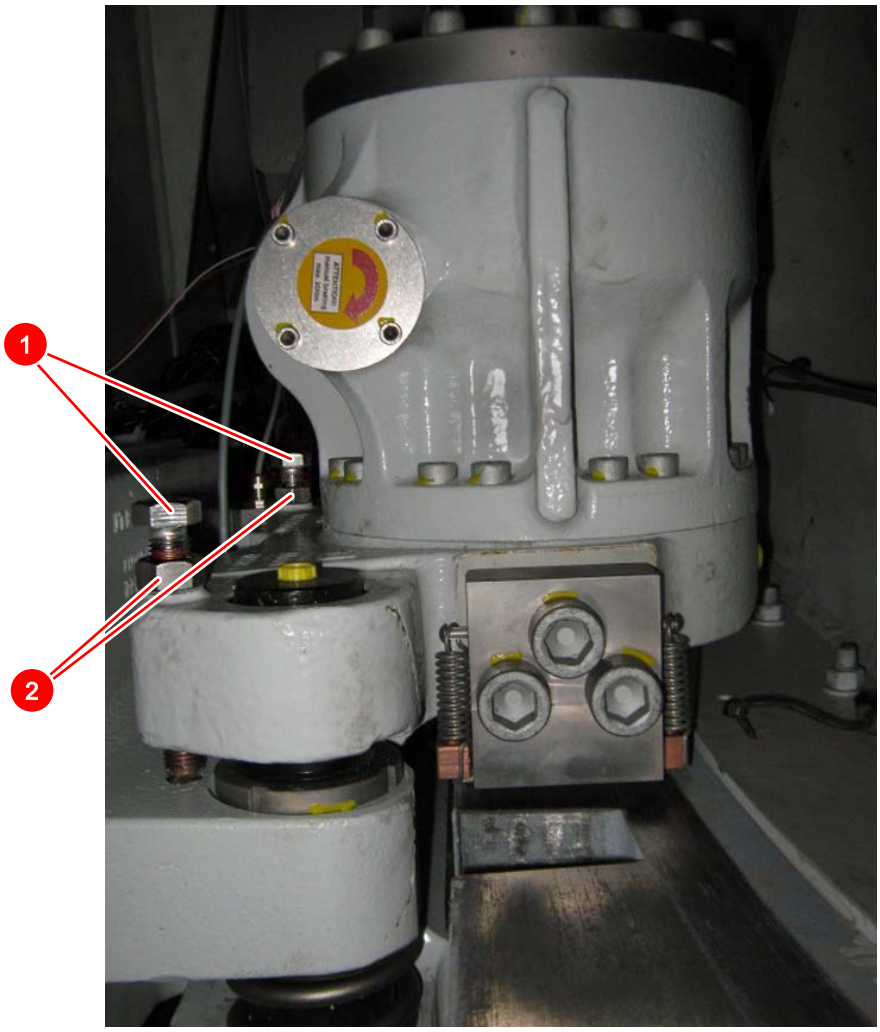


Fig. 145: Centring device of HEAW 300 T EVO

1	Centring bolts	2	Counter nuts

5. On the brakes that need adjusting, loosen the counter nut on each of the 2 centring bolts.

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Turning the centring bolts clockwise increases the release clearance on the loose side of the brakes.

Turning the centring bolts anti-clockwise increases the release clearance on the fixed side of the brake.

6. Use the centring bolts to adjust the release clearance between brake disk and brake pad on the fixed side of the brake calliper to 2 mm (+0.5 mm tolerance).
7. Tighten the 2 counter nuts to a torque of **115 Nm**.
8. Re-insert the plugs in the brakes and lock them with locking clips.
9. Actuate the brakes at least twice to check them.

The brake adjustment is correct if the release clearance is the same on fixed side and loose side. The release clearance must be at least 2 mm on both sides.

10. Move the brakes back fully and pull the plugs.
11. Measure the release clearance of the brakes on fixed side and loose side again.
12. Make sure that the release clearance is the same on the fixed side and loose side.
13. Make sure that the release clearance between the brake disk and the brake is 2 mm (+0.5 mm tolerance).
14. Re-insert the plugs in the brakes and lock them with locking clips.

↪ The brakes have been adjusted.

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Adjusting the release clearance for KTR 300 RTD

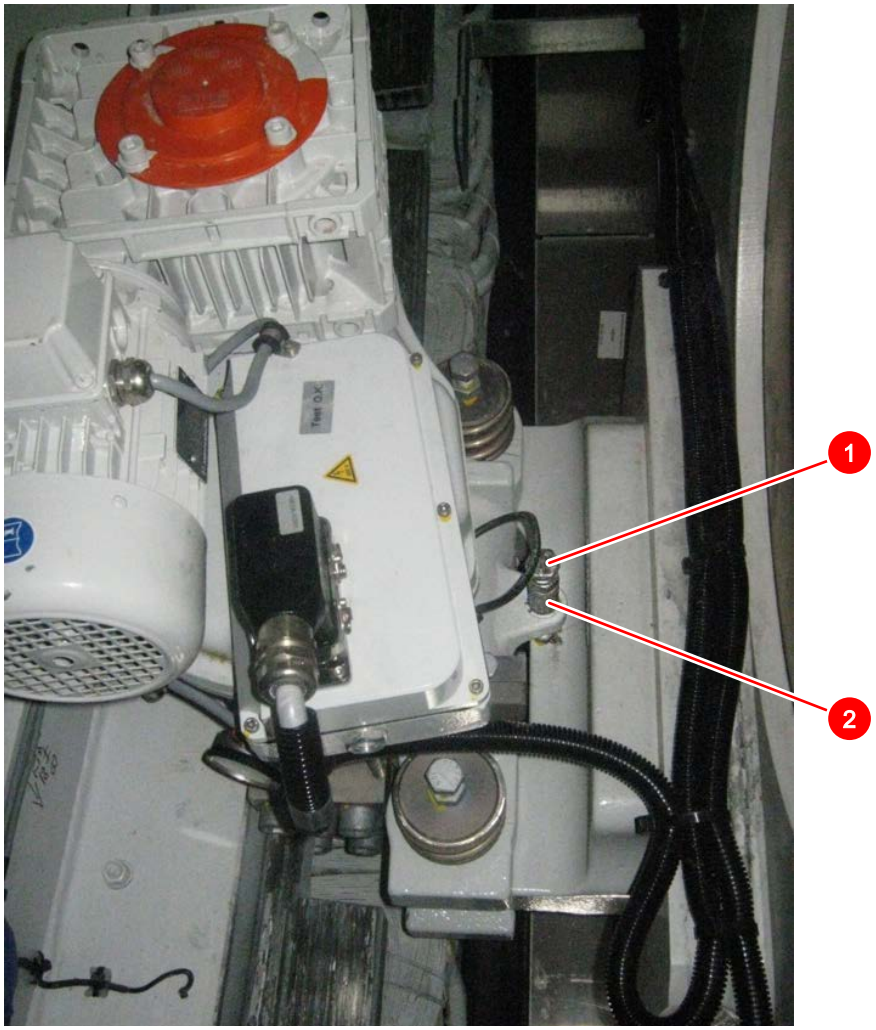


Fig. 146: Centring device of KTR 300 RTD

1	Centring bolt	2	Counter nut

18. On the brakes to be adjusted, loosen the counter nut (size 24) of the manual calliper centring device.
19. Use the centring bolt (size 24) to adjust the release clearance between brake disk and brake pad on the fixed side of the brake calliper to 2 mm (+0.5 mm tolerance).
20. Tighten the 2 counter nuts to a torque of **140 Nm**.
15. Re-insert the plugs in the brakes and lock them with locking clips.
16. Actuate the brakes at least twice to check them.

The brake adjustment is correct if the release clearance is the same on fixed side and loose side. The release clearance must be at least 2 mm on both sides.

17. Move the brakes back fully and pull the plugs.
18. Measure the release clearance of the brakes on fixed side and loose side again.

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Make sure that the release clearance is the same on the fixed side and loose side.

Make sure that the release clearance between the brake disk and the brake is 2 mm (+0.5 mm tolerance).

19. Re-insert the plugs in the brakes and lock them with locking clips.

↪ The brakes have been adjusted.

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12 Finishing steps

12.1 Perform a visual inspection and cleaning work

✓ The work inside and on the WEC is complete.

1. Check the entire WEC for foreign objects.
2. Ensure that all components and cables are secured in the rotating area.
3. Clean the entire WEC.
4. If necessary, carry out paint repair according to TD-esc-07-ger-xxx-13-007 “Reparaturanweisung Farbreparaturen” (Repair instructions for paint damage).
5. Put down any tools and materials no longer required.

12.2 Releasing the rotor lock

NOTICE

Rotor locked for too long after installation has been completed

Damage to rotor lock and hub bearing

⇨ Release the rotor lock as soon as possible after the installation of the third rotor blade. The rotor head should be able to idle on the day of the last crane lift at the latest.

⇨ Before releasing the rotor, turn all rotor blades into vane position and have the feathered position checked by two persons (double-control principle).

⇨ Ensure that all loose cables and components in the rotating area are adequately secured with cable ties.

⇨ Ensure that the wind energy converter in idle mode cannot collide with the crane or with the nearby repowering WEC.

1. Under observation, turn the nacelle so that the entrance ladder is **not** located above the descent hatch in the tower. If possible, position the nacelle rear to face the crane platform. When rotating the nacelle, make sure that the rotor blades **do not** collide with the crane.
2. Use the installation aid to rotate the second rotor blade into feathered position (90° position).
3. Use the installation aid to rotate the first rotor blade into feathered position (90° position).
4. Carry out a visual inspection to check that the rotor blades are turned correctly into the feathered position.
5. Disconnect V1 nacelle installation aid.

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6. Connect V2 nacelle installation aid to the winch and the stator sub-distribution system.
7. Lower V1 nacelle installation aid using the winch.
8. Release the rotor lock, see ch. 10.4.3, p. 130.

12.3 Leaving the WEC

✓ Rotor blades are in feathered position and the rotor head can idle.

1. Close all hatches and passes properly.
2. Make sure that the entrance area (stairs, foundation, etc.) is clean.
3. Close the tower door.
4. Put tarpaulins and frames in a single location on the pre-assembly area for the return transport.

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Appendix

Torque table

Torques for bolt connections

Certain bolt connections must be tightened to a special torque, for example when assembling operating equipment. These special torques are specified in the corresponding work steps.

Tab. 4: Torque table for set screws and ALCOA nuts [Nm]

Type	Hot-dip galvanised		Hot-dip galvanised + Torque´n Tension		HSFG hot-dip galvanised	A2/A4 stainless steel
Lubrication	MoS2 lubrication		No further lubrication		MoS2 lubrication	Klüberpaste 46 MR 401
Remarks/ special features	Nuts typically moly-coated		Transparent blue coating		Nuts always moly-coated	
Friction coefficient	μ = 0.10		μ = 0.10			μ = 0.14
Property class	8.8	10.9	8.8	10.9	(HSFG = 10.9)	-
M 8	18	26	18	26	-	17.5
M 10	36	52	36	52	-	35
M 12	61	90	61	90	100	50
M 14	100	145	100	145	-	-
M 16	160	230	160	230	250	120
M 18	225	320	225	320	-	-
M 20	320	460	320	460	450	-
M 22	440	630	440	630	650	-
M 24	560	790	560	790	800	-
M 27	820	1170	820	1170	1250	-
M 30	1120	1600	1120	1600	1650	-
M 33	1530	2200	1530	2200	2200	-
M 36	1970	2800	1970	2800	2800	-
M 48	-	6500	-	6500	6500	-

Pretensioning forces for bolt connections

If hydraulic preloading is prescribed for bolt connections, the required pretensioning forces are specified in the particular work steps.

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