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APCO
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OWNER ENGINEER

MOTT MACDONALD

EPC CONTRACTOR TECHNICAL ADVISOR

WorleyParsons
resources & energy

OWNER NAME

ATTARAT POWER COMPANY

PROJECT NAME

2X235MW Attarat Oil Shale Power Plant-Jordan

VENDOR NAME

SIEMENS AG

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Ingenuity for life

CONTRACT No.	01.00.13.058
PO No.	GPEC-JDP-X-CON1-PCM-003
PLANT/AR	POWER BLOCK
TAG No./KKS CODE	10MKA
EQUIPMENT TYPE	GENERATOR
DOC No.	DV-RPG1-J01008-10MKA-&MDB030-360063
DOC TITLE	Preliminary Operating and Maintenance M.

____ REVIEWED AND ACCEPTED - RA

____ REVIEWED AND ACCEPTED AS NOTED (RESUBMIT FOR RECORD) - RN

____ NOT ACCEPTED (RESUBMIT FOR REVIEW) - NA

__O__ INFORMATION ONLY (REVIEW WAIVED) - I

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DATE 2017/8/30 BY Niu Weifeng

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Turbogenerator Attarat 2x235MW Oil Shale Power Plant | EG000333

Operating and Maintenance Manual

SIEMENS

Operating and Maintenance Manual

TO – Operating Manual

Project name	Attarat 2x235MW Oil Shale Power Plant
Project code	JO1008
Generator type	SGen5-1200A 118/55
	Two-Pole Turbogenerator with Directly Air-Cooled Rotor Winding and Indirectly Air-Cooled Stator Winding
	Unit 1
Order no.	3000017203
Machine no.	EG000333
Internal ID	FERT00532498
Siemens Document no.	DPSDES-0000... en

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Original manual

TO – Operating Manual

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Turbogenerator | Operating and Maintenance Manual

General Information 1

Preface

Please note the following information about this manual.

The Operating and Maintenance Manual (OMM) is divided into two parts:

Part 1: Operating Manual

The Operating Manual comprises the technical documents required by the operating personnel for normal plant operation. It also describes the possible operating personnel interventions under plant conditions which deviate from normal operating conditions and which are annunciated by means of alarms. The Operating Manual builds upon the user guides for the individual equipment units (see Implementation Documentation). It contains only information not contained in the user guides for the equipment units or that result from the interaction of the equipment units.

Part 2: Implementation Documentation

The Implementation Documentation comprises the technical documents representing the structure of the individual systems and equipment. This includes the documents and data which are required for operation and maintenance. In particular, it includes the documents which describe the operating principles of the equipment and which constitute or contain the user guides for this equipment.

⚠ CAUTION

Knowledge of the information provided in the OMM is an essential condition for the proper operation and maintenance of the turbogenerator, and for avoiding any personal injury or damage to property.

▶ Read this manual through carefully and thoroughly.

Intended use of the OMM

This manual has been prepared for operating and maintenance personnel who has comprehensive knowledge of power plant technology and power plant operation, and who has already received a briefing on the operation and maintenance of the system by instructed personnel.

The present manual cannot contain comprehensive information about all aspects of the turbogenerator, its operation and maintenance. Furthermore, it does not provide instructions or information about every eventuality that can arise during the assembly, operation or maintenance of the generator. All questions that cannot be clearly answered with the aid of this manual must be referred to Siemens AG.

All the information contained in this manual is intended solely for the use of the buyer and for the specific purpose stated by the buyer to Siemens AG for the purchase of the generator. The use by other persons, entities and bodies for other purposes is not authorized. Siemens AG does not accept any liability for any consequences due to any type of such unauthorized use.

This manual is not a guarantee or contractual document. The obligations of Siemens AG are regulated solely in the purchase contract. The information contained in this manual cannot be interpreted in any way to change or extend the obligations of Siemens AG.

NOTE

The manual must be kept up to date in order to ensure safe operation. Accordingly, the supplements and updates provided by Siemens AG should be inserted in the documentation promptly after their receipt.

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Safety Instructions

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1 General

This section contains the relevant information necessary for safe operation of a generator.

Although the generator is designed to state-of-the-art technology and complies with the applicable safety standards, hazards which could result in personal injury to the user or third parties and damage to the generator or other property cannot be ruled out completely.

Please read this section carefully and make sure that you comply with the instructions in order to safeguard against personal injury and damage to the generator.

Please note that the safety information in this section is general and applies to different types of generators. In the individual chapters of this document, you will find safety notes that must be obeyed absolutely, for your own safety, to protect other people and to avoid damage to property.

Apart from the safety instructions in this section observe all indications on safety in the supplier documentations included in this manual.

2 Warnings

The operating instructions use a range of key words and symbols to identify information which is of particular importance. The key words **Danger**, **Warning**, **Caution** and **Notice** give you a better idea of the significance of the warning notices:

⚠ DANGER — ... indicates an imminently hazardous situation which, if not avoided, **will** result in death or serious injury.

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

⚠ CAUTION — ... indicates a potentially hazardous situation which, if not avoided, **may** result in minor or moderate injury.

NOTICE — ... indicates a potentially hazardous situation which, if not avoided, **may** result in property damage.

NOTE — Additionally, the signal word NOTE is used to identify any information relevant to ensure maximum generator efficiency.

Such kind of information can be complemented by the pictograph Information.

In order to emphasize the above mentioned warning notices, these are used together with pictographs. In this manual you will find the following hazard warning signs, mandatory signs and prohibition signs, which in each case are followed by an explanatory remark.

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Warning signs

A black graphical symbol inside a yellow triangle with a black triangular band defines a safety sign that indicates a hazard. For example:

General warning sign

Warning: Electricity

Prohibition signs

A black graphical symbol inside a red circular band with a red diagonal bar defines a safety sign that indicates that an action shall not be taken or shall be stopped.
For example:

General prohibition sign

No access

Mandatory signs

A white graphical symbol inside a blue circle defines a safety sign that indicates that an action shall be taken to avoid a hazard. For example:

General mandatory sign

Ear protection required

3 Proper Usage of the Generator

The function of a generator is to convert rotating mechanical energy to electrical energy. Alternatively generators are used as synchronous condensers.

To ensure normal and trouble-free operation of the generator, it is necessary to comply with the operating instructions as well as the inspection and maintenance intervals specified for the generator.

Siemens AG do not accept any liability for any damage which may occur as a result of use of the generator for any other purpose or noncompliance with the aforementioned operating instructions or inspection and maintenance intervals.

4 General Organization

The following instructions must be followed to ensure safe and reliable operation:

- Based on this technical documentation shift procedures must be prepared with additional information regarding responsibilities, work organization and workflows.
- Any personnel working on the generator and its auxiliary systems must be familiarized with the operating instructions and shift procedures and in particular with the safety instructions and regulations before starting work. This particularly ap-

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plies to personnel such as maintenance personnel who do not work on the generator on a regular basis.

- In addition to the operating instructions, the general legal provisions and other regulations for employment protection, the prevention of accidents and fire as well as the protection of the environment must be observed. The operator is responsible for the implementation and the correct adherence of the staff. Protective apparel and equipment must be used.
- Note safety data sheet when using hazardous material.
- Place signs at the entrance to the operating room of the generator according to the local legal and employment protection requirements. Every person who enters the operating room must wear personal protective equipment according to these local requirements and the requirements stated in this documentation.
- In case that equipment, protection systems or instrumentation and control components are damaged or defect, the generator must be handled as specified (shut down if necessary) and the supervisor must be informed. In some cases local authorities must be informed as well. The local authorities can conduct extraordinary examinations in an event of damage in some individual cases.
- It must be ensured that work on oil carrying systems and piping must be conducted after emptying. Switch off procedures must be strictly adhered. Special procedures for environmental and employment protection must also be considered.
- If work is done on several systems at the same time, it must be coordinated in a way to avoid mutual endangering.
- During start-up and synchronization of the generator only authorized staff with defined task is allowed to stay within the machine room.
- Only use suitable and faultless climbing equipment (e.g. ladders) for work in larger heights. Scaffolding can be necessary and further safeguards like anti-fall guard. Do not step on armatures, thermometers and the bearing.
- The use of pipes, cables, terminal boxes and fittings as a kick or hold is inadmissible. Parts get visible or invisible damages which may lead to a failure beside the danger of injury.
- The operating instructions must always be kept on hand.

NOTE

We recommend engaging the support and services of your local Siemens service center for all planning, installation, commissioning and maintenance work.

5 Personnel

With regard to personnel working on the generator, compliance must be ensured with the following:

- Work on the generator and its auxiliary systems is to be performed by authorized personnel only. Activities and associated responsibilities are to be clearly defined for the personnel.
- Staff must be trained on the basis of the manufacturer technical documentation. They must be physically and mentally suitable for the tasks and must have the required expertise. Staff must be able to carry out maintenance measures inde-

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pendently and to take decisions in the case of disturbances or deviations from the stated operation condition independently. Depending on local regulations it can be required that these people have a certification from special trainings.

- Personnel requiring or undergoing training must only be allowed to perform work on the generator or its auxiliary systems under the constant supervision of an appropriately qualified member of staff.
- Work on the electrical systems of the generator may only be performed by electrical engineers or by suitably qualified personnel under the supervision of an electrical engineer in compliance with the relevant electrical engineering standards.
- The staff has to avoid dangers or reduce them as far as possible. This also contains the self-control of completed work. In addition, it has to be checked before work execution whether all necessary safety measures are taken.
- The operator's position during operation of the generator is the control room. Abidance near the generator is only permitted for inspection and attendance purposes which are required for the operation.

6 Lifting and Working Posture

When working on the generator make sure to comply with the local rules regarding lifting and working posture. All work shall be planned in order to be executed in a safe and healthy manner.

Lifting that can be a risk to health and safety shall be avoided. The usage of lifting equipment should be preferred for all lifting workings at the generator. This applies to all generator equipment such as filters, manhole covers etc. Observe the local requirements regarding the recommended lifting weight and carrying distance.

7 Modifications to Generator

Do not carry out any modifications to the generator or perform any other work on the generator which might impair safety. Any changes must be approved by Siemens AG prior to their implementation.

8 Spare Parts and Special Tools

Spare parts and special tools must comply with the technical standards set forth by Siemens and other suppliers. Compliance with the aforementioned standards is only ensured if original parts and tools are used. Special tools should only be used as intended by Siemens or the supplier.

Spare parts and special tools must be stored in a way to ensure quality and functionality. Further requirements from the supplier documentations must be fulfilled including the guarantee conditions. The spare parts and special tools should be checked at regular intervals.

Do not remove any blocks, braces, anchors and/or cushions used during shipment until just before erection or installation of spare parts.

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9 Environment Protection and Waste Disposal

Waste products of any kind (e.g. lubricants) must be disposed of in compliance with the applicable waste disposal regulations. An environmentally friendly disposal (recycling e.g.) has to be striven.

For the de-installation and professional disposal of the generator experts of Siemens AG have to be contacted.

10 Safety Instructions Regarding Special Operating Phases

10.1 Shipment, Transport and Storage

The following safety instructions apply during generator shipment, transport and storage:

⚠ WARNING

Suspended load

Falling loads may cause injury to persons.

- Keep safe distance. Place barriers if necessary.
- Only use specified load attachment points. Only use suitable lifting equipment. The lifting equipment must be in good condition and have a sufficient load carrying capacity.

- Refer to the shipping documents for information about the dimensions and weights of generator components.
- For transportation of heavy machine parts in buildings a sufficient load-capacity of the building has to be guaranteed along the complete transport route as well as at the operation or stock location.
- Prevent generator rotor from rope-induced damage by using suitable cushions at load attachment points. Hitch ropes to fully extracted bollards only. Insert and lock bollards during transport.
- Carefully check components for evidence of damage, moisture and corrosion on arrival. Notify manufacturer in written and photo documentation of any damage.
- If transport locks must be removed for the purpose of control of the components, these guards must be reattached and removed just before installation of the components.
- Adhere to all measures for protection during transport described in this manual.
- Take appropriate measures to protect and preserve the generator at standstill. Observe the storage instructions in this manual.
- Fill in the generator packing checklist for long time storage, if necessary. Storage goods must be checked monthly.

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10.2 Erection

The following safety instructions apply during generator erection:

⚠ CAUTION

Crushing hazard

These may cause injury to persons.

- Installation, raising, transporting of heavy objects only with the help of hoists.

- Before erection remove protective coating and any other protective material from components using a suitable cleaning agent. Observe environmental regulations.
- Check the generator for foreign objects. Even minimal-size metallic particles left inside after work on the generator can lead to large-scale damage during generator operation.
- If it is necessary to open parts of the system the openings must be covered. The used covers must be sufficiently exact and stable to prevent a contamination with foreign material.
- Use only suitable lubrication and seal material for the respective purpose. They must comply with the later operation conditions.

10.3 Start-up

The following safety instructions apply during generator start-up:

⚠ WARNING

Rotating components

These may cause injury to persons.

- Before commencing with generator start-up ensure that personnel are not exposed to any hazards. The start-up sequence must be adhered.

- All mechanical and hydraulic components as well as the generator protection system must be checked with regard to function and settings.
- Before start-up/ re-commissioning all components must be checked for safety and for recognizable defects. Defective parts and systems must be repaired before start-up.
- Obligatory documentation requirement: Prepare start-up record. Record all operating data after allowing sufficient time for steady-state conditions to be established.

10.4 Operation

The following safety instructions apply during generator operation:

⚠ CAUTION

Hot surface.

Parts of the generator can be very hot and may cause serious burns.

- Do not touch.

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⚠ CAUTION

Operating noise of generator may damage hearing.

- Wear ear plugs when staying next to the operating generator.

- Any irregular events which occur during operation must be reported directly, and the generator shut down if necessary.
- In the event of loss of control voltage the generator must be shut down immediately.
- Only qualified staff with a specified work order should stay near the running generator.
- Obligatory documentation requirement: Record requisite checks during generator operation.

10.5 Maintenance in Operation

The following safety instructions apply during generator maintenance in operation:

⚠ WARNING

Rotating components

These may cause injury to persons.

- Ensure compliance with the scope of work set forth in the maintenance instructions.
- Do not remove any safeguard during operation.

- Operating personnel must be notified before starting any maintenance work. Appoint a suitably qualified supervisor.
- Empty pockets before starting maintenance work. Remove jewelry and other metal objects. Record all tools used in a list and check that tools have been completely removed from generator when finishing work.

10.6 Maintenance at Standstill

The following safety instructions apply during generator maintenance at standstill:

⚠ WARNING

Danger of serious injuries and substantial material damage.

- The machine must be electrically disconnected.
- Identify all additional dangerous sources of energy e.g. compressed air, hydraulic systems, water.
- The machine must be secured against being switched on accidentally.
- A notice must be attached in the control room that work is in progress.

- Parts which are undergoing inspection or repair activities must be de-energized. Disconnected parts must be checked for voltage, grounded and short-circuiting. Neighboring energized parts must be isolated and covered.
- It must be ensured that the generator cannot be switched on if somebody is working on it. It has to be made sure that no one stays in an area where it could come to injuries during start-up process.

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- The removal of safeguards must be avoided. It is only allowed when it is required for the work and does not endanger the staff. Removed safeguards must be re installed and checked just after the work task.
- Switch pressurized systems off before starting to work on it. Take care of ram pressures. Loosen screw connections carefully.
- Disconnect cable connections to electrical devices and ground terminals before lifting any cover. Remove electrical devices before dismantling components.
- Check the generator for foreign objects. Even minimal-size metallic particles left inside after work on the generator can lead to large-scale damage during generator operation.

10.7 Shutdown

The following safety instructions apply during generator shutdown:

⚠ WARNING

Rotating components

These may cause severe injury to persons.

- Ensure that rotor has coasted down.
- Do not remove any guards until generator has come to a full standstill.

- Obligatory documentation requirement: Record requisite checks during and following generator shutdown.

11 Special Hazards

11.1 Electric Current

Ensure compliance with the following instructions:

⚠ DANGER

Electrical hazard

Touching electrical equipment during operation can result in damage to property, serious injury and even death.

- Do not remove any safeguards or open cabinets during operation.

- Work on the electrical systems of the generator may only be performed by electrical engineers or by suitably qualified personnel under the supervision of an electrical engineer in compliance with the relevant electrical engineering standards.
- Local requirements regarding work on electrical installations must be strictly adhered to.
- For all work on electrical installations observe the five safety rules:

  1. Disconnect from the mains
  2. Secure against reconnection
  3. Verify that the system is dead
  4. Carry out earthing and short circuiting
  5. Provide protection from adjacent live parts.

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- During operation very high voltages occur, which can remain in existence for long periods of time even after switching off due to remanence or discharge of capacitors. As long as the generator is still rotating it carries a dangerous voltage. Do not touch the equipment before all 5 rules are fulfilled.
- Regularly check the electrical equipment, grounding system and isolation levels. Immediately repair any defects.

11.2 Electromagnetic Fields

⚠ WARNING

Electromagnetic fields are generated during the operation of the generator.

Electromagnetic fields can interfere with electronic devices. This could lead to malfunction of such devices.

- Therefore persons with active medical implants must not enter these areas.

- The system operator must put appropriate measures, markings and warnings into effect so that the personnel working there are sufficiently protected against possible injury. Also observe the local requirements.

11.3 Heat

⚠ WARNING

Hot surface

Parts of the generator can be very hot and may cause serious burns.

- Do not touch.

- The surface of oil lines, covers etc. become hot during operation.
- The surface of anti-condensation heaters switched on automatically during standstill becomes hot.

11.4 Noise

⚠ CAUTION

Operating noise of generator may damage hearing.

- Wear ear plugs when staying next to the operating generator.

- The generator may produce noise levels of approx. 90 dB(A) depending on model and type. In the long term such noise levels may result in damage to hearing.

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Turbogenerator | Operating and Maintenance Manual

Description 2

Technical Data (1)

Identification Data	**Generator**
Code word	Attarat 2x235MW Oil Shale Power Plant Unit 1
Type	SGen5-1200A 118/55
Year of construction	2017
Machine number	EG000333
Serial number of rotor	...
Serial number of stator	…

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Rating Plate Data

Kind of machine:	Generator	Serial no.	3xxxx	Year of manufacture:	2017
Machine code:	SGen5-1200A	Machine No.:	EG000333	Direction of rotation:	CW
No. of phases: Connection:	3 YY	Frequency:	50 Hz	Rated speed:	3000 rpm
Range of rated voltage:	20000 V +/-5%	Phase sequence:	U1 V1 W1	Operating mode:	S1
Rated power:	326000 kVA	Rated current:	9411 A		
Type of excitation:	External excitation	Rated power factor:	cos φ = 0.85	Type of construction:	IM 7215
Class of insulation design:	F	Type of cooling:	Air cooling	Degree of protection:	IP 55
Temperature rise corresponds to class:	B	Cooling air temperature:	48.5°C		
Total weight:	374100 kg	Standard:	IEC 60034		
Rotor weight:	66200 kg	Stator active part and base frame weight:	252500 kg		

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GENERATORS
for Steam- and Gas-Turbines

TECHNICAL DATA FOR GENERATOR OFFER ER15028

Type: SGen5-1200A-2P 118-55 M07

FOR THE PROJECT EG000333/EG000334

Attarat

S_N =	326,00	MVA	PF =	0,85			
U_N =	20,00	kV	f_N =	50	Hz	Design corresponds to:	
I_N =	9,411	kA	n_N =	3000	rpm	IEC 60034	

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US and EU Export Controls

Technology Classification: ECCN: **EAR99** AL: **N** US-Content: **No**

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The given data are calculated values (if not indicated differently)

Generator Type: **SGen5-1200A-2P 118-55 M07** **EG000333/EG000334**

Load Point						N		A		B	
Standard						IEC 60034		IEC 60034		IEC 60034	
Thermal Classification: Design / Using						F / B		F / B		F / B	
Apparent Power	Active Power			MVA	MW	326,00	277,10	337,00	286,45	318,00	270,30
Cold Air Temp.	Cooling Water Temp.			°C	°C	49,0	45,0	49,0	45,0	54,0	50,0
Voltage				kV		20,00		20,00		20,00	
Voltage Deviation		+	-	%		5,0	5,0	5,0	5,0	5,0	5,0
Armature Current				kA		9,411		9,728		9,180	
Frequency	Speed			Hz	rpm	50	3000	50	3000	50	3000
Power Factor				-		0,85		0,85		0,85	
Excitation Requirements	No load	I_{f0}	U_{f0}	A	V	452	135	452	136	452	136
	4/4-load	I_{fN}	U_{fN}	A	V	1213	362	1244	374	1191	359
	5/4-load	$I_{f5/4}$	$U_{f5/4}$	A	V	1445	431	1486	447	1416	427
Cooling Air	Losses			kW		3333		3412		3278	
	Air flow	Temp. rise		m^3/s	K	78,0	40,9	78,0	41,9	78,0	40,2
Sudden-SCC at No-Load and Nominal Voltage	I_S: 3-phase (peak)			kA		171		171		171	
	I_{K3}: 3-ph. (sustained at I_{fN})			kA		13,5		13,8		13,2	
	I_{K2}: 2-ph. (sustained at I_{fN})			kA		21,4		22,0		21,0	
Short Circuit Ratio				(tol. ± 5%)		**0,53**		0,52		0,55	
Reactances	x''_d	unsat.	sat.	%	%	18,7	**14,0**	19,3	14,5	18,2	13,7
	x'_d	unsat.	sat.	%	%	24,2	21,8	25,0	22,5	23,6	21,3
calculated values, tolerance **+/-15%** acc. IEC 60034-3	x_d	unsat.	sat.	%	%	209	188	216	194	204	183
	x''_q	unsat.	sat.	%	%	20,5	15,4	21,2	15,9	20,0	15,0
	x'_q	unsat.	sat.	%	%	49,3	44,6	51,5	46,6	47,2	42,7
	x_q	unsat.	sat.	%	%	199	169	205	174	194	165
	x_2	unsat.	sat.	%	%	19,6	14,7	20,3	15,2	19,1	14,3
	x_0	unsat.		%		9,5		9,9		9,3	
	x_{leak}	unsat.		%		14,6		15,0		14,2	
Time constants at 95°C winding temperature	T''_d	T_q''		s	s	0,029	0,068	0,029	0,067	0,029	0,069
	T'_d	T_q'		s	s	1,388	0,500	1,388	0,506	1,388	0,490
	T'_{d0}	T_{q0}'		s	s	12,770	2,500	12,770	2,500	12,770	2,500
	T''_{d0}	T_{q0}''		s	s	0,040	0,150	0,040	0,150	0,040	0,150
	T_a			s		0,549		0,549		0,549	
Resistance at 20°C	Stator winding / phase			mΩ		0,80		0,80		0,80	
	Rotor winding			mΩ		222,31		222,31		222,31	
Voltage regulation	PF = rated P.F.			%		37,1		37,7		36,6	
	PF = 1,00			%		31,0		31,7		30,4	
Max. unbalanced load	Continuous			%		8		8		8	
	Short time $i_2^2 * t$			s		8		8		8	
Power at PF = 0	Underexcited			Mvar		148,9		148,9		148,9	
	Overexcited			Mvar		252,9		262,0		246,2	
Winding temp. rise	Stator (RTD)			K	°C	60	109	63	112	59	113
Winding temp.	Rotor (average)			K	°C	58	107	61	110	57	111
Losses	Bearing losses			kW		178		178		178	
	Windage losses			kW		1402		1402		1402	
	Core losses			kW		570		570		570	
	Short circuit losses			kW		827		884		787	
	Rotor I^2R losses			kW		425		447		410	
	Total losses			kW		3402		3480		3346	
Efficiencies with tolerance at static excitation and rated P.F. (incl. bearing losses)		4/4-load		%		**98,79**		98,80		98,78	
		3/4-load		%		98,62		98,65		98,61	
		2/4-load		%		98,20		98,25		98,17	
		1/4-load		%		96,78		96,87		96,71	

Generator - Type: SGen5-1200A-2P 118-55 M07 EG000333/EG000334

Load Point	Rated	A	B
S_N =	326,00 MVA	337,00 MVA	318,00 MVA
U_N =	20,00 kV	20,00 kV	20,00 kV
I_N =	9,411 kA	9,728 kA	9,180 kA
f_N =	50 Hz	50 Hz	50 Hz
PF =	0,85	0,85	0,85
$T_{Cold\ Air}$ =	49,0 °C	49,0 °C	54,0 °C

Generator - Type: SGen5-1200A-2P 118-55 M07 EG000333/EG000334

S_N =	326,00	MVA	PF =	0,85		S(1,0) =	11,4 %
U_N =	20,00	kV	SCR =	0,53		S(1,2) =	42,6 %
I_N =	9,411	kA	I_{f0} =	452	A		
f_N =	50	Hz	I_{fk} =	848	A		

Generator - Type: SGen5-1200A-2P 118-55 M07 EG000333/EG000334

S_N =	326,00 MVA	PF =	0,85	I_{f0} =	452 A
U_N =	20,00 kV	f_N =	50 Hz	I_{fN} =	1213 A
I_N =	9,411 kA	$T_{Cold\ Air}$ =	49,0 °C		

V-Curves Refer to Apparent Power

practical stability limit (rotor angle safety margin at 83 degrees)

heating limit of stator and rotor winding

Generator - Type: SGen5-1200A-2P 118-55 M07 EG000333/EG000334

S_N =	326,00 MVA	PF =	0,85	$T_{Cold\ Air}$ =	49,0 °C
U_N =	20,00 kV	f_N =	50 Hz		
I_N =	9,411 kA	n_N =	3000 rpm		

Max. permitted values of negative sequence current incl. percentage caused by harmonic load.

None of the phase currents may exceed the nominal current.

Generator - Type: SGen5-1200A-2P 118-55 M07 EG000333/EG000334

S_N =	326,00	MVA	PF =	0,85		$T_{Cold\ Air}$ =	49,0 °C
U_N =	20,00	kV	f_N =	50	Hz	Efficiency acc. to:	
I_N =	9,411	kA	n_N =	3000	rpm	IEC 60034	

Apparent Power Output		MVA	81,5	163,0	244,5	326,0
		p.u.	0,25	0,50	0,75	1,00
Efficiency at P.F. =	1,00	%	97,29	98,51	98,87	99,01
	0,85	%	96,78	98,20	98,62	98,79

Generator - Type: **SGen5-1200A-2P 118-55 M07** **EG000333/EG000334**

S_N =	326,00	MVA	PF =	0,85		$T_{Cold\ Air}$ =	49,0 °C
U_N =	20,00	kV	f_N =	50	Hz	I_{fN}=	1213 A
I_N =	9,411	kA	n_N =	3000	rpm		

Time [s]	10	30	60	120
Stator Current I/I_N [%]	218	150	127	115
Field Current I_f/I_{fN} [%]	209	146	125	113

Fullfills IEC and ANSI requirements

The generator is capable of operating at 150 percent of rated stator current for 30 sec.

The generator field winding is capable of operating at 125 percent of rated load field current for 1 min.

Both requirements are fullfilled starting from stabilized temperatures at rated conditions.

It is recognized that winding temperatures under these conditiones will exceed rated-load values.

Number of such operations should be limited to two times a year (corresponds to ANSI and IEC).

Generator - Type: **SGen5-1200A-2P 118-55 M07** **EG000333/EG000334**

S_N =	326,00 MVA	PF =	0,85	$T_{Cold\ Air}$ =	49,0 °C
U_N =	20,00 kV	f_N =	50 Hz		
I_N =	9,411 kA	n_N =	3000 rpm		

I_0 [A] Ground fault current over neutral point to earth

Time [s] Limitation time for I_0 to prevent damage from stator iron core

Diagram basis is $I^2 * t$ = const.; 10 A for 30 s is Siemens standard for dimensioning earthing.

When exceeding limitation curve, stator iron is endangered melting in the fault region.

Worst case is earth fault on phase side (opposite to neutral point side) of winding.

In that case the potential of neutral point changes from zero to phase-to-phase-voltage / √3.

Fault current and recommended trip time depend on earthing resistance.

Generator - Type: **SGen5-1200A-2P 118-55 M07** **EG000333/EG000334**

S_N =	326,00 MVA	PF =	0,85	$T_{Cold\ Air}$ =	49,0 °C
U_N =	20,00 kV	f_N =	50 Hz		
I_N =	9,411 kA	n_N =	3000 rpm		

Limits for continuous operation with nominal load (S1)

Voltage max.:	+5,0 % 1)	**Frequency max.:**	+2,0 %
Voltage min.:	-5,0 %	**Frequency min.:**	-2,0 % 1)

1) In case of overvoltage and underfrequency at the same time the sum of both deviations for continuous operation is limited to: 5,0 %

Siemens AG	Excitation Data Sheet *Erreger- und Reglerangaben* **Attarat**	Rev.	Printed at *Druck am*
E F PR GN ERF EN 3		A	13.06.2017

Generator SGen5-1200A-2P 118-55 M07

S_N =	326,00	MVA	
U_N =	20,00	kV	+5/-5%
I_N =	9,411	kA	
f =	50	Hz	
n =	3000	min-1	
cos φ =	0,85		

Generator-Number / *Generator-Nummer*: EG000333/-4

Cold Air Temp. / *Kaltlufttemperatur*: Generator 49 °C; Exciter --- °C 1)

Rotor Resistance / *Läuferwiderstand*: 20°C 222 mΩ; warm 298 mΩ

Direction of Rotation (view from turbine to generator): / *Drehrichtung bei Sicht von Turbine auf Generator:* **Clockwise** *im UZS*

Main Exciter Type n/a (static excitation)

Capability at --- °C cold air temperature:

--- V	--- A	--- kW	S1
--- V	--- A	--- kW	10 sec.

No Load Time Constant / *Leerlaufzeitkonstante*: --- s (T'_{D0})

Load Time Constant / *Belastungszeitkonstante*: --- s (T'_{DL})

Field-Resistance / *Feldwiderstand*: 20°C --- Ω; warm --- Ω

Pilot Exciter Type none / ohne

Frequency --- Hz

Capability at --- °C cold air temperature:

--- V	--- A	--- kVA	S1
--- V	--- A	--- kVA	10 sec.

Commut. Reactance (XCom) / *Kommutierungsreaktanz*: --- Ω

1) Depending on cooling air circuit; Cold air temperature of exciter can be different from cold air temperature of generator.

Characteristics (Project Data) / *Kennlinien (projektbezogen)*

Generator- Load / *Generator-Belastungszustand*		Winding temp. / *Wicklungstemp.*	Generator I_f [A]	Generator U_f [V]	Main Exciter I_E [A]	Main Exciter U_E [V]	
No Load (0,50*U_N)	*Leerlauf (0,50*U_N)*	20°C	203	45	---	---	
No Load (0,80*U_N)	*Leerlauf (0,80*U_N)*	20°C	337	75	---	---	
No Load (0,95*U_N)	*Leerlauf (0,95*U_N)*	20°C	418	93	---	---	
No Load (1,00*U_N)	*Leerlauf (1,00*U_N)*	20°C	452	101	---	---	
No Load (1,00*U_N)	*Leerlauf (1,00*U_N)*	warm	452	135	---	---	
Rated Load	*Nennlast*	warm	1213	362	---	---	S1
25% Overcurrent	*25% Überstrom*	warm	1445	431	---	---	S2 60 sec.
Peak Load (2-times)	*Stoßerregung*	warm	2426	724	---	---	S2 10 sec.

Excitation Response / *Auferregungsgeschwindigkeit*: --- s^{-1} at --- V Controller Voltage / *Reglerausgangsspannung* (*acc. to IEC 60034*)

Voltage rise at sudden discharge and rated excitation / *Generatorspannungsüberhöhung bei Entlastung und Nennerregung*: 37,1 %

Generated from order data table *Erzeugt aus der Auftragsdatentabelle* **H. Kaluza**	Checked *Geprüft*	Ka; 2017-06-13

Moments and Critical Speeds	Moments and Speeds	Unit
Maximal short-circuit torque of stator in single-phase two-winding short-circuit	10101	kNm
Polar mass moment of inertia for generator rotor	10375.9	kgm²
Critical speeds of rotor (calculated)	nk1 = 843 nk2 = 2502	min-1

Flow of Cooling Air Volume	Volume	Unit
Flow of cooling air	78	m³/s

Parts	Weight	Unit
Rotor complete	66200	kg
Stator active part	205000	kg
Base frame	47500	kg
Bearings, intermediate frame	5000	kg
Cover (sound attenuation)	27000	kg
Brush gear, incl. ventilation	900	kg
Main terminal support	3700	kg
Cooling elements, cover	18300	kg
Accessories, anchoring	500	kg
Total weight	374100	kg
Max. shipment weight (withour packaging)	324600	kg

Brushes, Brush Holders and Limits of Wear		Exciting Current Transmission	Shaft Earthing for Generator Rotor
Slip rings	new size	Ø 422 mm	
	smallest size	Ø 400 mm	
Brush holders	drawing no.	06.08.0200.11	06.00.0468.00
	quantity	28	2
Carbon brush	drawing no.	4-123066	EMT 513-005
	quantity	28	4
	new size	64 mm	32 mm
	smallest size	30 mm	16 mm

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1 Introduction

The present specification deals with the requirements concerning the mineral oils which may be used.

The respective oils are mineral oils on a paraffin basis, containing additives to increase protection against corrosion and resistance to aging.

Oils of other viscosity may be used only subject to our consent.

2 Requirements

Oils of viscosity classes ISO VG 32, ISO VG 46 and ISO VG 68 are used in accordance with DIN ISO 3448.

The oil must not contain additives which result in negative effects on the materials of the oil system. Moreover, the additives must not contain any metal-organic compounds (e.g. organic zinc compounds).

The oil should be of such quality that bearing temperatures of max. 120°C and oil temperatures of max. 90°C will not cause negative changes of the oil properties.

The oil must be of such quality that the persons working with the oil will not suffer any injury to their health as long as the necessary hygienic measures are taken and observed.

3 Requirements for State as Supplied

Test Criteria			Value	Unit	DIN Test	ASTM Test
Air-separation ability	at 50 °C	max.	5	min	DIN ISO 9120	D3427
Neutralization number		max.	0.20	mgKOH/g	51558	D974
Water content		max.	0.1	weight-%	51777	D1744
Foam behavoir	at 25 °C					
Foam formation		max.	400	cm³	-	D892
Foam stability	0 cm³	max.	450	s		
Water-separation ability		max.	300	s	51589	-
Kinematic viscosity	at 40 °C					
a) ISO VG 32		min.	28.8	mm²/s (cSt)	53019	D445
		max.	35.2			
b) ISO VG 46		min.	41.4			
		max.	50.6			
c) ISO VG 68		min.	61.2			
		max.	74.8			
Density	at 15 °C	max.	0.900	g/cm³	51757	D1298
Flash point						
a) ISO VG 32		min.	160	°C	ISO 2592	D92
b) ISO VG 46		min.	185	°C		
c) ISO VG 68		min.	240	°C		
Pour point, equal to or lower than			-5	°C	ISO 3016	D97
Degree of purity according to ISO 4406		min.	17/15/12	Code	ISO 4406	-
De-emulsification capability		max.	20	min.	DIN ISO 6614	D1401
Colour		max.	2	-	ISO 2049	D1500
Corrosive effect on copper		max.	2-100A3	-	-	-
Corrosive effect on steel		max.	O-B	-	-	-
Aging behavior						
Increase of neutralization number after 2500 h		max.	2.0	mgKOH/g	51587	D943

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Turbogenerator | Operating and Maintenance Manual

Description 2

System Circuit Diagram (P&ID)

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P&ID Generator
R&I Generator

Content

Description Beschreibung	Sheet Blatt
Generator instrumentation	2

DRAFT

UNID:	PROJECT: Attarat Oil Shale Power Plant			QUALITY: INIT
PC: JO1008	OBJECT: 10MKA	DCC: MFB030	REGISTER NO.: 320201	PROJECT-REV.:

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REVIEWER:		
RELEASER:		

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[InvalidExp]-AUX0408T-A	TE-GUIDELINES GENERATOR
[InvalidExp]-AUX0405T-A	PIPE CONNECTION LIST GENERATOR
DPPPG-700xxxxx	GENERATOR OUTLINE DRAWING
A-004404-981131	P&ID Pressure Oil / Return Flow

Reference Documents / Dokumentenverweise

Remarks / Bemerkungen

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Description 2

Generator – General

1 General

The international standard **IEC 60034** is basis for the generator design. The insulation system is designed in heat resistance class F but used in class B.

The type of contruction is **IM 7215** (IEC 60034-7). The machine is placed on a base plate; the inductor runs in two pedestal bearings and has a coupling flange at the turbine end.

The cooling-air circulation is closed. The cooling elements are located by the sides of the core-and-coil assemblies.

The generator's degree of protection provided by the enclosure is **IP 55** (IEC 60034-5).

For sliprings and brushholder assembly in case of static excitation the degree of protection differs from that of the main generator. It is IP 23 because of the open ventilated cooling air circuit.

The machine's main component parts are described in detail in the corresponding sections of this manual.

2 Main Design Groups

The generator basically consists of the following main parts:

- Base frame
- Stator core
- Stator winding
- Cover
- Rotor shaft
- Rotor winding
- Rotor retaining rings
- Bearings
- Field connections
- Brush assembly
- Cooler

Turbogenerator operation requires the following additional equipment:

- Lubrication oil supply
- Excitation equipment / voltage regulator
- Protection and monitoring system
- Synchronization equipment

3 Cooling System

The heat losses arising in the generator interior are dissipated through air.

Direct cooling of the rotor essentially eliminates hot spots and differential temperatures between adjacent components which could result in mechanical stresses.

Indirect air cooling is used for the stator winding.

4 Air Cooling Circuit

The cooling air for the generator is drawn by axial-flow fans arranged on the shaft legs via lateral openings in the housing.

The cooling air flow is divided into three flow paths after each fan:

Flow path 1 is directed into the rotor end winding space for cooling the rotor winding.

One part of the cooling air flows past the individual coils for cooling the rotor end windings and then leaves the end winding space via bores in the rotor teeth at the ends of the rotor body.

The other portion of the cooling air is directed from the rotor end winding space into the slot-bottom ducts where it is discharged into the air gap via a large number of radial ventilating slots in the coils and bores in the rotor wedges. Along these paths the heat of the rotor winding is directly transfered to the cooling air.

Flow path 2 is directed over the stator end windings to cold air ducts and into the cold air compartments in the stator frame space between the generator housing and the stator core. The air then flows into the air gap through slots in the core where it absorbs the heat from the stator core and stator winding.

Flow path 3 is directed into the air gap via the rotor retaining rings. The air then flows past the clamping fingers and via ventilating slots in the stator core into the hot air compartments in the stator frame. This flow path mainly coils the rotor retaining rings, the ends of the rotor body and the ends of the stator core.

Flows 2 and 3 mix in the air gap with flow 1 leaving the rotor. The cooling air then flows radially outward through ventilating slots in the core within the range of the hot air compartments for cooling further portions of the stator core and stator winding. The hot air is discharged to the cooling elements or to the air filter unit via exhaust ducts.

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Operation 3

Running Routine

Strict observance of the operating and setting values is a prerequisite for reliable operation of the turbogenerator.

NOTE:

These values are documented in the Dimensional Drawing Text of the generator.

The dimensional drawing text provides an overview of sensors installed in the generator and of the operation, alarm and protection values if applicable.

All operating and setting values refer to rated output of generator and maximum cooling air (DAC) respectively cooling water (TEWAC) temperatures under steady-state conditions.

The operating and setting values initially specified in this manual are based on experience under due consideration of the specific site conditions, such as static head in case of pressure measuring points or thermal characteristics in case of temperature measuring points. These calculated values are intended as guiding values for making the preliminary settings during initial commissioning of the unit.

These settings require certain corrections to account for the actual conditions. The final settings obtained after startup and initial load operation are to be entered in the ***Operation Value*** column, and the corrected table should be promptly submitted to Siemens for revision.

Revised pages will then be sent to the holder of the instruction manual as updates the request to discard all pages that have been replaced by those of a later date.

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1 Operating Log

During initial startup and during normal operation, the turbogenerator, auxiliaries and all instruments and controls should be monitored to assure continuous reliable operation.

The observations and readings should be recorded. A typical operating log is contained in these operating instructions. This table will, of course, have to be adapted to the particular conditions of the plant. The important requirement is that all checks and readings be made at certain predetermined intervals and preferably at the same load point.

Any special conditions regarding the operation of the turbogenerator should be noted separately. Such notes may be useful in determining the cause of any subsequent trouble and speeding up corrections.

2 Normal and Special Operating Conditions

The generator should be continuously monitored from startup to shutdown.

During initial startup, all checks should be made at frequent intervals. Hourly readings may be taken after completion of the initial trial period.

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Project: M.-No.: Notes:

Operation values		Tag Number	Unit	Date / Measurement			
Active power			MW				
Reactive power			Mvar				
Stator current			kA				
Stator voltage			kV				
Field current			A				
Field voltage			V				
Speed			s^{-1}				
Stator slot temperature	Slot		°C				
			°C				
			°C				
			°C				
			°C				
			°C				
			°C				
			°C				
Cold-air temperature	TE		°C				
	EE		°C				
Warm-air temperature			°C				
Bearing temperature	TE		°C				
	EE		°C				
Shaft vibration	TE		µm				
S_{max} (VDI2059) *	TE		µm				
S_{PP} (ISO7919) *	EE		µm				
	EE		µm				
Bearing oil temperature	Inlet TE		°C				
	Inlet EE		°C				
	Outlet TE		°C				
	Outlet EE		°C				
Bearing oil pressure	TE		bar				
	EE		bar				
Total oil flow	TE		l/min				
	EE		l/min				
Cooling water volume flow			m^3/h				
Cooling water temperature	Inlet		°C				
	Outlet		°C				
Leakage water monitoring	TE						
	EE						

* Cancel whichever is not applicable

Data should be recorded during steady-state conditions after constant operation for several hours.

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Turbogenerator | Operating and Maintenance Manual

Operation 3

Start-up

1 General

The generator should be operated on the turning gear and run up in accordance with the turbine startup diagrams.

2 Turning Gear Operation

Prior to running the generator on turning gear, the shaft lift oil pump (if existing) and the bearing oil system must be placed into operation.

The oil flow to the bearings should be checked prior to turning gear operation to ensure an adequate flow. In addition, drains should be inspected for proper operation.

3 Run-up

During runup to rated speed, the bearing oil inlet temperature should be in accordance with the turbine manual.

During run-up the critical speed ranges should be passed through quickly and at an uniform rate.

Smooth running depends on several factors. Even minor temperature differences of 1 to 2 K between opposite sides of the rotor may result in rotor distortion which could lead to inadmissible vibrations due to unbalance.

During run-up the bearing and oil temperatures should be read and logged at short intervals.

To prevent these thermal unbalances during runup the turbine-generator should be run on turning gear. If the generator is run up following prolonged turning gear operation, no restriction regarding the rate of runup need be observed other than those required for the turbine.

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	Actual condition
1 Command: Start up generato	$\vartheta_{cold\ air} \geq$ -20 °C trip limit “cooling air temperature HH” may be deactivated [2]
Bearing oil supply system	in operation
Jacking oil supply	in operation [1]
Cooling system	in operation
Bearing oil inlet temperature/pressure	see Dimensional Drawing Text
Anticondensation heating system / dryer	in operation
Measuring devices and supervisory equipment	in operation
Automatic voltage regulator	ready for operation
Generator protection	no error
2 Command: Run up generator	
Anticondensation heating system / dryer	out of operation for n > 50 rpm
Speed	n ≈ 90% rated speed
Jacking oil supply	out of operation [1]
Vibrations	within the limits, see Dimensional Drawing Text
Bearing metal temperatures	within the limits, see Dimensional Drawing Text
Field circuit breaker	closed
Set point for rated voltage	set
Speed	n = rated speed
3 Synchronizing, parallelling and loading	$\vartheta_{cold\ air} \geq$ 0 °C trip limit “cooling air temperature HH” must be activated [2]
Synchronizing	
Parallelling	
Loading	to required load, however, only within the region of the capability curve

[1] The specific switching-on speed is shown in the *Dimensional Drawing Text* (chapter “Technical Data”).

[2] Relevant to gas turbines only!

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Example: Angular error +7° { Permissible speed deviation ± 0.54% max.
Permissible voltage difference ± 10,7% max.

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Operation 3

On-Load Running

1 Load Limits

The generator can be excited, synchronized and connected to the system after rated speed has been reached. To do this, the excitation system must be taken into operation. For details, see separate description.

After the generator has been connected to the system, the active power should be set by means of the turbine speed changer and the reactive power through the excitation system.

For the permissible loading, always refer to the capability curve. The following conditions are assumed to exist:

- Generator is operated at rated frequency
- Generator is operated at rated voltage
- Generator phase sequence corresponds to phase sequence of system

This diagram shows different limiting curves for operation which indicate the active and reactive power at a given power factor. The design point, representing the rated data of the generator, has been specially marked in this diagram. Any desired load setting is possible within the limits indicated as long as the load is not increased beyond the limit specified for the respective cold air temperature.

2 Rate of Loading

During operation, any desired load variation is permissible within the region of the capability curve. The permissible rate of loading depends on the condition of the winding insulation.

Generators provided with a *Micalastic*® stator winding insulation and a rotor winding of silver-alloyed copper with glass laminate insulation can be suddenly loaded and unloaded. The actual rate of loading should, however, be matched to the limits permissible for the turbine.

3 Unbalanced Load

The continuously permissible unbalanced load as specified must not be exceeded under any operating condition. Unbalanced load is defined as the ratio of negative sequence current to rated current, with the rated current not being exceeded in any of the three phases.

The rated current is the permissible stator operation current for the selected cold air temperature.

4 Load Restrictions

During service, operating conditions may arise at the generator which require the generator to be operated at reduced load in order to avoid damage to the unit.

5 Deviation of Voltage and Frequency

Loading of the generator with deviations from the rated generator voltage and/or frequency is only permissible up to the limits shown in attached diagram.

NOTE:

The operating temperatures can rise if the machine operating point deviates from the rated voltage and frequency values. The class B temperature limits can then be exceeded (the machine is used according to class F). This reduces the machine's service life.

The duration, extent and frequency of deviations from the rated values should therefore be restricted during operation of the machine.

6 Operation at low temperature

(Open Air Cooled machines only)

Open Air Cooled machines are also operated at ambient temperatures below 0°C. A generator cold air temperature below 0°C is not allowed. Therefore, an air-recirculation system is integrated in OAC-machines. The temperature control must generate a disturbance signal, when the generator cold air is below 0°C for more than 5 minutes.

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Operation 3

Shutdown

1 General Information

If a hydraulic shaft lifting device is available, it must be brought into operation at the latest when the generator runs down to the speed stated in the Dimensional Drawing Text.

2 Turning Gear Operation

In order to avoid difficulties caused by thermal asymmetries during the next start up and consequent warping of the rotor, when the generator is run down, the turning gear must be brought into operation at the speed (turning speed) stated in the Turbine Manual (this usually happens automatically) and it must remain in operation without interruption until the rotor has cooled to a temperature near room temperature.

3 Generator Drying

It must be ensured that the anti-condensation heaters and/or air-driers come into operation after the excitation has been switched off.

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Command: Unload generator	Actual condition
Generator load	$S < 0{,}05\ S_N$
Generator main circuit breaker	tripped
Speed	n ≈ 90% rated speed
Jacking oil supply	in operation[1)]
Excitation field circuit breaker	open
Turning Operation	see turbine manual
Anticondensation heating system / Dryer	in operation for n < 50 rpm
Speed	$n = 0\ s^{-1}$, at room temperature
Cooling system	out of operation trip limit “cooling air temperature HH” may be deactivated [2)]
Bearing oil supply system /Jacking oil supply	out of operation
Shutdown procedures	completed

[1)] The specific switching-on speed is shown in the *Dimensional Drawing Text* (chapter “Technical Data”).

[2)] Relevant to gas turbines only!

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Operation 3

Standstill

During a standstill, the space heaters installed in the stator end shields should be switched on and maintained in this condition until the generator is started up again. The space heaters prevent the formation of moisture condensate in the generator interior (alternatively the generator is equipped with an air dryer).

Even after having been taken out of service, a generator cannot be left fully unattended.

During a shutdown not exceeding 10 days:

The unit should be checked once a day.

During a shutdown for a longer period up to six months:

The gaps between the rotor shaft journals and the stator end shields should be sealed with cotton cord and acid-free Vaseline applied to the rotor shaft journals.

When recommissioning the generator, be sure to carefully wipe off the Vaseline from the shaft journals to prevent it from coming into contact with the turbine oil.

During a shutdown for a period exceeding two months:

Preservation measures will have to be taken. The scope of the preservation work required depends on the duration of the shutdown, on the overall conditions in the vicinity of the unit and on the extent to which checks and inspections are possible during such periods.

It will be necessary to request the services of specially trained Siemens personnel for the execution of such preservation measures. If it is intended to shut down the generator for a longer period, the competent Siemens Office should be informed, when requesting the services of the erection personnel, how long the unit is to be shut down, on the conditions prevailing in the vicinity of the unit during the outage and whether customer's personnel will be available for any required checks. The necessary preparations for the preservation will then be made in all details by the competent Siemens Office.

The services of Siemens erection personnel should again be requested if a preserved unit is to be recommissioned. The preservation measures will then be abolished by the Siemens personnel. For recommissioning, the same procedure should be followed as during initial startup.

In case of rust formation on the stator and/or rotor the rust shall be removed as far as possible by only using a sponge (e.g. Scotch-Brite™) and Rivolta SLX or ethanol as solvent. Do not use any other solvent!

NOTE:

Rust which cannot be removed can stay on the particular generator component; generator function will not be restricted due to it.

Use space heaters or air dryers during future standstills to avoid further rust formation.

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Example: Relative humidity of ambient air = 50% and room temperature = +20°C result in a dew-point temperature (DT) of +9°C, corresponding to an absolute humidity of 8.6 g/m^3.

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Phase	Keyword		Precautionary Measures and Checks
Transport	**Packing:**	**1**	Dry rotor retaining rings by blowing dry air into rotor end windings from portable air dryers (e.g. Munters dryer) shortly before packing. Multiple dry packing in sheetings with desiccant added.
	Accompanying documents:	**2**	Reference to special packing and request for restoration after opening due to customs or in-transit damage.
	Damage to packing:	**3**	Restore proper condition of dry packing immediately. For details, see description accompanying the cargo.
	Receiving:	**4**	Check effectiveness of dry packing and desiccant. Record condition in checklist. Request for repeat checks according to checklist during subsequent storage.
Storage	**Condition:**	**5**	Maintain dry packing until immediately before assembly.
	Check:	**6**	Monthly functional check of dry packing and desiccant according checklist.
	Storage area:	**7**	Indoor storage in dry building; outdoor storage in seaworthy packing, under shelter, protected against precipitation/ground moisture.
Installa-tion	**Outdoor installation:**	**8**	Transport to jobsite in dry packing. Acclimatization in dry packing to avoid condensation after unpacking.
		9	Installation under shelter. Removal of dry packing from retaining rings (1st layer) as late as possible.
	Open gene-rator, rotor installed:	**10**	With danger of condensation (outdoor installations and open power house), blow dry air from portable air dryers into rotor end windings and slipring assembly.
Ready for operation (standstill or turning gear operation)	**Generator closed:**	**11**	**Air cooled generators:** Gear operation: Pass small cooling water flow through the air cooler to ensure that the cooler is the coldest component in the generator (condensation hazard!). Standstill: Continuous operation with installed space heater or air dryer.
Scheduled mainten. without rotor removal	**Outdoor installation:**	**12**	**Generator closed:** Measures as under ***Ready for operation***.
		13	**Generator open:** Shelters must prevent precipitation from entering the generator; the retaining rings areas must be covered and kept dry by supplying dry air.
Scheduled mainten. with rotor removal	**Indoor installation:**	**14**	If rotor is set down in dry power house with even temperature, it is sufficient if the entire rotor is covered against dirt and wetness. If danger of condensation, the rotor area between the bearing journals must be provided with dry packing.
	Outdoor installation:	**15**	Set down rotor under shelter and provide rotor areas between bearing journals with dry packing.

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Preservation measures will have to be taken when a generator is to be shut down for a period exceeding two months.

The scope of the preservation work required depends on the duration of the shutdown, on the overall conditions in the vicinity of the unit and on the extent to which checks and maintenance are possible during such period.

The preservation measures recommended in the following are sufficient under normal conditions. High relative humidity in combination with severe temperature changes involves the risk that the temperature of certain surfaces in the generator may drop below the dew point, resulting in the possible formation of a moisture film due to condensation on these generator components.

1 Generator Interior

The air dryer should be switched on to protect the stator and rotor windings against moisture by maintaining the generator interior in a dry condition.

Prior to recommissioning the generator, the insulation resistances of the stator and rotor windings should be measured and the windings dried, if required.

2 Bearings

No preservation measures are required on the bearings of the turbogenerator.

However, the bearing oil system should be placed into operation once a week and the entire system adequately flushed with water-free oil. After activation of the oil system, the rotor should be operated on the turning gear for approximately three to four hours.

3 Coolers

All coolers should be drained on their cooling water sides and dried in a suitable manner. During the shutdown, the drains and vents should be kept open.

NOTICE

Never leave water-filled coolers standing idle for several weeks.

For cooler drying, hot air or dry ambient air may be used which should be admitted by means of blowers via the cooling water inlet/outlet flanges. A fan-forced heater with a rating of 1 to 2 kW has proved satisfactory for this purpose.

4 Slipring Assembly

The slip-ring assembly should be protected against moisture by maintaining the space below the enclosure at a moderate temperature by suitable means. This may be achieved with a hot air blower installed inside the enclosure.

The carbon brushes should be removed and the slip-rings covered with oiled paper.

5 Bright Components

All accessible bright components, e.g. exposed shaft portions, should be protected with a suitable corrosion inhibiting oil or grease, e.g. ***Tectyl***.

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During manufacture and transport the insulation of the stator winding may have been exposed to moisture which would reduce the insulation resistance of the windings. The insulation resistance should therefore be measured prior to initial startup, after prolonged shutdowns and after work on the windings. If required, the generator should be dried until a sufficient insulation resistance is obtained.

1 Required Insulation Resistance of Stator Winding

Fig. 1: Diagram for correction of insulation resistance measured to a temperature of 40 °C

The insulation resistance measured is dependent on the temperature. To permit a proper assessment, a correction to an agreed reference temperature (formerly 75 °C,167 °F) must be made.

An insulation resistance of 1 megohm per each kilovolt of rated voltage at 75 °C (167 °F) is normally attainable without any difficulties.

New international standards specify an insulation resistance of not less than 1 megohm per each kilovolt of rated generator voltage at 40 °C (104 °F).

A correction of the insulation resistance measured at the winding temperature prevailing during the measurement to the above reference temperature can be made using the diagram in fig. 1.

If the insulation resistance measured is lower than the specified minimum value, the neutral connections must be separated and the insulation resistances of the individual winding phases measured. During the test, the other two phases which are not involved should be grounded. If the insulation resistances of the individual phases are likewise lower than the required limit value, drying of the windings will be indispensable. Great differences in the insulation resistance values are indicative of local contaminations, e.g. insulators in bus duct or terminal-bushings. If practicable, additional connections should be separated.

If this measure does not result in an improvement, it is recommended to obtain the services of a specialist from the manufacturer's works.

2 Measurement of Insulation Resistance

Prior to each measurement, the generator must be de-excited and any static charges removed by grounding the windings. The windings should also be grounded after each measurement for the duration of the recharging period.

The insulation resistance of the stator is measured between the winding copper and the stator core.

The measurement should be made with a megger giving a scale reading of not less than 1000 megohm. The megger voltage should be not less than 1000 V, but may amount to up to 5000 V. The insulation resistance should be reached after one minute.

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1 General

Any reduction of the insulation resistance during transport, erection or a prolonged shutdown is mostly caused by the formation of a moisture film on the surface of the insulation. To prevent any damage to the insulation, the insulation resistance of the stator and rotor windings should be checked prior to running the unit at rated voltage. In the event of an insufficient insulation resistance being detected, a drying procedure is to be performed until a sufficient insulation resistance has been obtained.

2 Dry-Out Using a Space Heater

If the space heater is in operation, the temperature in the generator interior is maintained at a value slightly above ambient temperature. This prevents the formation of a moisture film on the surface of the stator and rotor windings, in case the temperature falls short of the dew point.

3 Dry-Out by Direct Current

If the generator dry-out cannot be performed by means of the space heaters, the following procedure should be employed:

For the direct-current dry-out, suitable d.c. sources, such as welding converters, should be available. When it is intended to employ several welding converters for drying, care should be taken that the converters have approximately the same characteristics. A direct-current dry-out of the stator can be performed already before the rotor is inserted. However, if the rotor is in the frame, it should be turned during the drying procedure. It will have to be ensured for interconnection of the three phases that the magnetic fields set up in the stator winding balance each other. When no suitable measures are taken in this respect, the turning gear may be destroyed owing to the large forces effective between stator and rotor. The connection of the stator winding for balancing the magnetic fields is shown in the illustrations.

Sources supplying a current amounting to about 1/4 to 1/3 of the rated generator current suffice for drying the stator winding with direct current. The voltage required is very low and may be approximately 5 to 15 V. A winding temperature of 75 °C (167 °F) should not be exceeded. As in normal operation, the winding temperature is measured through the resistance temperature detectors embedded in the slots. A sufficient exchange of the air within the generator housing should be ensured during the drying period. This can be effected by opening all connections and inspection holes. It is advisable to accelerate the exchange of the generator air by means of blowers or with clean compressed-air. The steady-state winding temperature of 75 °C (167 °F) should be reached not earlier than after six hours. The stator should thus be heated slowly by gradually raising the d.c. current and continuous supervision of the slot temperatures.

Fig. 1: Stator winding connections for dry-out by direct current

Also refer to the following information:

[1] 4.5-2300 Insulation Resistance Measurements on Stator Winding

[2] 4.5-3300 or 3301 Insulation Resistance Measurements on Rotor (and Exciter) Winding(s)

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1 The Insulation System of the Stator Winding

The insulation system serves to insulate the generator stator bars, which are subjected to a high-voltage potential of up to 30 kV, from each other and from the grounded stator iron parts for reliable protection against the additional thermal and mechanical stresses arising during operation.

The *Micalastic*® insulation consists of mica tapes applied continuously from end to end on the bars, including the end winding portions. Vacuum impregnation with epoxy resin provides an insulation system which is resistant to mechanical, thermal and electric stresses and also impervious to moisture. Drying the insulation prior to start-up of the generator will thus only be required to remove any moisture film on the surface.

2 Purpose and Kind of Electrical Tests

During the manufacturing process until delivery of the generator, a comprehensive quality verification program is performed by subjecting the insulation to electrical tests. Unless the insulated parts in the generator are stressed due to abnormal conditions during transport or during the installation and assembly at the power plant, no electrical testing would be required prior to placing a new generator into operation. For safety considerations, the insulation resistance should, however, be checked by means of a megger prior to each start-up.

It is a known fact that even the best insulation system is subject to aging during service, especially as a result of operational disturbances, such as voltage surges due to sudden short-circuits. etc.

During overhauls, the degradation of the insulation and any damage due to accidental disturbances should therefore be ascertained by a visual inspection and by means of suitable electrical tests to give assurance of trouble-free operation for further years.

There are several methods of electrical testing:

- Insulation resistance measurement (megger)
- Recharging and leakage current measurement for exact determination of insulation resistance
- Dissipation factor measurement
- Partial discharge measurements
- High-potential proof tests: AC voltage, DC voltage, 0.1-Hz voltage

3 Insulation Resistance Measurement

Insulation resistance measurement is one of the simplest tests to determine the integrity of the insulation. It is made with an instrument commonly known as megger and supplying a variable DC voltage between 100 V and 5000 V. The instrument is calibrated for direct reading of the insulation resistance in megohms. The DC voltage for measurement is generated by a hand-operated or motor-operated generator or by electronic means. This voltage should be applied for not less than one minute prior to reading the insulation resistance value to allow for the decay of the absorption current component with time due to a polarization of the dielectric in the electric field. This process, which follows an exponential function, is reflected at the instrument by a pointer deflection which is initially fast and then gradually slows down. The results of this reading indicate only the presence or absence of a winding short to ground and that the insulation resistance is at a level above the accepted minimum limit. This test is performed prior to each start-up of the unit and prior to each high-potential test on a winding.

4 Recharging and Leakage Current Measurement

To determine the true insulation resistance of an insulation, somewhat larger and more complicated equipment is required, permitting also a determination of the polarization index. For this test, a stabilized DC power source and a micro ammeter are required, enabling the current to be measured as a function of the test period under otherwise constant conditions and allowing the influence of temperature, moisture and dirt to be determined and considered.

The insulation of *Micalastic*®-insulated generators is not subject to moisture absorption. Recharging and leakage current behavior and the insulation resistance, respectively, may merely be affected by dirt or moisture on the surface of the end windings.

This test is just as easy to perform as the megger reading.

5 Dissipation Factor Measurement

The winding insulation system is primarily a capacitive setup, with the winding copper constituting one electrode and the grounded frame the other electrode. Such circuits are accessible for bridge methods of resistance measurement to determine the dielectric constant and the dielectric loss factor. Dielectric loss is defined as the ratio of active power to reactive power. In connection with insulation testing, the

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Fig. 1: Schering bridge

dielectric loss indicates the amount of electrical energy converted into heat in the insulation.

The dissipation factor and capacitance of a solid insulating material are not dependent on the test voltage applied as long as there is no change in the conduction mechanism. A change in the conduction mechanism of insulating materials occurs due to loss of bond between layers of insulation, with voids being formed in minute cracks. As the voltage is increased above a certain level (partial discharge start voltage) during the dissipation factor measurement, partial discharges will occur which increase with rising voltage and result in a dissipation factor tip-up.

Micalastic® insulation is impregnated with epoxy resin under vacuum to be essentially void-free. In new condition, this insulation thus exhibits a dissipation factor tip-up of less than 0.001 for each measuring interval of 20% of rated voltage.

Prolonged exposure to thermal and mechanical stresses and last but not least the effect of partial discharges may result in new separations and thus in additional discharges. Measurement of the dissipation factor as a function of the test voltage can therefore provide information on the aging of an insulation by a relatively simple method.

Measuring the dissipation factor on individual winding components, such as bars, is mostly performed by means of a guarded electrode to eliminate the effect of leakage currents across the coil end. Such a guarded electrode system cannot be provided for complete windings which are mostly equipped with an end corona protection. This effect must therefore be taken into consideration when evaluating the variation of the dissipation factor with voltage.

The dielectric constant and the dissipation factor are measured with a **Schering bridge** (see fig. 1). At balance, zero current flows through the bridge branch. The capacitance of the winding is then:

$$C_x = \frac{R_4 \cdot C_N}{R_3}$$

and the dissipation factor:

$$\tan \delta = R_4 \cdot \omega \cdot C_4$$

To perform dissipation factor measurements on generator windings, disturbing error capacitances can be eliminated with a universal capacitance/dissipation factor bridge using ancillary equipment for the initial balancing adjustment. This scheme offers an effective method for measurements on windings in a directly grounded stator.

6 Partial Discharge Measurements

The dissipation factor measurement described in the preceding section covers the sum of the losses occurring in the insulation voids due to partial discharges. Since partial discharge is a radio-frequency phenomenon, this opens up the possibility of using radio-frequency methods for detection (see fig. 2).

Partial discharge measurements provide useful information for the detection of localized defects in winding components, such as the phase connector insulation system. This method is also used for quality assurance during manufacturing.

In the case of generator windings, the partial discharge method has so far been applied to detect high-energy discharges, as caused, for instance, by a break in the internal corona shielding system. The measurement is performed in a manner similar to the dissipation factor measurement by recording the maximum apparent discharge magnitude as a function of the voltage for each phase up to 120 % of rated voltage. To do this, a coupling capacitor C_K is connected in parallel to the phase capacitance C_X. The partial discharge is then detected in the ground connection of the coupling capacitor with a suitable partial discharge detector via a four terminal coupling network AKV.

As with the dissipation factor measurement, the test voltage is applied via a regulating transformer, a high-voltage transformer and a reactor to compensate for the winding and coupling capacitances.

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Fig. 2: Partial discharge measurement

Such a test setup is sensitive to external noise which cannot be avoided at the power station or in the test field. If no additional measures for rejection of the external noise are taken, background noise levels from 100 pC to more than 1000 pC are to be expected.

7 High-Potential Proof Tests

All tests described in the preceding sections are performed with relatively low voltages. Using suitable standards for comparison, they provide information on the contamination, surface moisture condition and also on the aging of the insulation. They are indicative of the dielectric strength of the insulation with a certain probability only.

A high-voltage test is an indispensable last criterion for determining with assurance whether or not the insulation on a winding is suitable for continued operation with sufficient reliability. The application of a high test voltage is especially recommended in all cases where it is to be expected that the insulation may have a suffered and localized damage as a result of extremely high mechanical stresses due to a sudden short-circuit or extremely high electric stresses due to transients. A high-potential proof test is also applied in the case of serious aging as identified by a dissipation factor measurement and if localized weak points in the insulation cannot be ruled out.

Any breakdown occurring during a proof test indicates that the winding is approaching the end of its serviceability. After removal of bars on which a breakdown has occurred, the areas of the insulation most severely affected by degradation can be assessed, permitting scheduling of a suitable date for rewinding. If no breakdown occurs during the proof test or following the removal of already failed bars, this means that after completion of the test even the weakest area of the insulation still has a certain *life expectancy* which will be longer at the field intensity arising during normal operation than at the test stress level. This enhances the probability of troublefree operation at least for a certain service period following the test and avoids the risk of a breakdown occurring during operation together with the consequential damage resulting from the high currents arising.

7.1 AC Voltage Test

This test is normally performed with a power-frequency AC voltage of 1.5 times rated voltage. The use of a 50-Hz or 60-Hz AC voltage offers the advantage that the field distribution will be the same as during normal operation, especially at the transition between the straight slot section and the end winding, resulting in a proportional stressing of the winding components. As generator sizes increase, the capacitance of the winding to ground increases accordingly and thus also the transformer rating required for the test. To test one phase of a large turbogenerator, a test set of 400 kVA or more will fairly often be required. For this reason, resonance test circuits are frequently used, permitting a compensation of the high leading reactive power. An exact control of the preset test voltage is accomplished through a high-voltage instrument transformer.

7.2 DC Voltage Test

When utilizing a high DC voltage for proof testing, the field distribution will differ from that described in the preceding section especially at the end windings. As a result of this, DC testing subjects the end turn insulation to considerably higher stresses than AC testing. This drawback arises especially on so-called *discontinuous* insulation systems where different insulations are used for the end windings and the straight slot portions, resulting in a joint at the transition from the slot to the end winding. The continuous *Micalastic*® insulation does not involve this drawback.

The equipment involved in performing a DC high-potential test is considerably smaller and easier to transport than the AC test equipment. If DC testing is used for this reason, it is necessary to use a multiplication factor to obtain nearly equivalent searching ability as an AC test. It is recommended that 1.7 times the AC RMS test voltage be used.

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7.3 0,1-Hz Voltage Test

An AC high-potential test requires a large and heavy testing transformer which is capable of providing also the reactive power of the winding capacitance, whereas for DC over-voltage testing smaller and lighter test equipment is mostly sufficient. To make use of the lower weight, while retaining the advantage of a field distribution corresponding to that obtained with a power-frequency test equipment, tests are also performed at a reduced frequency of 0.1 Hz. Tests conducted at Swedish and American laboratories have shown that the 0.1-Hz test voltage to be applied must be higher than the 50-Hz or 60-Hz test voltage to obtain equivalent test conditions as an AC test. For such tests, a multiplication factor of 1.25 has been specified.

Laboratory tests on new and aged insulation systems have rendered greatly differing values of the multiplication factor to be used both for DC testing and 0.1-Hz testing to obtain equivalent results as a test at power-frequency alternating voltage. These multiplication factors are mostly considerably higher for new insulation systems than for aged insulations.

From this, it may be concluded that the stress mechanism during both DC testing and 0.1-Hz testing differs from that obtained by the use of an alternating voltage. Accordingly, the multiplication factor should be selected under due consideration of the aging of the winding insulation. However, since the high-potential test serves to establish the life of the insulation, it appears more appropriate to use a power-frequency alternating voltage for the high-potential test if it is practicable to obtain and transport the heavy test equipment.

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During manufacture and transport, the insulation of the rotor winding may have been exposed to moisture which would reduce the insulation resistance of the winding. The insulation resistance should therefore be measured prior to initial startup, after prolonged shutdowns and after work on the winding. If required, the generator should be dried until a sufficient insulation resistance is obtained.

1 Required Insulation Resistance of Rotor Winding

The insulation resistance should amount to ≥1 megohm at 40 °C (104 °F).

At winding temperatures other than 40 °C, a correction can be made using the curve shown in fig. 1.

Fig. 1: Correction curve for insulation resistance measured (R_{meas}) to a temperature of 40 °C

2 Measurement of Insulation Resistance

Prior to each measurement, the generator must be deexcited and any static charges removed by grounding the winding.

The insulation resistance should be measured between one slip-ring and the generator shaft, using a megger with a maximum voltage of 250 V. This voltage will present no danger to any of the devices in the excitation circuit. The insulation resistance of the entire excitation circuit should be measured with the brushes applied. If an insufficient insulation resistance value is obtained, all slip-ring carbon brushes should be lifted off and separate measurements conducted on the rotor winding and excitation circuit. The duration of the test should be approximately two minutes.

The measuring brush for ground monitoring should not be in contact with the slip-ring when measuring.

Messaufbau
Measuring Setup

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Maintenance 4

Maintenance – General

The turbogenerator and their auxiliaries require continuous maintenance and supervision to assure reliable operation and serviceability of the complete plant.

Some maintenance work can be performed during operation, but some activities can only be carried out when the machine is at a standstill.

The maintenance work required on the generator described herein is specified in the following section.

Follow the safety instructions for maintenance in the General information chapter, and the safety instructions in the supplier documentation.

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Work required	Maintenance intervals					
	Daily	Weekly	Monthly	Every 3 months	Every 6 months	Annually
Grounding Brushes						
Check the shaft grounding carbon brushes		x[1]				
Bearings						
Supervision of function of lubrication devices	x					
Supervision of bearing temperature	x					
Check EE generator bearing insulation					x	
Removing of oil mist condensate		x				
Cooler						
Check leakage air filter in the cooler cover for contamination, clean or replace the filter mats if necessary					x[2]	
Static Excitation System						
Check carbon brushes		x				
Clean brush holder compartment			x			
Check surface of slip-ring					x[3]	
Check free movement of the brushes in the holder			x			

[1] The maintenance interval starts with weekly inspections; this interval can later be adjusted according to the specific experience gained in the power plant.

[2] At the first shut down after commissioning, or after 6 months at the latest. The maintenance interval must be specified on the basis of the inspection after commissioning, according to the environmental conditions.

[3] Preferably at rotor standstill.

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Work required
Monitoring the stator winding temperature
Monitoring the cooling air temperatures
Monitoring the vibration level
Monitoring the rotor temperature
Monitoring the bearing temperature
Monitoring of the lubrication oil temperature, flow rate and pressure
Monitoring the exciter values
Monitoring the leak water level*

* if existing

1 Main operating characteristics

The monitoring of the generator is described in the Protection and Monitoring chapter.

Reference is made to the most important operating characteristics once again in the following. These must remain within defined limit values in order to ensure trouble-free plant operation. The characteristics must be recorded in the operating log. Long term trends have to be identified so that corrective measures can be taken during planned shutdowns, before the generator protection has to intervene in operation, and the risk of unplanned shutdowns arises.

2 Stator winding temperature

The temperature monitoring in and around the turbogenerator must ensure that the temperatures remain within their limit values. Attention must be paid to every unusual temperature change. The rated operating values must be restored as quickly as possible.

If there exists the danger of overheating, a corresponding load reduction should be made.

The temperatures between the top and bottom bars of the stator windings are measured with resistance temperatur detectors (RTD‘s).

The RTD‘s are distributed uniformly over the three phases. The RTD‘s should indicate approximately identical values for indentical currents in all three phases. If different temperatures are indicated with identical currents in the three phases, a check should be performed to determine if the slot RTD‘s are correctly calibrated and/or compensated.

Differences in the temperature indication up to 5 K may be due to tolerances in the RTD‘s, the compensating resistors and tolerances caused by differences in the contact at the measuring point selector switch. Other small temperature differences may be due to different mounting conditions at the RTD‘s.

3 Cooling-Air Temperatures

The temperatures of the cooling air in the machine are monitored at the drive and non-drive end cooling air inlets and in the hot air outlet of the generator.

The temperature transmitters installed in the cooling air inlet ducts indicate the temperature of the air used to cool the generator.

The temperature transmitters installed in the hot air outlet duct indicate the temperature of the heated air leaving the generator after cooling generator components.

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4 Smooth running of the rotor

The smooth running of the generator rotor must be monitored. Attention must be paid to any changes, and their causes must be found. In most cases, the turbogenerator must be shut down if there is a major change in the smooth running in order to be able to carry out the necessary investigations.

NOTICE

Before starting to align or dismount the rotor, all brushes contacting the rotor must be removed from their holders. Do not replace the brushes until all work has been completed.

5 Rotor temperature

The increase in temperature of the rotor must be monitored. The increase in temperature of rotors with a slip ring must be determined up to the upper load range according to the following formula and diagram.

The measurements must be made with the highest precision by specialists during the commissioning (initial measurement), and repeated after certain periods of operation, but as a minimum before each inspection. Whether the rotor needs to be dismounted and the cooling ducts checked during the next inspection depends on the impairment of the cooling found.

Contamination of the cooling ducts in the rotor of open-circuit, air-cooled generators cannot be ruled out, despite the in-built filters. The air filters must be maintained very thoroughly at regular intervals. The rotor temperature rises more strongly if the cooling ducts become contaminated.

$$\Delta T = \frac{U_f}{I_f} \cdot \frac{255}{R_{20}} - (235 + T)$$

ΔT	=	Rotor temperature rise
U_f	=	Field voltage
I_f	=	Field current
T	=	Cold air temperature in the generator
R_{20}	=	Rotor resistance
255; 235	=	Constant

Normal temperature rise; output measurement when commissioning
Increased temperature rise due to modified ventilation

Fig. 1: Rotor temperature rise

6 Bearing temperature

NOTICE

Danger due to bearing failure from excessively high temperature.

The causes of an increased bearing temperature must be determined and evaluated, see also document 4.3-9450.

The temperatures of the generator bearings are measured by thermosensors and displayed in the control room. The temperature measurement and registration, if necessary, takes place in conjunction with the turbine monitoring.

7 Lubrication oil temperature, flow rate and pressure

The temperature of the lubrication oil is determined by the setting of the volume of cooling water and the temperature of the cooling air for the bearing oil cooler. The temperature of the lubrication oil for all the bearings in the turboset is set on the cooler. The temperature measurement and registration, if necessary, takes place in conjunction with the turbine monitoring.

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Both the flow volume of the lubrication oil and the lubrication oil pressure must be checked at regular intervals. The setpoint values are stated in the text of the generator dimensional drawing. The bearings only function according to specifications if both values roughly correspond to the values in the text of the dimensional drawing.

8 Excitation system

The exciter values required for the particular load must be checked continually, and entered in the operating logs. All unusual events must also be entered in the operating logs as comments.

9 Leak water level

In some places, level indicators are installed to monitor the amount of liquid in the generator.

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Turbogenerator | Operating and Maintenance Manual

Fault Alarms

5

The details given herein on faults, their possible causes and the corrective measures cannot be considered complete in every respect, since all possible troubles cannot be covered in advance.

In most cases, the operator will have to decide on the measures to be taken. The individual measures required depend on the mode of operation.

Unless corrective measures can be taken in accordance with the following instructions, the turbogenerator should be shut down.

If required, the services of the manufacturer should be requested. In most cases, however, sufficient details will be found in the turbogenerator manual.

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Fault **Possible Causes**	**Remedy**
Differences in slot temperatures between top bar and bottom bar of stator winding	
• Malfunction of measuring equipment (esp. slot thermometers)	The embedded RTD`s should be checked when different slot temperatures are indicated while stator currents are of equal magnitude in the three phases. Such check should only be made with the generator at rest and in non-excited condition. The check should include resistance measurements as well as testing of the detector leads, the measuring point selector switches and the indicators. Care should be taken during resistance measurements of the embedded RTD`s to ensure that they are not heated as this will falsify the results. In many cases, a fault can be cleared by recalibration of the RTD`s.
High warm air temperature and/or High cold air temperature	
• A high-temperature rise can be caused by overload.	The load has to be reduced immediately to the permissible value.
• Insufficient cooler capacity	The cooling water system has to be checked. Furthermore, a cooler cleaning during a generator standstill can remedy things.
• Insufficient cooling-water volumetric flow or higher cooling-water temperature	A rise of the cooling-water temperature will require a higher cooling-water volumetric flow for removal of the loss heat. The cooling water volumetric flow should be increased. In addition, the cooler should be vented via the vent valves. If the cold-air temperature downstream of the cooler cannot be reduced to the permissible operating value, the generator load should be reduced.
• Loss of cooling-water flow	Restore cooling-water flow immediately. If this should not be possible, the generator should be unloaded and shut down.
Unbalanced load	
• Unequal phase loading of the system connected to generator	If the generator is operated with unbalanced load due to particular system conditions, care must be taken that the continuously permissible unbalanced load is not exceeded. The unbalanced load is defined as the ratio of negative sequence current to rated current. The permissible rated stator current should not be exceeded in any stator phase. When the unbalanced load is higher than the continuously permissible unbalanced load, steps should be taken for bringing about a uniform system load. The generator should be shut down if it is impossible to distribute the system load more uniformly over the three phases.
Power supplied fluctuates	
• Excitation system incorrectly adjusted	The excitation system adjustments have to be checked and re-adjusted.
Generator remains dead	
• Open circuit in field circuit	All switchgears and supply circuits have to be checked for breaks.
• Speed too low	The prime mover speed has to be increased accordingly.
• Excitation system defective	The function of the excitation system has to be checked.

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Fault **Possible Causes**	**Remedy**
Rated voltage not obtained when generator loaded	
• Overload	The loading has to be reduced immediately to the permissible value.
• Interturn short-circuit in field winding	A high temperature rise and even discoloured varnish can indicate an Interturn short-circuits. It is advisable to put the SIEMENS service personal in charge of removing it.
Generator draws inductive reactive power	
• Open circuit in field circuit	All switchgears and supply circuits have to be checked for breaks.
• Excitation system defective	The function of the excitation system has to be checked.
• Interturn short-circuit in field winding	A high temperature rise and even discoloured varnish can indicate interturns short-circuit. It is advisable to put the SIEMENS service personal in charge of removing it.
Unequal stator currents	
• Unbalanced load • Poor contact conditions • Interturn short-circuit in stator winding	Check whether unequal stator currents are due to unbalanced load. If it has been established that the unequal stator currents are not caused by unbalanced load, the unit must be shut down. After the unit has been shut down, first check the terminal bushings at the bus bars resp. cables for proper connection and reliable contact making. If no defect is detected and if the unequal currents are not due to poor condition of the contacts in the bus duct, the brazed soldered connections of the stator winding should be examined. It is also advisable to check the stator winding for Interturn short-circuits. In case of an interturn short-circuit the SIEMENS service personal should be put in charge of removing it.
Unequal phase voltages	
• One supply phase disconnected	All switchgears and supply circuits have to be checked for breaks.
• Stator winding incorrectly connected	In case of an incorrectly connected stator winding, the connection has to be corrected.
• Interturn or phase short-circuit in stator winding	A high temperature rise and even discoloured varnish can indicate an interturn or phase short-circuits. It is advisable to put the SIEMENS service personal in charge of removing it.

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Fault **Possible Causes**	**Remedy**
Sudden deterioration of rotor running condition	
• Interturn short-circuit in field winding • Rotor unbalanced • Rotor out of true. Shaft distorted; unequal air gap over poles • Misalignment • Unbalance/shocks from prime mover (turbine) • Uneven running caused by gearing • Resonance with foundation • Changes in foundation	Check whether the deteriorated running condition originated due to the turbine or whether the rotor bearings are damaged. A deterioration of the running condition may be caused by a change in the balancing condition or by a rotor winding short-circuit. Unload and shut down turbine generator as soon as feasible if cause cannot be located and corrected for severe condition. Since it is very difficult in most cases to find a definite cause, it is advisable to obtain the help of the SIEMENS service personal.

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Fault **Possible Causes**	**Remedy**
Temperatures of generator bearings too high	
Temperature variations at the generator bearings may be due to different causes. The turbogenerator can be kept in operation as long as the permissible bearing temperature is not exceeded. When a variation is noted, the operating temperatures should be carefully monitored to ensure the limit temperature is not exceeded. If the bearing temperature exceeds the permissible value, the turbogenerator should be shut down.	
• Cold oil temperature too high • Bearing oil pressure too low	If a deviation occurs, first the cold oil temperature (oil temperature after cooler) and the bearing oil pressure should be checked and corrected if necessary.
• Oil contaminated or aged	The bearing housing has to be cleaned. Possibly the oil has to be renewed.
• Low oil level	The oil level has to be checked. Oil has to be filled up if necessary.
• Oil viscosity too high	If the oil viscosity is too high, the oil has to be changed (thinner oil).
• Forced lubrication fails; oil or cooling water failure	The oil supply system has to be inspected.
• Residual oil pressure of bearings with oil jacking drops during operation with jacking oil pump inoperative	The jacking oil piping and the nonreturn valve have to be checked. It has to be checked, if the concerning bearing shell is skewed.
• Excessive axial thrust resp. radial load	The magnetic centre and the alignment have to be checked. In case of deviations, the bearings and/or the machine have to be realigned.
• Inadequate radial clearance	The concerning bearing shell has to be adapted by scraping or remachining (only carried out by experienced fitters)
• Damage to bearing lining. Defective bond between lining and supporting block of bearing shell	Change of the bearing.
• Oil pockets too small; transitation to bearing surface not smooth enough	The oil pockets have to be refinished accordingly (only carried out by experienced fitters).
• Bearing currents	The bearing insulation has to be checked and - if necessary - cleaned or replaced to remove possible creepage paths.
Jacking oil pressure drops	
• Bearing oil inlet temperature has changed • Leakage in the shaft lift oil system • Nonreturn valve leaky	Oil pressure depends in part on the bearing oil inlet temperature. Check first to determine whether the pressure drop was caused by an oil temperature variation. If not, the shaft lift oil system should be checked for leakages. The fault may be due to a leak at the nonreturn valve in the lift oil pipe. Replace or repair the nonreturn valve at the next shutdown or inspection.

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Fault **Possible Causes**	**Remedy**
Oil blackens prematurely or contains abraded matter	
• Low oil level	The oil level has to be checked. Oil has to be filled up if necessary.
• Oil viscosity too low	If the oil viscosity is too low, the oil has to be changed (thicker oil).
• Residual oil pressure of bearings with oil jacking drops during operation with jacking oil pump inoperative	The jacking oil piping and the nonreturn valve have to be checked. It has to be checked, if the concerning bearing shell is skewed.
• Excessive radial clearance	Change of the bearing.
• Damage to bearing lining. Defective bond between lining and supporting block of bearing shell	Change of the bearing.
• Bearing currents	The bearing insulation has to be checked and - if necessary - cleaned or replaced to remove possible creepage paths.
Bearing loses oil; oil drawn into machine	
• Oil viscosity too low	If the oil viscosity is too low, the oil has to be changed (thicker oil).
• Oil viscosity too high due to low oil temperature (esp. during start-up)	Bearing or oil have to be heated during or prior to start-up.
• Oil foams	The bearing vent has to be checked for perfect function. After enquiry with the supplier, different oil can be used. Possibly an anti-foam additive should be used.
• Oil pressure of forced lubrication system too high (> 0.5 bar)	The oil pressure has to be reduced, if necessary with an additional pressure reducing valve.
• Forced-lubricated bearing flooded	The correct adjustment of bearing oil rate and bearing oil level has to be checked. There must not be any obstructions in the oil discharge.
• Sealing rings defective. Gap between shaft and sealing ring too large	The sealing rings can serve its purpose only restrictedly and therefore should be replaced.
• Sealing-air supply incorrectly adjusted (SGen5/6-100A-2P-series only)	Tubing, valves and seals have to be inspected. The original pressure has to be readjusted.
• Leak in bearing part joint	The bearing part joint should be replaced.
• Oil mist exhaust does not function	In the bearing housing there must be a negative pressure of approx. 100 Pa with operation. Check the pressure in the bearing housing and guarantee the functioning of the oil mist exhaust.

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Fault **Possible Causes**	**Remedy**
Bearings operated in possible wear area during shutdown	
• Breakdown of the hydrostatic pump	After an event of fault, when the bearings had to be operated in possible wear area, an inspection would be advisable. Alternatively, the generator can be started and checked for variations of the bearing temperature and vibration values. Regular oil analysis can show how much wear material is removed in the oil. If the values did not change, the inspection of the bearings can be delayed until the next regular inspection.

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Fault **Possible Causes**	**Remedy**
Liquid in Generator	
• This fault is due to a leaking or defective cooler tube.	Identify the defective cooler section. Reduce the load and take this cooler out of operation. Drain the liquid entering the generator by drain screws of the level detector container. Then drain the cooling water from the cooler section. Detach the return water channel and the inlet/outlet water channel. Tightly seal lower tubesheet. Then fill cooler tubes with water. Re-install return water channel and supply compressed air to water in coolers tubes via the vent. After some time water from the defective tube will have been drained. Isolate the compressed-air supply and re-install the return water channel. The defective tube can be identified now since cooling water is drained from this tube, while all other tubes remain filled with water up to upper edge. Mark defective tube and drain water from the cooler section. Plug the defective tube at both ends. As a material for the plugs we recommend hardwood, rubber or plastic. Metal plugs should not be used. Insert plugs by light hammer blows. Cut off protruding part of plugs. Note that not more than 3% of the pipes of a cooling element should be plugged. Re-install inlet/outlet water channel and return water channel. **Fig. 1: Plugging a Defective Cooler Tube** 1 Plug 2 Upper tube sheet 3 Cooler tube 4 Lower tube sheet
High Cold-Air Temperature	
• The cause will be usually a fouled cooler.	A rise of the cooling water temperature will require a higher cooling water flow for removal of the loss heat. The cooling water flow should be increased. If this measure is not successful, the cooler may be contaminated and should be cleaned on its water side. Reduce the generator load and clean the cooler. If the results of cleaning on water side are not acceptable the cleaning of the cooler on its air side is required. To do this,shut down generator and remove cooler. Prior to performing such work, the vents on cooler gaskets should be checked. When a disturbed heat removal capacity of the coolers is detected during operation, pay attention to proper venting of the coolers.

Also refer to the specific maintenance and operating instructions – chapter *Cooler*.

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Failures during Carbon-Brush Operation

Carbon brush wear depends on the physical characteristic of the brush material, the operating conditions, the atmospheric conditions and the properties of the slip-rings used. Accordingly, failures may have quite different causes. Typical phenomena will be dealt with in the following.

One of the most frequent failures is brush sparking. Objections should only be raised if brush sparking leads to carbon brush and/or slip-ring damages. Slight sparking will practically be harmless in all cases and may also be permitted at continuous operation. If, however, actual sparks appear, the carbon material and the slip-rings will be affected. In case of sparking countermeasures should be taken soon while noisy electric arcing requires immediate action.

Possible reasons for severe brush sparking:

- off-roundness of slip-rings
- strong vibrations (chattering)
- too light brush pressure
- too low air humidity
- dusty environment
- corrosive gases
- excessive free play of brushes in the holder when using the wrong brush type
- dirty slip-rings
- highly stressed carbon brushes
- inadequately lapped brushes
- unfitting type of brush.

If one of the failures stated are established, special attention should be applied to the carbon brushes until failure elimination. Extract the brush holders at regular intervals and check the carbon brushes on damage. Worn or damaged brushes have to be exchanged.

⚠ WARNING

Dangerous voltage!

The brush holders are electrically live. When extracting and inserting the carbon brushes, wear insulating gloves to reduce the risk of accidents.

Protect your eyes and head from dust and hot air using a helmet and eye protection.

NOTICE

Danger of overload. Extract carbon brushes one by one only; never extract several at the same time!

Insert only brushes the running face of which has been adapted to the slip-ring contour. Perform lapping by means of a dummy or on the slip-rings at turboset standstill.

NOTE:

The plus slip-ring is subjected to more brush wear than the minus slip-ring. This is due to the fact that ions are wandering from the plus slip-ring into the carbon brush. During this process, metal is transferred to the carbon brush reducing the patina formation on the slip-ring while simultaneously increasing the carbon brush wear.

In case of the minus slip-ring, the carbon dust intrudes the slip-ring surface resulting in an adequate patina formation, reducing friction and consequently carbon brush wear.

Fault **Possible Causes**	**Remedy**
Sparking of carbon brushes on slip-rings and/or **Too high brush wear**	
• Chattering of carbon brushes (severe vibrations on carbon brushes)	Brush chattering results in breaking away of brush edges indicating too low brush load. The brush friction coefficient is too high due to inappropriate load or lack of air humidity. The most acceptable operating behaviour is gained with a specific brush current load of 8…10 A/cm^2 (equiv. to 80…100 A per brush). Current load below 6 A/cm^2 should be avoided. Adapt number of brushes per slip-ring according to the values specified.

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Fault **Possible Causes**	**Remedy**
• Too light brush pressure or restricted mobility within brush guide	Extract plug-in brush holder. Release lever and check carbon on free play by pressing it into the plug-in brush holder. Brush contact pressure produced by a spring in the telescopic apparatus, should amount to about 130 cN/ cm^2. The force to be applied to press the carbon into the plug-in brush holder should amount to about 1.2…1.5 kg (2.65…3.3 lbs.).
• Too high brush current load	Excessive brush current loading will result in brush sparking. The most acceptable operating behaviour results from a specific brush current load of of 8…10 A/ cm2 (equiv. to 80…100 A per brush). Current loads beyond 12 A/ cm2 should be avoided. Adapt number of brushes per slip-ring according to the values specified. Brushes supplied should be such that maximum exciter current can be transferred with optimum current density.
• Dirty or oily slip-rings	Sometimes sparking may be caused by slightly contaminated or oily slip-rings. Clean the slip-rings with an appropriate agent (Rivolta or similar) and cloth and insert new brushes.
• Off-roundness or non-parallel slip-rings	Off-roundness or non-parallel slip-ring surfaces will also lead to carbon brush sparking and considerable brush wear. Finish-turn or grind the slip-rings at the next standstill. Compass surface roughness depth Rz4 and true running accuracy of 0,02 mm. Don't waste more than 10 mm of slip-ring diameter for reworking. Apart from that change the slip-ring. The best way would be, if finish-turning or grinding were performed by the Siemens erection staff.
• Electrolytic effects	Remove the brushes from the slip-rings when the shaft is not running.

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Operating and Maintenance Manual

TP – Implementation Documentation

Project name	Attarat 2x235MW Oil Shale Power Plant
Project code	JO1008
Generator type	SGen5-1200A 118/55
	Two-Pole Turbogenerator with Directly Air-Cooled Rotor Winding and Indirectly Air-Cooled Stator Winding
	Unit 1
Order no.	3000017203
Machine no.	EG000333
Internal ID	FERT00532498
Siemens Document no.	DPSDES-0000... en

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Original manual

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Temperature Measuring – TMG: Resistance Thermometer WQ 0233 ..... 4.1-8653-0002 0412
Temperature Measuring – TMG: Slot Resistance Thermometer, Drawing 4-123317 ..... 4.1-8654-0003 0412
Temperature Measuring – TMG: Lamination Stator Core Resistance Thermometer WK93 / Drawing 2-121854 ..... 4.1-8657-0002 0412
Temperature Measuring – TMG: MIMS-thermocouple MQ 0206-PVDF – "sealed for oil" 4.1-8667-0001 1213
Leakage Water Monitoring – Siemens: SITRANS LVL100 – Transistor (PNP) ..... 4.1-8721-0002/1...33 0215
Rotor Grounding System – Schunk: Plug-in Brush Holder 06.00.0468.xx ..... 4.1-8765-0001/1...13 0116

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SIEMENS

Turbogenerator | Operating and Maintenance Manual

User Information

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Preface

Please note the following information about this manual.

The Operating and Maintenance Manual (OMM) is divided into two parts:

Part 1: Operating Manual

The Operating Manual comprises the technical documents required by the operating personnel for normal plant operation. It also describes the possible operating personnel interventions under plant conditions which deviate from normal operating conditions and which are annunciated by means of alarms. The Operating Manual builds upon the user guides for the individual equipment units (see Implementation Documentation). It contains only information not contained in the user guides for the equipment units or that result from the interaction of the equipment units.

Part 2: Implementation Documentation

The Implementation Documentation comprises the technical documents representing the structure of the individual systems and equipment. This includes the documents and data which are required for operation and maintenance. In particular, it includes the documents which describe the operating principles of the equipment and which constitute or contain the user guides for this equipment.

⚠ CAUTION

Knowledge of the information provided in the OMM is an essential condition for the proper operation and maintenance of the turbogenerator, and for avoiding any personal injury or damage to property.

▶ Read this manual through carefully and thoroughly.

Intended use of the OMM

This manual has been prepared for operating and maintenance personnel who has comprehensive knowledge of power plant technology and power plant operation, and who has already received a briefing on the operation and maintenance of the system by instructed personnel.

The present manual cannot contain comprehensive information about all aspects of the turbogenerator, its operation and maintenance. Furthermore, it does not provide instructions or information about every eventuality that can arise during the assembly, operation or maintenance of the generator. All questions that cannot be clearly answered with the aid of this manual must be referred to Siemens AG.

All the information contained in this manual is intended solely for the use of the buyer and for the specific purpose stated by the buyer to Siemens AG for the purchase of the generator. The use by other persons, entities and bodies for other purposes is not authorized. Siemens AG does not accept any liability for any consequences due to any type of such unauthorized use.

This manual is not a guarantee or contractual document. The obligations of Siemens AG are regulated solely in the purchase contract. The information contained in this manual cannot be interpreted in any way to change or extend the obligations of Siemens AG.

NOTE

The manual must be kept up to date in order to ensure safe operation. Accordingly, the supplements and updates provided by Siemens AG should be inserted in the documentation promptly after their receipt.

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Contact

1 Product service

The Siemens AG operates agencies in all larger cities at home and in most countries of the world. Please contact the agency applicable to you with regard to replacement-part orders, requirements of personnel as well as requests for technical information.

2 Returns

Returning address

When returning parts to the supplier's works it is essential to use the proper address and forwarding mode and to include the necessary supplementary information in the consignment to ensure the smooth initiation of processing. Returns to the Erfurt works should be addressed as follows:

Siemens AG
Generatorenwerk Erfurt
Wareneingang
Werner-von-Siemens-Straße 1
D-99086 Erfurt

Accompanying information

In the event of questions concerning the proper address and forwarding mode, please contact the Erfurt works for detailed information. Every component which is returned to the works should be accompanied by the following information:

- Name of sender
- Company, department and name of person who made the arrangements for the return

In addition, the consignment should be accompanied by the following information:

- Reason for return
- Department of Siemens AG which is already dealing with the matter
- Number of the machine to which the component belongs (see generator rating plate or the cover sheet of this manual)
- Part number or order number

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Safety Instructions

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1 General

This section contains the relevant information necessary for safe operation of a generator.

Although the generator is designed to state-of-the-art technology and complies with the applicable safety standards, hazards which could result in personal injury to the user or third parties and damage to the generator or other property cannot be ruled out completely.

Please read this section carefully and make sure that you comply with the instructions in order to safeguard against personal injury and damage to the generator.

Please note that the safety information in this section is general and applies to different types of generators. In the individual chapters of this document, you will find safety notes that must be obeyed absolutely, for your own safety, to protect other people and to avoid damage to property.

Apart from the safety instructions in this section observe all indications on safety in the supplier documentations included in this manual.

2 Warnings

The operating instructions use a range of key words and symbols to identify information which is of particular importance. The key words **Danger**, **Warning**, **Caution** and **Notice** give you a better idea of the significance of the warning notices:

⚠ DANGER — ... indicates an imminently hazardous situation which, if not avoided, **will** result in death or serious injury.

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

⚠ CAUTION — ... indicates a potentially hazardous situation which, if not avoided, **may** result in minor or moderate injury.

NOTICE — ... indicates a potentially hazardous situation which, if not avoided, **may** result in property damage.

NOTE — Additionally, the signal word NOTE is used to identify any information relevant to ensure maximum generator efficiency.

Such kind of information can be complemented by the pictograph Information.

In order to emphasize the above mentioned warning notices, these are used together with pictographs. In this manual you will find the following hazard warning signs, mandatory signs and prohibition signs, which in each case are followed by an explanatory remark.

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Warning signs

A black graphical symbol inside a yellow triangle with a black triangular band defines a safety sign that indicates a hazard. For example:

General warning sign

Warning: Electricity

Prohibition signs

A black graphical symbol inside a red circular band with a red diagonal bar defines a safety sign that indicates that an action shall not be taken or shall be stopped.
For example:

General prohibition sign

No access

Mandatory signs

A white graphical symbol inside a blue circle defines a safety sign that indicates that an action shall be taken to avoid a hazard. For example:

General mandatory sign

Ear protection required

3 Proper Usage of the Generator

The function of a generator is to convert rotating mechanical energy to electrical energy. Alternatively generators are used as synchronous condensers.

To ensure normal and trouble-free operation of the generator, it is necessary to comply with the operating instructions as well as the inspection and maintenance intervals specified for the generator.

Siemens AG do not accept any liability for any damage which may occur as a result of use of the generator for any other purpose or noncompliance with the aforementioned operating instructions or inspection and maintenance intervals.

4 General Organization

The following instructions must be followed to ensure safe and reliable operation:

- Based on this technical documentation shift procedures must be prepared with additional information regarding responsibilities, work organization and workflows.
- Any personnel working on the generator and its auxiliary systems must be familiarized with the operating instructions and shift procedures and in particular with the safety instructions and regulations before starting work. This particularly ap-

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plies to personnel such as maintenance personnel who do not work on the generator on a regular basis.

- In addition to the operating instructions, the general legal provisions and other regulations for employment protection, the prevention of accidents and fire as well as the protection of the environment must be observed. The operator is responsible for the implementation and the correct adherence of the staff. Protective apparel and equipment must be used.
- Note safety data sheet when using hazardous material.
- Place signs at the entrance to the operating room of the generator according to the local legal and employment protection requirements. Every person who enters the operating room must wear personal protective equipment according to these local requirements and the requirements stated in this documentation.
- In case that equipment, protection systems or instrumentation and control components are damaged or defect, the generator must be handled as specified (shut down if necessary) and the supervisor must be informed. In some cases local authorities must be informed as well. The local authorities can conduct extraordinary examinations in an event of damage in some individual cases.
- It must be ensured that work on oil carrying systems and piping must be conducted after emptying. Switch off procedures must be strictly adhered. Special procedures for environmental and employment protection must also be considered.
- If work is done on several systems at the same time, it must be coordinated in a way to avoid mutual endangering.
- During start-up and synchronization of the generator only authorized staff with defined task is allowed to stay within the machine room.
- Only use suitable and faultless climbing equipment (e.g. ladders) for work in larger heights. Scaffolding can be necessary and further safeguards like anti-fall guard. Do not step on armatures, thermometers and the bearing.
- The use of pipes, cables, terminal boxes and fittings as a kick or hold is inadmissible. Parts get visible or invisible damages which may lead to a failure beside the danger of injury.
- The operating instructions must always be kept on hand.

NOTE

We recommend engaging the support and services of your local Siemens service center for all planning, installation, commissioning and maintenance work.

5 Personnel

With regard to personnel working on the generator, compliance must be ensured with the following:

- Work on the generator and its auxiliary systems is to be performed by authorized personnel only. Activities and associated responsibilities are to be clearly defined for the personnel.
- Staff must be trained on the basis of the manufacturer technical documentation. They must be physically and mentally suitable for the tasks and must have the required expertise. Staff must be able to carry out maintenance measures inde-

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pendently and to take decisions in the case of disturbances or deviations from the stated operation condition independently. Depending on local regulations it can be required that these people have a certification from special trainings.

- Personnel requiring or undergoing training must only be allowed to perform work on the generator or its auxiliary systems under the constant supervision of an appropriately qualified member of staff.
- Work on the electrical systems of the generator may only be performed by electrical engineers or by suitably qualified personnel under the supervision of an electrical engineer in compliance with the relevant electrical engineering standards.
- The staff has to avoid dangers or reduce them as far as possible. This also contains the self-control of completed work. In addition, it has to be checked before work execution whether all necessary safety measures are taken.
- The operator's position during operation of the generator is the control room. Abidance near the generator is only permitted for inspection and attendance purposes which are required for the operation.

6 Lifting and Working Posture

When working on the generator make sure to comply with the local rules regarding lifting and working posture. All work shall be planned in order to be executed in a safe and healthy manner.

Lifting that can be a risk to health and safety shall be avoided. The usage of lifting equipment should be preferred for all lifting workings at the generator. This applies to all generator equipment such as filters, manhole covers etc. Observe the local requirements regarding the recommended lifting weight and carrying distance.

7 Modifications to Generator

Do not carry out any modifications to the generator or perform any other work on the generator which might impair safety. Any changes must be approved by Siemens AG prior to their implementation.

8 Spare Parts and Special Tools

Spare parts and special tools must comply with the technical standards set forth by Siemens and other suppliers. Compliance with the aforementioned standards is only ensured if original parts and tools are used. Special tools should only be used as intended by Siemens or the supplier.

Spare parts and special tools must be stored in a way to ensure quality and functionality. Further requirements from the supplier documentations must be fulfilled including the guarantee conditions. The spare parts and special tools should be checked at regular intervals.

Do not remove any blocks, braces, anchors and/or cushions used during shipment until just before erection or installation of spare parts.

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9 Environment Protection and Waste Disposal

Waste products of any kind (e.g. lubricants) must be disposed of in compliance with the applicable waste disposal regulations. An environmentally friendly disposal (recycling e.g.) has to be striven.

For the de-installation and professional disposal of the generator experts of Siemens AG have to be contacted.

10 Safety Instructions Regarding Special Operating Phases

10.1 Shipment, Transport and Storage

The following safety instructions apply during generator shipment, transport and storage:

⚠ WARNING

Suspended load

Falling loads may cause injury to persons.

- Keep safe distance. Place barriers if necessary.
- Only use specified load attachment points. Only use suitable lifting equipment. The lifting equipment must be in good condition and have a sufficient load carrying capacity.

- Refer to the shipping documents for information about the dimensions and weights of generator components.
- For transportation of heavy machine parts in buildings a sufficient load-capacity of the building has to be guaranteed along the complete transport route as well as at the operation or stock location.
- Prevent generator rotor from rope-induced damage by using suitable cushions at load attachment points. Hitch ropes to fully extracted bollards only. Insert and lock bollards during transport.
- Carefully check components for evidence of damage, moisture and corrosion on arrival. Notify manufacturer in written and photo documentation of any damage.
- If transport locks must be removed for the purpose of control of the components, these guards must be reattached and removed just before installation of the components.
- Adhere to all measures for protection during transport described in this manual.
- Take appropriate measures to protect and preserve the generator at standstill. Observe the storage instructions in this manual.
- Fill in the generator packing checklist for long time storage, if necessary. Storage goods must be checked monthly.

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10.2 Erection

The following safety instructions apply during generator erection:

⚠ CAUTION

Crushing hazard

These may cause injury to persons.

- Installation, raising, transporting of heavy objects only with the help of hoists.

- Before erection remove protective coating and any other protective material from components using a suitable cleaning agent. Observe environmental regulations.
- Check the generator for foreign objects. Even minimal-size metallic particles left inside after work on the generator can lead to large-scale damage during generator operation.
- If it is necessary to open parts of the system the openings must be covered. The used covers must be sufficiently exact and stable to prevent a contamination with foreign material.
- Use only suitable lubrication and seal material for the respective purpose. They must comply with the later operation conditions.

10.3 Start-up

The following safety instructions apply during generator start-up:

⚠ WARNING

Rotating components

These may cause injury to persons.

- Before commencing with generator start-up ensure that personnel are not exposed to any hazards. The start-up sequence must be adhered.

- All mechanical and hydraulic components as well as the generator protection system must be checked with regard to function and settings.
- Before start-up/ re-commissioning all components must be checked for safety and for recognizable defects. Defective parts and systems must be repaired before start-up.
- Obligatory documentation requirement: Prepare start-up record. Record all operating data after allowing sufficient time for steady-state conditions to be established.

10.4 Operation

The following safety instructions apply during generator operation:

⚠ CAUTION

Hot surface.

Parts of the generator can be very hot and may cause serious burns.

- Do not touch.

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⚠ CAUTION

Operating noise of generator may damage hearing.

- Wear ear plugs when staying next to the operating generator.

- Any irregular events which occur during operation must be reported directly, and the generator shut down if necessary.
- In the event of loss of control voltage the generator must be shut down immediately.
- Only qualified staff with a specified work order should stay near the running generator.
- Obligatory documentation requirement: Record requisite checks during generator operation.

10.5 Maintenance in Operation

The following safety instructions apply during generator maintenance in operation:

⚠ WARNING

Rotating components

These may cause injury to persons.

- Ensure compliance with the scope of work set forth in the maintenance instructions.
- Do not remove any safeguard during operation.

- Operating personnel must be notified before starting any maintenance work. Appoint a suitably qualified supervisor.
- Empty pockets before starting maintenance work. Remove jewelry and other metal objects. Record all tools used in a list and check that tools have been completely removed from generator when finishing work.

10.6 Maintenance at Standstill

The following safety instructions apply during generator maintenance at standstill:

⚠ WARNING

Danger of serious injuries and substantial material damage.

- The machine must be electrically disconnected.
- Identify all additional dangerous sources of energy e.g. compressed air, hydraulic systems, water.
- The machine must be secured against being switched on accidentally.
- A notice must be attached in the control room that work is in progress.

- Parts which are undergoing inspection or repair activities must be de-energized. Disconnected parts must be checked for voltage, grounded and short-circuiting. Neighboring energized parts must be isolated and covered.
- It must be ensured that the generator cannot be switched on if somebody is working on it. It has to be made sure that no one stays in an area where it could come to injuries during start-up process.

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- The removal of safeguards must be avoided. It is only allowed when it is required for the work and does not endanger the staff. Removed safeguards must be re installed and checked just after the work task.
- Switch pressurized systems off before starting to work on it. Take care of ram pressures. Loosen screw connections carefully.
- Disconnect cable connections to electrical devices and ground terminals before lifting any cover. Remove electrical devices before dismantling components.
- Check the generator for foreign objects. Even minimal-size metallic particles left inside after work on the generator can lead to large-scale damage during generator operation.

10.7 Shutdown

The following safety instructions apply during generator shutdown:

⚠ WARNING

Rotating components

These may cause severe injury to persons.

- Ensure that rotor has coasted down.
- Do not remove any guards until generator has come to a full standstill.

- Obligatory documentation requirement: Record requisite checks during and following generator shutdown.

11 Special Hazards

11.1 Electric Current

Ensure compliance with the following instructions:

⚠ DANGER

Electrical hazard

Touching electrical equipment during operation can result in damage to property, serious injury and even death.

- Do not remove any safeguards or open cabinets during operation.

- Work on the electrical systems of the generator may only be performed by electrical engineers or by suitably qualified personnel under the supervision of an electrical engineer in compliance with the relevant electrical engineering standards.
- Local requirements regarding work on electrical installations must be strictly adhered to.
- For all work on electrical installations observe the five safety rules:

  1. Disconnect from the mains
  2. Secure against reconnection
  3. Verify that the system is dead
  4. Carry out earthing and short circuiting
  5. Provide protection from adjacent live parts.

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- During operation very high voltages occur, which can remain in existence for long periods of time even after switching off due to remanence or discharge of capacitors. As long as the generator is still rotating it carries a dangerous voltage. Do not touch the equipment before all 5 rules are fulfilled.
- Regularly check the electrical equipment, grounding system and isolation levels. Immediately repair any defects.

11.2 Electromagnetic Fields

⚠ WARNING

Electromagnetic fields are generated during the operation of the generator.

Electromagnetic fields can interfere with electronic devices. This could lead to malfunction of such devices.

- Therefore persons with active medical implants must not enter these areas.

- The system operator must put appropriate measures, markings and warnings into effect so that the personnel working there are sufficiently protected against possible injury. Also observe the local requirements.

11.3 Heat

⚠ WARNING

Hot surface

Parts of the generator can be very hot and may cause serious burns.

- Do not touch.

- The surface of oil lines, covers etc. become hot during operation.
- The surface of anti-condensation heaters switched on automatically during standstill becomes hot.

11.4 Noise

⚠ CAUTION

Operating noise of generator may damage hearing.

- Wear ear plugs when staying next to the operating generator.

- The generator may produce noise levels of approx. 90 dB(A) depending on model and type. In the long term such noise levels may result in damage to hearing.

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Turbogenerator | Operating and Maintenance Manual

Technical Data 2

Technical Data (2)

Piping connection list

DRAFT

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Project:	Attarat Oil Shale Power Plant			Copyright (C)	Title:	Doc.-Number	[InvalidExp]-AUX0405T-x
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Legend

Column	Description
Arrangement drawing	Document number of the Arrangement drawing showing the connection point
Connection Point	Unique identifier of the connection point (e.g. 10MBA / 27B)
Counterpart supplied by	States who supplies the counterpart (Siemens SAG, Customer CST or Balance of Plant BOP)
Description	Description in the project language
Dimension	Dimension of the connection (e.g. "DN15")
Dimension weld end (OD, s)	Dimension of the weld end (outer diameter, schedule)
Force allow. max. (Fx/Fy/Fz)	Maximal allowable force at Terminal Point
Interface category	Connection interface type (Flange, Welding, Thread)
Material weld end	Material identification, preferably according to standards (DIN, ASME etc.)
Nominal pressure	Nominal pressure at the connection point
Notes	Additional notes related to the connection point
P&ID Number	Document number of the P&ID showing the connection point
Standard	Used DIN/ANSI norm of terminal point (Value list dependend on Connection Interface Type)
System	Name and identifier of the System or Skid the Terminal point belongs to
System requirements	Document number of the System requirement describing the connection point
Torque allow. max. (Mx/My/Mz)	Max. torque (thrust) which can be delivered or carried by an Material Class
Type	Type of the Terminal Point: TP: external Terminal Point SP: Service Point Internal: Siemens internal Terminal Point

DRAFT

Identification / Description		Connection Data		Data Weld End		Mechanical Data	References		Notes	
Connection Point	Description	Interface category	Standard	Counterpart supplied by	Dimension (OD / s)	Force allow. max. (Fx/Fy/Fz)	P&ID Number	Arrangement drawing	Notes	Rev
Type	System	Dimension	Nominal pressure	Material		Torque allow. max. (Mx/My/Mz)	System requirements			
10MKA / 1A	INLET BEARG.OIL TE	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 50	PN 16	C22.8		See Arrangement dwg	non applicable			
10MKA / 1B	INLET BEARG.OIL EE	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 50	PN 16	C22.8		See Arrangement dwg	non applicable			
10MKA / 2A	OUTLET BEARG.OIL TE	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 150	PN 16	C22.8		See Arrangement dwg	non applicable			
10MKA / 2B	OUTLET BEARG.OIL EE	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 150	PN 16	C22.8		See Arrangement dwg	non applicable			
10MKA / 30A	COOLING WATER INLET	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 80	PN 16	Edelstahl		See Arrangement dwg	non applicable			
10MKA / 30B	COOLING WATER OUTLET	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 80	PN 16	Edelstahl		See Arrangement dwg	non applicable			
10MKA / 31A	COOLING WATER INLET	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 80	PN 16	Edelstahl		See Arrangement dwg	non applicable			
10MKA / 31B	COOLING WATER OUTLET	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 80	PN 16	Edelstahl		See Arrangement dwg	non applicable			
10MKA / 32A	COOLING WATER INLET	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 80	PN 16	Edelstahl		See Arrangement dwg	non applicable			
10MKA / 32B	COOLING WATER OUTLET	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 80	PN 16	Edelstahl		See Arrangement dwg	non applicable			
10MKA / 33A	COOLING WATER INLET	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 80	PN 16	Edelstahl		See Arrangement dwg	non applicable			
10MKA / 33B	COOLING WATER OUTLET	Flange	DIN EN 1092-1; Form B1; Type 11	SAG	/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		DN 80	PN 16	Edelstahl		See Arrangement dwg	non applicable			
10MKA / 34A	AIR EXHAUST COOLER A	Thread	DIN ISO 228; ;	CST		See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			
10MKA / 34B	AIR EXHAUST COOLER B	Thread	DIN ISO 228; ;	CST		See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			
10MKA / 34C	AIR EXHAUST COOLER C	Thread	DIN ISO 228; ;	CST		See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			
10MKA / 34D	AIR EXHAUST COOLER D	Thread	DIN ISO 228; ;	CST		See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			
10MKA / 35A	DRAIN COOLER A	Thread	DIN ISO 228; ;	CST		See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			
10MKA / 35B	DRAIN COOLER B	Thread	DIN ISO 228; ;	CST		See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			
10MKA / 35C	DRAIN COOLER C	Thread	DIN ISO 228; ;	CST		See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			
10MKA / 35D	DRAIN COOLER D	Thread	DIN ISO 228; ;	CST		See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			
10MKA / 3A	HYDRAULIC SHAFT LIFTING TE	Thread	DIN ISO 228; ;		/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			

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FORMAL

Project:	Attarat Oil Shale Power Plant			Copyright (C)	Title:	Doc.-Number	[InvalidExp]-AUX0405T-x	
UNID:		Quality:	INIT	Siemens AG	Piping connection list			
PC:	Object:	DCC:	Register-No.:			Protection Class	Restricted	
JO1008	10MK	MMA020	320214	All Rights Reserved	THIS DOCUMENT IS SUBJECT TO THE HANDLING RESTRICTIONS SET FORTH ON THE TITLE PAGE	Revision	Page	3 / 4

Identification / Description		Connection Data		Data Weld End		Mechanical Data	References		Notes	
Connection Point	Description	Interface category	Standard	Counterpart supplied by	Dimension (OD / s)	Force allow. max. (Fx/Fy/Fz)	P&ID Number	Arrangement drawing	Notes	Rev
Type	System	Dimension	Nominal pressure	Material		Torque allow. max. (Mx/My/Mz)	System requirements			
10MKA / 3B	HYDRAULIC SHAFT LIFTING EE	Thread	DIN ISO 228; ;		/	See Arrangement dwg	[InvalidExp]-AUX0211T-A	Generator outline drawing		
TP		G 1/2	PN 16			See Arrangement dwg	non applicable			

DRAFT

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Project:	Attarat Oil Shale Power Plant			Copyright (C)	Title:	Doc.-Number	[InvalidExp]-AUX0405T-x		
UNID:		Quality:	INIT	Siemens AG	Piping connection list				
PC:	Object:	DCC:	Register-No.:			Protection Class	Restricted		
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Application range:	According to DIN EN ISO 12944-5, category of corrosivity **C4 middle**
Temperature range:	-30…120°C
Product properties:	• without lead, without chromium • temperature-stable: up to 100°C continuously, up to 120°C discontinuously • tropicalized • universally overcoatable
Surface preparation:	Blasting with standard grade of cleanliness Sa 2 ½

Coating:	**A**	**B**	**C**
Supplier, product:	International ® Intercure 200	International ® Intercure 420	International ® Interthane 990
Coating type:	2-components primer coating 2-K EP	2-components intermediate coating 2-K EP	2-components final coating 2-K PUR
Material:	Epoxy resin, zinc phosphate	Epoxy resin-micaceous iron ore	Polyurethane laquer (glossy)
No. of layers:	1	1	1
Dry film thickness:	80 µm	100 µm	60 µm
Application method:	Airless spraying	Airless spraying	Airless spraying
Shade:	Red brown	Silver grey	RAL7030 (stone grey)
Surface gloss:	Matt	Matt	High gloss

Generator component	**Coating inside**	**Coating outside**	**Painted at**
Base frame	A + B + C	A	Workshop (manufacturer)
Cover	A + B + C	A	Workshop (manufacturer)
Brush assembly	A + B + C	A + B + C	Workshop (manufacturer)
Bearing pedestal	n/a	A	Workshop (manufacturer)
Cooler cover	A + B + C	A	Workshop (manufacturer)
Intermediate frame	A + B + C	A + B + C	Workshop (manufacturer)
Support for bushigns	A + B + C	A	Workshop (manufacturer)
Shaft bushing	A + B + C	A	Workshop (manufacturer)
Junction boxes (standard)	A + B + C (RAL7035, light grey)		Workshop (manufacturer)
Junction boxes (stainless steel)	-		-

NOTICE

Insufficient coating can result in damages to machine parts.

Some components will be stored and/or delivered undercoated.

▶ Parts lying inside the cover have to be final-coated.

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For location of labels and signs see drawing DPPPG-70111492.

Pos. no.	Material	Label text	Sign
10	Company nameplate	SIEMENS	-
20	Rating plate	*(see document 4.1-1001)*	-
30	Label	BEARING INSULATION NOT SHORT-CIRCUITED.	-
40	Label	BEARING INSULATION SHORT-CIRCUITED.	-
50	Label	DIRECTION OF ROTATION	
60	Label	NO ACCESS DURING OPERATION! RISK DUE TO ELECTRICALLY LIVE PARTS. DURING MACHINE STANDSTILL ACCESS FOR TRAINED PERSONNEL ONLY!	-
70	Label	ACCESS FOR TRAINED PERSONNEL ONLY! CAUTION! ELECTRICALLY LIVE PARTS. CAUTION! ROTATING PARTS. CAUTION! RISK OF SLIPPING.	-
75	Sign *Danger: electricity, electric shock*	-	
80	Label	CAUTION! ROTATING PARTS. CAUTION! RISK OF SLIPPING.	-
100	Paper label (removed after installation)	ACHTUNG! Vor Inbetriebnahme die Transportsicherung (Beilagen und Distanzringe) aus den Lagern entfernen. NOTICE! Remove transportation securing device (shims and spacing rings) from the bearings.	-
110	Label	DISCONNECT GROUND TERMINALS AND INTERNAL ELECTRICAL DEVICES BEFORE LIFTING COOLER COVER.	-
130	Label	REMOVE THERMOMETERS AND SHAFT VIBRATION SENSORS BEFORE DISMANTLING BEARING! DO NOT STEP ON AUXILIARY EQUIPMENT, THERMOMETERS AND BEARING PARTS!	-
150	Glue for fixing labels	-	-

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Pos. no.	Material	Label text	Sign
170	Paper label (removed after installation)	ACHTUNG! Kammringe nach Zeichnung *Axiale und radiale Läuferspiele* einstellen. NOTICE! Adjust labyrinth rings as per drawing *Axial and radial rotor clearances*.	-
180	Rivets for fixing labels	-	-
190	Label	DISCONNECT FLEXIBLE LINKS, SEISMIC TIE-DOWN (IF EXISTING), GROUND TERMINALS AND LOCKING SCREWS BEFORE LIFTING COVER.	-
210	Label	WARNING! INSERT AND LOCK BOLLARDS DURING TRANSPORT. HITCH ROPES TO FULLY EXTRACTED BOLLARDS ONLY.	-
220	Label	Siemens Lifting Device MACHINE No.: MK011063 YEAR OF MANUFACTURE: 2016 LOAD CAPACITY: 130 t PER BOLLARD Siemens AG Energy Sector	-
230	Label	NOTICE! LIFTING POINT FOR COOLER UNIT.	-
231	Label	DO NOT USE THESE LIFTING EYES TO LIFT THE ENTIRE MACHINE. USE THE LIFTING EYE TO LIFT: MAIN HOOD / HALF HOOD. ONLY THE COMPONENT TO WHICH THE LIFTING EYE IS DIRECTLY ATTACHED CAN BE SAFELY LIFTED BY THE LIFTING EYE.	-
232	Label	DO NOT USE THESE LIFTING EYES TO LIFT THE ENTIRE MACHINE. USE THE LIFTING EYE TO LIFT: MAIN HOOD WITH ADDITIONAL EE HOOD. ONLY THE COMPONENT TO WHICH THE LIFTING EYE IS DIRECTLY ATTACHED CAN BE SAFELY LIFTED BY THE LIFTING EYE.	-
233	Label	DO NOT USE THESE LIFTING EYES TO LIFT THE ENTIRE MACHINE. USE THE LIFTING EYE TO LIFT: HALF HOOD. ONLY THE COMPONENT TO WHICH THE LIFTING EYE IS DIRECTLY ATTACHED CAN BE SAFELY LIFTED BY THE LIFTING EYE.	-

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Pos. no.	Material	Label text	Sign
234	Label	DO NOT USE THESE LIFTING EYES TO LIFT THE ENTIRE MACHINE. USE THE LIFTING EYE TO LIFT: MAIN HOOD WITH ADDITIONAL EE HOOD / MAIN HOOD / HALF HOOD. ONLY THE COMPONENT TO WHICH THE LIFTING EYE IS DIRECTLY ATTACHED CAN BE SAFELY LIFTED BY THE LIFTING EYE.	-
235	Label	DO NOT USE THESE LIFTING EYES TO LIFT THE ENTIRE MACHINE. USE THE LIFTING EYE TO LIFT: EXTRA ENCLOSURE / EXTRA ENCLOSURE HALVES. ONLY THE COMPONENT TO WHICH THE LIFTING EYE IS DIRECTLY ATTACHED CAN BE SAFELY LIFTED BY THE LIFTING EYE.	-
236	Label	DO NOT USE THESE LIFTING EYES TO LIFT THE ENTIRE MACHINE. USE THE LIFTING EYE TO LIFT: EXTRA ENCLOSURE HALVES. ONLY THE COMPONENT TO WHICH THE LIFTING EYE IS DIRECTLY ATTACHED CAN BE SAFELY LIFTED BY THE LIFTING EYE.	-
237	Label	DO NOT USE THESE LIFTING EYES TO LIFT THE ENTIRE MACHINE. LIFTING EYE TO LIFT THE ROOF SHEETING.	-
250	Label	COOLER UNIT TOTAL DRY WEIGHT: 16658 kg	-
260	Label	NOTICE! ROTOR GROUNDING BRUSHES. INSPECTION AT REGULAR INTERVALS IS REQUIRED. REMOVE PLATES FOR ACCESS. REPLACE BRUSHES AT A MINIMUM LENGTH OF 16MM. SEE ALSO OPERATING AND MAINTENANCE MANUAL.	-
280	Sign *Danger: hot surface*	-	
(on junction boxes)	Sign *Danger: electricity, electric shock*	-	

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Turbogenerator | Operating and Maintenance Manual

Product Description 3

Stator

The baseframe carries the stator, the bearings, the enclosure, the brushgear or stator of exciting machine (what provided) and the machine accessories.

The baseframe and anchoring elements transmit the forces occuring in the machine during operation and on short-circuits to the foundation.

The method of anchoring provided is shown in the Generator Dimensional Drawing.

Basis for the dimensional design of the base frame are the loads during operation and in case of failure (short-circuit) as well as the conditions during shipment of the complete generator including the rotor.

Further functions:

- Vibration- and noise-damping
- Realization of the cooling air circulation together with the upper enclosure
- Wiring and cable arrangement for supervising equipment and anticondensation heating system

Fig. 1: Stator, base frame (schematic illustration)

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The stator is manufactured as a three-part structure: the base frame, the inner stator and the enclosure.

The inner stator consists of the core and the stator winding. The stator core is stacked with insulated electrical sheet-steel laminations with a low loss index and is supported in the base frame by means of guide bars and rings. Inner stator and base frame are welded together.

The axial compression of the stator core is obtained by clamping fingers, pressure plates, bolts and beams. The arrangement of the clamping fingers ensures a uniform clamping pressure, especially within the range of the teeth.

After stacking the stator core the core key bars are installed in the respective slots. Clamping rings welded to the core key bars and the pressure plate further increase the stiffness obtained by compression and maintained by the bond between clamping bolts, key bars and pressure plate.

The two outer and if required further clamping rings of the inner stator are thicker. In the normal operation and in the case of failure they ensure safe transmission of the mechanical forces via connecting elements welded to the base frame.

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1 Stator core
2 Stator winding (bar winding)
3 Clamping finger
4 Pressure plate
5 Clamping bolt
6 Core key bar
7 Clamping ring

Fig. 1: Inner stator of a two-pole generator

1 General, Connection

The three-phase stator winding is a fractional-pitch two-layer type consisting of individual bars. Each stator slot accommodates two bars.

The slot bottom bars (bottom layer bars) and top bars (top layer bars) are displaced from each other by one winding pitch and connected at their ends to form coil groups. The coil groups are connected together with phase connectors inside the stator frame as shown in the connection diagram.

Impregnating the stator by total immersion improves the stiffness and electrical strength of the end winding.

2 Conductor Construction

The bar is a twisted transposed bar to reduce the skin effect losses. It consists of a large number of separately insulated strands.

The strands of small rectangular cross-section are provided with braided glass fibre insulation. In the straight slot portion the strands are transposed by 540°. At the Roebel crossover points, the insulation is reinforced with epoxy resin flooded gaps.

Prior to applying the bar insulation, the bar ends are bent with a special device which shapes the involutes over a cone shell. This ensures a uniform spacing of the bars over the entire length of the end turns after installation.

The bars get an Inner Corona Protection (see Fig. 1). The order of the Inner Corona Protection (ICP) is to constant the electrical bar potential.

Fig. 1: Inner Corona Protection

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The high voltage insulation along the straight bar section consists of the specified number of half overlapped, continuous layers of dry mica tape applied from end to end on the stator bars. A semiconducting tape applied as a final wrapping in the slot section provides the electrical contact to the grounded stator core (outer corona protection - OCP, see Fig. 2). Specially treated tapes are applied to the bar portions just outside the slot to provide a corona grading system which ensures uniform control of the electric field without corona discharges (end corona protection - ECP). The end turns are provided with an outer cover of highly flexible armoring tape in order to obtain a smooth surface.

In the course of manufacture, the bars are subjected to numerous electrical tests for quality control.

3 Winding Assembly

The pre-insulated and pre-shaped bars are carefully placed into the slots of the stator core. In the end windings, dry glass fabric pads are inserted between the coils as spacers, and the end turns are then lashed to each other and to the end winding support structure with glass fabric tapes. The insulated bars in the slot section are covered with prefabricated glass fabric pads and locked in plan by inserting slot wedges.

The phase connectors are likewise insulated with mica tapes. They are secured to the support brackets, using spacer blocks and lashings similar to those in the end windings, and then connected to the respective stator bars. The stator bars and all phase connectors are then taped with dry mica tape and with an outer cover of armoring tape as used on the end turns.

4 High Voltage Insulation

The high-voltage insulation is provided according to the proven Micalastic® system (see section 4.1-2320).

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1 Outer OCP
2 Double Fleece - Micanite Tape
3 OCP Tape
4 Inner OCP
5 Main Taping
Fine Mica Glass Fabric Tape

Fig. 2: Outer corona protection

1	Stator core
2	Slot wedge
3	Slide strip
4	Top strip
5	Separator int the main body iron
6	Roebel bar
7	High voltage insulation
8	Center filler

Fig. 1: Stator slot, two-bar design, 540°

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1 General

High-quality mica, selected epoxy resins and a matching vacuum impregnation process are the characteristic features of the *Micalastic*® insulation for large turbogenerators. This insulation system is the result of systematic development.

The first 10.5 kV winding of a turbogenerator to be impregnated in vacuum with a solventless synthetic resin and cured was completed in 1958. Since that time, this insulation system has been used on all direct cooled windings and also on indirect cooled windings of more than 350 turbogenerators with a total rating of 150000 MVA. Since 1960, this insulation system has been registered under the trademark *Micalastic*® for Siemens AG.

Today, this system can be used for the post-impregnation and curing of a fully wound-stator.

2 Impregnation and Curing

The stator core with the coils installed in place is predried in a vacuum tank, evacuated and impregnated by being flooded with epoxy resin. After this extensive impregnation cycle involving the application of pressure, the surplus impregnating resin is drained. The complete stator is then placed in an oven for curing. All mica tapes and parts to be impregnated for achieving an improved mechanical strength include an accelerator to speed up the curing process. The impregnating resin itself contains no accelerator and can thus drain off from the non-insulated surfaces of the core as heat is applied so that all cooling passages remain free from resin.

The application of appropriate monitoring methods ensures adherence to the specified conditions and limits during evacuation, heating, impregnation and curing of the fully wound stator. As a final treatment, a varnish coating is applied to the stator winding.

3 Tests

During bar manufacture, the standard strand tests according to IEC/VDE specifications are performed. Only bars without short-circuits between strands are released for further processing.

After installation of the taped bars in the core slots, dc-tests are carried out in order to promptly identify and eliminate any defects and weak points produced in the winding during installation without causing damage to other parts of the insulation.

After impregnation and curing of the winding a dissipation factor vs. voltage measurement as stipulated in the applicable national and international standard specifications is performed for each bar between all individual phase windings and to ground.

Guiding values for the dissipation factor and its rise with the voltage are merely given in the KEMA specifications. According to these specifiations, the maximum value shall not exceed 0.04 at 20% of rated voltage, and the rise shall not be greater than 0.006 per 20% of rated voltage up to 60% of rated voltage and 0.008 per 20% of rated voltage up to rated voltage. Windings manufactured by the *Micalastic*® post-impregnation process comply with these limits.

The higher rise of the dissipation factor as compared to the limit values established for individual conductor insulations using a guard electrode arrangement results from the loss attributable to the voltage grading material applied at the slot ends.

A final dielectric strength test performed at 105% of the winding test voltage ($U_P = 2 \cdot U_N + 1$ kV) serves to verify proper impregnation and the electrical quality of the insulation before the stator is installed in the base frame.

4 Properties of Micalastic®

The *Micalastic*® post-impregnation process ensures a mechanically firm bond between all winding components and between the winding and the stator which is capable of withstanding the various temperature rises occurring during operation. The *Micalastic*® system thus provides for reliable insulation of the windings at all machine voltages. The insulation is applied continuously from end to end on the stator bars providing effective protection against overvoltages arising during normal operation and against the high stresses that may occur at the slot ends when high test voltages are applied.

Micalastic® has a long electrical life as determined on hundreds of experimental bars and verified on numerous fullsize bars.

Micalastic® is a good conductor of heat by reason of its high mica content and the voidfree synthetic resin. Efficient heat transfer is particulary important for dissipation of the copper losses in machines that require thick insulation because of the high voltages and are not designed with direct cooled windings.

Micalastic® features a high thermal stability. The resin-impregnated and cured insulation permits the machine to be operated continuously under conditions corresponding to those for Class F insulation.

Micalastic® insulation shows only a small dissipation factor tip-up with increasing temperature, which is

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also affected by the loss attributable to the voltage grading material applied at the slot ends.

Micalastic® features an elastic response to thermomechanical stresses. Alternate heating and cooling with large differences in temperature are endured without detrimental effects on quality. The *Micalastic*® insulation remains firmly bonded to the copper conductors and the stator. This is confirmed by dissipation factor measured with rising voltage within the operating temperature range.

Micalastic® owes its insensitivity to high temperatures and temperature changes to the cured synthetic resin. This favorable performance under thermal stress is particularly advantageous for machines subject to frequent load changes, e.g. generators driven by gas turbines or peak-load generators in steam power plants.

Micalastic® does not burn. The insulation features such a low flammability that even on arcing it does not continue to burn once the arc has been extinguished. Fire extinguishing systems, such as CO_2 bottle racks, are therefore not necessary for *Micalastic*®-insulated windings.

Micalastic® provides protection against moisture due to its impregnation with synthetic resin which seals the winding completely.

Micalastic® is highly resistant to chemical action. Corrosive gases, vapors, lubricating oil, weak acids, to which the windings may be exposed under unfavorable conditions, do not attack the insulation; the impregnating resin does not react with chemicals.

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1 Description

1.1 Application

The generator is fitted with an anti-condensation heating system. This system is designed in a way that makes sure the temperature of the active parts of the machine is always higher than the ambient temperature and condensation is prevented. The heating power required is determined when designing the generator.

1.2 Design

The anti-condensation heating system consists of one or two heating tubes (fig. 1) which are connected to each other and arranged in the machine that way the warm air rises to the active parts and the winding insulation is not damaged by the high surface temperature of the heaters.

For rating and supply voltage, please refer to the dimensional drawing text.

Fig. 1: Heating tube

2 Installation

2.1 Connection

The heater connecting leads are brought to an auxiliary terminal box situated according to the position specified in the circuit book for a specific project. The supply leads should be connected according to the applicable circuit book.

⚠ WARNING

Danger of injury from electric shock.
Connect to earthing system.

2.2 Switching On

The anti-condensation heater must be switched off when the generator is running. Therefore an interlocking circuit is necessary which prevents the generator from being started while the heater is switched on.

On the other hand, it is advisable to make the switching-on of the heater dependent on the shut-down of the generator.

Attend to the generator startup / shut down diagram details.

3 Maintenance

3.1 Replacement

When replacing defective heating tubes, only use tubes of the same type.

It is advisable to order spare heating tubes from the machine manufacturer stating type and serial number which can be taken from the rating plate.

3.2 Cleaning

Remove dirt and dust deposits from the heaters and test for proper functioning when machine inspections are carried out.

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1 Recommended nominal tightening torques for bus bar bolting

Thread size	Indoor	Indoor & outdoor
	Lubricant: Oil or grease	Lubricant: MoS_2
	Tightening torque [Nm]	Tightening torque [Nm]
M4	1,5	2
M5	2,5	3
M6	4,5	5,5
M8	10	15
M10	20	30
M12	40	60
M16	80	120

Table data are valid for DC and AC up to 60 Hz. Screws and nuts have to be made of austenitic steel (e.g. A2-70 or A4-70), all other connecting and locking elements should be made of nonmagnetic material as well.

2 Connection Bus Bars – Connecting Pieces

1 Hexagon screw M12x110
2 Double-locking plate
3 Support plate
4 Elbow fitting
5 Hexagon screw M12x100
6 Connecting piece
7 Bus bar (Terminal connector)
8 Spacer plate
9 Clamping disk
10 Clamping disk cap
11 Twin nut

Fig. 1: Connection bus bars – connecting pieces

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3 Connection Bus Bars – Flexible Links

1 Hexagon screw M12x110
2 Double-locking plate
3 Support plate
4 Flexible Link
5 Terminal connector (bus bar)
6 Spacer plate
7 Clamping disk
8 Clamping disk cap
9 Twin nut

Fig. 2: Connection Bus Bars – Flexible Links

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The inner stator with inserted and fastened winding is pre-dried in a vacuum tank, evacuated and impregnated by being immersed in epoxy resin.

After this extensive impregnation cycle involving pressurizing according to the VPI method (Vacuum Pressure Impregnation), the surplus resin is drained until all cooling air passages are free from impregnating resin. The complete stator is then placed in an oven for curing at a temperature of 140°C.

All mica tapes and pads of glass fabric mat to be impregnated for improving their mechanical strength contain a catalyst in order to accelerate curing.

The epoxy resin contains no catalyst and thus freely drains off the exposed areas of the stator core on heating without blocking any cooling air passages.

Numerous control measures are performed during evacuation, impregnation and curing for quality assurance of the various treatment steps.

Prior to installation of the inner stator in the lower housing part, a dissipation factor measurement of each phase winding is performed, dependent on the machine voltage and as stipulated in the applicable national and international specifications.

A final dielectric test provides evidence of proper impregnation and confirms the electrical quality of the stator winding insulation.

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Product Description 3

Rotor

The rotor shaft is forged from a vacuum cast steel ingot.

The rotor consists of an electrically active portion and the two shaft ends. A shrunk on flange coupling to connect the rotor to the turbine is located outboard of the bearing.

Approximately 60% of the rotor body circumference is provided with longitudinal slots which hold the field winding. Slot pitch is selected so that the two solid poles are displaced by 180°.

Due to the non-uniform slot distribution on the circumference, different moments of inertia are obtained in the main axes of the rotor. This in turn causes oscillating shaft deflections at twice the system frequency. To reduce these vibrations, the deflections in the direction of the pole axis and the neutral axis are compensated by transverse slotting of the poles.

The rotor teeth at the end of the rotor body are provided with axial and radial ducts, enabling the cooling air to be discharged into the air gap for intensive cooling of the end windings.

After completion, the rotor is balanced in various planes at different speeds and then subjected to an overspeed test at 120% of rated speed for two minutes.

Fig. 1: Rotor shaft

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1 General

The rotor winding is symmetrical relative to the machine centre and the pole axis. The coils in each quarter obtained by the symmetrical configuration are subdivided into two cooling zones, the ***slot*** cooling zone and the ***end winding*** cooling zone, which in turn is subdivided into two separate cooling sections.

2 Slot Cooling Zone

The cooling air for the slot portion is admitted into the bottom ducts below the rotor winding at the end of the rotor body. As the rotor turns, the cooling air is passed through the radial ducts in the winding, insulating layers, slot-top fillers and rotor wedges by auto-circulation due to the centrifugal pumping head developed by the rotor and then discharged into the air gap.

3 End Winding Cooling Zone

The cooling air for the end winding is drawn from below the rotor retaining ring by the self-pumping rotor. An appropriate system of insulating pieces ensures intensive cooling of the rotor coils in the end windings.

The ***axial conductor cooling air*** enters the spaces between the coils at the axial-to-transverse conductor transitions and is discharged to the air gap via ducts in the ends of the rotor teeth.

The ***transverse conductor air*** is whirled by fillers between the coils. Continuously flowing-in cooling air displaces the warmed-up air into below the rotor retaining ring because of the density differences (thermosiphon principle). In the following the cooling air is discharged via slots in the pole area to the air gap.

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1 Construction

The field winding consists of several series connected coils inserted into the longitudinal slots of the rotor body. The coils are wound and electrically series-connected so that one north and one south magnetic pole are obtained.

The solid axial conductors arranged in the slots have a rectangular cross-section and are provided with axial slots for radial discharge of the cooling gas. The transverse conductors of the end winding have no axial slots and are wider than the axial conductors. As a result, a decreased heating by reason of current flow is obtained.

After insertion into the rotor slots, the individual conductors are combined to form full turns by brazing across corners.

2 Conductor Material

The conductors are made of copper with a silver content of approximately 0.1%. As compared to electrolytic copper, silver-alloyed copper features high strength properties at higher temperatures so that coil deformations due to thermal stresses are eliminated.

3 Insulation

The insulation between the individual turns is made of layers of glass fiber laminate. The coils are insulated from the rotor body with L-shaped strips of glass fiber laminate with ***Nomex*** filler.

To obtain the required leakage paths between the coil and the frame, thick top strips of glass fiber laminate are inserted below the slot wedges. The top strips are provided with axial slots of the same cross-section and spacing as used on the rotor winding.

4 Rotor Slot

(see also 4.1-3301)

To protect the winding against the effects of the centrifugal force, the winding is secured in the slots with wedges. The slot wedges are made from an alloy featuring high strength and good electrical conductivity, and are used as damper winding bars. The slot wedges extend below the shrink seats of the retaining rings. The rings act as short-circuit rings to induced currents in the damper winding.

5 End Winding Bracing

The spaces between the individual coils in the end winding are filled with insulating members. The insulating members prevent coil movement and are used for intensive cooling of the rotor end winding.

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Rotor Slot

1 Rotor slot wedge
2 Cooling air duct at ends of rotor body (cooling air for end winding)
3 Cooling air outlet duct in rotor slot wedge
4 Rotor shaft
5 Top strip
6 Slot liner
7 Conductor
8 Winding insulation
9 Slot bottom duct
10 Ventilation slot through conductors

Note: The number of conductors shown does not necessarily correspond to the number of conductors of the generator described.

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Rotor End Winding

1 Rotor body
2 Snap ring
3 Terminal lug
4 Rotor winding
5 Insulating piece
6 Retaining ring
7 End ring
8 Balancing nut

Note: The number of conductors/coils shown does not necessarily correspond to the number of conductors/coils of the generator described.

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The single-piece rotor retaining rings contain the centrifugal forces due to the end windings. One end of each ring is shrunk on the rotor body, while the other end of the ring overhangs the end windings without contacting the shaft. This ensures an unobstructed shaft deflection at the end windings.

The shrunk-on end ring at the free end of the retaining ring serves to reinforce the retaining ring and secures the end winding in the axial direction at the same time.

A locking ring is provided for additional protection against axial displacement of the retaining ring.

To reduce the stray losses and retain strength, the rings are made of non-magnetic, cold-worked material.

Comprehensive tests, such as control of the mechanical properties, ultrasonic examination and liquid penetrant examination, ensure adherence to the specified mechanical properties.

The retaining ring shrink-fit areas act as short-circuit rings to induced currents in the damper system. In case of increased unbalanced load requirements the shrink seats of the retaining rings are coated with nickel, aluminium and silver by a three-step flame spraying process to ensure low contact resistance.

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The field current is supplied to the rotating rotor through carbon brushes and two steel slip-rings arranged at the exciter-end shaft end.

1 Terminal Lug

The terminal lug consists of a copper conductor of rectangular cross section. One end of the terminal lug is brazed to the rotor winding, while the other end is screwed to the radial bolt.

2 Radial Bolt to the Rotor Winding

The field current lead in the shaft bore is connected to the terminal lug at the end winding through a radial bolt. The radial bolt is made from chrome copper and screwed into the field current lead located in the shaft bore.

3 Field Current Lead in Shaft Bore

The leads are run in the axial direction from the radial bolt to the end of the rotor. They consist of two semicircular steel sections insulated from each other and from the shaft.

4 Terminal bolts and slip-rings

The terminal bolts arranged between the slip-rings consist of chrome copper. They are screwed into the field current lead in the shaft bore and connected to the slip-rings through terminal lugs.

The slip-rings are shrink-fitted to the shaft extension and insulated from the shaft. The slip-rings are helically grooved. The slip-rings have axial and radial holes, which enable an intensive ventilation of the slip-rings with the grooves.

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1 Terminal bolts and slip-rings
2 Radial bolt to the terminal lug of the rotor winding
3 Bearing position

Fig. 1: Field connections with slip-rings

Fig. 1: Schematic arrangement of brushes on slip rings, unrolling view

Fig. 2: Schematic arrangement of brushes on slip rings, view from TE

NOTICE

Wrong brush arrangement may result in machine damage!

Pay attention to the axial rotor displacement with the arrangement of the plug-in brush mounts. The carbon brushes must seat on the slip rings at all thrust and expansion conditions. The abrasion of the slip rings should be as equally spaced as possible.

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Fig. 1: Brush holder

1 Handle
2 Pressure spring
3 Clamping pin
4 Telescope spring sleeve
5 Pressure spring
6 Pressure pin
7 Brush guide
8 Carbon brush

(Contact surfaces are tinned)

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The generator cooling air is circulated by two axial flow fans located on the two shaft ends.

To augment the cooling of the rotor winding, the pressure established by the fan works in conjunction with the air expelled from the discharge ports along the rotor.

The fan blades have a T-root fixture in the shaft. They are made of stainless steel. The last blade (1) is secured by a keeper (2). This keeper is fixed by three bolts (3) against the centrifugal forces.

Fig. 1: T-root fixture of fan blades

1	Blade
2	Keeper
3	Bolt

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SIEMENS

Turbogenerator | Operating and Maintenance Manual

Product Description 3

Generator Protection – General

Generators are high-performance electrical machines for securing the best possible continuity of power supply. They may be endangered by short-circuits, ground faults, overvoltages, underexcitation and excessive thermal stresses.

For reasons of safety, it is necessary to provide automatic protection facilities. The task of these facilities is to ensure re a fast and selective detection of any faults in order to minimize the fault-related damage.

The protective equipment must be designed so that any serious fault will result in an immediate disconnection, de-excitation of the generator and in a turbine trip if necessary.

Faults which do not cause any direct damage must be brought to the attention of the operating staff. The personnel are responsible for initiating the essential activities on the basis of the messages output. The machine can be moved out of the critical area. If necessary, there is the possibility to take precautionary measures for shutdown.

NOTE:

The protective functions described below are recommended by the manufacturer. The project-related implementation of the generator protection must be documented by the supplier of the protective device.

1 Differential Protection

Breakdown of insulation between different stator phase windings results in an internal short-circuit. This fault is detected by a differential relay which initiates immediate disconnection, de-excitation of the generator and shut down of the turbine.

- Operating value: 0.2 IN ?
- Relay time: < 60 ms

In certain cases, the generator may also be included in the over all differential protection for the main transformer and station service feeder. Generator faults are then detected by two differential protection devices. The both protective devices are graduated according to the operating value.

2 Stator Ground Fault Protection

Breakdown of insulation between the stator winding and frame results in a stator ground fault. The stator ground fault protection must cover at least 80% of the stator winding. Its task is to initiate immediate disconnection, de-excitation of the generator and turbine trip.

The relay time is specified depending on admissible load curve. This and further information can be found in section “Technical Data”, curve “Limitation of Earth Fault Current versus Time".

The load resistance of a grounding transformer and any required boost to raise the neutral point potential should be selected in such way that the ground current in case of a fault will not exceed 15 A.

3 Rotor Ground Fault Protection

In case of machines with brushless excitation, the rotor winding is checked for ground faults approx. 3 times a day.

The first alarm message is output when the insulation resistance is less than 8 kΩ. A second alarm message follows if the value falls below 2 kΩ. The purpose of the protective device is to stop the machine as quickly as possible in the event of an alarm. The relay time is 5 seconds.

The manufacturer must be informed without delay in the event of a rotor ground-fault. It is absolutely essential to find the cause and eliminate the short circuit to ground in order to avoid consequential damage from double ground faults.

4 Underexcitation Protection

Failure of the voltage regulator, maloperation of the generator or transformer control systems, or generator operation in a system with capacitive load may result in a reduction of the excitation required to ensure system stability below a predetermined minimum value.

Short-circuits or interruptions in the field circuit result in a complete loss of field and in instability of the generator. This causes higher temperature rises in the rotor and core end portions, rotor overvoltage, system swings and torsional vibrations of the shaft.

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A momentary excursion beyond the steady-state stability limit must not necessarily result in a loss of stability. Therefore it is advisable to design the underexcitation protection so that a warning will be given when the steady-state stability limit is reached. The generator will be shut down after a few seconds only.

The protection must operate quickly if a loss of field occurs when the steady-state stability limit is reached.

If the loss of field cannot be detected directly (e.g. exciters with rotating diodes), a second stator criterion is to be introduced covering the range of the permeance values $1 / x_d$ and $1 / x'_d$. There will be a quick tripping when this criterion is exceeded.

The precise setting of the tripping is made considering the stability diagram.

5 Overcurrent Protection

System faults may result in inadmissible thermal stressing of the generator. Therefore an overcurrent protection should be provided which operates on failure of the line protection.

A definite-time delay overcurrent relay may be used for this purpose, however, its delay time should be longer than that of the system protection.

- Operating value: 1.4 IN
- Relay time: 3 s considering the overriding protective system of the plant

To avoid long relay times, it is recommended that generators larger than 50 MW should be equipped with the second limit-value stage I>> tripping after short time.

If connected to the generator neutral point, the overcurrent protection serves as back-up protection for the differential protection.

Further information can be found in chapter 2, document “Extract of Technical Data”, sheet “Short Time Voltage / Frequency Capability”.

6 Load Unbalance Protection

Generators operating in an interconnected system are normally subjected to small load unbalances only. However, all one-and two-line-to-ground faults occurring in the system, phase interruptions or circuit breaker failures are in fact load unbalances which may result in a thermal overstressing of the rotor.

It is therefore advisable to provide a two-stage load unbalance protection. When the continuously permissible load unbalance is reached, an alarm is given, whereas after a short delay isolation from the system occurs when this value is exceeded.

In case of large units, it is recommended to implement a protection with unbalanced load/time characteristic. Operation value and relay time should be matched to the load unbalance/time characteristic applicable to the particular generator

7 Overvoltage Protection

Rejection of partial or complete system loads causes a voltage rise, followed by an increase in the prime mover speed. This reason may endanger the generator and its connected apparatuses due to unacceptable high voltages.

Maloperation during manual voltage regulation of the generator may also result in inadmissible voltage stressing of these equipment. Due to the sudden voltage variations resulting from switching operations, it is advisable, at least in the case of large units, to provide a two-stage rise-in voltage protection, i.e:

a) with high operation value (1.3 UN) and tripping after 0.75 s.

b) with high operation value (1.15 UN) and tripping after 5 s.

8 Under-Frequency Protection

Major disturbances in an interconnected system may result in operation of the generator at under-frequency. At rated voltage, the generator can be continuously operated at rated apparent power down to 95% of rated frequency.

To avoid excessive magnetic and thermal stressing, an under-frequency protection is provided.

Since the frequency deviation due to a system disturbance is normally accompanied by a voltage deviation, the protection will be designed on the basis of the permissible load characteristic of the generator on frequency and voltage deviations.

9 Reserve Power Protection

The reverse power protection is a protective equipment for the turbine. Specific faults in the turboset interior initiate emergency trip.

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In this case the steam supply to the turbine is interrupted. A reliable criterion of perfectly tight closure of the emergency stop valves is the reverse flow of power from the system back into the generator.

Disconnection of the unit from the system by the generator circuit breaker with a time delay of 1 s is only permissible after the reserve power has been drawn by the generator (short-time setting). If the stop valves are still open but the control valves are closed there has to be a trip by reverse power after 10 s.

- Operating value:
  approx. 50% of the reserve power measured with closed valves
- Relay time:
  long-time setting: approx. 10 s, short-time setting: approx. 1 s

10 Overvoltage Protective Equipment

The use of surge arrestors on the high-voltage side of the unit transformer is considered sufficient for protecting the generator against atmospheric overvoltages and switching surges in the system.

If the generator voltage level is led into the open field (danger of lightning) or if there is a breaker mounted between unit transformer and generator, overvoltage stress of generator must be avoided by suitable measures.

In order to implement these measures, it is necessary to use explosion-proof devices or implement appropriate structural measures which, in the event of overload, will eliminate the risk to people and damage to nearby parts of the plant.

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TT = Turbine Trip
GCB = Generator Circuit Breaker
FB = Field Breaker

Alarm is initiated when the electrical generator protection system is tripped.
Individual alarms for each criterion are provided.

* In case of a rotor ground fault only an alarm is initiated, but the system does not trip.

Grounding brushes are fitted to the bearing or labyrinth ring to remove the static charges of the shaft train.

When the grounding brushes are fitted, the direction of rotation of the rotor must be observed. In anti-clockwise operation brushes are to be mounted as shown in fig. 1; for clockwise operation see fig. 2.

Fig. 1: Plug-in brush holder with grounding brushes in anti-clockwise operation

1 Handle lever (moveable)
2 Finger plate
3 Two-layer grounding brush (design A)
4 Two-layer grounding brush (design B)
5 Rotor surface
6 Plug-in brush holder

Fig. 2: Plug-in brush holder with grounding brushes in clockwise operation

1 Handle lever (moveable)
2 Finger plate
3 Two-layer grounding brush (design B)
4 Two-layer grounding brush design A)
5 Rotor surface
6 Plug-in brush holder

The brush holders are arranged with 90° displacement. This arrangement ensures that at least one brush will make contact with the rotating shaft train.

Fig. 3: Arrangement of plug-in brush holder with a 90° displacement

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The monitoring of measured quantities relevant for every function is an essential condition for ensuring the reliable operation of a turbo-generator.

The number of measured quantities monitored should be sufficient to guarantee the comprehensive and unequivocal diagnosis of the operating condition on the one hand. But the number of measured quantities monitored must not exceed a certain amount in order to allow a quick and clear overview free of any doubt especially in critical operating situations on the other hand.

A relatively small number of measured quantities to be monitored will also reduce possible interference effects or the liability to interference of the measured quantity monitoring system.

The measuring and monitoring system to be installed on a generator depends on the wishes of its owner. An overview of the measuring and monitoring elements installed and of their locations may be obtained from the wiring manual.

Temperature and vibration are among the most important measured quantities that are monitored on a generator. The limit values applicable to temperature or vibration are indicated in the dimensional drawing text.

1 Temperature monitoring

1.1 Stator Slot Temperature

Resistance temperature detectors (RTD`s) in the shape of long thin strips are used for measuring the slot temperatures.

The platinum measuring wire is embedded in an insulating moulding to insulate it and relieve it of stress. Single Pt-100 elements with integrally cast four wire Teflon connecting cables are used.

The slot resistance thermometers are directly embedded in the stator slots between the top and bottom bars at those positions where the highest temperatures are expected. The thermometers lie embedded in glass-fiber laminate strips, encased by the resin of the Micalastic® insulation.

The coil-side corona shielding of the winding, which has ground potential, is located between the thermometer and the intermediate voltage potential of the winding.

The thermometers have high mechanical strength and are not affected by electrical or magnetic fields.

To avoid both capacitive and inductive noise factors, a filter corresponding to the line frequency (50 Hz or 60 Hz) should be inserted in the circuit.

Fig. 1: Slot thermometer arrangement

1.2 Cold and Hot Air Temperatures

The temperatures of the cold and hot air flows are measured by resistance temperature detectors (RTD`s).

Pt100 resistance temperature detectors with double or triple elements and four wire circuitry, or type K thermocouples as double or triple elements are used according to customer requirements.

1.3 Bearing Temperature

The bearing temperature allows the detection and the evaluation of deviations from a normal operating status under defined operating conditions.

The measurement and registration of the temperatures normally is done in conjunction with the turbine monitoring. The extended turbine protection is

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triggered if e.g. the maximum permissible bearing temperature is exceeded.

The measuring points of the bearing temperature are located in the lower bearing shell in the area of the joint of the bearing metal and the bearing shell. In addition, there is an option of fitting oil sump, radial and axial part sensors.

The temperature sensors are of screw-in resistance temperature detector of 2 x Pt100 type or thermo-couples.

2 Vibration monitoring

2.1 Bearing Pedestal Vibration

The absolute vibration of the bearing pedestal housing can be measured by sensors.

2.2 Shaft Vibration

Special sensors are fitted to detect the relative shaft vibrations. Boreholes are provided in the bearing cover for these sensors.

The measurement of the shaft vibration provides information about the running properties of the shaft (bearing play, unbalance etc.).

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SIEMENS

Turbogenerator | Operating and Maintenance Manual

Product Description 3

Auxiliary Wiring Diagrams

SIEMENS
ENERGY SECTOR
GN ERF (Erfurt plant)

AUXILIARY WIRING DIAGRAMS GENERATOR

PROJECT	Attarat 10, 20
ORDER NUMBER	EG000333 , 334
PURCHASER	
Final Customer / User	
Date of issue	2017, May 30

Revision A 2017, May 30

USE KKS-PREFIX:
11 FOR ATTARAT UNIT 10
12 FOR ATTARAT UNIT 20

NUMBER OF PAGES 63

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			Appr.	Heiland							EG000333	DPPPG-70140696	Page 1
REVISION	Date	Name	NORM		ECCN: EAR99	AL: N	ECL: N	US-Content: N					Pg. 63

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no.	sh. index	Date	Name	Description of changes
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Consumer List

no.	KKS	Description	Rated Power	Rated Voltage	400 V 50Hz	230 V 50Hz	24V DC		Start	Operation	Standstill	Notes
1	=MKA05AH011-E1	GENERATOR HEATER TE	1600 W	400 V 50Hz	1600 W				1600 W		1600 W	
2	=MKA05AH012-E1	GENERATOR HEATER EE	1600 W	400 V 50Hz	1600 W				1600 W		1600 W	
3	=MKA11CL001-B1	LEAKAGE WATER SENSOR	0,5 W	24V DC			0,5 W		0,5 W	0,5 W	0,5 W	
4	=MKA11CL002-B1	LEAKAGE WATER SENSOR	0,5 W	24V DC			0,5 W		0,5 W	0,5 W	0,5 W	
5	=MKA11CL003-B1	LEAKAGE WATER SENSOR	0,5 W	24V DC			0,5 W		0,5 W	0,5 W	0,5 W	
6	=MKA11CL004-B1	LEAKAGE WATER SENSOR	0,5 W	24V DC			0,5 W		0,5 W	0,5 W	0,5 W	
7	=MKC10GP002-E01/02	HOOD LIGHT	2x110 W	230 V 50Hz		220 W			220 W	220 W	220 W	
8	=MKC06AN001-M1	MOTOR SLIPRING VENTILATION	1000 W	400 V 50Hz	1000 W				1000 W	1000 W		
9	=MKC07AN001-M1	MOTOR SLIPRING VENTILATION	1000 W	400 V 50Hz	1000 W				1000 W	1000 W		
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30	**TOTAL ELECTRICAL CONSUMPTION [W]**				**5200 W**	**220 W**	**2 W**		**5222 W**	**2222 W**	**3222 W**	

KKS	DESCRIPTION	TYPE	MANUFACTURER
=MKA20CT001-B1	STATOR SLOT THERMOMETER 1	4-123317	TMG
=MKA20CT002-B1	STATOR SLOT THERMOMETER 2	4-123317	TMG
=MKA20CT003-B1	STATOR SLOT THERMOMETER 3	4-123317	TMG
=MKA20CT004-B1	STATOR SLOT THERMOMETER 4	4-123317	TMG
=MKA20CT005-B1	STATOR SLOT THERMOMETER 5	4-123317	TMG
=MKA20CT006-B1	STATOR SLOT THERMOMETER 6	4-123317	TMG
=MKA20CT007-B1	STATOR SLOT THERMOMETER 7	4-123317	TMG
=MKA20CT008-B1	STATOR SLOT THERMOMETER 8	4-123317	TMG
=MKA20CT009-B1	STATOR SLOT THERMOMETER 9	4-123317	TMG
=MKA20CT010-B1	STATOR SLOT THERMOMETER 10	4-123317	TMG
=MKA20CT011-B1	STATOR SLOT THERMOMETER 11	4-123317	TMG
=MKA20CT012-B1	STATOR SLOT THERMOMETER 12	4-123317	TMG
=MKA20CT013-B1	STATOR SLOT THERMOMETER 13 (SPARE)	4-123317	TMG
=MKA20CT014-B1	STATOR SLOT THERMOMETER 14 (SPARE)	4-123317	TMG
=MKA20CT015-B1	STATOR SLOT THERMOMETER 15 (SPARE)	4-123317	TMG
=MKA35CT001-B1	STATOR CORE THERMOMETER 1	2-121854	TMG
=MKA35CT002-B1	STATOR CORE THERMOMETER 2	2-121854	TMG
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=MKA35CT005-B1	STATOR CORE THERMOMETER 5	2-121854	TMG
=MKA35CT006-B1	STATOR CORE THERMOMETER 6	2-121854	TMG
=MKD11CT013A/B/C-B1	BEARING METAL THERMOM. TE	MQ 0206-PVDF	TMG
=MKD12CT013A/B/C-B1	BEARING METAL THERMOM. EE	MQ 0206-PVDF	TMG
=MKA71CT011A/B-B1	COLD AIR THERMOMETER TE	WQ 0233	TMG
=MKA71CT012A/B-B1	COLD AIR THERMOMETER TE	WQ 0233	TMG
=MKA73CT011A/B-B1	COLD AIR THERMOMETER EE	WQ 0233	TMG
=MKA73CT012A/B-B1	COLD AIR THERMOMETER EE	WQ 0233	TMG
=MKA76CT011A/B-B1	WARM AIR THERMOMETER	WQ 0233	TMG

KKS	DESCRIPTION	TYPE	MANUFACTURER
=MKA11CL001-B1	LEAKAGE WATER SENSOR TE	SITRANS LVL100 (7ML5745-1BA42-1BA0)	Siemens
=MKA11CL002-B1	LEAKAGE WATER SENSOR TE	SITRANS LVL100 (7ML5745-1BA42-1BA0)	Siemens
=MKA11CL003-B1	LEAKAGE WATER SENSOR EE	SITRANS LVL100 (7ML5745-1BA42-1BA0)	Siemens
=MKA11CL004-B1	LEAKAGE WATER SENSOR EE	SITRANS LVL100 (7ML5745-1BA42-1BA0)	Siemens
=MKD11CY041-B1	REL. SHAFT VIBRATION SENSOR TE-X	TQ412	MEGGIT
=MKD11CY041-U1	SIGNAL CONDITIONER	IQS450	MEGGIT
=MKD11CY042-B1	REL. SHAFT VIBRATION SENSOR TE-Y	TQ412	MEGGIT
=MKD11CY042-U1	SIGNAL CONDITIONER	IQS450	MEGGIT
=MKD12CY041-B1	REL. SHAFT VIBRATION SENSOR EE-X	TQ412	MEGGIT
=MKD12CY041-U1	SIGNAL CONDITIONER	IQS450	MEGGIT
=MKD12CY042-B1	REL. SHAFT VIBRATION SENSOR EE-Y	TQ412	MEGGIT
=MKD12CY042-U1	SIGNAL CONDITIONER	IQS450	MEGGIT
=MKD11CY021-B1	ABSOL. BEARING VIBRATION SENSOR TE-A	CA202	MEGGIT
=MKD11CY021-U1	SIGNAL CONDITIONER	IPC704	MEGGIT
=MKD11CY022-B1	ABSOL. BEARING VIBRATION SENSOR TE-B	CA202	MEGGIT
=MKD11CY022-U1	SIGNAL CONDITIONER	IPC704	MEGGIT
=MKD12CY021-B1	ABSOL. BEARING VIBRATION SENSOR EE-A	CA202	MEGGIT
=MKD12CY021-U1	SIGNAL CONDITIONER	IPC704	MEGGIT
=MKD12CY022-B1	ABSOL. BEARING VIBRATION SENSOR EE-B	CA202	MEGGIT
=MKD12CY022-U1	SIGNAL CONDITIONER	IPC704	MEGGIT
=MKA05AH011-E1	HEATER TE	ERCH III/38	Schniewindt
=MKA05AH012-E1	HEATER EE	ERCH III/38	Schniewindt
=MKA40CE001-B1	AIR GAP FLUX PROBE	FLUX PROBE	IRIS POWER

TOP VIEW - SCHEMATICAL DRAWING

+MKA11GC041
JUNCTION BOX MEASURING

+MKD11GF001
JUNCTION BOX VIBRATION TE

+MKD12GF001
JUNCTION BOX VIBRATION EE

+MKA11GE031
JUNCTION BOX VOLTAGE

+MKC10GP001
JUNCTION BOX HOOD LIGHT

+MKA40GC001
JUNCTION BOX ROTOR EARTHING

+MKC05GE001
JUNCTION BOX SLIP RING VENTILATION

+MKA11GC042
AIR GAP FLUX PROBE

TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting
+MKA11GC041
JUNCTION BOX MEASURING

REMARKS FOR ASSEMBLY AT SITE

NONE

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

CABLING
STATOR SLOT THERMOMETER
LOCATION DIAGRAM

=
+ CABLING

EG000333 | DPPPG-70140696

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TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting

+MKA11GC041
JUNCTION BOX MEASURING

REMARKS FOR ASSEMBLY AT SITE

NONE

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

CABLING
STATOR CORE THERMOMETER
LOCATION DIAGRAM

=
+ CABLING

EG000333 | DPPPG-70140696

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TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting
+MKA11GC041
JUNCTION BOX MEASURING

REMARKS FOR ASSEMBLY AT SITE

NONE

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

CABLING
BEARING THERMOMETER
LOCATION DIAGRAM

=
+ CABLING

EG000333 | DPPPG-70140696

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TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting
+MKA11GC041
JUNCTION BOX MEASURING

WITH ANGLE BRACKET

IN THREATED HOLE G 1/2"

REMARKS FOR ASSEMBLY AT SITE

NONE

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

CABLING
AIR THERMOMETER
LOCATION DIAGRAM

=
+ CABLING

EG000333 | DPPPG-70140696

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TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting
+MKA11GC041
JUNCTION BOX MEASURING

Leakage water detector SITRANS LVL100
in leakage water collector of cooler

LEAKAGE WATER DETECTION UNIT

WIRING AT BOTTOM SIDE OF COOLER

HAN3A

REMARKS FOR ASSEMBLY AT SITE

CONNECT PLUG CONNECTORS TO
LEAKAGE WATER ELECTRODES

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	CABLING LEAKAGE WATER DETECTION LOCATION DIAGRAM		=		
			Drawn	Möbius					+ CABLING		
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	13
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting

PROBE HOUSING
PROXIMITORS ARRANGED IN JUNCTION BOX

+MKD11GF001
JUNCTION BOX VIBRATION MEASUREMENT TE

+MKD12GF001
JUNCTION BOX VIBRATION MEASUREMENT EE

REMARKS FOR ASSEMBLY AT SITE

NONE

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	CABLING RELATIVE SHAFT VIBRATION LOCATION DIAGRAM		=	
			Drawn	Möbius					+ CABLING	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 14
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting

+MKD11GF001
JUNCTION BOX VIBRATION MEASUREMENT TE

+MKD12GF001
JUNCTION BOX VIBRATION MEASUREMENT EE

REMARKS FOR ASSEMBLY AT SITE

NONE

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	CABLING ABSOL. BEARING VIBRATION LOCATION DIAGRAM		=		
			Drawn	Möbius					+ CABLING		
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	15
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting

+MKA11GC042
AIR GAP FLUX PROBE

AIR GAP FLUX PROBE ON STATOR SLOT

BNC-SOCKET WITH VOLTAGE FUSE
IN WALL OF BASE FRAME

REMARKS FOR ASSEMBLY AT SITE

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

CABLING
FLUX PROBE
LOCATION DIAGRAM

=
+ CABLING

EG000333 | DPPPG-70140696

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TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting

+MKA11GC041
JUNCTION BOX MEASURING

REMARKS FOR ASSEMBLY AT SITE

NONE

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

CABLING
ROTOR POTENTIAL MEASURING
LOCATION DIAGRAM

=
+ CABLING

EG000333 | DPPPG-70140696

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TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting

+MKA11GE031
JUNCTION BOX VOLTAGE

WITH ANGLE BRACKET

REMARKS FOR ASSEMBLY AT SITE

NONE

[FOR I&C PURPOSE IS USED ONLY MKC05AH001]

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

CABLING
ANTICONDENSATION HEATER
LOCATION DIAGRAM

=
+ CABLING

EG000333 | DPPPG-70140696

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TOP VIEW - SCHEMATICAL DRAWING

REMARKS FOR ASSEMBLY AT FACTORY

Check all devices after mounting

REMARKS FOR ASSEMBLY AT SITE

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

CABLING
HOOD LIGHT
LOCATION DIAGRAM

=
+ CABLING

EG000333 | DPPPG-70140696

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MANUFACTURER HÄWA
STANDARD CASING
K20-40/40
DEGREE OF PROTECTION
IP66

TAPPED HOLES IN REAR WALL
(SIEMENS)

FLANGE PLATES AT
TOP AND BOTTOM
(CUSTOMER)

MOUNTING RAIL
TS 35 (EN60715)

ALL DIMENSIONS IN MM

SCALE 1:2(A3)

COLOUR: RAL 7035

VIEW ON RIGHT HAND SIDE

FRONT VIEW WITHOUT COVER

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX MEASURING MOUNTING PLATE	DPPPG-70064514		=	
			Drawn	Möbius						+ MKA11GC041	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	20
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

JUNCTION BOX MEASURING
STATOR WINDING TEMPERATURE

DPPPG-70064514

=
+ MKA11GC041

EG000333 DPPPG-70140696

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			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

JUNCTION BOX MEASURING
STATOR WINDING TEMPERATURE

DPPPG-70064514

=
+ MKA11GC041

EG000333 DPPPG-70140696

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			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

JUNCTION BOX MEASURING
STATOR WINDING TEMPERATURE

DPPPG-70064514

=
+ MKA11GC041

EG000333 DPPPG-70140696

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STATOR CORE TEMPERATURE

DE ... DRIVE END
NDE ... NON DRIVE END

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX MEASURING STATOR CORE TEMPERATURE		=	
			Drawn	Möbius					+ MKA11GC041	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 24
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

BEARING METAL TEMP. TE
TRIPLE ELEMENT

=MKD11CT013A/B/C-B1

BEARING METAL TEMP. EE
TRIPLE ELEMENT

=MKD12CT013A/B/C-B1

TE ... TURBINE END
EE ... EXCITER END

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX MEASURING BEARING TEMPERATURE	DPPPG-70064514		=	
			Drawn	Möbius						+ MKA11GC041	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	25
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

COLD AIR TEMP. TE

DOUBLE ELEMENT

=MKA71CT011A/B-B1

DOUBLE ELEMENT

=MKA71CT012A/B-B1

TE ... TURBINE END
EE ... EXCITER END

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX MEASURING COLD AIR TEMPERATURE	DPPPG-70064514	=	
			Drawn	Möbius					+ MKA11GC041	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 26
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

COLD AIR TEMP. EE

DOUBLE ELEMENT

=MKA73CT011A/B-B1

DOUBLE ELEMENT

=MKA73CT012A/B-B1

TE ... TURBINE END
EE ... EXCITER END

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX MEASURING COLD AIR TEMPERATURE	DPPPG-70064514	= + MKA11GC041	
			Drawn	Möbius						
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 27
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

WARM AIR TEMPERATURE
DOUBLE ELEMENT

=MKA76CT011A/B-B1

TE ... TURBINE END
EE ... EXCITER END

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX MEASURING WARM AIR TEMPERATURE	DPPPG-70064514	= + MKA11GC041	
			Drawn	Möbius						
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 28
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

LEAKAGE WATER SENSOR TE

LEAKAGE WATER SENSOR EE

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX MEASURING LEAKAGE WATER DETECTION	DPPPG-70064514	= + MKA11GC041	
			Drawn	Möbius						
			Appr.	Heiland						
REVISION	Date	Name	NORM		Replacement for	Replaced by		EG000333	DPPPG-70140696	Page 29 Pg. 63

DE ... DRIVE END
NDE ... NON DRIVE END

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX ROTOR POTENTIAL MEASURING	DPPPG-70135682		=	
			Drawn	Möbius						+ MKA11GC041	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	30
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

Terminal diagram

Terminal strip
=+MKA11GC041-X0

item designation	Lev.	no. cable	type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev.	no. cable	type cable	page / track
							1		-F01	2				30 2
							2		-F01	4				30 3
							3		-F01	6				30 4
							4							
							5		-F01	14				30 5
							6		-F01	22				30 5
							7		-F01	13				30 5
							8		-F01	21				30 5
							9							
							10							
							PE							
							PE							

SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKA11GC041-X0		=		
			Drawn	Möbius					+ MKA11GC041		
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	31
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

Terminal diagram

item designation					Lev. / no. cable / type cable	Terminal strip =+MKA11GC041-X1 destination A	terminal	link	terminal number		destination B	terminal	Lev. / no. cable / type cable	MKA10SWT001 TEFLON	MKA10SWT002 TEFLON	MKA10SWT003 TEFLON	MKA10SWT004 TEFLON	MKA10SWT005 TEFLON	MKA10SWT006 TEFLON	MKA10SWT007 TEFLON	MKA10SWT008 TEFLON	page / track
SLOT 3 -U								⊙	1		=MKA20CT001-B1			BU								21 0
=								⊙	2		=MKA20CT001-B1			RD								21 1
=								⊙	3		=MKA20CT001-B1			GY								21 1
=								⊙	4		=MKA20CT001-B1			YE								21 1
SLOT 39 -V								⊙	5		=MKA20CT002-B1				BU							21 2
=								⊙	6		=MKA20CT002-B1				RD							21 2
=								⊙	7		=MKA20CT002-B1				GY							21 2
=								⊙	8		=MKA20CT002-B1				YE							21 2
SLOT 21 -W								⊙	9		=MKA20CT003-B1					BU						21 3
=								⊙	10		=MKA20CT003-B1					RD						21 3
=								⊙	11		=MKA20CT003-B1					GY						21 4
=								⊙	12		=MKA20CT003-B1					YE						21 4
SLOT 4 -U								⊙	13		=MKA20CT004-B1						BU					21 5
=								⊙	14		=MKA20CT004-B1						RD					21 5
=								⊙	15		=MKA20CT004-B1						GY					21 5
=								⊙	16		=MKA20CT004-B1						YE					21 6
SLOT 40 -V								⊙	17		=MKA20CT005-B1							BU				21 6
=								⊙	18		=MKA20CT005-B1							RD				21 6
=								⊙	19		=MKA20CT005-B1							GY				21 7
=								⊙	20		=MKA20CT005-B1							YE				21 7
SLOT 22 -W								⊙	21		=MKA20CT006-B1								BU			21 8
=								⊙	22		=MKA20CT006-B1								RD			21 8
=								⊙	23		=MKA20CT006-B1								GY			21 8
=								⊙	24		=MKA20CT006-B1								YE			21 8
SLOT 29 -U								⊙	25		=MKA20CT007-B1									BU		22 0
=								⊙	26		=MKA20CT007-B1									RD		22 1
=								⊙	27		=MKA20CT007-B1									GY		22 1
=								⊙	28		=MKA20CT007-B1									YE		22 1
SLOT 11 -V								⊙	29		=MKA20CT008-B1										BU	22 2
=								⊙	30		=MKA20CT008-B1										RD	22 2
=								⊙	31		=MKA20CT008-B1										GY	22 2
=								⊙	32		=MKA20CT008-B1										YE	22 2

SEPARATION PLATE
SEPARATION WITH TS-K

Terminal diagram

item designation	Lev. / no. cable / type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev. / no. cable / type cable	MKA10SWT009 TEFLON	MKA10SWT010 TEFLON	MKA10SWT011 TEFLON	MKA10SWT012 TEFLON	page / track
		Terminal strip =+MKA11GC041-X1												
SLOT 47 -W				⊕	33		=MKA20CT009-B1			BU				22 3
=				⊕	34		=MKA20CT009-B1			RD				22 3
=				⊕	35		=MKA20CT009-B1			GY				22 4
=				⊕	36		=MKA20CT009-B1			YE				22 4
SLOT 30 -U				⊕	37		=MKA20CT010-B1				BU			22 5
=				⊕	38		=MKA20CT010-B1				RD			22 5
=				⊕	39		=MKA20CT010-B1				GY			22 5
=				⊕	40		=MKA20CT010-B1				YE			22 6
SLOT 12 -V				⊕	41		=MKA20CT011-B1					BU		22 6
=				⊕	42		=MKA20CT011-B1					RD		22 6
=				⊕	43		=MKA20CT011-B1					GY		22 7
=				⊕	44		=MKA20CT011-B1					YE		22 7
SLOT 48 -W				⊕	45		=MKA20CT012-B1						BU	22 8
=				⊕	46		=MKA20CT012-B1						RD	22 8
=				⊕	47		=MKA20CT012-B1						GY	22 8
=				⊕	48		=MKA20CT012-B1						YE	22 8
SLOT 2 -U				⊕	49									
=				⊕	50									
=				⊕	51									
=				⊕	52									
SLOT 38 -V				⊕	53									
=				⊕	54									
=				⊕	55									
=				⊕	56									
SLOT 20 -W				⊕	57									
=				⊕	58									
=				⊕	59									
=				⊕	60									
SLOT 22 -W				⊕	PE									
SLOT 48 -W				⊕	PE									
				○										
				○										

SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKA11GC041-X1	=	
			Drawn	Möbius				+ MKA11GC041	
			Appr.	Heiland				EG000333	DPPPG-70140696
REVISION	Date	Name	NORM		Replacement for	Replaced by		Page 33	Pg. 63

Terminal diagram

Terminal strip
=+MKA11GC041-X1A

item designation	Lev.	no. cable	type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev.	no. cable	type cable	MKA10SCT001 TEFLON	MKA10SCT002 TEFLON	MKA10SCT003 TEFLON	MKA10SCT004 TEFLON	MKA10SCT005 TEFLON	MKA10SCT006 TEFLON	page / track
SLOT /						⊛	1		=MKA35CT001-B1					BN						24 0
=						⊛	2		=MKA35CT001-B1					WH						24 1
=						⊛	3		=MKA35CT001-B1					GN						24 1
=						⊛	4		=MKA35CT001-B1					YE						24 1
=						⊛	5		=MKA35CT002-B1						BN					24 2
=						⊛	6		=MKA35CT002-B1						WH					24 2
=						⊛	7		=MKA35CT002-B1						GN					24 2
=						⊛	8		=MKA35CT002-B1						YE					24 2
=						⊛	9		=MKA35CT003-B1							BN				24 3
=						⊛	10		=MKA35CT003-B1							WH				24 3
=						⊛	11		=MKA35CT003-B1							GN				24 4
=						⊛	12		=MKA35CT003-B1							YE				24 4
=						⊛	13		=MKA35CT004-B1								BN			24 5
=						⊛	14		=MKA35CT004-B1								WH			24 5
=						⊛	15		=MKA35CT004-B1								GN			24 5
=						⊛	16		=MKA35CT004-B1								YE			24 6
=						⊛	17		=MKA35CT005-B1									BN		24 6
=						⊛	18		=MKA35CT005-B1									WH		24 6
=						⊛	19		=MKA35CT005-B1									GN		24 7
=						⊛	20		=MKA35CT005-B1									YE		24 7
=						⊛	21		=MKA35CT006-B1										BN	24 8
=						⊛	22		=MKA35CT006-B1										WH	24 8
=						⊛	23		=MKA35CT006-B1										GN	24 8
=						⊛	24		=MKA35CT006-B1										YE	24 8
=						⊛	PE													
						○														
						○														
						○														
						○														
						○														
						○														
						○														

SEPARATION PLATE
SEPARATION WITH TS-K

Terminal diagram

Terminal strip
=+MKA11GC041-X2

item designation	type cable	destination A	terminal	link	terminal number	destination B	terminal	type cable	page / track
BEARING METAL TEMP. TE					1	=MKD11CT013A/B/C-B1	1		25 1
=					2	=MKD11CT013A/B/C-B1	2		25 1
=					3	=MKD11CT013A/B/C-B1	3		25 1
=					4	=MKD11CT013A/B/C-B1	4		25 1
=					5	=MKD11CT013A/B/C-B1	5		25 2
=					6	=MKD11CT013A/B/C-B1	6		25 2
=					7				
=					8				
BEARING METAL TEMP. EE					9	=MKD12CT013A/B/C-B1	1		25 4
=					10	=MKD12CT013A/B/C-B1	2		25 4
=					11	=MKD12CT013A/B/C-B1	3		25 5
=					12	=MKD12CT013A/B/C-B1	4		25 5
=					13	=MKD12CT013A/B/C-B1	5		25 5
=					14	=MKD12CT013A/B/C-B1	6		25 5
=					15				
=					16				
BEARING METAL TEMP. TE					17				25;25 2;1
BEARING METAL TEMP. EE					18				25;25 5;5
=					19				
=					20				
=					PE				

SEPARATION PLATE
SEPARATION WITH TS-K

Terminal diagram

item designation	Lev. / no. cable / type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev. / no. cable / type cable	MKA10CAT001 340-C-PUR	MKA10CAT002 340-C-PUR	MKA10CAT003 340-C-PUR	MKA10CAT004 340-C-PUR	page / track
		Terminal strip =+MKA11GC041-X3												
COLD AIR TEMP. TE					1		=MKA71CT011A/B-B1	1		WH				26 1
=					2		=MKA71CT011A/B-B1	2		BN				26 1
=					3		=MKA71CT011A/B-B1	3		GN				26 1
=					4		=MKA71CT011A/B-B1	4		YE				26 1
=					5		=MKA71CT011A/B-B1	5		GY				26 2
=					6		=MKA71CT011A/B-B1	6		PK				26 2
=					7		=MKA71CT011A/B-B1	7		BU				26 2
=					8		=MKA71CT011A/B-B1	8		RD				26 2
=					9		=MKA71CT012A/B-B1	1			WH			26 3
=					10		=MKA71CT012A/B-B1	2			BN			26 4
=					11		=MKA71CT012A/B-B1	3			GN			26 4
=					12		=MKA71CT012A/B-B1	4			YE			26 4
=					13		=MKA71CT012A/B-B1	5			GY			26 4
=					14		=MKA71CT012A/B-B1	6			PK			26 4
=					15		=MKA71CT012A/B-B1	7			BU			26 5
=					16		=MKA71CT012A/B-B1	8			RD			26 5
COLD AIR TEMP. EE					17		=MKA73CT011A/B-B1	1				WH		27 1
=					18		=MKA73CT011A/B-B1	2				BN		27 1
=					19		=MKA73CT011A/B-B1	3				GN		27 1
=					20		=MKA73CT011A/B-B1	4				YE		27 1
=					21		=MKA73CT011A/B-B1	5				GY		27 2
=					22		=MKA73CT011A/B-B1	6				PK		27 2
=					23		=MKA73CT011A/B-B1	7				BU		27 2
=					24		=MKA73CT011A/B-B1	8				RD		27 2
=					25		=MKA73CT012A/B-B1	1					WH	27 3
=					26		=MKA73CT012A/B-B1	2					BN	27 4
=					27		=MKA73CT012A/B-B1	3					GN	27 4
=					28		=MKA73CT012A/B-B1	4					YE	27 4
=					29		=MKA73CT012A/B-B1	5					GY	27 4
=					30		=MKA73CT012A/B-B1	6					PK	27 4
=					31		=MKA73CT012A/B-B1	7					BU	27 5
=					32		=MKA73CT012A/B-B1	8					RD	27 5

SEPARATION PLATE
SEPARATION WITH TS-K

Terminal diagram

Terminal strip
=+MKA11GC041-X3

item designation	Lev. / no. cable / type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev. / no. cable / type cable	MKA10WAT001 / 340-C-PUR	MKA10CAT001 / 340-C-PUR	MKA10CAT002 / 340-C-PUR	MKA10CAT003 / 340-C-PUR	MKA10CAT004 / 340-C-PUR	page / track
WARM AIR TEMPERATURE					33		=MKA76CT011A/B-B1	1		WH					28 1
=					34		=MKA76CT011A/B-B1	2		BN					28 1
=					35		=MKA76CT011A/B-B1	3		GN					28 1
=					36		=MKA76CT011A/B-B1	4		YE					28 1
=					37		=MKA76CT011A/B-B1	5		GY					28 2
=					38		=MKA76CT011A/B-B1	6		PK					28 2
=					39		=MKA76CT011A/B-B1	7		BU					28 2
=					40		=MKA76CT011A/B-B1	8		RD					28 2
COLD AIR TEMP. TE					41										26 2
=					42										26 5
COLD AIR TEMP. EE					43										27 2
=					44										27 5
WARM AIR TEMPERATURE					45										28 2
=					PE										

SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKA11GC041-X3		=		
			Drawn	Möbius					+ MKA11GC041		
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	37
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

Terminal diagram

Terminal strip
=+MKA11GC041-X5

item designation	Lev. / no. cable / type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev. / no. cable / type cable	MKA10LWD001 / MEGAFLEX 500	MKA10LWD002 / MEGAFLEX 500	page / track
LEAKAGE WATER SENSOR TE					1		=MKA11CL001-B1	1		1		29 1
=					2		=MKA11CL001-B1	2		2		29 1
=					3		=MKA11CL001-B1	3		3		29 1
=					4		=MKA11CL002-B1	1			1	29 3
=					5		=MKA11CL002-B1	2			2	29 3
=					6		=MKA11CL002-B1	3				29 4
LEAKAGE WATER SENSOR EE					7							
=					8							
=					9							
=					10							
=					11							
=					12							
LEAKAGE WATER SENSOR TE					PE		=MKA11CL001-B1	PE		GNYE		29 2
=					PE		=MKA11CL002-B1	PE				29 4
LEAKAGE WATER SENSOR EE					PE							
=					PE							

SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKA11GC041-X5
			Drawn	Möbius			
			Appr.	Heiland			
REVISION	Date	Name	NORM		Replacement for	Replaced by	

=
+ MKA11GC041

EG000333 DPPPG-70140696

MANUFACTURER HÄWA
STANDARD CASING K12-30/20
DEGREE OF PROTECTION IP65

TAPPED HOLES

MOUNTING RAIL TS 35 (EN60715)

ALL DIMENSIONS IN MM

SCALE 1:2 (A3)

BOTTOM SIDE FOR CUSTOMER CONNECTION DRILLED AT SITE

COLOUR: RAL 7035

VIEW ON RIGHT HAND SIDE

FRONT VIEW WITHOUT COVER

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX VIBRATION MOUNTING PLATE TURBINE END	DPPPG-70012281	=		
			Drawn	Möbius					+ MKD11GF001		
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	39
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

BEARING TE

REL. SHAFT VIBRATION TE-X

REL. SHAFT VIBRATION TE-Y

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

JUNCTION BOX
RELATIVE SHAFT VIBRATION
DRIVE END

DPPPG-70012281

=
+ MKD11GF001

EG000333 DPPPG-70140696

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Pg. 63

BEARING TE

ABS. BEARING VIBRATION TE-A

ABS. BEARING VIBRATION TE-B

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX ABSOLUTE BEARING VIBRATION DRIVE END	DPPPG-70012281	=	
			Drawn	Möbius					+ MKD11GF001	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 41
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

MANUFACTURER HÄWA
STANDARD CASING K12-30/20
DEGREE OF PROTECTION IP65

TAPPED HOLES

MOUNTING RAIL TS 35 (EN60715)

ALL DIMENSIONS IN MM

SCALE 1:2 (A3)

BOTTOM SIDE FOR CUSTOMER CONNECTION DRILLED AT SITE

COLOUR: RAL 7035

VIEW ON RIGHT HAND SIDE

FRONT VIEW WITHOUT COVER

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

JUNCTION BOX VIBRATION
MOUNTING PLATE
EXCITER END

DPPPG-70012281

=
+ MKD12GF001

EG000333 DPPPG-70140696

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Pg. 63

BEARING EE

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX VIBRATION RELATIVE SHAFT VIBRATION NON DRIVE END	DPPPG-70012281	= + MKD12GF001	
			Drawn	Möbius						
			Appr.	Heiland						
REVISION	Date	Name	NORM		Replacement for	Replaced by		EG000333	DPPPG-70140696	Page 43 Pg. 63

BEARING EE

ABS. BEARING VIBRATION EE-A

ABS. BEARING VIBRATION EE-B

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX VIBRATION RELATIVE SHAFT VIBRATION NON DRIVE END	DPPPG-70012281	= + MKD12GF001	
			Drawn	Möbius						
			Appr.	Heiland						
REVISION	Date	Name	NORM		Replacement for	Replaced by		EG000333	DPPPG-70140696	Page 44 Pg. 63

MANUFACTURER HÄWA
STANDARD CASING K12-30/20
DEGREE OF PROTECTION IP66
TAPPED HOLES

MOUNTING RAIL TS 35 (EN60715)

ALL DIMENSIONS IN MM

SCALE 1:2 (A3)

BOTTOM SIDE FOR CUSTOMER CONNECTION DRILLED AT SITE

COLOUR: RAL 7035

VIEW ON RIGHT HAND SIDE

FRONT VIEW WITHOUT COVER

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

JUNCTION BOX VOLTAGE
MOUNTING PLATE
GENERATOR HEATER

DPPPG-70064702

=
+ MKA11GE031

EG000333 DPPPG-70140696

Page 45
Pg. 63

GENERATOR HEATER TE

GENERATOR HEATER EE

[FOR I&C PURPOSE IS USED ONLY MKC05AH001]

			Date	30.05.2017	Attarat		SIEMENS ENERGY SECTOR	JUNCTION BOX VOLTAGE GENERATOR HEATER	DPPPG-70064702	=
			Drawn	Möbius						+ MKA11GE031
			Appr.	Heiland					EG000333	DPPPG-70140696
REVISION	Date	Name	NORM		Replacement for	Replaced by				Page 46 / Pg. 63

Terminal diagram

Terminal strip
=+MKA11GE031-X0

item designation	Lev.	no. cable	type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev.	no. cable	type cable	MKA10AH001 MEGAFLEX 500	MKA10AH002 MEGAFLEX 500	page / track
GENERATOR HEATER TE							1		=MKA05AH011-E1	L1				1		46 1
GENERATOR HEATER EE							2		=MKA05AH012-E1	L1					1	46 4
GENERATOR HEATER TE							3		=MKA05AH011-E1	L2				2		46 1
GENERATOR HEATER EE							4		=MKA05AH012-E1	L2					2	46 4
GENERATOR HEATER TE							5		=MKA05AH011-E1	L3				3		46 1
GENERATOR HEATER EE							6		=MKA05AH012-E1	L3					3	46 4
GENERATOR HEATER TE							7		=MKA05AH011-E1	N				4		46 2
GENERATOR HEATER EE							8		=MKA05AH012-E1	N					4	46 4
GENERATOR HEATER TE							PE		=MKA05AH011-E1	PE				GNYE		46 2
GENERATOR HEATER EE							PE		=MKA05AH012-E1	PE					GNYE	46 5

SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKA11GE031-X0
			Drawn	Möbius			
			Appr.	Heiland			
REVISION	Date	Name	NORM		Replacement for	Replaced by	

=
+ MKA11GE031

EG000333 DPPPG-70140696

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Pg. 63

MANUFACTURER HÄWA
STANDARD CASING K12-20/20

DEGREE OF PROTECTION IP65

TAPPED HOLES

MOUNTING RAIL TS 35 (EN60715)

ALL DIMENSIONS IN MM

SCALE 1:2 (A3)

COLOUR RAL 7035

BOTTOM SIDE FOR CUSTOMER CONNECTION DRILLED AT SITE

VIEW ON RIGHT HAND SIDE

FRONT VIEW WITHOUT COVER

VIEW ON LEFT HAND SIDE

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

JUNCTION BOX
HOOD LIGHT
MOUNTING PLATE

DPPPG-70064704

=
+ MKC10GP001

EG000333 DPPPG-70140696

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Pg. 63

COVER HOOD LIGHT

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX HOOD LIGHT	DPPPG-70064704	= + MKC10GP001	
			Drawn	Möbius						
			Appr.	Heiland						
REVISION	Date	Name	NORM		Replacement for	Replaced by		EG000333	DPPPG-70140696	Page 49 Pg. 63

Terminal diagram

item designation	MKA13	MKA12	MKA11	MKA10	Lev. / no. cable	Terminal strip =+MKC10GP001-X1							Lev. / no. cable									page / track
	MEGAFLEX 500	MEGAFLEX 500	MEGAFLEX 500	MEGAFLEX 500	type cable	destination A	terminal	link	terminal number		destination B	terminal	type cable									
SWITCH LEFT SIDE				1		=MKC10GP002-S01-S01	2		1													
=				2		=MKC10GP002-S01-S01	1		2													
SWITCH RIGHT SIDE			3			=MKC10GP002-S02-S02	3		3													
SWITCH LEFT SIDE				3		=MKC10GP002-S01-S01	3		4													
SWITCH RIGHT SIDE			2			=MKC10GP002-S02-S02	1		5													
=			1			=MKC10GP002-S02-S02	2		6													
LIGHT		1				=MKC10GP002-E01-E100	x1		7													
=		2				=MKC10GP002-E01-E100	x2		8													
=									9													
=									10													
SWITCH LEFT SIDE			GNYE			=MKC10GP002-S01	PE		PE													
SWITCH RIGHT SIDE		GNYE				=MKC10GP002-S02	PE		PE													
LIGHT	GNYE					=MKC10GP002-E01	PE		PE													
=	GNYE					=MKC10GP002-E02	PE		PE													

SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKC10GP001-X1		=	
			Drawn	Möbius					+ MKC10GP001	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 50
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

+MKC05GE001

POWER SUPPLY
415V / 50Hz

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX SLIP RING VENTILATION		=	
			Drawn	Möbius					+ MKC05GE001	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 51
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

+MKC05GE001

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX SLIP RING VENTILATION		=		
			Drawn	Möbius					+ MKC05GE001		
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	52
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

+MKC05GE001

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX SLIP RING VENTILATION		=		
			Drawn	Möbius					+ MKC05GE001		
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	53
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

+MKC05GE001

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX SLIP RING VENTILATION		=	
			Drawn	Möbius					+ MKC05GE001	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 54
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

+MKC05GE001

OPERATION FAN 1	OPERATION FAN2	FAULT EXHAUST AIR	MAINTANANCE FILTER
MKC06CG001A	MKC07CG001A	MKC10EU010	MKC10CP001

Terminal diagram

item designation	Lev.	no. cable	type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev.	no. cable	type cable	page / track
				Terminal strip =+MKC05GE001-X0										
							1		-2E1					51;52 3;4
				-X1	PE		PE							

SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKC05GE001-X0			=		
			Drawn	Möbius						+ MKC05GE001		
			Appr.	Heiland				EG000333	DPPPG-70140696		Page	56
REVISION	Date	Name	NORM		Replacement for	Replaced by					Pg.	63

Terminal diagram

item designation			Y-JZ	Y-JZ	type cable	destination A	terminal	link	terminal number		destination B	terminal	type cable								page / track
			W2	W1	no. cable / Lev.	Terminal strip =+MKC05GE001-X1							no. cable / Lev.								
								⊙	1		-2S1	1									51 0
								⊙	2		-2S1	3									51 0
								⊙	3		-2S1	5									51 0
						-X10	1	⊙	4		-4K1	2									52 2
						-X10	2	⊙	5		-4K1	4									52 2
						-X10	3	⊙	6		-4K1	6									52 2
						-X10	4	⊙	7		-3K1	Z1									52 4
						-X10	5	⊙	8		-3K1	Z2									52 4
						-X11	1	⊙	9		-5K2	2									52 5
						-X11	2	⊙	10		-5K2	4									52 5
						-X11	3	⊙	11		-5K2	6									52 5
						-X11	4	⊙	12		-3K2	Z1									52 7
						-X11	5	⊙	13		-3K2	Z2									52 7
								⊙	N		-2T1	N									51 4
								⊙	PE		-X0	PE									51 4
						-X10	PE	●	PE		-X0	PE									51 4
						-X11	PE	●	PE												
								○													
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SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKC05GE001-X1		=		
			Drawn	Möbius					+ MKC05GE001		
			Appr.	Heiland				EG000333	DPPPG-70140696	Page	57
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg.	63

Terminal diagram

Terminal strip
=+MKC05GE001-X2

item designation	W3 / Y-JZ	no. cable / type cable	Lev.	destination A	terminal	link	terminal number		destination B	terminal	no. cable / type cable	Lev.	page / track
							1		-4N1				53 6
							2		-5K1	A1			54 2
				-X20	1		3		-5S1	1			54 4
				-X20	2		4		-5K2	A1			54 4

SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKC05GE001-X2
			Drawn	Möbius			
			Appr.	Heiland			
REVISION	Date	Name	NORM		Replacement for	Replaced by	

=
+ MKC05GE001

EG000333 DPPPG-70140696

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Pg. 63

Terminal diagram

Terminal strip
=+MKC05GE001-X3

item designation	Lev.	no. cable	type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev.	no. cable	type cable	page / track
						⊙	1		-4K1	13				55 2
						⊙	2		-4K1	14				55 2
						⊙	3		-4K2	13				55 3
						⊙	4		-4K2	14				55 3
						⊙	5		-4K4	11				55 4
						⊙	6		-4K4	12				55 4
						⊙	7		-4K4	14				55 4
						⊙	8		-5K2	11				55 6
						⊙	9		-5K2	12				55 6
						⊙	10		-5K2	14				55 6
						○								
						○								
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SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	AIR GAP FLUX PROBE		=	
			Drawn	Möbius					+ MKA11GC042	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 60
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

MANUFACTURER HÄWA
STANDARD CASING K08-15/15
DEGREE OF PROTECTION IP66
TAPPED HOLES

MOUNTING RAIL TS 35 (EN60715)

ALL DIMENSIONS IN MM

SCALE 1:2 (A3)

BOTTOM SIDE FOR CUSTOMER CONNECTION DRILLED AT SITE

COLOUR: RAL 7035

VIEW ON RIGHT HAND SIDE

FRONT VIEW WITHOUT COVER

			Date	30.05.2017	Attarat	
			Drawn	Möbius		
			Appr.	Heiland		
REVISION	Date	Name	NORM		Replacement for	Replaced by

SIEMENS
ENERGY SECTOR

JUNCTION BOX ROTOR EARTHING
MOUNTING PLATE

=
+ MKA40GC001

EG000333 | DPPPG-70140696

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ROTOR EARTHING BRUSHES
TE

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	JUNCTION BOX ROTOR EARTHING		=	
			Drawn	Möbius					+ MKA40GC001	
			Appr.	Heiland				EG000333	DPPPG-70140696	Page 62
REVISION	Date	Name	NORM		Replacement for	Replaced by				Pg. 63

Terminal diagram

Terminal strip
=+MKA40GC001-X0

item designation	Lev.	no. cable	type cable	destination A	terminal	link	terminal number		destination B	terminal	Lev.	no. cable	type cable	page / track
							1		-V1					62 2
							2		-V2					62 3
							PE							
							PE							

SEPARATION PLATE
SEPARATION WITH TS-K

			Date	30.05.2017	Attarat	SIEMENS ENERGY SECTOR	Klemmenplan : =+MKA40GC001-X0
			Drawn	Möbius			
			Appr.	Heiland			
REVISION	Date	Name	NORM		Replacement for	Replaced by	

=
+ MKA40GC001

EG000333 DPPPG-70140696

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SIEMENS

Turbogenerator | Operating and Maintenance Manual

Maintenance 4

Storage and Commissioning Preparation

1 Packing

The goods to be dispatched are packed in packing cases in the manufacturing works according to the conditions and climatic influences encountered in transport and in the country of destination.

1.1 Symbols

The package is marked with additional symbols for transport and storage and instructions for proper handling. These symbols are to observe absolute.

1.2 Desiccant in sealed packages

A desiccant is used to take up the moisture in the interior of the package. The amount used depends on the volume of the sealed package, duration of transport and the climate. Due to the corrosion hazard, the desiccant bags must not come into direct contact with metal surfaces. Appropriate openings and instructions are provided for regeneration and replacement of the desiccant.

NOTICE

Desiccant must not come into contact with metal.

1.3 Checking of desiccant

The moisture content may be read off from the indicators suspended inside the sealed package. Indicators are often provided with color charts. When unaffected by dampness, all the humidity indicators are colored blue (see fig. 1).

Open the appropriate marked flap immediately after arrival and check the indicator.

- Indicator blue: Desiccant still fully effective
- Indicator pink: Contents moist, desiccant no longer effective

NOTE:

The color charts contain further information.

Small cases do not have a flap; open lid to read indicator. **Storage goods must be checked monthly!**

Fig. 1: Humidity indicator

1.4 Measures to be taken in the event of moisture

If assembly is to take place within about one week, open case, check plastic sheeting for leaks and patch with adhesive tape; if necessary, protect against rain.

If assembly is possible within about one week or if there is water in the sheeting, unpack contents and place in a dry, well-ventilated room; heat room with electric heaters if necessary and ventilate well.

If neither of those measures is possible, open plastic sheeting carefully at a suitable point, insert fresh or regenerated desiccant, carefully re-close sheeting with clear adhesive tape or, if possible, heat-seal.

Desiccant can be regenerated. To do this, take desiccant from bag and spread in a thin layer on a pan, dry at between 120°C and 130°C for several hours, stirring continuously (desiccant becomes useless through calcination). Regeneration is completed when the weight of the desiccant remains constant.

For more checks of indicators the regeneration of moisture indicators is necessarily, too.

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1.5 Inspection at receipt

Immediately after receipt of the goods, the packing should be examined all round for any signs of damage. The external condition of the packing does not immediately reveal the condition of the contents. If necessary, remove the case lid or a few slats so that the contents may be seen. **Do not damage plastic sheeting in the case of sealed packages!**

NOTICE

Before unpacking equipment that is damaged or suspected to be damaged, make arrangements for appropriate storage in a dry place.

Immediate examination is important to determine the extent of damage, cause of damage and the person, if any, responsible for the damage. In line with rail, ship and road forwarding practice (that is particularly in Europe), notify the carrier concerned immediately (within prescribed time limits) and invite him to draw up a joint damage report. This is essential as evidence in claims for damages or for lodging claims with the insurance company.

If damage is discovered upon arrival overseas, it is essential to notify without delay the competent insurance agents (e.g. average adjusters of Hamburg and Bremen underwriters, the agents of Lloyds, or the local Insurance company) to enable them to inspect and certify the damage. If a thorough examination of the contents of the case cannot be made immediately (poor storage facilities), recourse at a much later date to the carrier or other persons responsible for the damage is rendered difficult, if not completely impossible. Such additional risks should be borne in mind when taking out shipping insurance, e.g. by extending coverage for an appropriate period after the arrival of the goods (max. 90 days).

NOTE:

It is always advisable to photograph serious damage.

Inform order department at the Siemens Plant of any damage in a damage report.

1.6 Transport

After receipt of the shipment, carry out transport on or to the site with circumspection and care. The means of transport must be suitable as regards their construction and load carrying capacity.

NOTICE

Pay attention to inscriptions on the packages for details of weight, mode of lifting and transport.

When loading and unloading heavy parts, particularly if they have to be moved with winches jacks, crowbars, etc. the truck should be braced from below by props or jacks to prevent its loading surface from caving in or canting (truck suspension 1) Truck brakes must be on. Heavy parts should be secured against movement or displacement during transport, steel ropes should he cushioned with wooden blocks to prevent them from rubbing against the cases.

⚠ WARNING

Note loading capacity of set-down surfaces.

When using hoists take note of their carrying capacity and hoist attachment points on the packing or parts. Transport heavy parts using cranes If possible, or place in horizontal position on suitable trucks, rollers or guide ways, etc.

2 Storage

2.1 Outdoor storage

All components can be stored within their transportation boxes as long as humidity indicators show no indication. If these boxes are damaged all parts shall be unpacked and packed again with new desiccant inside the box.

Upon receipt of unit and components, visually inspect them for damages, moisture or other foreign contamination. Fill in the Generator Packing Checklist. Any indication of this must be reported to the supplier for corrective action.

Protect the cases against ground clamp by placing them on boards. Select the storage area to offer maximum protection against damp (flooding), dirt, vermin such as rats, mice, termites, etc. and tampering.

Avoid stacking heavy goods one on top of the other.

Record the humidity indicators of all boxes every 4 weeks. Fill in the ”Generator Packing Checklist – Humidity Check During Long Time Storage”. Depending on indication boxes can be stored, desiccant must be replaced or packing must be renewed.

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If there is any indication of the humidity indicator at the main generator box the generator must be dried out by special procedure.

At field conditions the use of a dehumidifier is proved. This dehumidifier can be attached to the internal packing tarp, to a tarp arrangement around the unpacked generator or to the generator enclosure that is assembled on top of the generator. The de-humidifier shall run the entire storage time. Megger stator winding once a month and record results so that any trending may be detected. Visually inspect the interior of the generator every three months.

If the unit suffers any unusual moisture damage for any reason, submit a Field Action Request (FAR) to *Engineering.*

2.2 Indoor storage

The storeroom should be well ventilated and dry if possible, and spacious enough to allow stable and clearly arranged storage. Pay attention to the load-bearing capacity of the flooring.

2.3 Rust on Rotor and Stator Surface

In case of rust formation the rust shall be removed as far as possible by only using a sponge (e.g. Scotch-Brite™) and Rivolta SLX or ethanol as solvent. Do not use any other solvent!

NOTE:

Rust which cannot be removed can stay on the particular generator component; generator function will not be restricted due to it.

Use space heaters or air dryers during future standstills to avoid further rust formation.

2.4 Removal from storage

Do not remove parts from store until immediately before assembly. If possible, transport components complete with packing to inspection/assembly site and place ready for use in proper sequence. Secure heavy components against slipping or canting.

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This checklist shall be completed by the responsible Siemens or other representatives at site for each generator.

NOTE:
This generator checklist is required for every shipping item arriving at site!

STEP	PROCEDURE	CHECK IF STATUS = "O.K."	INITIAL/DATE CHECKED
	Receipt of Generator Components and Generator		
A.	Verify that the following components are stored in a clean and dry area. Generator packing is not suitable for long-term storage.		
	1. Generator itself		
	2. Generator coolers		
	3. Enclosure		
	4. Oil Piping		
	5. Automatic Voltage Regulator		
	6. Jacking Oil Supply Unit		
	7. Anchoring and other loose shipped parts		
	8. Main lead assembly containing current transformers		
	9. Neutral lead assembly containing current transformers		
B.	Visually inspect all components of the generator and collector/exciter for evidence of damage, moisture and corrosion. Photo documentation should be retained documenting condition of the components whether damaged or not. Inspections should document any water ingestion, loose hardware, foreign objects, rust or any damage to any components. Replace all protective coverings and all bolting hardware after verification.		
	1. A crawl through should take place on the generator and every opened packing verifying as received conditions.		
	2. The exciter machine or collector and collector rings should be inspected to verify them as received condition.		
	3. The rotor should be inspected externally to verify it as received condition.		

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This checklist shall be completed by the responsible Siemens or other representatives at site for each generator.

NOTE:
This checklist is required for every stored shipping box and needs to be filled out during long time storage every 4 weeks!

STEP	PROCEDURE	CHECK IF STATUS = "O.K."	INITIAL/DATE CHECKED
	Order-No.:		
	Checking of Generator Components and Generator		
A.	Verify that the boxes of the following components are stored in a clean and dry area. The packing boxes are subject of control respective moisture, damaging and destruction. Additional care shall be taken for checking the fixing of tarpaulins on the box roofs.		
	1. Generator itself		
	2. TEWAC or Air Filter unit		
	3. Enclosure		
	4. Oil Piping		
	5. Automatic Voltage Regulator		
	6. Jacking Oil Supply Unit		
	7. Anchoring and other loose shipped parts		
	8. Main lead assembly containing current transformers		
	9. Neutral lead assembly containing current transformers		
B.	Visually inspect all humidity indicators of each box. Photo documentation should be retained documenting condition of the components whether damaged or not if indicators respond. Inspections should document any water ingestion, loose hardware, foreign objects, rust or any damage to any components. Taken photos shall show labels adjacent to the indicators readable. Replace all protective coverings and all bolting hardware after verification.		

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4.3 Making Plastic Sheeting Covers
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Preliminary Note

Generator rotors are components which are sensitive to moisture. For this reason, they must be protected against corrosion and mechanical damage during transport and storage.

The packing precautions and the organizational measures for protection during transport and storage are described below and summarized in document [1] (see end of this document). This description contains all details required for restoring the standard packing provided by Siemens AG for delivery of the rotor. If a rotor is to be returned to the manufacturer's works for overhaul or in the case of a prolonged outage of the generator involving a separate storage of the rotor, the requirements specified in the following must be met for protection of the rotor.

Any deviations from the standard packing due to special circumstances shall be subject to the approval of Siemens AG.

1 Basic Make-up of Packing

The packing precautions and organizational measures during transport and storage are intended for reliably preventing the effects of moisture on the rotor and especially on the rotor retaining rings which may be endangered by the effects of moisture and for protection against mechanical damage during transport and transhipment procedures.

For protection against the effects of moisture, the rotor retaining rings and the rotor body are packed in sealed plastic sheeting covers, adding materials for moisture absorption. This sealed packing is protected with a second plastic sheeting cover. In the case of sea transport, a third plastic sheeting cover is provided for the rotor retaining rings and the rotor body. This cover forms a second additional barrier against the diffusion of moisture into the innermost plastic sheeting cover.

The metallically bright shaft ends (shaft journals and couplings) are protected with a hard wax coating.

The rotor is then placed on a skid with closed bottom and secured in position for protection against mechanical damage. For land transport not exceeding one month, this unit is protected against external influences by a wooden enclosure resting on the bottom frame of the skid. This enclosure must be removed prior to each transshipment to hitch the rotor with a lath grid in place at the middle of the rotor body.

In the case of land transport exceeding one month and with sea transport, the enclosure forms an integral part of the skid. The hitch should then be taken directly at the skid. The complete cargo is covered with tarpaulins for protection from the elements.

Rotors with water-cooled winding are protected against corrosion by filling the water passages with pure nitrogen after drying to a gauge pressure of 0.5 – 1 bar (7 – 14 psig) via a cover at the exciter end. The pressure can be read on a permanently installed pressure gauge.

2 Definitions

2.1 Land Transport

The packing provided for this mode of shipment affords sufficient protection for land transport under moderate climatic conditions and for a scheduled transit period of not more than one month. This provides a reliable protection for short-distance transport (to destinations in the German Republic or in neighbouring countries).

This type of packing also ensures adequate protection during subsequent storage in a covered hall, e.g. power house. Following the receiving inspection, the insulation resistance of the rotor winding and the condition of the desiccant should be checked at inter-

vals of one month and the desiccant reactivated, if necessary.

2.2 Sea Transport

The packing provided for this mode of shipment affords protection during shipment by sea, during unavoidable outdoor storage and for transport periods and under conditions exceeding those under Item 2.1.

The additional packing, as compared to land transport, consists of a third plastic sheeting cover and a closed, seaworthy outer packing. The desiccant included in the plastic sheeting covers is sufficient for the scheduled transport period, but for not more than six months.

The inspections required during storage are the same as specified for land transport under Item 2.1.

Fig. 1: Sealed Packing of Rotor Retaining Ring

1 Moisture-proof plastic sheeting
2 Desiccant pouch
3 Moisture indicator

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3 Summary of Rotor Packing Requirements

The summary in document [1] contains information on the makeup of the packing and on the procedures required to maintain the packing in sealed condition. A detailed description is given in the following section.

4 Sealed Packing

To obtain a reliable and long-lasting corrosion protection, both suitable production appliances and materials and appropriate methods of packing are required.

The basic prerequisites are:

- **Dry Condition of Rotor Prior to Packing**

The rotor must be dried if it is expected to be in a wet condition due to operational faults. To do this, the rotor and especially the rotor retaining rings and end winding portions should be dried with dry air by means of an air dryer (e.g. Munters dryer).

- **Water-Cooled Rotor Winding**

Drying the cooling water circuit of the rotor winding should be performed with a vacuum pump, heating the winding with direct current to approximately 60 – 70 °C (140 – 158 °F). Drying can be terminated when a pressure of less than 5 torr has been maintained on

the hot rotor for a period of five hours. Following this, the rotor winding should be filled with pure nitrogen to a gauge pressure of 0.5 bar (7 psig) via the end cover at the exciter end.

The equipment and power sources required for vacuum drying should be obtained by the owner in due time. The mechanical data for the procurement of the equipment are available from Siemens AG on request.

- **Weather-Protected Packing Area**

Packing and unpacking are only permissible in a weather-protected area, preferably in a hall.

- **No Delays in Packing Procedure**

Care must be taken to ensure that after its removal the rotor will not suffer any moisture condensation or accidental wetting. Packing the rotor should therefore be performed immediately after withdrawal of the rotor and any required drying procedure in order to minimize any uncontrolled phases.

4.1 Appliances and Packing Material

In addition to the standard tools, such as scissors, knife etc., special appliances are required for obtaining a packing affording corrosion protection:

- Heat-impulse fixture for heat-sealing of polythene plastic sheeting, consisting of: heat-impulse generator and heat-sealing tongs for a minimum seam length of 200 mm (7.8 in.).
- Heated plate to melt wax-coated sheeting for bonding (e.g. electric iron).
- Blower with low delivery rating for checking the plastic sheeting covers for tightness and for extracting the test air (e.g. vacuum cleaner).
- Air dryer for any required drying of rotor end windings prior to packing (e.g. Munters dryer).

The following packing materials are used, which are available from Siemens AG on request:

- Polythene sheeting, 0.2 mm (0.008 in.) thick, endless, preferred width 6000 mm (236.2 in.)
- Rubber board with canvas reinforcement, 3 mm (0.12 in.) thick, minimum width 1000 mm (39.4 in.)
- Wax-coated linen binding with 1 mm (0.04 in.) wax coating, 100 mm (3.94 in.) wide (e.g. Denso binding)
- Hard wax for application by brush (e.g. Tectyl 506)
- Cold degreasing agent
- Wax-coated aluminium foil
- Adhesive for plastic sheeting
- Adhesive tape for plastic sheeting
- Foam material which does not absorb water, 5 – 10 mm thick (e.g. polyurethane)
- Silica gel in linen pouches as desiccant
- Moisture indicators for functional checking of desiccant with German end English inscriptions (color indicators for 30 %, 40 % and 50 % relative humidity)
- Hemp rope, 2 mm (0.08 in.) thick, for attaching desiccant pouches
- Fabric tape, 20 mm (0.8 in.), endless
- Steel band, 1 mm (0.04 in.) thick, 30 mm (1.2 in.) wide, with turnbuckle and tensioning device
- Lath grid for taking a hitch at the rotor body, consisting of hardwood laths, 50x80x3000 mm (1.97x3.15x118 in.), nailed to 5 mm (0.2 in.) thick fabric mat.

4.2 Protection of Metallically Bright Shaft Ends

The metallically bright shaft ends should be cleaned and degreased and protected with a hard wax coating (e.g. Tectyl 506) of sufficient thickness (dark-brown). In addition, the areas of support in the skid should be wrapped with two layers of wax-coated bindings (e.g. Denso binding) and a 3 mm thick canvas-reinforced rubber mat. All other areas contacting the skid should also be covered with 3 mm (0.12 in.) thick rubber board.

4.3 Making Plastic Sheeting Covers

The polythene sheeting covers are made directly on the components to be protected. To protect the plastic sheeting cover from damage, any contact with sharp edges must be avoided. Edges should be padded with layers of rubber board or foam rubber. The use of excelsior, corrugated cardboard, felt or other hygroscopic materials is not permissible. Care should be taken to ensure that the plastic sheeting cover remains intact during the subsequent packing procedures. Even pinpricks and minute tears in the plastic sheeting will render tight sealing ineffective. Within the range of rotor support in the skid and of other contact points (upper shipping saddles), the polythene sheeting should be inserted between two rubber boards of sufficient size for protection against damage. In the retaining ring area, each plastic sheeting cover is provided with a 500 mm dia. opening for connection of a plastic sheeting hose having the same diameter and a length of approximately 1 m.

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After checking the cover for tight sealing, the desiccant is added via this hose, which is then closed by heat-sealing.

To maintain the sealed range in a dry condition, desiccant (see Item 4.4) is added to each plastic sheeting cover.

After heat-sealing and tight wrapping with wax-coated bonding, each plastic sheeting cover should be checked for tight sealing. To do this, one corner of the plastic-sheeting hose should be cut for insertion of a vacuum cleaner hose (discharge end) and tightly sealed with a binding. If the cover remains inflated during the following two hours, the cover is properly sealed. Following this check, the air should be drawn off.

First Plastic Sheeting Cover

As a first step, the entire rotor body should be wrapped with wax-coated aluminium foil with 50 – 70 mm (2 – 2.8 in.) overlap, with the wax coating facing the rotor body. Seams and overlapping portions should be sealed airtight by melting the wax coating with an electric iron.

To protect the aluminum foil from being damaged by the handling ropes, a canvas-reinforced rubber mat, 3 mm thick and approximately 2500 – 3600 mm (98 – 142 in.) wide (dependent on overall length of rotor) should be placed around the center of gravity of the rotor. This rubber mat consists of individual sections, each having a length corresponding to the rotor body diameter +100 mm (3.94 in) and arranged with an overlap of not less than 100 mm. All overlap seams should be sealed with wax-coated canvas bindings. Axial overlap seams should be additionally secured with steel bands. The overlap seam at the top on the circumference is to be secured in axial direction by a wooden lath, 80x40 mm (3.15x1.57 in.), which is also held in place with steel bands.

Finally, a lath grid (hardwood laths attached to fabric mat or fabric tape) should be placed in position for hitching. The grid should cover not less than the lower half two-thirds of the rotor body circumference and be adequately secured with steel bands. The wooden laths must be on the outside and arranged so that the rubber mat is approximately 150 mm (6 in.) wider at each end of the rotor. The range between the wax-protected shaft portion and the end of the rotor body should then be wrapped with polythene sheeting which is to be sealed tightly with wax-coated canvas bindings at the rotor body and free shaft portion.

Experience has shown that in the case of larger rotor body diameters (>1300 mm, 51.2 in.), the aluminium foil cannot be wrapped around the rotor with sufficient tightness and may thus be omitted. In such cases, the above mentioned polythene sheeting should extend beyond the rubber mat at the middle of the rotor body and should be wrapped tightly with wax-coated canvas bindings at these points.

The precautionary measures specified under Items 4.2 to 4.3. – *First Plastic Sheeting Cover* provide for the minimum packing requirements and are sufficient for land transport not exceeding 20 hours. In the case of rotors provided with aluminium foil within the range of the rotor body, sealing of the rubber mat at the middle of the rotor body will not be required for short-distance transport.

Second Plastic Sheeting Cover

In addition to the first plastic sheeting cover described above, a second polythene sheeting cover of the same type should be provided between the shaft ends and the rubber mat at the middle of the rotor body. To separate the two plastic sheeting covers, a 5-10 mm (0.2 – 0.4 in.) thick layer of foam material should be placed over the top half circumference of the rotor retaining rings and rotor body.

Two plastic sheeting covers are required for land transport and storage as defined under Item 2.1.

Third Plastic Sheeting Cover

For sea transport and outdoor storage as defined under Item 2.2, an additional diffusion barrier should be provided. This third polythene sheeting cover protects the entire range of the rotor between the shaft journals at either end. It is placed over the plastic sheeting covers according to Items *First Plastic Sheeting Cover* and *Second Plastic Sheeting Cover* and is to be made in the same manner.

The plastic sheeting is placed over the rotor before the rotor is supported on the skid. Within the range of rotor support, the plastic sheeting is inserted between two rubber mats of 3 mm thickness each. After the rotor has been supported on the skid, its upper half portion (rotor body and retaining rings) should be covered with a 5 – 10mm (0.2 – 0.4 in.) thick layer of foam material outside the lath grid area, and then the plastic sheeting cover should be heat-sealed.

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Rotor body diameter < 1300 mm | Rotor body diameter > 1300 mm

First plastic sheeting cover

Second plastic sheeting cover
(first cover not shown, except for rubber mat)

Third plastic sheeting cover
(first and second covers not shown)

Hard wax coating
Polythene sheeting
Wax-coated aluminium foil
Rubber mat
Wax-coated canvas binding
Lath grid or wooden lath
Polyurethane foam mat

LI Location identification

Moisture indicator with location identification

Desiccant pouch

Cover with potential measuring points for insulation resistance measurements and, if applicable, pressure gauge for nitrogen pressure in water-cooled rotor winding

Fig. 2: Sealed packing

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4.4 Desiccant

Type and Application

The desiccant consists of silica gel in dust-free and air-permeable pouches. It should be inserted into each plastic sheeting cover via the plastic sheeting hoses at the two retaining rings. The desiccant must be placed so that it can be replaced when this becomes. necessary and that it does not come into contact with steel or winding components (danger of corrosion). If necessary, cover contact area with polythene or rubber sheeting.

Fig. 3: Moisture Indicator

50% relative humidity
All circles pink:
Danger of corrosion!

40% relative humidity
Two circles pink:
Replace desiccant!

30% relative humidity
One circle pink:
Warning!

Fig. 4: Indicated ranges of relative humidity
(exact location identification to be entered in handwriting)

All pouches must be tied together with a hemp rope, and, when used, they must be in an active, i.e. absolutely dry condition.

Desiccant Quantities

The desiccant quantities (also see end of this document, [1]) are proportioned to accommodate highly adverse climatic conditions. The maximum quantity is sufficient for a transport period not exceeding six months.

Checking and Reactivation

The moisture absorption capacity of the desiccant must be checked after arrival at site, after interruptions in transit involving a storage period of more than one month and during normal storage at the site (see Item 7.2). To do this, use the moisture indicators (fig. 3) inserted in the plastic sheeting covers at a distance of not less than 5 cm (2 in.) the sheeting.

The moisture indicators are marked with their respective location identifications as illustrated in fig. 2 and show the relative humidity inside the cover in three ranges: > 30 %, > 40 % and > 50 % (fig. 4). With the packing in dry condition, all circles are blue. A change in colour to pink in the respective circle indicates the relative humidity in percent. As soon as the 40 % indicator changes to the pink colour, the desiccant must be removed and replaced or reactivated by drying.

Make sure that sufficient replacement desiccant or the necessary drying facility for reactivation is available. After opening, the plastic sheeting cover should be provisionally resealed, but must not be left in this condition for more than 20 hours.

For reactivation, the pouches should be dried in a drying oven at a temperature of 110 °C (230 °F) for 12 hours. If a drying oven is not available, the desiccant should be removed from the pouch spread out in a thin layer on a metal plate and dried at 110–130 °C (230–266 °F) for several hours until the weight of the desiccant remains constant. The desiccant should then be filled back into the pouches which are to be closed and reinserted into the plastic sheeting covers as quickly as possible. Care should be taken to ensure that the pouches do not come into contact with metal parts. The opening in the plastic sheeting cover should then be resealed with a heat-sealing unit.

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5 Skid and Outer Protection

Siemens AG generator rotors are delivered in box type shipping containers, consisting of a skid and an enclosure. Fig. 5 and 6 depict typical examples. It is recommended to keep this shipping container for future needs, unless an adjustable universal skid is used for land transport which is available from Siemens AG if requested in due time. The information given in the following relates to the remounting of the rotor in sealed packing on the skid and to the provision of the outer protection.

5.1 Land Transport (Less Than One Month)

For land transport, the rotor should be supported on a skid similar to fig. 5. The points of support should be padded with rubber mats for protection of the plastic sheeting covers. At the shaft ends, the rotor should be attached to the skid by means of upper saddles and secured in axial direction.

For loading operations, the hitch should be taken either at the middle of the rotor body (lath grid) or at the rotor ends.

During transit, the rotor should be protected against external influences by a wooden enclosure resting on the bottom frame of the skid. Both long sides of this protective enclosure should be clearly stencil-marked with the following note:

NOTE

Remove protective enclosure for rotor transhipment.

The complete cargo should be covered with a lashed tarpaulin.

5.2 Land Transport or Sea Transport of Longer Duration

For land transport exceeding one month and for sea transport, the rotor should be packed in a closed, self-supporting container. The setup for two-pole rotors corresponds to fig. 5.

The container bottom should have openings with perforated-plate covers for ventilation and to prevent the accumulation of water. In addition, inspection openings with covers should be provided on the long sides for access to the desiccant pouches via the plastic sheeting hoses. An inspection opening at the exciter end should provide access to the contact pins on the EE end cover of the rotor for measurement of the insulation resistance of the rotor winding.

Prior to closing the container, the rotor should be covered with 3 mm (0.12 in.) thick pressboard panels and polythene sheeting, taking care to avoid the formation of troughs in which water might accumulate.

Fig. 5 Skid for prolonged land or sea transport of rotors <100 Mg (outer enclosure not yet provided)

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Fig. 6 Shipping container for sea transport of rotors > 100 Mg

The container lid should be covered with tar board sanded on one side and folding down over the edges not less than 200 mm (7.87 in.).

The total weight and the dimensions of the cargo should be marked on the container. In addition the hitching range should be colour-marked. The complete cargo should be covered with a tarpaulin for protection against the elements.

6 Protection of Packing during Transit

6.1 Organizational Measures

Proper packing of the rotor will prevent both the ingress and the condensation of moisture during transit, unless the sealed packing is damaged by improper loading procedures or customs inspections. This should be avoided by suitable precautions, enabling a quick restoration of the dry condition of any damaged sealed packing. These measures include:

On the cargo:

- Instructions for correct handling.
- Reference to ***Sealed Packing*** on shipping container.
- Indication of desiccant quantity inserted into each individual plastic sheeting cover behind inspection hole cover.
- Attaching this instruction.

In the accompanying documents:

- Reference to ***Sealed Packing***.
- Reference to arrangements for customs clearance at place of installation.
- Request for immediate drying in case of transport damage with moisture penetration.
- Check list relating to condition of desiccant [2].
- Check list relating to insulation resistance of rotor winding [3].

6.2 Loading

If a flatcar is used for transport, the cargo should be loaded so that it can slide on the car, i.e. the skid must not be secured in position and must be free to move in both directions of running. Provision should be made for a sliding distance of approximately 1.5 m (59 in.) at either end.

Planks, approximately 50 mm (2 in.) thick, should be nailed to the long sides adjacent to the battens.

If a deep well wagon is used for transport, the skid-mounted rotor should be secured in position at both ends of the loading bridge. The bridge trough should be sealed with boards for protection against stones.

During shunting operations, the car must never be allowed to pass over a hump. A corresponding note should be included in the waybill and affixed to the car in a well visible location.

6.3 Receiving Inspection

After arrival of the rotor, the consignee should examine the packing for external damage. The condition of the desiccant can be ascertained at the moisture indicators. In addition, the insulation resistance of the rotor winding should be checked. In the case of a

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water-cooled rotor winding, the pressure of the nitrogen blanket should also be checked. The date of the receiving inspection should be entered in the respective section on the inspection hole covers. The results of the receiving inspection should be recorded in the check lists [2], [3], copies of which should be forwarded to the consignor.

If the packing is found in damaged condition, it should be resealed as soon as possible. The same requirement applies if the seals were opened by the customs authorities.

If the moisture absorption capacity of the desiccant is no longer sufficient (40 % indicator is pink), the desiccant should be removed from the plastic sheeting cover, with the shipping container protected from the environment, and reactivated (see Item 4.4.3). If the rotor is unpacked immediately after delivery, it may become necessary to bring it to ambient temperature level for protection against moisture condensation. If the rotor temperature is equal to or higher than the room temperature, there will be no need for raising the temperature of the rotor to the level of the ambient temperature. The rotor temperature can be measured at the accessible rotor ends using a temperature measuring instrument. If the rotor temperature is lower than the ambient temperature, steps must be taken to ensure that the rotor temperature will be 5 K (safety margin) higher than the dew point temperature of the ambient air [4].

In the case of outdoor units, the rotor assembly phase should be timed so that the unpacked rotor will not be exposed to extreme changes in temperature as this will involve the risk of moisture condensation.

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7 Storage

The precautionary measures during storage provide for maintaining the dry condition of the rotor in the sealed packing without any interruptions until commencement of the assembly.

To this end, certain minimum requirements must be observed, which are dependent on the condition of the storage area. In addition, the condition of the packing and of the desiccant contained in the packing must be checked at regular intervals. To obtain additional verification, the insulation resistance of the rotor winding should be measured.

As long as the nitrogen pressure is still slightly above atmospheric, it will normally not be necessary to recharge a water-cooled rotor winding with nitrogen. If the nitrogen pressure has dropped to zero, the winding should be filled with pure nitrogen to a gauge pressure of 0.5 bar (7 psig) from the nitrogen bottle permanently installed in the shipping container.

7.1 Storage Area

Sufficiently ventilated and dry storage rooms for stable support of the parts in a fully accessible location are favourable preconditions for storage. If outdoor storage cannot be avoided, a heavy-duty outer packing of the seaworthy type must be provided. The outdoor storage facility must be set up in such a way that the stored item is protected against rainfall and moisture from the ground.

This would include placing a waterproof shelter over the shipping container which affords sufficient ventilation. In addition, the stored item should be blocked up on the solid ground for protection against moisture. Enough space must be left between the boxes to permit inspections and checks.

7.2 Checks During Storage Period

Following the receiving inspection, surveillance of the equipment should be conducted by repeat checks at intervals of four weeks. The checks required are the same as specified for the receiving inspection under Item 6.3. The dates of the repeat checks should be recorded on the outer packing below the date of the receiving inspection and in the check lists [2], [3].

7.3 Removal From Storage

If the storage area and the place of installation are not located in the same room (power house or workshop), the rotor temperature may be below the dew point level on transfer of the rotor from a cool storage area to a warm power house. To protect the rotor from moisture condensation, it should be left in its sealed packing for several days and allowed to assume the ambient temperature prior to removing the packing for immediate assembly.

Also refer to the following information:

[1] 4.5-0031 Preventive Measures for Transport and Storage of Generator Rotors (Summary)
[2] 4.5-0032 Checking Desiccant in Packing of Components
[3] 4.5-0033 Insulation Resistance Measurements on Rotor and Exciter Windings during Storage (Test Report)
[4] 4.5-0019 Determination of Dew point Temperature

Purpose / Phase	Components	Prev. Measure	Protective Materials and Setup	
			Land Transport Short Distance, Transport Period Less Than One Month	**Sea Transport** Shipment by Sea or Transport Period More Than One Month
A **Corrosion protection of shaft ends**	**Shaft journals** **Couplings**	**(1)**	Hard wax coating (e.g. Tectyl 506) of sufficient thickness (dark-brown color). Additionally protect areas of support in skid with two layers of wax-coated bindings and one layer of 3 mm (0.12 in.) canvas-reinforced rubber mat.	
B **Corrosion protection of rotor winding**	**Water-cooled rotor winding**	**(2)**	Fill dried rotor winding with pure nitrogen to a gauge pressure of 0.3 – 0.5 bar (0.2 – 0.34 psig) through cover at exciter end.	
C **First packing of rotor retaining rings and rotor body in plastic sheeting cover** **(sufficient for short-distance transport up to 20 hours and immediate installation)**	**Rotor body**	**(3)**	Place wax-coated aluminium foil over entire range of rotor body (only for rotor body diameters <300 mm (<11.8 in.), due to difficult handling).	
		(4)	Place 3 mm (0.12 in.) canvas-reinforced rubber mat, 2500 – 3600 mm (98 – 141 in.) wide (dependent on length of rotor) around center of gravity; seal overlap seams with wax-coated bindings and steel bands; secure axial overlap seam with wooden lath.	
		(5)	Place lath grid on fabric mat, about 300 mm (11.8 in.) narrower than **(4)**, around two-thirds of rotor circumference and secure at top.	
	Retaining rings **Fans (waterboxes)**	**(6)**	Place 0.2 mm (0.08 in.) polythene sheeting between shaft ends **(1)** and body ends **(3)** and rubber mat **(4)**, respectively; seal joints with wax-coated bindings at both ends; heat-seal seams.	
		(7)	Check plastic sheeting cover for tight sealing by inflation with air and recheck after two hours.	
		(8)	Add desiccant per m^2 (1 m^2 = 1.2 sq.yd.) of sheeting surface: shipping time up to 1 month: 500 g (1.1 lb.); up to 3 months: 1000 g (2.2 lb.); up to 6 months: 1500 g (3.3 lb.). Plus 280 g (0.62 lb.) for each kg of wood and 35 g (1.23 oz.) for each kg of foam material within plastic cover. Moisture indicators for relative humidity >30 %, >40 %, >50 %.	
D **Protection of first packing C by second plastic sheeting cover**	**Rotor body and retaining rings**	**(9)**	Place 0.2 mm (0.008 in.) polythene sheeting between shaft ends **(1)** and rubber mat **(4)** over a 5 – 10 mm (0.2 – 0.4 in.) foam mat around top half circumference of rotor retaining rings and rotor body.	
		(10)	Check heat-sealed and tightly wrapped plastic cover **(9)** for tight sealing as under **(7)**.	
		(11)	Add desiccant and moisture indicators as under **(8)**.	
E **Protection of packings C and D by third plastic sheeting cover**	**Rotor body and retaining rings**	**(12)**	Not required for land transport.	Place 0.2 mm (0.008 in.) polythene sheeting over a foam mat and cover entire rotor between shaft ends as under **(9)**. With four-pole rotors, foam mat is split within range of lath grid; insert plastic sheeting between 3 mm (0.008 in.) rubber boards. Check for tight sealing as under **(7)**. Add desiccant as under **(8)**.
F **Transit protection**	**Tightly sealed rotor**	**(13)**	Tightly sealed rotor **(1)** to **(11)** on skid with closed bottom under enclosure and tarpaulin.	Tightly sealed rotor **(1)** to **(12)** in closed self-supporting shipping container under tarpaulin.

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Purpose / Phase	Components	Prev. Mea-sure	Protective Materials and Setup	
			Land Transport Short Distance, Transport Period Less Than One Month	**Sea Transport** Shipment by Sea or Transport Period More Than One Month
G Loading	**Complete cargo**	**(14)**	Hitch point on rotor at lath grid in center of gravity after removal of enclosure.	Hitch point on shipping container; in the case of four-pole rotors on steel sleeve at mid-length of skid.
H Receiving of Cargo	**Complete packing and rotor winding**	**(15)**	Check outer packing and relative humidity inside plastic sheeting at moisture indicators. Replace desiccant when relative humidity is higher than 40 %. Return check list with details on condition of packing and insulation resistance of rotor winding to consignor.	
		(16)	Prior to unpacking the rotor in a weather-protected location, a cold rotor must have ambient or dew-point temperature plus 5 K safety margin to prevent moisture condensation.	
J Storage	**Storage area**	**(17)**	With packing for land transport, only in a hall kept at a moderate temperature. For outdoor storage, seaworthy packing plus additional precautions are required: storage on well tamped and suitable reinforced ground and set on blocks for protection against moisture, case under protective roof.	
	Complete packing and rotor winding	**(18)**	During storage (including interruptions in transit), check outer packing for damage and tight sealing, insulation resistance of rotor winding and, if applicable, nitrogen blanket at intervals of four weeks.	
K Removal from storage	**Rotor**	**(19)**	Maintain tight sealing of packing as long as possible until rotor is installed. Protection against condensation hazard by preventive measure (16).	

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Desiccant Checking Requirements

The absorbent capacity of the desiccant must be checked after shipment has been completed and at intervals of one month during any subsequent storage period. The results should be recorded in the table below. The control interval must be reduced to one week as soon as the 40% indicator reacts by changing to a pink colour. The protective coating must be renewed immediately the 50% indicator reacts by changing to a pink colour.

Job name: **SI. No.:** **Type:**

Shipping or storage phase	Date	Name	Company	Condition of component	Condition of outer packing	Location identification of moisture indicator	Moisture indicator blue or pink?			Weight of desiccant in packing in kg (1 kg = 2.2 lb.)	Replacement or reactivation of desiccant
							Bottom circle (30 %)	Center circle (40 %)	Top circle (50 %)		
Prior to shipment						TE 1					
						TE 2					
						TE 3					
						EE 1					
						EE 2					
						EE 3					
						TE 1					
						TE 2					
						TE 3					
						EE 1					
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						EE 2					
						EE 3					

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The insulation resistance of the rotor winding should be checked after shipment has been completed and at intervals of one month during any subsequent storage period. The results should be recorded in the table below.

Job name: **Sl. No.:** **Type:** **Component:**

Shipping or storage phase			Prior to shipment									
Date												
Name												
Company												
Storage area												
Temperature in storage area in °C												
Rel. humidity of ambient air in storage area in %												
Rotor temperature in °C												
Moisture indicator in packing blue or pink?	TE1	50						-				
		40										
		30										
	EE1	50										
		40										
		30										
Pressure of nitrogen blanket in bar												
Applied voltage in V												
Insulation resistance in megohm	15 s											
	30 s											
	45 s											
	1 min											
	2 min											
	3 min											
	4 min											
	5 min											
	6 min											
	7 min											
	8 min											
	9 min											
	10 min											

Notes

1. The insulation resistance should be measured with an insulation measuring device with max. 500 V measuring voltage with start-up and due to possible impurities max. 250 V with later revisions.
2. Prior to each measurement, any static charges should be removed by grounding the windings as a precautionary measure (10 minutes).
3. The connection to the rotor winding should be made at a specially identified bolt on the EE end cover.
4. The connection to the rotor body should be made at a second bolt on the EE end cover.
5. After each measurement, any static charges should be removed by short-circuiting the winding through the rotor body (not less than 20 minutes).

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1 General

The machinery parts to be assembled are delivered ready for mounting, unless certain portions must be protected during transport against corrosion or damage.

In case of orders for delivery to ***European*** countries, all sensitive portions of the machinery parts, e.g. journals, are provided with a protective coating and protected against damage.

In case of orders for delivery to ***overseas*** countries, all machined surfaces are provided with a protective coating. In addition, complete assemblies are sealed in plastic sheeting.

2 Removal of Protective Coating

The protective coating applied at the manufacturer's work should be carefully removed prior to installation. The surfaces to be cleaned should be washed with petroleum or a similar agent. When using trichloroethylene, the cleaned surfaces should be carefully dried and afterwards a thin oil film should be applied. Non-observance of this requirement implies the danger of corrosion.

Particularly thick layers of protective coating should be softened by applying one of the above-mentioned cleaning agents and then be removed by means of a hardwood board (approx. 10 cm x 10 cm x 1 cm, 3.94 in. x 3.94 in. x 0.4 in.).

NOTICE

Never use scrapers, finishing trowels or sheet metal strips for removing the protective coating from highly sensitive machinery parts (journals, etc.).

Cleaning of internal and external threads should be done by chasing, using suitable taps or cutting dies. The dimensions of the external and internal threads may be taken from the respective drawings. Use dry compressed air to blow out the rethreaded tapped holes.

Where no taps are available, cleaning of the tapped holes may also be carried out with the aid of the original screws. At first, the screws should be cleaned by means of solvent and a brush. The cleaned screws should then be dipped into a solvent and immediately afterwards be screwed into the holes for thread cleaning.

If required, this procedure should be repeated several times until the threads are free from protective coating.

3 Remedying of Minor Damage

Damaged machinery parts should be reconditioned as dictated by the extent of the damage and the operational requirements unless the nature of the damage does not warrant such remedying.

Seriously damaged parts should be returned to the manufacturer's works together with a damage or failure report.

The machinery parts and the fixing and locating elements should be checked for burrs and compression marks, and such imperfections should be removed by means of a smooth-cut file. Fine-finished surfaces should only be polished by means of an oilstone.

NOTICE

Burrs and compression marks on bearing metal surfaces should only be removed by means of a spoon scraper or flat scraper.

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1 General

The prerequisite for fault-free operation of the oil circuits is proper and complete assembly of all the components provided according to the drawing specifications of the machine component manufacturer involved with the oil system, and thorough cleansing of the entire oil system after it has been completed.

The objective of these activities is to remove contaminants that have penetrated into the pipework during installation. The assembly and cleansing of the oil systems of generators and their drive systems require specific knowledge and great care. The currently valid work, fire and environmental protection regulations must be complied with when handling oil and oil-wetted components, and when flushing with oil.

Ensure that fire-fighting equipment is available and in good working order before flushing with oil. The areas surrounding the generator and its prime mover, and the escape and rescue routes must be kept clear. These tasks may only be performed by competent, trained installation technicians.

After the installation of the lubricating and lifting oil pipe systems has been completed, the circuits are subjected to a cleaning process, which is usually done with the operating medium at operating temperature. All tanks, oil coolers, pipes, hoses, fittings and other system components should be included in the cleaning process.

Appropriate filters should be mounted upstream of the bearing connections and in the return line upstream of the sump. The filters must be dimensioned so that they do not significantly affect the desired high speed of the oil through the circuit. The filter elements should be exchangeable so that the filter stages can be matched to the progress of the cleansing. Appropriate auxiliary connectors, suitable fittings etc. are to be used to mount the filters in the oil circuits. Bypasses with suitable cross-sections can be used to maintain the flushing process during the filter cleaning period.

If switchable bypasses are not available during filter cleaning, switch off the oil pumps, and secure them against being unintentionally switched on again.

It is not permissible to close shut-off elements in the oil return system while pumping. Any flexible pipes and connecting elements used must be suitable for the operating pressures and temperatures.

Measures must be taken to prevent oil from leaking or spraying out during the flushing process. All flanges and seals in the oil circuit must be checked before the pumps are switched on. The lower parts of the outer bearing housing multi-lip sealing rings should be mounted in order to prevent oil spraying out.

The maximum possible quantity of flushing oil can be set for each bearing with the corresponding bearing oil choke in the circuit.

2 Preparation of the Bearing Compartments

The bearings and bearing compartments of the generator are supplied in a clean condition and ready for operation. Cleansing, in the form of flushing with oil, is not necessary. Lines are therefore laid to bypass the bearing connections before starting to flush with oil. However, if it becomes necessary to clean the bearings and bearing compartments for unexpected reasons, then they are to be included in the oil circuit at the original connection points.

Any dirt deposits must be cleared out of the bearing compartments after the flushing process has finished. This must be done carefully with lint-free cloths (cotton waste must never be used). Any cleanser used must not be allowed to mix with the oil. There must not be any residues remaining in the bearing housing. The bearings and bearing compartments must be given a thorough visual inspection after cleaning.

3 Preparatory Work

If a bypass cannot be mounted, ensure that the upper half-shells of the bearings are dismounted and that temporary oil drain pipes are fitted to the inlet openings of the lower half-shells. The installation must be made so that the flushing oil cannot flow between the shaft and the lower half-shell of a bearing.

The connecting hoses within the bearing housing are mounted but not attached to the bearing shells, so that they are integrated into the flushing process.

4 Flushing Oil

The oil used for flushing must be provided by the user and oil supplier as laid down in the generator manufacturer's oil specification. In this connection, it may also be necessary to consult the turbine manufacturer.

The following methods are possible:

Use of the same oil grade for both flushing and operation. On completion of the flushing procedure, oil samples should be taken and analyzed to decide whether the flushing oil charge can be used as operating oil after treatment by the oil supplier.

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Fig. 1: Oil inlet holes in lower half-shell

These four holes are to be sealed by suitable means, e.g. profile rubber so that flushing oil cannot penetrate between the shaft and the lower half-shell of the bearing.

These holes are found on both sides of the bearing.

Use of an oil grade intended for use as flushing oil only. Its properties, particularly its viscosity, are matched to the specific intended purpose. This oil charge is completely drained on completion of the flushing procedure and replaced by fresh operating oil. The properties of the operating oil and the flushing oil must be compatible.

5 Flushing Procedure

During the flushing process, the oil should flow as fast as possible through the oil circuit pipes and temperatures up to a maximum of 80°C are to be maintained.

The flushing process can take place simultaneously along the entire generator-turbine axis through all bearing oil pipes and all pressure oil pipes of the hydraulic shaft lifting device. If the speed of the oil flow drops too far over the entire generator-turbine axis, shut-off elements can be fitted so that parallel branches can be flushed locally one after the other.

The oil temperature is not raised during the first hours. Heavier particles are entrained as a result of the higher oil density and the higher oil speed achieved with the coarser filters. After finer filters have been fitted, the oil temperature is raised to a maximum of 80°C.

The oil pipes must be continually tapped during the flushing process to dislodge dirt particles from the inside walls of the pipes.

The drive pumps should be repeatedly switched on and off to generate flow surges.

During the flushing, the screens upstream of the bearings and in the return line must be checked and cleaned as and when necessary. The filters must be cleaned regularly and replaced by finer elements according to the quantities of dirt found and its grain sizes. The flushing process must not be ended until no further dirt has been found in the finest filters and screens for a considerable period of time.

Remove and clean all filters and screens after completion of the relevant flushing process. Filters and screens removed for the flushing process must be refitted or replaced by those in the original generator-turbine axis equipment. All by-passes, restrictor plates and blind disks, and additionally fitted filters must be removed. The hoses of the shaft lifting devices are to be connected to the bearings and checked for leaks.

Finally, all bearings, bearing covers, multi-lip sealing rings and flanges must be fitted ready for operation.

All concluding work on the oil system and bearings must be performed with care, and with the use of appropriate measures to prevent renewed contamination.

After completion of all work on the oil system, the outsides of the pipes, flanges and connectors are cleaned and then subjected to a system pressure and leak test.

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1 General

The tinned contact surfaces and the bright copper surfaces of the contact faces should be treated with contact grease primarily to fill up the gaps remaining after bolting.

In addition, the contact grease improves the electrical conductivity of the contact surfaces, it is chemically inert and water-repellent, it does not dry up, it cleans oxidized contact surfaces and protects them against corrosion.

Contact grease has a grease-like, pasty consistency.

2 Application

Degrease tinned contact surfaces by means of a cloth wetted with solvent.

NOTICE

In the case of the terminal bushings make sure that the insulators never come into contact with the solvent.

Copper surfaces without tin coating should be cleaned and degreased by means of solvent after emery-polishing.

After this preparatory treatment, apply the contact grease to the contact surfaces with clean fingers in such a quantity that a little excess grease is pressed out all around on bolting of the contact faces.

If greased surfaces are soiled prior to making the bolted connection, these should be cleaned and greased anew.

Excess contact grease should be wiped off with a clean rag.

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It is prerequisite for startup of the turbogenerator that continuous contacts be maintained between all plant sections directly or indirectly involved in the starting procedure

Checking the Transmitters

Prior to startup, all connections should be rechecked. This applies to piping as well as to cabling. When checking the cabling, special attention should be paid to testing the metering and signal cables. All alarm systems should be checked by changing the setting of the contacts. Where changes in the contact setting cannot be made, the alarm system shoud be checked for proper functioning by short-circuiting the terminals at the relevant signal transmitters.

All temperature measuring points should also be checked. This applies to the local as well as the remote reading thermometers. Unless temperature rises where brought about by other preparatory work at the measuring points, temperatures of approximately ambient or room temperature should be indicated. When doubts exist regarding the electrical temperature measurements, *calibration* and *line compensation* should be repeated.

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SIEMENS

Turbogenerator | Operating and Maintenance Manual

Maintenance 4

Maintenance

Work required	Maintenance schedule					
	Daily	Weekly	Monthly	Every 3 months	Every 6 months	Annually
Check the carbon brushes on turbine end and exciter end		x[1]				

1) Maintenance schedule can be update according operation experience on specific site after starting with a weekly cycle time.

1 General notes

During operation, the useful length of each individual carbon brush can be determined by a visual inspection. The carbon brushes must be changed when the length remaining falls below 16 mm. The wearmark on the carbon brushes signals this condition (see Fig. 1).

Carbon brushes must preferably be changed while the machine is stationary. If this is not possible, then they can be changed during operation, but all described safety precautions must be observed.

The work must be done with great care by qualified personnel. Close-fitting working clothes must be worn in order to avoid the risk of clothing coming into contact with rotating parts. Protective goggles must be worn. We recommend wearing thin, well-fitting protective gloves. These gloves must not restrict the mobility of the fingers and must enable small parts to be handled safely and surely.

Fig. 1: Worn-out carbon brushes

Always ensure that the brushes are changed one after the other. Never remove more than one brush at any one time.

The new brushes are to be used in such a way that in direction of rotation of the rotor shaft the silver layer brush follows after the carbon film brush (see Fig. 2).

1 Grip lever (movable)
2 Finger plate
3 Grounding brush (design A) Carbon
4 Grounding brush (design B) Silver
5 Rotor surface
6 Plug-in brush holder

Fig. 2: Plug-in brush holder with grounding brushes

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2 Replacing carbon brushes

⚠ WARNING

Rotating machine parts.

There is a risk of injury when changing the carbon brushes.

- ***Do not touch the rotating shaft.***
- ***Do not touch the rotating coupling.***
- ***Do not place anything on the shaft or nearby parts of the machine (bearing).***

- ***Ensure that you have a secure footing (do not stand on rotating components).***
- ***Pay attention to sufficient lighting (e.g. helmet lamp).***

- ***Wear work clothing, safety glass and protective gloves.***

2.1 Demounting plug-in brush holder

It must be ensured that always only one plug-in brush holder will be demounted.

1. Open maintenance flap.
2. Press the moveable grip lever and pull out from the holder.

   Remove the plug-in brush holder together with the brush. The carbon brush remains in the holder.

Fig. 3: Disassembly brush holder (1)

Fig. 4: Disassembly brush holder (2)

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Fig. 5: Disassembly brush holder (3)

3. Open the grip lever of the brush holder and allow the carbon brush to slide out

Fig. 6: Disassembly brush holder (4)

4. Loosen the cable lug
5. Swing back the finger plate and remove the worn brush.
6. Clean the contact surfaces (K) on the grip lever

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2.2 Assembly plug-in brush holder

Reassemble in the reverse order. Make sure that design A and design B are each fitted on the correct side (see Fig. 2).

Fig. 7: Assembly brush holder (1)

1. Insert carbon brush in the guide
2. Clamp cable lug (M 6, 6 to 8 Nm)
3. Pressing the grip levers together and insert plug-in brush holder. Pay attention that the contact surfaces on the grip lever are correctly fitted in the holder

   Pressing the grip levers together, clamps the carbon brush in place and it cannot fall out.
4. Open the grip of the plug-in brush holder.
5. Mount the finger plate on the carbon brush.

   The carbon brush is brought into its final position against the pressure of the spring.

Fig. 8: Disassembly brush holder (2)

Fig. 9: Disassembly brush holder (3)

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2.3 Possible sources of error

Ensure that the mounting direction of grip levers (Y)!

Grip levers point toward the bearing pedestal.

Fig. 10: Correct mounting direction of grip levers

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Work required	Maintenance schedule					
	Daily	Weekly	Monthly	Every 3 months	Every 6 months	Annually
Supervision of function of lubrication devices	x					
Supervision of bearing insulation					x	
Removing of oil mist condensate		x				

1 General notes

During normal operation, no service or maintenance work is required on the generator plain bearing. Smooth running and the bearing and lubrication oil temperatures are part of the turbine monitoring.

All lubrication units and instruments provided for monitoring must be continually observed during operation. Perform a bearing inspection when running noises change.

NOTE:
***You will find more detailed information about maintenance work on the bearings in the supplier documentation (see chapter* Components and Purchased Parts).**

2 Start-up and run-up

If a hydraulic shaft jacking device is available, check the rotor lift before startung the generator. The rotor lift must be set to between 0.08 and 0.12 mm. The increase must be checked simultaneously by means of dial gauge at both bearings. The shaft should turn easily with active hydrostatics and must not jam in the top of the wiper bearing seal. Oil film pressures of 40 to 80 bar are reached at higher speeds and at the rated speed. The oil film pressures must be recorded in the operating log. If the oil film pressures fall over the course of time, the affected bearing shells must be checked.

3 Supervision of bearing insulation

The measurement of the shaft voltage of the generator rotor can be used as an indirect indicator to check the bearing insulation during operation.

4 Removing of oil mist condensate

The oil mist exhaust is to be adjusted to a negative pressure of at least 100 Pa.

⚠ WARNING
Risk of injury from contact with cleansers.
Wear protective gloves and goggles.
Avoid contact with the skin or eyes.
Follow the instruction manual for the cleanser used.

If oil mist condensate runs out of the bearing, the oil mist and/or smaller oil leakages at the appropriate bearing house openings are to be removed with suitable means.

NOTICE
Only use cleansers that do not attack the bearing metal, for example
- VALVOLINE 150 or
- Solvents and alkaline cleansers (pH 6 to 9, short application time).

NOTICE
Never use fraying cloths or cotton waste.
If fibres are allowed to remain in the bearing, they lead to excessive heating.

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Work Required	Maintenance intervals					
	Daily	Weekly	Monthly	Every 3 months	Every 6 months	Annually
Check leakage air filter in the cooler cover for contamination, clean or replace the filter mats if necessary					x[1)]	

1) At the first shut down after commissioning, or after 6 months at the latest. The maintenance interval must be specified on the basis of the inspection after commissioning, according to the environmental conditions.

1 General

NOTE:

Only trained personnel may check and change the filter mats.

The maintenance of the leakage air filters must be documented during the warranty period.

If possible, check and change the filter mats with the generator at a standstill. In order to avoid interrupting operations, the work can also be done very carefully while the generator is in operation. In this case, each time a cover is opened it must be shut again as quickly as possible.

NOTICE

Blocked filters can lead to dirt being deposited in the machine!

The leakage air filter mats must be checked regularly for contamination and cleaned or changed if required.

The filters must be checked without fail if work creating dust is performed near the machine.

The leakage air filter in the cooler cover becomes contaminated as a result of the continuous air exchange in the generator cooling system.

Each leakage air filter consists of two stages:

- Stage 1: a pre-filter to absorb larger particles.
- Stage 2: a fine filter to absorb very small particles.

The filter must be checked at the first operational shut down after commissioning, or after 6 months at the latest in the case of uninterrupted operation. The maintenance intervals then have to be specified according to the degree of contamination.

The maintenance interval should be shortened if, after a certain operating time, a change in the environmental conditions leads to a higher rate of filter contamination. The maintenance intervals can also be lengthened if the inspections do not show any discernable contamination of the filters.

2 Cleaning or changing the air filter

The filter mats can be changed without having to open the doors leading to the cooler hood as the protective filter covers are located outside and can be screwed off.

NOTE:

Two fine filter mats and two pre-filter mats have to be placed per door.

1. After removing the filter protection cover take the both pre-filter mats and the both fine filter mats out of the filter frame. Check the filter mats for contamination.
2. Replace the filter mat in case of heavy contamination. In case of minor contamination, mostly a blowing-out of the filter mat with dry compressed air is sufficient.
3. Fit the cleaned or new filter mats in right sequence (fine filter inside to the generator, pre-filter outside) in the frame and fix the filter protection cover.

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Work required	Maintenance schedule					
	Daily	Weekly	Monthly	Every 3 months	Every 6 months	Annually
Check the field current transmission carbon brushes		x				
Clean brush holder compartment			x			
Check surface of slip-ring					x[1)]	
Check free movement of the brushes in the holder			x			
Measure insulation resistance of the the rotor winding						x[1)]

[1)] With rotor stationary

1 General notes

Carbon brush wear depends on several factors. The cleanliness and relative humidity of the environmental air and the type of load have a great effect on the brush wear. The normal operational life of a carbon brush cannot be established until a lengthy period of operation has passed as the initial wear on a new brush is especially high. The brush wear can be up to 8 mm for 1000 operating hours under regular environmental and operational conditions.

It is a prerequisite for troublefree current transfer at the slip-rings that certain specific current densities are observed. The most favourable current density is 8 to 10 A/cm2. The current density during continuous operation should, if possible, not fall below 6 A/cm2 and not exceed 12 A/cm2. The number of brushes is adapted to these limits. The supplied brushes are designed so that the maximum field current can he transferred at the most favourable current density.

1 Gage stick
2 Notch mark
3 Telescopic plunger
4 Feeder cable to the carbon brush
5 Grip lever

Fig. 1: Plug-in brush holder with gage stick

2 Checking carbon brushes

The wear of each individual brush can be checked during operation without removing the brush holder by inserting the gage stick of insulating material, which is scope of supply, into the bore of the telescopic plunger. The gage stick is provided with several notch marks showing the useful length of the carbon brush. The brush must be exchanged without fail as from the center of the last field (frequently marked red).

When the gage stick can be inserted in the bore so that the inner end face of the stick handle beds against the telescopic plunger; then operational readiness is no longer guaranteed.

Fig. 2: Checking the brush wear using the gage stick

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3 Replacing carbon brushes

The carbon brushes can be exchanged during all operational and load conditions. For withdrawal of the plug-in brush holder, the handle should be tightened whereby the carbon brush is clamped in its guide through a clamping pin and the brush holder released from the clamping position of the plug-in brush holder socket. The brush holder can now be withdrawn and is no longer alive. This permits a replacement of the carbon brush outside the machine safely.

After a new carbon brush has been inserted, notch 1 of the inserted gage stick reaches as far as the upper edge of the telescopic plunger.

⚠ WARNING

Danger to injury from electric shock

The high-voltage insulated gloves supplied must be worn when removing holders from and inserting them into the brush-holder support while the machine is excited.

NOTICE

Danger of overload.

Only one plug-in brush holder may be withdrawn per polarity in order not to endanger the transmission of the field current during the inspection and maintenance work. A second brush holder must not be withdrawn until the first brush holder has been re-inserted and is contributing properly to the transmission of the excitation current (observe contact area).

Fig. 3: Pulling out the brush holder

The brush holder is of unsymmetrical shape rendering impossible any wrong insertion. Any contact between the brush holder and the rotating slip-ring is precluded by a stop.

NOTE:

When changing the brushes, one should only use brushes with a contact surface that largely matches the slip-ring contour.

The pre-bedding in can be done with a phantom or on the slip-rings with the turboset at a standstill.

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3.1 Removing the worn carbon brush

1. Pull the brush holder assembly, keep the handle tight

2. Press brush with finger against spring in the guide

3. Release the grip lever
4. Let brush slip out (as far as possible)

5. Unbolt telescopic plunger

6. Pull brush out of guide

7. Unclamp the cable lug

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3.2 Inserting a new brush

1. Insert the brush into the guide
2. Reclamp the cable lug

3. Bolt telescopic plunger

4. Insert brush into guide pressing finger against spring

5. Tighten grip lever

6. Insert plug-in brush holder into brush holder socket.

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4 Checking the slip-rings

Heavily soiled slip-rings should be cleaned at shut-down, preferably using clean brushes and dry linen cloths leaving no fluff. Depending on the kind of contamination use a cleaning liquid (Rivolta ® or equivalent) If necessary, dress the slip-rings by means of polishing cloth At such occasional inspections, the slip-ring grooves should be checked for the formation of burrs, which would accelerate the brush wear. Such burrs should be removed by breaking the edges. Polishing over the slip-rings and careful removal of the metal dust will be required afterward.

Slip-rings must be reworked when the surfaces are damaged, e.g. by scratches or chatter marks. A roughness depth of Rz4 and a run-out accuracy of 0.02 mm (true running) must be reached when reworking. Reworking may reduce the diameter of the slip-ring by a maximum of 10 mm. Otherwise a slip-ring exchange is required.
It is recommended to perform turning or grinding of the slip-rings by the Siemens Service staff.

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SIEMENS

Turbogenerator | Operating and Maintenance Manual

Maintenance 4

Inspection

1 Preventive maintenance

Reliable operation of the turbine generator will be ensured only if inspections and overhauls are carried out at regular intervals so that any faults can be detected and corrected before they result in costly failures. Following each inspection, the next inspection should be scheduled.

Provided that commercial tools can be used and that no special skills are required for the dismantling and erection work, the inspections can be performed by skilled power station personnel. The services of trained Siemens service personnel are required for all work which requires special tools as well as specific knowledge of assembly.

It is a checklist of the inspections which have to be performed, and for the creation of the corresponding material and personnel plans. Siemens offers the appropriate support for the entire process, including the supply of tools and personnel, as well as support for efficient inspection and maintenance planning. For more detailed information, please contact your local Siemens representative or your contact person at Siemens itself.

All findings should be documented for subsequent examinations.

The spare parts stored for repairs and inspections should be checked at regular intervals. Components packed in plastic sheeting mostly contain a desiccant which must be replaced or reactivated from time to time.

Apart from its scope, the timing of an inspection is important. To account for the deterioration and stresses due to different modes of operation, the number of operating hours, the number of starts and the turning times are used as criteria in determinating the intervals between the inspections.

The intervals recommended in the following are based on the recommendations of the VGB guideline for Intervals between Generator Inspections [1] which are based on the accumulated experience of the German public utilities and manufacturers. This Foreword contains a large number of extracts from the VDE Recommendations.

The VGB recommendations are a guide to help power plant owners and operators schedule inspections, however they should also take into account their own experience of the performance of their generators and that of sister machines.

2 Types of Inspection

Depending on the scope, date and duration of the inspections, a differentiation is made between

- Minor Inspection (MiI) (or Short Inspection)
- Medium Inspection (MeI)
  (or Intermediate Inspection)
- Major Inspection (MaI) (or Main Inspection)

Type	Features	Duration
MiI	Checks and measures required based on observations during operation and checks **with** partial disassembly (opening the manhole cover only) but **without** rotor removal	Days
MeI	Checks and measures required based on observations during operation and checks **with** partial disassembly but **without** rotor removal	A few weeks
MaI	Checks and measures required based on observations during operation and checks **with** extended disassembly and **optionally with** rotor removal, but **only if really required**	Several weeks

Tab. 1: Types of Inspection, Features and Duration

The time periods given in table 1 are guiding values. Inspection intervals can be either shortened or lengthened, according to the scope of the planned work and the findings of the inspections.

The **Minor Inspection (MiI)** can be routinely scheduled or performed when a shutdown occurs. It serves to detect changes at an early stage which have not yet been detected by the monitoring system as well as to verify its results. The generator remains fully assembled during an MI, only the manholes are opened.

The scheduling of **Medium Inspections (MeI)** is generally determined by other power station components. The downtime can be used not only for an extensive inspection but also for small improvements and minor repairs.

During **Major Inspection (MaI)** comprehensive inspections, repairs and renewal of parts, even to a larger extent, are made. The auxiliary plant units have to be integrated. The rotor removal is optionally, but it is required in case of supposed earth fault, vibration deviations or excitation current deviations.

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Optionally, a **Sub-minor Inspection** (Initial Inspection) of the generator is possible. It is designed as a visual inspection requiring only the opening of the manhole covers. That reduces the duration so that it matches the Minor Inspection duration of the gas turbine.

The scheduling of the inspections mainly depends on the number of operating hours, the number of starts and the turning gear operation times. The influences are considered according VGB Recommendation for an equivalent operation time under consideration of the machine output in four performance groups

The total number of equivalent operating hours since the initial commissioning, the last Main Inspection or other incidents important for the inspection schedule corresponds to:

$$T_{equiv} = T_1 + K_2 \cdot T_2 + n \cdot T_3$$

while:

T_{equiv} - Equivalent operating hours

T_1 - Operating hours since the initial commissioning or the last Main Inspection

K_2 - Weighting factor for turning gear operation

T_2 - Turning gear operation in hours since the initial commissioning or the last Main Inspection

n - Number of starts since the initial commissioning or the last Main Inspection

T_3 - Weight time in hours per start.

In some cases, the turning gear operation time T_2 is not exactly known. In this case, an estimated numerical value may be used which takes into account the mode of operation and corresponds to the minimum of two values.
In some cases, the turning gear operation time T_2 is not exactly known. In this case, an estimated numerical value may be used which takes into account the mode of operation and corresponds to the minimum of two values.
The following equation reflects the VGB recommendation [1] for calculating the annual turning gear operation time. A turning gear operation time of 50 hours is assumed for each shutdown procedure, but not more than the difference between 8500 hours per year and the annual operating hours.

$$T_2 = \min \{ n \cdot 50; \quad 8500 \cdot t_{cal} - T_1 \}$$

while:

t_{cal} - Calendar time in years since the initial commissioning, since the last Main Inspection or since every other incident used to calculate Te.

The maximum number of operating hours per year is assumed to be the maximum possible operating hours according to VGB recommendations [1]. A calendar year has 365 days = 8,760 hours. However, the VGB assumes that every plant has standstills based on the actual mode of operation. Therefore the average maximum annual operating time is less than the calendar time.
As shown in Figure 1, the evaluation factor for turning gear operation (K2) depends on the nominal apparent power of the generator (**S**).

Fig. 1: Weighting factor for turning gear operation K2

The numerical value of (K2) for a specific nominal apparent power of the generator (S) in MVA corresponds to:

$$K_2 = S / 4000 + 0.2$$

with a maximum value of $K_2 = 0.5$

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As shown in Figure 2, the equivalent evaluation time (T3) depends on the nominal apparent power of the generator (S).

Fig. 2: Weighted time in hours per start T3

The numerical value of T3 for a specific nominal apparent power of the generator (S) in MVA corresponds to:

T_3 = 0.015h x S/MVA + 7h
with a minimum value of 10 h and a maximum value of 25 h

3 Additional Factors and Recommendations for Scheduling Inspection Intervals

The recommendations given in the following apply to normal operation without major incidents. Abnormal disturbances, such as close-in system faults, faulty synchronizing, asynchronous running and inadmissibly high unbalanced load, may necessitate shortening of the respective inspection interval or an immediate check.

When scheduling inspections, also consider the following factors:

- Ambient conditions (moisture, salty air ect.)
- Mode of operation (frequent large and rapid load changes; frequent start-ups and shut-downs)
- Wear and deterioration of components
- Deterioration of running behaviour
- Number of load shedding with overspeed
- Earth faults or interturn faults in generator field circuit
- Water or cooler leaks
- Change in coolant flow rates
- Fouling of air-cooled generators
- Deterioration of shaft insulation
- Generator-type specific experience
- Cleanliness of the lubricating oil.

With proper performance of the generator and provided that the inspection findings obtained by the preceding inspections (s) have been favourable, the intervals between inspections may be lengthened within reasonable limits.

4 Recommendation for Inspection Intervals

The Major Inspection (MaI) after an equivalent operating time

$$80000\ \text{h} < T_{equiv\ r} < 106000\ \text{h}$$

.

It is recommended that one or more Minor and Medium Inspections are performed between Major Inspections.

This point of time is not dependance to the technical requirements of the generator, but also to the most generator dependend moments of shut down periods of the machine set.

Irrespectively of the above-mentioned recommendations, the following total time (operating time + turning gear operation time + shutdown time) between two inspections on account of adverse long-term influences should not exceed:

	Total time between two inspections
MiI	3 years
MeI	6 years
MaI	12years

Tab. 2: Maximum Total Time between Inspection Intervals

5 Exemplary calculations of equivalent operating hours and intervals between Main Inspections

Exemplary calculations of equivalent operating hours using the above-mentioned methods and equations are given below. These calculations use various nominal outputs for the generator, various turning gear operation times and different numbers of starts. All these parameters are taken into account in the correct selection or calculation of the evaluation factor K2 for turning gear operation and the equivalent evaluation time T3 in hours per start.
In this way, the number of equivalent operating hours is calculated adequately for five typical modes of operation, which reflect the various combinations of

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the regular annual operating time, the turning gear operation time and the number of starts. Selected combinations are shown in Table 3, and they are to a great extent identical with real practical operation.

The number of equivalent operating hours is calculated for a calendar year (t_{cal} = 1 year). It is assumed that the actual, exact value for the turning gear operation time is unknown. Therefore an estimated equivalent is calculated using the method described above and the number of starts **n** (Table 3).

Operating Mode	Load Ranges	Annual Operation Time in h	Annual No. of Starts	Annual turning gear operation time in h
A	Base load	7000	10	500
B	Lower medium load	5000	50	2500
C	Upper medium load	3000	150	5500
D	Peak load	2000	250	6500
E	Operation in industrial power station	7000	10	500

Tab. 3: Typical Operating Modes

The five modes of operation in Table 3 are used in Table 4 for different generator nominal outputs.

Generator rated power **S** = 600 MVA				
Operating type	$T_2 \cdot K_2$	$n \cdot T_3$	T_{equiv} per year	Intervals for Main Inspections in years
A + E	175	160	7335	11
B	875	800	6675	12
C	1925	2400	7325	11
D	2275	4000	8275	10

Generator rated powers **S** = 300 MVA				
Operating type	$T_2 \cdot K_2$	$n \cdot T_3$	T_{equiv} per year	Intervals for Major Inspections in years
A + E	175	160	7335	11
B	688	575	6262	12*
C	1513	1725	6237	12*
D	1788	2875	6662	12

Generator rated powers **S** = 100 MVA				
Operating type	$T_2 \cdot K_2$	$n \cdot T_3$	T_{equiv} per year	Intervals for Major Inspections in years
A + E	113	100	7213	11
B	563	500	6063	12*
C	1238	1500	5738	12*
D	1463	2500	5963	12*

Table 4: Exemplary calculations of equivalent operating hours T_{equiv} of the generators for one year and intervals between Main Inspections.

* The calendar time which has passed since the last Major Inspection / the first commissioning must not exceed 12 years.

The currently recommended scope of the inspections is described on the following pages. Please contact Siemens for the up-to-date, complete inspection recommendations of the Engineering Dept.

Further information on this subject

[1] Inspection Recommendations for Turbine Generators
VGB-R167, Edition 2010,
published by VGB PowerTech e.V.;
VGB PowerTech Service GmbH;
ISBN 978-3-86875-332-5

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Work required	Short inspection	Intermediate inspection	Main inspection
Vibration measurement at various load stages on the entire shafting	x	x	x
Shaft voltage measurement to assess the bearing insulation	x	x	x
Check bearing insulation	x	x	x
Record operating data of the generator and the auxiliary systems	x	x	x

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Work required	Minor inspection	Medium inspection	Major inspection
Electrical measurements			
Implement insulation resistances measurement of stator winding	x	x	x
Implement insulation resistances measurement of temperature sensor	x[1)]	x[1)]	x
Implement winding resistances measurement	x[1)]	x[1)]	x
Implement resistances measurement of temperature sensors	x[1)]	x[1)]	x
Perform high pot (high-voltage) test[3)]			x
Perform tan δ - and partial discharge measurement[4)]			x[2)]
Perform stator core interlamination verification test			x
Visual inspections			
Check end winding spacers	x	x	x
Check circuit ring and circuit ring supports	x	x	x
Check pressure plates and their locking elements	x	x	x
Check flexible connectors and their locking elements	x	x	x
Check stator core bore for pressure marks in the core tooth area			x
Check end winding support and its bracing	x	x	x
Check end winding insulation	x	x	x
Inspection of the outer corona protection (OCP) insulation in the step iron region	x	x	x
Check surface sealing	x	x	x
Check winding end leads	x	x	x
Check resistance thermometer connections	x	x	x
Check tightness of foundation bolting	x	x	x
Inspection of the sealing between laminated core and air guide walls, or between air guide walls and housing, and, if necessary, between laminated core and housing			x
Check stator vent slots			x

1) Recommended, but not strictly required
2) Test results only comparable if the same equipment is used with identical boundary conditions using the same procedure
3) Test to be conducted depending on available measurement equipment wether as AC test (preferred) or as DC test
4) Tests to be performed if AC equipment is available on site

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1 Insulation Resistance Measurement

After each shutdown, prior to carrying out the inspection, the insulation resistances should be measured according to documents [1], [2] and [3] (see end of document).

2 Stator Winding

Depending on the scope of the inspection, the windings in the slot section of the core and in the end winding areas should be inspected for proper seating. After opening the generator, the interior should always be inspected for contamination of any kind. If contamination is detected, its cause should be determined and corrected in order to preclude any new contamination. The generator interior should be cleaned thoroughly.

The exposed OCP of the end windings should be visually inspected for signs of erosion. The areas of inspection are located at the exit edge of both ends of the core, in the step iron regions. A boroscope should be used for this inspection. Any findings should be reported to Siemens Engineering for evaluation and further recommendation.

3 Terminal Bushings and Phase Connectors

The terminal bushings should be inspected to establish their condition. It should be checked that the flexible links are still in good condition and are properly attached. Checking of proper attachment of the flexible links covers both the connections to the terminal bushings and the connections to the phase connectors. The terminal bushings should also be checked for proper connection to the bus bars arranged external to the generator.

4 Visual Inspections

Visual inspections to be performed such as accessibilities are given. Manhole openings are placed that samples are showing sufficient area of the devices to be inspected. If a finding is reported further inspection needs to be performed meaning further disassembly measures to be taken.

Visual inspection should be made of the end windings (parallel ring cleat, support brace to short circuit stop gap, series connection insulation), core finger plates, core laminations, wedges, main and neutral lead components, etc., looking particularly for signs of overheating, looseness, or dirt contamination.

Minor amounts of dirt contamination on the end windings and oxidation of the core have little to no impact on the generator's operation. It is also expected that the short circuit stop gaps will close over time. This condition is normal and can be addressed by resetting the gaps as needed. The stator bore should be explored for debris or foreign metallic objects. The stator should be checked for slot wedge migration, and the laminations and structural parts should be checked for evidence of overheating or mechanical damage. As a characteristic of the global vacuum pressure impregnated stator coils, indications of minor frictional wear and resin cracks may be observed in the stator end winding brace systems. These minor indications are normal and are not necessarily indicative of a natural frequency near the driving frequency.

5 Replacement of Flexible Links

Flexible links that are no longer in good condition [4] must be replaced without delay. The following requirements must be observed during replacement of flexible links:

- Grounding of the phase connector ends and the generator terminal bushings must be performed before work is started.
- Cleanness (absence of foreign matter) of the end-winding region must be assured at all times. The precautionary measures given in Table 1 must be strictly observed.
- The new flexible links must be of the same type and length as the flexible links to be replaced. Fitting of flexible links of differing types or lengths should only take place when expressly instructed by Siemens.
- Replacement flexible links are to be checked first for proper condition (surface finish, absence of deformation).
- Flexible links are to be installed in accordance with the binding assembly procedures.
- Vibration behavior of replacement flexible links is to be checked with the aid of a stroboscope at 50 or 60 Hz and 100 or 120 Hz after restart. Any significant differences in vibration behavior relative to unreplaced flexible links should be reported to Siemens.

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6 Flanged Joints and Metering Connections

All stator flanges should be checked for proper attachment. The stator should be checked for tight anchoring to the foundation. All metering connections should be checked for proper mounting and condition so far as practicable.

Prior to restart, the insulation resistance of the stator winding should be measured. If necessary, appropriate measures should then be taken to increase insulation values.

NOTICE

Even minimal-size metallic particles left inside after work on the generator can lead to large-scale damage during generator operation.

In order to prevent such damage to the generator and the stator winding, the following precautionary measures must be taken.

1. Only persons as signed to such work may enter the interior of the generator.
2. Persons assigned to such work must be in the possession of clear work procedures and have been informed of special features of the work scope involved and of the associated potential dangers.
3. All persons entering the interior of the generator must wear clean overshoes.
4. Before entering the generator interior, all persons must empty their pockets and remove all metallic objects worn (such as watches, chains, earrings etc.).
5. Tools required for work inside the generator may only be transported within boxes, and must be returned to these boxes after use.
6. After completion of work inside the generator, the completeness of tool kits should be verified against tool lists and the results of this check logged.
7. All winding areas on which work is to be performed must be covered off carefully before work is started.
8. All parts to be installed or removed should be listed, with details of their exact whereabouts.
9. Should a part be dropped despite all the above precautionary measures, it is imperative that it be located and removed. Site management should be informed in the case of any problems in this context.
10. Generator openings should be closed off with the original covers for the duration of any work breaks.
11. The use of the attached check list (4.5-2001) for works at the generator is strictly required.

Also refer to the following information (if included):

[1] 4.5-2300 Insulation Resistance Measurements on Stator Winding
[2] 4.5-3300 or 3301 Insulation Resistance Measurements on Rotor Winding
[3] 4.5-2310 or 2311 Drying the Windings
[4] 4.4-4211 Maintenance and Supervision of Stator

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Work required	Minor inspection	Medium inspection	Major inspection
Electrical measurements			
Measurement of insulation resistance	x	x	x
Measurement of winding resistance	x	x	x
Voltage drop test on slip-ring supply lead	x[1)]	x[1)]	x
Visual inspections			
Check for true running	x	x	x
Remove and check the rotor			x[2)]
Visual inspection of the slot wedge			x
Visual inspection of the retaining rings		x	x
Inspection of the sealing surfaces	x	x	x
Inspection of the coupling flange			x[2)]
Inspection of the fans	x	x	x
Removal, cleaning and non-destructively testing of all the fan blades			x
Check balancing weights per knock test	x	x	x
Inspection of the end windings via bore-sonic inspection	x	x	x
Endoscopic inspection of end windings, including, in particular, the contacts between axial direct-current supply line and A coil (J-Strap)		x	x
Endoscopic inspection of the sub slot air channels		x	x
Endoscopic inspection of the corner brazed joint at the pole transition conductor at the transition from pole 1 to pole 2		x	x
Inspection of the air outlet ducts			x
Insert, align and couple the rotor			x[2)]

1) Recommended, but not strictly required
2) Only, if rotor removal really required (supposed earth fault, vibration deviations, excitation current deviations)

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1 Rotor Wedges and Retaining Rings

After withdrawal, the rotor should at first be subjected to a simple visual examination. The wedges and retaining rings should be inspected for proper condition.

2 Shaft Journals

The shaft journals should be checked for grooves. In the event of any irregularities being detected, the reconditioning should be carried out according to the instructions given by our erection engineers.

3 Cleaning the Rotor

After each withdrawal, the rotor should be cleaned thoroughly, even if the visual inspection did not reveal any contamination. Cleaning the rotor should be done very carefully so as not to impair any of the numerous insulated parts. It is, therefore, recommended to make use of the services of our experienced erection personnel, who will carefully remove any dirt accumulations below the retaining rings and within the range of the end windings by means of a special vacuum cleaner. Any inexpert use of compressed air may involve the risk of cooling duct clogging and of damage to insulating parts.

4 Fan blades

⚠ WARNING

Risk of injury from the effects of arcs and flying debris.

Fan blades must be handled with great care! Damaged or incorrectly mounted fan blades can work loose and cause a short circuit in the stator end winding. Flying debris could break through the enclosure.

- ***The fan blades may only be removed and refitted by trained assembly personnel. This must be done very carefully.***
- ***If the vibration values increase, the vibration protection monitor must power down the system immediately.***

The fan blades must be removed and tested non-destructively. The fan has to be turned to do this. Check that the threads are in faultless condition.

Siemens Service must be informed promptly if the tests find defects. They will initiate the necessary actions.

5 Coupling

The coupling flange at the rotor should be checked both at the guide flange and the fitting bolt holes. The coupling bolts should be checked for proper condition.

6 Insulation Resistance Measurements

Prior to re-commissioning, the insulation resistance of the rotor winding should be measured (see below, document [1]) and, if necessary, improved by drying the windings (see document [2]).

Also refer to the following information:

[1] 4.5-3301 Insulation Resistance Measurement on Rotor Winding (Chapter *Storage and Commissioning Preparation*)

[2] 4.5-2310 or 2311 Drying the Windings (Chapter *Operation*, Section “Standstill”)

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Work required	Minor inspection	Medium inspection	Major inspection
Check cooling water inlet and outlet pipes	x	x	x
Check vent and drain pipes	x	x	x
Check temperature measuring device	x	x	x
Remove the radiator and clean the water and air pipes			x
Replace gaskets of the radiator water and air pipes, if required			x
Pressure test			x
Inspect boroscopicly returning chambers of the coolers; check the coating condition	x	x	x
Replace gaskets of the returning chambers of the coolers open			x

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1 General

Depending on the extent of the inspection, the air cooler sections should be cleaned thoroughly both on the air and water sides. During a less extensive inspection, the tubes should be cleaned on the water-side only. For this purpose, no withdrawal of the cooler sections will be necessary.

The cooler cleaning interval depends on the cooling water condition and is indicated when a substantial reduction of the heat removal capacity is observed at the cooler sections. A repetition of the tube cleaning every two months may be necessary when the cooling water is heavily contaminated. It may be possible, however, that the interval between one cleaning and the next may amount to several years. It is recommended to perform the first cleaning operation two months after initial commissioning. The date at which the next cleaning will be required can be determined at that time. The intervals for cleaning can, however, be definitely fixed only after several years of operation.

The coolers should be withdrawn from their wells when more extensive inspection work is required. After withdrawal, the coolers should be thoroughly inspected on the air side. On detection of any contamination, the air side should be cleaned by means of dry and clean compressed air. The coolers should then be installed in the generator housing, using new gaskets for reassembly.

Depending on machine size and total cooling air flow the leakage air flow can amount to 0,5 m^3/s. Control the leakage air filter sequentially.

2 Mechanical Cleaning on Water Side

For this purpose, no withdrawal of the cooler sections will be necessary.

Close water inlet valves at the individual cooler sections and then open vent and drain valves.

Detach return water channels after all water has been drained from the cooler sections.

The tubes are cleaned by special brushes, which are moved up and down in the individual tubes of the tube bundle. After all tubes are brushed, a new flat gasket should be fitted and the return water channel bolted tightly to the tube sheet of the cooler section. This should be followed by reopening the inlet and outlet valves, whereby the tube bundle is flushed with cooling water.

3 Chemical Cleaning

Brushing of the tubes normally suffices for cleaning. Any scale deposits which cannot be removed by brushing should be dissolved with a chemical solution.

The following commercially available cleaning agents are recommended:

Water Side:

Cleaning agent	Manufacturer
P3-288	Henkel KGaA, Düsseldorf
SAF-ACID	Drew Ameroid GmbH, Hamburg
Vecom BA-S	Vecom GmbH, Hamburg

Air Side:

Cleaning agent	Manufacturer
P3 Grato 90	Henkel KGaA, Düsseldorf
Ameroid ACC9	Drew Ameroid GmbH, Hamburg
Vecom B-85	Vecom GmbH, Hamburg

Equipment Required:
Pump
Vessel
Piping
Shutoff fittings
Cleaning agents

Close water inlet valves and then open vent and drain valves. Drain water from cooler sections. Close drain valves and water outlet valves. Connect circulating pump to cleaning circuit via water inlet and outlet pipes. Fill system. Close vent valves and circulate cleaning agent through the circuit. After cleaning, thoroughly flush circuit with water.

Remove cleaning equipment. Place water circuit in service again. It is advisable, in the event of sufficient experience not being available, to have such chemical cleaning work performed by specialist firms.

⚠ WARNING

Toxic materials.

When performing chemical cleaning work be sure to observe the applicable instructions for the handling of chemicals.

4 Hydraulic Cleaning

Close water inlet valves at the individual cooler sections and then open vent and drain valves. Detach return water channel after the water has been completely drained from the cooler.

High-Pressure Water Spray Cleaning

Connect high-pressure water spray cleaning unit and push spray nozzle into each individual tube.

Steam Cleaning

Connect steam lance to a steam generator or operating steam supply. Insert steam lance into each individual tube.

After cleaning, remove cleaning equipment. Refit return water channels, using only new gaskets and place water circuit in service again.

Cleaning Cooler on Air Side

To do this, the cooler sections must be removed according to the respective instruction and set down on a support.

To remove minor contaminations, clean the fins and tubes with dry compressed air.

In case of more severe fouling, high-pressure water spray cleaning may be used. Recommended pressure: 120 bar with 3 mm dia. spray nozzle. Distance between spray nozzle and tube bundle should be approximately 2 meters.

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Work Required	Minor inspection	Medium inspection	Major inspection
Check contact and bonding of the white metal of bearings		x	x
Check bearing journals		x	x
Visual inspection of bearings for any oil leakages	x	x	x
Check bearing surfaces and babbitt bonding (dye penetrate and ultrasonic)		x	x
Check bearing clearances		x	x
Check seat of bearing shell in bearing shell support		x	x
Check and renew rigid labyrinth seals if necessary		x	x
Check bearing thermometer	x	x	x
Check hydraulic shaft jacking	x	x	x
Replace the HP hoses for shaft jacking device		x	x
Implementation of bearing pedestal insulation measurement	x	x	x
Implementation bearing clearances and slackness measurement		x	x
Test run up to occurrence of steady-state bearing temperature	x	x	x
Cover up the seal in the bearings, readjust oil wiper		x	x

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1 General information

⚠ WARNING

Starting machine parts. People could be severely injured.

Before starting any work on the generator or its auxiliary equipment:

- ***Disconnect them from the electricity supply***
- ***Secure against accidental switching on again***

Do not launch the turbine-generator set if persons are working on the generator or its vicinity!

The insulation resistance of insulated bearings should be measured prior to each inspection. If the insulation resistance is found to be bad, a particularly thorough inspection must be made to see whether any form of electrical corrosion (electrochemical erosion) can be found.

The bearings should then be dismantled and cleaned thoroughly. Bearing sleeves and shaft journals should be checked for proper condition. All parts of the bearings must be examined for signs of wear.

The inspection procedure described above should be performed at all sleeve bearings of the turbine generator.

NOTE:

You will find more detailed information about inspection work on bearings in Section 4.2* Bearings *of Chapter 4* Components and Purchased Parts *of the Supplier Documentation.

2 Check the state of wear of all parts of the bearings.

The state of wear of all parts of the bearings must be determined by a visual inspection. Especially the assessment of the bearing surfaces of the bearing shells requires a great deal of experience. In case of doubt, always insert new bearing parts.

The insulating coatings on the spherical surfaces in the upper and lower parts of the housing must be inspected. Contact Siemens without delay if they are found to be damaged.

It is normal for the bearing babbitt to wear over time and need refurbishment. This is not always indicative of an operational issue.

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Work required	Minor inspection	Medium inspection	Major inspection
Check condition of slip ring	x	x	x
Check alignment			x[1)]
Check carbon brushes for field current transmission	x	x	x
Check and clean brush holder area	x	x	x
Check insulation resistance of the brush holder assembly	x	x	x
Check slip-ring surface	x	x	x
Check free movement of the brushes in the brush holder	x	x	x
Determine remaining length of each carbon brush	x	x	x

1) Only in case of rotor removal

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1 General

The scope of work to be performed during an inspection depends mainly on the equipment on which defects have been detected since the last inspection. It will therefore be necessary to extract from the operating log all deficiencies to be corrected during the inspection.

2 Carbon Brushes

The Brush holders should be carefully cleaned and checked for proper condition.

After completion of the inspection, new carbon brushes should be fitted, making sure to use brushes of the same type and grade as otherwise proper current transfer may be impaired. To ensure full contact between the brushes and the slip-ring, the new brushes are to be ground to the required contour. To do this, wrap a strip of emery cloth tightly around the slip-ring, with the abrasive side facing the brushes, and pull it to and from unit the brush contact faces match the slip-ring contour. To complete grinding, move emery cloth strip a few times only in the direction of rotation. Use a standard fine-grain emery cloth for initial bedding down and an ultra-fine polishing cloth for final grinding. Carefully remove carbon dust after completion of bedding procedure.

Work required	Minor inspection	Medium inspection	Major inspection
Check condition and performance of temperature gauges and alarms	x	x	x
Check condition and performance of grounding brushes	x	x	x
Visual inspection of earthing cables (baseframe-enclosure, enclosure-cooler)	x	x	x
Check leakage water detector*	x	x	x
Check performance of anticondensation heater*	x	x	x

* If existing

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Work required	Minor inspection	Medium inspection	Major inspection
Disassembly			
Disassemble the generator cooler		x	x
Disassemble the generator excitation enclosure	x	x	x
Disassemble the generator panels	x	x	x
Disassemble the air baffle ring completely		x	x
Remove air baffle ring from installed position on sliding pedestal tool	x		
Open the bearing and coupling cladding		x	x
Measure the bearing clearances, contact pattern and slackness		x	x
Check for true running			x
Measure bearing pedestal insulation			x
Measure the state of alignment			x
Remove the rotor			x[1)]
Open coupling			x
Reassembly			
Insert, align and couple the rotor			x
Measure the bearing clearances and slackness		x	x
Seal in the bearings, cover them up, readjust oil wiper		x	x
Mount oil pipes			x
Complete generator	x	x	x
Reassamble generator cooler		x	x

1) Only, if rotor removal really required (supposed earth fault, vibration deviations, excitation current deviations)

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Work required	Minor inspection	Medium inspection	Major inspection
Control of shaft lifting (hydrostatic) of bearing before start-up	x	x	x
Control of oil lubrication flow of bearing before start-up	x	x	x
Visual inspection of bearings for any oil leakages	x	x	x
Test run up to occurrence of steady-state bearing temperature	x	x	x
Vibration measurement at various load stages on the entire shaft	x	x	x
Shaft voltage measurement to assess the bearing insulation	x	x	x

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1 Introduction

The initial inspection is the optional first inspection of the generator. An extensive visual inspection through the man holes is required. In case of air cooled GVPI generators the extent of the Initial Inspection corresponds to the medium inspection.
The initial inspection shall take place during the first two years of the generator lifetime.

	Recommended	Required
MEASURES WHILE GENERATOR IN OPERATION		
Vibration measurement at various load stages on the entire shafting		x
Shaft voltage measurement to assess the bearing insulation		x
Check bearing insulation		x
Record operating data of the generator and the auxiliary systems		x
STATOR		
Electrical measurements		
Implement insulation resistances measurement of stator winding		x
Implement insulation resistances measurement of temperature sensor	x	
Implement winding resistances measurement	x	
Implement resistances measurement of temperature sensors	x	
Visual inspections		
Check end winding spacers		x
Check circuit ring and circuit ring supports		x
Check pressure plates and their locking elements		x
Check flexible connectors and their locking elements		x
Check end winding support and its bracing		x
Check end winding insulation		x
Check surface sealing		x
Check winding end leads		x
Check resistance thermometer connections		x
Check tightness of foundation bolting		x

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ROTOR		
Electrical measurements		
Measurement of insulation resistance		x
Measurement of winding resistance		x
Voltage drop test on slip-ring supply lead	x	
Visual inspections		
Check for true running		x
Visual inspection of the retaining rings		x
Inspection of the sealing surfaces		x
Inspection of the fans		x
Check balancing weights per knock test		x
Inspection of the end windings via bore-sonic inspection		x
Endoscopic inspection of end windings, including, in particular, the contacts between axial direct-current supply line and A coil (J-Strap)		x
Endoscopic inspection of the sub slot air channels		x
Endoscopic inspection of the corner brazed joint at the pole transition conductor at the transition from pole 1 to pole 2		x
COOLER		
Check cooling water inlet and outlet pipes		x
Check vent and drain pipes		x
Check temperature measuring device		x
Inspect boroscopicly returning chambers of the coolers; check the coating condition		x
BEARINGS		
Check contact and bonding of the white metal of bearings		x
Check bearing journals		x
Visual inspection of bearings for any oil leakages		x
Check bearing surfaces and babbitt bonding (dye penetrate and ultrasonic)		x
Check bearing clearances		x
Check seat of bearing shell in bearing shell support		x
Check and renew rigid labyrinth seals if necessary		x
Check bearing thermometer		x
Check hydraulic shaft jacking		x
Replace the HP hoses for shaft jacking device		x
Implementation of bearing pedestal insulation measurement		x
Implementation bearing clearances and slackness measurement		x
Test run up to occurrence of steady-state bearing temperature		x
Cover up the seal in the bearings, readjust oil wiper		x

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STATIC EXCITATION SYSTEM		
Check condition of slip ring		x
Check carbon brushes for field current transmission		x
Check and clean brush holder area		x
Check insulation resistance of the brush holder assembly		x
Check slip-ring surface		x
Check free movement of the brushes in the brush holder		x
Determine remaining length of each carbon brush		x
SUPERVISORY EQUIPMENT		
Check condition and performance of temperature gauges and alarms		x
Check condition and performance of grounding brushes		x
Visual inspection of earthing cables (baseframe-enclosure, enclosure-cooler)		x
Check leakage water detector*		x
Check performance of anticondensation heater*		x
DIS-/REASSEMBLY		
Disassembly		
Disassemble the generator cooler		x
Disassemble the generator excitation enclosure		x
Disassemble the generator panels		x
Disassemble the air baffle ring completely		x
Open the bearing and coupling cladding		x
Measure the bearing clearances, contact pattern and slackness		x
Measure bearing pedestal insulation		x
Reassembly		
Measure the bearing clearances and slackness		x
Seal in the bearings, cover them up, readjust oil wiper		x
Complete generator		x
Reassamble generator cooler		x
COMMISSIONING		
Control of shaft lifting (hydrostatic) of bearing before start-up		x
Control of oil lubrication flow of bearing before start-up		x
Visual inspection of bearings for any oil leakages		x
Test run up to occurrence of steady-state bearing temperature	x	
Vibration measurement at various load stages on the entire shafting		x
Shaft voltage measurement to assess the bearing insulation		x

* If existing

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	Recommended	Required
MEASURES WHILE GENERATOR IN OPERATION		
Vibration measurement at various load stages on the entire shafting	x	
Shaft voltage measurement to assess the bearing insulation	x	
Record operating data of the generator and the auxiliary systems		x
STATOR		
Electrical measurements		
Implement insulation resistances measurement of stator winding with star point staying closed		x
Visual inspections		
Check end winding spacers		x
Check circuit ring and circuit ring supports		x
Check pressure plates and their locking elements		x
Check flexible connectors and their locking elements		x
Check end winding support and its bracing		x
Check end winding insulation		x
Check surface sealing		x
Check winding end leads		x
Check tightness of foundation bolting		x
ROTOR		
Electrical measurements		
Measurement of insulation resistance		x
Visual inspections		
Inspection of the sealing surfaces		x
Inspection of the fans		x
Check balancing weights per knock test		x
Endoscopic inspection of the end windings		x
COOLER		
Check cooling water inlet and outlet pipes		x
Check vent and drain pipes		x
Check temperature measuring device		x

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BEARINGS		
Visual inspection of bearings for any oil leakages		x
Check bearing thermometer		x
Check hydraulic shaft jacking oil system		x
Implementation of bearing pedestal insulation measurement		x
Implementation bearing clearances and slackness measurement		x
STATIC EXCITATION SYSTEM		
Check condition of slip ring		x
Check carbon brushes for field current transmission		x
Check and clean brush holder area		x
Check insulation resistance of the brush holder assembly		x
Check free movement of the brushes in the brush holder		x
Determine remaining length of each carbon brush		x
SUPERVISORY EQUIPMENT		
Check condition and performance of temperature gauges and alarms		x
Check condition and performance of grounding brushes		x
Visual inspection of earthing cables (baseframe-enclosure, enclosure-cooler)		x
Check water leakage detector*		x
Check performance of anticondensation heater*		x
DIS-/REASSEMBLY		
Disassembly		
Disassemble the generator panels		x
Reassembly		
Complete generator**		x
COMMISSIONING		
Control of shaft lifting (hydrostatic) of bearing before start-up		x
Control of oil lubrication flow of bearing before start-up		x
Visual inspection of bearings for any oil leakages		x
Test run up to occurrence of steady-state bearing temperature	x	
Vibration measurement at various load stages on the entire shafting	x	
Shaft voltage measurement to assess the bearing insulation	x	

* If existing
** Replace gaskets as necessary during reassembly.

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1 General

During operation of a generator, voltages are set up along the rotor due to magnetic unbalances. This shaft voltage would cause a destructive current to flow through the bearings and other components if the rotor were not insulated from ground at least at the exciter end. For reasons of interchangeability; all stator components coming into contact with the generator rotor are insulated.

2 Checking the Bearing Insulation During Installation

2.1 Bearings

Prior to inserting the rotor and supporting it on the bearings, the insulation resistance of the assembled bearings should be measured separately by means of a 100 V megger applied between the bearing and the base plate. The values measured should be recorded.

The bearing shells are insulated inside the bearing housings. The shaft seals are insulated mounted. The bearing shell potentials are lead out of the bearing housings by wires.

With satisfactory insulation, a value in excess of 0.5 megohms is to be expected. If an insulation resistance value below 0.5 megohms is measured, the insulating parts should be checked for moisture, contamination or metallic contacts. The measurement should be repeated immediately after the rotor has been supported on the bearings.

NOTICE

During this measurement both rotor bearings must be insulated, and the generator rotor must not come into contact with the turbine shaft through measuring devices or similar parts, to prevent the generator rotor from being grounded.

Since, with the rotor inserted, all individual resistances measured previously are now in parallel in the measuring circuit, the total resistance will be slightly lower than the lowest individual resistance value measured before.

2.2 Final Checking

After the generator rotor has been insulated from the bearings, a final insulation check should be performed. The total insulation resistance must not be less than 0.5 megohms. Due to contact with the shaft, the measuring circuit covers in parallel:

TE/EE bearings with pipework

3 Checking the Bearing Insulation of the Assembled Unit

Checking the bearing insulation during operation may be done by way of the shaft voltage prevailing with the generator running in an excited condition. For this purpose, the potential of the insulated bearings is accessible external to the generator. With the generator running, the components coming into contact with the shaft are separated from the shaft by an oil film, which has insulating properties. Consequently, a non-defined resistance value is set up at the potential measuring points of the bearings which is dictated by the magnitude of the resistances of the oil film and insulating parts. The following method permits the insulation to be checked without disassembly of components being required.

Useful results are, however, to be accepted only if the turbine end of the generator rotor and the turbine shaft are grounded properly during the measurements. Grounding must be maintained to discharge to ground any static charges occurring continuously during operation due to steam and oil film friction.

3.1 Checking the Insulation with the Generator in an Excited Condition

Due to the rotor grounding arrangement at the turbine end, the shaft voltage should be measured at the exciter end. Since the result depends, however, on the function of the rotor grounding system (carbon brush sliding on shaft), the shaft voltage should first be measured according to fig. 1 with the generator running and excited. Normally, this will be an ac voltage of a few volts on which a small dc component is superimposed. Measurement should be performed by means of a voltmeter in the ac range. The voltage should be picked off the shaft for example through a sliding contact with an insulated handle, which is connected to the meter by a cable (all not scope of supply!).

The shaft voltage measured in this way should then be compared with the voltage measured according to fig. 2. If the two readings are not identical, the rotor grounding system should be rectified first before taking any further readings to check the insulation for shaft currents.

If the shaft voltage can be accurately measured according to fig. 2, the measuring brush on the shaft

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should first be connected to the potential measuring terminal on the insulated bearing at the exciter end by means of a cable. The oil film is thus bridged, and the component assumes the shaft potential. With satisfactory insulation, the instrument will continue to indicate a shaft voltage of the original magnitude. Insufficient insulation resistance will result in a current flow through the insulation that can be read on the ammeter. The bridging of the oil film results in a reduction of the original shaft voltage or in its complete collapse.

The resulting current can be measured for a brief moment by means of an ammeter connected into the circuit between the measuring brush and the potential measuring terminal (fig. 3).

3.2 Checking the Insulation With the Generator in Non-Excited Condition

A bridge instrument must be used to locate insulation defects with the generator running and in non-excited condition. To measure the resistance of the insulated component with respect to the shaft and ground, the bridge instrument should be connected between this component and ground. The resistances (***R_{oil}*** and ***R_{ins}*** in series) of the parts in contact with the shaft are then connected in parallel with the measuring voltage.

This measurement is not practicable with the generator at standstill, since a stable oil film providing for full insulation can only be formed above a speed of approximately 3.33 to 6.66 s^{-1}.

In case of a low insulation resistance, it must be assumed that the insulation is defective, requiring detailed checking of the insulating parts. Such an insulation test requires great experience in the interpretation of the results and should be performed only by a Siemens specialist.

1 Voltmeter (ac range)

Fig. 1 Measurement of shaft voltage with the generator in excited condition

1 Voltmeter (ac range)

Fig. 2 Measurement of shaft voltage at exciter end with the generator in excited condition

1 Voltmeter (ac range)
2 Ammeter

Fig. 3 Measurement of shaft current with the generator in excited condition

1 Bridge instrument

Fig. 4 Measurement of insulation resistance with the generator in non-excited condition

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During an inspection, the individual components of the generator are exposed to the ambient conditions which may result in hazards to these components. It is therefore strongly recommended to take suitable measures for preventing any exposure to moisture, especially rain, snow, liquids of any kind and condensation. Covering the components will not afford sufficient protection.

To avoid the above-mentioned hazards, the assembly work during an inspection should be accomplished under protection from weather conditions. The generator should only be opened if an uninterrupted execution of the work will be ensured and provided that the necessary protective measures can be taken. After opening of the unit and withdrawal of the rotor, the stator openings should be promptly reclosed. The stator should be dried by means of a portable air dryer or fan-forced heater and kept above ambient temperature level. The air dryer or fan-forced heater should be arranged so that the air will circulate through the stator interior in a closed circuit for ventilation of the entire internal space.

The rotor should be protected in such a manner that especially the retaining ring area can be kept dry and above ambient temperature level. The air dryer or fan-forced heater should be arranged so that the air will circulate in a closed circuit.

The cooling water should be drained from the coolers. The coolers should be cleaned, dried and maintained in dry condition by suitable measures.

Normally, a condensation hazard can be recognized with the help of a dewpoint measuring device. In case of doubt, however, it is recommended to dry the components on a continuous basis in order to achieve a markedly low dew-point temperature on these components, i.e. to maintain their temperature above ambient temperature level.

For further information see chapter *Standstill*.

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	Description of works to be carried out	To be checked by	Date	Name/Signature
1	Issuing of work permit for works on generator			
2	Area around generator to be barred off (work passes to be issued to individual workers) and supervisor to be nominated for the period the generator is open. Closing during breaks and process interruptions to be assured.			
3	Cleanness check of area around generator			
4	Instruction of workers regarding working inside and around the generator			
5	Listing of all tools used for repairwork inside of generator. Tools to be marked			
6	Checking of inside of generator immediately after manholes are opened (first man inside generator)			
7	All opening of generator, pipework and bearings to be temporarily covered			
8	Listing of all material removed from the generator parts to be collected in separate boxes			
9	Checking of complete generator inside prior to closing of manholes (last man inside generator)			
10	Check of whereabout of tools used inside of generator			
11	Checking the material removed from generator			
12	Release of generator for start-up			
13	Return of work permit			

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1 Safety Precautions for the Rotor Removal

The removal and installation of the generator rotor requires specialist knowledge and particular care. Accordingly, this job may only be carried out by experienced expert installation mechanics. Observe both the general safety rules and the accident prevention rules applicable on the construction site.
Lifting gear and sling equipment should be dimensioned according to the required load-carrying capacity. When using lifting gear and sling equipment, comply with the general technical and safety requirements specified by the manufacturers.
Component parts should always be put down safely after transportation. Any openings or possible safety hazards created should be protected and/or sufficient warning should be ensured. Observe the applicable safety rules when working on platforms or at heights of more than ***1*** metre.
Do not store any tools or component parts in the area of the base frame or of the generator and rotor windings. Protect removed parts or exposed openings using suitable packaging material, e.g., plastic sheeting, etc. to avoid soiling or penetration by any foreign matter.

1.1 Information for the Nominated Person in Control of the Electrical Installation

Follow the local and industry-specific safety and setup regulations.

The persons responsible for the plant must ensure the following:

- Planning and configuration work and all work carried out on and with the generator is only to be done by qualified personnel.
- The operating instructions must always be available for all work.
- The technical data as well as the specifications relating to the permissible installation, connection, ambient and operating conditions are taken into account at all times.
- The specific setup and safety regulations as well as regulations on the use of personal protective equipment are observed.

Use the services and support provided by the appropriate Service Center for planning, installation, commissioning and servicing work.

In the individual chapters of this document, you will find safety instructions that must be obeyed absolutely, for your own safety, to protect other people and to avoid damage to property.

Observe the following safety instructions for all activities on and with machine.

1.2 Five Safety Rules

For your personal safety and to prevent material damage when working on the machine, always observe the safety instructions and the following five safety rules, according to EN 50110-1 (“Working in a voltage-free state”). Apply the five safety rules in the order stated before starting work at the machine.

Five safety rules:

1. Disconnect the system. Disconnect the auxiliary circuits, for example anti-condensation heating.
2. Prevent reconnection.
3. Make sure that the equipment is at zero voltage.
4. Ground and short-circuit.
5. Cover or isolate nearby Components that are still live.

To energize the system, apply the measures in reverse order.

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1.3 Qualified Personnel

All work at the generator must be carried out by qualified personnel only. For the purpose of this documentation qualified personnel is taken to mean people, who fulfill the following requirements:

- Through appropriate training and experience, they are able to recognize and avoid risks and potential dangers in their particular field of activity.
- They have been instructed to carry out work on the machine by appropriate person responsible.

1.4. Safe Handling

Workplace safety depends on the attentiveness, care and common sense of the personnel who install, operate and maintain the machine. In addition to the safety measures cited as a matter of principle, the use of caution is necessary when you are near the machine. Always pay attention to your safety.

Also observe the following to prevent accidents:

- General safety regulations applicable in the country where the machine is deployed.
- Manufacturer-specific and application-specific regulations.
- Special agreements made with operator.
- Separate safety instructions supplied with the machine.
- Safety symbols and instructions on the machine and its packaging.

	⚠ **WARNING** **Live parts** Electric machines contain live parts. Fatal or severe injuries and substantial material damage can occur if the covers are removed or if the machine is not handled, operated or maintained properly. - Always observe the “five safety rules” when carrying out any work on the machine. - Only remove the cover using the methods described by these operating instructions. - Operate the machine properly. - Regularly and correctly maintain the machine.
	⚠ **WARNING** **Rotating components** Electric machine contain dangerous rotating parts. Fatal or severe injuries and substantial material damage can occur if the covers are removed or if the machine is not handled, operated or maintained properly. - Only remove the covers using the methods described by these operating instructions. - Take attention to mounted parts inside the machine also exciter, e.g. turning the rotor. - Be carefully when turning the machine by hand during alignment checks. - Secure free-standing shaft end. - Cover free-running couplings.
	⚠ **WARNING** **Hot surfaces** Electric machines have hot surfaces. Do not touch these surfaces. They could cause burns. - Allow the auxiliary system, such as heaters, to cool before starting work on the machine. - Only remove the covers using the methods described by these operating instructions. - Operate the system properly.

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	⚠ WARNING **Hazardous substances** Chemical substances required for the setup, operation and maintenance of machines can present a health risk. Poisoning, skin damage, cauterization of the respiratory tract and other health damage may result. - Read the information in these operating instructions and the product information supplied by the manufacturer. - Observe the relevant safety regulations and wear the personal protective equipment specified.
	⚠ WARNING **Flammable substances** Chemical substances required for the setup, operation and maintenance of machines may be flammable. Burns and other damage to health and material may result. - Read the information in these operating instructions and the product information supplied by the manufacturer. - Observe the relevant safety regulations and wear the personal protective equipment specified.
	⚠ WARNING **Noise emissions** During operation, the machine's noise emission level can exceed those permitted at the work place, which can cause hearing damage. Take steps to reduce noise, such as introducing covers and protective insulation or adopting hearing protection measures, so that the machine can be operated safely within your system.
	NOTE **Do not damage mounted parts** Mounting parts such as temperature sensors, speed sensors or vibration sensors are attached to the machine and could be ripped off or destroyed as a result of improper handling. This could lead to machine malfunction, extending even to total loss of the generator. - Where necessary, use suitable steps when performing work on the generator. - Do not stand on cables or attachments during removal and installation. Do not use attachments as steps.

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2 Requirements for the Rotor Removal

2.1 Checking the Load Handling Attachments

Inspect the load handling attachments such as the load stands, lifting eyes and ring bolts and also the lifting gear, before lifting and transport the generator rotor:

- Inspect the load handling attachments on the machine for possible damage. Replace any load handling attachments that are found to be damaged.
- Check before use that the load handling attachments are correctly secured.
- When lifting the generator rotor, use only approved and undamaged lifting gear of sufficient rated capacity. Check these before using.

	⚠ WARNING **Generator rotor can be dropped** If the load handling attachments and lifting gear are damaged or not correctly secured, the generator rotor may be dropped during lifting and transportation. This can result in death, serious injury, or material damage. Inspect the load handling attachments and lifting gear before use.

2.2 Lifting and Transporting Parts of the Generator

- Persons driving cranes and fork-lift trucks must hold appropriate licences.
- When lifting the rotor and parts, use only approved and undamaged sling guides and spreaders of sufficient rated capacity. Check these before using them. The weight of the parts is shown on the rating plate.
- When lifting the parts, refer to the information on the lifting plate. Comply with the specified spreading angles. Do not extend the maximum lifting acceleration and lifting speed specified on the lifting plate. Lift the parts without jerking it.
  Acceleration $a \leq 0.4$ g
  Speed $v \leq 20$ $^{m}/_{min}$
- When lifting, use only the load handling attachments, such as lifting eyes or pulling bolts.

	⚠ **WARNING** **Transporting or lifting the generator parts** The generator parts set may be lifted and transported only using the load handling attachments at the intended positions. Otherwise, the machine may tip over, slip in the direction of lifting or fail. Death, serious injury, or material damage can result. - Only use the load handling attachments. - Use suitable rope guiding or spreading device. The weight of rotor is 66200 kg.
	⚠ **WARNING** **Center of gravity when transporting or lifting the generator parts** If the center of gravity of a load is not located centrally between the attachment points, the machine part can tip over or slip out of the lifting equipment when it is being transported or lifted. This can result in death serious injury, or material damage. - Comply with the handling instructions on the generator parts when transporting it. - Be aware of the possibility of different loads on the sling ropes or lifting straps and the carrying capacity of the lifting equipment. - Always take account of the center of gravity when transporting or lifting the generator parts. If the center of gravity is not located centrally between the attachment points, then position the hoisting hook above the center of gravity.
	⚠ **DANGER** **Never remain under a suspended load** If the lifting gear or load handling attachments were to fail, the parts could fall. This can result in death serious injury, or material damage. Never remain under the parts when it is raised.

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3 Preparatory Equipment for Rotor Removal

3.1. General

For rotor removal follow auxiliary material and equipment are necessary.
Sling equipment, 2 chain pulley blocks, steady rests, copper shims, securing devices, 2 hydraulic jack for 50 t each or more, 2 hydraulic jack for 35 t, film sheet, slide grease, slide supports, double-T beams, and wooden wedges.
A tent in front of the machine building over the installation frame is necessary to protect the rotor.
In case of transportation the rotor a provision of a crane with sufficient capacity e.g. 200-400t, taking into account the local conditions and the necessary projection angle of the mounting arm.

3.2. Required Auxiliary Special Tools and Devices

Not standard scope of supply, separately to order!

Design group (DG) **SFA7001:** 1x rotor installation carriage (4x threaded rods M30, 8x body blocks, 2x shaft blocks, 2x U-rails)
DG **SFA4900** 1x slide plate, 2x rotor sliding pad's, 1x sliding pedestal and 1x support blocks rotor body

DG **SFA7001**

Rotor installation carriage, weight 1300kg

Assembly version „Body“

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DG **SFA4900**

Sliding pedestal, weight 146kg

Sliding pad, weight 20kg

40; Shaft block, weight: 133kg

10; Base block 60 kg 20; Plate 2x 22 kg 30; Block 2x 25 kg

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3.3. Additional Equipment

(Not standard scope of supply, separately to order!)

DG **SFA7002,** Rotor installation frame

DG **SFA7002**

Example: The rotor installation frame will be used for rotor removal and installation.

Or:
The customer should provide a stable platform or base plates / beams /frame, depending on the installation height. They should be positioned without abutment axially behind the exciter base frame, and be aligned horizontally at all sides. The capacity of load of the platform or of the supports must be dimensioned at least for the weight of rotor, exciter end bearing block, and operating personnel. The surface condition should be sufficient for the expected surface loading. The installation and coupling of the supports or of the platform must be such that the supports will not move even when loaded on one side only when rotor is supported or when personnel is moving. It could be necessary to build the railway on a high load trailer in front of the generator foundation.

Example of a base, rail way on auxiliary support in level in front of exciter end, build on a high load trailer

Rotor installation frame / High load trailer are not scope of supply by Siemens Energy ERF

You should take account of the sub base or foundation conditions regarding wheel loads (if necessary, use steel rails for axial movement.

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4 Preparatory Work for Rotor Removal

4.1 General

All activities must be coordinated with possible necessary displacement of other auxiliary equipment and installations around the generator foundation. The necessary space and movement of auxiliary cranes and tools must be checked before the preparatory work for the rotor removal can start.

Disassemble stairs, steps and ladders around the sound enclosure entries. Disconnect necessary earthing wire, electrical connection, such as power excitation cable, cabling for thermo and shaft vibration monitoring on the bearings. Disconnect electrical connections on the extra sound enclosure (light e.g.). Disassemble the shaft vibration sensors from all the bearings.

Protect the cable ends with suitable material against damaged. Label the positions of the cable terminals in the terminal boxes and on the pedestals. This connection will be reconnected during reinstallation.

4.2 Removal of Turbine End (TE) Bearing Cover

Dismantle the TE cover from the TE bearing.

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4.3 Removal of Coupling Bolts, Opening of Generator Coupling

Dismantle the coupling cover and open the coupling bolts. Mark out the position of the coupling bolts and number every bolt and the corresponding hole.

4.4 Removal of Lube Oil Supply Lines on Turbine End (TE) and Exciter End (EE)

Disassemble all lube oil and jacking oil lines or hoses on the TE and EE bearings. If necessary disassemble the complete oil supply line beside the sound enclosure.

Disassemble oil outlet flanges and hydraulic blocks with pressure gauge from the pedestal TE and EE.

Disconnect thermo couples.

Dismantle rigid labyrinth seals from the pedestal TE and EE.

4.5 Removal of Extra Cover of Sound Enclosure on EE

Disassemble the two air outlet cone on top the extra cover and the air inlet filter house in front. Loosen the screwing of EE extra cover and disassemble the single parts one by one.

4.6 Removal of Excitation System (Brush Gear)

Loosen all electrical connection from the excitation system. Remove all ventilation air channel and disassemble the excitation system

4.7 Removal of End Walls of Sound Enclosure on TE and EE

Loosen the screwing and remove the end walls (1) of generator sound enclosure on TE and EE.

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4.8 Removal of Shaft Seal Labyrinths and Shaft Bushings on TE and EE

Loosen the screwing (1) of shaft seals (divided) and remove it. Loosen the air hose connection (2) and remove it. Loosen the dowel pins and screwing of shaft bushings (3) (divided) and remove it.

Example: Shaft seal labyrinths.

Shaft bushings (3).

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4.9 Removal of Air Guide Rings on TE and EE

Loosen the screwing of air guide rings (4) (divided) on TE and EE. Loosen and dismantle the screwing of split lines. Remove the top halves of air guide rings and after the bottom halves.

Example: Air guide ring (4).

After this activity the rotor is only lying in the TE and EE bearing and ready for removal.
Prepare now the rotor installation frame in front of the EE bearing. Align the installation frame in level and height of generator. Connect the installation frame on the base frame of generator.

5 Rotor removal

5.1 Assembly of the Rotor Installation Frame

(Not standard scope of supply, separately to order!)

Install the rotor installation frame in front of generator EE side.
.

Align the rotor installation frame in height to the base frame of generator by hydraulic jacks.
After, align the six screwed support blocks (adjustable 60mm in height) to the installation frame.
Bolt the six screwed support blocks under the installation frame; secure them each with two screws.
Remove the four hydraulic jacks.
Install the connecting plate between rotor installation frame and base frame of generator, to secure the frame, see Fig: 1.

Install the rotor installation frame in front of EE (see Fig. 1).

Fig. 1

Rotor installation frame

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5.2 Rotor removal sequence

Lift the rotor with a jack, on EE.
Install a sliding pad between rotor body and stator core, on EE.
Remove the bearing shell, on EE.
Remove the pedestal (1) and the pedestal base (2), on EE see Fig: 2.

Fig. 2 Sliding pad Polyester cord

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Lift the rotor with a jack and take out the sliding pad on the polyester cord.
Install a greased slide plate between rotor body and stator core, from EE in.
Install the sliding pad between rotor body and slide plate.
Install the rotor installation carriage on the installation frame in front of EE, see Fig: 3 and 4.

Fig. 3 Slide plate Sliding pad EE Polyester cord Installation carriage

Install the rotor carriage on the bearing shaft, on EE.
Change the jack to TE.
Lift the rotor with a jack an install a sliding pad, on TE.
Remove the bearing shell, on TE.
Remove the pedestal (1) and the pedestal base (2), on TE (see Fig. 4).

Fig. 4 Polyester cord Sliding pad TE Rotor installation carriage

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Install the sliding pedestal on the shaft bearing, on TE.
Install two wire gripper (3) between installation carriage and the front of the installation frame, (see Fig. 5).

Fig. 5 Sliding pedestal Sliding pad TE Rotor installation carriage

Pull the rotor carriage with the two wire gripper in EE direction.
Lift the rotor with a jack on EE and install the support block rotor body.
Set the rotor on the support block (1).
Dismantle the rotor carriage, on EE (see Fig. 6 and 7).

Fig. 6 Support block rotor body (1)

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Lift the rotor with a jack on EE and move the installation carriage below the rotor body.
Install the wooden blocks assembly variant “body” on the installation carriage.
Dismantle the support block (1).
Release the jack and pull the rotor carriage with two wire gripper further out (see Fig. 7).

Fig. 7 Support block rotor body (1) Installation carriage

Fig. 8

In a second step, set the rotor carriage with assembly variant “body” in the center of rotor body.
Use the jack on EE to lift the rotor, when moving the carriage in the center of the rotor, see Fig: 8

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Fig.9 Sliding pedestal Rotor carriage Gripper

Pull the rotor out till the final position is reached.
Take out the slide plate, clean and cover the plate.

Example: Rotor on installation carriage.

Rotor out on installation carriage on rotor installation frame, fan blades dismantled.

Example: Stator core with slide plate.

Take out the slide plate.
Close all openings with wood and keep the winding dry and clean from dirtiness and dust.

6 Rotor Installation

For rotor installation, proceed in reverse order.

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1 Dismounting Air Baffle Ring

STEP 1:

Assemble the sliding pedestal (pos. 1) for the air baffle ring on the shaft.

Loosen the screws (pos. 2, M10, 32 pcs.) on the bars between air baffle ring and base frame wall.

Record the position of the spacers (pos. 3) to ensure that they are later fitted at the same places when mounting.

Loosen the nuts (pos. 4, M36, 12 pcs.) from the base frame wall. Use the special wrench according to section *4.5-9940*.

1

3

4

STEP 2:

Pull the complete air baffle ring on the sliding pedestal towards shaft end. Use a ratchet lever hoist for pulling.

Assemble the turning support (pos. 5). Use the nuts (pos. 6, M36, 4pcs.) to connect the turning support with air baffle ring and sliding pedestal.

5

6

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STEP 3:

Rotate the ring through 180°. The turning support must be at the bottom. For turning loosen the srews of the sliding pedestal.

Release the screw connections of the two ring halves.

STEP 4:

Put down the first ring half on the shaft.
Use a protection material for the shaft.

Pull the ring half towards the shaft end and draw it off.

STEP 5:

Rotate the second ring half through 180° to the top.

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STEP 6:

Disassemble the turning support.

Put down the second ring half on the shaft.
Use a protection material for the shaft.

Pull the ring half towards the shaft end and draw it off.

2 Mounting Air Baffle Ring

For mounting of the air baffle ring proceed in reverse order. For axial adjusting of the air baffle ring use the special wrench according to section *4.5-9940*.

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Special Tools

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1 Generator Shipping

For generator shipping see Installation Manual.

Special tool		Manufacturer's internal no.	Qty.
Hitching spreader beam Working load limit = 185 t l = 4.6 m		P0027161600	2 pcs
Round sling PES Working load limit = 110 t l = 4.0 m		P0027161800	4 pcs
Round sling PES Working load limit = 100 t l = 5.0 m		P0027161900	4 pcs
Container Working load limit = 2.0 t 2000×1200×1000 mm		P0027162000	1 pcs

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2 Generator Alignment

For generator alignment see Installation Manual.

Special tool	Manufacturer's internal no.	Qty.
Cylinder RC-506	PE119944	3 pcs
Manual pump P 80	PE109777	3 pcs
Hydraulic hose HC 7206 l = 1.8 m; d = 3/8"	PE119945	3 pcs
Pressure gauge GF-510B	PE119946	3 pcs
Transport crate CM-4 l = 787 mm; w = 457 mm; h = 355 mm	PE119947	3 pcs

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3 Air Baffle Ring Dismounting and Mounting

For application of the special wrench see document 4.5-9940.

For application of sliding pedestal and turning support see document 4.5-9918.

Special tool	Manufacturer's internal no.	Qty.
Special wrench consisting of 2 wrenches and 2 parallel pins 	P0015622800	1 pce
Sliding pedestal and turning support (mounted) 	P0015601500	1 pce

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4 Rotor Removal and Installation

For rotor removal and installation see document 4.5-9914.

Special tool	Manufacturer's internal no.	Qty.
Rotor installation carriage with assembly variants *Body* (1) and *Journal* (2) (1) (2)	P0023596100	1 pce
Sliding plate	P0007562600	1 pce
Sliding shoe	P0017396200	2 pcs
Sliding pedestal	P0007571700	1 pce

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Special tool	Manufacturer's internal no.	Qty.
Set-down trough	P0017408400	2 pcs
Rubber plate 4×1000×2000	PE260979	2 pcs
Round sling PES WLL 35000 kg l = 11 m	P0027162200	2 pcs
Grease Bechem Berutox MB II-H	PE112415	1 kg

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5 Checking the Brushes of the Field Current Transmission System

For checking the brushes see document 4.4-4993.

Special tool	Manufacturer's internal no.	Qty.
Protective gloves	PE114905	1 pce
Gage stick	PE113155	1 pce

6 Cooler Cleaning

For cooler cleaning see document 4.5-1240.

Special tool	Manufacturer's internal no.	Qty.
Cooler cleaning brush	P0017462100	1 pce

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The delivered special wrench is required for mounting, dismounting, and axial adjusting of the air baffle ring.

It consists of 2 wrenches (items 6 and 8) and 2 parallel pins (item 7). It is required for axial adjusting by turning the screw collars (item 3).

For mounting or dismounting of the air baffle ring only 1 wrench (item 8) is required to tighten or loosen the hexagon nuts (item 2).

Before axial adjusting or dismounting of the air baffle ring the cotter pins have to be removed. After axial adjusting or mounting of the air baffle ring **new** cotter pins have to be inserted. One set of new cotter pins is included.

Fig. 1: Special wrench

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Spare Parts

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Parts identification number	Designation		Installed quantity	Recommended quantity for 2 years	Unit
Generator bearings					
P0007951000	Bearing shell E-ZTQ 45-450 with hydrostatic		2	2	pcs
P0007958100	Chamber seal (shaft) type 20; 45-500 ø 500, IP 44; width 50		2	2	pcs
P0007958200	Chamber seal (shaft) type 22; 45-500 ø 500, IP 55, width 80, with connection for earth brush		1	1	pcs
P0038442700	Chamber seal (shaft) type 20; 45-500 ø 500, IP 44, width 50, with connection for earth brush		1	1	pcs
PE104083	Jointing compound Hylomar M		1	2	pcs

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Parts identification number	Designation	Installed quantity	Recommended quantity for 2 years	Unit
Rotor grounding system				
PE113413	Plug-in brush holder assembly 06.00.0468.00	2	4	pcs
P0002947100	Two-layer contact brush, design A* EMT 513-005, 20×8×32 mm	2	20*	pcs
P0002946000	Two-layer contact brush, design B* EMT 513-005, 20×8×32 mm	2	20*	pcs
	* Brushes design A and B should be ordered in same quantities.			
Cooler				
P0017560800	Filter mat M5 314×314×25	4*	8*	pcs
P0017561100	Filter mat F7 314×314×4	4*	8*	pcs
* Filter mats M5 and F7 are used in double quantities, see maintenance description 4.4-4321.				
Anti-condensation heating				
PE111723	CSN Threaded heating body ERCH III/38, 1.6 kW, 3×400V, G2", M20	2	1	pcs

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Parts identification number	Designation	Installed quantity	Recommended quantity for 2 years	Unit
Generator monitoring				
PE119889	Resistance thermometer type WQ 0233 2×PT100 installation length 250 mm HAN 8D	5	1	pcs
P0007519800	Shell thermocouple type MQ 0206-PVDFö 3×TC (K) installation length 571 mm HAN 8D	2	2	pcs
P0008726800	Leakage water monitoring 7ML5745-1BA42-1BA0	4	1	pcs
P0035875900	Proximity probe TQ412 for shaft vibration	4	1	pcs
P0035876300	Signal conditioner IQS450 for shaft vibration	4	1	pcs
PE134403	Accelerometer CA202 for bearing vibration	4	1	pcs
P0023098400	Signal conditioner IPC704 for bearing vibration	4	1	pcs

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Parts identification number	Designation	Installed quantity	Recommended quantity for 2 years	Unit
Brush assembly				
PE105015	Brush holder 78.0993.0008 Art. 06.08.0200.11	28	1	pcs
PE105013	Brush holder fixing arrangement 78.0993.0035 Art. 06.41.0008.00	28	1	pcs
PE123066	Carbon brush 32×32×64 mm	28	56	pcs
P0046066700	Halogen wall lamp 230 V AC; 2 × 55 W	2	1	pcs
tba	Bag filter M5 for brush gear ventilation 592×592×600 mm	2	4	pcs

NOTE:

For the use of spare parts not bought at Siemens AG there is no guarantee for damages or defects resulting from this.

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Drawings

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Drawing List

Item	Drawing title	Drawing no.	Included in manual / chapter
01	Piping and Instrumentation Diagram (P&I D)		TO[1] / 2 Description
02	P&I D Legend		TO / 2 Description
03	Auxiliary Wiring Diagrams of Generator	DPPPG-70140696	TP[2] / 3 Product Description
04	Generator Dimensional Drawing	DPPPG-70139229	TP / 7 Drawings
05	Generator Dimensional Drawing Text	DPPPG-70139230	TP / 7 Drawings
06	Axial and Radial Rotor Clearances		TP / 7 Drawings
07	Connection Diagram of Stator Winding		TP / 7 Drawings
08	Generator Labels – Drawing		TP / 7 Drawings
09	Cooling Elements – Drawing		TP / 7 Drawings
10	Cooler Cover – General Drawing		TP / 7 Drawings
11	Filter/Fan Unit for Slipring Unit		TP / 7 Drawings
12	Generator Bearing TE – Drawing		TP / 7 Drawings
13	Generator Bearing TE – Parts List		TP / 7 Drawings
14	Generator Bearing EE – Drawing		TP / 7 Drawings
15	Generator Bearing EE – Parts List		TP / 7 Drawings
16	Bearing Oil Inlet – Drawing and Parts List		TP / 7 Drawings
17	Hydrostatic Control Unit – Drawing and Parts List		TP / 7 Drawings

[1] TO = OMM Part 1 – Operating Manual
[2] TP = OMM Part 2 – Implementation Documentation

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Achtung bei der Fundamentplanung beachten!
Zum Ausgleich der Wärmedehnung der Generatorwelle im Nennlastbetrieb wird diese bei der Montage um diesen Betrag zuzüglich des Turbinenschubes im Nennbetrieb außerhalb der magnetischen Mitte des Generators in Richtung Turbine gestellt.
CAUTION! IMPORTANT FOR FOUNDATION DESIGN!
DURING INSTALLATION THE GENERATOR IS TO PULL OUT OF THE ROTOR.
IN TURBINE DIRECTION THE ROTOR MUST PULLED OUT THIS VALUEPLUS THE AXIAL TURBINE TRUST UNDER STEADY STATE CONDITIONS.

Achtung!
Die dynamische Fundamentsteifigkeit muss groeszer sein als:
CAUTION!
THE DYNAMIC FOUNDATION STIFFNESS MUST BE LARGER THEN:
VERTICAL: >8x10^6N/mm; HORIZONTAL: >4x10^6N/mm

2 Wassereinlassflansch / WATER INLET FLANGE

3 Wasserauslassflansch / WATER OUTLET FLANGE

Die Bezeichnung der Phasenklemmen erfolgt durch U1, V1, W1; die entspr. Sternpunktklemmen durch U2, V2, W2.
Die Klemmenspannung erreicht ihr positives Maximun in der Reihenfolge U1, V1, W1.
THE LINE TERMINALS ARE DESIGNATED U1,V1,W1.
CORRESPONDING NEUTRAL TERMINALS DESIGNATED U2,V2,W2.THE VOLTAGE REACHES ITS POSITIVE MAXIMUM VALUE AT THE TERMINALS ORDER OF U1,V1,W1.

1 Oel zu- u. Ablauf, sowie die Wasseranschlussflansche sind nicht als Festpunkte fuer Rohrleitungen vorgesehen.
OIL IN- AND OUTLET AS WELL AS COOLING WATERCONNECTION FLANGES ARE NOT DESIGNED TO SERVE AS PIPING-FIXPOINT NOZZLE LOADS ARE THEREFORE REGARDED AS NEGIGIBLE.

Erlaeuterungen der Positionen siehe Maszbildtext
Zeichn. Nr.: DPPPG-70139230

COMMENT FOR ITEMS SEE OUTLINE DRAWING TEXT
DRAWING No.: DPPPG-70139230

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WEIGHT:	SCALE: 1:25	SPEC.:KUN351.00	
ORIGINATED:	2017-04-28 LANGE	TITLE: GENERATOR MASSBILD	
CHECKED:	2017-04-28 PETZOLDT		
RELEASED:	2017-04-28 LANGE	GENERATOR OUTLINE DRAWIN	
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Die Abmessungen von Phasen- und Sternpunkt sind identisch
THE DIMENSION OF NEUTRAL- AND LINE SIDE CONNECTION POINT ARE IDENTICAL

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Erdunganschluss Ausleitungskonsole
GROUND CONNECTION BUS DUCT SUPPORT

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ES
EE

Einzelheit Haubenbefestigung
DETAIL COVER FIXING

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Detail Befestigung
Kuehler
DETAIL FIXING
COOLER

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(min. 17500 fuer geraden Laeuferausbau bei abgebauter ES Zusatzhaube)
(MIN. 17500 FOR STRAIGHT ROTOR REMOVAL, IF ADDITIONAL COVER EXCITER END IS REMOVED)

(min. 19000 fuer geraden Laeuferausbau bei nicht abgebauter ES Zusatzhaube)
(MIN. 19000 FOR STRAIGHT ROTOR REMOVAL, IF ADDITIONAL COVER WILL NOT BE REMOVED)

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Schnitt D-D
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(PAGE 1
C-1)

Beschreibung Kuehlerausbau
Siehe Betriebs- und Wartungshandbuch
DESCRIPTION COOLER REMOVAL
CAN BE FOUND IN OPERATION AND MAINTENANCE MANUAL

1000

Freier Platz fuer Ausbau Kuehler benoetigt
FREE SPACE NEEDED FOR COOLER REMOVAL

min.5000

Freier Platz fuer Ausbau Kuehler benoetigt
FREE SPACE NEEDED FOR COOLER REMOVAL

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Q
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Poller maximal ausgezogen fuer Transport
Ausgelegt auf einen Transport mit Stahlseilen
BOLLARD PULLED OUT FOR TRANSPORT
DESIGNED FOR A TRANSPORT WITH STEEL CABLE

VIEW TE
1:50

Dach ist komplett abnehmbar
ROOF CAN BE REMOVED COMPLETELY

Haube ist in der Mitte geteilt
ENCLOSURE CAN BE SEPARATED IN THE MIDDLE

3-geteilte Kuehlerhaube
zur Demontage der Kuehlelemente nach vorne
SEPARATED COOLER HOOD
FOR FRONT DISASSEMBLY OF COOLING LEMENTS

VIEW EE
1:50

Vorrichtung zum Anheben und Abstuetzen
der Haube beim Ausrichten des Generators
auf dem Fundament
LIFTING EQUIPMENT FOR LIFTING
COVER DURING ADJUSTING
GENERATOR ON FOUNDATION

Ansicht von Unten
VIEW FROM BELOW
3:200

CODE WORD:	Attarat 10+20
ORDER NUMBER:	EG000333/334

US and EU Export Controls
Technology Classification:
ECCN: EAR99 AL: N US-Content: NO
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ORIGINATED:	2017-04-28 LANGE	TITLE: GENERATOR MASSBILD	
CHECKED:	2017-04-28 PETZOLDT		
RELEASED:	2017-04-28 LANGE	GENERATOR OUTLINE DRAWIN	
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1:25

DO NOT SCALE, WORK TO DIMENSIONS SHOWN

Pro/ENGINEER AQ

1:25

Fundamentkraefte Generator
FOUNDATION LOADS GENERATOR

1:25

Description		1			2			3			7			9													
COMPONENT	LOAD POINT	STATIC LOAD (STATONARY)			STATIC LOAD (ROTATING)			POWER TORQUE (NTL)			DYNAMIC LOADS (NUS@3000RPM)			SHORT CIRCUIT			EARTHQUAKE 0,6g horizontal and 0,4g vertical acceleration									UNIT
																	EARTHQUAKE ±X			EARTQUAKE ±Y			EARTHQUAKE ±Z			
		F_x	F_y	F_z	F_x	F_y	F_z	F_x	F_y	F_z	Fx	Fy	Fz	F_x	F_y	F_z	F_x	F_y	F_z	F_x	F_y	F_z	F_x	F_y	F_z	kN
GENERATOR CASING	GE1	-1	-35	-2													±9	±41	±7	±4	±18	±2	±4	±62	±10	kN
	GE2	-3	-33	-2													±20	±55	±5	±4	±15	±3	±20	±51	±11	kN
	GE3	-1	-13	-1													±9	±35	±1	±1	±6	±1	±8	±27	±5	kN
	GE4	1	-28	-2													±10	±15	±4	±1	±16	±3	±11	±22	±14	kN
	GE5	-1	-25	-3													±6	±32	±6	±2	±13	±3	±5	±38	±14	kN
	GE6	1	-12	-1													±4	±26	±3	±1	±6	±1	±2	±7	±5	kN
	GE7	3	-28	-2													±7	±37	±5	±2	±14	±2	±20	±21	±11	kN
	GE8	8	-23	-2													±25	±83	±4	±4	±13	±3	±31	±86	±8	kN
	GE9	-8	-17	-1													±12	±7	±4	±4	±7	±1	±7	±10	±11	kN
	GE10	-8	-17	-1													±12	±7	±4	±4	±7	±1	±7	±10	±11	kN
	GE11	-8	-17	1													±10	±4	±4	±4	±7	±1	±1	±11	±6	kN
	GE12	-8	-17	1													±10	±4	±4	±4	±7	±1	±1	±11	±6	kN
	GE13	8	-23	2													±21	±45	±7	±4	±12	±1	±4	±10	±55	kN
	GE14	3	-28	2													±19	±57	±4	±2	±13	±2	±21	±47	±10	kN
	GE15	-1	-12	1													±8	±35	±1	±1	±6	±1	±8	±26	±5	kN
	GE16	-1	-25	3													±10	±14	±4	±2	±12	±3	±12	±22	±14	kN
	GE17	1	-28	2													±6	±33	±6	±1	±16	±3	±5	±40	±14	kN
	GE18	-1	-13	1													±5	±25	±3	±2	±5	±1	±3	±7	±5	kN
	GE19	-3	-33	2													±9	±32	±6	±5	±14	±2	±21	±26	±12	kN
	GE20	-1	-35	2													±11	±84	±3	±5	±17	±1	±26	±99	±8	kN
GENERATOR ANCHORING	GA1		-178									±133			19,44		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA2		-168,35						35,24						116,64		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA3		-187,775						35,24						291,6		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA4		-194,25						35,24						369,36		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA5		-207,2						35,24						388,8		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA6		-194,25						35,24						369,36		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA7		-187,775						35,24						191,6		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA8		-168,35						35,24						116,64		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA9		-178									±133			19,44		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA10		-178									±133			-19,44		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA11		-168,35						-35,24						-116,64		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA12		-187,775						-35,24						-291,6		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA13		-194,25						-35,24						-369,36		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA14		-207,2						-35,24						-388,8		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA15		-194,25						-35,24						-369,36		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA16		-187,775						-35,24						-191,6		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA17		-168,35						-35,24						-116,64		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
	GA18		-178									±133			-19,44		±155	±155	±126	±78	±78	±63	±155	±155	±126	kN
GENERATOR COOLER	GC1	-1	-31	-3													±46	±65	±19	±0	±15	±2	±14	±86	±26	kN
	GC2	0	-42	-5													±65	±25	±11	±0	±20	±3	±20	±80	±36	kN
	GC3	1	-31	-3													±46	±22	±6	±0	±15	±2	±14	±60	±19	kN
	GC4	0	-27	4													±0	±19	±15	±0	±19	±3	±0	±70	±26	kN
	GC5	0	-40	3													±0	±26	±8	±0	±26	±2	±0	±85	±27	kN
	GC6	0	-27	4													±0	±24	±1	±0	±19	±3	±0	±71	±22	kN
GENERATOR ROTOR	W5					-324,7						±265	±244													kN
	W6					-324,7						±265	±244													kN
	GQ1								246,7						1944											kN
	GQ2								-246,7						-1944											kN
PRELOAD	GA1-GA18		470																							kN
ERECTION LOADS	E1-E6	±127	±127	±127																						kN

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Ansicht ohne TS und ES Zusatzhaube
VIEW WITHOUT TE AND EXCITER EMD ENCLOSURE

7:200

7:200

Ansicht aufs Fundament Generator ausgeblendet und Wasserflansche angedeuted
VIEW ON FOUNDATION WITHOUT GENERATOR WATER CONNECTION FLANGES SHOWN

7:200

Ansicht auf TS
VIEW ON TE

7:200

Ansicht auf ES
VIEW ON EE

7:200

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Maßbildtext *OUTLINE DRAWING TEXT*	Kennwort/CODE: **Attarat 10 + 20**
Zeichnungsnummer/*DRAWING NUMBER*: **DPPPG-70139230**	No.: **EG000333, EG000334**
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A	03.05.17	Petzoldt	Lange	FIRST RELEASE

Hierzu gehört Maßbild
TO THIS BELONGS OUTLINE DRAWING

DPPPG – 70139229
22 – GNS0110T – 70139229

ECCN: EAR99	AL: N	ECL: N	US-Content: N

SIEMENS PG GT MGN ERF	Form 44	Z.- Sys. 70	Zeichnungs-Nummer / DRAWING NUMBER **DPPPG-70139230**	Index a	Blatt SHEET 1 Von OF 15
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Nenndaten	*RATINGS*	Wert *VALUE*	Einheiten *DIM.*	REV.

Generator Typ: SGEN5-1200A

Nenndaten	***RATED DATA***			
Scheinleistung S_N	*APPARENT POWER*	326	MVA	
cos φ	*P.F.*	0,85		
Drehzahl	*SPEED*	3000	min^{-1} *R.P.M.*	
Zulässige Überdrehzahl im Störfall (+10%)	*PERMISSIBLE OVERSPEED FOR FAULT CONDITION (+10%)*	3300	min^{-1}	
Drehrichtung, bei Sicht von Turbine auf Gen.	*DIRECTION OF ROTATION, VIEW FROM TURBINE TO GEN.*	Uhrzeigersinn clockwise		
Spannung	*VOLTAGE*	20 +/-5 %	kV	
Strom	*CURRENT*	9411	A	
Frequenz	*FREQUENCY*	50	Hz	
Thermische Zeitkonstante Ständer	*THERMAL TIME CONSTANT STATOR*	20,68	Min	
Thermische Zeitkonstante Läufer	*THERMAL TIME CONSTANT ROTOR*	8,27	Min	
Kapazität Ständerwicklung pro Phase gegen Erde	*CAPACITY STATOR WINDING AGAINST EARTH PER PHASE*	0,572	µF	
Kapazität Läuferwicklung gegen Erde	*CAPACITY ROTOR WINDING AGAINST EARTH*	0,565	µF	
Kühlluftmenge	*RATE OF COOLING AIR*	78	m^3/s	
Kühllufttemperatur	*COOLING AIR TEMPERATURE*	48,5	°C	
Kaltwassertemperatur	*COOLING WATER TEMPERATURE*	45	°C	
Abzuführende Verluste (Kühler)	*HEAT LOSSES (COOLER)*	3333	kW	
Bauform	***TYPE OF CONSTRUCTION***			
Bauform (DIN IEC 34 T.7)	*TYPE OF CONSTRUCTION*	IM 7215		
Schutzart (DIN IEC 34 T.5)	*DEGREE OF PROTECTION*	IP 55		
Kühlart (DIN IEC 34 T.6)	*METHODS OF COOLING*	IC8A1W7		
Schalldruckpegel (ISO 3744)	*SOUND PRESSURE LEVEL (ISO 3744)*	85	dB(A)	
Aufstellungsart	*TYPE OF INSTALLATION*	indoor		
Farbe	*COLOR*	RAL 7030 (INNER AREA) GROUNDING (OUTER AREA)		
Verladebedingung	***SHIPMENT INDICATION***			
Min. zulässige Transporttemperatur	*MIN. ALLOWED TRANSPORT TEMPERATURE*	-20	°C	

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Nenndaten	*RATINGS*	Wert *VALUE*	Einheiten *DIM.*	REV.

Gewicht	***WEIGHTS***			
Induktor komplett	*ROTOR COMPLETE*	66.200	kg	
Ständer-Aktivteil	*STATOR ACTIVE PART*	205.000	kg	
Grundrahmen	*BASE FRAME*	47.500	kg	
Lager, Zwischenrahmen	*BEARING/INTERMEDIATE FRAME*	5.000	kg	
Abdeckhaube (Schallschutz)	*ACUSTIC COVER*	27.000	kg	
Bürstenapparat (inkl. Belüftung)	*BRUSH GEAR (INCL. VENTILATION)*	900	kg	
Ausleitungskonsole	*SUPPORT MAIN TERMINALS*	3.700	kg	
Kühler, Kühlerhaube	*COOLING ELEMENTS, COVER*	18.300	kg	
Zubehör; Verankerung	*ACCESSORIES; ANCHORING*	500	kg	
Gesamtgewicht	*TOTAL WEIGHT*	374.100	kg	
Max. Transportgewicht (ohne Verpackung)	*MAX.SHIPMENT WEIGHT (WITHOUT PACKING MATERIAL)*	324.600	kg	
Erregung	***EXCITATION***			
Stationäre Stromrichteranlage (Schleifringe und Kohlebürsten)	*STATIONARY EXCITATION (EQUIPMENT, SLIP RINGS AND CARBON BRUSHES)*			
Mechanische Daten	***MECHANICAL DATA***			
Trägheitsmoment ($m*r^2$) (Läufer komplett)	*MOMENT OF INERTIA ($M*R^2$) (ROTOR COMPLETE)*	10375,9	kgm^2	
Losbrechmoment mit Druckölentlastung	*BREAK AWAY TORQUE WITH PRESSURE OIL*	438	Nm	
Losbrechmoment ohne Druckölentlastung	*BREAK AWAY TORQUE WITHOUT PRESSURE OIL*	36530	Nm	

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	Allgemeines	***GENERAL INFORMATION***			
1	Ausleitung	*LINE SIDE*			
2	Sternpunkt	*NEUTRAL SIDE*			
	Die Bezeichnung der Phasen-klemmen erfolgt durch U1, V1, W1; die der entsprechenden Sternpunktklemmen durch U2, V2, W2. Die Klemmenspannung erreicht ihr positives Maximum in der Reihenfolge U1, V1, W1. Angeschlossene Kabel oder Schienen müssen zuentlastet sein	*THE LINE TERMINALS ARE DESIGNATED U1, V1, W1; THE CORRESPONDING NEUTRAL TERMINALS DESIGNATED U2, V2, W2.* *THE VOLTAGE REACHES ITS POSITIVE MAXIMUM VALUE AT THE TERMINALS IN THE ORDER OF U1, V1, W1.* *CONNECTING CABLES OR BARS MUST BE STRAIN-RELIEVED*			
3	Generatorflansch TS (angeschmiedet)	*GENERATOR FLANGE TE (FORGED-ON SHAFT COLLAR)*			
4	Maß zur Kompensation der Generatorwellendehnung im Betriebszustand	*DIMENSION FOR COMPENSATION OF SHAFT EXPANSION BY GENERATOR IN OPERATION STATE*	4,48	mm	
5	Maß für das Ausfahren des Läufers. Ausbauvorrichtung (Rutsch-blech, Gleitbock, Gleitschuhe) liefert PG GT MGN ERF.	*DIMENSION FOR REMOVAL OF THE ROTOR.* *ASSEMBLY DEVICE (SLIDING PLATE; SLIDING PEDESTAL; SLIDE SHOES) SUPPLIED BY PG GT MGN ERF.*			
6	Abdeckhaube. Vor dem Abheben ist das Erdungskabel zu lösen.	*COVER.* *BEFORE LIFTING THE COVER RELEASE THE GROUND CABLE.*			
7	Erforderliche Kranhakenhöhe zum Abheben der Haube.	*HEIGHT OF THE CRANE HOOK WHEN LIFTING THE COVER*			
8	Leistungsschild	*RATING PLATE*			
9	Firmenschild	*COMPANY NAME PLATE*			
10	Zwischenrahmen unter den Lagerböcken.	*INTERMEDIATE FRAME UNDER THE BEARINGS.*			
11	Verschiebbare Ahhängepoller für Komplettransport	*MOVABLE BOLLARDS FOR COMPLETE TRANSPORTATION*			
12	Schleifringhaube mit Schalldämpfer und Belüftungseinheit	*SLIP RING COVER WITH SOUND ABSORBER AND VENTILATION UNIT*			
	Klemmenkasten	*TERMINAL BOX*			
	Anschluss für Belüftungseinheit	*CONNECTION FOR VENTILATION UNIT*	400 3 50 2000	V / AC PH Hz W	
13	Flanschplatte für Kabeldurchführung Kunde (ungebohrt)	*FLANGE PLATE FOR CUSTOMER CABLE PENETRATION (UNDRILLED)*			

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	Verankerung	***ANCHORING***			
15	Grundrahmenbefestigung mit Zubehör liefert PG GT MGN ERF, ebenso die Montagevorschrift	*ANCHOR BOLTS, ACCESSORIES AND ASSEMBLY PROCEDURE SUPPLIED BY PG GT MGN ERF.*			
	Zuganker Erstauflageplatten Ausrichtschrauben Ausrichtplatten	*ANCHOR BOLTS* *PRIMARY BEARING PLATES* *LEVELING SCREWS* *LEVELING PLATES*	18 x M42 4 28 x M42 28		

	Lagerangaben	***BEARING DETAILS***			
	Achtung! Innerhalb der Lagergehäuse entsteht durch die Rotation der Welle Ölnebel. Der Ölnebel ist durch geeignete Maßnahmen des Anlagen-betreibers aus dem Lager-gehäuse abzusaugen. Der empfohlene Unterdruck im Lagergehäuse beträgt 100 Pa.	***ATTENTION !*** *WITHIN THE BEARING HOUSING OIL MIST RESULTS FROM THE ROTATION OF THE ROTOR. THE OIL MIST IS TO BE SUCKED OFF FROM THE BEARING HOUSING BY SUITABLE MEASURES OF THE PLANT OPERATOR. THE RECOMMENDED NEGATIVE PRESSURE IN THE BEARING HOUSING AMOUNTS TO 100 Pa*			
	Ölsorte Nichtschäumendes Mineralöl (Lager werden ohne Ölfüllung geliefert).	*OIL GRADE* *NON-FROTHING MINERAL OIL* *(THE BEARINGS ARE SUPPLIED WITHOUT OIL).*	ISO VG32 ISO VG46		
	Ölinhalt beider Lager insgesamt:	*TOTAL OIL VOLUME OF THE TWO BEARINGS:*	400	l *litres*	
	Erforderliche Umlaufölmenge für beide Lager insgesamt mindestens:	*REQUIRED CIRCULATION OIL VOLUME FOR BOTH BEARINGS AT LEAST:*	400	l/min *litres/min*	
	maximale Öleintrittstemperatur:	*MAX. OIL INLET TEMPERATURE:*	ISO VG32: 50 ISO VG46: 55	°C	
	Öldruck am Ölzulauf Min.: Max.:	*OIL PRESSURE AT OIL INLET* *MIN.:* *MAX.:*	 1,5 2,0	bar	
	Lagerverluste je Lager	*BEARING LOSSES PER BEARING*	ISO VG32: 179 ISO VG46: 194	kW kW	
	Ölreinheitsklasse (ISO 4406)	*OIL PURITY CLASS (ISO 4406)*	20 / 17 / 15		
20	TS Lager, Durchmesser: Länge der Auflagefläche: (Umlaufschmierung ohne Schmierring)	*TE BEARING, DIAMETER:* *AREA OF SUPPORT LENGTH:* *(CIRCULATION OILING WITHOUT LUBRICATION RING)*	∅ 450 319	mm mm	
21	ES Lager, Durchmesser: Länge der Auflagefläche: (Umlaufschmierung ohne Schmierring)	*EE BEARING, DIAMETER:* *AREA OF SUPPORT LENGTH:* *(CIRCULATION OILING WITHOUT LUBRICATION RING).*	∅ 450 319	mm mm	

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22	Lagerisolierung; TS und ES durch isolierte Lagerschalen. Das Potential der Lagerschalen ist über Kabel nach außen geführt. Die Isolierung des TS-Lagers ist überbrückt. Die Isolation des ES-Lagers darf nicht überbrückt werden.	*BEARING INSULATION;* *TE AND EE BY INSULATED SHELLS. BEARING SHELL POTENTIAL IS TAKEN OUTWARD BY CABLE. INSULATION OF TE BEARING IS BYPASSED. INSULATION OF EE-BEARING SHOULD NOT BE BYPASSED.*			
23	Ölzulauf mit Flansch; Material: Edelstahl 1A, 1B	*OIL INLET WITH FLANGE;* *MATERIAL: STAINLESS STEEL* *1A, 1B*	ANSI 2“ B16.5 150lbs		
24	Ölabfluß mit Flansch Material: Edelstahl 2A, 2B	*OIL OUTLET WITH FLANGE* *MATERIAL: STAINLESS STEEL* *2A, 2B*	ANSI 6“ B16.5 150lbs		
	Ölabflußrohre mit Gefälle verlegen von mindestens:	*OIL DRAIN PIPES INSTALLED WITH A SLOPE OF AT LEAST :*	5	%	
25	Druckölanschluß: Gewinde 3A, 3B	*JACKING OIL CONNECTION:* *3A, 3B*	THREAD G 1/2"		
	Anhebedruck:	*LIFTING PRESSURE:*	ISO VG32: 14,0 ISO VG46: 14,0	MPa MPa	
	Haltedruck:	*HOLDING PRESSURE:*	ISO VG32: 10,0 ISO VG46: 9,5	MPa MPa	
	Erforderliche Ölmenge je Lager (bei max. 50°C Öltemperatur).	*REQUIRED OIL VOLUME PER BEARING* *(50°C MAX. OIL TEMPERATURE).*	ISO VG32: 4,0 ISO VG46: 4,0	l/min *litres/min*	
	Minimale Starttemperatur	*MIN. START-UP TEMPERATURE*	ISO VG32: 12 ISO VG46: 19	°C °C	
	min. zulässige Turndrehzahl (mit Druckölentlastung)	*MINIMUM TURNING SPEED:* *(WITH JACKING OIL)*	50	min^{-1} *R.P.M.*	
	Kleinste zulässige Drehzahl beim Hochfahren aus dem kalten Zustand. (Ausschalt-punkt der Hydrostatik)	*LOWEST SPEED WHILE START UP FROM THE COLD STATE. (POINT OF SWITCHING OFF THE JACKING OIL)*	ISO VG32: 75 ISO VG46: 45	min^{-1} *R.P.M.*	
	Kleinste zulässige Drehzahl ohne Hydrostatik im warmen Zustand (Einschaltpunkt der Hydrostatik)	*LOWEST SPEED WITHOUT JACKING OIL IN WARM STATE (POINT OF SWITCHING ON THE JACKING OIL)*	ISO VG32: 185 ISO VG46: 145	min^{-1} *R.P.M.*	
26	Maximales axiales Lagerspiel:	*MAX. AXIAL BEARING CLEARANCE:*	± 45	mm	
27	Lagerthermometer	*BEARING THERMOMETER*	1 (TS / TE) 1 (ES / EE)	Triplex TC typ K	
28	Relative Schwingungs-messung: 2 Gewindebohrungen um 90° versetzt im Lagerdeckel TS und ES (Schwingungs-aufnehmer Lieferumfang PG GT MGN ERF)	*RELATIVE SHAFT VIBRATION MEASUREMENT: TWO TAPPED HOLES DISPLACED BY 90° ON THE BEARING COVER TE AND EE (VIBRATION PICKUP ARE SCOPE OF SUPPLY PG GT MGN ERF)*		¾-14NPT	
	Schwingungsaufnehmer Typ:	*VIBRATION PICKUP TYPE:*	Meggit TQ 412		

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29	Lagerbockschwingung: 2 Meßstellen um 45° versetzt im Lagerdeckel TS und ES (Schwingungsaufnehmer Lieferumfang PG GT MGN ERF)	*BEARING STATOR VIBRATION: TWO MEASURING-POINTS DISPLACED BY 45° ON THE BEARING COVER TE AND EE (VIBRATION PICKUP ARE SCOPE OF SUPPLY PG GT MGN ERF)*			
	Schwingungsaufnehmer Typ:	*VIBRATION PICKUP TYPE:*	Meggit CA 202		

	Klemmenkästen	***TERMINAL BOXES***			
35	Klemmenkasten	*TERMINAL BOX*	**+MKA11GC041**		
	Anschluss für Nutenthermometer	*CONNECTION SLOT THERMOMETER*	12 3 (Reserve/SPARE)	1*Pt100	
	Anschluss für Kaltluftthermometer	*CONNECTION FOR COLD AIR THERMOMETER*	2 (TS / TE) 2 (ES / EE)	2*Pt100 2*Pt100	
	Anschluss für Warmluftthermometer	*CONNECTION FOR WARM AIR THERMOMETER*	1	2*Pt100	
	Anschluss für Lagerthermometer	*CONNECTION FOR BEARING THERMOMETER*	1 (TS / TE) 1 (ES / EE)	Triplex TC typ K	
	Leckwasserüberwachung	*LEAKAGE WATER SUPERVISION*	4 24 4x1,3	Stck/pcs V / DC W	
	Anschluss für Blechpaketthermometer	*CONNECTION STATOR CORE THERMOMETER*	6	1*Pt100	
	Anschluss für Wellenspannungsmessung	*CONNECTION FOR SHAFT VOLTAGE MONITORING*	4 Brushes	ES/EE	
36	Klemmenkasten	*TERMINAL BOX*	**+MKA11GE031**		
	Anschluss für Stillstandheizung	*CONNECTION FOR ANTICONDENSATION HEATING*	400 3 50 2x1,6	V / AC PH Hz kW	
37	Klemmenkasten	*TERMINAL BOX*	**+MKC10GP001**		
	Anschluss für Haubenbeleuchtung (inkl. Notbeleuchtung)	*CONNECTION FOR ENCLOSURE LIGHTING (INCL. EMERGENCY LIGHTS)*	230 1 50 2x54	V / AC PH Hz W	
38	Klemmenkasten	*TERMINAL BOX*	**+MKC05GE001**		
	Anschluss für Schleifringbelüftung	*CONNECTION FOR SLIP RING VENTILATION*	400 3 50 1	V / AC PH Hz KW	
39	Klemmenkasten	*TERMINAL BOX*	**+MKD11GF001**		
	Anschluss für Relative Schwingungsmessung TS	*CONNECTION FOR RELATIVE SHAFT VIBRATION TE*	2	Meggit TQ 412	
	Anschluss für Lagerbockschwingung TS	*CONNECTION FOR BEARING CASING VIBRATION TE*	2	Meggit CA 202	

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40	Klemmenkasten	*TERMINAL BOX*	**+MKD12GF001**		
	Anschluss für Relative Schwingungsmessung ES	*CONNECTION FOR RELATIVE SHAFT VIBRATION EE*	2	Meggit TQ 412	
	Anschluss für Lagerbockschwingung ES	*CONNECTION FOR BEARING CASING VIBRATION EE*	2	Meggit CA 202	
41	Klemmenkasten	*TERMINAL BOX*	**+MKA11GC042**		
	Luftspaltsensor für Seimeon System	*ROTOR FLUX PROBE FOR SIEMON SYSTEM*	1	IRIS TF	

	Erdung	***GROUNDING***			
45	Erdungsbürsten 2 Doppelbürstenhalter 90° versetzt	*GROUND BRUSHES 2 DOUBLE BRUSH HOLDERS 90° DISPLACED*	4	Stck/pcs	
46	Erdungsanschlüsse Grundrahmen M12 (TS+ES)	*GROUND CONNECTIONS BASE FRAME M12 (TE+EE)*	2	Stck/pcs	
47	Erdungsanschlüsse, Ausleitungskonsole	*GROUND CONNECTIONS SUPPORT FOR BUSHINGS*	1	Stck/pcs	

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	Kühlanlage Generator	***COOLING PLANT GENERATOR***			
50	Kühlerhaube mit Kühlelementen:	*COOLERCOVER WITH COOLER-ELEMENTS:*	4x33	**%**	
	zulässige Generatorleistung bei Betrieb mit einem Kühlerelement außer Betrieb (Klasse B):	*ADMISS. GENERATOR OUTPUT WITH ONE COOLER ELEMENT OUT OF OPERATION (CLASS B)*	80	%	
	Druckverlust wasserseitig:	*PRESSURE DROP WATER-SIDE*	~0,5	bar	
	Wassereintrittstemperatur:	*NORMAL WATER INLET TEMPERATURE*	45	°C	
	Wasseraustrittstemperatur:	*WATER OUTLET TEMPERATURE*	…	°C	
	Erforderliche Wassermenge:	*REQUIRED WATER FLOW*	…	m³/h	
	Kühlwassergeschwindigkeit:	*WATER VELOCITY*	…	m/s	
	Auslegungsdruck:	*DESIGN PRESSURE*	12	bar	
	Prüfdruck:	*TESTING PRESSURE*	18	bar	
	Verschmutzungsfaktor	*FOULING FACTOR*	n.s.	m2*K/kW	
	Glykolgehalt	*GLYCOL CONCENTRATE*	n.s.	%	
	Kühlerwerkstoffe	***COOLER MATERIALS***			
	Rohre:	*PIPES*	CuNi10		
	Rippen:	*FINS*	Al		
	Rohrböden:	*TUBE PLATES*	…		
	Wasserkammern:	*WATERBOXES*	…		
	Kühlerentleerung (Hahn mit Gewinde)	*COOLER DRAIN (COCK WITH SCREW)*			
51	Kühlerentlüftung 34A, 34B	*COOLER VENTS 34A, 34B*	Cock + G1/2		
52	Kühlerentleerung 35A, 35B, 35C, 35D	*COOLER DRAIN 35A, 35B, 35C, 35D*	Cock + G1/2		
53	Kühlwasseranschlußflansche (mit Gegenflanschen) 30A, 30B, 31A, 31B, 32A, 32B, 33A, 33B	*COOLING WATER CONNECTION FLANGE (WITH COUNTER FLANGES) 30A, 30B, 31A, 31B, 32A, 32B, 33A, 33B*	ANSI … B16.5 150lbs		
54	Leckwassersensoren (mit Auswertegerät) SIEMENS SITRANS LVL100	*LEAKAGE WATER SENSORS (WITH ANALYZE EQUIPMENT) SIEMENS SITRANS LVL100*	2 2	TS/TE ES/EE	

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Wellenverlagerung / SHAFT DISPLACEMENT

Drehrichtung: **Im Uhrzeigersinn** (Sicht auf TS)
DIRECTION OF ROTATION: ***CW*** *(VIEW ON TE)*

V* = Umgebungstemperatur: **20 °C**
AMBIENT TEMPERATURE **30 °C**
40 °C

mm	ISO VG 32		ISO VG 46	
	X	Y	X	Y
Wellenversatz durch Ölfilm *DISPLACEMENT DUE TO OIL FILM*	0,126	0,249	0,127	0,243
Thermisches Wachsen Läufer *THERMAL EXPANSION ROTOR*	-	0,162	-	0,178
		0,135		0,151
		0,108		0,124
Thermisches Wachsen Lager *THERMAL EXPANSION BEARING*	-	0,263	-	0,290
		0,219		0,246
		0,176		0,202
Thermisches Wachsen Zwischenrahmen *THERMAL EXPANSION INTERMEDIATE FRAME*	-	0,062	-	0,062
		0,031		0,031
		0		0
Gesamthöhenwachstum *TOTAL DISPLACEMENT*	0,126	0,737	0,127	0,773
		0,635		0,671
		0,533		0,569

Für die Berechnung der Wellenverlagerung wird davon ausgegangen, dass die Welle im kalten Zustand in der Unterseite der Lagerschale liegt.

FOR THE CALCULATION OF THE TOTAL SHAFT DISPLACMENT IT IS ASSUMED THAT IN THE COLD CONDITION THE SHAFTS LIE IN THE BOTTOM OF THE BEARINGS.

Axialdehnung Δ Z:	*AXIAL DISPLACEMENT Δ Z:*	4,48	mm
Achtung! Maß ist ohne Turbinendehnung. Zum Ausgleich der Wärmedehnung der Turbinen- u. Generatorwellen im Nennlastbetrieb ist die Generatorwelle bei der Montage um diesen Betrag zuzüglich Turbinenschub außerhalb der magnetischen Mitte des Generators in Richtung Turbine zu stellen.	***ATTENTION!*** *DIMENSION WITHOUT TURBINE EXPANSION.* *TO OFFSET THE THERMAL EXPANSION OF THE TURBINE- AND GENERATOR- SHAFTS IN RATED OPERATING CONDITION, THE GENERATOR SHAFT HAS TO BE PULLED WITH THIS VALUE AND ADDITIONAL TURBINE SHAFT EXPANSION OUT OF THE MAGNETIC CENTRE INTO TURBINE DIRECTION.*		

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Fundamentbelastung/*FOUNDATION LOADING*

Durch das Generatorgewicht ausgeübte Kräfte im Punkt:	*FORCE EXERTED BY GENERATOR WEIGHT IN POINTS:*	A: B: C: D: Summe:	1366 1366 469 469 3670	kN kN kN kN kN	
Maximale Kraft errechnet aus dem maximalen Stoßmoment (2-poliger Klemmenkurzschluß)	*MAXIMUM FORCE CALCULATED FROM MAX. SUDDEN TORQUE (2 PHASE SHORT CIRCUIT)*	F_{dyn} =	±1944	kN	
Gesamt-Fundamentlast in A und B:	*TOTAL-FOUNDATION LOAD ON A AND B:*	A/B:	1366 ±1944	kN	
Durch den Kühler ausgeübte Kräfte in Punkt:	*FORCE EXERTED BY COOLER WEIGTH IN POINT:*	E :	180	kN	
Die Kräfte treten unabhängig von der Drehrichtung wechselseitig auf (in A und B).	*FORCES OCCUR ALTERNATELY INDEPENDENT OF DIRECTION OF ROTATION (ON A & B).*				
Berechnung und Ausführung des Fundamentes wird von der Bauabteilung ausgeführt. Eine Schwingungsübertragung von Nachbaraggregaten muß durch entsprechende Fundamentgestaltung vermieden werden. Die Fundamenteigenfrequenz nach Montage des Maschinensatzes muß mindestens ± 20 % von der Nenndrehzahl abweichen.	*CALCULATION AND CONSTRUCTION OF FOUNDATION IS PROVIDED BY CIVIL ENGINEERING COMPANY.* *TRANSFER OF VIBRATIONS FROM SURROUNDING EQUIPMENT HAS TO BE AVOIDED BY APPROPRIATE FOUNDATION LAYOUT.* *NATURAL FREQUENCIES OF FOUNDATION AFTER ERECTION OF THE TURBOSET MUST DIFFER AT LEAST ± 20 % FROM FREQUENCIES AT RATED SPEED.*				

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Betriebs- und Einstellwerte Generatorüberwachung/
OPERATING AND SETTING VALUES – GENERATOR MONITORING

Kriterium PARAMETER		Ausgangsleistung *POWER OUTPUT* KKS *TAG NUMBER*	S_N=326,00 MVA Betrieb OPERATING *>260,8*	 *<=260,8* *COOLER EMER-GENCY OPERA-TION* ****	Einstellwert *SETTING VALUE* Meldung ALARM HIGH *>260,8*	 *<=260,8* *COOLER EMER-GENCY OPERA-TION* ****	 Turbine Schutzausl TURBINE TRIP *>260,8*	 *<=260,8* *COOLER EMER-GENCY OPERA-TION* ****	Einheit UNIT MVA
PHASE/SLOT	*3*	MKA20CT001	109	103,5	122		127*****		°C
	39	MKA20CT002							
Nuttemperatur	21	MKA20CT003							
Ständer	4	MKA20CT004							
STATOR SLOT	40	MKA20CT005							
TEMPERATURE	22	MKA20CT006							
Pt100	29	MKA20CT007							
	11	MKA20CT008							
	47	MKA20CT009							
	30	MKA20CT010							
	12	MKA20CT011							
	48	MKA20CT012							
Siemens SPARE	2	MKA20CT013							
Siemens SPARE	38	MKA20CT014							
Siemens SPARE	20	MKA20CT015							
Warmlufttemperatur WARM AIR TEMPER. Doppel – Pt100 DOUBLE – PT100	TS TE	MKA76CT011A/B	89,5	90,8					°C
Kaltlufttemperatur Doppel - Pt100 COLD AIR TEMPERATURE DOUBLE – PT100	TS TE	MKA71CT011A/B MKA71CT012A/B	48,5	55	54******	60******	59******	65******	°C
	ES EE	MKA73CT011A/B MKA73CT012A/B							
Lagertemperatur Triplex TC typ K BEARING TEMPERATURE TRIPLEX TC TYPE K	TS TE	MKD11CT013A/B/C	71*		100		105		°C
	ES EE	MKD12CT013A/B/C							
Blechpaket Thermometer Simplex – Pt100 *STATOR CORE* *TEMPERATURE*		MKA35CT001							°C
		MKA35CT002							
		MKA35CT003							
		MKA35CT004							
		MKA35CT005							
		MKA35CT006							
Leckwasserüber- wachung LEAKAGE WATER DETECTION	TS	MKA11CL001			X				
	TE	MKA11CL002					X*****		
	ES	MKA11CL003			X				
	EE	MKA11CL004					X*****		
Relative Wellen- schwingung ** RELATIVE SHAFT VIBRATION **	TS TE	MKD11CY041 MKD11CY042	90		165		240*****		µm
	ES EE	MKD12CY041 MKD12CY042							
Absolute Lagerbock schwingung *** ABSOLUTE BEARING	TS TE	MKD11CY021 MKD11CY022	3,8		7,5		11,8		mm/s
	ES	MKD12CY021							

SIEMENS PG GT MGN ERF	Form 44	Z.- Sys. 70	Zeichnungs-Nummer / DRAWING NUMBER **DPPPG-70139230**	Index a	Blatt SHEET 13 Von OF 15
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Die Betriebs- und Einstellwerte beziehen sich auf Maximalleistung des Generators bei entsprechender Kaltlufttemperatur.
THE OPERATING AND SETTING VALUES REFER TO MAXIMUM OUTPUT AT CORRESPONDING COOLING AIR TEMPERATURE.

* Die angegebenen Temperaturen sind Rechenwerte und werden nach der Inbetriebnahme korrigiert.
* *THE STATED TEMPERATURES ARE CALCULATED VALUES AND WILL BE CORRECTED AFTER INITIAL START-UP.*

** s_{p-p} nach ISO 7919-2 / ACCORDING TO ISO 7919–2
*** v_{eff} nach ISO 10816-2 / ACCORDING TO ISO 10816–2

**** Bei Ausfall eines Kühlelementes / *FAILURE OF ONE COOLING ELEMENT*

***** Alarm HH / *ALARM HH*

****** variabler Kaltgastemperaturschutz / VARIABLE COLD GAS TEMPERATURE PROTECTION

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Bestimmung der Taupunkttemperatur / *Determination of Dewpoint Temperature*

Beispiel: Relative Luftfeuchte der Umgebungsluft = 50 % und Raumtemperatur = +20 °C ergeben eine Taupunkttemperatur (TP) = +9 °C. Dies entspricht einer absoluten Luftfeuchte von 8,6 g/m³.

Example: Relative humidity of ambient air = 50 % and room temperature = +20 °C result in a dew-point temperature (DT) of +9°C, corresponding to an absolute humidity of 8,6 g/m³.

SIEMENS	Form	Z.- Sys.	Zeichnungs-Nummer / DRAWING NUMBER	Index	Blatt SHEET	15
PG GT MGN ERF	44	70	**DPPPG-70139230**	a	Von OF	15

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SIEMENS

Turbogenerator | Operating and Maintenance Manual

Components, Purchased Parts 8

Cooler

Manufacturer: **Sterling Thermal Technology Limited**

Documentation title: **Installation, Operation and Maintenance Instructions for CACW Elements**

No. of pages: 28

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Installation, Operation and Maintenance Instructions

For

CACW Elements

Sterling thermal technology

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1. General Information

1.1 Overview

This manual supplies information and instructions for the correct and safe installation, use and maintenance of the CACW Elements Heat Exchanger. It must be carefully read in conjunction with the General Arrangement Drawing(s) for the equipment and fully understood prior to the installation of the equipment. If questions still exist after reading this manual, you must contact the manufacturer / supplier / contractor for more information.

Many accidents occur due to incorrect or inappropriate use of equipment, therefore the instructions in this manual must always be fully understood and correctly carried out.

The equipment must not be put into use until all unclear issues have been resolved

1.2 Pictograms Used in this Manual

Reference to important, useful or supplementary information regarding the use of the equipment

Warning of a dangerous situation which could cause personal injury or damage to the equipment

1.3 Documentation

The following documents will be sent to the originator of the order by STT:-

- General Arrangement Drawing(s), Certificate of Conformity, Certificate of Test, plus Data Dossier if specified in the order.
- Other documentation as requested in the order to STT
- Invoice

The following will be delivered with the cooler:-

- These Installation, Operation and Maintenance Instructions
- Delivery note

The following documentation will be provided at no charge if it is requested at the time of order:-

- Pressure Equipment Directive Statement
- Instrument manufacturers documentation (where applicable)

1.4 Important Notes

The following important notes must be taken into account when using the equipment:-

- Do not pass air across the element unless the heat exchange medium is circulating
- The warranty will be made void if the equipment is not maintained as detailed in this manual.
- The equipment must be earthed if it is used in explosive areas.
- The ingress protection (IP) rating of the element will not be maintained unless appropriate seals are installed as detailed in this manual.
- This manual must be read in conjunction with the drawing(s) for the equipment
- Read the label on the element and ensure that the equipment is suitable for the required use before installation.
- Element fins are fragile and can be easily damaged; they must be handled with care. If damage does occur to fins, the heat exchange properties of the element may be affected.
- Damaged fins can be straightened with the use of a proprietary fin comb.

2. Description

2.1 Product Information

Product: Heat Exchanger element with removable covers

Type: See information plate on heat exchanger, technical specification and General Arrangement Drawings

Typical Assembly:

2.2 Product Use

CACW Elements heat exchangers are primarily used to exchange heat between a liquid and a gas; the liquid flowing through the tubes and the gas passing across the finned surface. A typical example is a motor or generator cooler where they are used to remove the excess heat created by the motor or generator; in this instance, the hot air created flows over the finned tubes and the heat contained within it is passed to the cooling water running through the tubes.

Although supplied “stand-alone” the CACW Elements heat exchangers are often built into purpose made heat exchange enclosures.

The properties of the fluid flowing through the tubes may create erosion, corrosion or internal fouling of the tubes necessitating a regular planned cleaning strategy. A filter / strainer installed in the system pipework will greatly lessen the chance of damage due to erosion.

2.3 Product Conformity

The equipment conforms to the following:-

- EU Directives
- Machinery Directive
- Pressure Equipment Directive
- Hazardous Areas Usage

- CE Marking (if specified)
- IEC Specifications (if specified)

2.4 Guarantee

Sterling TT guarantees all products supplied by them to be sound and suitable for the given specification for a period of 12 months after being put into operation or 12 months from delivery (whichever is the sooner) unless covered by a separate agreement.

The guarantee will be voided if the equipment is not stored, handled, used and maintained in accordance with the information given within this manual; if it is utilised with an incorrect medium (i.e. not the design / specified medium); or any adaptions / changes are made.

3. Safety, Storage, Inspection and Handling

3.1 Preservation and Shipping of Equipment

Sterling TT drain all water cooler heat exchangers prior to despatch. However, under normal circumstances some residual water may remain in the tubeside areas due to the circuit configuration. Full drying can be executed where requested as part of the contract requirements. If not specified additional steps need to be taken where equipment is being packed for extended storage and/or shipped through a range of climatic conditions. These steps may include drying and/or evacuating followed by pressurisation with a dry gas. Please refer to STT for advice on these long term preservation requirements.

Where silica gel is used to protect against moisture ingress it must not be placed above or in direct contact with the finned area of the equipment.

Following any operation of the equipment (e.g. string tests) the water passages must be drained before onward shipment. The extent to which further drying is necessary will be dependent of time scales and shipping methods employed.

3.2 Receipt of Goods

On receipt of the equipment, inspect and check that the goods are undamaged. It is important that any damage is noted on the delivery note which you will be asked to sign. If any further damage or omissions are subsequently noticed then you should advise STT immediately.

3.3 Loose Items

Some components, such as leak detectors, will be packaged separately. This is generally for safety and to prevent damage. Any such items will be identified on the delivery note. Please ensure they are present and undamaged. If problems are found note them on the delivery note at the time of signing it.

3.4 Storage

- Where possible keep the equipment in the packing case in which it was delivered until it is to be installed.
- Do not climb on heat exchangers.
- Keep all connection pipes, drains etc. covered and/or plugged to protect them from the ingress of insects, vermin or foreign bodies.
- Coolers designed for an ‘indoor application’ must not be left outdoors as they may not have the sealing, paint system, or general corrosion resistance for such conditions.
- Finned surfaces must always be protected from the ingress of foreign bodies.
- Relaxation of gaskets may occur during storage. The bolts/nuts of the water box should be re-torqued to the final assembly figure when the element is installed, starting at the centre and working towards the corners (ref to para 4.4 & 6.15). This may also be required if the cooler has been subjected to vibration or large temperature deviations during transport to site. (See installation).

- If the cooler elements have been stored for more than 1 year before putting into service, they must be hydrostatically tested to the pressure shown on the cooler nameplate and special attention should be given to the gasketed joints. If a leakage is observed, then it is recommended that the header bolts / nuts are re-torqued as indicated above. (See "Tightening of Bolts" for details para 4.4 & 6.15).
- If the cooler element has been filled for thermal or other testing at any stage, it must be fully drained and the connections covered and plugged before being put into storage.
- If the cooler element has been subjected to occasional use or left drained for extended periods the headers must be re-torqued as above.
- The cooler element must be stored at a temperature above freezing point and protected from mechanical contact. Where the possibility of being below zero exists, it must be examined to ensure it is emptied of water to the extent that only a few droplets may remain.
- The fins must be protected such that there is no risk of damage or fouling to them.

3.5 Handling

The General Arrangement drawing(s) supplied before delivery contain important information regarding the safe handling of the equipment, including:-

- Dry weight
- Position of lifting points
- Angle of chains to be used (if relevant)
- Size and thread of eyebolts (if required)

Personnel involved in handling the equipment must be suitably authorised, trained and qualified and have access to and review the supplied General Arrangement drawing(s) before handling. Lifted or handling must not be carried out at temperatures below -29°C

3.6 Safety

<u>Paint Finish</u>

The equipment is painted to customer specification. Please refer to the paint specification and obtain the correct material safety data sheets for the paint prior to carrying out touching up or paint removal procedures especially in the case of two pack epoxy paints.

<u>Design Parameters</u>

Do not operate the unit beyond the design conditions given on the identification technical specification. If these parameters are exceeded, the equipment must not be used without prior consultation with the manufacturer. Usage of the equipment in a non-design situation will invalidate the warranty. In addition, Sterling TT WILL NOT be held responsible for any material damage or personal injury resulting from such use; this risk is solely the responsibility of the equipment owner / user.

Safety of Personnel

Physical injuries can be caused to personnel by the incorrect handling, operating or maintenance of the equipment.

- Always use suitable personal protective equipment (PPE) for the task being carried out. Safety glasses, gloves, boots and protective clothing should be used as a minimum.
- Burns can be caused by touching the heat exchanger when it is in use.
- The element fins are sharp and can cut.
- The accidental release of a medium under pressure (especially steam and medium or high temperature hot water) presents a risk of burns, scalds and other injuries.
- Even after switching off the installation, the heat exchanger may remain hot. A cool down period of at least 30 minutes should be allowed.
- Maintenance must only be carried out when the equipment is shut down.

Damage to the Equipment

Damage can be caused to the equipment by the following:-

- External forces
- Atmospheric and Chemical Corrosion
- Erosion
- Fatigue
- Steam or thermal shock
- Too high a pressure or temperature
- Impact load
- Freezing
- Incorrect transport / storage / lifting or handling

All of the above parameters must be taken into account when handling, operating and maintaining the equipment.

Working at Height Regulations

If the heat exchanger is located above ground level, due attention must be paid to the Working at Height Regulations when handling, operating or maintaining the equipment.

Danger of Freezing

The heat exchanger must be drained down when not in use; the pipe contents may freeze when exposed to low ambient conditions, leading to burst pipes and deformation of the element

Legionnaires Disease

If the heat exchanger is used in a situation where stagnant water can form i.e. with a drain pan and / or condensate removal system or for dehumidification purposes, a Legionella Risk Assessment must be carried out. Appropriate steps must be taken as dictated by legislation local to the installation; e.g the Health and Safety Executive document HSE L8 “The control of legionella bacteria water systems” and The CIBSE publication TM13:2013 “Minimising the Risk of Legionnaires Disease” in the UK.

Pressure System Safety Regulations

If the heat exchanger is used with a pressurised medium, the recommendations given within the Pressure Systems Regulations 2000 must be followed.

4. Installation

4.1 Siting

- Unless specifically designed otherwise, coolers must be fitted flat and level
- Gaskets (supplied by others) must be fitted between the cooler and the enclosure which ensures the specified ingress protection (IP) level for the system is met.
- The gasket must be compliant enough to seal between the mating faces.
- All pipework attached to the heat exchanger must be supported so that no load is applied via the connections either statically or dynamically (as a result of thermal expansion or vibration).
- Flexible connections / couplings must be fitted wherever vibration transfer may occur to or from pipework.
- It is recommended that pressure and temperature access fittings are installed for the purpose of commissioning and checking the system operating parameters
- If regular venting of the system is difficult or inconvenient then STT recommend that automatic air release valves are fitted to the cooler and other high points in the system.
- The torque on header bolts must be in accordance with Appendix 1 (note that the return end header may be under a bolted cover box)
- Access must be provided for maintenance, withdrawal and cleaning of the element.

4.2 Preparation

- It is expected that recirculating water supplies will be treated with one or more of the following as appropriate to the actual site conditions:-

  1. Corrosion inhibitors
  2. PH regulators
  3. Anti-freeze agent

- The user is responsible for ensuring that the circulated fluid is compatible with the materials offered on the contract data sheet.
- All loose fittings supplied must be attached prior to installation.
- The installation must only be carried out by suitably qualified personnel.
- Remove all packaging and cover caps etc. prior to installation.

4.3 Installation

- The instructions for transport and hoisting must be followed when placing or moving the equipment,
- The weights given on the General Arrangement Drawing(s) are for guidance purposes only.
- All pipes and flanges must not be mounted under stress to the equipment
- Pipes must be able to expand. Flexible connections, anchors and expansion joints should be fitted to the pipes to suit the actual installation.
- Bolt : nut connections must be clean and lightly oiled
- The correct gasket for the application must be installed
- Do not install the equipment at temperature below -29°C

4.4 Tightening of Bolts

The bolts for the removable covers must be tightened with a torque wrench in the manner shown below. Standard bolting tensile is Steel grade 8.8 and stainless steel grade 80. The figures given below are based on those materials.

Header Style	Gasket Material	Bolt Size	Initial Torque	2nd pass	Final Torque
Grid & Cover	1.5 mm Klingersil C4106	M12 or ½”	45	60	80
Grid & Cover	1.5mm Klingersil C4106	M16 or 5/8”	50	80	100
Praxair Style	1.5mm Novus 34	M16 or 5/8”	50	80	100
Formed	3mm EPDM	M12 or ½”	25	35	40
Fabricated	3mm EPDM	M12 or ½”	25	35	40
Oil Coolers	3mm Nitrile	M12 or ½”	25	35	40

Klingersil C4106 is a non-asbestos material consisting of premium quality cork and with a nitrile binder and aramid fibre reinforcement, Compressibility ASTM F36A 20%-30%, Recovery 50%

Novus 34 is a blend of aramid / inorganic fibres and special additives, with a high quality nitrile rubber binder, Compressibility ASTN F36 9%, Recovery ASTM F36 55%.

EPDM has 70-80 Shore hardness

5. Operation

The installation must be inspected, operated, maintained and repaired only by authorised and suitably trained personnel.

5.1 Inspection Before Use

The unit has been tested by Sterling TT in accordance with the test pressures stamped on the type plate attached to the equipment.

- The element fins must be undamaged and straight to ensure the design heat exchange takes place. If problems are found, use a fin comb to remedy them.
- Burrs must be removed from element connections.
- The element must be flushed to remove all swarf and other foreign bodies that may be present.
- The correct gasket for the application must be installed.
- The correct seals for the application must be used.
- The connected systems (fluid and gas) circuits much be checked to ensure they are complete, suitable for the application and correctly installed.
- The connected systems (fluid and gas) must be operating at the correct temperature and pressure.

5.2 Filling and Venting

When first filling the heat exchanger with water ensure that:-

- the pumps are turned off
- the vent plug is open
- the drain plug is closed
- the flow and return valves are cracked open to allow slow filling. (opening a pressurized supply when the block is full of air could displace inter-pass gaskets)
- Turn on the pumps and allow water to circulate for 5-10 minutes
- Either stop pump or close supply valve and release the air vent plug to release any air bubbles in the headers. (This may need to be repeated on new installations until all trapped air escapes)

If a cold medium is present in the heat exchanger but is not circulating whilst a hot medium is flowing through the heat exchanger, the cold medium may start boiling and the heat exchanger will be damaged.

5.3 Re-tightening of Bolts

The bolts on the gasket and the connecting flanges must be re-tightened to the correct torque after the heat exchanger has cooled down for the first time (ref to para 4.4 & 6.15).

5.4 Testing and Commissioning

Fluid Flow

It is important to set the water flow rate accurately as it is crucial to performance to attain the optimal tube velocity. It is also important to avoid the onset of destructive cavitation by ensuring that excessive velocities are avoided. If in doubt contact STT for advice on maxima and minima for your installation

STT recommends the installation of commissioning valves in the pipework circuit to allow flows to be trimmed as necessary.

Fluid Temperature

Water temperature can generally be measured reliably with a probe inserted at a self-seal test point (Binder or similar) or using fixed pocketed RTD's. Facilities for this are not supplied by STT unless specifically requested.

STT do not fit tappings for air temperature measurement unless specifically requested. Where probes are inserted for the purpose of commissioning it is important to ensure that they are positioned in the fully mixed airflow.

Vibration

STT heat exchangers are generally resistant to vibrations up to 20mm/sec and every effort is made to avoid key frequencies at 50 Hz and 60 Hz. However it is impossible to design a completely rigid cooler and still permit efficient heat transfer.

If when commissioning, it is found that a particular forcing frequency is affecting the cooler, it is important that you contact STT for advice on how to deal with it.

Note that Coolers for machines with Diesel drives, particularly common bed plate mounted are particularly affected. A special execution is available for these cases.

Performance

When commissioning a cooler, it is important to compare the estimated duty on the machine circuit with the extracted heat. A balance within 10% would indicate a reasonable set of results.

5.5 Inspection During Operation

Inspect the element itself and all connections for leakage during the first hour of operation and at regular intervals thereafter.

5.6 Shut Down

To shut down for maintenance purposes:-

- Display appropriate warning notices.
- Ensure heat input has stopped
- Close element flow isolating valve.
- Allow water in element to cool to ambient temperature.
- Close element return double regulating valve.

Drain the element if it is to be shut down for a lengthy period of time to prevent frost protection unless the fluid medium contains an anti-freeze solution.

Flush the element with clean filtered water if it is anticipated that corrosive residues may be present. Chlorination may be appropriate if bio-fouling is a risk.

Drain the element if it is to be shut down for over 48 hours to prevent corrosion.

5.7 Gaskets

If an element has been:-

- in long term storage
- has remained unused for 12 months from manufacture
- has been outside recommended storage temperatures

It is advisable to re-torque the header bolts (see block reassembling for details) prior to being pressurised in service. All polymer gaskets are susceptible to long term creep when under stress.

5.8 Standby Service

Where coolers are on standby for long periods, it is essential that certain actions are taken to ensure that they will perform correctly when called on. Unless frost is anticipated, keep filled with water, even if the supply is isolated.

Note that in the case of seawater, the system must be protected from the potential for marine growths. This may dictate alternative standby arrangements.

6 monthly
- Check for relaxation of gaskets and tighten as necessary
- Vent coolers to ensure no trapped air
- Follow actions as laid out in the Maintenance section.

6. Maintenance

6.1 General

The installation must be inspected, operated, maintained and repaired only by authorised and suitably trained personnel.

Maintenance and cleaning must be carried out when the equipment is shut down and is at ambient temperature.

Physical injuries can be caused to personnel by the incorrect handling, operating or maintenance of the equipment.

- Always use suitable personal protective equipment (PPE) for the task being carried out. Safety glasses, gloves, boots and protective clothing should be used as a minimum.
- Burns can be caused by touching the heat exchanger when it is in use.
- The elements fins are sharp and can cut.
- The accidental release of a medium under pressure (especially steam and medium or high temperature hot water) presents a risk of burns, scalds and other injuries.
- Even after switching off the installation, the heat exchanger may remain hot. The metal temperature should be checked before maintenance activities commence.

The installation must be inspected, operated, maintained and repaired only by authorised and suitably trained personnel.

6.2 Maintenance Frequency

It is recommended that the equipment is maintained at least once every 8000 hours of operation or 12 months, whichever is the shorter period. This frequency may need to be varied due to specific site conditions e.g. exposure to salt water.

6.3 Inspection - Equipment

The following must be inspected at the maintenance frequency given above to ensure the correct operation of the equipment:-

- Ensure fin surfaces are not damaged, dirty or blocked
- Ensure that there is no evidence of leakage from header gaskets
- Ensure there is no fluid leakage from the equipment / pipework connections
- The primary and secondary medium temperate and pressure are within the correct limits

6.3 Inspection – Equipment Continued

- Ensure condensate drains away adequately if applicable
- Check for fouling of the heat exchanger (this will give a drop in capacity).
- Ensure there are no strange noises or vibration at the equipment.
- Check the general condition of the equipment and repair any damage found
- Check for corrosion and carry out remedial work as necessary
- Ensure all safety devices function correctly
- Check the torque of all bolts and re-tighten accordingly
- Check that there is no evidence of leakage from the vent / drain fittings
- Check the leakage detector pipe where fitted to see that it is clear
- With the flow stopped, open the vent plug to release trapped air.

6.4 Inspection - Ducting / Gas Side

The following must be inspected at the maintenance frequency given above to ensure the correct operation of the equipment:-

- that all external fasteners are tight
- that the ducting remains free from corrosion
- that there are no new resonances or vibration which might indicate component failure

6.5 Inspection – Pipework / Fluid Side

The following must be inspected at the maintenance frequency given above to ensure the correct operation of the equipment:-

- Remove water supply pipe and through the connection flange, examine visible surfaces for corrosion, erosion, scaling.
- If anodes are fitted, remove and check that they are in good condition, replace as required.

6.6 Cleaning the Heat Exchanger – Liquid Side

A heat exchanger with straight tubes can be cleaned internally with a special brush available directly from Sterling TT. The covers must be disassembled. See “Header Removal”. After cleaning, the tubes must be thoroughly rinsed with a clean medium.

6.7 Cleaning the Heat Exchanger – Air Side

Protect adjacent equipment or remove element to an area where that equipment will not be adversely affected by cleaning operations. Blow the fins clean using compressed air in the opposite direction to the normal airflow. Take care that the fins do not deform. If further cleaning is deemed necessary, STT recommend the use of a proprietary foaming coil cleaner (see internet for your local vendor) and washed off with a *low pressure* hose using town water. Finned surfaces must be dried using warm air before putting back into service.

Under no circumstances may a pressure washer or steam cleaner be used as this is liable to drive the fouling into the centre of the matrix and / or deform the fins with permanent adverse effect.

6.8 Dissassembly of the Heat Exchanger

Isolate the hot medium first, then once the heat exchanger has cooled to the temperature of the cold medium, isolate the cold medium. Wait until the heat exchanger is cool before progressing any further.

- Isolate the hot and cold media on to and off the heat exchanger
- Drain the liquid medium with the heat exchanger vent open
- Note the location of parts to be disassembled.
- Remove the liquid media flow and return connections and disassemble the cover. The covers must be supported due to their weight.

During the disassembly process, it is possible that residual medium will seep from the heat exchanger. Use a drip tray or similar to catch any drips or leakage.

6.9 Assembly of the Heat Exchanger

- Always use new gaskets – never re-used old ones
- Make sure gasket faces are clean and undamaged
- Apply the gaskets
- Assemble the cover taking note of any markings made during the disassembly process and ensuring the bolts are tightened to the correct torque.

6.10 Straightening Fins

Bent fins can be straightened by careful use of long nosed pliers and a fin comb. Whilst sometimes unsightly, repaired fins do not adversely affect performance.

Fouled fins need to be cleaned, which in most cases require removal of the equipment from the ducting. In the first instance the fin leading and trailing edges should be cleaned with a soft bristle brush, and compressed air.

6.11 Gasket Leaks

Gasket leaks may be sealed by re-torquing in line with the data in Appendix 1
If this fails to seal, then the cooler must be stripped and new gaskets fitted.
It is important to identify the type of gasket used and to replace with an equivalent. (Contact STT for gasket availability or advice on alternatives)

6.12 Tube Leaks

Tube to tube plate leaks at commissioning are rare, but if found can usually be sealed by reprocessing (expanding or welding). In service leaks can be sealed by use of a taper plug (contact STT for details). Leaks can usually indicate the end of the coolers useful life, although in the case of double tube coolers, it may be possible to run in a fault condition until a service replacement is available.

6.13 Corrosion

Ducting

Corrosion on the surface of ducting should be stopped as soon as seen by application of a proprietary conversion paint followed by touching up with the original paint system.

Tubes

Corrosion/erosion is most often found in the ‘vena-contracta’ area at the tube entrance. This is often the result of excessive velocity which should be corrected by controlling the water flow rates within the range specified on the STT data sheet. If found early enough it may be possible to extend the life of the tubes by installation of proprietary nylon sleeves.

If it is impossible to sufficiently control water velocities, then consideration should be given to replacing the heat exchanger with one employing velocity tolerant materials such as titanium.

Fins

Corrosion on fins is detrimental to the efficiency of the heat exchanger. If serious corrosion is encountered, the cause of such must be established and advised to STT before replacing the cooler.

Tube Plates

Surface corrosion of ferrous tubeplates can be repaired by shot blasting locally and treating with Zinga or a suitable epoxy paint. Corrosion in excess of 3mm depth will require replacement of the cooler matrix.

Corrosion of non-ferrous tubeplates is usually indicative of excessive velocity, poor water quality or anodic corrosion due to the component being the least noble metal in system

Fixings

Fixings supplied may be plated or coated to resist corrosion. It is not recommended to overcoat these with paint systems as such application may inhibit the maintenance of the equipment and in particular the correct torqueing of pressure bolts.

Tubes, Tubeplates and protective coatings can all be damage by particulates in the water. Whenever coolers are used with non-recirculated water (ie River water, Seawater, etc.) the filtration level should allow no particles larger than 250 microns.

6.14 Header Removal

Formed and fabricated headers:-

- Remove header to tubeplate fasteners leaving two at the top loosely fastened.
- Support weight of header
- Gently prise header away from tubeplate
- Remove last two bolts and remove.

Grid and cover:-

- Remove two bolts from the bottom run of bolts and replace with two temporary studs
- Remove the rest of the fasteners
- Gently prise the cover plate away from the tubeplate and remove
- Note position and handing of grid for replacement.
- Remove grid

All:-

- Remove all traces of gasket from both the tubeplate and header faces with care to prevent damage to the faces. A metal scraper can be used for this purpose if used with care.
- Note: On grid and cover plate header constructions the gasketed joints between tubeplate and grid, as well as between grid and cover plate will require careful removal.
- Inspect the surfaces to be gasketed paying particular attention to surface scratches, dents, and misalignments in machining or local undulations.
- If the gasket sealing surfaces are painted or otherwise coated, it is important that the coating is flat, continuous and without cracks or flakes.
- If the surfaces are damaged then STT should be consulted to recommend a suitable method of repair.

6.15 Header Reassembly

Formed and fabricated headers:-

- Lay a clean piece of paper larger than the grid on a flat surface and place the grid on it.
- Coat the gasket sealing surface with gasket dressing (Spraytack) by Industrial Adhesives Ltd or equivalent.
- Apply a new gasket to the tacky surface
- Ensure that the gasket is firmly held at the pass baffle positions

Note some coolers with formed headers are fitted with self adhesive strip gaskets

- Apply 1 row of strip gasket just touching the inside of the border holes and overlapping the strips slightly at the corners.
- The U-profile gasket should form a continuous flat upper face by butting sides. Do not try to mitre or take it round bends.
- The U-channel gasket improves the reliability of the seal in circumstances where centre baffle seals have been displaced due to sudden opening of water valves when the cooler is empty. If you would like to retro fit your cooler with this type of gaskets, please contact STT technical department for advice.

Grid and cover:-

- Fit two temporary studs in the tubeplate to support the grid during assembly.
- Fit two temporary studs coincident with the location tabs on the gasket to support gaskets during assembly. (if no tabs use spraytack as formed headers)
- Fit new gasket to tubeplate, ensuring correct orientation.
- Assemble the grid to the tubeplate, second new gasket and the coverplate to the grid in accordance with the drawing ensuring that any grid baffles are correctly orientated.

All:-

- Lubricate all bolts/studs threads prior to fitting. This will ease assembly and allow validation of the torque measurements.
- Mild steel fasteners - lubricate with a few drops of light oil. i.e. 3 in 1 type.
- Stainless fasteners- lubricate with copper slip. i.e. Rocol antisieze J 166.

Formed or Fabricated Header box

Grid & Coverplate Header Box

- Assemble all bolts (or studs and nuts), nipping up to a light pressure.
- Tighten progressively to initial torque (appendix 1) in a symmetrical pattern starting at the centre and working toward each end as Figure 1

+ 46	+ 43	+ 42	+ 39	+ 38	+ 35	+ 34	+ 31	+ 5	+ 4	+ 1	+ 7	+ 10	+ 11	+ 14	+ 15	+ 18	+ 19	+ 22	+ 23	+ 26
+ 47																				+ 27
+ 49																				+ 29
+ 50																				+ 30
+ 48																				+ 28
+ 45	+ 44	+ 41	+ 40	+ 37	+ 36	+ 33	+ 32	+ 6	+ 3	+ 2	+ 8	+ 9	+ 12	+ 13	+ 16	+ 17	+ 20	+ 21	+ 24	+ 25

Figure 1

- Re tighten to 2nd pass torque using the same symmetrical pattern.
- Re tighten to final torque using the same symmetrical pattern.
- Finally, re tighten at same torque starting with a bolt on the centre line and working around clockwise.

6.16 Pressure Test

- Fit blanking plates to the connection flanges
- Fill with water
- Slowly increase pressure
- Check for leaks
- Pressure test to the pressure on the rating plate or as advised by STT for a period of 30 minutes.

After 24 hours EPDM gaskets should be re-torqued to allow for settling.

Follow commissioning guide for return to service.

6.17 Vent and Drain Connections

Rilsan coated Formed and fabricated headers

Subject to the application, two main differing types of vent and drain connection may be fitted:-

1. A non-ferrous boss silver soldered into the steel header. The boss is fitted with a ¼" BSP parallel plug with an o-ring seal under the head. Boss size and thread may vary subject to contract requirements.

2. Welded in stub pipe with an external thread, fitted with a non-ferrous ring nut which can employ several different fittings depending on application. Normally it is not necessary to undo the ring nut as venting/draining can be carried out on the fitting. See below.

Other attachments

It is not permissible to direct couple pipe work to the stub unless the fitting seals with a sealing washer on the end.

Grid and cover headers

The grid will have ¼" BSP threaded ports fitted with a parallel plug having an o-ring seal under the head. The plug is cross drilled so that venting can be safely carried out without completely removing the plug.

7. Fault Finding

Fault	Possible Cause	Remedy
Heat exchanger has insufficient capacity	There is air in the fluid side	Vent and top up as necessary
	Operating conditions are different to design	Adjust the operating conditions to the specified design
	The heat exchanger is fouled	Clean the heat exchanger
	The heat exchanger has been piped incorrectly	Check and remedy any problems found
	Gasket pass partition has been displaced	Reposition or replace gasket.
	The fins are damaged or dirty	Clean and re-align the fins
Heat exchanger is leaking	Gasket faces dirty or damaged	Check and clean gasket faces. If found to be damaged contact STT
	Defective gasket	Replace gasket
	Bolts incorrectly tightened	Check and re-tighten to the recommended torque
	Defective tube	When a tube is defective it can be blocked as an emergency measure using plugs on the inlet and outlet sides. This may only be done after consulting and obtaining permission from STT
	External forces / stresses	The installation must be stress and vibration free. Check cause and remedy any fault found.
	Defective tube to tube plate connection	Contact STT to replace a tube or repair the heat exchanger.

8. Spares

8.1 Ordering Spare Parts

Spare parts can be ordered directly from STT. The following information is required as a minimum:-

Project / order number
Description / model of product (see GA)
Description of part (see GA)
Equipment Serial Number (See Cooler Nameplate)

8.2 Recommended Spares

Please contact our Spares Department for an up to date spares listing:

t: +44 (0)1296 487171
f: +44 (0)1296 436805
mail@sterlingtt.com

9. Customer Service

9.1 How to Contact Us

Full contact details are given on the rear cover of this document

9.2 Complaints Procedure

In the event of any malfunction, complaints or dissatisfaction with this equipment, please contact the STT Service Department using the contact details on the rear of this document

10. Optional Extras

10.1 Leak Detection Package

Float Type

Periodically open leakage detector sump and ensure that it is clean, test operation of alarm by manually lifting float. Inspect leak detector pipes to ensure they are not clogged.

Ultrasonic type

These are self-checking and have an indicator to show system health.

10.2 Pressure Relief Package

A pressure relief valve may be supplied to protect the equipment form over pressure. This will be set at an agreed value for the equipment – normally the design pressure. The discharge port must be kept free from any obstruction or foreign matter. If discharging during normal operation check system for overpressure and / or valve for failure with a view to replacement.

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SIEMENS

Cooling System, Three-Part – Side Mounting

Installation and Maintenance Guide

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1 Preliminary Remarks

This Installation and Maintenance Guide describes the structure and installation of the cooling system on the generator, and provides instructions for inspecting and maintaining the air/water heat exchangers.

NOTE

In some cases, the structure of the cooling system described in this manual may differ from the versions actually supplied.

Fig. 1: Cooling system, three-part, examples of design variants

Cooler frame
Heat exchanger
Cooler cover

Fig. 2: Cooling system – Water inlet side (still without supports mounted; they are located at the bottom when mounted)

Fig. 3: Cooling system – deflection chamber side (at the top when mounted)

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2 General Safety Instructions

- Secure all loose and movable parts.
- Avoid impacts and suddenly changing stresses on the hood.
- Wear appropriate protective clothing, and hearing protection to prevent hearing impairment.
- Do not wear any jewellery or loose clothing.
- Adequately ground all connected electric circuits to prevent electric shocks.
- Do not drastically change the operating conditions.

3 Description of the Cooling System

Fig. 4: Cooling system, view of the deflection chamber side (top)

1 Cooler frame
2 Lifting lugs for cooling system (horizontal)
3 Mounting frame for heat exchanger
4 Lifting lugs for cooling system (vertical)
5 Heat exchanger (pairwise)
6 Front sealing panel
7 Centering bolt (if present)
8 Cover of the centering bolt
9 Cooler cover
10 Lifting lugs for cooler cover
11 Inspection hatch with leakage air filter

→ *Warm air*
→ *Cold air*

Fig. 5: Cooling system, view of the water inlet side (bottom)

1 Heat exchanger (pairwise)
2 Water connection flange
3 Subframe
4 Support
5 Measuring transducer enclosure with leakage water sensor
6 Splash strip

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3.1 General

The generator is equipped with a cooling system to facilitate totally enclosed water-to-air cooling (TEWAC), which dissipates the operating heat from the interior of the generator.

The cooling system is mounted on the side of the sound attenuation cover of the generator. The cooling system consists of the cooler frame welded to a subframe, heat exchangers mounted in pairs, the two cooler covers, and the supports with their axial bracing struts, some of which are bolted and other welded. Any pre-installed electric wiring must be connected to the customer's corresponding terminal boxes. Follow the manufacturer's instructions.

Together the cooling system and the sound attenuation cover keep out dirt, sand, water and moisture. After the generator has been assembled, it is therefore important to attach the cooling system to the sound attenuation cover of the generator as quickly as possible. Once the cooling system has been received and unpacked on site, any apertures should be temporarily sealed with foil to keep out dirt, sand, water and moisture.

3.2 Design

Cooler frame

The cooler frame consists of a welded profile frame structure, in which there are two side-by-side mounting frames. 2 pairs of heat exchangers are mounted and positioned one behind the other into each of these frames. The front of the cooler frame is closed by 2 cooler covers.

The cooler frame is designed to ensure effective distribution of the cooling air to the heat exchangers and to minimize pressure losses. The interior lining is sound insulated and designed to match the local conditions of the particular customer.

Heat exchanger

Liquid coolant flowing through these heat exchangers absorbs the heat energy from the circulating air. The maximum working and test pressures are marked on the rating plates of the individual heat exchangers. The heat exchangers stand upright in mounting frames in the cooler frame.

After the two cooler covers have been removed, the heat exchangers can be lifted up out of the cooling system for maintenance and cleaning purposes. Follow the manufacturer's detailed instructions when maintaining, cleaning, disassembling and reassembling the individual heat exchangers.

Protection against condensation water and leakage water

A splash strip is mounted in the transition area between the cooler frame bottom and the generator to prevent condensation water or uncontrolled water from a leaking pipe penetrating into the interior of the generator. Two measuring transducer enclosures, each with a least one leakage water sensor to monitor leaks, are located on the cooler frame bottom (Fig. 6). The cabling and function of these warning electrodes must be tested with test magnets after completion of the installation.

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Fig. 6: Measuring transducer enclosure with a leakage water sensor mounted under the cooler frame bottom

1 Cooler frame bottom
2 Measuring transducer enclosure
3 Screwed-in leakage water sensor
4 Threaded drain plug
5 Water connection chamber

4 Transport and Storage

Transport

The cooling system is delivered packed in a transport crate (Fig. 7).

After the packaging has been removed, only the eyebolts on the cooler frame may be used for transporting and mounting the cooling system.

⚠ WARNING

Danger of crushing! Risk of damaging the cooling system and generator! Only the lifting lugs on the cooler frame are intended for suspending the cooling system.

- Do not use the two lifting lugs on each of the cooler covers for transporting the cooling system.
- Do not use the lifting lugs on the cooler frame for heavier loads. Use the lifting lugs only for transporting and mounting the cooling system or the cooler frame.

Storage

Check the moisture indicators on the packaging every month while the cooling system is in storage in its unopened packaging. No other action has to be taken as long as the indicators remain blue. If the indicators turn pink, the silica gel desiccant in the packaging must be renewed, that is it must be dried separately or replaced.

5 Assembly Instructions

5.1 Unloading the Cooling System from the Transport Truck

⚠ WARNING

Danger of injury from falling objects.

- Do not stand or walk under suspended loads during the transport work.

Work steps

1. Use two steel ropes with an adequate loading capacity.
2. Hitch the transport crate at the marked hitching points (Fig. 7).
3. Lift the crate off the transport truck and lower it onto a flat surface so that it is evenly supported.
4. Check that the packaging and moisture indicators are undamaged.

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5.2 Removing the Packaging

Work steps

1. Remove the metal edge protection profiles from the top and bottom of the packaging.
2. Use a nail puller and crowbar to force apart the sides (3), ends (4) and roof (2) of the packaging. Remove the roof of the crate with a crane.
3. Use a nail puller and crowbar to force apart one side wall from one end wall and the floor.
4. Carefully remove the side wall, the end wall, the second side wall and the second end wall one after the other with a crane.
5. Remove the tie-downs from the floor of the crate, as well as the aluminum and foam foils.

Fig. 7: Unloading from the transport truck

1 Steel ropes
2 Cover
3 Side wall
4 End wall

6. Remove the pallet holding the accessory cartons from the floor of the crate.
7. Check the accessory parts against the enclosed packing list for completeness.
8. Inspect the visible outer surfaces of the cooling system.
9. Hitch each of two load bars or adequate spread angles (for long ropes) to two of the 4 lifting lugs provided (Fig. 8). Closed-system load suspension devices, such as hook locks or shackles, must be used.
10. Lift the cooling system evenly with 2 cranes until the hitching chains or ropes are taut. The maximum spread angle is 90°.

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Fig. 8: Diagram of the cooling system hitched for transport

1 *Hitching gear*
2 *Lifting lugs for cooler cover*
3 *Lifting lugs for cooling system (horizontal)*
4 *Rubber seal on the open end of the frame*

A *The maximum spread angle of the steel ropes is 90°*

11. Undo the screws connections holding the cooling system to the floor of the crate, and lift the cooling system carefully. Do not damage the rubber seal running around the open end of the frame, which faces downwards.

12. Remove the floor of the crate.

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Fig. 9: Turning the cooling system into a vertical position

1 *Crane hitching gear 1*
2 *Crane hitching gear 2*
3 *Deflection chamber side (upwards)*
4 *Lifting lugs for cooling system (horizontal)*
5 *Lifting lugs for cooling system (vertical)*
6 *Water inlet side (downwards)*
7 *Water connection flange*
8 *Rubber seal on the open end of the frame*

13. Turn the suspended cooling system into a vertical position with the water connection side facing down (Fig. 9).

14. Place the lower edge of the cooling system on a flat surface, and remove the lower load suspension devices. Slowly turn the cooling system into an upright position by traversing the crane.

NOTICE

Risk of damaging the heat exchangers and cooler frame!

- Place the cooling system, with the water connection side facing down, on a wooden frame or similar construction. It must not rest on the projecting water connection flanges of the heat exchangers.

15. Inspect the cooling system, including the heat exchangers and internal parts. Remove all desiccant bags.

5.3 Mounting the Cooling System

The cooling system is normally supplied fully assembled. However, local conditions may make it impossible to mount a complete cooling system on the generator. The cooling system can therefore be mounted in two different ways on the generator sound attenuation cover:

- In one single complete part, that is with the heat exchangers and cooler covers mounted
  (variant 1: single part)
- Separate mounting of the three main parts: cooler frame, heat exchangers and cooler covers (variant 2: three-part).

Mounting the cooling system, variant 1: single part

Prerequisites

- ✓ The **cooling system** is completely mounted with the heat exchangers and cooler covers.
- ✓ The cooling system is clean and dry.
- ✓ The rubber seal in the flange area of the cooler frame is undamaged.
- ✓ The **sound attenuation cover** of the generator is clean and dry.
- ✓ All transport covers have been removed from the sound attenuation cover.
- ✓ All blind covers have been mounted on the sound attenuation cover (manholes).

NOTICE

Dirt hazard!

If the cooling system is dirty, the required standard of cleanliness of all the air-carrying components is no longer ensured.

- Keep the cooling system clean, and clean it thoroughly before mounting it on the generator.
- Do not leave any loose parts, such as nuts and bolts, in the cooling system.
- Do not perform any work that creates dirt or chips, such as grinding and welding, near the open cooling system.

Work steps

1. With the cooling system in its working orientation (vertical position), attach the ropes to the inner 4 lifting lugs provided on the deflection chamber side with a maximum spread angle of 90°. Use four-strand load suspension devices with an adequate loading capacity (Fig. 10).

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2. Lift the cooling system with the crane so that it is alongside the generator sound attenuation cover and, with it suspended horizontally, align it in the longitudinal direction with the flange of the sound attenuation cover.

3. If a centering bolt is present:
Mount the M20 centering bolt with washers and dampening rubber through the flange of the cooling system and into the generator sound attenuation cover to attach the cooling system to the generator sound attenuation cover.
If no centering bolt is present:
Use the screws, washers and nuts supplied to mount the cooling system along the all-round flange joint to the generator sound attenuation cover.

NOTICE

Risk of damaging the cooling system!

- The entire cooling system remains suspended by the crane throughout the mounting procedure until all the supports have been mounted, aligned and secured below the cooler system.
- Centering bolt and screws are only intended to fasten the cooling system, and do not bear any weight!

4. After the cooler hood has been aligned with the sound attenuation cover, bolt the supports to the subframe with the bolts provided. Secure the supports by welding the top and bottom parts. Bolt the feet of the supports to the foundation with the anchor pins provided (Fig.10).

Fig. 10: Supporting the entire cooling system or the cooler frame in a vertical position and mounting the supports

1 Four-strand hitching gear
2 Centering bolt (if present)
3 Subframe
4 Water connection flange
5 Support
6 Axial support
7 Anchor pegs

5. Pull the cooling system to the sound attenuation cover of the generator with the aid of the M16 threaded bolts on the lower transverse girders of the sup-

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porting frame. Secure the threaded bolts with lock nuts. The crane must not release the load until this has been done.

6. Screw the cross beams and axial supports to the subframe with the screws provided, and then weld them to the corresponding supports. All weld seams must be cleaned, and sealed with a protective coating.

7. Check the seal around the flange connection between the cooling system and the generator sound attenuation cover for leaks.

Mounting the piping

8. Connect the supply and return pipes to the water connection side of the heat exchangers (see general drawing of the cooler hood for the actual layout (also see page 15). Welding neck flanges, as counterflanges for the heat exchanger flanges, are premounted or supplied loose, together with corresponding hexagonal nuts, bolts and gaskets. Install shut-off valves in the supply and return pipes.

NOTICE

- Check the direction of flow in the supply and return pipes to the flanges of the heat exchangers.
- Lay the pipes stress and torque-free, so that no forces are transmitted to the connectors. Use compensators. Install connecting pieces, for pressure and temperature tests during commissioning.

9. Mount the pipes for venting the heat exchangers with appropriate holding clamps (Fig. 11).

Fig. 11: Pipes for venting the heat exchangers

1 Vent valve
2 Ventilation pipes
3 Holding clamps
4 Measuring transducer enclosure with leakage water sensor
5 Inspection hatch with leakage air filter

10. Check the filter mats or mount them in the mounting frames of the leakage air filters.

11. Clean the leakage water sensor enclosures, and make the electrical connections.

12. Safely ground all mounted components. Connect the intended grounding points between the cooler hood and generator cover.

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NOTICE

- If necessary climb into the inside of the hood through the inspection hatches: Before doing so, empty all pockets, remove watches and jewellery.
- Do not leave any loose parts, such as nuts and bolts, in the cooler hood.

Mounting the cooling system, variant 2: three-part

Prerequisites

- ✓ The **cooling system** is disassembled into its three main parts (cooler frame, heat exchangers, cooler cover).
- ✓ All parts of the cooling system are clean and dry.
- ✓ The rubber seal in the flange area of the cooler frame is undamaged.

- ✓ The **sound attenuation cover** of the generator is clean and dry.
- ✓ All transport covers have been removed from the sound attenuation cover.
- ✓ All blind covers have been mounted on the sound attenuation cover (manholes).

Work steps

Assembling the cooler frame and supports

1. With the cooler frame in its working orientation (vertical position), attach the ropes to the inner 4 lifting lugs provided on the deflection chamber side of the cooling system (see also Fig. 4, page 3) with a maximum spread angle of 90°. Use four-strand load suspension devices with an adequate loading capacity (Fig. 12-1).

Fig. 12: Supporting the cooler frame in a vertical position and mounting the supports

1 *Generator sound attenuation cover*
2 *Cooler frame*
3 *Four-strand hitching gear*
4 *Lifting lugs for cooling system (vertical)*
5 *Centering bolt (if present)*
6 *Subframe*
7 *Supports*
8 *Cooler frame flange connection*
9 *Axial support*
10 *M16 threaded bolt*

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2. Position the cooler frame with the crane or suitable lifting and transporting tools alongside the generator sound attenuation cover and, with it suspended horizontally, align it in the longitudinal direction with the flange of the sound attenuation cover.

3. If a centering bolt is present:
   Mount the M20 centering bolt with washers and dampening rubber through the flange of the cooler frame and into the generator sound attenuation cover to attach the cooler frame to the generator sound attenuation cover.
   If no centering bolt is present:
   Use the screws, washers and nuts supplied to mount the cooler frame along the all-round flange joint to the generator sound attenuation cover.

NOTICE

Risk of damaging the cooling system!

- The cooler frame remains suspended by the crane throughout the mounting procedure until all the supports have been mounted, aligned and secured below the cooler system.
- Centering bolt and screws are only intended to fasten the cooler frame, and do not bear any weight!

4. After the cooler frame has been aligned with the sound attenuation cover, bolt the supports to the subframe with the bolts provided (Fig. 12-2). Secure the supports by welding the top and bottom parts. Bolt the feet of the supports to the foundation with the anchor pins provided.

5. Pull the cooling system to the sound attenuation cover of the generator with the aid of the M16 threaded bolts on the lower transverse girders of the supporting frame. Secure the threaded bolts with lock nuts. The crane must not release the load until this has been done (Fig. 12-3).

6. Screw the cross beams and axial supports to the subframe with the screws provided, and then weld them to the corresponding supports. Clean all weld seams and seal them with protective paint.

7. Check the seal around the flange connection between the cooler frame and the generator sound attenuation cover for leaks.

Mounting the heat exchangers

To mount the heat exchangers, see also Section 5.4, page 14 ff.

1. Mount the flat rubber frame gasket on the heat exchangers. To do this, slide the gasket over the pairs of heat exchangers from the water connection side, and attach it to the projecting tube sheet on the deflection chamber side (Fig. 13-1, page 13).

2. Insert the two pairs of heat exchangers into the open cooler frame from the front. To do this, raise the heat exchangers (for example with the aid of transport lifting brackets, see page 14) approx. 20 cm above the edge of the interior mounting frames, and insert them into the mounting frames from above. Then carefully lower the heat exchangers with light pressure to within 5 cm of the cooler frame flange connector. Depending on the design of the cooling system, before lowering, it may be necessary to mount the front sealing wall for the flat rubber frame gasket on the cooler frame.

3. Lower and bolt the heat exchangers to the projecting tube sheet (flange), with the gasket on the cooler frame (counterflange) (see Fig. 16, page 16).

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Fig. 13: Mounting the heat exchangers and cooler covers

1 *Four-strand hitching gear*
2 *Transport lifting brackets*
3 *Heat exchanger, deflection chamber side*
4 *Projecting tube sheet*
5 *Rubber-frame gasket*
6 *Water connection flange*
7 *Tube sheet flange connection*
8 *Front sealing panel*
9 *Cooler cover*
10 *Lifting lugs for cooler cover*
11 *Cooler cover flange connection*

4. Check the seal around the flange connection between the tube sheet and the cooler frame for leaks.

Mounting the cooler cover and pipes

1. Mount the two cooler covers, left and right, in front of the heat exchangers (Fig. 13-2).
2. Check the seal around the flange connection between the cooler cover and the cooler frame for leaks (Fig. 13-3).
3. Connect the supply and return pipes to the water connection side of the heat exchangers (see general drawing of the cooler hood for the actual layout (also see page 15). Welding neck flanges, as counterflanges for the heat exchanger flanges, are premounted or supplied loose, together with corresponding hexagonal nuts, bolts and gaskets. Install shut-off valves in the supply and return pipes.

NOTICE

- Check the direction of flow in the supply and return pipes to the flanges of the heat exchangers.
- Lay the pipes stress and torque-free, so that no forces are transmitted to the connectors. Use compensators. Install connecting pieces, for pressure and temperature tests during commissioning.

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4. Mount the pipes for venting the heat exchangers with appropriate holding clamps of the cooler cover (Fig. 11, page 10).
5. Check the filter mats or mount them in the frames of the leakage air filters.
6. Clean the leakage water sensor enclosures, and make the electrical connections.
7. Safely ground all mounted components. Connect the intended grounding points between the cooler frame and generator cover.

NOTICE

- If necessary climb into the inside of the cooler through the inspection hatches: Before doing so, empty all pockets, remove watches and jewellery.
- Do not leave any loose parts, such as nuts and bolts, in the cooling system.

5.4 Dismounting and Mounting the Heat Exchanger

The cooling system is normally supplied with the heat exchangers mounted. However, in certain cases, they may have to be mounted or dismounted, depending on the local conditions.

NOTE

When dismounting and mounting the heat exchangers, ensure without fail that there is sufficient clearance above the cooling system, follow the manufacturer's technical documentation, and use the spare parts it recommends.

NOTE

Lifting devices, such as transport lifting bracket or eyebolts, can be mounted to suspend the individual or pairwise mounted heat exchangers if necessary. Follow the manufacturer's instructions.

Example: transport lifting brackets

Transport lifting brackets are only attached for the purpose of mounting and dismounting heat exchangers, so that they can be lifted by a crane. There are 12 mm boreholes in the bottom flanges of the brackets so that they can be bolted to the heat exchanger.

Fig. 14: Transport lifting brackets

1 Borehole d = 12 mm (2 ×)

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Fig. 15: Transport lifting bracket – attached (left), detached (right)

1 *ISO 4017 M10 × 20 hexagonal bolt to attach the transport lifting bracket*
2 *The 14 mm borehole for bolting the cooler to the enclosure is hidden by the by the transport lifting bracket*
3 *The transport lifting bracket is unbolted, and used for inserting the next cooler.*
The bolted joint underneath the cooler attaching it to the enclosure is tightened.
4 *Borehole for M12 hexagonal bolt for bolting the cooler to the enclosure*

Measures during installation

- All pipes and flange connections must be laid stress and torque-free to the heat exchangers, and seals fitted that are appropriate for the water quality, pressure and temperature.
- The cooling water should be neutral and free from contamination. Prepare with anti-corrosion agents, pH regulator and/or antifreeze according to the on-site conditions.
- A suitable filter can be fitted on the cooling water inlet during the first commissioning to prevent blockages in the cooling pipes. Check or clean the filter, and remove after connecting the water unit.
- If necessary, vent and subject the cooling system to overpressure so that all heat exchangers can work optimally under all operating conditions.

NOTE

When mounting and dismounting the heat exchangers and pipes, observe the following without fail:

The heat exchangers are bolted tightly to the cooler frame only by the top surface of the cooler frame, and sealed with a rubber-frame gasket. The bottom side of the cooling unit is not bolted to the frame, but sealed to the flange of the hood by a rubber profile (e.g. round cord). A pressure frame holds the rubber profile in place. This arrangement allows the heat exchangers to expand downwards and contract in response to changes in temperature (Fig. 16).

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Fig. 16: Bolting the heat exchangers

1 Water chamber
2 Projecting tube sheet
3 Rubber-frame gasket
4 Cooler frame
5 Bolt-on strip
6 Cooling tube
7 Clamping frame
8 Round cord seal
9 Water inlet/water outlet flange

Work steps

1. There are 14 mm boreholes in the projecting tube sheet of the heat exchanger for bolting the heat exchanger to the enclosure. Bolt the transport lifting brackets temporarily to it with M10 hexagonal bolts.
2. After inserting the heat exchanger, unbolt the brackets, and use them to insert the next heat exchanger.
3. Bolt the projecting tube sheet of the inserted heat exchanger to the enclosure with M12 hexagonal bolts.

6 Commissioning the Cooling System

Before commissioning

- Before commissioning the cooling system after a lengthy period of storage (over 3 months), retighten the bolted joints of the chambers of the individual units. Observe the sequence of work and torques specified by the corresponding manufacturers. Check all seals, and replace if they are more than two years old.
- Check that the cooling system has been properly mounted with a seal on the generator to prevent the uncontrolled escape of cooling air.
- Check that all additional units, such as leakage water warning electrodes and thermometers, have been connected correctly.
- Fill the cooling system pipes with clean coolant, and vent the heat exchangers at the highest point above the vent lines. Open the supply valves little by little to avoid water hammer. The flow rate of the coolant should be regulated solely by the return valves, whereas the supply valves remain fully open. Close the venting valves when there is a smooth flow of water in the vent lines and they do not contain any air.

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Checks and measures after the first commissioning

- Check the pressure and, if necessary, the flow rate to the heat exchangers.
- Check all connections and the heat exchangers for water leaks.
- Check the system for vibrations and unusual noises.
- Check the floor of the cooler frame under the heat exchangers for condensation. If necessary, open the drain plugs to drain the measuring transducer enclosures.

NOTE

If corrosive coolants (e.g. water) are used, continuous operation of at least two months is required to build up a passive protective coating on the metal surfaces.

7 Regular Inspections and Control List

Regular inspections and checks have to be made to ensure trouble-free operation of the cooling system. The times for inspections and checks are to be taken from the Maintenance and Inspection sections of this manual.

Inspection

In general, the following checks are recommended:

- Visual inspection of the general condition of the system
- Check for dirt and damage on the outside surfaces
- Check the surfaces of the cooling fins for blockages and damage
- Check the pipes for blockages and damage
- Check for water leaks in all areas
- Check the water pressure or, if necessary, the flow rate
- Check and clean the leakage air filters, if necessary replace the filter mats
- Check for vibrations and unusual noises
- Check water-carrying parts for corrosion
- Check the function of the safety devices, such as the leakage water warning electrodes

8 Decommissioning the Cooling System

Work steps

1. Shut down the generator.

⚠ CAUTION

Danger of burns if the heat exchangers have not yet cooled down.

▶ After the generator has been shut down, the cooling water pumps should continue to run for some time to dissipate the residual heat.

NOTICE

▶ If necessary climb into the inside of the cooler through the inspection hatches: Before doing so, empty all pockets, remove watches and jewellery.

▶ Do not leave any loose parts, such as nuts and bolts, in the cooling system.

2. Shut down cooling water pump.

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3. Depressurize the system: First shut the return valves, and then the supply valves.
4. Disconnect the power supply to the leakage water warning electrodes.
5. Drain and vent the heat exchangers through the corresponding pipes.

9 Maintenance and Cleaning

NOTE

When maintaining and cleaning the heat exchangers, follow the manufacturer's technical documentation and use the recommended spare parts without fail. The following sections contain only general instructions.

NOTICE

Risk of damaging the heat exchangers.

▶ Have the cleaning work done by an expert.

The heat exchangers have to be cleaned to maintain a good heat transfer and avoid corrosion. It is recommended to remove the heat exchangers for cleaning from the slide-in frames of the cooler hood. When refitting, ensure that there is a correct seal between heat exchangers and enclosures (see also the pipe fitting instructions on page 13).

Follow the documentation of the manufacturer of the heat exchangers without fail.

9.1 Cleaning the Air-Side of the Heat Exchangers

The external hot surfaces of the heat exchangers, whether mounted or dismounted, are preferably vacuum cleaned. When dismounted, they can also be cleaned with dry compressed air. When blowing out, ensure that the cooling air is blown out in the opposite direction to the normal air flow.

If the external hot surfaces are cleaned with water and a pH-neutral cleanser, subsequently blow out the heat exchangers with compressed air, and dry with hot air.

NOTICE

The compressed air can damage the cooling fins.

▶ Use the compressed air carefully.

9.2 Cleaning the Cooling Tubes of the Heat Exchangers

Work steps before cleaning the cooling tubes

1. Drain the heat exchangers and remove all operating materials.
2. Dismount the heat exchangers from the hood.
3. Dismount the water chambers by undoing the screwed connections.
4. If there are tapped holes in the water chamber flange for screwing in forcing-off screws, use these screws to carefully force off the chamber.

Cleaning the cooling tubes

Loosely adhering dirt is cleaned off the internal tubes by means of oil-free compressed air. Clean out firmly adhering dirt with a high-pressure water jet (maximum temperature: 90°C). The spray must be directed in the opposite direction to the flow of the coolant. Only use pH-neutral cleanser (pH 6.0 to 7.5) for cleaning. As a rule all, all washing up liquids lie within this range. A round nylon brush of the appropri-

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ate diameter can also be used for cleaning, here again use it against the direction of flow of the coolant.

NOTICE

Danger of damaging or removing the passive protective coatings from the surfaces of the heat exchangers during the cleaning process.

- A method that does not damage the protective coating is preferred for mechanically cleaning the internal pipes of the heat exchangers.
- Do not clean heat exchangers by poking mechanically or with a wire brush, and do not bore out blocked pipes.

If the usual mechanical methods are unsuccessful, chemical cleaning of the cooling pipes can be considered.

NOTICE

With chemical cleaning, there is a risk of burning the cooling pipes.

- The cleaning process should only be carried out under the supervision of a chemist, who specifies the concentration of the cleansing solution and the duration of application according to the degree of contamination and the pipe material.
- Alkaline and acidic cleansers must not be used.
- Ensure that all chemical residues are thoroughly flushed out with water after the cleaning process.

Work steps after cleaning the cooling pipes

1. When re-assembling the water chambers, ensure that the guide plates and diverter plates are correctly oriented in their correct places.
2. Fit the water chambers with new seals, and tighten the screwed connections with the specified torques. The screwed connections are tightened alternately, diagonally from the inside to the outside to ensure that the seals settle evenly.
3. After re-assembling the heat exchangers, ensure that seals used are fully functional. Make a water-pressure test to check the tightness of the heat exchangers (see page 20).

9.3 Cleaning the Water Chambers

Clean the water chambers with water, commercial, pH-neutral cleanser and a nylon brush. Follow the manufacturer's instructions.

NOTICE

Risk of damaging or removing the corrosion protection in the water chambers.

This may lead to pitting and irreparable damage to the water chambers.

- If the corrosion protection becomes detached it has to be renewed.

9.4 Cleaning the Cooler Frame

Vacuum clean the insides of the cooler frame and the sound attenuation cover of the generator (in as far as they are accessible) and wipe down with a damp cloth. Add commercial pH-neutral cleanser to the wiping water. Finally, thoroughly dry the damp surfaces.

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10 Reworking, Repairing and Testing the Heat Exchangers

If leaks occur in the heat exchangers, the procedures for testing and repairing the components should always be agreed with the responsible department of Siemens AG. Leaks in the area of the chambers, seals and shell can usually be localized from the outside. A leak should be repaired by skilled personnel according to its type and position.

If a leak cannot be found from the outside, it has to be localized by a leak test of the heat exchanger. Depending on the type of heat exchanger and the suspected position of the leak, test for leaks either from the outside (shell side) or the inside (chamber space). The leak test localizes the defective pipe or the position of the leak. If the heat exchanger has been dismounted, test for leaks with the medium suitable for the particular operating material of the shell or chamber space. The tubes and water chambers are tested for leaks from the inside by, for example, **water pressure tests**, and from the outside after, for example, weld repairs by the **dye penetration test**. The most frequent leaks are in the **weld seams of the water chambers** and **leaks in the tubes in the joints of the chamber floors**.

10.1 Water Pressure Test

The water pressure test on the heat exchanger ensures that there are no leaks in the expansion and connection elements, seals, welded chambers or fitted pipes.

Equipment

The following equipment is required to perform a water pressure test:

- A hand water pump with adequate capacity for the specific test pressure
- A calibrated manometer
- Connecting hoses or elements

NOTICE

Risk of damaging the heat exchanger.

▶ Allow the water pressure test to be performed only by trained personnel.

Work steps

1. Connect the pump to the inlet flange of the heat exchanger, and mount the manometer on the outlet flange.
2. Mount all other parts as shown in Fig. 17.
3. Fill the heat exchanger with water, and vent it through the air cocks on the water chambers.
4. Close the air cocks and gradually increase the water pressure to the specified test pressure.
5. Monitor the test pressure for at least 2 hours.
6. All parts of the heat exchanger – such as chambers, pipes, seals, welded seams – are tested during the pressure test. During the pressure test there should be no measurable pressure fall on the manometer.

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Fig. 17: Connecting the heat exchanger for the water pressure test

1 *Heat exchanger*
2 *Water outlet flange*
3 *Gasket*
4 *Blind flange*
5 *Pressure gauge*
6 *Water inlet flange*
7 *Connecting flange*
8 *Non-return / cut-off valve*
9 *Hose*
10 *Hose union*
11 *manual pump*
12 *Reservoir*
13 *Pump handle*

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10.2 Dye Penetration Test after Weld Repairs

NOTICE

Risk of damaging the heat exchanger.

- Always have the dye penetration test performed by an expert.

The dye penetration test can test surfaces and weld seams for the smallest cracks and openings in the surface. It serves to prove that there are no leaks after weld repairs to the cooling system. The smallest faults are made visible by a coloured penetration agent and a developer with high colour contrast to the penetration agent.

10.3 Leaks in the Weld Seams of the Water Chambers

NOTICE

Risk of damaging the heat exchanger.

- Allow necessary tests of weld seams and weld repairs to be performed only by trained, authorized personnel.

Work steps

1. During the pressure test, mark possible leaks in weld seams with chalk or paint.

2. Reduce the pressure and drain the heat exchanger. If necessary, blow the heat exchanger dry with compressed air to remove all traces of moisture.
3. Use a dye penetration test to find whether there is a leak at the affected spot.
4. Regrind the defective spot and weld the crack.
5. Then perform another dye penetration test to check the weld seam.
6. Remount the heat exchanger, and perform another pressure test.

10.4 Leaks in Pipes in the Joints of the Chamber Bottoms

NOTICE

Risk of damaging the heat exchanger.

▶ Allow the repairs to be performed only by trained personnel.

Work steps

1. During the pressure test, mark pipe leaks with chalk or paint.
2. Reduce the pressure and drain the heat exchanger. If necessary, blow the heat exchanger dry with compressed air to remove all traces of moisture.
3. Remove the affected water chambers.
4. If the damaged spot is not obvious, search for the leak in the tube sheet with a light. If necessary, test the pipes individually.
5. Check the bore of the pipe at the joint, and widen the joint.
6. If the affected pipe still leaks after another pressure test, seal both ends of the pipe with conical copper plugs, and braze the pipe and plug together. A suitable two-component adhesive can also be used.

NOTE

Alternatively, the defective pipe can be replaced by a new one. Whether this exchange is made depends on whether a replacement is available, and the time frame involved. In this case contact Siemens AG.

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The cooler unit comprises four cooling elements, each of which contributes 33 percent of the cooling capacity.

The generator can be operated in emergency mode at 80 percent of rated power and with only three active cooling elements.

The damaged element has to be shut-off. It is important that it remains in the cooler unit until it is replaced.

NOTICE

Damaged cooling elements must be replaced as early as possible!

The reported and protection values of the cold air temperature are invalid during emergency mode. All other values (especially the stator slot temperatures) remain valid during emergency mode.

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SIEMENS

Turbogenerator | Operating and Maintenance Manual

Components, Purchased Parts 8

Bearings

Manufacturer: RENK AG

Bearing designation: TE / EE: EGXTQ 45-450

Shaft seals:

TE

1 × Rigid labyrinth seal type 20 45-500
(protective system IP 44)

1 × Rigid labyrinth seal type 22 45-500
(protective system IP 55)
with connection for earth brush

EE

1 × Rigid labyrinth seal type 20 45-500
(protective system IP 44)

1 × Rigid labyrinth seal type 20 45-500
(protective system IP 44)
with connection for earth brush

Temperature measurement: journal parts (radial)

Bearing insulation: insulated spherical seals

Bearing material: THERM 89

NOTE:
You will find more detailed information in the Dimensional Drawing Text.

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Manufacturer: **RENK AG**

Documentation: **Bearing Calculation**

- For ISO VG 32, T = 50°C:
  - Calculation of a Hydrodynamic Plain Journal Bearing on Steadystate Conditions
  - Calculation of a Hydrostatic Jacking

- For ISO VG 46, T = 55°C:
  - Calculation of a Hydrodynamic Plain Journal Bearing on Steadystate Conditions
  - Calculation of a Hydrostatic Jacking

No. of pages: 8

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RENK Aktiengesellschaft

Werk Hannover

Calculation of a Hydrodynamic Plain Journal Bearing on Steadystate Conditions Progr.: ALP3T (rev. 4.2)

Customer:	Siemens Erfurt H-MPA	Date:	29.03.2012
Ref.- Number:	870071/hmpa-t04		
Bearing:	EGXYCQ 45-450	edited:	Koh
Special Features:		Department:	Hse

Input data:	Nominal diameter		D	=	450	mm
	Effective bearing width		B	=	318,8	mm
	Number of sliding surfaces		Z_r	=	2	-
	Angular span of bearing sliding surface		Ω_r	=	136,2	°
	Relative bearing clearance		ψ	=	1,69	‰
	Mean relative bearing clearance by DIN 31698		ψ_{DIN}	=	1,6	‰
	Radial clearance		C_R	=	0,380	mm
	Eccentricity of bearing sliding surfaces		e_B	=	0,47	mm
	Profile factor (see annotation below)		K_P	=	2,238	-
	Preload factor (see annotation below)		m	=	0,553	-
	Shaft deviations by DIN 31698	over-allowance	es	=	-0,629	mm
	(basic hole system)	under-allowance	ei	=	-0,669	mm
	Lubricant viscosity grade by ISO 3448		ISO VG		32	-
	Lubricant supply temperature		$T_{r,en}$	=	50	℃
	Radial bearing load		F_r	=	326	kN
	Rotational speed of rotor		N	=	3000	min-1
Results:	Specific radial bearing load		$\overline{p}_r$	=	2,3	MPa
	Circumferential speed of journal		U_J	=	70,7	m/s
	Eccentricity (distance between journal and bearing axis)		e	=	0,279	mm
	Journal attitude angle (related to direction of load)		β	=	26,9	°
	Minimum admissible radial lubricant film thickness		$h_{r,lim}$	=	0,018	mm
	Minimum radial lubricant film thickness		$h_{r,min}$	=	0,067	mm
	Maximum lubricant film pressure of journal bearing		$p_{r,max}$	=	7,2	MPa
	Frictional power of journal bearing		$P_{f,r}$	=	179,3	kW
	Lubricant flow rate of journal bearing		Q_r	=	200	l/min
	Lubricant temperature at exit of journal bearing		$T_{r,ex}$	=	80	℃
	Maximum temperature of segment sliding surface		$T_{B,max}$	=	110	℃
	Lubricant film stiffness coefficients of journal bearing		c_{11}	=	1167,4	kN/mm
			c_{12}	=	724,4	kN/mm
			c_{21}	=	3567,5	kN/mm
			c_{22}	=	6434,5	kN/mm
	Lubricant film damping coefficients of journal bearing		d_{11}	=	1,559	kN·s/mm
			d_{12}	=	1,944	kN·s/mm
			d_{21}	=	1,940	kN·s/mm
			d_{22}	=	16,571	kN·s/mm
	Horizontal bearing housing stiffness (EN-GJL-300)		c_h	=	3000	kN/mm
	Vertical bearing housing stiffness (EN-GJL-300)		c_v	=	6500	kN/mm

The terms and definitions follow DIN 31651 and DIN 31657.

Calculation of a Hydrodynamic Plain Journal Bearing on Steadystate Conditions Progr.: ALP3T (rev. 4.2)

Customer:	Siemens Erfurt H-MPA	Date:	29.03.2012
Ref.- Number:	870071/hmpa-t04		
Bearing:	EGXYCQ 45-450	edited:	Koh
Special Features:		Department:	Hse

Lubricant film coefficients on speed variation (isothermal)

N [min^{-1}]	c_{11} [kN/mm]	c_{12} [kN/mm]	c_{21} [kN/mm]	c_{22} [kN/mm]	d_{11} [kN·s/mm]	d_{12} [kN·s/mm]	d_{21} [kN·s/mm]	d_{22} [kN·s/mm]
500	2192,9	1053,1	9051,4	21128,0	19,673	56,598	56,911	359,784
1000	2039,6	591,5	7437,2	13724,9	10,593	25,286	25,575	145,207
1500	1802,6	586,8	6422,6	11234,5	5,929	12,958	12,946	80,245
2000	1568,8	677,8	5379,1	9522,2	3,551	7,018	7,038	47,613
2500	1407,2	718,0	4483,8	8080,9	2,475	4,331	4,340	30,000
3000	1146,9	741,9	3171,2	6396,7	1,560	2,049	2,037	15,789
3300	968,6	630,6	2779,3	5721,6	1,213	1,348	1,359	12,231
3600	866,6	545,7	2600,7	5269,6	1,041	1,038	1,032	10,292
4000	805,1	460,1	2466,6	4763,9	0,924	0,795	0,793	8,603
5000	704,9	248,2	2168,3	3800,9	0,878	0,529	0,518	6,698
6000	617,2	89,4	2008,6	3325,6	0,819	0,267	0,249	5,498
7000	549,4	-81,1	1953,7	3118,8	0,844	0,026	-0,019	4,869

Annotation:

The profile factor is related
to the preload factor by: $K_P = 1/(1-m)$

Reference coordinate system

Calculation of a Hydrodynamic Plain Journal Bearing on Steadystate Conditions Progr.: ALP3T (rev. 4.2)

Customer:	Siemens Erfurt H-MPA	Date:	29.03.2012
Ref.- Number:	870071/hmpa-t04		
Bearing:	EGXYCQ 45-450	edited:	Koh
Special Features:		Department:	Hse

Lubricant film coefficients on speed variation (isothermal, dimensionless)

So	c_{11}^*	c_{12}^*	c_{21}^*	c_{22}^*	d_{11}^*	d_{12}^*	d_{21}^*	d_{22}^*
[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
21,872	55,861	26,827	230,57	538,206	26,240	75,490	75,908	479,879
10,704	25,977	7,534	94,726	174,811	14,129	33,727	34,112	193,676
7,300	15,306	4,983	54,536	95,394	7,908	17,283	17,267	107,030
5,478	9,991	4,316	34,256	60,641	4,736	9,361	9,387	63,506
4,378	7,169	3,658	22,844	41,170	3,302	5,776	5,789	40,014
3,646	4,869	3,150	13,464	27,158	2,081	2,733	2,717	21,059
3,314	3,739	2,434	10,727	22,083	1,617	1,798	1,812	16,313
3,039	3,066	1,931	9,201	18,644	1,389	1,385	1,377	13,727
2,734	2,564	1,465	7,854	15,169	1,232	1,061	1,057	11,475
2,188	1,796	0,632	5,523	9,682	1,171	0,706	0,690	8,934
1,819	1,310	0,190	4,264	7,060	1,093	0,356	0,332	7,333
1,564	1,000	-0,147	3,555	5,675	1,126	0,035	-0,026	6,494
1,093	0,603	-0,828	2,940	4,175	1,266	-0,630	-0,691	6,427
0,839	0,467	-0,963	2,676	3,555	1,216	-0,785	-0,835	6,215
0,670	0,387	-1,037	2,549	3,206	1,186	-0,887	-0,937	6,144
0,504	0,313	-1,100	2,453	2,871	1,158	-0,985	-1,026	6,124
0,336	0,239	-1,145	2,383	2,583	1,129	-1,096	-1,142	6,109
0,251	0,210	-1,170	2,385	2,436	1,124	-1,138	-1,179	6,172
0,167	0,184	-1,190	2,382	2,292	1,122	-1,176	-1,219	6,222
0,083	0,159	-1,206	2,384	2,145	1,119	-1,220	-1,256	6,283
0,033	0,144	-1,215	2,379	2,066	1,120	-1,242	-1,283	6,302
0,017	0,139	-1,219	2,396	2,032	1,123	-1,252	-1,289	6,344

For the calculation of the coefficients a constant effective viscosity is considered as follows.

Effective lubricant viscosity η_{eff} = 5,64 mPas

Annotation:

The profile factor is related to the preload factor by: $K_P = 1/(1-m)$

Reference coordinate system

RENK Aktiengesellschaft

Werk Hannover

Calculation of a Hydrostatic Jacking Progr.: HYDRA (rev. 1.0)

Customer:	Siemens Erfurt H-MPA	Date:	13.04.2012
Ref.- Number:	870071		
Bearing:	EGXYCQ 45-450	edited:	Koh
Special Features:	two groove pocket design	Department:	Hse

Input data:	Nominal diameter	D	=	450	mm
	Effective bearing width	B	=	318,8	mm
	Mean relative bearing clearance (contact angle)	ψ	=	0,84	‰
	Lubricant viscosity grade by ISO 3448	ISO VG		32	
	Seal type		rigid		
	Pocket variant		special		
	Radial bearing load	F_r	=	326,0	kN
Results:	Starting pressure	p_{start}	=	13,5	MPa
	Operating pressure	p_{op}	=	9,0	MPa
	Flow rate	Q_{hj}	=	5,0	l/min
	Minimum starting temperature	$T_{min, st}$	=	16	℃
	ON/OFF speed "cold"	$N_{min,hj,c}$	=	50	rpm
	ON/OFF speed "warm"	$N_{min,hj,w}$	=	150	rpm

NOTES:

A) Calculations for speed limits are based on journal degree of shaft accuracy (by DIN 31699) of 10.

B) The calculated pressures are for the bearings only.
Pressure losses inside the supply system (units, pipes, components, etc.) have to be considered additionally.

C) The evaluation of the hydrostatic pressures is based on simplified modelling together with generally good-practical accordance (supported shaft at standstill). For individual cases we cannot exclude noteworthy deviations, so we recommend to re-adjust the control elements in accordance with the actual rock pressure conditions at operating state temperatures. (See also point B).

D) Due to the behaviours of the supply system dynamic pressure peaks (impulse) during start-up of the pumps higher than the calculated start-up pressure can occure.

E) Except as specified otherwise we design the supply unit for a pressure capacity of min. 20 MPa.

F) Interactions by different pressure requirements - also temporary - are not admissible. Hence it must be ensured that a certain oil volume will be constantly provided to each hydrostatic pocket independant from other operational conditions in other supply paths. This is the case when several bearings and/or multiple hydrostatic pockets per bearing have to be feeded parallel.

G) To keep the necessary oil volume - and as a result of this the compliance - as low as possible we recommend to use short supply lines and pipes with small cross-sections. Air inclusions in the supply line (pressure oil) could disturb the functionality and have to be avoided.

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Werk Hannover

Calculation of a Hydrodynamic Plain Journal Bearing on Steadystate Conditions Progr.: ALP3T (rev. 4.2)

Customer:	Siemens Erfurt H-MPA	Date:	29.09.2011
Ref.- Number:	870071/hmpa-t03		
Bearing:	EGXYCQ 45-450	edited:	Koh
Special Features:		Department:	Hse

Input data:	Nominal diameter		D	=	450	mm
	Effective bearing width		B	=	318,8	mm
	Number of sliding surfaces		Z_r	=	2	-
	Angular span of bearing sliding surface		Ω_r	=	136,2	°
	Relative bearing clearance (vertical)		ψ	=	1,69	‰
	Mean relative bearing clearance by DIN 31698		ψ_{DIN}	=	1,60	‰
	Radial clearance		C_R	=	0,380	mm
	Eccentricity of bearing sliding surfaces		e_B	=	0,47	mm
	Profile factor (see annotation below)		K_P	=	2,238	-
	Preload factor (see annotation below)		m	=	0,553	-
	Shaft deviations by DIN 31698	over-allowance	es	=	-0,629	mm
	(basic hole system)	under-allowance	ei	=	-0,669	mm
	Lubricant viscosity grade by ISO 3448		ISO VG		46	-
	Lubricant supply temperature		$T_{r,en}$	=	55	°C
	Radial bearing load		F_r	=	326	kN
	Rotational speed of rotor		N	=	3000	min-1
Results:	Specific radial bearing load		$\overline{p}_r$	=	2,3	MPa
	Circumferential speed of journal		U_J	=	70,7	m/s
	Eccentricity (distance between journal and bearing axis)		e	=	0,274	mm
	Journal attitude angle (related to direction of load)		β	=	27,6	°
	Minimum admissible radial lubricant film thickness		$h_{r,lim}$	=	0,018	mm
	Minimum radial lubricant film thickness		$h_{r,min}$	=	0,071	mm
	Maximum lubricant film pressure of journal bearing		$p_{r,max}$	=	7,1	MPa
	Frictional power of journal bearing		$P_{f,r}$	=	185,8	kW
	Lubricant flow rate of journal bearing		Q_r	=	200	l/min
	Lubricant temperature at exit of journal bearing		$T_{r,ex}$	=	86	°C
	Mean lubricant side flow temperature		T_{sf}	=	74	°C
	Maximum temperature of segment sliding surface		$T_{B,max}$	=	118	°C
	Lubricant film stiffness coefficients of journal bearing		c_{11}	=	1113,7	kN/mm
			c_{12}	=	663,1	kN/mm
			c_{21}	=	3522,3	kN/mm
			c_{22}	=	6215,5	kN/mm
	Lubricant film damping coefficients of journal bearing		d_{11}	=	1,533	kN·s/mm
			d_{12}	=	1,839	kN·s/mm
			d_{21}	=	1,830	kN·s/mm
			d_{22}	=	16,586	kN·s/mm
	Horizontal bearing housing stiffness (EN-GJL-300)		c_h	=	3000	kN/mm
	Vertical bearing housing stiffness (EN-GJL-300)		c_v	=	6500	kN/mm

The terms and definitions follow DIN 31651 and DIN 31657.

Calculation of a Hydrodynamic Plain Journal Bearing on Steadystate Conditions Progr.: ALP3T (rev. 4.2)

Customer:	Siemens Erfurt H-MPA	Date:	29.09.2011
Ref.- Number:	870071/hmpa-t03		
Bearing:	EGXYCQ 45-450	edited:	Koh
Special Features:		Department:	Hse

Lubricant film coefficients on speed variation (isothermal)

N [min^{-1}]	c_{11} [kN/mm]	c_{12} [kN/mm]	c_{21} [kN/mm]	c_{22} [kN/mm]	d_{11} [kN·s/mm]	d_{12} [kN·s/mm]	d_{21} [kN·s/mm]	d_{22} [kN·s/mm]
500	2187,4	972,1	8852,6	20105,4	20,323	56,887	57,034	352,291
1000	2034,7	562,7	7362,7	13218,8	10,679	25,130	25,263	143,226
1500	1728,6	602,6	6163,8	10780,7	5,563	11,938	11,953	76,231
2000	1591,6	654,7	5478,3	9488,7	3,753	7,413	7,317	49,369
2500	1370,9	679,1	4413,8	7851,9	2,438	4,204	4,200	29,713
3000	1112,5	703,7	3101,3	6196,6	1,522	1,969	1,965	15,570
3300	961,2	615,3	2744,6	5622,9	1,216	1,349	1,351	12,230
3600	817,5	500,2	2471,1	5052,1	0,997	0,961	0,948	9,929
4000	789,8	444,7	2419,3	4670,4	0,924	0,788	0,777	8,517
5000	691,3	237,0	2144,8	3758,3	0,870	0,488	0,476	6,623
6000	611,2	71,6	2003,7	3283,4	0,833	0,261	0,243	5,521
7000	537,3	-103,4	1949,6	3094,1	0,852	-0,005	-0,049	4,905

Annotation:

The profile factor is related to the preload factor by: $K_P = 1/(1-m)$

Reference coordinate system

Calculation of a Hydrodynamic Plain Journal Bearing on Steadystate Conditions Progr.: ALP3T (rev. 4.2)

Customer:	Siemens Erfurt H-MPA	Date:	29.09.2011
Ref.- Number:	870071/hmpa-t03		
Bearing:	EGXYCQ 45-450	edited:	Koh
Special Features:		Department:	Hse

Lubricant film coefficients on speed variation (isothermal, dimensionless)

So	c_{11}^*	c_{12}^*	c_{21}^*	c_{22}^*	d_{11}^*	d_{12}^*	d_{21}^*	d_{22}^*
[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
20,255	51,595	22,929	208,81	474,231	25,099	70,257	70,438	435,088
10,123	23,996	6,637	86,833	155,897	13,189	31,036	31,201	176,888
6,485	13,591	4,738	48,462	84,762	6,871	14,743	14,762	94,148
5,342	9,385	3,861	32,305	55,953	4,635	9,155	9,036	60,972
4,057	6,467	3,204	20,822	37,041	3,011	5,192	5,187	36,696
3,381	4,373	2,766	12,192	24,360	1,880	2,431	2,427	19,229
3,070	3,435	2,199	9,809	20,095	1,501	1,666	1,668	15,105
2,819	2,678	1,639	8,095	16,551	1,232	1,187	1,171	12,262
2,535	2,329	1,311	7,133	13,770	1,142	0,973	0,959	10,519
2,018	1,631	0,559	5,059	8,865	1,075	0,603	0,588	8,180
1,690	1,201	0,141	3,938	6,454	1,028	0,323	0,300	6,819
1,449	0,905	-0,174	3,285	5,213	1,052	-0,006	-0,061	6,057
1,013	0,559	-0,790	2,755	3,886	1,190	-0,603	-0,660	6,054
0,779	0,435	-0,912	2,523	3,323	1,144	-0,745	-0,794	5,874
0,622	0,359	-0,982	2,398	3,000	1,115	-0,842	-0,888	5,794
0,467	0,292	-1,039	2,315	2,690	1,089	-0,932	-0,971	5,784
0,312	0,222	-1,080	2,248	2,427	1,061	-1,038	-1,080	5,762
0,233	0,196	-1,102	2,251	2,288	1,060	-1,073	-1,117	5,826
0,156	0,171	-1,121	2,249	2,153	1,057	-1,110	-1,150	5,871
0,077	0,149	-1,136	2,252	2,019	1,054	-1,150	-1,184	5,931
0,031	0,137	-1,145	2,251	1,941	1,057	-1,168	-1,208	5,956
0,016	0,131	-1,148	2,257	1,919	1,057	-1,178	-1,214	5,974

Annotation:
The profile factor is related
to the preload factor by: $K_P = 1/(1-m)$

Reference coordinate system

RENK Aktiengesellschaft

Werk Hannover

Calculation of a Hydrostatic Jacking Progr.: HYDRA (rev. 1.0)

Customer:	Siemens Erfurt H-MPA	Date:	05.12.2013
Ref.- Number:	870071		
Bearing:	EGXYCQ 45-450	edited:	Koh
Special Features:	two groove pocket design	Department:	Hse

Input data:	Nominal diameter	D	=	450	mm
	Effective bearing width	B	=	318,8	mm
	Mean relative bearing clearance (contact angle)	ψ	=	0,84	‰
	Lubricant viscosity grade by ISO 3448	ISO VG		46	
	Seal type		rigid		
	Pocket variant		special		
	Radial bearing load	F_r	=	326,0	kN
Results:	Starting pressure	p_{start}	=	13,5	MPa
	Operating pressure	p_{op}	=	9,5	MPa
	Flow rate	Q_{hj}	=	2,0	l/min
	Minimum starting temperature	$T_{min, st}$	=	10	°C
	ON/OFF speed "cold"	$N_{min,hj,c}$	=	45	rpm
	ON/OFF speed "warm"	$N_{min,hj,w}$	=	135	rpm

NOTES:

A) Calculations for speed limits are based on journal degree of shaft accuracy (by DIN 31699) of 10.

B) The calculated pressures are for the bearings only.
Pressure losses inside the supply system (units, pipes, components, etc.) have to be considered additionally.

C) The evaluation of the hydrostatic pressures is based on simplified modelling together with generally good-practical accordance (supported shaft at standstill). For individual cases we cannot exclude noteworthy deviations, so we recommend to re-adjust the control elements in accordance with the actual rock pressure conditions at operating state temperatures. (See also point B).

D) Due to the behaviours of the supply system dynamic pressure peaks (impulse) during start-up of the pumps higher than the calculated start-up pressure can occure.

E) Except as specified otherwise we design the supply unit for a pressure capacity of min. 20 MPa.

F) Interactions by different pressure requirements - also temporary - are not admissible. Hence it must be ensured that a certain oil volume will be constantly provided to each hydrostatic pocket independant from other operational conditions in other supply paths. This is the case when several bearings and/or multiple hydrostatic pockets per bearing have to be feeded parallel.

G) To keep the necessary oil volume - and as a result of this the compliance - as low as possible we recommend to use short supply lines and pipes with small cross-sections. Air inclusions in the supply line (pressure oil) could disturb the functionality and have to be avoided.

Manufacturer:	**RENK AG**
Documentation Title:	**Slide Bearings Type EG** **Size 45** Instructions for Installation and Maintenance
No. of pages:	39
Documentation Title:	**Instructions for Installation, Operation and Maintenance** **– Hydrostatic Jacking Device**
No. of pages:	2

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Slide Bearings TYPE EG

Size 45

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Bearing Coding

❶ Type	❷ Housing	❸ Heat Dissipation	❹ Shape of Bore and Type of Lubrication	❺ Thrust part	❻ Size - Diameter	
E	R - finned pedestal bearing (size 35 - 45) G - smooth pedestal bearing	N - natural cooling Z - lubrication by oil circulation with external oil cooling X - lubrication by oil circulation with external oil cooling for high oil throughput U - circulating pump and natural cooling T - circulating pump and water cooling (finned cooler in oil sump) W - water cooling (finned cooler in oil sump)	C - plain cylindrical bore without oil ring L - plain cylindrical bore with loose oil rings Y - two-lobe bore (lemon shape) without oil ring T: - Tragspiegel bore without oil ring W: - three-lobe-bore without oil ring V: - four-lobe-bore without oil ring	Q - without thrust part (non locating bearing) B - plain sliding surfaces (locating bearing) K - taper land faces for both senses of rotation (locating bearing) A - elastically supported circular tilting pads (locating bearing) E - taper land faces for one sense of rotation (locating bearing)	35 45 56 71 90 112	300≤D≤450 375≤D≤560 475≤D≤710 600≤D≤900 750≤D≤1000 950≤D≤1250

Example for bearing coding:

❶	❷	❸	❹	❺	❻
E	G	Z	L	A	35-355

Type E slide bearing with smooth foot-mounted housing, lubrication by oil circulation with external oil cooling, plain cylindrical bore with loose oil ring, locating bearing with elastically supported circular tilting pads, size 35, diameter 355.

Shaft seals

Type 20 - rigid labyrinth seal (IP 44)

Type 22 - rigid labyrinth seal (IP 55)

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General Drawing

Slide Bearing type EG

Size 45

1
5
34
26, 33
23
22
20
18
14
14
17
4
7
6
27
10
32
35
8
19
16

1	Oil filling hole
2	
3	
4	Positioning pin
5	Housing - top half
6	Shell - top half
7	Positioning pin hole
8	Housing - bottom half
9	
10	Spherical surface
11	Cooling water in-or outlet (Type E.T..)
12	Cooling water out-or inlet (Type E.T..)
13	Cooler (Type E.T..)
14	Hexagon head plug (Oil drain plug)
15	Foot plate (Type ER...)
16	Foot plate holes
17	Dowel pin hole
18	Connection hole for oil sump temperature measurement
19	Oil outlet pipe with special pipe nut and lead seal
20	Oil sight glass
21	Screw plug
22	Connection hole for journal bearing temperature measurement
23	Oil inlet connection hole
24	Screw plug
25	Connection hole for thrust part supply (optional)
26	Engraved number
27	Shell - bottom part
28	Engraved number
29	
30	Engraved number
31	
32	Tapped hole (shell - top and bottom halves)
33	Engraved number
34	Screw (split line of the housing)
35	Eye bolt
36	Connection hole for thrust part temperature measurement (optional)

General drawing

Rigid Labyrinth Seal

59
60
65
61
64
63

59	Rigid labyrinth seal - top half
60	Screw
61	Screw (split line)
63	Rigid labyrinth seal - bottom part
64	Engraved number
65	Engraved number
66	Taper sleeves

1 Considerations for Use

The instructions for installation and maintenance are addressed to qualified technical personnel (fitters, mechanic installers, mechanical engineers).

Read these instructions carefully before starting assembly.

Slide bearings of type EG are almost universally used in the engineering industry. Therefore it is not possible to provide detailed information on all possible types and range of applications for these bearing types. For instance, the position of the connection points for supply and monitoring equipment is determined by the place of application (in the following called “installation “). Please keep ready the guidelines with the technical documentation before starting installation and maintenance of the slide bearings.

Additional technical documentation with detailed information is supplied in case of special design bearings. Please contact RENK Export or Domestic Department for supplementary information on bearings. Please indicate the bearing coding and the full reference number, too.

Following indications should be observed when reading these instructions.

Safety instructions are marked as follows:

Danger!
Warning of dangers for personnel.
Example: Warning of injury

Attention!
Warnings of damage for the bearing or drive train.

Useful recommendations and additional information are framed.

E...Q

This is how chapters, instructions or recommendations are marked when referring to a single type or size of a bearing.

Example: Slide bearing type E without thrust pads (non-locating bearing)

- Instruction follows.

• Beginning of an enumeration.

( ) This is how the different parts of a bearing as described in the general drawings (numbers) are marked in the text.

– Use the enclosed check-list before starting assembly or operation. Copies available on request.
– The check list provides the experienced mechanical fitters for RENK bearings with the necessary instructions for installation and operation.

2 Safety Instructions

Danger!
The installation and maintenance of the slide bearings should be carried out by:
- persons nominated by the safety representative
- persons correspondingly trained and instructed
- persons with knowledge on appropriate standards, regulations and accident prevention rules
- persons with knowledge on first-aid measures and local rescue centres.

Warning of injury!
Before starting work on the bearing:
- Switch off the installation.
- Make sure the installation is not in operation.

Never lift or transport machines, etc.by the bearing eye bolts. These are only intended for assembly and dismantling of the bearing!

Warning of injury!
Do not grab such heavy bearing parts as the housing during assembly or dismantling works. This could result in bruising or injury to hands!

Attention!
All parts of a slide bearing consisting of top and bottom part such as the housing, shells, shaft seals are marked by engraved numbers. Fit together only the parts with the same number.

Attention!
In case
- the admissible bearing temperature exceeds 15 K
- inadmissible vibrations occur
- unusual noises or odours are noticed
- monitoring equipment triggers alarm

shut down the installation and inform the maintenance personnel in charge.

Attention!
Do not operate the bearing below the transition speed values indicated in the bearing calculation, thus avoiding inadmissible operating conditions, which could lead to damage of the bearing.

Attention!
Please observe our leaflet Technical Information No. 85 which refers to various sealing compounds for extended technical applications.

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3 Preparatory Works

3.1 Tools and equipment

– Following tools and equipment are necessary:

- Allan key set
- Wrenching key set
- Open-jawed spanner set
- Feeler gauges (up 0,05 mm)
- Calliper gauge
- Emery paper, plain scraper
- Oil rubber
- Lifting equipment
- Permanent sealing compound
- Clean cloth
- Oil with the viscosity indicated (see bearing type plate)
- Detergents
- Liquid screw locking compound (e.g. LOCTITE 242)
- Liquid sealing compound and Teflon-tape

3.2 Use of lifting equipment

Warning of injury!

Before transport or lifting check if the eye bolts are tight! Insecure eye bolts could result in bearing becoming loose.

Before moving the bearing by the eye bolts make sure that the split line screws are tightened, otherwise the bottom half of the bearing could become detached.

Make sure that the eye bolts are not exposed to bending stress, otherwise the bolts could break.

Follow exactly the instructions for the use of lifting equipment.

– Use lifting equipment for assembly or transport of the bearing items:
– Following steps are to be observed before using the lifting equipment:

Whole bearing unit

– Check if the screws are tight (34):

Bearing size	45
Torque value [Nm] μ_{tot} = 0,1 (lightly oiled)	2010
Wrench size (Allen key) [mm]	27

– Check if the eye bolts (35) are tight.
– Connect the lifting equipment to the eye bolts (35).

Top half of the housing

– Check if the eye bolts (35) are tight.
– Connect the lifting devices to the eye bolts (35).

weight	550 kg

Bottom half of the housing

– Screw two eye bolts (35) with suitable threads tight into the cross-placed opposite tapped holes.

Bearing size	45
Tapped hole	M 36
weight	915 kg

– Connect the lifting equipment to the eye bolts (35).

Shells

– Screw two eye bolts or screw hooks with suitable threads tight into the tapped holes (32):

Bearing size	45
Tapped hole	M 20
weight	1375kg

– Connect the lifting equipment to the eye bolts or to the screw hooks.

Adapter plate

weight	910kg

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3.3 Dismantling of the bearing

Attention
Make sure that the work place and the parts to be assembled are clean. Contamination and damages to the bearing, especially of the working surfaces, have a negative influence on the operating quality and could lead to premature fatigue.

3.3.1 Dismantling of the Rigid labyrinth seal (type 20 and 22)

Illustration 1: Dismantling of the rigid labyrinth seal

- Loosen all screws (60) of the top half (59).
- Take out the screws (61).
- After removing the screws (61) pull out in upward direction the taper sleeves (66) from the split line bores. You can separate both halves of the rigid labyrinth seal only after removing the taper sleeves (66). The taper sleeves (66) are provided with M 10 threads in which you can screw counter nuts or any other suitable pulling tool.
- Screw an eye bolt M12 or a screw hook into the threaded hole on the top half (59).
- Connect the lifting equipment to the eye bolts or to the screw hooks.
- Remove the screws (60) of the top half (59).
- Take away the top half carefully, in axial direction, from the housing.
- Loosen the screws of the bottom half (63).
- Screw two eye bolts M12 or screw hooks into the threaded holes of the bottom half (63).
- Further on proceed as in the case of the top half.
- Remove the gasket from the flange surface.
- Damaged gaskets must be renewed.

3.3.2 Dismantling of the housing

- Unscrew the screws (34) and lift the top half of the housing (5).
- Take out both top (6) and bottom (27) halves of the shell from the bottom half (8) of the housing.

Attention!
Do not damage the thrust and radial working surfaces!

Attention!
In the case of insulated housings (white plastic insulating foil) avoid any jamming of the top half of the shell when you lift it up
Jamming could lead to damage of the insulating foil in the bottom half of the housing.

- Remove the taper pins (30) by using suitable tools and unscrew both screws (31).
- Separate top and bottom half of the shell (6), (27) without using any tools or other devices.

3.4 Cleaning of the bearing

Attention!
Use only non-aggressive detergents, such as for instance:
- VALVOLINE 150.
- Alkaline cleaning compounds (pH-value 6 to 9, short reaction time).

Warning of injury!
Please observe the instructions for the use of the detergents.

Attention!
Never use cleaning wool or fibrous cloth. Residues of such materials left in the bearing could lead to excessive temperatures.

- Clean the following parts thoroughly, to remove all residues of preservation :

- inside the top half of the housing (5)
- inside the bottom half of the housing (8)
- all plain parts of the top and bottom half of the housing (5), (8)
- top half of the shell (6)
- bottom half of the shell (27)
- sealing surfaces of the seal carrier

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3.5 Check-up

- Please check if there is any visible damage. Check the split line and the working surfaces in particular.

Insulated Bearings

- Check the insulating layer of the spherical seating (10).
- If necessary, change the damaged parts.

Attention!
The insulating layer of the spherical surface can be repaired ones with special tools and insulating material.

4 Assembly of the Bearing

Attention!
Remove all impurities or other objects such as screws, nuts, etc. from inside the bearing. If left inside the bearing assembly they could lead to damage of the bearing. Cover up the opened bearing during breaks.

Attention!
Carry out all assembly operations without making use of force.

Attention!
Use a liquid screw locking compound (e.g. LOCTITE 242) for all housing, split line and flange screws.

4.1 Assembly of the bottom half of the bearing on foundations

Attention!
Make sure that all bearings installed on a shaft line are opened. To open them untighten the screws or the nuts of the split line of the housing.

Attention!
Do not let the lifting device touch the working surfaces of the shaft.

- Lift the shaft high enough to get sufficient room for assembly. Make sure the shaft does not move.
- Adjust the bottom half of the housing on the foundation on site. (See also the Technical Documentation for the Installation).

Insulated bearings

Chapter 7.1 provides information on the assembly of pedestal insulation of the bearings.

– Make sure that the bottom half of the housing (8) lies on the foot plate (15). This is the only way to avoid deflexion of the bearing.

Illustration 2: Foot plates of EG bearing

– Twist suitable foot screws loose into the holes (16) (about 4 turns) to fix the bottom half of the bearing safely into its place. For bearings with high thrust or radial loads use 8.8 quality screws.

Bearing size	45
Bore for foot screws (16) [mm]	62
Suitable foot screw thread	M 48
Wrench size [mm]	75
Torque value [Nm] μ_{tot} = 0,1 (lightly oiled)	4890

4.2 Fitting in the bottom half of the shell

– Apply some lubricant to the spherical seating (10) in the bottom half of the housing (8) and on the working surfaces of the shaft. Use the same type of lubricant as indicated for bearing operation
(see type plate).
– Place the bottom half of the shell (27) on the working surface of the shaft. Turn the bottom half of the shell (27) into the bottom half of the housing (8) with the split line surfaces of both halves in true alignment.

If the shell does not turn in easily, readjust the bottom half of the housing.

– Lower down the shaft till it sits on the bottom half of the shell (27).

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4.3 Fitting in the top half of the shell

- Apply some lubricant on the working surfaces of the shaft. Use the same type of lubricant as indicated for bearing operation (see type plate).
- Check if the engraved number (28) on the bottom half of the shell corresponds with the engraved number (30) on the top half of the shell.
- Place the top half of the shell (6) on the shaft; both engraved numbers (28), (30) should be on one side.

Attention!
An incorrectly placed shell could jam the shaft thus leading to the damage of both shaft and bearing.

Insulated bearings

In the case of bearings arranged for insulation monitoring, connect the black cable for insulation monitoring to the shell.

According to the bearing type, there are two possibilities of connection.

1. The black cable is provided with a cable connector.

- Plug the cable with the cable connector into the counterpart available on the top of the shell.
- Lead the cable through the cable gland in the bottom half of the housing and out of the bearing.
- Tighten the cable gland oil-tight.

2. The black cable is provided with an eyelet.

- Fasten the cable with the eyelet to the split line of the shell, by using one of the shell joint bolts.
- Lead the cable through the cable gland in the bottom half of the housing and out of the bearing.
- Tighten the cable gland oil-tight.

- Assemble both halves of the shell by carefully inserting the taper pins.
- Tighten up the screw (31) by using the following torque values:

Bearing size	45
Torque [Nm] μ_{tot} = 0,1 (lightly oiled)	330
Wrench size (Allen key) [mm]	17

- Check the split line of the shell by using a feeler gauge. The split line gap should be less than 0.05 mm. If the split line is greater than this, dismantle both top (6) and bottom (27) halves of the shell. Rework the split line surfaces of the top (6) and bottom (27) half of the shell with an oil rubber.

4.4 Assembly of the top half of the housing

– Check the true alignment of the split lines of the shell (6), (27) and bottom (8) half of the housing.

E..Y.

The positioning pin (4) in the top half of the housing fits in the corresponding positioning pin hole (7) in the shell.

– Check if the engraved numbers (26) and (33) on the top and bottom halves of the housing correspond.
– Clean the split line surfaces of the top and bottom halves of the housing (5) (8).
– Apply CURIL T over the whole surface of the split line of the bottom half (8) of the housing.

Please observe the instructions for the use of sealing compound.

– Lower the top half of the housing (5) vertically on the bottom half of the housing (8). The engraved numbers should be on the same side of the bearing. Lower the top half of the housing (5) till the split line of the housing is not visible any more.
– Gently hit the bottom half of the housing (8) with a nylon hammer, thus ensuring the alignment of the spherical seating.
– Insert the six screws (34). Tighten them crosswise by using the following torque values:

Bearing size	45
Torque value [Nm] μ_{tot} = 0,1 (lightly oiled)	2010
Wrench size (Allen key) [mm]	27

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Insulated bearings

Insulation monitoring

In the case of electric insulated bearings provided with insulation monitoring, the cable coming out of the housing must be connected in a professional manner.

According to the type supplied, please follow the assembly instructions given below.

a) The cable is very short and provided with a further cable connector at the end of it.
This cable is ready for connection to the housing.
The bottom half of the housing is provided with the counterpart.

– Plug the cable connector into the counterpart.

Attention!
This connection bypasses the electrical insulation of the bearing.
In the case of electric machines, make sure at least one bearing is electrically insulated.

To check the electrical insulation, interrupt the connection cable - housing. Check the electrical resistance with a suitable measuring instrument. Make sure that both bearings and the coupling are electrically insulated.

Insulation resistance is to be tested according to the procedures and acceptance criteria of DIN 31692-4.

b) The cable has a free end. In this case the customer has to make the connection.

Attention!
If only one bearing is insulated, the end of the cable must not be earthed.

Any further connection depends on the customer’s requirements related to the insulation monitoring and can not therefore be described here.

4.5 Alignment of the bearing

Attention!
If both a non-locating and a locating bearing are to be mounted on a shaft line, both bearings must be adjusted in turn. Start with adjustment of the locating bearing.

– Measure the distances (a, b, c, d) between shaft and lateral bores of the housing on both sides of the bearing.
  The measured values a and c must not differ by more than 0.3 mm on each side.

Illustration 3: Alignment of the bearing

In case of large clearances and disadvantageous tolerances the measured values b and d can differ by more than 0.3 mm on one side. If so the values b and d must be compared separately for both sides of the bearing. However, even in such a case the deviation of the measured value b on each side must not exceed 0.3 mm. The same is valid for value d.

– To do so always loose the screws of the split line of both bearings.
– Use lining plates for the height adjustment of the bottom half of the housing (8).
– After every measurement tighten up the split line screws again.

After adjustment of both bearings,

– Tighten up the plate screws or the nuts respectively with the necessary torque.
  The necessary torque values are depending on
- the used plate screws
- the material of the housing and the anchoring in the foundation
  (see also the Technical Documentation of the Installation).

– Check the alignment.
– Drill both holes for the positioning pin holes (17) and insert the positioning pins.

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5 Assembly of rigid labyrinth seal (Type 20, 22)

- Check if the engraved numbers (64) and (65) on the bottom half (63) and top half (59) of the rigid labyrinth seal correspond.
- Clean
  - the flange surfaces of the top half (59) and bottom half (63) of the rigid labyrinth seal
  - the split line surfaces of the top half (59) and bottom half (63) of the rigid labyrinth seal
  - The flange surfaces of the housing.
- Apply a uniform layer of sealing compound on the split lines of the bottom half (63) of the rigid labyrinth seal.
- Before assembling the rigid labyrinth seal place a new gasket into the flange surface of the housing. Make sure the nut edge is upwards.
- Place the top half (59) of the rigid labyrinth seal on the shaft and press slightly the bottom half (63) of the rigid labyrinth seal from below against it. Lightly push the rigid labyrinth seal completely into the housing.
- Tighten the screws (61) with the taper sleeves (66) to the rated torque: 10 Nm
- Place in parallel alignment the split line of the rigid labyrinth seal and the split line of the housing. Press the rigid labyrinth seal slightly from below against the shaft. Adjust the rigid labyrinth seal in such a way that the clearance "f" between the shaft and the rigid labyrinth seal at both split lines has the same figure.
- The resulting clearance is between 0.135 mm and 0.295 mm.

Illustration 4: Alignment of the rigid labyrinth seal

- Tighten the screws (60) by using the following torque values:

Bearing size	45
Torque [Nm]	40
Wrench size (Allen key) [mm]	8

6 Instructions for Assembly of Peripheral Equipment

6.1 Assembly of the oil supply equipment

The oil supply equipment together with the pressure, temperature and flow measuring instruments are usually provided by the user. The oil quantity and viscosity necessary for the operation of the bearing are indicated in the bearing calculations. This manual contains only indications on the connection points with the bearing. The connection bores for the oil inlets are on both lateral sides of the bearing, bolted with screw plugs. Remove only those plugs where pipes will be connected.

Connection conditions

	Pipelines	Flow speed	Indications
Inlet	Precision steel pipe DIN 2391 Steel pipe DIN 2448	about 1,5 m/s	Place the throttle valve in the inlet pipeline directly in front of the bearing
Outlet	Steel pipe DIN 2448	Max. 0,15 m/s	• 15° inclination • If 15° inclination is not possible enlarge correspondingly the cross sections of the pipeline directly behind the bearing. Too low inclination or / and too small cross-section lead to oil back pressure in the bearing. Leakage or overflowing are the consequences.

– Before starting assembly pickle all pipes which
  - have been welded
  - have been bent hot
  - are contained and rusty inside.

Warning of injury!

Please observe the instructions for the use of the pickle. Wear rubber gloves, rubber apron, rubber boots and safety glasses.

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Rinsing of the oil circuit

– Rinse the whole oil circuit to remove all impurities. The bearing must not be connected to the oil circuit during rinsing operations. The rinsing should be done before connecting the oil supply to the bearing or the bearing should be disconnected from the oil circuit. If this is not possible, dismantle the top half of the housing and remove the shells.

To avoid damage to the fittings:

– Remove all measuring terminal and switching fittings.
– Close all connections (see also the Technical Documentation of the Installation).
– Fill up the oil supply installation with lubricant. Use the type with the viscosity indicated on the bearing type plate.
– Start operating the oil supply installation. Collect the first charge of high contaminated oil separately. Continue rinsing till the lubricant contains no impurities any more.
– Drain off the oil supply installation completely. Clean the oil tank and the filters.

Warning of environmental pollution!
Please observe the instructions for the use of the lubricant. The manufacturer could provide information on waste oil disposal.

– Assemble all fittings.

Oil inlet

– Connect the inlet pipe at the connection hole (23) for the oil inlet. Seal with Teflon tape or liquid sealing compound.
Depending on the bearing size, the connection hole has the following threads:

Bearing size	45
Connection Oil inlet (23)	SAE 2“

If the bearing calculation specifies a separate supply source for the thrust parts:

– Connect the inlet pipes at the connection hole of the thrust part supply (25) on the lateral side of the bearing. Seal with Teflon tape or liquid sealing compound.

Oil outlet

E.Z.., E.X..

– Screw the oil outlet (19) tight to the housing. Connect the oil outlet pipe to the flange.

6.2 Temperature measurement

– Fix suitable feeler gauges:

- into one of the connection holes (22) for temperature measurements of the journal parts

Proceed as follows:

– Take out the screw plugs (24) from the connection holes.
– Place the thermo sensor into the bore by using Teflon tape or sealing compound.
– Connect the thermo sensor at the temperature monitoring equipment of the installation (see the Technical Documentation of the Installation for connecting and adjustment).

7 Bearing Insulation

71 Bearings with insulated spherical seating

These bearings are delivered insulated. The electrical insulation is guaranteed by:

- Plastic coating of the spherical seating (10)
- Shaft seals out of non-conducting materials
- Insulated positioning pin (4)
- Insulated screwed connections for thermometers.

It is not necessary to insulate the pipelines.

– Mark the insulated bearing with the delivered plate “Insulated shells". Mount the plate at a visible place by using two grooved drive studs.

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8 Operation

8.1 Fill up lubrication oil

Attention!
Make sure that no impurities get into the bearing.

– Tighten all screw plugs (24) in the connection holes (14), (18), (21), (22), (23), (25), (36) with the necessary torque values:

Screw plug threads	BSP ½“	BSP ¾“	BSP 1“
Torque [Nm] for plugs with moulded on plastic seal	40	60	110
Torque [Nm] for plugs with elastic seal	60	85	130
Wrench size (Allen key) [mm]	10	12	17

– Retighten the connection holes for oil inlet and outlet, and for the thrust parts (if existing). The necessary torque values depend on the screw connections used.

In case thermo sensor or Pt100 is used:

– Check if they are tight (according the manufacturer's instructions).

E.Z..
E.X..

– Fill up the oil supply installation with lubricant. Use a lubricant with the viscosity indicated for the bearing operation.
– Start operating the oil supply installation in order to fill the bearing with lubricant.

Attention!
- Not enough lubricant leads to temperature rises and thus to damages to the bearing.
- Too much lubricant leads to leakages. In the case of bearings with lubrication by loose oil ring too much lubricant could brake the oil rings considerably, thus leading to damages to the bearing.

8.2 Trial run

– Before the trial run, check the following:
- The way the oil supply system works (see also the Technical Documentation of the Installation).The lubricant quantity at the bearing oil inlet must correspond to the values indicated in the EDP-calculations.
- if the temperature monitoring equipment works

Attention!
Not enough lubricant leads to
- temperature rises and thus damage of the bearing.

Too much lubricant leads to
- leakages.

The bearing is ready for operation.

– Supervise the bearing during the trial run (5-10 operating hours).
Pay special attention to:

- the way the oil supply installation works(necessary lubricant quantity, lubricant temperature, lubricant pressure before entering the bearing)
- bearing temperature
- sliding noises of the shaft seals
- tightness
- Occurrence of inadmissible vibrations.

Attention!
If the bearing temperature exceeds the calculated value by more than 15 K (see bearing calculation) stop the installation immediately. Carry out an inspection of the bearing.

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9 Maintenance and Inspection

9.1 Maintenance Schedule

Maintenance work	Schedule
Exterior cleaning of the bearing	every 100-1000 hours
Oil change	Every 20.000 operating hours (please observe also the indications for the use of the lubricating oil). Periodic (at least annual) analysis of the lubricant to verify the specified properties.
Bearing inspection	During prevention maintenance work for the installation. Immediately if: • the bearing temperature exceeds 15 K over the indicated value (see the EDP-calculations) • unusual operating noises occur • unusual changes of the lubricating oil become visible
Maintenance work	Deadline

9.2 Oil Change

Risk of pollution!
Please observe the instructions for the use of the lubricating oil. The manufacturer can provide information on waste oil disposal.

- Shut down the installation and secure it against unintended operation.
- Take all necessary measures to collect the whole quantity of the lubricating oil.
- Let off the lubricating oil in still warm condition. Impurities and residues will thus be scavenged.
- Unscrew the hexagon head plug (14). Let off the lubricating oil and collect it.

Attention!
In case the lubricating oil contains unusual residues or is visibly changed, eliminate the causes. If necessary, carry out an inspection.

- Tighten the hexagon head plug (14) by using the following torque values:

Bearing size	45
Torque [Nm]	110

- Remove the screw plugs (21) from the oil filling hole (1).

Attention!
Make sure that no impurities get into the bearing.

Attention!
- Not enough lubricant leads to temperature rises and thus to damages to the bearing.
- Too much lubricant leads to leakages.

- Tighten the screw plug (21) into the oil filling hole (1) by using the following torque values:

Bearing size	45
Torque [Nm]	110

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9.3 Cleaning and Checking of the Bearing

Attention!
Use only non-aggressive detergents such as for instance
- VALVOLINE 150
- alkaline cleaning compounds (pH-value 6 to 9, short reaction time).

Warning of injury!
Please observe the instructions for the use of the detergents.

Attention!
Never use cleaning wool or cloth. Residues of such materials left in the bearing could lead to excessive temperatures.

– Clean the following parts thoroughly:

- top half of the housing (5)
- bottom half of the housing (8)
- top half of the shell (6)
- bottom half of the shell (27)
- sealing surfaces of the seal carrier

– Carry out a visual check of the wear condition of all bearing parts. The following graph provides information on the parts that must be replaced in case of wear. The right evaluation of the wear condition, especially of the working surfaces of the shell, implies a lot of experience. If in doubt, replace the worn part with new ones.

Bearing part	Wear condition	Maintenance proceedings
Shell	Scoring	Bearing temperature before inspection: • not increased - no new shells • increased - new shells
	White metal lining damaged	New shell
	Bow wave ridges	New shells
Shaft seal	Baffles broken or damaged	New shaft seal
Loose oil ring	Geometrical form (roundness, flatness) visibly changed	New loose oil ring

insulated bearings

– Check the insulating layer of the spherical seating (10) of the top half (5) and bottom half (8) of the housing. In case of damage contact the RENK-sales agency in charge.

9.4 Starting Operation after Inspection

- Fit the thermo sensors for temperature measurement of the journal part in the connection holes (22).
- Retighten all screw plugs in the connection holes (14), (18), (19), (22), (32) by using the following torque values:

Screw plug threads	G 3/8	G 1/2	G 3/4	G 1	G 1 1/4	G 1 1/2	G 2	G 2 1/2
Torque [Nm] for plugs with moulded on plastic seal	30	40	60	110	160	230	320	500
Torque [Nm] for plugs with elastic seal	34	60	85	130	240	300	330	410

- Retighten the connection holes for oil inlet and outlet and the bores for the thrust part oil supply. The torque depends on the threaded joints used.
- Retighten the foot bolts to the rated torque. The torque depends on:
  - the foot bolts used
  - the material the housing and the foundation are made of (see also the Technical Documentation of the Installation).
- Carry out a visual check of the assembled bearing.

E.Z..
E.X..

- Fill up the oil supply system with lubricant. Use the same type of lubricant as indicated on the type plate.
- Start operating the oil supply system in order to fill up the bearing with lubricant.
- Check
- The way the oil supply system works (see also the Technical Documentation of the Installation). The lubricant quantity at the bearing oil inlet must correspond to the values indicated in the EDP-calculations.
- If the temperature monitoring equipment works.

Attention!
Make sure that no impurities get into the bearing.

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– Tighten the screw plug into the oil filling hole (1) by using the following torque values:

Bearing size	45
Torque [Nm]	110

– Check if the temperature monitoring equipment works.

The bearing is ready for operation.

– Supervise the bearing during the trial run (5-10 operating hours).
  Pay special attention to:

- the way the oil supply installation works(necessary lubricant quantity, lubricant temperature, lubricant pressure before entering the bearing)
- bearing temperature
- sliding noises of the shaft seals
- tightness
- Occurrence of inadmissible vibrations.

Attention!
If the bearing temperature exceeds the calculated value of 15 K (see the EDP-bearing calculations) stop the installation immediately. Carry out an inspection of the bearing and find out the causes.

10 Bearing repair

Repairs are not necessary if bearings are operated correctly.

For serious Babbitt damage or journal resizing please contact RENK. It is not recommend to re-babbitting due to the potential problems with re-babbitting or increased babbitt thickness (resizing).

RENK maintains spares at their facilities that can be sized quickly upon request.

There are several service facilities throughout the world available. Please contact RENK for service support:

USA, KANADA, MEXICO
RENK Corporation
304 Tucapau Road
Duncan, S.C. 29334
USA
Phone: +1 864 433-0069
Fax: +1 864 433-0636
E-mail: bearings@renkusa.com

EUROPE, ASIA
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11 Corrosion Protection for Longer Standstill Periods

If you want to protect the bearing mounted on an installation against corrosion proceed as follows:

- Dismantle the bearing (see Chapter 3.3).
- Clean the bearing (see Chapter 9.3).
- Paint or spray the top half (6), and the bottom half (27) of the shell and the shaft with Tectyl 511.
- Assemble the bearing (see Chapter 4).
- Close all connection holes with screw plugs.
- Seal the gaps between
  - shaft seal and housing
  - shaft seal and shaft

  by using a self-adhesive, permanent tape.
- Spray some anti-corrosive such as Tectyl 511 or VALVOLINE into the bearing.

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- Put a bag of desiccant (silicate gel) inside. The desiccant absorbs the humidity and prevents the formation of condensation water inside the bearing.

In case the standstill period is **longer than 1/2 year**:

- Repeat the preservation procedures.
- Put a new bag of desiccant into the bearing.

In case the standstill period **lasts more years:**

- Dismantle the shells.
- Preserve and store the bearing parts.

12 Transport Protection

In case of a machine equipped with slide bearing type EG:

- Carry out the corrosion protection as described in Chapter 10 and apply enough lubricant on the working surfaces of the bearing.
- Pull the rotor against the sub-frame by using timbers placed across the shaft and press firmly into the bearing.

Illustration 5: Transport protection

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13 Glossary

Rigid labyrinth seal

The rigid labyrinth seal (type 20, 22) is used with slide bearings type E with high oil throughput. It corresponds to the protective system IP44, IP55 and is made of an aluminium alloy. The rigid labyrinth seal is built of two halves, flanged at the housing. The labyrinths that wipe out the lubricant are arranged into two groups. The first two labyrinths , installed inside keep back most of the lubricant. Five further labyrinths protect the bearing from outside. They prevent the lubricant overflow and the ingress of impurities. The overflow lubricant is collected into a chamber between the both groups of labyrinths. Through the return bores the lubricant flows back into the bearing.

Spherical seating

The spherical seating is a special feature enabling the alignment of the shell in the housing. The shell is seated on two spherical seatings. The advantages of the spherical seating are:

- easy at assembly
- good heat transfer from the shell to the housing
- suitable for such applications with high thrust or journal loads.

Instructions for Installation, Operation and Maintenance

Hydrostatic Jacking Device

Safety Instructions

Attention!
Do not operate the bearing without hydrostatic jacking device below the transition speed indicated in the EDP-calculation during shaft start-ups or run-downs as well as during turn speed operation for maintenance works. Following this advice, you prevent inadmissible operation condition causing damage to the bearing.

Start-Up After Standstill

- Start operation of the hydrostatic jacking device and check its function (see also the Technical Documentation of the Hydrostatic Jacking Device).

Oil Change

Risk of pollution!
Please observe the instructions for the use of the lubricant. Check with the supplier for information on waste oil disposal.

- Stop the bearing and ensure the machine against starting-up.
- Turn out the oil supply system / the hydrostatic jacking device.
- Collect the lubricant in suitable containers.

Let off the lubricant in still warm condition. Impurities and residues will thus be scavanged.

Proceed as follows:

- Let off and collect the lubricant of the oil supply system.
- Open the oil drain plugs. Let off the oil and collect it.

Attention!
In case the lubricating oil contains unusual residues or is visibly changed, investigate and eliminate the causes. If necessary, carry out inspection works.

- Close the drain plugs and ensure them against unintended draining of the oil.
- Fill up the oil supply system with lubricating oil. Use a lubricant with the viscosity indicated in the EDP-calculations.
- Start operating the oil supply system in order to fill up the bearing with lubricant.
- Start operating the hydrostatic jacking device.

Disassembly

- Shut down the oil supply system / hydrostatic jacking device. Ensure the machine against unintended operation.
- Please consult the Technical Documentation of the Oil Supply System /Hydrostatic Jacking Device for information on maintenance and inspection. Carry out all necessary maintenance and inspection works.
- Loosen the hydrostatic hose (A) by removing the pipe joint (C) from the adapter (B) on the inside of the bottom half of the bearing housing.
- Lift the shaft up to the point where shaft and bottom half of the shell do not touch each other any more. Use suitabale lifting gear. Protect the shaft against unintended movement.
- Turn out the bottom half of the shell from the housing and remove it.

Assembly

- Fix the hydrostatic hose (A) by screwing the pipe joint (C) into the adapter (B) on the inside of the bottom half of the housing.
- Retighten the flange screws of the oil inlet, oil outlet, oil drain plugs and of the hydrostatic jacking device.
- Start operating the hydrostatic jacking device and check its funtion (see also the Technical Documentation of the Hydrostatic Jacking Device).

Starting Operation After Inspection

Attention!

Not enough lubricant leads to temperature rises and thus to damage to the bearing.
Too much lubricant leads to leakages.

- Pay special attention to:
  - the way the oil supply system and the hydrostatic jacking device work (necessary lubricant quantity, lubricant temperature, lubricant pressure before entering the bearing)
  - bearing temperature
  - sliding noises of the shaft seals
  - tightness
  - occurence of inadmissible vibrations.

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Turbogenerator | Operating and Maintenance Manual

Components, Purchased Parts 8

Excitation

The excitation current for the rotor winding is obtained from a stationary excitation equipment. Slip-rings and carbon brushes are used to transmit the excitation current to the rotating generator rotor. For enabling a replacement of worn carbon brushes during operation at full speed and with live equipment, the brush gear comprises plug-in brush holders.

The plug-in brush holders are inserted in brush holder boxes which are attached to brush spindles. The brush holder is designed for a square brush 32 x 32 mm and with cable and cable lug and a brush length of 64 mm. The brush holder essentially comprises the holder body with brush guide, a telescopic plunger with thrust pin and a retaining arm with spring. For brush replacement, the retaining arm should be actuated to clamp the brush in the brush guide through a plastic plug and the brush holder released from the box.

1 Dip stick
2 Measuring notch
3 Telescopic plunger
4 Carbon brush cable
5 Retaining arm

Fig. 1 Plug-in brush holder with dip stick

The brush holder can now be withdrawn and is no longer alive. This permits a replacement of the carbon brush outside the machine. The brush holder is of unsymmetrical shape rendering impossible any wrong insertion. Any contact between the brush holder and the rotating slip-ring is precluded by a stop.

The wear of each individual carbon brush can be checked during operation by inserting a dip stick into the bore of the telescopic plunger. Easy brush replacement requiring no interruption of service permits a full utilization down to the wearing limit of each individual carbon brush.

Simple and rapid withdrawal of the plug-in brush holders enables the number of carbon brushes in operation to be matched to the respective excitation current for maintaining a favourable current density.

Fig. 2: Withdrawal of the plug-in brush holder

⚠ WARNING

Electrical current! Danger of injury.

Before you start any work, be sure to put on safety gloves approved for work on electrical installations which are life and energized in order to avoid injury by electrical current.

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Manufacturer: **RGS Technischer Service GmbH**

Documentation title: **DOCUMENTATION**
Brush Gear Ventilation

No. of pages: …

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Turbogenerator | Operating and Maintenance Manual

Protection and Monitoring 9

Protective Devices and Supervisory Equipment

Manufacturer: **Iris Power**

Documentation title: **Rotor Flux TFProbe™ and Large Air Gap FFProbe™**

- Product Brochure
- Installation Guide v5.1
  Extract:
  1. Introduction
  2. Technical Data
  5. Customer Support

No. of pages: 13

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IRIS POWER
A QUALITROL Company

Iris Power Magnetic Flux Probes

To detect rotor winding shorted turns

The Iris Power TFProbe™ and Iris Power FFProbe™ measure the air gap flux rate of change to detect shorted rotor winding turns in synchronous motors, hydrogenerators, and turbine generators. The probes, when connected to the portable Iris Power RFAII™ instrument, the Iris Power FluxTracII™ continuous monitor, or the Iris Power GuardII™ monitor with Flux Add-On, allow the user to monitor the health of motor and generator field windings on-line, periodically or continuously.

IRIS POWER TFProbe™

The Iris Power TFProbe has been primarily designed for hydrogenerators and other salient pole machines. This probe can also be used in round rotor machines with air gap size less than 50 mm. The probe sensing element is a small printed board (12 mm wide, 25 mm long, 4 mm thick) which is affixed to a stator tooth with epoxy. In many machine designs, it is even possible to install the probe without removing the rotor – a definite advantage in retrofit applications.

IRIS POWER FFProbe™

The Iris Power FFProbe is used in turbine generators with an air gap size 50 mm and over. The probe is installed with the rotor out and affixed to a stator wedge with non-metallic pins. The probe height is customized. The probe has a foldable layout to facilitate the rotor introduction without damaging the probe.

Probe appearance may vary.

FLUX PROBE INSTALLATION KIT

- Flux probe with attached shielded, twisted-pair, heat resistant cable (15 m long)
- Termination box (148 mm x 94 mm x 151 mm)
- Fixing material and grounding cable

Iris Power TFProbe, Iris Power FFProbe, Iris Power RFAII, Iris Power FluxTracII and Iris Power GuardII are trademarks of Qualitrol-Iris Power.

ORDER

M1511: TFProbe kit for air cooled salient pole machines with an air gap size less than 50mm. Includes TFProbe with a 15.2m probe cable, fiberglass termination box, sync sensor, epoxy and installation guide.

M1513: TFProbe kit for air cooled round rotor machines with an air gap size less than 50mm. Includes TFProbe with a 15.2m probe cable, fiberglass termination box, epoxy and installation guide.

M1521: TFProbe kit for hydrogen cooled machines with an air gap size less than 50mm. Includes TFProbe with a 15.2m probe cable, SMA-twisted pair adapter, hydrogen penetration kit, termination box, epoxy and installation guide.

M1515: FFProbe kit for air cooled round rotor machines with an air gap size 50mm and over. Includes FFProbe with a 15.2m probe cable, fiberglass termination box, epoxy and installation guide.

M1538: FFProbe kit for hydrogen cooled machines with an air gap size 50mm and over. Includes FFProbe with a 15.2m probe cable, SMAtwisted pair adapter, small hydrogen penetration kit, termination box, epoxy and installation guide.

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Rotor Flux TFProbe™ and Large Air Gap FFProbe™

Installation Guide

Document ID: Flux Probe Installation Guide

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This document only contains information regarding Flux Probe installation for non-hazardous locations. For information regarding hazardous locations, refer to the TFProbe Installation Guide for Hazardous Locations.

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Version 4.0 –Jan 2012 (new termination box)
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Version 2.3 –Nov 2008 (changes to Appendix 2)
Version 2.2 –Sept 2008 (changes to Appendix 1)
Version 2.0 – June 2008
Version 1.0 – April 2008

This document is a guideline only. It is not a machine-specific detailed Instruction.
The installation of the rotor Flux Probe must be directed by an IRIS POWER specialist or performed by a person trained in the installation procedure to ensure that the integrity of the system is not impaired.

Iris Power cannot take responsibility for installations performed by others.

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1. Introduction

This document only contains information regarding Flux Probe installation for non-hazardous locations. For information regarding hazardous locations, refer to the TFProbe Installation Guide for Hazardous Locations.

1.1. Overview

The Flux Probe is a sensor used to detect rotor magnetic flux in salient and non-salient pole rotor machines. Rotor magnetic flux can be measured while the machine is on-line, using portable or permanently installed instruments. Analysis of rotor flux measurements can indicate the number and position of rotor coils/poles with shorted turns. Iris offers two types of rotor flux probes – low profile TFProbe™, suitable for most applications, and high profile FFProbe™, used in machines with large air gap of 2" (50mm) or larger.

Since the TFProbe is installed on the top of the stator core tooth, it is at ground potential. The TFProbe does not have an electrical connection to the winding. No special precautions are required to protect or isolate the TFProbe when high potential testing of the stator winding, or testing of the core, is performed. This is also valid for the FFProbe, which is installed on the stator winding wedge and also doesn't have electrical connections to the winding.

Generally, one Flux Probe per machine is installed.

In order to be able to use the Iris flux monitoring instruments in automatic or continuous mode, it is desirable to have a rotor shaft position sensor. This signal is used to initiate data gathering during rotation and, particularly in salient pole machines, permit easy identification of the individual poles. This Installation Guide does not cover the physical details for installation of the shaft synchronization sensor since these will be unique to each situation. However, some general information is provided to assist in using either an existing synchronizing signal or, in the case of hydro-generators, the use of a sensor provided in the installation kit for that purpose. Please refer to the installation instructions provided with the part supplied and Section 6.1.

1.2. Description of TFProbe

The TFProbe measures the total magnetic flux of the rotating machine rotor and is a low voltage (usually 24 VAC or less but sometimes it may be higher) passive device that detects the electromagnetic energy from passing rotor coils/poles. Except for machines with a relatively large air gap (over 2" or 50mm) there is one size of the TFProbe for all applications, although the connection method is different for various machine designs. In air-cooled machines, the TFProbe is connected directly to the TFProbe Termination Box via an attached twisted-pair shielded connection cable. In hydrogen-cooled generators, the TFProbe cable is connected to two feed through connectors on a supplied penetration flange.

Figure 1-1 TFProbe

A finished TFProbe is black in color with 15m (50 ft.) of connection cable permanently attached (see Figure 1-1), which should be trimmed to the appropriate length on site. This cable is Teflon wrapped and insulated in order to operate at elevated temperatures. The cable has a fiberglass sleeve over a length of 1.2m (4ft) at the probe end to facilitate securing the cable within the stator. The flat side of the TFProbe is to be attached to the stator core surface at a suitable distance from the core end to avoid the effects of rotor retaining rings, magnetic wedges or salient pole end-plates. The cable is to be cut on site and terminated in the TFProbe Termination Box, or onto the inside terminals of a penetration flange if the machine is hydrogen-cooled.

1.3. Description of Large Air Gap FFProbe

Large air gap machines (over 50mm) require a different FF (Foldable Flux) Probe shown in Figure 1-2 (actual probe appearance may vary). Each probe is customized to the monitored machine during the probe manufacture. Installation of this probe is described in Section 6.4. Please contact Iris Technical Support for additional information regarding application and installation of the large air gap FFProbe; refer to Section 5.1 for contact information.

Figure 1-2 Large Air Gap FFProbe

Figure 1-3 TFProbe Dimensions (probe appearance may vary without notice)

1.4. Flux Probe Installation Locations

The TFProbe is intended for installation on a stator slot tooth. This is different from the large air gap (>50mm) probe that must be installed on a stator wedge although all other requirements for the probe location are the same for the both types. Here and in the following sections the TFProbe will be described; for more information regarding the large air gap FFProbe please refer to Section 6.4.

To avoid damage to the TFProbe (or FFProbe) during the rotor insertion or removal, it is recommended to install the TFProbe at the 3 or 9 o'clock position on the turbine end of the core for horizontal shaft machines as shown in Figure 1-4. The TFProbe may be installed on the exciter end as well, if it is more convenient due to the location of a penetration point, for example on hydrogen-cooled machines with IRIS Stator Slot Couplers (SSC) installed and using a common penetration. On vertical shaft machines, the TFProbe can be installed on the most convenient (easiest to access) top of a tooth position, that is at least 3 packets from the core end to avoid of fringing effect of the rotor.

Figure 1-4 Recommended TFProbe Installation Position

The TFProbe connection cable should be routed towards the end of the core and then to the location of the termination box outside the frame or, in the case of a hydrogen-cooled generator, to the casing penetration point. The cable is fixed (glued with epoxy) to the surface of the stator teeth and further routed to the back of the core and then to the penetration point.

To determine the location of the TFProbe at a specific position along the stator tooth some machine design details should be known. In general, the position of the probe should be in

an area of uniform magnetic flux; that is areas of the air gap that are not affected by fringing effect. For cylindrical rotors (generally 2 or 4 poles), the probe must be positioned such that it is beyond the magnetic influence of the rotor winding retaining ring. In addition, the TFProbe must **not** be located in a position facing any magnetic wedges that may be used around the circumference of a rotor in those slots containing the rotor winding. These are usually adjacent to the retaining ring and serve to control flux at the core ends. And finally, it must be positioned in a uniform core area which means it must be beyond any step iron at the core end.

The TFProbe is recommended to be placed not less than 12" (300mm) from the retaining ring or magnetic wedges. If the distance cannot be measured on the rotor and there are no magnetic wedges, it is generally acceptable to locate the TFProbe about 14" (350mm) from the edge of the stator core. If the actual distance that the retaining ring impinges on the core is unknown (it is generally only 2"-2.75" (50-70mm) or so) it is better to allow for error and position the TFProbe further into the core. Keep in mind that the objective is to place the probe at a location where air-gap flux is not influenced by anything except the rotor field winding.

There are some turbine generator rotor designs that make provisions for a special damper winding imbedded in the rotor pole face area. These are usually covered with magnetic wedges that extend the entire length of the rotor. This type of rotor design can easily be identified by dragging a small magnet along the length of each slot. Such slots will be in the pole face area and not where the field winding is. Magnetic wedges in these slots will not interfere with TFProbe operation and no special precautions are required for the flux probe location. In such cases the probe can be installed in the regular position of about 14" (350mm) from the core end.

For hydro generators and other machines with salient pole rotors the recommended flux probe location could be in any convenient position along the length of the stator except of the end core packets. This should be at least 6in (150mm) from the core end.

The location of the TFProbe Termination Box should satisfy the criteria of:

- The most convenient position relative to the machine casing penetration point
- The easiest access to the Termination Box for future testing
- The maximum length of the supplied connection cable

IRIS POWER

If the termination box has to be mounted further away than the length of the included 50ft/15m cable allows, please contact Iris Technical Support for installation options; refer to Section 5.1 for contact information.

In hydrogen-cooled generators, the location of the penetration will be selected based on the same criteria used in Iris SSC coupler installations. See Section 4.2 for more details.

2. Technical Data

Iris Flux Probes are passive devices that do not require external power to operate.

Voltage Output	
Iris Power TFProbe™	0 to 60VACp-p (depends on machine design and rotor air gap)
Iris FFProbe	0 to 3VACp-p (depends on machine design and rotor air gap)
Iris supplied sync sensor (only for salient pole machines)	0 to -23V, once pulse per revolution
Iris supplied sync sensor (only for salient pole reversible machines)	0 to -23V, three pulses per revolution

Rotor Air Gap	
Iris Power TFProbe™	5/32” to 2” (4 to 50mm)
Iris FFProbe	2” to 5” (50 to 130mm)
Rotor in-situ	Contact Technical Support (refer to Section 5.1)

Connections	
Flux Probe Termination Box:	
Terminal Block Connector	Conductor cross section 2.5mm^2 max, 12AWG max
Terminal Block Torque min/max	0.5/0.6Nm
Terminal Block Tool Blade Dimensions	0.6 x 3.5mm
Iris-Supplied Sync Sensor:	
Terminal Block Connector	Conductor cross section 2.5mm^2 max, 12AWG max
Terminal Block Torque min/max	0.5/0.6Nm
Terminal Block Tool Blade Dimensions	0.6 x 3.5mm
Flux Probe Signal Cable	Integrated with Flux Probe Teflon jacket 50’ (15.2m)
Iris-Supplied Sync Sensor	No cable is supplied. Customer to source Belden 88770 or similar

Operating Conditions	
Magnetic Flux Density	0 to 2.5Tesla
Operating Voltage of the Machine	3 to 30kV
Operating Temperature	-20 to 185°C (Flux Probes) -20 to 120°C (supplied epoxy)
Signal Cable Insulation Rating	600VAC

Synchronization Sensor	
Type	Capacitive, PNP open collector

Power Supply	-24VDC, supplied by test instrument
Sensing Distance	15mm
Enclosure	30mm screw-on; supplied in a custom adjustable metal bracket housing
Maximum Machine RPM	Refer to Section 6.1.5.
Target Material	PDM Rubber (60mm x 60mm x 9mm)

Supplied Chemicals	
For routing the signal cable	2-component thixotropic epoxy; MSDS is included in the installation kit
For temporary cable support	Cyanoacrylate; MSDS is included in the installation kit

Hydrogen Sealed Penetration	
Method of Application	Drill and weld
Drill Size to drill machine casing	1.93” (49.0mm) – Flux+SSC Penetration ¼” (6.3mm) – Flux-Only Penetration (pilot hole) 37/64” (14.75mm) – Flux-Only Penetration (through hole)
Material	Carbon Steel
Number of Sensors	1; can be combined with up to 12 Iris Power SSC sensors

Environmental Conditions	
Temperature (Operating/Storage)	-20°C to 120°C/-20°C to 75°C
Relative Humidity (Maximum Operating and Storage)	95% non-condensing
Installation Site	Sheltered and protected from direct sunlight

Enclosure	
Material	Fiberglass for air-cooled applications Metal for Hydrogen-cooled applications
Construction	Front Door with Continuous Hinge
Ratings	NEMA4X

Dimensions	
TFProbe	0.57” x 1.05” x 0.126” (14.5 x 26.8 x 3.2mm)
FFProbe – folded position Refer to Figure 6-21 for details	1.18” x 0.79” to 2.78” (30.0 x 20.0 x 70.6mm) MIN 1.18” x 0.79” to 6.20” (30.0 x 20.0 x 157.5mm) MAX
FFProbe – extended position Refer to Figure 6-21 for details	2.00” x 0.79” to 2.10” (50.8 x 20.0 x 53.3mm) MIN 2.00” x 0.79” to 5.52” (50.8 x 20.0 x 140.2mm) MAX
Air-Cooled Termination Box	Refer to Figure 3-7
Hydrogen-Cooled Termination Box	Refer to Figure 4-16 and Figure 4-21
Single Flux-Probe Penetration	Refer to Figure 4-21
Flux Probe and SSC Sensor Penetration	Refer to Figure 4-16

5. Customer Support

5.1. Technical Support

If you require additional technical support, please contact our Technical Support group. The following information is helpful for technical support (the more information about the issue, the faster the resolution):

- Contact data (name, email, phone)
- Product Information
- Symptoms
- On-site troubleshooting results

Contact Iris Power Technical Support at:

Email:	techsupport.iris@qualitrolcorp.com
Phone:	1-905-677-4824 Between 09:00 and 16:00 (GMT-5hrs)
Fax:	1-905-677-8498
Address:	Iris Power 3110 American Drive Mississauga, ON L4V1T2 Canada

5.2. Sales

If you would like to obtain additional installation materials, please contact our Sales Department.

Email:	sales.iris@qualitrolcorp.com
Phone:	1-905-677-4824 Between 09:00 and 15:00 (GMT-5hrs)
Fax:	1-905-677-8498
Address:	Iris Power 3110 American Drive Mississauga, ON L4V1T2 Canada

5.3. Product News and Updates

For firmware upgrades, software upgrades, product updates and new product information, visit our website www.irispower.com regularly. Contact our Sales Department for more information.

Iris Power Field Services

Iris Power offers installation supervision services for all of its monitoring systems. Our field specialist will arrive on site and provide supervision and installation training to staff directly involved in the installation process. A written installation report is also provided.

Iris Power Educational Services

Iris Power professional training (designed to achieve hands-on performance based objectives) prepares operations, maintenance, and engineering personnel to install, test, configure, operate and maintain Iris Power products.

Iris Power Accelerated Delivery

Iris Power provides accelerated delivery on many products and services including replacements, spare parts and repairs.

About Iris Power

Iris Power LP was established to provide high-quality products and services to improve maintenance capabilities for large motors and generators used by power utilities and heavy industries throughout the world. The goal of Iris Power LP is to provide excellent quality products that will continuously meet the stated and implied needs of our customers.

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Manufacturer: **Meggitt Sensing Systems SA**

Documentation title: **Proximity Measuring System**
TQ 402 and TQ 412 / EA 402 / IQS 450
Version 5 / 08.11.2012

Proximity transducer with signal conditioner – data sheet

No. of pages: 14

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MEGGITT
smart engineering for extreme environments

TQ 402 and TQ 412 / EA 402 / IQS 450

Proximity measuring system

FEATURES

- From the Vibro-Meter® product line
- TQ 402 conforms to API 670 recommendations
- Non-contact measurement system based on eddy current principle
- Certified for use in potentially explosive atmospheres
- 1 m, 5 m and 10 m systems
- Temperature compensated system
- Voltage or current output with protection against short circuits
- Frequency response: DC to 20 kHz (−3 dB)
- Measuring range: 2 or 4 mm
- Temperature range: −40 to +180 °C

IECEx

DESCRIPTION

This proximity system allows contactless measurement of the relative displacement of moving machine elements. It is particularly suitable for measuring the relative vibration and axial position of rotating machine shafts, such as those found in steam, gas and hydraulic turbines, as well as in alternators, turbo-compressors and pumps.

The system is based around a TQ 402 or TQ 412 non-contact transducer and an IQS 450 signal conditioner. Together, these form a calibrated proximity system in which each component is interchangeable. The system outputs a voltage or current proportional to the distance between the transducer tip and the target, such as a machine shaft.

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DESCRIPTION *(continued)*

The active part of the transducer is a coil of wire that is moulded inside the tip of the device, made of Torlon® (polyamide-imide). The transducer body is made of stainless steel. The target material must, in all cases, be metallic.

The transducer body is available with metric or imperial thread. The TQ 412 version is intended for reverse-mount applications. The TQ 402/412 has an integral coaxial cable, terminated with a self-locking miniature coaxial connector. Various cable lengths (integral and extension) may be ordered.

The IQS 450 signal conditioner contains a high-frequency modulator/demodulator that supplies a driving signal to the transducer. This generates the necessary electromagnetic field used to measure the gap. The conditioner circuitry is made of high-quality components and is mounted in an aluminium extrusion.

The TQ 402 and TQ 412 transducers can be matched with a single EA 402 extension cable to effectively lengthen the front-end. Optional housings, junction boxes and interconnection protectors are available for the mechanical and environmental protection of the connection between the integral and extension cables.

The proximity system can be powered by associated signal processing modules (for example, VM600 cards) or a rack power supply.

SPECIFICATIONS

Overall proximity system

Operation

Sensitivity
- *Ordering option B21* : 8 mV/µm (200 mV/mil)
- *Ordering option B22* : 2.5 µA/µm (62.5 µA/mil)
- *Ordering option B23* : 4 mV/µm (100 mV/mil)
- *Ordering option B24* : 1.25 µA/µm (31.2 µA/mil)

Linear measuring range (typical)
- *Ordering option B21* : 0.15 to 2.15 mm, corresponding to a −1.6 to −17.6 V output
- *Ordering option B22* : 0.15 to 2.15 mm, corresponding to a −15.5 to −20.5 mA output
- *Ordering option B23* : 0.3 to 4.3 mm, corresponding to a −1.6 to −17.6 V output
- *Ordering option B24* : 0.3 to 4.3 mm, corresponding to a −15.5 to −20.5 mA output

Linearity : See Performance curves on pages 4 and 5

Frequency response : DC to 20 kHz (−3 dB)

Interchangeability of elements : All components in system are interchangeable

Environmental – explosive atmospheres

Available in Ex approved versions for use in hazardous locations

Type of protection Ex i: intrinsic safety		
Europe	EC type examination certificate	LCIE 11 ATEX 3091 X II 1G (Zones 0, 1, 2) Ex ia IIC T6 to T3 Ga
International	IECEx certificate of conformity	IECEx LCI 11.0061X Ex ia IIC T6 to T3 Ga
North America	cCSAus certificate of compliance	1514309 Class I, Divisions 1 and 2, Groups A, B, C, D Ex ia

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SPECIFICATIONS *(continued)*

Type of protection Ex nA: non-sparking apparatus		
Europe	Voluntary type examination certificate	LCIE 11 ATEX 1010 X II 3G (Zone 2) Ex nA II T6 to T3 Gc
International	IECEx certificate of conformity	IECEx LCI 11.0063X Ex nA II T6 to T3 Gc
North America	cCSAus certificate of compliance	1514309 Class I, Division 2, Groups A, B, C, D

For specific parameters of the mode of protection concerned and special conditions for safe use, please refer to the certificates that are available from Meggitt SA on demand.

System calibration

Calibration temperature : +23°C ± 5°C
Target material : VCL 140 steel (1.7225)

Note: If special calibration is required, please define the alloy precisely or supply a sample of alloy (min. Ø50 mm / 1 cm thick) according to Meggitt Sensing Systems' drawing number PZ 7009/1.

Total system length

The total system length (TSL) is the sum of the length of the TQ 4xx transducer's integral cable and the length of the EA 40x extension cable. The supported TSLs can be obtained from different combinations of cables.

Total system lengths

- 1 m : 1.0 m integral cable with no extension cable
- 5 m : 0.5 m integral cable + 4.5 m extension cable
  1.0 m integral cable + 4.0 m extension cable
  1.5 m integral cable + 3.5 m extension cable
  2.0 m integral cable + 3.0 m extension cable
  5.0 m integral cable with no extension cable
- 10 m : 0.5 m integral cable + 9.5 m extension cable
  1.0 m integral cable + 9.0 m extension cable
  1.5 m integral cable + 8.5 m extension cable
  2.0 m integral cable + 8.0 m extension cable
  5.0 m integral cable + 5.0 m extension cable
  10.0 m integral cable with no extension cable

The combination of cables selected for a particular total system length depends on the application. For example, to obtain the optimum location for the separation between the integral and extension cables or to eliminate the requirement for an extension cable.

Total system length trimming

Due to the characteristics of the coaxial cable, an "electrical trimming" of the nominal length of extension cables is necessary to optimize the system performance and the transducer interchangeability.

TSL for a 1 m measuring chain : 0.9 m minimum
TSL for a 5 m measuring chain : 4.4 m minimum
TSL for a 10 m measuring chain : 8.8 m minimum

SPECIFICATIONS *(continued)*

Performance curves for TQ 402 and TQ 412 with IQS 450 (ordering options B21 and B22)

Proximity transducer: TQ 402 / TQ 412
Signal conditioner: IQS 450 (ordering option B21 and B22)
Standard target material: VCL 140 (1.7225)
Equivalent materials: A 37.11 (1.0065), AFNOR 40 CD4, AISI 4140

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SPECIFICATIONS *(continued)*

Performance curves for TQ 402 and TQ 412 with IQS 450 (ordering options B23 and B24)

Proximity transducer:	TQ 402 / TQ 412
Signal conditioner:	IQS 450 (ordering option B23 and B24)
Standard target material:	VCL 140 (1.7225)
Equivalent materials:	A 37.11 (1.0065), AFNOR 40 CD4, AISI 4140

SPECIFICATIONS *(continued)*

TQ 402 and TQ 412 proximity transducers

General

Transducer input requirements	: High-frequency power source from an IQS 450 signal conditioner

Environmental

Temperature ranges	
• *Transducer*	: −40 to +180 °C with drift < 5% (operation). +180 to +220 °C with drift > 5% (short-term survival).
• *Transducer and cable*	: **−40 to +195 °C if used in an Ex zone**
• *Cable and connector*	: −40 to +200 °C
• *Heat shrinkable sleeve (modified Polyolefin)*	: −40 to +135 °C
Protection rating (according to IEC 60529)	: The entire transducer assembly is rated IP68 (transducer tip, integral cable and self-locking miniature coaxial connector, including all joins)
Vibration (according to IEC 60068-2-26)	: 5 g peak between 10 and 500 Hz
Shock acceleration (according to IEC 60068-2-27)	: 15 g peak (half sine-wave, 11 ms duration)

Physical characteristics

Transducer construction	: Wire coil Ø8 mm, Torlon (polyamide-imide) tip, encapsulated in stainless steel body (AISI 316L) with high-temperature epoxy glue
Integral cable	: FEP covered 70 Ω coaxial cable, Ø3.6 mm
• *Option*	: Flexible stainless steel hose (protection tube). Note: The hose is not leak-tight and the heat-shrinkable sleeve is splash-proof only.
Connector	: Self-locking miniature coaxial connector (male). Note: When connecting, this should be hand-tightened, until locked.

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SPECIFICATIONS *(continued)*

IQS 450 signal conditioner

Output

Voltage output, 3-wire configuration

- *Voltage at min. gap* : −1.6 V
- *Voltage at max. gap* : −17.6 V
- *Dynamic range* : 16 V
- *Output impedance* : 500 Ω
- *Short-circuit current* : 45 mA

Current output, 2-wire configuration

- *Current at min. gap* : −15.5 mA
- *Current at max. gap* : −20.5 mA
- *Dynamic range* : 5 mA

Output capacitance : 1 nF
Output inductance : 100 µH

Supply

Voltage output, 3-wire configuration

- *Voltage* : −20 V to −32 V*
- *Current* : −13 ± 1 mA (−25 mA max.)

Current output, 2-wire configuration

- *Voltage* : −20 V to −32 V*
- *Current* : −15.5 to −20.5 mA

Supply input capacitance : 1 nF
Supply input inductance : 100 µH

Environmental

Temperature ranges

- *Operation* : −35 to +85°C*.
  0 to +70°C if used in an Ex zone.
- *Storage* : −40 to +85°C

Humidity : Max. 95% non condensing.
100% condensing (not submerged).

Protection rating (according to IEC 60529) : IP40

Vibration (according to IEC 60068-2-26) : 2 g peak between 10 and 55 Hz

Shock acceleration (according to IEC 60068-2-27) : 15 g peak (half sine-wave, 11 ms duration)

Physical characteristics

Construction material : Injection moulded aluminium

*See Thermal considerations on page 8.

SPECIFICATIONS *(continued)*

Electrical connections

Input	: Self-locking miniature coaxial connector (female). Note: When connecting, this should be hand-tightened, until locked.
Output and power	: Screw terminal strip

Weight

Standard version	: 140 g (approx.)
Ex version	: 220 g (approx.)

Thermal considerations

The IQS 450 signal conditioner will operate at ambient temperatures as high as 85 °C, but to do so, it requires derating of the maximum input voltage. The IQS 450 must operate between the minimum supply voltage and the maximum supply voltage, as shown on the following graph.

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MECHANICAL DRAWINGS AND ORDERING INFORMATION

TQ 402 proximity transducer

Ordering number:

111 - 402 - 000 - 013 - A - B - C - D - E - F - G - H

Environment (A)	
Standard	1
Explosive Ex i	2
Explosive Ex nA	3

Body thread (B)	
M10 x 1	1
M14 x 1.5	2
M16 x 1.5	3
3/8″-24UNF	6
5/8″-18UNF	7
1/2″-20UNF	8

Body length (C)	
Each 1 mm, from 20 to 250 mm	
20 mm min.	020
250 mm max.	250

Unthreaded length (D)	
Each 1 mm, from 0 to 230 mm	
0 mm min.	000
230 mm max.	230

Integral cable length (E)*	
0.5 m	005
1.0 m	010
1.5 m	015
2.0 m	020
5.0 m	050
10 m	100

Total system length (H)*	
01	1 m
05	5 m
10	10 m

Flexible hose (G)	
Each 0.1 m, from 0 to 9.8 m	
000	None
001	0.1 m min.
098	9.8 m max.

Protection (F)		
	Cable	Connector
0	None	None
1	Flexible hose	None
2	Flexible hose with sleeve	None
3	Movable flexible hose	None
4	Movable flexible hose with sleeve	None
5	None	IP 172
6	Flexible hose	IP 172
7	Flexible hose with sleeve	IP 172
8	Movable flexible hose	IP 172
9	Movable flexible hose with sleeve	IP 172

Notes
All dimensions are in mm unless otherwise stated.
*The “Total system length (H)” = Integral cable length + Extension cable length.
*For information on combining integral and extension cables to obtain a particular total system length, see Total system length on page 3.
*For information on cable length tolerances, see Total system length trimming on page 3.

MECHANICAL DRAWINGS AND ORDERING INFORMATION *(continued)*

TQ 412 proximity transducer

Ordering number: 111 - 412 - 000 - 013 – A – B – E – F – G – H

Environment (A)	
Standard	1
Explosive Ex i	2
Explosive Ex nA	3

Body thread (B)	
M10 x 1	1
3/8″-24UNF	6

Total system length (H)*	
01	1 m
05	5 m
10	10 m

Integral cable length (E)*	
0.5 m	005
1.0 m	010
1.5 m	015
2.0 m	020
5.0 m	050
10.0 m	100

Protection (F)	
None	0
Flexible hose	1
Flexible hose with sleeve	2
Movable flexible hose	3
Movable flexible hose with sleeve	4

Flexible hose (G)	
	Each 0.1 m, from 0 to 9.8 m
000	None
001	0.1 m min.
098	9.8 m max.

Notes
All dimensions are in mm unless otherwise stated.
*The “Total system length (H)” = Integral cable length + Extension cable length.
*For information on combining integral and extension cables to obtain a particular total system length, see Total system length on page 3.
*For information on cable length tolerances, see Total system length trimming on page 3.

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MECHANICAL DRAWINGS AND ORDERING INFORMATION *(continued)*

EA 402 extension cable

Ordering number: 913 - 402 - 000 - 013 - A - E - F - G

Environment (A)	
Standard	1
Explosive Ex i	2
Explosive Ex nA	3

Flexible hose (G)	
	Each 0.1 m, from 0 to 9.3 m
000	None
001	0.1 m min.
093	9.3 m max.

Extension cable length (E)*	
3.0 m ±150 mm	030
3.5 m ±150 mm	035
4.0 m ±150 mm	040
4.5 m ±150 mm	045
5.0 m ±200 mm	050
8.0 m ±300 mm	080
8.5 m ±300 mm	085
9.0 m ±350 mm	090
9.5 m ±350 mm	095

Protection (F)		
Cable	Connector	
None	None	0
Flexible hose	None	1
Flexible hose with sleeve	None	2
None	IP 172	5
Flexible hose	IP 172	6
Flexible hose with sleeve	IP 172	7

Notes
All dimensions are in mm unless otherwise stated.
*For information on combining integral and extension cables to obtain a particular total system length, see Total system length on page 3.
*For information on cable length tolerances, see Total system length trimming on page 3.

MECHANICAL DRAWINGS AND ORDERING INFORMATION *(continued)*

IQS 450 signal conditioner

Ordering option I0

Ordering option I1

Note: All dimensions are in mm unless otherwise stated.

Ordering number: 204 - 450 - 000 - 002 - A - B - H - I

Environment (A)	
Standard	1
Explosive Ex i	2
Explosive Ex nA	3

Installation (I)	
0	Signal conditioner only
1	Signal conditioner assembled on mounting adaptor

Measuring range	Sensitivity (B)	
2 mm	8 mV/µm	21
	2.5 µA/µm	22
4 mm	4 mV/µm	23
	1.25 µA/µm	24

Total system length (H)	
01	1 m
05	5 m
10	10 m

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MOUNTING ACCESSORIES

ABA 15x	Industrial housings	: Refer to corresponding data sheets
IP 172	Interconnection protection	: Refer to corresponding data sheet
JB 118	Junction box	: Refer to corresponding data sheet
KS 107	Flexible conduit	: Refer to corresponding data sheet
MA 130	Mounting adaptor	: See below
PA 15x	Probe mounting adaptors	: Refer to corresponding data sheets
SG 1xx	Cable feedthroughs	: Refer to corresponding data sheets

MA 130 mounting adaptor

Mechanical drawing

Note: All dimensions are in mm unless otherwise stated.

Ordering number : 809-130-000-011

Headquartered in the UK, Meggitt PLC is a global engineering group specializing in extreme environment components and smart sub-systems for aerospace, defence and energy markets.

Meggitt Sensing Systems is the operating division of Meggitt specializing in sensing and monitoring systems, which has operated through its antecedents since 1927 under the names of ECET, Endevco, Ferroperm Piezoceramics, Lodge Ignition, Sensorex, Vibro-Meter and Wilcoxon Research. Today, these operations are integrated under one strategic business unit called Meggitt Sensing Systems, headquartered in Switzerland and providing complete systems, using these renowned brands, from a single supply base.

The Meggitt Sensing Systems facility in Fribourg, Switzerland was formerly known as Vibro-Meter SA, but is now Meggitt SA. This site produces a wide range of vibration and dynamic pressure sensors capable of operation in extreme environments, leading-edge microwave sensors, electronics monitoring systems and innovative software for aerospace and land-based turbo-machinery.

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Manufacturer:	**Schniewindt GmbH**
Screw-in Heating Body Type:	ERCH III / 38
Voltage Range:	380 V AC – 660 V AC
Frequency:	50/60 Hz
Y-Connection	
Output Power:	1600 W
Surface Load:	2.5 W/cm²
Degree of Protection:	IP 54

Manufacturer:	**Meggitt Sensing Systems SA**
Documentation title:	**Piezoelectric Accelerometer CA 202** Data sheet version 7 / 16.08.2010
No. of pages:	4
Documentation title:	**Signal Conditioner IPC 704** Data sheet 06.06
No. of pages:	10

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Vibro-Meter

CA 202

Piezoelectric Accelerometer

FEATURES

- Industrial vibration monitoring
- High sensitivity
- Differential output
- Hermetically welded
- Internal case insulation
- Integral cable
- Certified for use in potentially explosive atmospheres
- Frequency response:
  0.5 Hz to 5000 Hz
- Sensitivity:
  100 pC/g
- Temperature range (operational):
  −55 °C to +260 °C

DESCRIPTION

The CA 202 accelerometer features a symmetrical shear mode polycrystalline measuring element which has internal case insulation. The transducer is designed for heavy-duty industrial vibration monitoring and measurement. The accelerometer is fitted with an integral cable protected by a flexible stainless steel tube welded to the case.

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SPECIFICATIONS

GENERAL

Input power requirements	: None
Signal transmission	: 2-pole system insulated from casing, charge output
Signal processor	: Charge amplifier

OPERATING

(at +23 °C ± 5 °C)

Sensitivity (at 120 Hz)	: 100 ± 5 pC/g
Dynamic measuring range (random)	: 0.01 g to 400 g peak
Overload capacity (spikes)	: Up to 500 g peak
Linearity	: ± 1% between 0.01 g and 20 g peak, ± 2% up to 400 g peak
Transverse sensitivity	: ≤ 3%
Resonant frequency (mounted)	: 20 kHz nominal
Frequency response	: ± 5% between 0.5 Hz and 5000 Hz (lower cut off frequency is determined by conditioner used)
Internal insulation resistance	: Min. 10^9 Ω
Capacitance (nominal)	
• *Pole to pole*	: 4500 pF for transducer + 105 pF/m of cable
• *Pole to casing*	: 10 pF for transducer + 210 pF/m of cable

ENVIRONMENTAL

Temperature range	
• *Transducer*	: −55 °C to +260 °C operation
	: −70 °C to +280 °C survival
• *Cable*	: −55 °C to +200 °C operation
	: −62 °C to +250 °C survival
Temperature error	
• *−55 °C to +23 °C*	: 0.25 %/°C
• *+23 °C to +200 °C*	: 0.08 %/°C
• *+200 °C to +260 °C*	: 0.25 %/°C
Shock acceleration	: ≤ 1000 g peak (half sine wave, 1 ms duration)
Explosive atmospheres	: Available in Ex version
• *EC type examination certificate*	: LCIE 02 ATEX 6179 X II 1 G (Zones 0, 1, 2) Ex ia IIC T6 to T1
• *Voluntary type examination certificate*	: LCIE 09 ATEX 1044 X II 3G (Zone 2) Ex nA II T6 to T2

⚠ **For specific parameters of the mode of protection concerned and special conditions for safe use, please refer to the appropriate "EC type examination certificate". These certificates are available from Vibro-Meter SA on demand.**

Corrosion, humidity	: Stainless austenitic steel, hermetically welded
Base strain sensitivity	: 0.1 x 10^{-3} g/με at 250 με peak-peak

SPECIFICATIONS *(Continued)*

MECHANICAL

Weight	
• *Accelerometer (nominal)*	: 250 g
• *Cable*	: 135 g/m
Cable	: 2 pole twisted and shielded
Mounting	: 4 Allen screws, size M6x35, with M6 spring-lock washers, screw torque 15 Nm. No need for electrical insulation of mounting surface.

CALIBRATION

Dynamic calibration at factory at 5 g peak and 120 Hz (+23 °C). No subsequent calibration necessary.

MECHANICAL DRAWING

ORDERING INFORMATION

To order please specify:

Type	Designation	Ordering Number
CA202	Standard version, 3 m cable length	144-202-000-205
	Standard version, 6 m cable length	144-202-000-215
	Standard version, 11 m cable length	144-202-000-225
	Standard version, 20 m cable length	144-202-000-235
	Ex version, 3 m cable length	144-202-000-105
	Ex version, 6 m cable length	144-202-000-115
	Ex version, 11 m cable length	144-202-000-125
	Ex version, 20 m cable length	144-202-000-135

MOUNTING ACCESSORIES

MA 133 Thermal insulation kit : See drawing 809-133-000V011

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MEGGITT
smart engineering for extreme environments

Vibro-Meter

IPC 704

Signal conditioner

FEATURES

- For CA piezoelectric accelerometers and CP dynamic pressure transducers
- Configurable high-pass and low-pass filters
- Frequency range: 0.5 Hz to 20 kHz
- Optional integrator to give a velocity output
- Optional 2-wire current or 3-wire voltage transmission
- Certified for use in potentially explosive atmospheres
- A range of installation options are available

DESCRIPTION

The IPC 704 signal conditioner converts the charge-based signal from a piezoelectric transducer into a current or a voltage signal. This current or voltage signal is transmitted to the processing electronics via a standard 2-wire or 3-wire transmission cable.

The current modulation technique allows transmission over a distance of up to 1 km. A GSI galvanic separation unit is required for this configuration.

The electronic circuitry of the IPC 704 signal conditioner is incorporated into a moulded aluminium enclosure. The signal conditioner has configurable high-pass and low-pass filters and an optional integrator to give a velocity output. Furthermore, RFI filters protect the input and output against radio-frequency interference and other electromagnetic influences.

A range of installation options are available for the IPC 704 signal conditioner, including:

- A polyester enclosure providing environmental protection against dust, oil and water jets
- A mounting adaptor allowing the IPC 704 signal conditioner to be mounted on a DIN rail

BLOCK DIAGRAM

SPECIFICATIONS

ENVIRONMENTAL CHARACTERISTICS

Specifications according to iec 68.2 recommendations

General

Temperature	
• *Operation*	-30°C to +80°C
• *Storage*	-40°C to +85°C
Humidity	Max. 95% non-condensing
Protection class	IP 40 according to IEC classification
Vibration	2 g peak between 10 and 500 Hz
Shock	15 g peak, 11 ms, half-sine pulse

Signal conditioner with industrial housing (ordering option G1)

Protection class	IP 66 according to EN 60529
Impact resistance	> 4 mJ/mm^2 (DIN 53453)
Chemical resistance	Good resistance to seawater, acids, alkaline solutions, gasoline and oils
Flammability	UL94V-0 self-extinguishing

Explosive atmospheres

Without industrial housing (ordering options A2 and G0/G2)

• *EC type examination certificate*	LCIE 02 ATEX 6085 X II 2 G (Zones 1, 2) EEx ib IIC T6 to T4
• *cCSAus certificate*	cCSAus 1243981 Class I, Div 1, Groups A, B, C, D Ex ia (T6 to T4)

With industrial housing and stuffing glands (ordering option A2 and G1)

Industrial housing

Available in Ex-approved version for use in hazardous locations

• *Environment*	II 2 G (Zones 1, 2)EEx ia IIC T6
• *Surface resistivity for Ex version*	< 10^9 Ω (DIN 53482)

SPECIFICATIONS *(Continued)*

Stuffing glands

Available in Ex-approved version for use in hazardous locations

- *Environment* II 2 G/D (Zones 1, 2) EEx e II

For specific parameters of the mode of protection concerned and special conditions for safe use, please refer tothe "EC type examination certificate" that is available from Vibro-Meter SA on demand.

TRANSFER CHARACTERISTICS (ORDERING OPTION B)

Transfer without integrator	0.1 to 10 mV/pC or 0.1 to 10 μA/pC
Transfer with integrator	981 to 98 100 mV/(pC.s) or 981 to 98 100 μA/(pC.s)
Linearity error	≤ 0.2%
Temperature stability	100 ppm/°C typical

INPUT CHARACTERISTICS (ORDERING OPTION C)

Matching transducer	Any piezoelectric transducer, symmetrical or non-symmetrical, case grounded or insulated
Dynamic range	100 000 pC peak
Input sensitivity	Accelerometer: 10 to 200 pC/g Dynamic pressure transducer: 10 to 2000 pC/bar
Charge amplifier	Symmetrical
RFI filter	Symmetrical LC network
Resistance	≥ 50 kΩ (transducer and cable)
Capacitance	≤ 10 nF (transducer and cable)

OUTPUT CHARACTERISTICS (ORDERING OPTION D)

Voltage	18 to 30 V_{DC}
Current	Max. 25 mA
RFI filter	Symmetrical LC network

2-wire current transmission

• *Dynamic signal*	Max. ±5 mA peak
• *Standing current*	12 mA ± 0.5 mA
• *Electrical connection*	+24 V = "+", COM = "-"
• *Output sensitivity*	See ordering information
• *Max. dynamic range*	5 mAp / output sensitivity

3-wire voltage transmission

• *Dynamic signal*	Max. ±5 V peak
• *Standing voltage*	7.5 V ± 0.2 V
• *Output sensitivity*	See ordering information
• *Output impedance*	750 Ω (3-wire configuration)
• *Max. dynamic range*	5 Vp / output sensitivity

The 3-wire voltage output without galvanic separation unit should only be used with piezoelectric transducers which are insensitive to frame voltage. Dynamic pressure transducers should always be used with a GSI galvanic separation unit.

SPECIFICATIONS *(Continued)*

FILTER CHARACTERISTICS (ORDERING OPTIONS E AND F)

High-pass filter

- *Cut-off frequencies (at -3 dB)* 0.5, 1, 2, 5 and 10 Hz
- *Slope* 24 dB/octave (4th order)

When selecting a high-pass filter, be careful to select an appropriae cut-off frequency of the change amplifier (see graphs below).

Low-pass filter

- *Cut-off frequencies (at -1 dB)* 200, 500, 1000, 2000, 5000, 10 000, 20 000 Hz
- *Slope* 12 dB/octave (2nd order)

Charge amplifier cut-off frequencies versus transfer unit

a) Accelerometer (acceleration output)

b) Accelerometer (velocity output)

C) Pressure sensor

SPECIFICATIONS *(Continued)*

PHYSICAL CHARACTERISTICS

Signal conditioner without industrial housing (ordering option G0)

- *Enclosure* — Injection moulded aluminium, anodized
- *Mounting* — 2 or 4 x M4 screws
- *Weight* — Standard version: 170 g
  Exi version: 250 g (the signal conditioner is moulded into silicon)
- *Dimensions* — Refer to mechanical diagram
- *Electrical connection (input)* — 3 screw terminals - wire section max. 2.5 mm^2
- *Electrical connection (output)* — 3 screw terminals - wire section max. 2.5 mm^2

Signal conditioner with industrial housing (ordering option G1)

Enclosure

- *Material* — Polyester reinforced with glass fibre
- *Cover seal* — Silicone gasket
- *Mounting* — M6 x 30 mm Allan screws
- *Dimensions* — Refer to mechanical diagram

Input/output stuffing glands (ordering options H and I)

- *Type* — See ordering information
- *Material* — Nickel-plated brass with viton seal

Signal conditioner with mounting adaptor (ordering option G2)

Universal DIN rail holder type — TSH35
DIN rail type — EN50022-35 x 7.5 or EN50022-35 x 15

MECHANICAL DIAGRAMS

Signal conditioner without industrial housing (ordering option G0)

MECHANICAL DIAGRAMS *(Continued)*

Signal conditioner with industrial housing (ordering option G1)

Signal conditioner with mounting adaptor (ordering option G2)

ORDERING INFORMATION

To order please specify:

Type and designation: IPC 704 signal conditioner

Ordering number: Refer to the ordering instructions below

Ordering number :
244 - 704 - 000 - 042 - A B C D E F G H I

ENVIRONMENT (A)	
Standard	1
Explosive	2

TRANSFER UNIT (B)		
INPUT	OUTPUT	
pC/g	µA/g	01
pC/g	mV/g	02
pC/g	µA/mm/s	03
pC/g	mV/mm/s	04
pC/g	µA/in/s	05
pC/g	mV/in/s	06
pC/bar	µA/mbar	07
pC/bar	mV/mbar	08
pC/psi	µA/psi	09
pC/psi	mV/psi	10

INPUT SENSITIVITY (C)
Sensor sensitivity

OUTPUT SENSITIVITY (D)
Value per mechanical unit

HP FILTER (E)
Value in Hz

High-pass filter
0.5 Hz
1 Hz
2 Hz
5 Hz
10 Hz

LP FILTER (F)
Value in Hz

Low-pass filter
200 Hz
500 Hz
1000 Hz
2000 Hz
5000 Hz
10 000 Hz
20 000 Hz

INSTALLATION (G)	
Without industrial housing	0
With industrial housing	1
Mounted on mounting adaptor	2

	INPUT CABLE FITTING (H)	
(1)	NO HOLE	0
	M16 x 1.5 with plug	1
	Cable gland M12 x 1.5 for cable Ø4 - Ø8 mm	3
	Cable gland M16 x 1.5 for cable Ø6 - Ø11 mm	4

	OUTPUT CABLE FITTING (I)	
(1)	NO HOLE	0
	M16 x 1.5 with plug	1
	Cable gland M12 x 1.5 for cable Ø4 - Ø8 mm	3
	Cable gland M16 x 1.5 for cable Ø6 - Ø11 mm	4
	Adapter M16 x 1.5/PG9 with plug to be used for KS 106 (flexible protection tube)	8

(1): With option H0, only option I0 is available. For special options (ie. H1/3/4 and I0 or I1/3/4/8 and H0), please contact your nearest Vibro-Meter sales office.

ACCESSORIES

Mechanical diagram: ABA 160 industrial housing

Ordering information: ABA 160 industrial housing

Type and designation:	ABA 160 industrial housing
Ordering number:	Refer to the ordering instructions below

Ordering number :
830 - 160 - 000 - 111 – A [ ] — B1 [ ] [ ] — C1 [ ] [ ]

ENVIRONMENT (A)	
Standard polyester	1
Explosive polyester	2

	CABLE FITTING INPUT (B)	
(1)	NO HOLE	00
	M16 x 1.5 with plug	01
	Cable gland M12 x 1.5 for cable Ø4 - Ø8 mm	03
	Cable gland M16 x 1.5 for cable Ø6 - Ø11 mm	04

	CABLE FITTING OUTPUT (C)	
(1)	NO HOLE	00
	M16 x 1.5 with plug	01
	Cable gland M12 x 1.5 for transducer cable Ø4 - Ø8 mm	03
	Cable gland M16 x 1.5 for transducer cable Ø6 - Ø11 mm	04
	Adapter M16 x 1.5/PG9 to be used for KS 106 (flexible protection tube)	08

(1): With option B00, only option C00 is available. For special options (ie. B01/03/04 and C00 or C01/03/04/08 and B00), please contact your nearest Vibro-Meter sales office.

ACCESSORIES *(Continued)*

Mechanical diagram: MA 130 mounting adaptor

Ordering information: MA 130 mounting adaptor

Type and designation	MA 130 DIN rail mounting adaptor
Ordering number	809-130-000-011

ACCESSORIES *(Continued)*

Mechanical diagram: base plate for IPC 704 signal conditioner

This aluminium base plate can be used when an old IPC 620 unit is replaced by an IPC 704 signal conditioner. The housing of the IPC 620 can be recuperated and the IPC 704 mounted on it.

Ordering information: base plate for IPC 704 signal conditioner

Type and designation	Base plate for IPC 704 signal conditioner
Ordering number	244-620-002S034

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ISO 9001

MEGGITT
smart engineering for extreme environments

Manufacturer:	**tmg – Temperaturmesstechnik Geraberg GmbH**
Plug connection:	Harting plug connector item-no.: 09360083001(stud element on the RTD) Crimp contacts silvered
Sensor:	2* or 3*Pt100, class B acc. to EN 60751
Circuit configuration:	2*Pt100 – 4-wire circuit / 3*Pt100 – 2-wire circuit
Protecting tube:	Diameter 9 * 1 mm (1.4571)
Protection class.:	IP 54 acc. to EN 60 529
Media:	Air, oil, water
Pressure strength:	16 bar

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Fig. 1: Thermometer – drawing with dimensions

Manufacturer:	**tmg – Temperaturmesstechnik Geraberg GmbH**
Measuring Resistance:	PT100, BIFILAR – wound, 3.5 mm wide
Tolerance:	Class B ACC. DIN IEC 751
Insulation Class:	F
Connection Lead:	4 * 0.22 mm² (AWG 24)
Conductor Structure:	19 * 0.16 tinned
Wire Insulation:	Teflon (PTFE / FEP)
Sheath:	Teflon (FEP), grey
Colour Code:	BU, RD, GY, YE

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Fig. 1: Thermometer – drawing with dimensions

Fig. 2: Wiring diagram

Manufacturer:	**tmg – Temperaturmesstechnik Geraberg GmbH**
Scope of Application:	Temperature measurement in tooth region of end lamination stator core
Suppl. Standards & Spec.:	VDE 0530, DIN IEC 751, GEN 672.01 T.2*) *) GEN 672.01 T.2 section 2-7, test voltage according to section 3.1:1000VDC
Design Sensor:	Measurement Resistance simplex-PT100 at 0°C according to DIN IEC 751, Chip-Sensor 2*2 Tolerance: class B according to DIN IEC 751 Isolating class: H Measurement range: 0°C…180°C Sensor casing Ø 3
Measuring current:	max. 1 mA
Vibrostability:	>5 g at 120Hz, 20h

Fig. 1:
Thermometer – drawing with dimensions

Fig. 2:
Wiring diagram

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Manufacturer:	**tmg – Temperaturmesstechnik Geraberg GmbH**
Sensor:	2 or 3 thermocouples, type K (NiCr–Ni) acc. to EN 60 584 / 1
Construction:	2 or 3 thermocouples as “exposed hot junctions”
Plug connection:	Harting plug connector item-no.: 09360083001 (stud element on the RTD), crimp contacts silvered
Diameter:	Ø 6 mm
Measuring range:	0…+120 °C
Process connection:	G 1/2A-outer thread (PVDF)

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Fig. 1: Thermometer drawing with dimensions

EBL = length of thermometer
BT = dimension of borehole plus 4 mm (spike of borehole)

Fig. 2: Bearing drawing with dimension of borehole (BT)

Manufacturer:	**SIEMENS**
Documentation title:	**SITRANS LVL100 – Transistor (PNP)** **Operating Instructions**
No. of pages:	32

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Vibrating Switches

SITRANS LVL100

- transistor (PNP)

Operating Instructions • 07/2013

SITRANS

SIEMENS

Safety Guidelines: Warning notices must be observed to ensure personal safety as well as that of others, and to protect the product and the connected equipment. These warning notices are accompanied by a clarification of the level of caution to be observed.

Qualified Personnel: This device/system may only be set up and operated in conjunction with this manual. Qualified personnel are only authorized to install and operate this equipment in accordance with established safety practices and standards.

Unit Repair and Excluded Liability:

- The user is responsible for all changes and repairs made to the device by the user or the user's agent.
- All new components are to be provided by Siemens Milltronics Process Instruments.
- Restrict repair to faulty components only.
- Do not reuse faulty components.

Warning: Cardboard shipping package provides limited humidity and moisture protection. This product can only function properly and safely if it is correctly transported, stored, installed, set up, operated, and maintained.
This product is intended for use in industrial areas. Operation of this equipment in a residential area may cause interference to several frequency based communications.

Note: Always use product in accordance with specifications.

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1 About this document

1.1 Function

This operating instructions manual provides all the information you need for mounting, connection and setup as well as important instructions for maintenance and fault rectification. Please read this information before putting the instrument into operation and keep this manual accessible in the immediate vicinity of the device.

1.2 Target group

This operating instructions manual is directed to trained specialist personnel. The contents of this manual should be made available to these personnel and put into practice by them.

1.3 Symbolism used

Information, tip, note
This symbol indicates helpful additional information.

Caution: If this warning is ignored, faults or malfunctions can result.

Warning: If this warning is ignored, injury to persons and/or serious damage to the instrument can result.

Danger: If this warning is ignored, serious injury to persons and/or destruction of the instrument can result.

Ex applications
This symbol indicates special instructions for Ex applications.

• **List**
The dot set in front indicates a list with no implied sequence.

→ **Action**
This arrow indicates a single action.

1 **Sequence of actions**
Numbers set in front indicate successive steps in a procedure.

Battery disposal
This symbol indicates special information about the disposal of batteries and accumulators.

2 For your safety

2.1 Authorised personnel

All operations described in this operating instructions manual must be carried out only by trained specialist personnel authorised by the plant operator.

During work on and with the device the required personal protective equipment must always be worn.

2.2 Appropriate use

The SITRANS LVL100 is a sensor for point level detection.

You can find detailed information on the application range in chapter "*Product description*".

Operational reliability is ensured only if the instrument is properly used according to the specifications in the operating instructions manual as well as possible supplementary instructions.

For safety and warranty reasons, any invasive work on the device beyond that described in the operating instructions manual may be carried out only by personnel authorised by the manufacturer. Arbitrary conversions or modifications are explicitly forbidden.

2.3 Warning about incorrect use

Inappropriate or incorrect use of the instrument can give rise to application-specific hazards, e.g. vessel overfill or damage to system components through incorrect mounting or adjustment.

2.4 General safety instructions

This is a high-tech instrument requiring the strict observance of standard regulations and guidelines. The user must take note of the safety instructions in this operating instructions manual, the country-specific installation standards as well as all prevailing safety regulations and accident prevention rules.

The instrument must only be operated in a technically flawless and reliable condition. The operator is responsible for trouble-free operation of the instrument.

During the entire duration of use, the user is obliged to determine the compliance of the necessary occupational safety measures with the current valid rules and regulations and also take note of new regulations.

2.5 Safety label on the instrument

The safety approval markings and safety tips on the device must be observed.

2.6 CE conformity

The device fulfills the legal requirements of the applicable EC guidelines. By affixing the CE marking, we confirm successful testing of the product.

3 Product description

3.1 Configuration

Scope of delivery

The scope of delivery encompasses:

- SITRANS LVL100 point level switch
- Test magnet
- Documentation
  - this operating instructions manual
  - if necessary, certificates

Constituent parts

The SITRANS LVL100 consists of the components:

- Housing with electronics
- Process fitting with tuning fork

Fig. 1: SITRANS LVL100

Type plate

The nameplate contains the most important data for identification and use of the instrument:

- Article number
- Serial number
- Technical data
- Article numbers, documentation

3.2 Principle of operation

Application area

SITRANS LVL100 is a point level sensor with tuning fork for point level detection.

It is designed for industrial use in all areas of process technology and can be used in liquids.

Typical applications are overfill and dry run protection. With a tuning fork of only 38 mm length, SITRANS LVL100 can be also mounted e.g. in pipelines from DN 25. The small tuning fork allows use in vessels, tanks and pipes. Thanks to its simple and robust measuring system, SITRANS LVL100 is virtually unaffected by the chemical and physical properties of the liquid.

It functions even under difficult conditions such as turbulence, air bubbles, foam generation, buildup, strong external vibration or changing products.

Function monitoring
The electronics module of SITRANS LVL100 continuously monitors via frequency evaluation the following criteria:

- Strong corrosion or damage on the tuning fork
- Loss of vibration
- Line break to the piezo drive

If a malfunction is detected or in case of power failure, the electronics takes on a defined switching condition, i.e. the output is open (safe condition).

Functional principle

The tuning fork is piezoelectrically energised and vibrates at its mechanical resonance frequency of approx. 1100 Hz. When the tuning fork is submerged in the product, the frequency changes. This change is detected by the integrated electronics module and converted into a switching command.

Voltage supply

SITRANS LVL100 is a compact instrument, i.e. it can be operated without external evaluation system. The integrated electronics evaluates the level signal and outputs a switching signal. With this switching signal, a connected device can be operated directly (e.g. a warning system, a pump etc.).

The data for power supply are specified in chapter "*Technical data*".

3.3 Adjustment

The switching status of SITRANS LVL100 can be checked with closed housing (signal lamp). Products with a density > 0.7 g/cm^3 (0.025 lbs/in^3) can be detected.

3.4 Storage and transport

Packaging

Your instrument was protected by packaging during transport. Its capacity to handle normal loads during transport is assured by a test based on ISO 4180.

The packaging of standard instruments consists of environment-friendly, recyclable cardboard. For special versions, PE foam or PE foil is also used. Dispose of the packaging material via specialised recycling companies.

Transport

Transport must be carried out in due consideration of the notes on the transport packaging. Nonobservance of these instructions can cause damage to the device.

Transport inspection

The delivery must be checked for completeness and possible transit damage immediately at receipt. Ascertained transit damage or concealed defects must be appropriately dealt with.

Storage

Up to the time of installation, the packages must be left closed and stored according to the orientation and storage markings on the outside.

Unless otherwise indicated, the packages must be stored only under the following conditions:

- Not in the open
- Dry and dust free
- Not exposed to corrosive media
- Protected against solar radiation
- Avoiding mechanical shock and vibration

Storage and transport temperature

- Storage and transport temperature see chapter "*Supplement - Technical data - Ambient conditions*"
- Relative humidity 20 … 85 %

4 Mounting

4.1 General instructions

Suitability for the process conditions

Make sure that all parts of the instrument coming in direct contact with the process, especially the sensor element, process seal and process fitting, are suitable for the existing process conditions, such as process pressure, process temperature as well as the chemical properties of the medium.

You can find the specifications in chapter "*Technical data*" and on the nameplate.

Switching point

In general, SITRANS LVL100 can be installed in any position. The instrument only has to be mounted in such a way that the tuning fork is at the height of the desired switching point.

Keep in mind that the swichting point can vary dependent on the installation position.

The switching point refers to the medium water (1 g/cm^3/0.036 lbs/in^3). Please keep in mind that the switching point of the instrument shifts when the medium has a density differing from water.

Fig. 2: Vertical mounting

1 Switching point in water
2 Switching point with lower density
3 Switching point with higher density

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Fig. 3: Horizontal mounting

1 Switching point
2 Switching point (recommended mounting position, particularly for adhesive products)

Moisture

Use the recommended cables (see chapter "*Connecting to power supply*") and tighten the cable gland.

You can give your SITRANS LVL100 additional protection against moisture penetration by leading the connection cable downward in front of the cable entry. Rain and condensation water can thus drain off. This applies mainly to outdoor mounting as well as installation in areas where high humidity is expected (e.g. through cleaning processes) or on cooled or heated vessels.

Fig. 4: Measures against moisture penetration

Transport

Do not hold SITRANS LVL100 on the tuning fork.

Pressure/Vacuum

The process fitting must be sealed if there is gauge or low pressure in the vessel. Before use, check if the seal material is resistant against the measured product and the process temperature.

The max. permissible pressure is specified in chapter "*Technical data*" or on the type label of the sensor.

Handling

The vibrating level switch is a measuring instrument and must be treated accordingly. Bending the vibrating element will destroy the instrument.

Warning:
The housing must not be used to screw the instrument in! Applying tightening force can damage internal parts of the housing.

Use the hexagon above the thread for screwing in.

4.2 Mounting instructions

Welded socket

For threaded versions of SITRANS LVL100 in combination with a mounting boss with O-ring in front and welding marking.

SITRANS LVL100 with thread sizes ¾" and 1" have a defined thread runout. This means that every SITRANS LVL100 is in the same position after being screwed in. Remove therefore the supplied flat seal from the thread of SITRANS LVL100. This flat seal is not required when using a welded socket with front-flush seal.

Before welding, unscrew SITRANS LVL100 and remove the rubber ring from the welded socket.

The welded socket is provided with a marking (notch). For horizontal mounting, weld the socket with the notch facing upward or downward; in pipelines (DN 25 to DN 50) aligned with the direction of flow.

Fig. 5: Marking on the welded socket

1 Marking

Adhesive products

In case of horizontal mounting in adhesive and viscous products, the surfaces of the tuning fork should be vertical in order to reduce buildup on the tuning fork. The position of the tuning fork is indicated by a marking on the hexagon of SITRANS LVL100. With this, you can check the position of the tuning fork when screwing it in. When the hexagon touches the seal, the thread can still be turned by approx. half a turn. This is sufficient to reach the recommended installation position.

In adhesive and viscous products, the surfaces of the tuning fork should protrude into the vessel to avoid buildup. Therefore sockets for flanges and mountings bosses should not exceed a certain length.

Fig. 6: Adhesive products

Inflowing medium

If SITRANS LVL100 is mounted in the filling stream, unwanted false measurement signals can be generated. For this reason, mount SITRANS LVL100 at a position in the vessel where no disturbances, e.g. from filling openings, agitators, etc., can occur.

Flows

To make sure the tuning fork of SITRANS LVL100 generates as little resistance as possible to product flow, mount the sensor so that the surfaces are parallel to the product movement.

5 Connecting to power supply

5.1 Preparing the connection

Note safety instructions

Always keep in mind the following safety instructions:

- Connect only in the complete absence of line voltage

Connection cable

The instrument is connected with standard two-wire cable without screen. If electromagnetic interference is expected which is above the test values of EN 61326 for industrial areas, screened cable should be used.

Use cable with round cross section. Depending on the plug connection, you have to select the outer diameter of the cable respectively so that the seal effect of the cable gland is ensured.

- Valve plug ISO 4400, ø 4.5 … 7 mm
- Valve plug ISO 4400 with IDC crimping technology, ø 5.5 … 8 mm

Cable glands

Use cable with a round wire cross section and tighten the cable gland.

When mounting outdoors, on cooled vessels or in moist areas in which cleaning is made with steam or high pressure, the sealing of the cable gland is very important.

5.2 Wiring plan

Housing overview

Fig. 7: Overview of the connection versions

1 M12 x 1 plug connection
2 Valve plug ISO 4400
3 Valve plug ISO 4400 with IDC method of termination

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Plug versions

M12 x 1 plug connection
This plug connection requires a prefabricated cable with plug. Depending on the version, protection IP 66/IP 67 or IP 68 (0.2 bar).

Valve plug ISO 4400
For this plug version, standard cable with round wire cross-section can be used. Cable diameter 4.5 … 7 mm, protection IP 65.

Fig. 8: Connection, valve plug ISO 4400

1 Pressure screw
2 Pressure disc
3 Seal ring
4 Fixing screw
5 Seal washer
6 Plug housing
7 Plug insert
8 Profile seal
9 Control lamp
10 SITRANS LVL100

Valve plug ISO 4400 with IDC method of termination
For this plug version you can use standard cable with round wire cross-section. The inner conductors do not have to be stripped. The plug connects the conductors automatically when screwing in. Cable diameter 5.5 … 8 mm, protection IP 67.

Fig. 9: Connection, valve plug ISO 4400 with IDC crimping technology

1 Compression nut
2 Cable
3 Seal ring
4 Terminal insert
5 Plug housing

Transistor output

For connection to binary inputs of a PLC.

Fig. 10: Wiring plan, Transistor output with valve plug ISO 4400

PA Potential equalisation
R_L Load resistance (contactor, relay, etc.)

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Fig. 11: Wiring plan (housing), transistor output with M12 x 1 plug connection

1 Brown
2 White
3 Blue
4 Black
R_L Load resistance (contactor, relay, etc.)

6 Setup

6.1 Indication of the switching status

The switching status of the electronics can be checked via the signal lamps (LEDs) integrated in the upper part of the housing.

The signal lamps have the following meaning:

- Green lights - voltage supply connected
- Yellow lights - vibrating element covered
- Red lights briefly - function test during instrument start (for 0.5 s)
- Red lights - shortcircuit or overload in the load circuit (sensor output high-impedance)
- Red flashes - Error on the vibrating element or the electronics (sensor output high impedance)

6.2 Simulation

The SITRANS LVL100 has an integrated function for simulation of the output signal which can be activated magnetically. Please proceed as follows:

→ Hold the test magnet (accessory) against the circle symbol with the label "TEST" on the instrument housing

Fig. 12: Simulation of the output signal

The test magnet changes the current switching condition of the instrument. You can check the change on the signal lamp. Please note that all connected device are activated during the simulation.

If SITRANS LVL100 does not switch over after several tests with the test magnet, you have to check the plug connection and the connection cable and try it again. If there is no switching function, the electronics will be defective. In this case you have to exchange the electronics or return the instrument to our repair department.

Caution:
It is absolutely necessary that you remove the test magnet from the instrument housing after the simulation.

6.3 Function chart

The following chart provides an overview of the switching conditions depending on the set mode and the level.

	Level	**Switching status**	**Control lamp Yellow - coverage**	**Control lamp Green - voltage indication**	**Control lamp Red - fault signal**
Mode max.		closed	○	☼	○
Mode max.		open	☼	☼	○
Mode min.		closed	☼	☼	○
Mode min.		open	○	☼	○
Fault	any	open	any	☼	☼

7 Maintenance and fault rectification

7.1 Maintenance

If the instrument is used properly, no special maintenance is required in normal operation.

7.2 Rectify faults

Reaction when malfunctions occur

The operator of the system is responsible for taking suitable measures to rectify faults.

Failure reasons

SITRANS LVL100 offers maximum reliability. Nevertheless, faults can occur during operation. These may be caused by the following, e.g.:

- Sensor
- Process
- Voltage supply
- Signal processing

Fault rectification

The first measure to be taken is to check the output signal. In many cases, the causes can be determined this way and the faults rectified.

Checking the switching signal

Error	Cause	Rectification
Green signal lamp off	Voltage supply interrupted.	Check the voltage supply and the cable connection
	Electronics defective	Exchange the instrument or send it in for repair
Red signal lamp lights (switching output high-impedance)	Error with the electrical connection	Connect the instrument according to the wiring plan
	Shortcircuit or overload	Check the electrical connection
Red signal lamp flashes (switching output high-impedance)	Virbating frequency out of specification	Check the vibrating element on buildup and remove it
	Buildup on the vibrating element	Check the vibrating element and the sensor if there is buildup and remove it
	Vibrating element damaged	Check if the vibrating element is damage or extremely corroded

Reaction after fault rectification

Depending on the reason for the fault and the measures taken, the steps described in chapter "*Set up*" may have to be carried out again.

7.3 Instrument repair

If it is necessary to repair the instrument, please contact Siemens Milltronics Process Instruments Inc. You find the locations on our homepage "www.siemens.com/processautomation".

8 Dismounting

8.1 Dismounting steps

Warning:
Before dismounting, be aware of dangerous process conditions such as e.g. pressure in the vessel, high temperatures, corrosive or toxic products etc.

Take note of chapters "*Mounting*" and "*Connecting to power supply*" and carry out the listed steps in reverse order.

8.2 Disposal

The instrument consists of materials which can be recycled by specialised recycling companies. We use recyclable materials and have designed the parts to be easily separable.

WEEE directive 2002/96/EG
This instrument is not subject to the WEEE directive 2002/96/EG and the respective national laws. Pass the instrument directly on to a specialised recycling company and do not use the municipal collecting points. These may be used only for privately used products according to the WEEE directive.

Correct disposal avoids negative effects on humans and the environment and ensures recycling of useful raw materials.

Materials: see chapter "*Technical data*"

If you have no way to dispose of the old instrument properly, please contact us concerning return and disposal.

9 Supplement

9.1 Technical data

General data	
Material 316L corresponds to 1.4404 or 1.4435	
Materials, wetted parts	
– Tuning fork	316L
– Process seal	Klingersil C-4400
– Process fittings	316L
Materials, non-wetted parts	
– Housing	316L and plastic PEI
Weight approx.	250 g (9 oz)
Process fittings	
– Pipe thread, cylindrical (DIN 3852-A)	G½, G¾, G1
– American pipe thread, conical (ASME B1.20.1)	½ NPT, ¾ NPT, 1 NPT
– hygienic fittings	Clamp 1", Clamp 1½", Clamp 2", PN 16 DIN 32676, ISO 2852/316L, bolting DN 25 PN 40, bolting DN 40 PN 40, bolting DN 50 PN 25, SMS DN 38 PN 6
Max. torque - process fitting	
– Thread G½, ½ NPT	50 Nm (37 lbf ft)
– Thread G¾, ¾ NPT	75 Nm (55 lbf ft)
– Thread G1, 1 NPT	100 Nm (73 lbf ft)
Surface quality	
– Standard	R_a < 3.2 µm (1.26^{-4} in)
– Hygienic version	R_a < 0.8 µm (3.15^{-5} in)

Measuring accuracy	
Hysteresis	approx. 2 mm (0.08 in) with vertical installation
Switching delay	approx. 500 ms (on/off)
Measuring frequency	approx. 1100 Hz

Ambient conditions	
Ambient temperature on the housing	-40 … +70 °C (-40 … +158 °F)
Storage and transport temperature	-40 … +80 °C (-40 … +176 °F)

Process conditions	
Process pressure	-1 … 64 bar/-100 … 6400 kPa (-14.5 … 928 psig)
Process temperature - Standard	-40 … +100 °C (-40 … +212 °F)

Fig. 31: Dependendency ambient temperature to process temperature

1 Ambient temperature in °C (°F)
2 Process temperature in °C (°F)

Process temperature - High temperature version (option)	-40 … +150 °C (-40 … +302 °F)

Fig. 32: Dependendency ambient temperature to process temperature

1 Ambient temperature in °C (°F)
2 Process temperature in °C (°F)

Viscosity - dynamic	0.1 … 10000 mPa s
Flow velocity	max. 6 m/s (with a viscosity of 10000 mPa s)
Density	0.7 … 2.5 g/cm^3 (0.025 … 0.09 lbs/in^3)

Adjustment

Plug connections	Specification see "*Connecting to power supply*"
Signal lamps (LED)	
– Green	Voltage supply on
– Yellow	Vibrating element covered
– Red	Fault

Output variable	
Output	Transistor output PNP
Load current	max. 250 mA (output, permanently short-circuit proof)
Voltage loss	< 3 V
Switching voltage	< 34 V DC
Blocking current	< 10 µA
Mode	
– Min./Max.	Changeover by electronic connection
– Max.	Overflow protection
– Min.	Dry run protection

Voltage supply	
Operating voltage	9.6 … 35 V DC
Power consumption	max. 0.5 W

Electromechanical data	
Valve plug ISO 4400	
– Wire cross-section	1.5 mm^2 (0.06 in^2)
– Outer cable diameter	4.5 … 7 mm (0.18 … 0.28 in)
Valve plug ISO 4400 with IDC method of termination	
– Wire cross-section	for wire cross-section of 0.5 … 1 mm^2 (0.02 … 0.04 in^2)
– Single-wire diameter	> 0.1 mm (0.004 in)
– Wire diameter	1.6 … 2 mm^2 (0.06 … 0.08 in^2)
– Outer cable diameter	5.5 … 8 mm (0.22 … 0.31 in)
– Connection frequency	10 x (on the same cross-section)

Electrical protective measures	
Protection rating	
– Valve plug ISO 4400	IP 65
– Valve plug ISO 4400 with IDC method of termination	IP 67
– M12 x 1 plug connection	IP 66/IP 67 or IP 68 (0.2 bar)
Overvoltage category	III
Protection class	II

Approvals

Depending on the version, instruments with approvals can have different technical data. For these instruments, please note the corresponding approval documents. They are included in the scope of delivery.

9.2 Dimensions

SITRANS LVL100, standard version - thread

Fig. 33: SITRANS LVL100, standard version - thread

1 *Thread G½ (DIN ISO 228/1), ½ NPT (M12 x 1)[1)]*
2 *Thread G¾ (DIN ISO 228/1), ¾ NPT (valve plug ISO 4400)*
3 *Thread G1 (DIN ISO 228/1), 1 NPT (valve plug ISO 4400 with DC method of termination)*
4 *Switching point*

[1)] Keep in mind that the total length is extended by the plug connection.

SITRANS LVL100, standard version - thread G¾, G1, ¾ NPT, 1 NPT

Fig. 34: SITRANS LVL100, standard version - thread G¾, G1, ¾ NPT, 1 NPT

1 Thread G¾, G1 (DIN ISO 228/1), ¾ NPT or 1 NPT (M12 x 1)[2)]
2 Thread G¾, G1 (DIN ISO 228/1), ¾ NPT or 1 NPT (valve plug ISO 4400)
3 Thread G¾, G1 (DIN ISO 228/1), ¾ NPT or 1 NPT (valve plug ISO 4400 with IDC crimping technology)
4 Switching point
L Length with G¾ (DIN ISO 228/1), ¾ NPT: 64 mm (2.5 in)
L Length with G1 (DIN ISO 228/1), 1 NPT: 67 mm (2.64 in)

[2)] Keep in mind that the total length is extended by the plug connection.

SITRANS LVL100, high temperature version

Fig. 35: SITRANS LVL100, high temperature version

1 *Thread G½, G¾, G1 (DIN ISO 228/1), ½ NPT, ¾ NPT or 1 NPT (M12 x 1)*[3)]
2 *Thread G½, G¾, G1 (DIN ISO 228/1), ½ NPT, ¾ NPT or 1 NPT (valve plug ISO 4400)*
3 *Thread G½, G¾, G1 (DIN ISO 228/1), ½ NPT, ¾ NPT or 1 NPT (valve plug ISO 4400 with IDC crimping technology)*
4 *Switching point*
L *Length with G½ (DIN ISO 228/1), ½ NPT: 62 mm (2.44 in)*
L *Length with G¾ (DIN ISO 228/1), ¾ NPT: 64 mm (2.5 in)*
L *Length with G1 (DIN ISO 228/1), 1 NPT: 67 mm (2.64 in)*

3) Keep in mind that the total length is extended by the plug connection.

SITRANS LVL100, hygienic versions

Fig. 36: SITRANS LVL100, hygienic versions

1 Clamp (valve plug ISO 4400)
2 Bolting (valve plug ISO 4400)
3 SMS 1145 (valve plug ISO 4400)
4 Switching point
L Length with Clamp: 53 mm (2.1 in)
L Length with bolting: 53 mm (2.1 in)
L Length with SMS 1145: 53 mm (2.1 in)

Notes

Notes

43191-EN-141016

Notes

For more information

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Manufacturer: **Schunk Bahn- und Industrietechnik GmbH**

Documentation: **DOCUMENTATION**
Plug-in Brush Holder 06.00.0468.xx

Description
Assembly
Maintenance
Information

No. of pages: 12

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DOCUMENTATION

Plug-in Brush Holder Assembly
06.00.0468.xx

Description
Assembly
Maintenance
Information

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1 Description of the problem

If current flows through the bearings of an electrical machine, high current densities come about at the small contact points within each bearing and these bring about localized melting of the metal surfaces at these points. Small craters and groove patterns are the consequence. These increase the friction in the bearing and lead to the failure of the bearing through the relatively high degree of heating up in combination with the poorer lubrication. In general a shaft voltage of 500 mV is considered the highest level permissible for anti-friction bearings.

Shaft voltages can be caused by:

- Asymmetries in the magnetic circuit of rotating electrical machines
- Electrostatic charging of the shaft
- Capacitive coupling of voltages with static exciter systems

1.1 Task of the brush holder assembly

Fundamentally the brush holder in combination with appropriate carbon brushes serves as a bridge of low resistance for the transmission of current from fixed to rotating components. Here one differentiates between the following types of current transmission:

- Transmission of operating current
- Transmission of signal current
- Protective earthing of the rotating components

1.2 Structure

Two plug-in brush holders aligned at 90° relative to one another are used for the earthing of turbine shafts.

The Schunk plug-in brush holder assembly is characterized by the opportunity it permits for the brushes to be replaced while the generator system is in operation. To make this possible, the carbon brushes are seated in separate plug-in holders which can be locked and unlocked by simply pressing together the two grab handles.

1.3 Types

The Schunk plug-in holder assembly is available in different types. The variants differ in the length and position of their compression levers to respond towards dificult mounting situations and to assure easy maintenance.

This technical prescription is valid for the following plug-in holder types:

Type	Article-No.	Drawing-No.
angled lever clamp type A	10236289	06.00.0468.00
straight lever short clamp type A	10417001	06.00.0468.04
straight lever long clamp type A	10557274	06.00.0468.05
angled lever clamp type B	10573181	06.00.0468.06
straight lever short clamp type B	10578465	06.00.0468.07
straight lever long clamp type B	10578463	06.00.0468.08

1.4 Part List (Carbon Brushes)

The above listed holder types are to be quipped with the following brushes:

Material	Dokument	Materialkurztext	Menge	ME
10322358	02.40.0017.00	Set Erdungsbürsten 20x8x32 02.40.0017.00	0	ST
10022511	16.19.0148.00	Bürsten 101 161 115 002 S13/F19	1	ST
10022760	16.19.0148.01	Bürsten 101 161 115 001 F19/S13	1	ST
10214867	33.01.005	Minigrip-Beutel 120x170x0,09 33.01.005	1	ST

1.5 State as delivered

The plug-in brush holder assembly is supplied as one fully assembled unit as well as loose parts. In the state as delivered, the two legs are aligned at an angle of 180° to one another. Two dowel pins (item 6) are enclosed loose with the holder.

1.6 Micro switch

The micro switch is an optional accessory, which is not included in the standard design.

Together with an on-site monitoring system the micro switch indicates an upcoming carbon brush replacement. As the switch is normally closed, an open circuit will indicate that the brush has reached a usable rest length of approx. 3mm.
Please note that the micro switch may not be used for any current transmission operation except as specified below. Make sure the signal wire does not hinder or jam the carbon brush working area.

Specification			
Temperature range °C -40°C to +85°C/120°C			
Protection IP 6K7			
Cable length 3m			
Signal point 3mm before end of lever stop			
Functions normally-closed			
AC	minimum: 12V / 10mA	maximum:	250V / 5A
DC	minimum: 12V / 10mA	maximum:	30V / 5A

Micro switch position on holder:

2 Mounting

2.1 Securing of the brush holder assembly

(1) The distance of the securing pin (Ø=16 mm) from the surface of the shaft is to be determined in accordance with the following table:

Ø shaft / slip-ring [mm]	Distance centre of pin to shaft surface [mm]
600	57
500	58
400	60
360	60.5
300	61.5
250	63

(2) Care must be taken that the securing pin is parallel to the axis of the shaft and that it permits the brush holder to be secured firmly.
(3) The brush holder assembly is pushed on to the fixing bolt and secured so that it cannot rotate. Make sure that the clamping pieces don't tilt and all clamping screws are fastened equally with fastening torque 10Nm.
(4) After this the legs are aligned to the shaft. The distance between the lower side of the holder and the surface of the shaft may be 1 – 2 mm.
(5) The position of the legs is fixed with the aid of the hexagonal screws.
(6) After the angle between the legs has been set, the brush holder assembly is removed from the securing pin again so that the two dowel pins can be fitted. For this purpose there are holes in the two legs. These must be carried over to the central clamping piece (hole diameter = 3 mm).
(7) The dowel pins are pressed into the holes with the aid of a punch.
(8) Finally the brush holder assembly can be mounted on the securing pin again. (see step 3)

2.2 Mounting of the carbon brushes

The two plug-in holders are first removed from the brush holder assembly by pressing the grab handles together.

After the compression levers have been opened, the carbon brush is inserted in the guide provided for it and the power cable is screwed to the plug-in holder (hexagonal screw beneath the grab handle).

Important: This version is designed exclusively for one-direction running. For two-direction running, other solutions must be selected. Ensure that the orientation of the brushes is correct. The arrow marking on the carbon brush must point in the direction in which the shaft rotates.

Then the compression lever is closed and the plug-in holder with the brush is pressed on a flat surface in order to press the brush upwards in its guide.

When the grab handles are pressed together, the brush is located in position and the plug-in holder can be mounted again.

Here care must be taken that the locking mechanism of the plug-in holder engages properly.

The carbon brush used is a multi-layer carbon brush of silver and graphite with a "right-hand" and a "left-hand" form of execution. By reason of the mounting of the brushes in the plug-in holders and the securing of the power cable on the holder, the power cables are secured in the brush in different ways. In this way it is ensured that the graphite layer of the brush always points in the direction in which the shaft rotates while the silver-graphite layer points in the opposite direction.

3 Technical data

The technical data stated below refer exclusively to products from the scope of delivery of Messrs. Schunk with account being taken of the documentation relating to the particular product.

3.1 Brushes

Number of brushes:	2 (pieces) (see part list chapter 1.4)
Brush dimensions :	20 x 8 x 32 (mm)
Brush material:	layer material F19 / S13
Nominal brush pressure:	160-200 (cN/cm²)

3.2 Requirements to be satisfied by the counter face

Material of the counter face	steel (stainless)
Diameter of the shaft	250 – approx. 1500 [mm]
Initial meaned peak-to-valley height	Ra<1,6 / Rz < 7 [µm]
Concentricity properties	< 40 [µm]
circumferential speed	93 [m/s]

Important : Under no circumstances may oil or similar fluid lubricants be allowed to get into the region of the brushes or of the holder.

3.3 Current load

Max. steady current Ieff.	15 [A/cm²]
Max. short-term overload (<30s)	20 [A/cm²]
Max. voltage eff	30 [V]

3.4 Ambient conditions

Air humidity:	>3 to >15g/m³

4 General statements on operating and maintenance

4.1 Maintenance intervals

Under normal operating conditions and assuming that the brush holder has been properly mounted and that the peripheral speed of the counter surface is 20 – 70 m/s, an average brush wear of 1 – 4 mm / 1000 h is to be reckoned on.

I. The brush used (initial length 32 mm) is to be replaced at the latest when it has worn down to a length of 15 mm.

IMPORTANT: If the brushes are not replaced early enough the axle surface may be damaged seriously by the worn brushes.

II. If the system, in which the holder assembly is used, is maintained at different intervals, then the brush holder assembly is to be included in the maintenance measure for the system. Within every brush-replacement, the holder has to checked regarding the following criteria:

   a. Correct adjustment (distance between holder and slipring surface: 1-2mm)

   b. Easy movement of brushes in the holder

   c. Correct position of security pins

   d. Transition resistance measured accoring the attached drawing (refer to chapter 6). The usage of a conventional resistance measurement tool with 4-point measuring mode is recommendend to avoid measuring mistakes caused by cable lengths).

III. After a maximum of 10 years the brush-holder must be replaced

5 Normal operating

The situation of normal operating in the sense of directive 94/9 EC (ATEX) is given when all requirements of this documentation in respect of mounting, maintenance, operating and ambient conditions are maintained.

6 Symbolic view with measuring points

Arrows mark measuring points for resistance measurement according to proper maintenance.

Test certificate

for Plug-in Brush Holder Assembly as type 06.00.0468.XX

In case of any brush change of the plug-in brush holder a measurement of the contact resistance between the brushes and terminal screw must be done, according to Schunk technical regulation. It must be measured between the measuring points as marked on the drawing on both brushes with a calibrated digital voltmeter using conventional probes. The measurement results are filled in the space provided on the attached table in milliohms. There are used to demonstrate the proper brush change.

Anlage / Standort: _____

Betreiber:_____

Bürsten-wechsel	Datum	Messwert IST- [mOHm]	Messwert SOLL [mOhm]	Unterschrift
1.			<30	
2.			<30	
3.			<30	
4.			<30	
5.			<30	
6.			<30	
7.			<30	
8.			<30	
9.			<30	
10.			<30	

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