NUCLEAR ENGINEERING DEPARTMENT

DESIGN ENGINEERING

Technical Requirement Specification for:

Inverter System Replacement

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REVISIONS

Revision	Date	Scope of the revision	Compiler	Reviewer	Approver
0	2013-11-18	Original Issue.	PH	BT	RG
1	2023-08-29	• Incorporated PQE comments. • Added 0LZC to scope.	PH	DK	RG

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1. INTRODUCTION

1.1. Purpose

This technical requirement specification (TRS) is intended to define the requirements applicable for the system replacement of the inverters installed at Koeberg Power Station, under modification 09082. This includes the detailed design, engineering services, procurement, manufacture, fabrication quality control, factory acceptance testing, delivery, site storage, installation, site acceptance testing, training of personnel, updating all affected documents, supply of drawings and manuals, for the inverter system replacement.

1.2. Existing Design

1.2.1. The LNi (A/B/C/D) systems

These systems are specific for each Koeberg Unit and consist of electrical components designed to supply and distribute vital energy at 220 V AC (alternating current) without cut-off (permanent). Each LNi (A/B/C/D) system consists of an inverter (5 kVA), an emergency supply transformer, a static switching unit plus vital 220 V AC distribution. For each system, these components form a single set with “Inverter-Regulator” and “Switchboard” as generic denominations; each switchboard set is installed in a cabinet arranged for easy access to the various components and to facilitate testing operations during maintenance inspections.

The vital 220 V AC which is necessary for the four reactor protection sets also powers certain sensors used both for reactor protection and control, as well as for certain control channels, their associated indication meters, and ex-core nuclear instrumentation. These vital 220 V AC systems provide electrical power to the redundant process instrumentation and nuclear instrumentation systems related to reactor protection. The breakdown is as follows:

- LNA powers reactor protection set nº 1 (Train A)
- LNB powers reactor protection set nº 2 (Train B)
- LNC powers reactor protection set nº 3 (Train A)
- LND powers reactor protection set nº 4 (Train B)

Vital 220 V AC is normally produced by the inverter (DC–AC solid state inverter) powered by the 125 V DC sources from the following “LB” safety-related systems:

- LBC for LNA
- LBD for LNB
- LBE for LNC
- LBF for LND

A 380/220 V AC transformer powered with 380 V AC (emergency power supply) replaces the inverter 220 V AC output supply (normal power supply) if it fails, almost instantaneously due to the use of a thyristor static switching system. The 380 V AC power supply comes from the following “LL” safety-related systems:

- LLC for LNA
- LLD for LNB
- LLC for LNC
- LLD for LND

1.2.2. The 9LNi (F/G/H), 0LZC, 6SSC/D systems

These systems consist of electrical components designed to supply and distribute vital energy at 220 V AC (alternating current) without cut-off (permanent) to the non-safety related systems.

- 9LNF – Nuclear Auxiliary Building
- 9LNG – Demineraliser Plant
- 9LNH – Chlorination Plant
- 0LZC – High Voltage Yard Control
- 6SSC/D – Security (CAS)

Each 9LNi (F/G/H) system consists of an inverter (5 kVA), 0LZC consists of an 8 kVA inverter and 6SSC/D consists of 50 kVA inverters each. These systems also consist of an emergency supply transformer, a static switching unit and vital 220V AC distribution. For each system, these components form a single set with “Inverter-Regulator” and “Switchboard” as generic denominations; each switchboard set is installed in a cabinet arranged for easy access to the various components and to facilitate testing operations during maintenance inspections.

Vital 220 V AC is normally produced by the inverter (DC-AC solid state inverter) powered by the 125 V DC sources, and 230 V DC for 0LZC, from the following non-safety related systems:

- 9LBG for 9LNF
- 9LBH for 9LNG
- 9LBL for 9LNH
- 0LZB for 0LZC
- 6SSE for 6SSC
- 6SSG for 6SSD

A 380/220 V AC transformer powered with 380 V AC (emergency power supply) replaces the inverter 220 V AC (normal power supply) if it fails, almost instantaneously due to the use of a thyristor static switching system. The 380 V AC power supply comes from the following non-safety related systems:

- 9LKI for 9LNF
- 9LKN for 9LNG
- 9LKP for 9LNH
- 9LKK for 0LZC
- 6SSA for 6SSC
- 6SSB for 6SSD

1.2.3. The LNE systems

The LNE system is specific for each Koeberg Unit. This system is not redundant, and it consists of electrical components designed to supply and distribute energy at 220 V AC (alternating current) to, amongst others, the following non-safety related systems: GRE, RCP, RGL, RIC and SIT. This system has three 50% single-phase inverters (20 kVA) connected in parallel to a 220 V AC distribution switchboard. The LNE inverters are supplied from the LAA 230 V DC power source. This power source is a 230 V DC switchboard with battery and charger battery powered from Train A. There is no emergency supply transformer for the LNE switchboard.

Figure 1 below depicts a basic single line diagram of a typical inverter system at Koeberg.

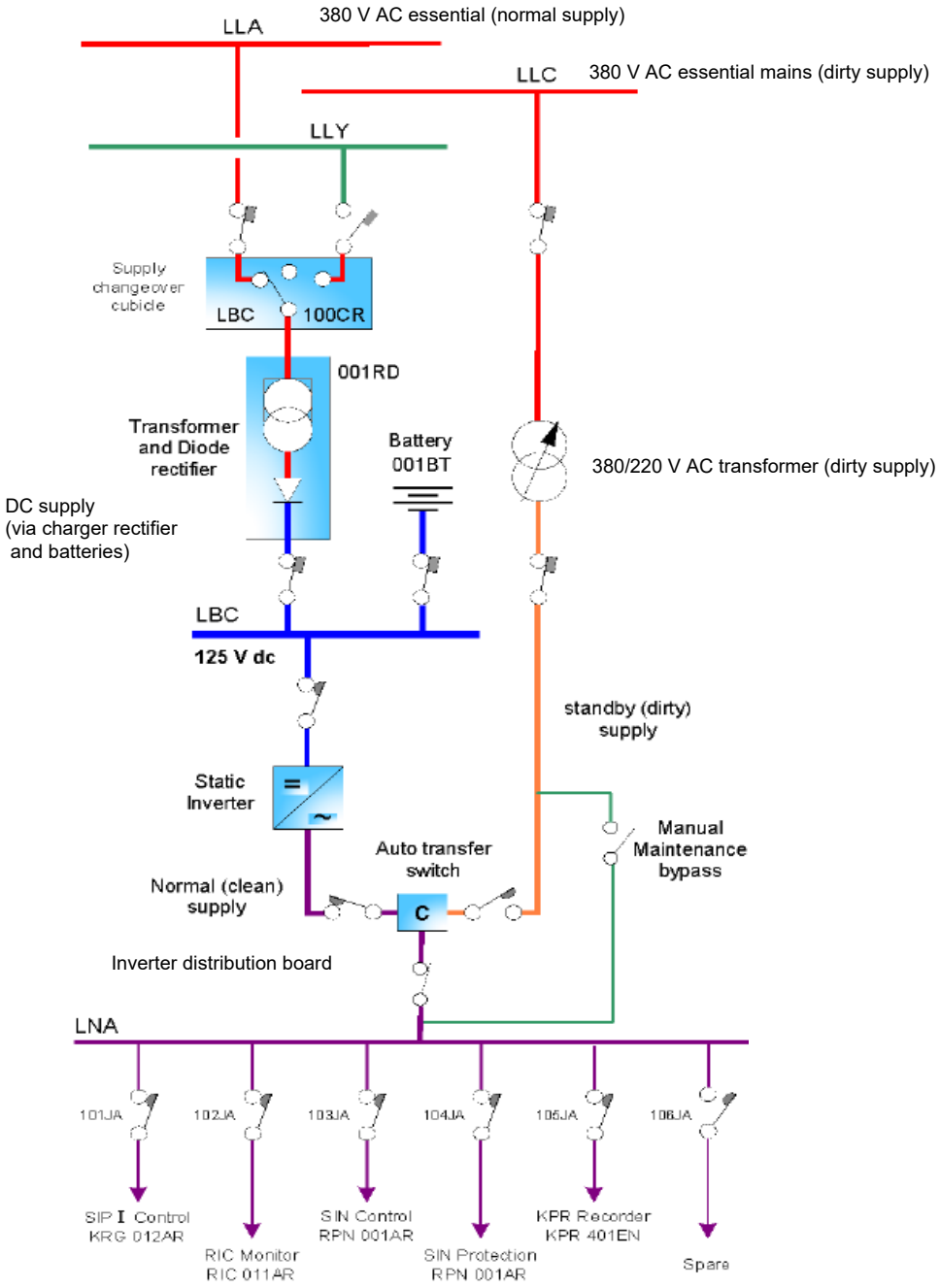


Figure 1: Line diagram of a typical inverter system (with a dirty supply)

1.2.4. Ratings and functions of the existing Inverter systems at Koeberg are detailed in Table 1 below:

220 V AC	Rating	Qty	Boards	Plant supplied
LNi Vital	5 kVA	8	LNA/B/C/D	Four reactor protection systems
LNE Continuous	20 kVA	6	LNE	Unit control, protection, monitoring equipment
Other inverters Continuous	5 kVA	3	9LNF/G/H	Outside plant
	50 kVA	2	6SSC/D	Security systems
	8 kVA	1	0LZC	High Voltage Yard Control
LMK Continuous	40 kVA	2	LMK 001 TB	Plant Computer
KRT Vital	10 kVA	2	KRT 001 DL	Radiation Monitoring

Table 1: Existing inverter ratings and functions

1.2.5. Existing Plant Characteristics

1.2.5.1. 380 V AC Power System

The 380 V AC supply to all inverters has the following characteristics:

Normal voltage : 380 V AC (± 10%)

Normal frequency : 50 Hz (± 1%)

Abnormal voltage : same as normal

Abnormal frequency : 50 Hz (+1 Hz, -2 Hz) for 5 hours maximum

50 Hz (+2 Hz, -3 Hz) for 1 hour maximum

1.2.5.2. 125 V DC System (applicable to inverters with 125 V DC input only)

The 125 V DC supply to the inverters has the following characteristics:

<u>Batteries</u>

Number of cells : 59

Voltage rating : 125 V DC

Float voltage : 128 to 131 V DC

Charging voltage	:	128 to 131 V DC (normal charge)
		129 to135 V DC (boost charge)
Lowest voltage	:	109.7 V DC
Capacity	:	150 Ah (for LNA/B/C/D and MTR)
		420 Ah (for 9LNF)
		200 Ah (for 9LNG)
		108 Ah (for 9LNH)

1.2.5.3. 230 V DC System (applicable to inverters with 230 V DC input only)

The 230 V DC supply to the inverters has the following characteristics:

Batteries

Number of cells	:	109
Voltage rating	:	230 V DC
Float voltage	:	240 to 245 V DC
Charging voltage	:	243 V DC (normal charge)
		251 V DC (boost charge)
Lowest voltage	:	202 V DC
Capacity	:	1000 Ah (for LNE)
		720 Ah (for 6SSC/D)

1.2.5.4. Battery Chargers for 125 V DC batteries:

Normal Conditions

Voltage variation	:	120 to 130 V DC
Floating mode	:	128.5 to 131.1 V DC
Full charge mode	:	133.2 to 135.8 V DC
RMS ripple	:	< 1%
Peak-to-peak ripple	:	< 2 %

Emergency Conditions

Voltage	:	100 to 135 V DC
RMS ripple	:	≤ 3%
Peak-to-peak ripple	:	≤ 5%

1.2.5.5. Battery Chargers for 230 V DC batteries:

Normal Conditions:

Voltage	:	220 to 240 V DC
Floating mode	:	237.4 to 242.2 V DC
Full charge mode	:	246 to 251 V DC
RMS ripple	:	< 1%
Peak-to-peak ripple	:	< 2%

Emergency Conditions:

Voltage	:	183 to 252 V DC
RMS Ripple	:	≤ 3%
Peak-to-peak ripple	:	≤ 5%

1.3. **Problems with the Existing Design**

The existing inverters, Merlin Gerin (MG) 30 CS series range, have been in operation since commissioning of Koeberg Operating Units 1 and 2, in 1984 and 1985 respectively. These inverters have been in operation for almost 30 years, however, its electronic components only have an expected lifespan of 20 years.

The inverters are currently operating with the following risks:

- Spares unavailability
- Obsolescence
- Reliability issues
- Component failures
- Functional problems
- Not aligned to CP1

2. SCOPE

The general scope of supply for the inverter replacement modification at Koeberg Power Station comprises the following:

2.1. Complete inverter system and associated switchboard replacement, in accordance with this technical specification requirement.

2.2. The replacement of the inverters, its associated switchboards including new upgrades is listed in Table 2 below.

220 V AC	Existing Rating	Qty	Boards	DC Volts	New upgrades
LNi Vital	5 kVA	8	LNA/B/C/D 001 DL	125	Bypass with stabiliser
LNE Continuous	20 kVA	6	LNE 001/2/3 DL/TB	230	30 kVA (new rating) 60 kVA bypass with stabiliser
Other inverters Continuous	5 kVA	3	9LNF/G/H 001 DL/TB	125	10 kVA (new rating) with bypass and stabiliser
	8 kVA	1	0LZC 001 DL/TB	230	10 kVA (new rating) with bypass and stabiliser
	50 kVA	2	6SSC/D 001 DL 6SSC/D 001/2 AR	230	50 kVA bypass with stabiliser
Maintenance and Training Rig inverter (MTR)	-	1	-	230	5 kVA UPS (charger and inverter), 5 kVA bypass with stabiliser
Note: The inverters listed below have recently been replaced with new units, Gutor Type. To facilitate standardisation, these new units shall be included into the scope of the replacement should the *Contractor* choose a different supplier.					
LMK Continuous	40 kVA	2	LMK 001 TB	220	-
KRT Continuous	10 kVA	2	KRT 001 DL	125	-

Table 2: Inverter System Replacement Scope

3. DEFINITIONS AND ABBREVIATIONS

3.1. The ***Contractor*** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility.

3.2. The ***Manufacturer/Supplier*** is the party which manufactures or supplies equipment and services to perform the duties specified by the *Contractor.*

3.3. ***Inverter:*** Equipment that converts dc power to ac power. It includes auxiliary devices such as transfer switches, alternate source transformers and regulators, input rectifiers (other than battery chargers), and isolation devices (e.g., blocking diodes).

3.4.	AC	Alternating Current
3.5.	AR	Distribution Panel
3.6.	DBE	Design Basis Event
3.7.	CSR	Critically Safety Related
3.8.	DC	Direct Current
3.9.	DL	Inverter
3.10.	DSE	System Description Manual (DSE is a French abbreviation)
3.11.	FMEA	Failure Modes and Effects Analysis
3.12.	LED	Light Emitting Diode
3.13.	LCD	Liquid Crystal Display
3.14.	MB	Maintenance Basis
3.15.	MTBF	Mean Time Between Failures
3.16.	MTR	Maintenance and Training Rig
3.17.	NC	Non Classified
3.18.	NNR	National Nuclear Regulator
3.19.	NSA	Not Safety or Availability Related
3.20.	NSF	No Safety Function
3.21.	OEM	Original Equipment Manufacturer
3.22.	QADP	Quality Assurance Data Package
3.23.	RD	Requirement Document
3.24.	SR	Safety Related
3.25.	TCP	Transmission Control Protocol
3.26.	TB	Switchboard
3.27.	UPS	Uninterruptible Power Supplies

4. PRODUCT REQUIREMENTS

This section specifies the features and qualities of the product.

4.1. Codes and Standards

As a minimum the following codes and standards contain(s) provisions that, through reference in this specification, constitute requirements of this document:

International Standards

4.1.1.	ASME NQA 1	Quality Assurance Requirements for Nuclear Facility Applications
4.1.2.	IEC 62040-1,2,3	Uninterruptable Power Systems (UPS)
4.1.3.	IEC 60085	Electrical insulation - Thermal evaluation and designation
4.1.4.	IEC 60146-2	Inverters
4.1.5.	IEC 60529	Degrees of Protection Provided by Enclosures
4.1.6.	IEC 60880	Nuclear power plants - Instrumentation and control systems important to safety - Software aspects for computer-based systems performing category A functions.
4.1.7.	IEC 60947-2	Low Voltage Switchgear and Control Gear
4.1.8.	IEC 61378-1	Convertor Transformers – Transformers for industrial applications
4.1.9.	IEC 61439-1,2	Low-voltage switchgear and control gear assemblies Part 2: Power switchgear and control gear assemblies
4.1.10.	IEC 62138	Instrumentation and control important for safety – Software aspects for computer-based systems performing category B or C functions.
4.1.11.	IEEE 650	Standard for Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Power Generating Stations
4.1.12.	ISO 9001	Quality Management Systems – Requirements

National Standards

4.1.13.	SANS 1091	National Colour Standard
4.1.14.	SANS 10142-1	The Wiring of Low Voltage Premises: Part 1
4.1.15.	OHSA No. 85/93	Occupational Health and Safety Act No. 85 of 1993

Eskom Standards and Guidelines

4.1.16.	DSG-311-088	Technical Specification For Low Voltage Power Distribution Boards
4.1.17.	DSG-318-033	Specification for Seismic Qualification of Electrical and Mechanical Equipment
4.1.18.	GGSS 0456 (36-797)	Specification for Switchboards and associated

		Equipment for Voltages up to 1000 V AC and 1500 V DC
4.1.19.	36-817	Generation Specification – Static Uninterruptible Power Supplies
4.1.20.	36-965	Acceptance and Commissioning of DC supply equipment in Generation

Other standards to be used are included in the references in section 8.0.

4.2. **General Product Requirements**

4.2.1. Where different standards, specifications or requirements to those identified in this specification have been used by the *Contractor*, it shall be the *Contractor's* responsibility to prove that those standards used are equivalent or better than those detailed in this specification.

4.2.2. Should any conflict arise between this specification and other referenced documents, the *Contractor* shall not proceed but shall request clarification, in writing, from Eskom. The *Contractor* may only proceed once permission and agreement have been received from Eskom in writing.

4.2.3. The *Contractor* shall be responsible for obtaining any additional information that is only available from the relevant OEM or Supplier.

4.2.4. The new design must allow for all existing operating configurations.

4.2.5. The new design requirements shall be based on eliminating obsolescence from the current inverter system.

4.2.6. All existing design limits and criteria shall be respected for all normal operating, incident, and accident conditions.

4.3. **Inverter System Requirements**

The existing inverter systems shall be completely replaced with new inverters and switchboards in its position with a type already installed and proven in the nuclear power generating industry and other industrial applications. As a minimum the new inverter system functionality shall be the same as the existing inverter system. Any functional deviations shall be discussed with Eskom.

4.3.1. **1E and NSF Inverter System Requirements**

4.3.1.1. Where there is a conflict between these requirements and that of 4.3.2, the requirements listed in 4.3.2 take precedence for 1E equipment.

4.3.1.2. The inverter/UPS shall meet the requirements of IEC 62040 parts 1 to 3 and IEC 60146-2.

4.3.1.3. The inverter/UPS shall meet the requirements of 36-817 'Generation Specification – Static Uninterruptible Power Supplies'.

4.3.1.4. The control and switchgear used shall meet the requirements of IEC 60947-2

and IEC 61439-2.

4.3.1.5. The new inverter systems shall be tested in accordance with IEC 62040-3, 'Testing and Performance'.

4.3.1.6. The monitoring section of the inverter shall house the necessary equipment for detecting and protecting against the following faults, but not limited to:

- Overvoltage
- Under-voltage
- Ground faults

4.3.1.7. All failures shall be alarmed through a common alarm, for each of the inverter/UPS systems.

4.3.1.8. All switches shall be monitored and flagged.

4.3.1.9. Provision shall be made for the following output signals (voltage free contacts suitable for interfacing with a 48 V dc relaying system), but not limited to:

- Inverter fault
- Feeder fault (signal to indicate an output feeder trip)

4.3.1.10. The power terminals shall be identified by letters R, W, B (representing the colours red, white and blue) for the three phases and N for the neutral conductor.

4.3.1.11. The wiring and cabling shall be red, white, and blue for phase cables, green/yellow for earth cables, and black for neutral cables. Alternatively, the end of the cables shall be marked with colour-coded heat shrink.

4.3.1.12. The new design shall provide standardisation of the inverter systems and its associated components for the ease of spares management during plant operation. Where possible, spares shall be interchangeable between 1E and NSF inverter systems.

4.3.1.13. **Bypass transformer**

4.3.1.13.1. The dry type bypass transformer shall be specified, designed and tested in accordance to IEC 61378-1 before it is integrated into the inverter system.

4.3.1.13.2. The bypass transformer shall have the following parameters:

- Dry type isolation transformer (Class H, 180°C)
- Single phase coupling
- Built-in winding screen
- Phase shift shall be zero

4.3.1.13.3. A bypass transformer 380 V AC / 220 V AC shall provide an alternate supply (from the system mains) should the normal DC supply to the inverter fail. It shall be rated for the full inverter/UPS rating (60 KVA for LNE).

LNE bypass transformer

4.3.1.13.4. The new LNE bypass transformer shall be supplied from LLE and LLI.

4.3.1.13.5. The 1E LLE and LLI boards shall be fitted with a 1E protection device to provide a barrier between the 1E and an NSF system.

4.3.1.13.6. If the OEM 1E protection devices are obsolete, then the contractor shall source equivalent devices or qualify a new device (including its associated components) for this application.

4.3.1.13.7. A supply changeover switch shall be used to select between LLE and LLI.

4.3.1.14. **Stabiliser**

4.3.1.14.1. The Stabiliser shall meet the requirements of IEC 60085 and IEC 62040-1, 2.

4.3.1.14.2. A servo-controlled voltage stabilizer shall be applied in case of unstable or weak bypass mains. It shall provide galvanic isolation with a short circuit capacity of at least 1000% for 100ms. Static output voltage tolerance shall be less than ±1% with steady load variations between 0% and 100% of the bypass circuit rating in conjunction with mains voltage variations of ±10% to ±20% from nominal value. Phase shift from input to output shall be zero.

4.3.1.14.3. The Stabiliser shall be rated for the full inverter/UPS rating (60 kVA for LNE).

4.3.1.15. **Manual Bypass Switch**

This switch shall have 3 switching positions:

Auto: The load will be supplied from the inverter, with the static bypass energised for automatic transfer (when needed).

Test: The load will be supplied directly from the alternative supply (static switch circuit energised) and the DC supply system can be tested without disturbing the load.

Bypass: The load will be supplied directly from the alternative supply. The DC supply system will be isolated, and the static switch will be isolated from the bypass.

4.3.1.16. **Static Switches**

The static switches shall enable switchover from inverter to alternative supply if the inverter fails or when the preferred DC input is out of limits (long term variations of short-term transients), within 5 milliseconds. The switchover from normal supply to alternative supply should be automatic.

4.3.1.17. **Switchboards/Distribution**

4.3.1.17.1. The switchboards shall meet the requirements of GGSS 0456 (36-797) ‘Specification for Switchboards and associated Equipment for Voltages up to 1000 V AC and 1500 V DC.

4.3.1.17.2. The distribution boards shall meet the requirements of DSG-311-088 ‘Technical Specification For Low Voltage Power Distribution Boards’

4.3.1.17.3. Each feeder circuit shall have a facility to be locked out individually by means

of a padlock.

4.3.1.17.4. For each outgoing section, equipped feeder spares shall be supplied as follows. The sizing of the spare breakers will be determined during the design.

- LNi (A/B/C/D) - 5 extra feeders each
- LNE - 15 extra feeders
- 9LNF - 10 extra feeders
- 9LNG/H - 5 extra feeders each
- 0LZC - 5 extra feeders
- 6SSC/D - 5 extra feeders each

4.3.1.17.5. Each outgoing feeder shall be fitted with a device for monitoring the open position of the feeder. If a feeder trips or is isolated, a signal (common to all feeders) shall be generated. This signal will be routed to the site alarm system to warn the operator of the trip/opening of a feeder. This is the feeder fault referred to in 4.3.1.9.

Protection Devices

4.3.1.17.6. Protection devices (like circuit breakers) shall be of the Merlin Gerin or equivalent type.

4.3.1.17.7. Protection devices shall be sized to be able to continuously carry the load currents when mounted within the compartment specified.

4.3.1.17.8. The breaking capacity of protection devices selected is determined in accordance with the fault rating of its associated switchboard.

Busbars

4.3.1.17.9. Main busbars and vertical busbars shall be made of hard drawn copper of suitable dimensions and in accordance with IEC 60439-1.

4.3.1.17.10. Insulating materials shall be resistant to flame propagation, non-hygroscopic and resistant to tracking.

4.3.1.17.11. All busbars shall be marked in such a manner that they are easily identified as to the pole they are connected to when any covers are removed.

4.3.1.17.12. AC power live busbars shall be coloured red and black for the neutral.

4.3.1.17.13. The calculation for the sizing of the busbars shall be provided to the *Contractor* in writing for approval prior to manufacture.

4.3.1.18. **Inverter Output Characteristics**

4.3.1.18.1. The output of the inverter and the transformer voltage regulator shall be synchronised but not electrically connected. It shall not be possible to initiate a preferred-to-alternative or alternative-to-preferred transfer unless their voltages are in phase.

4.3.1.18.2. Normal Output Conditions

Output : 5 kVA (for LNA/B/C/D, MTR)

10 kVA (for 9LNF/G/H, 0LZC)

30 kVA (for LNE)

50 kVA (for 6SSC/D)

Power factor	:	0,8 pf lag
Voltage	:	220 V AC (± 1%)
Harmonic distortion	:	< 5%
AC distortion	:	< 5%
Frequency	:	50 Hz (± 0.5)

Transient Conditions

For instantaneous load variations of ± 50% with initial power between 30% and 100% full power, and the inverter input voltage within + 10% to -15% band, the output voltage shall return to within ± 5% of it set value within 100 milliseconds.

Short term overload capabilities should be better than:

Inverter

1 min at 150%

10 min at 125%

Bypass

100 ms at 1000%

4.3.1.19. **Efficiency**

At nominal voltage the minimum efficiencies, at the various loads shall be:

- 55% at 25% of rated load
- 70% at 50% of rated load
- 80% at full load

4.3.1.20. **Cabinet requirements**

4.3.1.20.1. The inverter/UPS system shall be installed in one or more free standing, self-supporting steel cabinets forming an enclosure arranged for floor mounting. The thickness of the steel sheets shall at least be 1,5 mm thick for side and back panels and 2,0 mm thick for doors.

4.3.1.20.2. The enclosure shall provide minimum degree of protection of IP23 as per IEC standard 60529.

4.3.1.20.3. Provision shall be made for bonding the cabinets to the station earth.

4.3.1.20.4. All doors shall be earthed.

4.3.1.20.5. The cabinets shall be ultra-marine blue in accordance with SANS 1091 colour F09, or an equivalent RAL colour.

4.3.1.20.6. The board shall be designed to allow quick and easy access to outgoing and inverter sections, and for replacement of parts.

4.3.1.20.7. There shall be easy access to various measurement points.

4.3.1.20.8. All access doors shall be locked. The supplier shall specify the type of locking mechanism proposed in their offer.

4.3.1.20.9. The inverters shall preferably be self-ventilated and shall conform to IEC 60146-2.

4.3.1.20.10. Where forced cooling is required, i.e. LNE and 6SSC/D, 0LZC the following shall apply:

- Redundant n+1 monitored fans

4.3.1.20.11. Power and control cables shall be segregated upon entry into the cabinets.

4.3.1.20.12. Gland plates shall be supported to prevent movement of cables.

4.3.1.20.13. Wires passing through holes in compartments shall be protected by means of neoprene grommets.

4.3.1.20.14. Adequate supports shall be provided to securely position each cable with a clamp within the cabling compartment.

4.3.1.20.15. Cable entry into the cabinets is detailed in Table 4 below:

Inverter/UPS unit	**Cable Entry**
LNA/B/C/D	Top
LNE	Top
9LNF	Top
9LNG	Bottom
9LNH	Bottom
0LZC	Top
6SSC/D	Bottom
MTR	Top

Table 4: Cable Entry Requirements

4.3.1.20.16. The dimensions provided below are approximate and shall be confirmed during the detailed design phase. The dimensions are detailed in Table 3 below:

Inverter/ switchboard	**Length (mm)**	**Depth (mm)**	**Height (mm)**	**Comments**
LNA/B/C/D	1250 overall 820 inverter 430 switchboard	830	2000 w/o vent 2150 with vent	Switchboard is integrated into inverter
LNE	1227 per inverter	870	2000 w/o fan hood	

Inverter			2550 with fan hood	
LNE switchboard	3600 overall 900 per board	620	2230	Switchboard has 4 cabinets
9LNF/G/H Inverter	1250 overall	830	2000 w/o vent 2190 with vent	Same as LNA/B/C/D units, but has a separate switchboard
9LNF/G/H Switchboard	900	630	2300	
0LZC Inverter	1250 overall 820 inverter 430 switchboard	830	2000 w/o vent 2150 with vent	Switchboard is integrated into inverter
6SSC/D UPS	2640 overall 670 rectifier 1300 control unit 670 inverter	1000	2000	
6SSC/D 001 TR transformer	660	1000	2000	Separate cabinet for bypass transformer
6SSC/D 001AR	500	1100	2200	Protection and monitoring equipment
6SSC/D 002AR	800	1100	2200	Distribution

Table 3: Inverter and switchboard dimensions

4.3.1.20.17. These cabinets should be similar to the current design to ensure existing mounting and cable reconnections can be redone without any modifications to the mounting and cables.

4.3.1.20.18. Indications, in the form of LEDs/LCDs and/or measuring instruments, shall be provided on the front outside panel of the unit to enable verification of the operational status of the inverter/UPS.

4.3.1.20.19. The indications shall be presented on a mimic with clear descriptions of the inverter/UPS component, circuit or status.

4.3.1.20.20. Green shall indicate the open position of the breakers. Red shall indicate the closed position of the breakers and White shall indicate faulty breaker status.

4.3.1.20.21. As a minimum, the following indications shall be fitted on the front face:

- Power supply voltage (V DC)
- Power supply current (A DC)
- Output voltage (V AC)
- Output current (A AC)
- DC supply healthy
- Inverter stack energised
- Inverter fault
- Phase fault

4.3.2. **Specific 1E Inverter Systems Requirements**

4.3.2.1. **LNA/B/C/D**

4.3.2.1.1. An inverter rated at 5 kVA shall provide an uninterruptable 220 V AC output, with a nominal input voltage of 125 V DC.

4.3.2.1.2. The switchboards shall be integrated into the inverter units as an outgoing section in the cabinet containing the output circuits, protection, monitoring and indication devices.

4.3.2.1.3. Further to the requirements stipulated in 4.3.1:

- The new inverter systems and switchboards shall meet the requirements in IEEE 650-2006, 'Standard for Qualification of Class 1E Static Battery Chargers and Inverters for Nuclear Generating Stations'.
- The qualification documents of these 1E inverter systems and switchboards in accordance with IEEE 650 6.3, 6.4 and 6.5 shall be generated.
- Attachment A "Specification for Seismic Qualification of Electrical and Mechanical Equipment" provides an extract from specification DSG-318-033 detailing the response spectra.

4.3.2.1.4. The 1E qualified life of the inverter system including switchboards shall be at least 40 years.

4.3.2.1.5. The maintenance regime required to ensure the 1E qualified life shall be specified by the equipment manufacturer.

4.3.3. **Specific NSF Inverter Systems Requirements**

4.3.3.1. **9LNF/G/H**

4.3.3.1.1. An inverter rated at 5 kVA shall provide an uninterruptable 220 V AC output, with a nominal input voltage of 125 V DC.

4.3.3.1.2. The switchboards shall be separate from the inverter units as an outgoing distribution of the 220 V AC section containing the output circuits, protection, monitoring and indication devices.

4.3.3.2. **LNE**

4.3.3.2.1. The LNE inverter shall constitute of 3 x 50% inverter stages connected in parallel with a single bypass common to the 3 inverter stages. It shall be rated at 90 kVA (3 x 30 kVA units) providing an uninterruptable 220 V AC output, with a nominal input voltage of 230 V DC. Its maximum load shall be limited to 60 kVA such that the battery bank and charger units do not require any modification.

4.3.3.2.2. All Inverter stages shall work as masters so to switch individual units OFF for service.

4.3.3.2.3. A communication system shall exist between paralleled inverter stages to facilitate active load sharing between inverter stages active on the LNE inverter system.

4.3.3.2.4. The switchboards shall be separate from the inverter units as an outgoing distribution of the 220 V AC section containing the output circuits, protection, monitoring and indication devices.

4.3.3.3. **0LZC**

4.3.3.3.1. An inverter rated at 10 kVA shall provide an uninterruptable 220 V AC output, with a nominal input voltage of 230 V DC.

4.3.3.3.2. The switchboards shall be separate from the inverter units as an outgoing distribution of the 220 V AC section containing the output circuits, protection, monitoring and indication devices.

4.3.3.4. **6SSC/D**

4.3.3.4.1. A 50 kVA UPS, charger rectifier and inverter unit, shall provide an uninterruptable 220 V AC output, with a normal input voltage of 230 V DC.

4.3.3.4.2. The switchboards shall be separate from the inverter units as an outgoing distribution of the 220 V AC section containing the output circuits, protection, monitoring and indication devices.

4.3.3.5. **Maintenance and Training Rig (MTR) consists of:**

4.3.3.5.1. A 5 kVA UPS, charger rectifier and inverter unit, shall provide an uninterruptible 220 V AC output, with a normal input voltage of 230 V DC battery (sealed lead acid as installed on LMK) supplied to provide a standby time of 30 minutes.

4.3.3.5.2. The switchboards shall be integrated into the inverter units as an outgoing section in the cabinet containing the output circuits, protection, monitoring and indication devices.

4.3.3.5.3. The MTR UPS shall use components common to LNi, LNE and 6SSC/D. The MTR shall closely match 6SSC/D.

4.4. **Inverter Software**

4.4.1. To provide the highest confidence in software (firmware), digital inverter systems shall be pre-qualified digital inverter system which fully complies with IEC 60880 and IEC 62138 which covers the domain of the software aspects of computer-based systems used in nuclear power plants to perform functions important to safety.

4.4.2. Documentary evidence shall be supplied which certifies full compliance of the pre-qualified design, and evidence that the equipment supplied to Eskom is identical to the pre-qualified design.

4.5. **Availability**

4.5.1. The 1E inverter system shall be available and fully functional after design basis events (DBE), and inverter transient overload conditions.

4.5.2. The hardware, including control circuitry of the inverter/UPS shall be suitable for the environmental conditions, detailed in section 5.1, during full load operation and its associated overload profile.

4.5.3. Burn in tests under full load conditions shall be carried out to minimise the possibility of early component or system failure and to prove the design.

4.5.4. The chosen supplier shall provide evidence to confirm that the minimum mean time between failures (MTBF) of the inverters/UPSs as specified below:

- MTBF rate: 200 000 hours

4.5.5. The chosen supplier shall maintain a complete spare parts programme and support capacity, for at least 20 years after installation.

4.6. **Maintenance and Maintainability**

4.6.1. As a minimum the following maintenance objectives shall be considered when selecting an inverter system:

- Accessibility
- Serviceability
- Ease of maintenance
- Inter-changeability of spares
- Minimum use of special tools and equipment
- Easy identification of faults
- Standardisation for ease of spares management during operation
- The maintenance regime shall be achievable within Koeberg's planned maintenance and outage programs

4.6.2. The Contractor shall provide failure mode and effects analyses in accordance

with 240-49230046 “Failure Mode and Effects Analysis” (FMEA) Guideline on all components/systems.

4.6.3. The contractor shall perform a maintenance regime according to AP913 and complete a QFR-026, PM Strategy Input Sheet, on all components/systems.

4.6.4. The *Contractor* shall provide a minimum spare holding of plant items upon handover, as agreed upon with Eskom. These spares shall be part of the Contractor’s work scope and should be sufficient for 5 years.

4.7. **Standardisation**

4.7.1. At Koeberg, 4 inverters were recently replaced with new Gutor type units, in position:

- KRT 001 DL: Gutor WEW 1010-125/220-EAN
- LMK 001 TB: Gutor PEW 1040-220/220-EA

4.7.2. Should the *Contractor* choose a different supplier than listed above, these 4 inverters shall be included in the scope of the inverter replacement under modification 09082.

4.7.3. The purpose for the strategy is to facilitate standardisation of the inverter systems/components and its associated spares. This shall ensure an ease of spares management, due to the inter-changeability of spares during plant operation. Furthermore, operator and maintenance personnel shall be trained on one plant type, and this shall reduce human error during plant operations and/or maintenance interventions.

4.7.4. The detailed technical requirement specifications for these inverters are attached as follows:

- KRT 001 DL: Attachment B (Extract from KBA 1215 G03 512)
- LMK 001 TB: Attachment C (Extract from KBA 1217 LMK 1003)

4.8. **Plant & Materials provided “free issue” by the Employer**

4.8.1. There shall be no free issue of plant and materials from Eskom.

4.9. **Procurement of Plant Materials**

4.9.1. The *Contractor* shall be responsible for the procurement and supply of all plant and materials required for this modification.

4.9.2. The *Contractor* shall meet the Eskom supplier’s quality requirements as specified in DSG-318-087, ‘Quality Requirements for the Procurement of Assets, Goods and Services’.

4.10. **Tests and inspections before delivery**

4.10.1. The *Contractor* shall together with Eskom ensure that the Factory Acceptance Tests and inspections are performed on the inverter systems

and switchboards.

4.11. **Specialised Equipment (including temporary works).**

4.11.1. The Employer or his nominated deputy, reserves the right to request that inspection equipment is tested for correct calibration prior to and after use at the expense of the Contractor. The Contractor shall be responsible for completing site test sheets, which will need to be completed to adequately record test information for all items of equipment provided.

4.11.2. If there is any specialised equipment required for the installation and testing of this modification, the *Contractor* shall provide Eskom with the necessary documentation of this equipment for Eskom's review and acceptance, which includes but is not limited to the following:

- calibration certificates
- manufacturing specifications
- manufacturing and test records
- supplier's certificates of conformance
- supplier's inspection and test certificates

4.11.3. Castor wheel interface points must be designed on the base of the new equipment frame to allow for the attachment of temporary castor wheels for easy manoeuvring of new equipment during installation.

5. INTERFACE REQUIREMENTS

5.1. **Environmental Conditions**

Normal Environment

Pressure	:	Atmospheric
Minimum Temperature	:	+15 ºC
Maximum Temperature	:	+35 ºC
Maximum Short Duration Temperature	:	+ 40ºC
Relative Humidity	:	85 %

5.2. **Existing interfacing**

5.2.1. The new Inverter systems shall maintain all existing interfaces to KIT (Computer and data processing system), KSA (Alarm processing system) and Power Supplies.

5.2.2. The power supplies available for the inverter systems remain the same as for the existing inverter systems, i.e. 48 V DC, 125 V DC, 230V DC, 380 V AC and 220 V AC.

5.2.3. The design shall be such that the dimensions of the new installation are similar to the existing inverter systems.

5.2.4. This design shall re-use existing cabling and prevent unnecessary cable replacements and extensions, as far as reasonably possible.

5.2.5. The *Contractor* shall evaluate the effect of this modification on plant interfaces and interrelated systems, which shall include, but is not limited to the following:

- Cabling and loading of cable trays
- Charger rectifier
- AC circuit breakers
- DC circuits breakers
- DC bus bars
- Output isolators
- Battery bank
- KSA
- KIT
- JDT (Fire detection system)
- Inverter system cabinet mounting

5.2.6. The *Contractor* shall be responsible for modifications to plant affecting an interrelated system, as impacted upon by the inverter replacement modification. Should changes be required to plant (e.g. bus bars in switchboards, mountings), the *Contractor* shall ensure that the plant maintains its qualification.

5.2.7. As far as possible the existing method of securing the inverters to the floor shall be retained.

5.2.8. Design calculations for the floor mounting/support (new or existing method) for the new inverter system shall be performed to verify its seismic resistance requirement.

5.3. **Additional interfacing requirements**

5.3.1. Digital communication Link

5.3.1.1. The new inverters shall include dual redundant digital communication ports (RJ45 Ethernet ports are preferred) to interface to the existing plant computer system.

5.3.1.2. MODBUS TCP protocol over Ethernet is preferred for the future communication link to the Plant Computer.

5.3.1.3. The Contractor shall supply all the necessary information / documentation to help facilitate the establishment of the communication link between the

inverters and plant computer.

5.3.2. The addition of a new configuration watchdog grouped alarm to KSA (white alarm) and KIT EC (hardwired to KIT I/O) to inform the operators that a parameter change (intentional or unintentional) has occurred in the inverter parameter settings, or the communication link is faulted. This alarm is required for cyber security reasons and must be separate from the KIT interface link.

5.4. **KIT, KSA and the Training Simulator**

Upgrade KIT, KSA and the Training Simulator to include the requirement of 5.3.2.

6. QUALITY ASSURANCE REQUIREMENTS

6.1. **Component Classification**

The original plant has the following classifications. Any equivalent component and/or system shall have the same classifications

6.1.1. Electrical Classification – LNA/B/C/D

Classification Number	:	0277/88Q
Safety Class	:	1E
Seismic Classification	:	1A
Quality	:	Q1
Environmental Class	:	0
Importance Category	:	CSR

6.1.2. Electrical Classification – LNE

Classification Number	:	0278/88Q
Safety Class	:	NSF
Seismic Classification	:	NC
Quality	:	Q2
Environmental Class	:	0
Importance Category	:	SR

6.1.3. Electrical Classification – 9LNF

Classification Number	:	0278/88Q
Safety Class	:	NSF

Seismic Classification : NC

Quality : Q2

Environmental Class : 0

Importance Category : SR

6.1.4. Electrical Classification – 9LNG/H

Classification Number : 0278/88Q

Safety Class : NSF

Seismic Classification : NC

Quality : Q2

Environmental Class : 0

Importance Category : NSA

6.1.5. Electrical Classification – 0LZC

Classification Number : 0278/88Q

Safety Class : NSF

Seismic Classification : NC

Quality : Q2

Environmental Class : 0

Importance Category : NSA

6.1.6. Electrical Classification – 6SSC/D

Classification Number : 0007/88Q

Safety Class : NSF

Seismic Classification : NC

Quality : Q2

Environmental Class : 0

Importance Category : NSA

6.2. **Design Quality Requirements**

6.2.1. In accordance with 331-94, ‘Importance Listing’, the importance classification for the various inverter systems involved in the new design are:

- LNA/B/C/D : CSR
- LNE : SR
- 9LNF : SR

- 9LNG/H : NSA
- 0LZC : NSA
- 6SSC/D : NSA

6.2.2. The design shall be a CSR design performed by competent authorised designers in accordance with 331-86, 'Design Changes to Plant, Plant Structures or Operating Parameters', and 331-87, 'Design Engineering Guide'.

6.2.3. Authorised design reviewers shall conduct the design review in accordance with 331-86 and 331-87.

6.2.4. The design text shall comply with GGS-1168, 'Standard for Grammar, Spelling and Notation'.

6.2.5. The design shall be submitted to the NNR for approval.

6.2.6. The *Contractor* shall be certified and demonstrate compliance with the Quality Standard applicable to the work being performed determined by RD-0034.

6.2.7. The modification affects CSR equipment, and is therefore classified CSR, with a design service of Q1 and an RD-0034 level of L1 required of the organisation performing the design service.

6.3. **Equipment Installation Quality Requirements**

6.3.1. The *Contractor* and Equipment Manufacturer shall have a quality assurance system that complies with the requirements of IAEA GS-R-3 (Q1 level) or 10 CFR 50 Appendix B.

6.3.2. The *Contractor* and Equipment Manufacturer shall be certified in accordance with ISO 9001 and shall meet the quality requirements of ASME NQA-1.

6.3.3. The *Contractor* shall demonstrate compliance with the Eskom requirements as detailed in KAA-733, 'Monitoring of the Receipt Inspection Process'.

6.3.4. The *Contractor* shall inform Eskom of the plant and material arrival on site, for the *Contractor* to perform an 'Open Package and Receipt Inspection'. Eskom shall witness the open package and receipt inspection and review all associated documentation to ensure compliance.

6.3.5. Cable installation shall be carried out in accordance with the following Koeberg specifications:

- KBA 0015 M00 007 : Earthing Circuits
- KBA 1215 K00 007 : Technical Specification for Cable Installation
- KBA 1215 K00 031 : Cable Way Equipment according to Trains and Colours

6.4. **Engineering Quality Requirements**

6.4.1. The tasks shall be executed in accordance with Section 4 of this technical requirement specification.

6.4.2. All documentation prepared by the *Contractor* needs to be approved by Eskom prior to the start of manufacture and works i.e. quality control plans, etc.

6.4.3. The *Contractor* shall provide documented proof that the inverters meet the requirements of this specification.

6.4.4. The *Contractor* shall provide Eskom with suppliers' certificates of conformance for catalogued and off-the-shelf items.

6.4.5. The *Contractor* shall ensure that the supplier is present for on-site commissioning at Koeberg. The supplier shall provide qualified personnel to assist with commissioning and possible fault-finding.

6.4.6. The *Contractor* shall issue a Certificate of Compliance (COC) once all physical work has been completed. Eskom shall then issue a Construction Status Certificate (CSC). Thereafter, the *Contractor* shall test the plant using the test program approved by Eskom.

6.4.7. Eskom reserves the right to reject any component or part that does not meet the requirements of this specification.

7. GENERAL REQUIREMENTS

7.1. **Nuclear Safety**

7.1.1. The new design shall not pose a risk to nuclear safety nor challenge nuclear safety margins.

7.1.2. The *Contractor* shall perform a safety screening and evaluation, performed in accordance with Koeberg procedure 240-143604773 [KAA-709].

7.2. **Conventional Safety and Security**

7.2.1. The new design shall not introduce additional risks to personnel or plant integrity.

7.2.2. The *Contractor* shall perform plant and safety risk assessments for the modification installation.

7.3. **Packaging, Shipping and Handling Requirements**

7.3.1. The *Contractor* shall ensure that the supplier packages the new inverter systems, ready for shipment, in accordance with the requirements of ASME NQA-1 subpart 2.2.

7.3.2. The Eskom requirements, as detailed in KBA 1215 G03 161, 'Special

instructions for packing, transportation, storage and assembling of electronic equipment', shall be complied with.

7.4. **Qualification and Competency of Staff**

Contractor staff performing the design and/or installation work shall be qualified by means of formal technical qualifications and have sufficient experience with work of a similar nature and who have been evaluated and authorised by the *Contractor.* The *Contractor* shall provide details of their experience with design and installation of similar qualified components in the tender submittal. All persons compiling the design shall be appropriately professionally registered.

The design and installation work for the 6SSC and 6SSD inverter systems will require security vetting for key staff. Appropriate measures shall be put in place to ensure that sensitive information is only available to vetted staff.

7.5. **Marking and Identification**

7.5.1. All equipment marking and identification shall be in accordance with KNPS standards with KBA 1222 F00 00.

7.5.2. The contractor shall supply and fit all equipment labels on all new equipment. Where simple replacements take place the old numbering system shall be retained.

7.5.3. All separate components as well as cabinet internal cables and wires shall be labelled with a unique identifier.

7.5.4. The labels must have chamfered edges and must be in suitable holders or attached by double sided adhesive tape approved type (3MTM type 4032 preferred).

7.5.5. Details of the equipment numbers and titles shall be supplied by Eskom.

7.5.6. New identification numbers will be issued by Eskom on request.

7.6. **Verification and Testing Requirements**

7.6.1. The Contractor shall submit a full testing and commissioning plan in accordance with KFA-006, 'Testing of Plant Modifications' and KAA-648, 'Administration and Responsibilities for Requalification Testing' and shall be submitted to the Employer for acceptance.

7.6.2. The Contractor shall produce testing and re-qualification procedures to ensure that the modification is comprehensively tested once installation is complete.

7.6.3. The scope of the testing shall include full inverter system functionality as the proposed modifications affects interfaces to other systems, KSA etc.

7.6.4. Factory acceptance testing (FAT) shall be performed to demonstrate the performance of the new inverter/UPS units. The tests shall meet the

requirements as specified in IEC 62040 parts 1 to 3.

7.6.5. Provision shall be made for Eskom personnel to witness the FAT in the factory. The offer shall indicate the number of personnel that can witness the FAT, plus the intended dates.

7.6.6. Site acceptance testing (SAT) shall be performed to demonstrate the performance of the new inverter/UPS units.

7.6.7. The site acceptance testing shall include the following tests:

- Cold commissioning tests (without power)
- Hot commissioning tests (with power)

7.7. Training Requirements

It is the responsibility of the Contractor to provide training to Eskom personnel for the plant and material being supplied.

The Contractor shall provide a training proposal, with details of the training content, including duration and location. The training proposal shall consider operator training, as well as maintenance training. As a minimum, the number of Eskom personnel requiring training is:

- 2 x Engineers
- 3 x Maintenance technicians
- 2 x Operators (instructors)

The Operator Training Group (OTG) will be responsible for the training of the Operating Department.

7.8. Documentation and Configuration Management

7.8.1. Deliverable Documents

7.8.1.1. Detailed Design

A detailed design document according to 331-86, ‘Design Changes to Plant, Plant Structures or Operating Parameters’ populated in the latest detailed design template available from Design Engineering.

The detailed design for the new inverter systems and switchboards shall take into consideration the requirements of this specification and plant conditions. The detailed design shall be submitted to Eskom for review and acceptance.

7.8.1.2. Equipment Procurement Specification

The Contractor shall be responsible for compiling a detailed procurement specification to the supplier for the new inverter systems and switchboards. It shall specify the following, but is not limited to:

7.8.1.2.1. Equipment Classification

- Classification (According to 240-89294359)

7.8.1.2.2. Industry Codes, Specifications and Standards

- IEEE, IEC standards etc.

7.8.1.2.3. Documents to be submitted by the Supplier

- List of documents for information
  - Component Technical Specification Sheets
  - Installation, Operation, Maintenance and Trouble-Shooting Manuals
  - QA Manual
  - Seismic and Environmental Qualification Test Reports
- Documentation for approval prior to manufacture
  - Detailed construction programme
  - QC Plan.
  - FAT Procedure
  - Manufacturing and Inspection Points Program

    Shall be sent to the Contractor and Eskom for approval and selection of witness and hold points
  - Packaging, shipping and storage procedure
- Quality Assurance Data Package
  - Manufacturing and Inspection Points Program filled out and approved as performed.
  - Manufacturing Inspections Certificates.
  - Certificates of Conformity

    Must certify the detailed supplies are manufactured in accordance with the technical specification of the contract, order or sub order and that, all inspections, operations and tests having been completed, the supplies comply in every respect with the relevant particular specifications, drawings and relevant standards and regulators in force. It must also include reference to, purchase order number, qualification test report, specification and/or drawing applied, list of components included in the supply and serial and/or batch number of the equipment.
  - Factory Acceptance Test certificates.
  - Contractor Quality Release also signed off by the manufacture.
  - Deviation Notices, If any.

The procurement specification shall be submitted to Eskom for review and acceptance before the equipment is ordered.

7.8.1.3. **Manufacturing and Test Records**

The *Contractor* shall be responsible for collating the equipment manufacturing and test records for submission to Eskom for review and acceptance.

7.8.1.4. **Equipment Qualification Reports**

The *Contractor* shall be responsible for collating the equipment qualification (1E) reports for submission to Eskom for review and acceptance.

7.8.1.5. **Configuration Control File**

The *Contractor* shall be responsible for assessing the impact of this modification on existing Koeberg documentation as well as new documentation to be added to the existing documentation. This includes, but is not limited to:

- DSE
- MB
- Training
- Procedures
- Drawings

The Contractor shall compile a configuration control file listing all documents to be removed, added or modified.

7.8.1.6. **Quality Assurance Data Package**

The *Contractor* shall supply a detailed Quality Assurance Data Package (QADP) that includes, but is not limited to, documents cited in 7.8.1.

7.8.1.7. **Spares List**

The Contractor shall supply a list of recommended spares for the system. This list shall include prices, guaranteed supply period and the recommended routine maintenance required to maintain maximum availability, as well as an indication as to which spares are considered critical spares.

7.8.2. **Configuration Management**

7.8.2.1. The Koeberg Modification Process as prescribed in KAA-501 shall be adhered to during all phases of the Inverter system modification.

7.8.2.2. All equipment manuals shall be added to the documentation system. If a system or maintenance manual does not exist for the system or sub-system, one shall be created. If one exists, it shall be comprehensively updated.

7.8.2.3. The Maintenance and Engineering Documentation to be included in the DSE or Maintenance Manual shall be as per standard Koeberg practices and style.

7.8.2.4. All existing drawings and documentation that will be affected by this project shall be updated as part of the documentation for this project.

7.8.2.5. All documents and drawings shall be signed and approved by an ECSA professionally registered qualified engineer, or an equivalent as approved by

Eskom in accordance with ECSA guidelines.

7.8.2.6. All drawings, data and technical documents supplied to Eskom by the contractor shall be in English language with SI system of measurements. These requirements apply to manufacturing drawings. The drawings, data and technical documents shall be submitted in accordance with the requirements stated in this specification.

7.8.2.7. The contractor shall complete and submit procedures for Eskom's review and approval in the form of two sets of hard copies and electronic media. This includes procedures for fabrication, inspection, testing, cleaning, storage, handling, packaging, coating, and shipping. This applies to requirements and guidelines for the installation, operation, and maintenance procedures as well as maintenance bases and training material.

7.8.2.8. Documents shall be supplied in electronic form in either Word or PDF format.

7.8.2.9. Hard copies of documents submitted for review and approval shall be in the form of two sets of clear, legible, full-size paper copies of reproducible quality.

7.8.2.10. Hard copies of the final submittal of Contractor's documentation shall be in the form of three sets of clear, legible, full-size paper copies of reproducible quality suitable for microfilming and/or scanning.

7.8.2.11. Final computer aided drafting (CAD) drawings (i.e. vendor equipment drawings) in shall be supplied in order of extension preference: Microstation™ (any version). dgn; autoCAD™ (version 2002 and below) .dwg; drawing exchange format (any version) .dxf.

7.8.2.12. The contractor shall demonstrate that the CAD drawings are clearly transferrable to Eskom's system before any bulk submission.

7.8.2.13. All drawings to have drawing numbers issued by Eskom prior to submission.

7.8.2.14. All symbols shall be used as specified in the Koeberg document KBA 0000 G00 1000 (Koeberg Standard Graphic Symbols).

7.8.2.15. The final documentation and drawing submitted electronically to Eskom shall be from the signed, approved, final as-built original.

7.8.2.16. Eskom will review all documentation.

7.8.2.17. The *Contractor* shall submit the supplier's detailed Installation Instructions for the inverter units.

7.8.2.18. Eskom shall have complete and unrestricted ownership rights to all technical reports, drawings, designs, (except computer codes that constitute a pre-existing program or method and are designated as proprietary to the contractor), procedures and other written information developed solely for Eskom by the contractor during its performance under the contract.

7.8.2.19. The contractor shall provide all documents necessary to fully operate and modify the Inverter system in-situ.

8. REFERENCES

8.1.	DSG-318-087	Quality Requirements for the Procurement of Assets, Goods and Services.
8.2.	ESKASAAU7	Quality Requirements for the Procurement of Assets, Goods and Services
8.3.	GGS-1168	Standard for Grammar, Spelling and Notation.
8.4.	IAEA GS-R-3	The Management System for Facilities and Activities
8.5.	IEEE 323-2003	Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations
8.6.	IEEE 344-2004	Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Generating Stations
8.7.	KAA-501	Modifications to the Plant, Plant Structures or Operating Parameters that affect the Design Base
8.8.	KSU-002	Design Control
8.9.	331-83	Requirements for Plant Changes affecting the Design of Koeberg Nuclear Power Station
8.10.	331-85	Design Documentation Change Process
8.11.	331-86	Design Changes to Plant, Plant Structures or Operating Parameters
8.12.	331-87	Design Engineering Guide
8.13.	331-93	Guide for Classification of Plant Components, Structures and Parts
8.14.	331-94	Importance Category Classification Listing
8.15.	331-433	Detailed Design Review Report
8.16.	KAA-664	Issuing a Construction Status Certificate/Safety Clearance Certificate
8.17.	KAA-648	Administration and Responsibilities for Requalification Testing
8.18.	KAA-733	Monitoring of the Receipt Inspection Process
8.19.	KAA-913	Integrated Equipment Reliability Process
8.20.	KSA-132	Lifting and Rigging Program
8.21.	240-143604773	Process for Performing Safety Evaluations, Screenings and Justifications (KAA 709)

8.22.	240-49230046	Failure Mode and Effects Analysis (FMEA) Guideline
8.23.	240-89294359	Nuclear Safety, Seismic, Environmental, Quality, Importance and Management System Level Classification Standard
8.24.	KBA 0015 M00 007	Earthing Circuits
8.25.	KBA 1215 G03 512	1/2 KRT 001 DL Gutor Inverter Technical Specification
8.26.	KBA1217 LMK 1003	1/2 LMK 001 TB Gutor Inverter Technical Specification
8.27.	KBA 1215 K00 007	Technical Specification for Cable Installation
8.28.	KBA 1215 K00 031	Cable Way Equipment according to Trains and Colours
8.29.	KBA 1215 G03 001	Technical Specification, 5 kVA and 20 kVA inverters, Non class
8.30.	KBA 1215 G03 140	Electrical Characteristics, 5 kVA non class
8.31.	KBA 1215 G03 143	Electrical Characteristics, 20 kVA non class
8.32.	KBA 1217 LNI 800	Equipment Specification, LNI System, Vital Source 220 V AC Production and Distribution boards
8.33.	KBA 1222 F00 001	Equipment Marking
8.34.	KBA 1215 G03 161	Special instructions for packing, transportation, storage and assembling of electronic equipment
8.35.	KBA 1216 G01 055	Engraved Labels and Marker Plates – Lettering and Colouring Specifications
8.36.	KBA 1216 J10 317	Indicating Label Definition
8.37.	KBA1216 G01 055	Engraved Labels and Marker Plates – Lettering and Colouring Specifications
8.38.	KBA 0000 G00 1000	Koeberg Standard Graphic Symbols
8.39.	KFA-006	Testing Procedure for Plant Modifications
8.40.	KFA-007	Design Field Changes
8.41.	KFA-035	Design Change Package Implementation Approval Form
8.42.	KSA-011	The Requirements for Controlled Documents
8.43.	MM 316	Inverter Maintenance Manual
8.44.	SAR	Safety Analysis Report

8.45.	QFR-026	PM Strategy Input Sheet
8.46.	RD-0034	Quality and Safety Management Requirements for Nuclear Installations
8.47.	36-698	Quality requirements for Engineering and Construction Works and Generation
8.48.	238-101	Quality and Safety Management Requirements for Nuclear Suppliers Level 1

9. ATTACHMENTS

Attachment A: Specification for Seismic Qualification of Electrical and Mechanical Equipment Extract from DSG 318 -033

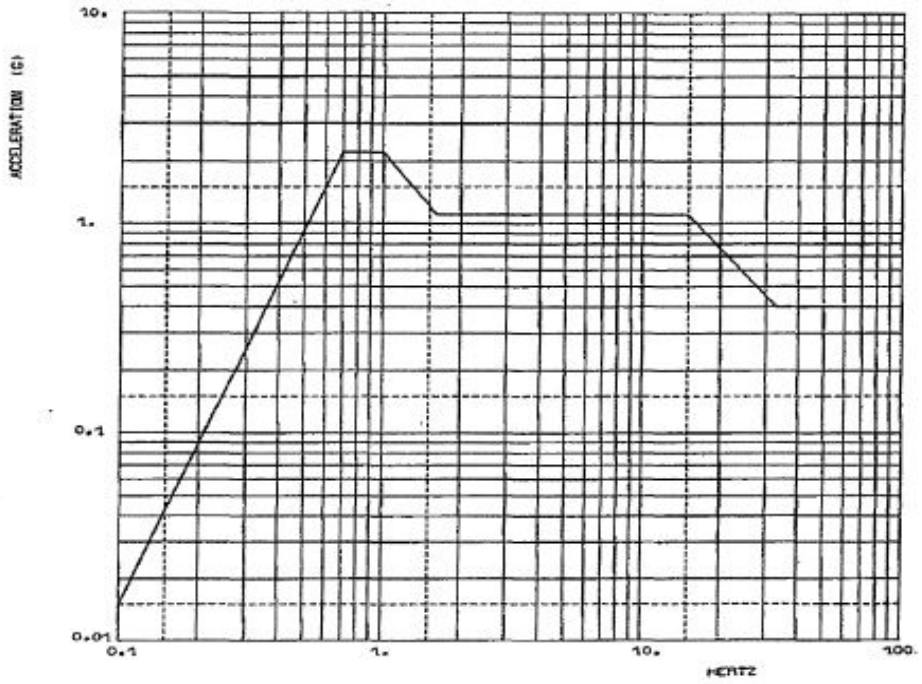
Attachment B: 1/2 KRT 001 DL Gutor Inverter Technical Specification

Extract from KBA 1215 G03 512

Attachment C: 1/2 LMK 001 TB Gutor Inverter Technical Specification Extract from KBA 1217 LMK 1003

Attachment A: Specification for Seismic Qualification of Electrical and Mechanical Equipment Extract from DSG 318 -033

Appendix 8.2: Koeberg Seismic Island Horizontal Envelope Floor Response Spectrum (2% damping)

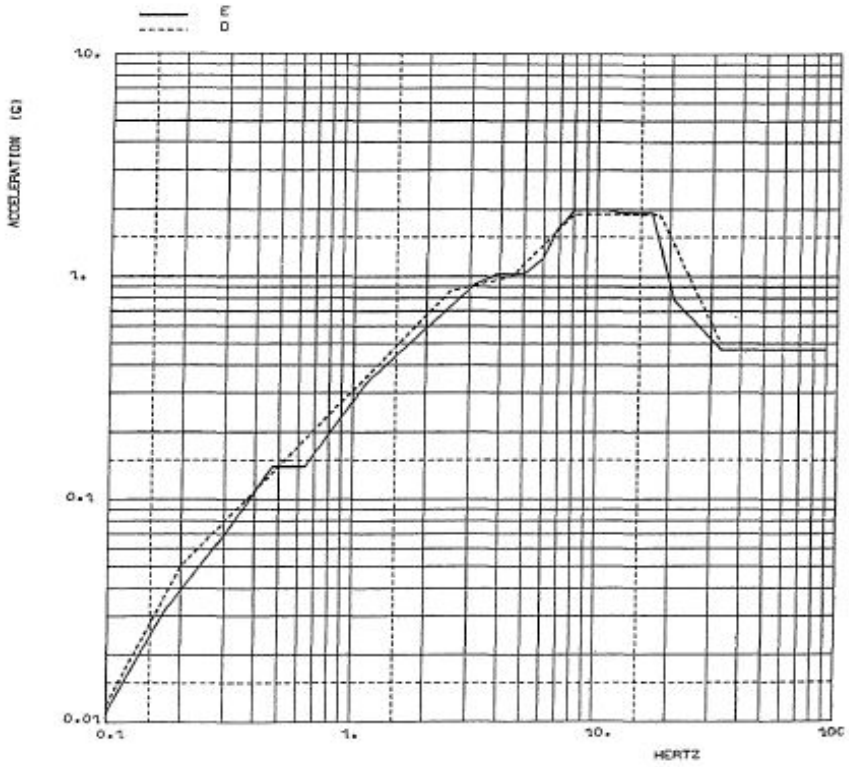


HERTZ	ACCELERATION (G)
0.10	0.015
0.30	2.20
1.00	2.20
1.61	1.10
15.0	1.10
33.0	0.40
80.0	0.40

Attachment A: Specification for Seismic Qualification of Electrical and Mechanical Equipment Extract from DSG 318 -033

Reference	Rev	Page
DSG-318-033	2	19 of 19

Appendix 8.3: Koeberg Seismic Island Vertical Envelope Floor Response Spectrum (2% damping)



HERTZ	ACCELERATION (G)
0.10	0.011
0.17	0.031
0.31	0.072
0.47	0.14
0.64	0.14
1.16	0.34
3.14	0.92
3.87	1.02
5.00	1.02
6.00	1.20
6.71	1.58
8.06	1.99
10.9	1.99
12.3	1.93
16.7	1.93
21.0	0.78
33.0	0.47
90.0	0.47

Attachment B: 1/2 KRT 001 DL Gutor Inverter Technical Specification
(Extract from KBA 1215 G03 512)

TECHNICAL DATA
of
INVERTER SYSTEM, Type: WEW 1010-125/220-EAN
Item #: 1 KRT 001 DL & 2 KRT 001 DL

TABLE OF CONTENTS:

	Revision 1 (A)	Revision 2 (B)	Revision 3 (C)	Revision 4 (D)	Revision 5 (E)	Revision 6 (F)	Revision 7 (G)
prepared: Dat./Vis.	11-06-30 mp						
approved: Dat./Vis.	11-06-30 HAA						
released: Dat./Vis.	11-06-30						

arised from: 7RA9221GB

Client Ref.: - - -

GUTOR by Schneider Electric
GUTOR Electronic LLC
Wettingen / Switzerland

4A-1110059001/23GB | Rev. 1 | Page 1 / 5

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TECHNICAL DATA — WEW 1010-125/220-EAN

1. SYSTEM CONFIGURATION

One complete Inverter system is consisting of:

Pcs:

1 Inverter incl. Static Switches EA & EN

1 Manual bypass switch with 3 switching positions

1 Bypass mains Stabilizer

1 Distribution

2. MECHANICAL SPECIFICATION

INVERTER

Enclosure	:	The Inverter is housed in a free-standing, fully metal enclosed cabinet arranged for floor mounting.
Arrangement / Dimensions	:	see drawing: 1110059001/00 Chapter 01
Protection class (according to IEC 60529)	:	IP 21
with open doors	:	IP 20, Operator protection
Painting	:	RAL 5002 (MUNSELL: 7.5PB3/10)
Inside and Top covering	:	galvanized
Ventilation	:	Internal fans. Air inlet in the back and in front below, outlet on the top
Cable entry	:	from bottom
Terminal size	:	see drawing: 1110059001/00 Chapter 04
Weight total (without Distribution)	:	815 kg

3. GENERAL SPECIFICATION

Installation altitude with full rating	:	max. 1000m ASL
With derating of 7% per additional 1000m	:	max. 4000m ASL
Ambient temperature range, at air inlet		
- for operation (100 % nominal load)	:	-10 °C .... +40 °C
- with derating at increased air throughput	:	max. 55 °C
- for storage	:	-20 °C .... +70 °C for systems

TECHNICAL DATA — WEW 1010-125/220-EAN

Relative air humidity		:	≤ 95%, not condensing
Audible Noise level (1 m height, 1 m distance)			
with Standard N+1 Fans	approx.	:	60...70 dBA (depending on type)
100 % redundant Fans	approx.	:	65...75 dBA (depending on type)
Reliability MTBF with Bypass		:	> 200000 h
Functional (performance) test		:	IEC / EN 62040-3
General and Safety requirements		:	IEC / EN 62040-1-2
EMC requirements		:	IEC 62040-2
Quality assurance		:	ISO 9001

4. ELECTRICAL SPECIFICATION OF ONE SYSTEM UNIT

BYPASS MAINS TRANSFORMER

Rated power		:	10 kVA
Input voltage		:	380V AC ± 10%, 3 ph, 3 wire
Input frequency		:	50 Hz ± 6%
Input current (at rated power)	$I_1 = I_3 =$	:	15.8 A AC
	$I_2 =$	:	31.6 A AC
External protection	(gG Type)	:	50 A AC
Output voltage		:	220 VAC, 1 ph
Output voltage regulation		:	± 2 %
Nominal output current		:	45.5 A AC
Short circuit impedance	Bypass transformer / stabilizer	:	7 %
Short circuit current	(rms)	:	14 x output current (infinite low impedance of the supply source assumed)

INVERTER

Nominal input voltage		:	125 V DC
Input voltage tolerance			
- for adherence to the output data		:	- 15 % / + 20 %
- for adherence to the function		:	± 25 %

TECHNICAL DATA — WEW 1010-125/220-EAN

Input current at load cos φ 1.0

at Nominal input voltage	100% Load	:	95 A DC
at "Low DC voltage - Warning"	100% Load	:	108 A DC
at "Low DC voltage - Warning"	150% Load	:	163 A DC
External protection	(gG Type)	:	200 A DC
Output rating		:	10 kVA
Power factor range		:	0,4 ind. .... 0,9 cap.
rated for		:	cos φ 0.8 lag
Output voltage		:	220 VAC, 1 ph
Output voltage regulation		:	± 1 %
Output frequency		:	50 Hz
Output frequency regulation, not synchronized		:	± 0,01 %

Output current	nominal	100%	:	46 A AC
	short-circuit for 0...100ms	200%	:	91 A AC
	overload for 0...1min	150%	:	68 A AC
	overload for 1...10min	125%	:	57 A AC
	overload continuous	105%	:	48 A AC

Efficiency at nominal load : 85 %
Tolerances according to IEC 60146-2

Distortion factor	total, with linear load	:	< 4 %
	any individual harmonic	:	< 3 %
	with non-linear load according to IEC / EN 62040-3	:	5 %

STATIC SWITCH EN (BYPASS)

Output current	nominal	100%	:	46 A AC
	overload for 0...1min	150%	:	68 A AC
	overload for 1...10min	125%	:	57 A AC
	overload for 100ms	1000%	:	455 A AC

DISTRIBUTION ► see drawing: 1110059001/00 Chapter 04

SYSTEM

Overall efficiency : 85 %
Tolerances according to IEC 60146-2

TECHNICAL DATA — WEW 1010-125/220-EAN

5. ADJUSTMENTS

INVERTER

			Possibilities	Settings
DC Earth fault current		:		30mA
Low DC voltage	Warning	:		109 V DC
	Shutdown	:		96 V DC
High DC voltage	Warning	:		157 V DC
	Shutdown	:		170 V DC
Synchronization range		:	±0,5/1/2/4/6 %	± 6%
Slewrate		:	0,25/0,5/1/2/4 Hz/s	1 Hz/s

SYSTEM

		Possibilities	Settings
Delay of Common Alarm relay	:	0...327 s	5 s

6. OPERATIONAL PARAMETERS

		Possibilities	Settings
Second language in Display	:	**Two languages:** CZ / DE / DK / ES / FI / FR / HU / IT / NL / NO / PL / PT / RU / SE / SK	**DE + GB**
Autostart	:	ON/OFF	**OFF**
Bypass operation	:	ON/OFF	
Adaptive slewrate	:	ON/OFF	

Attachment C: 1/2 LMK 001 TB Gutor Inverter Technical Specification
(Extract from KBA1217 LMK 1003)

TECHNICAL DATA
of
UPS SYSTEM, Type: PEW 1040-220/220-EA
Item #: 1 LKM 001 TB & 2 LKM 001 TB

TABLE OF CONTENTS:

	Revision 1 (A)	Revision 2 (B)	Revision 3 (C)	Revision 4 (D)	Revision 5 (E)	Revision 6 (F)	Revision 7 (G)
prepared: Dat./Vis.	10-03-29 mp						
approved: Dat./Vis.	10-03-29 SMI						
released: Dat./Vis.	10-03-29						

arised from: 7RA9021GB

Client Ref.: -

GUTOR by Schneider Electric

GUTOR Electronic LLC
Wettingen / Switzerland

4A-1100040001/23GB | Rev. 1 | Page 1 / 6

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TECHNICAL DATA — PEW 1040-220/220-EA

1. SYSTEM CONFIGURATION

One complete UPS system is consisting of:

Pcs:

- **1 Rectifier / Charger**
- **1 Inverter incl. Static Switch EA**
- **1 Battery Fuse Box**
- **1 Battery**
- **1 Distribution**

2. MECHANICAL SPECIFICATION

UPS

Enclosure	:	The UPS is housed in a free-standing, fully metal enclosed cabinet arranged for floor mounting.
Arrangement / Dimensions	:	see drawing: 1100040001/00 Chapter 01
Protection class (according to IEC 60529)	:	IP 41
....with open doors	:	IP 20, Operator protection
Painting	:	RAL 5002
Inside and Top covering	:	galvanized
Ventilation	:	Internal fans. Air inlet in the back and in front below, outlet on the top
Cable entry	:	Power cables: from bottom Signal cables: from top
Terminal size	:	see drawing: 1100040001/00 Chapter 04
Weight .... total (without Distribution)	:	1100 kg

BATTERY FUSE BOX ⟶ see drawing: 1100040001/00 Chapter 30

BATTERY

Mounting	:	The battery is mounted in prefabricated modules.

TECHNICAL DATA — PEW 1040-220/220-EA

Arrangement / Dimensions	:	see drawing: 1100040001/00 Chapter 02	
Weight	:	3240 kg	
Number of cells	:	1 string x 108 cells (18 blocks)	
Manufacturer	:	EXIDE	
Type	:	6-90A09	
Capacity	:	344 Ah / 8 h	
Autonomy ..... total	:	20 min	at Load 40 kVA, p.f. 0.8 lag ambient temperature 20 °C

3. GENERAL SPECIFICATION

Installation altitude with full rating	:	max. 1000m ASL
With derating of 7% per additional 1000m	:	max. 4000m ASL
Ambient temperature range, at air inlet		
- for operation (100 % nominal load)	:	-10 °C .... +40 °C
- with derating at increased air throughput	:	max. 55 °C
- for storage	:	-20 °C .... +70 °C for systems (for batteries in accordance with manufacturer data)
Relative air humidity	:	≤ 95%, not condensing
Audible Noise level (1 m height, 1 m distance)		
with Standard N+1 Fans ..... approx.	:	60...70 dBA (depending on type)
100 % redundant Fans ..... approx.	:	65...75 dBA (depending on type)
Reliability MTBF with Bypass	:	> 200000 h
Functional (performance) test	:	IEC / EN 62040-3
General and Safety requirements	:	IEC / EN 62040-1-2
EMC requirements	:	IEC 62040-2
Quality assurance	:	ISO 9001

TECHNICAL DATA — PEW 1040-220/220-EA

4. ELECTRICAL SPECIFICATION OF ONE SYSTEM UNIT

RECTIFIER

Mains input power	max.	: 67.8 kVA
Input voltage	(3ph, PE)	: 3 x 380 V AC
- Tolerance — DC in tolerance		: + 15 / - 10 %
- Tolerance — for function		: + 15 / - 15 %
Input current	max.	: 103 A AC
Input frequency		: 50 Hz ±8%
External protection	(gG type)	: 125 A AC
Power factor		
- at nominal mains and float charge		: ≈ 0,90 ind.
- at - 10 % mains and float charge		: ≈ 0,96 ind.
- at + 10 % mains and float charge		: ≈ 0,85 ind.
Nominal voltage of DC intermediate circuit	max.	: 220 VDC
Static voltage control tolerance		: ± 1 % (IU-characteristics)
Making behaviour		: Electronic softstart
Efficiency at rated load		: 94.0 %
Tolerances according to IEC 60146-2		

INVERTER

Nominal input voltage		: 220 V DC
Input voltage tolerance		
- for adherence to the output data.		: - 15 % / + 20 %
- for adherence to the function		: ± 25 %
Input current at load cos φ 1.0		
at Nominal input voltage	100% Load	: 204 A DC
at "Low DC voltage - Warning"	100% Load	: 238 A DC
at "Low DC voltage - Warning"	150% Load	: 357 A DC
Output rating		: 40 kVA
Power factor range		: 0,4 ind. .... 0,9 cap.
rated for		: cos φ 0.8 lag
Output voltage		: 220 VAC, 1 ph
Output voltage regulation		: ± 1 %

TECHNICAL DATA — PEW 1040-220/220-EA

Output frequency		:	50 Hz
Output frequency regulation, not synchronized		:	± 0,01 %
Output current	nominal 100%	:	182 A AC
	short-circuit for 0...100ms 200%	:	382 A AC
	overload for 0...1min 150%	:	273 A AC
	overload for 1...10min 125%	:	227 A AC
	overload continuous 105%	:	191 A AC
Efficiency at nominal load		:	89 %
Tolerances according to IEC 60146-2			
Distortion factor	total, with linear load	:	< 4 %
	any individual harmonic	:	< 3 %
	with non-linear load according to IEC / EN 62040-3	:	5 %

BATTERY MCCB

Voltage		:	500 V DC
Current		:	350 A DC

SYSTEM

Overall efficiency		:	84 %
Tolerances according to IEC 60146-2			

5. ADJUSTMENTS

RECTIFIER / BATTERY

Float charge voltage		:	243 V DC
Boost charge voltage		:	254 V DC
	time interval	:	12 h
Total current limitation		:	250 A DC
Battery current limitation		:	50 A DC
Rectifier High DC voltage	Shutdown	:	284 V DC

TECHNICAL DATA — PEW 1040-220/220-EA

INVERTER

			Possibilities	Settings
Low DC voltage	Warning	:		189 V DC
	Shutdown	:		173 V DC
High DC voltage	Warning	:		280 V DC
	Shutdown	:		302 V DC
Synchronization range		:	±0,5/1/2/4/6/8 %	± 6%
Slewrate		:	0,25/0,5/1/2/4 Hz/s	1 Hz/s

SYSTEM

		Possibilities	Settings
Delay of Common Alarm relay	:	0...327 s	5 s

6. OPERATIONAL PARAMETERS

		Possibilities	Settings
Second language in Display	:	**Two languages:** CZ / DE / DK / ES / FI / FR / HU / IT / NL / NO / PL / PT / RU / SE / SK	**DE + GB**
Autostart	:	ON/OFF	OFF
Bypass operation	:	ON/OFF	N/A
Boost charge	:	ON/OFF	
Autoboost	:	ON/OFF	OFF
Adaptive slewrate	:	ON/OFF	
Battery capacity Test	:	ON/OFF	
Battery monitor Test	:	ON/OFF	
Battery monitor Reset	:	ON/OFF	