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| Assets Planning and Delivery GroupEngineering |

DESIGN STANDARD DS 26-34

Type Specifications – Electrical

Type Specification

for High Voltage System Active Filter

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| JUNE 2023 |

**FOREWORD**

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

[Overview of Western Australia’s Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)](https://www.dmirs.wa.gov.au/sites/default/files/atoms/files/overview_general_regulations.pdf)

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**Head of Engineering**

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**The revision status of this standard is shown section by section below.**

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DESIGN STANDARD DS 26-34

Type Specifications – Electrical

Type Specification for

High Voltage System Active Filter

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# General

* + - * 1. This Specification covers the requirements for the design, manufacture, assembly, factory testing and delivery of an active filter and an associated power coupling transformer which together are suitable for reducing the level of non zero sequence harmonic currents taken from an incoming power supply system by A.C. variable speed drives which are connected directly or by transformer to a Water Corporation High Voltage electrical installation.
				2. This Specification shall be read in conjunction with Water Corporation Type Specification DS26.16 - Type Specification for Dry Type Step Down Transformer which in turn shall be read in conjunction with the Annexure to this Specification.
				3. The active filter shall operate at Low Voltage and shall be coupled to the High Voltage system via a power transformer and monitoring current transformers.
				4. The active filter shall be supplied to site complete with the power coupling transformer and all necessary accessories and miscellaneous material, minor parts and other such items to complete assembly, testing and commissioning of the active filter.
				5. The Contractor shall return to the site to commission the active filter once the work specified at Clause 5 to be done by the Principal has been completed.

# Site

The location of the site for the installation of the active filter and the power coupling transformer shall be as shown in the Annexure. The type of access to the site is as shown in the Annexure.

# Ambient Conditions

* + - * 1. The active filter shall be suitable for operation at maximum load, provided that the active filter is mounted on firm foundations, in a well ventilated area without excessive dust or aggressive gases where the ambient conditions do not exceed the following values:

Maximum temperature: 50 °C

 Temperature derating: nominal rated current at 40°C, derated continuously with increasing temperature to not less than 60% of nominal rated current at 50°C.

Maximum Average Daily Temperature: 35 °C

Maximum Relative Humidity: 95% non condensing

Contamination Levels: IEC 60721-3-3 chemical class 3S2

 IEC 60721-3-3 mechanical class 3S2

* + - * 1. The ambient conditions for the power coupling transformer shall be as shown in the Annexure to the attached specification for same.

# Operating Mode

* + - * 1. The active filter shall operate by taking harmonic currents 180 degrees out of phase with the harmonic currents taken by the non linear loads, thus reducing the magnitude of harmonic currents taken from the incoming supply.
				2. The active filter shall not generate reactive power and control power factor.

# Work by the Principal

* + - * 1. The High Voltage current transformers providing the input current signal to the active filter will be provided by the Principal.
				2. The connection of the active filter to the associated power coupling transformer and the connection of active filter to the associated current transformers will be carried out by the Principal.
				3. Any other work to be performed by the Principal shall be as specified in the Annexure.

# Information to be Provided by the Contractor

The Contractor shall provide the following information in respect to the active filter and the power coupling transformer within the listed number of days after receipt of the Principal’s order.

(a) General Arrangement Drawings 28 days

(b) Electrical Wiring and Schematic Drawings 28 days

(c) Manufacture and Delivery Schedule 14 days

(d) Inspection and Test Plan 35 days

(e) Test Certificates On Delivery

(f) Operating and Maintenance Manual On Delivery

# Drawings

* + - * 1. The Contractor shall submit two A3 copies of the Drawings for acceptance. The drawings shall detail the general arrangement, circuit diagrams (power and control) and equipment specifications.
				2. All drawings provided by the Contractor shall be in accordance with the latest edition of the relevant Australian Standards and shall be available in electronic format.
				3. Adequate contrast shall be maintained between drawing detail and background, and the clarity and quality of the drawings shall enable the Principal to microfilm the prints and to reproduce by photographic processes clear and legible A3 copies for record purposes.
				4. The drawings shall provide, in the title block, the number and the title of the Contract, as well as details to identify the drawing, its contents, revision status and date of issue.
				5. Drawings shall be prepared on Al metric size drawing sheets, incorporating the Principal’s border and title block.

# Standards

* + - * 1. The workmanship, equipment and materials provided in accordance with this Specification shall comply in design, construction, rating and performance with the current relevant Australian Standards and Codes. In their absence, the equipment shall comply with relevant International Standards together with the requirements of competent Authorities having jurisdiction over all or part of the manufacture, installation and operation of the equipment.

 The equipment shall be in accordance with the requirements of AS 3000 and with the further requirements of this Specification.

* + - * 1. Specific reference is made in this Specification to the following national and international standards:

AS 3000 Electrical Installations

AS 60044.1 Instrument Transformers

 Part 1 Current transformers (IEC 60044.1)

AS60076.1 Power transformers – General (IEC 60076.1 modified)

AS 60146.1.1 Semiconductor Converters - General requirements and line commutated converters – Specifications of basic requirements (IEC 60146.1.1)

AS 60146.1.3 Semiconductor Converters - General requirements and line commutated converters – Transformers and reactors (IEC 60146.1.3)

AS 60269.4.1 Fuses - Low Voltage fuses - Supplementary requirements for fuse links for the protection of semiconductor devices

AS61800.3 Adjustable speed electrical power drive systems EMC requirements and test methods (IEC 618000.3)

AS 60529 Degrees of Protection Provided by Enclosures for Electrical Equipment (IEC 60529)

AS/NZS 61000.6.2 Electromagnetic compatibility – Generic Standards – Immunity standards for industrial environments (IEC61000.6.2)

AS/NZS 61000.6.4 Electromagnetic compatibility – Generic Standards – Emissions standards for industrial environments (IEC61000.6.4)

AS/NZS ISO 9001 Quality Management Systems – Requirements

IEC 60721-3-3 Classification of environmental conditions

 Section 3.3 Stationary use at weather protected locations

IEC 62208 Empty enclosures for low voltage switchgear and controlgear assemblies

IEEE Std C57.110 Recommended practice for establishing transformer capability when supplying non sinusoidal load currents

ISO 9223 Corrosion of metals and alloys – classification of corrosivity of atmospheres.

# Electromagnetic Compatibility

The active filter shall comply with electromagnetic compatibility standards AS/NZS 61000-6-4 and AS/NZS 61000-6-2 and shall carry the CE-Mark certifying as such. The equipment shall also be entitled to carry the Australian C-tick mark.

# Quality Assurance

The active filter and associated power coupling transformer shall be manufactured under a Quality System certified by an Accredited Authority to be in accordance with AS/NZS ISO 9001 or an approved equivalent.

# Electrical Work

All electrical work shall be performed by appropriately qualified and experienced personnel who shall hold a current electrical worker’s licence to perform such work.

# Active Filter System Description

The active filter system shall consist of an active filter, a set of High Voltage current transformers and a power coupling transformer which connects the active filter output to the High Voltage system.

# Power Coupling Transformer Description

## Transformer Description

* + - * 1. The power coupling transformer shall be a separately mounted dry type transformer in accordance with Type Specification DS26.16 and the project related Annexure thereto.
				2. The transformer winding connections shall be Dy1 in accordance with AS 60076.1, ie the High Voltage winging shall be delta connected, the Low voltage winding shall be star connected, and the phase shift High Voltage to Low Voltage shall be minus 30 degrees.
				3. The star point of the secondary (ie Low Voltage) winding shall be directly earthed, but the star point of the primary (ie High Voltage) winding shall be left unearthed.

## Voltage Ratings

1. The nominal voltage of the High Voltage winding of the power coupling transformer shall be as shown in the Annexure to this Specification (and repeated in the attached Annexure to Type Specification DS26.16).
2. The nominal voltage of the Low Voltage winding of the power coupling transformer shall be matched to the voltage rating of the active filter as specified clause 18.3.

## Power Rating

The 50 Hz kVA rating of the transformer shall be the next transformer standard size greater than the size necessary to pass the harmonic currents specified in the Annexure without exceeding the transformer’s rated temperature rise with the transformer operating under the specified maximum ambient conditions (as further defined in Type Specification DS26.16)

## Impedance

The power coupling transformer impedance shall be 4.5% ± 0.5%

# L.V. Connection

The Low Voltage power circuit between the power coupling transformer and the active filter shall be 3 wire and earth, i.e. no neutral connection shall be made between the power coupling transformer and the active filter.

# Control Signals

1. The active filter in conjunction with the power coupling transformer shall operate by injecting into the High Voltage mains harmonic currents of the same magnitude as the harmonic currents generated by the associated converters, but 180 degrees out of phase with same.
2. The converter generated harmonic currents shall be measured by current transformers located on the line side of the power connecting transformer point of connection to the High Voltage mains.
3. The current transformers will be supplied and installed by others.
4. Connection of current transformer secondary circuits to the active filter shall be 6 wire.
5. The active filter shall be provided with a phase angle correction function in order to compensate for the phase shift through the power connecting transformer, so that the harmonic currents injected into the High Voltage mains via the power connecting transformer are 180 degrees out of phase with the harmonic currents generated by the associated converters.
6. Phase angle compensation may be achieved either by the provision of Dy1 connected input signal current transformers or by other approved means specified in the Contractor’s Tender Response Schedule.

# Current Transformers

## Voltage and Current Ratings

1. The primary voltage rating of the current transformers will be the same as shown in the Annexure for the primary voltage rating of the power coupling transformer.
2. The primary current rating of the current transformers will be as shown in the Annexure.
3. The secondary current rating of the current transformers will be 1 amp or 5 amps as specified in the Annexure.

## Accuracy Class

The current transformers will be 50 Hz. Class 0.5M metering current transformers in accordance with AS 60044.1.

## Burden

The burden of the active filter current measuring circuit shall not exceed 15 VA. The Principal will ensure that the current transformers have sufficient capacity to drive this burden together with the burden of the cables connecting the current transformers to the active filter.

# Active Filter Description

## General

The active filter shall comply with the requirements of AS 60146.1. The active filter shall consist of the following components all as described hereunder:

(a) filter short circuit protection device

(b) a filter capacitor pre-charging network

(c) line reactors

(d) an inverter switching frequency filter

(e) an IGBT inverter

(f) an IGBT inverter controller

(g) a filter system man-machine interface

(h) a filter cooling system and

(i) an overall enclosure.

## Active Filter Enclosure

1. The active filter enclosure shall be floor mounted.
2. The active filter enclosure shall be in accordance with the requirements of IEC 62208.

## Filter Short Circuit Protection Device

The active filter shall be protected against short circuit faults by appropriately rated semiconductor protection fuses in accordance with AS 60269.4.1. Alternatively the active filter shall be protected against short circuits by a fast acting circuit breaker having an adequate short time current rating.

## Filter Capacitor Pre-charging Network

The active filter shall be provided with a precharging network to limit the initial inrush current. The active filter precharging network shall be bypassed once capacitors are charged.

## Line Reactors

* + - * 1. Line reactors shall be in accordance with AS 60146.1.3.
				2. Line reactors shall be air cooled.

## Inverter Switching Frequency Filter

* + - * 1. The inverter switching frequency filter shall be of the L/C type and shall (or L/R/C type) and shall prevent inverter switching frequency currents being injected into the supply network.
				2. The high frequency power port disturbance voltage emission shall not exceed the limits specified for Class 4 in AS 61800.3 (IEC 61800.3).

## Inverter

* + - * 1. The inverter shall be in accordance with AS 60146.1 Part 1.
				2. The inverter shall be of the pulse width modulated type employing IGBT power transistors.
				3. The power circuits in the inverter shall be optically isolated from the control circuits.

## Controller

* + - * 1. High Voltage current transformers measuring the harmonic currents being taken from the incoming power supply shall provide the input signal to the controller.
				2. The controller shall operate under closed loop control to reduce the level of these harmonic currents to preset levels.
				3. The controller shall be capable of measuring and reducing individually not less than 20 non zero sequence harmonic currents.
				4. The controller shall incorporate digital control algorithms exclusively.

## Man–Machine Interface Unit

* + - * 1. The active filter shall be fitted with a man - machine interface unit including a key pad and full graphics display.
				2. The man - machine interface unit shall enable complete programming of the active filter including the degree to which each individual harmonic current is to be reduced.
				3. The man - machine interface unit shall measure and display a wide range of active filter parameters including those listed hereunder.
		1. line voltages at the input terminals of the filter
		2. line currents at filter voltage
		3. filter currents at filter voltage
		4. frequency
		5. line voltage distortion at the input terminals of the filter
		6. line current distortion,
		7. line power factor assuming no phase shift through the power coupling transformer
		8. line displacement power factor assuming no phase shift through the power coupling transformer.
			- 1. Voltages and current values shall be able to be displayed as waveforms and either harmonic charts or harmonic tables.
				2. The man - machine interface unit shall include a Modbus or similar serial communications link to allow programming and monitoring of the active filter performance on a separate portable computer if such a facility is specified in the Annexure.

## Cooling System

* + - * 1. The active filter shall be force fan air cooled by an integral cooling fan. The discharge cooling air shall exit from the top of the enclosure.
				2. If the active filter is specified in the Annexure to be suitable for ducted air discharge, facilities shall be provided to allow the discharge cooling air to be ducted directly outside the associated switch room building via a duct not more than 2 metres long. The integral cooling fan shall have sufficient capacity to ensure adequate air circulation under such circumstances.

## Arcing Fault Protection

The design of the active filter shall be such as to minimise the risk of an internal arcing fault developing and further to minimise the risk to the operator should such a fault develop.

## Degree of Protection

The active filter enclosure shall provide a degree of protection in accordance with AS 60529 of not less than IP21 with the enclosure doors closed and of not less than IP20 with the enclosure doors open.

## Locking

* + - * 1. All active filter doors shall be keyed alike.
				2. Access to live parts via active filter doors shall be controlled by the Water Corporation standard EL2 key of the type applicable to the particular Water Corporation Region.

## Corrosion Protection

* + - * 1. All metallic parts shall be provided with appropriate corrosion protection either by metallic plating or by paint finishes.
				2. The active filter enclosure shall be provided with a gloss paint finish providing medium term protection in ISO 9223 Cat. 3 (industrial and marine) environments.

## Software

* + - * 1. If so specified in the Annexure, software shall be provided to enable programming and monitoring of the active filter using a separate portable computer.
				2. Such software shall enable enhanced displays of the parameters provided on the man - machine interface unit.

#  Active Filter Ratings and Performance

## Active Filter Current Rating

1. The line reactors shall be sized to allow the active filter to be able to pass the filter rated current all as 5th harmonic current.
2. The active filter rated current shall not be less than the maximum value of Ih\*h/5 where Ih is the filter load current at harmonic number h**.**
3. The active filter rated current at the maximum ambient temperature specified in clause 3 shall be not less than the root mean square (RMS) value of the filter load harmonic currents shown in the Annexure.

## Peak Current Capacity

The combined output peak current capacity of the active filter shall be not less than 2.5 times the rated RMS output current.

## Active Filter Power Supply

The active filter shall be rated for operation from a power supply having characteristics as specified hereunder.

1. Number of phases: 3 phase 3 wire with the neutral solidly grounded at the terminals of the power coupling transformer
2. Phase sequence: RWB
3. Line to line voltage: As specified in the Annexure
4. Line to line voltage tolerance: ± 10%
5. Fundamental frequency: 50 Hz ± 5%.

The control power shall be derived from the incoming 3 phase 3 wire power supply.

## Active Filter Harmonic Frequency Range

The active filter shall have a non zero sequence filtering range of 2nd to 50th harmonic.

## Active Filter Filtering Efficiency

The active filter filtering efficiency for all filtered harmonic currents shall be not less than 95% of the filtering level set.

## Active Filter Response Time

The active filter response time shall be not more than 40 milliseconds for filtering step change of 10% of set level to 90% of set level.

## Active Filter Inrush Current

The inrush current of the filter proper shall be not more than 2 times nominal rated peak current.

## Active Filter Power Factor

When operating in the mode specified clause 4, the power factor of the active filter shall be within the range 0.9 inductive to 0.9 capacitive.

## Active Filter Losses

The power losses in the active filter at full load shall not exceed 3% of the filter full load kVA rating.

## Active Filter Noise Level

The sound power level emitted from the active filter at full load shall not exceed 78 dBA for a 315 kVA unit. The sound power upper limits for units of other sizes shall be proportional to unit full load kVA rating e.g. the sound power upper limit for a 160 kVA unit shall be 72 dB.

## Mean Time Between Failure

The active filer shall have a Mean Time Between Failure rating of not less than 50,000 operating hours.

## Capacitor Peak Voltage

With the incoming High Voltage at the H.V. system highest voltage as specified in the Annexure, the peak voltage across the inverter switching frequency filter capacitors shall not exceed the long term voltage rating of the capacitors.

# Protection and Alarm Functions

## Overload Protection

The active filter shall be non over-loadable.

## Over Temperature Protection

The active filter shall be provided with protection to shut the filter down in the event of overheating of the control board, the inverter, or the power coupling transformer.

## Ground Fault Protection

The active filter shall be provided with protection against excessive ground current.

## Alarms

The active filter shall display warning messages on the man machine interface in respect to:

(a) over voltage

(b) under voltage

(c) control board over temperature

(d) inverter over temperature

(e) power coupling transformer over temperature

(f) ground fault.

## Output Contacts

The active filter shall provide separate voltage free output contacts to signal warning and fault.

# Type Tests

## Electromagnetic Compatibility General Immunity

The active filter shall have been successfully type tested to verify general EMC immunity for industrial environments in accordance with AS/NZS 6000.22.

## Electromagnetic Compatibility General Emission

The active filter shall have been successfully type tested to verify general EMC emission Class A in accordance with AS/NZS 6000.2.4.

## Performance Type Tests

The active filter shall have been successfully type tested in accordance with Table 4 of AS 60146.1.1 including all of the optional tests specified therein.

## Transformer Type Tests

In addition to the type tests specified in Type Specification DS26.16, the transformer shall be type tested to verify the level of phase to neutral third harmonic voltage at no load.

# Routine Tests

The active filter shall be subjected to routine tests at the manufacturer’s works. Such routine tests shall include all of the routine tests listed in Table 4 of AS 60146.1.1.

# Delivery and Installation

* + - * 1. The Contractor shall deliver, unload, unpack and assemble as necessary the complete active filter and power coupling transformer at the site.
				2. The Contractor shall inspect the unpacked active filter and power coupling transformer and shall ensure that neither is damaged.
				3. The Contractor shall give the Principal seven days notice when the active filter and power coupling transformer will be ready for installation.
				4. The Contractor shall install the active filter and power coupling transformer in their permanent positions ready for connection by others.

# On Site Testing

* + - * 1. Before the Contractor makes the active filter and power coupling transformer available to the Principal for connection to the electrical system, the Contractor shall carry out insulation resistance tests.
				2. Once the active filter has been connected, the Contractor shall commission the active filter in association with the Principal so as to verify the performance values quoted. The active filter shall be operated on load for a period of 3 hours during which time the Contractor shall monitor its operation.During this test, oscilloscope measurements shall be made to ensure that the phase to earth voltages at the input terminals of the active filter do not exceed 5%.
				3. The Contractor shall carry out any other tests necessary to confirm that the switching frequency filter capacitors are not being over stressed.
				4. The Contractor shall make the results of commissioning tests available to the Principal within 14 days of the completion of such tests.

# As Constructed Information

The Contractor shall provide as-constructed information on all drawings. As-constructed drawings shall be provided electronically with A3 size hard copies.

# Manuals

* + - * 1. The Contractor shall supply 3 copies of comprehensive instruction manuals, written in English and covering the complete operation and maintenance requirements of all equipment supplied under the Contract.
				2. The manuals shall be printed on high grade A4 size paper and shall be bound in a high grade A4 size loose leaf binder.
				3. Information included in the manuals shall include:
		1. operating instructions
		2. safety instructions and warnings
		3. maintenance instructions and schedules
		4. recommended spare parts and special tool list
		5. as constructed drawings
		6. detailed equipment performance specifications and
		7. test reports and test certificates.

# Spare Parts

The Contractor shall guarantee to hold in Australia, one complete set of electronics spare parts for the active filter.

# Technical Support

The Contractor shall maintain an adequate level of technical support within Australia.

# Training

The Contractor shall supply as part of the Contract training for the number of Water Corporation electrical technicians specified in the Annexure. Such training shall cover commissioning as well as first line fault finding and first line servicing of the active filter.

**Annexure to Specification
for**

**High Voltage System Active Filter**

**Project:** .....................................................................................................................................

**Site Location:** ............................................................................................................................................

**Type of Access to Site**:

**Work by the Principal**

The following work will be carried out by the Principal:

**Current Transformer**

 Primary current rating …………………...………………………………………amps

 Secondary current rating…………………………………………………………amps

**Active Filter**

 **Input Voltage Rating**  volts line to line

 **Serial Communications Link** *(required or not)*

**Cooling Ducted Air Discharge** *(required or not)*

**Software for Computer Displays** *(required or not)*

**Training r**equired for technicians

**Annexure to Specification
for**

**High Voltage System Active Filter**

**Load Harmonic Currents**

Filter harmonic currents to be those necessary to achieve the following reductions:

 5th harmonic H.V current of amps to be reduced by %

 7th harmonic H.V current of amps to be reduced by %

 11th harmonic H.V current of amps to be reduced by %

 13th harmonic H.V current of amps to be reduced by %

 17th harmonic H.V current of amps to be reduced by %

 19th harmonic H.V current of amps to be reduced by %

 23rd harmonic H.V current of amps to be reduced by %

 25th harmonic H.V current of amps to be reduced by %

 29th harmonic H.V current of amps to be reduced by %

 31st harmonic H.V current of amps to be reduced by %

 35th harmonic H.V current of amps to be reduced by %

 37th harmonic H.V current of amps to be reduced by %

 41st harmonic H.V current of amps to be reduced by %

 43rd harmonic H.V current of amps to be reduced by %

 47th harmonic H.V current of amps to be reduced by %

 49th harmonic H.V current of amps to be reduced by %

|  |
| --- |
| **Type Specification for High Voltage System Active Filter Tender Technical Response Schedule** |
|  **DS26.34** | **Subject** | **Noted** | **Compliance** | **Comments** |
|  **Clause No.** |  |  | **Yes** | **No** |  |
| **1.** | **General** |  |  |  |  |
| **2.** | **Site** |  |  |  |  |
| **3.** | **Ambient Conditions** |  |  |  |  |
| **4.** | **Operating Mode** |  |  |  |  |
| **5.** | **Work by Principal** |  |  |  |  |
| **6.** | **Information from Contractor** |  |  |  |  |
| **7.** | **Drawings** |  |  |  |  |
| **8.** | **Standards** |  |  |  |  |
| **9.** | **Electromagnetic Compatibility** |  |  |  |  |
| **10.** | **Quality Assurance** |  |  |  |  |
| **11.** | **Electrical Work** |  |  |  |  |
| **12.** | **Active Filter System Description** |  |  |  |  |
| **13.** | **Power Coupling Transformer** |  |  |  |  |
| 13.1 | Transformer Description |  |  |  | Winding connection = |
| 13.2 | Voltage Rating |  |  |  | Primary rated kV = |
|  |  |  |  |  | Secondary rated kV = |
| 13.3 | Power rating |  |  |  | Rated kVA = |
| 13.4 | Impedance |  |  |  | Impedance % = |
| **14.** | **Low Voltage Connection** |  |  |  |  |
| **15.** | **Control Signals** |  |  |  | Phase angle correction type = |
| **16.** | **Current Transformers** |  |  |  |  |
| 16.1 | Voltage and Current Ratings |  |  |  | Rated for C.T. input amp = |
| 16.2 | Accuracy Class |  |  |  | Required C.T. accuracy class = |
| 16.3 | Burden  |  |  |  | Filter C.T. VA = |
| **17.** | **Active Filter Description** |  |  |  |  |
| 17.1 | General |  |  |  |  |
| 17.2 | Active Filter Enclosure |  |  |  | Type of mounting = |
| 17.3 | Filter Short Circuit Protection |  |  |  | Fuses or ACB? |
|  |  |  |  |  | Fuse rated amps =  |
|  |  |  |  |  | ACB rated amps = |
|  |  |  |  |  | ACB rated short time kA = |
| 17.4 | Filter Capacitor Precharging Network |  |  |  |  |
| 17.5 | Line Reactors |  |  |  |  |
| 17.6 | Inverter Switching Frequency Filter |  |  |  |  |
| 17.7 | Inverter |  |  |  |  |
| 17.8 | Controller |  |  |  | No. of harmonics filtered = |
| 17.9 | Man-machine Interface |  |  |  | Type of serial interface = |
| 17.10 | Cooling System |  |  |  |  |
| 17.11 | Arcing Fault Protection |  |  |  |  |
| 17.12 | Degree of Protection |  |  |  | Doors closed IP rating =  |
|  |  |  |  |  | Doors open IP rating = |
| 17.13 | Locking |  |  |  |  |
| 17.14 | Corrosion protection |  |  |  |  |
| 17.15 | Software |  |  |  |  |
| **18.** | **Transformer** | Transformer responses required are at end of this schedule |
| **19.** | **Current Transformers** |  |  |  |  |
| **20.** | **Type Tests** |  |  |  |  |
| 20.1 | EMC immunity |  |  |  |  |
| 20.2 | EMC emissions |  |  |  |  |
| 20.3 | Performance type tests |  |  |  |  |
| **21.** | **Routine Tests** |  |  |  |  |
| **22.** | **Delivery and Installation** |  |  |  |  |
| **23.** | **On Site Testing** |  |  |  |  |
| **24.** | **As Constructed Information** |  |  |  |  |
| **25.** | **Manuals** |  |  |  |  |
| **26.** | **Spare Parts** |  |  |  |  |
| **27.** | **Technical Support** |  |  |  | Technical support function location is |
| **28.** | **Training** |  |  |  | Located in ………………………… |

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