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| Assets Planning and Delivery GroupEngineering |

DESIGN STANDARD DS 26-35

Type Specifications – Electrical

Type Specification for

Low Voltage System Active Filter

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**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)

Enquiries relating to the technical content of a Design Standard should be directed to the Senior Principal Engineer, Electrical (Standards) Section, Engineering. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

**Head of Engineering**

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This Standard is provided for use only by a suitably qualified professional design engineer who shall apply the skill, knowledge and experience necessary to understand the risks involved and undertake all infrastructure design and installation specification preparation work.

Any interpretation of anything in this Standard that deviates from the requirements specified in the project design drawings and construction specifications shall be resolved by reference to and determination by the design engineer.

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REVISION STATUS

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DESIGN STANDARD DS 26-35

Type Specifications – Electrical

Type Specification for

Low Voltage System Active Filter

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# GENERAL

This Specification covers the requirements for the design, manufacture, assembly, factory testing and delivery of an active filter suitable for reducing the level of harmonic currents taken from an incoming power supply system by non linear loads connected to a Water Corporation Low Voltage electrical installation.

The active filter shall be supplied to site complete with all necessary accessories and miscellaneous material, minor parts and other such items to complete assembly, testing and commissioning of the active filter.

As specified in clause 5 the connection of the active filter will be carried out by the Principal after any on site assembly and positioning has been completed by the Contractor. Once connection of the active filter is complete, the Contractor shall return to the site to commission the active filter under the overall direction of the Principal.

# SITE

The location of the site for the installation of the active filter shall be as shown in the Annexure.

# AMBIENT CONDITIONS

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 shall 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 3C2

 IEC 60721-3-3 mechanical class 3S2

# OPERATING MODE

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.

If so specified in the Annexure, the active filter shall correct the power factor by taking fundamental current 180 degrees out of phase with the reactive component of the installation load current.

The filtering of harmonic currents shall take precedence over the power factor correction function, so that in the event of the capacity of the active filter being inadequate to filter the harmonic to the levels specified in the Annexure and also to correct the power factor to the levels specified in the Annexure, the power factor shall be corrected only to the level possible with the active filter capacity available after filtering of the harmonic currents.

The active filter shall correct the power factor to the degree specified in the Annexure or to the maximum allowable within the capacity of the active filter remaining after harmonic filtering is complete.

# WORK BY THE PRINCIPAL

The supply and installation of the current transformers and the connection of the active filter to the power supply and to the current transformers will be carried out by the Principal.

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 within the listed number of days after receipt of the Principal’s order.

1. General Arrangement Drawings 28 days
2. Electrical Wiring and Schematic Drawings 28 days
3. Manufacture and Delivery Schedule 14 days
4. Inspection and Test Plan 35 days
5. Test Certificates On Delivery
6. Operating and Maintenance Manual On Delivery

# DRAWINGS

1. All drawings provided by the Contractor shall be in accordance with the latest issue of the Water Corporation Design Standard DS24 – Electrical Drafting
2. All drawings shall be prepared in AutoCAD format, Release 2018 or later software
3. Drawings shall be prepared on the “Electrical” A1 metric drawing sheet and title block provided in the Water Corporation eXternal (WCX) package (available for download) in accordance with the Water Corporations Design Standard DS80
4. The drawings shall provide within the title block, the details to identify the drawing, including but not limited to its title, plan number, revision status, date of issue, Corporate project number, contractor’s name and reference number (if applicable)
5. Drawings detail shall include, but not limited to, the general arrangement, panel layout, power and control circuit diagrams and equipment specifications, as required
6. The contractor shall submit drawings in both AutoCAD and PDF formats in accordance with the Drawing Submission Process. Adequate contrast within the PDF image shall be maintained between drawing content and background to ensure the clarity and quality of the drawings

# STANDARDS

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.

Specific reference is made in this Specification to the following national and international standards:

AS 3000 Electrical Installations

AS 61869.2 Instrument Transformers- Instrument Transformers – Additional Requirements for Current Transformers

AS 60146.1 Semiconductor Converters -General requirements and line commutated converters specifications of basic requirements

AS 60269.4 –Low-voltage fuses - Supplementary requirements for fuse links for the protection of semiconductor devices

AS/NZS 61439.1 Low-voltage switchgear and controlgear assemblies - General Rules

AS 60529 Degrees of Protection Provided by Enclosures (IP Code)

AS 61800.3 Adjustable speed electrical power drive systems - EMC requirements and specific test methods

AS/NZS ISO 9001 Quality management systems – Requirements

IEC 60721-3-3 Classification of environmental conditions - Part 3.3: Classification of groups of environmental parameters and their severities - Stationary use at weather protected locations

AS 61000.6.2 Electromagnetic Compatibility (EMC) – General standards - Immunity standards for industrial environments

AS 61000.6.4 Electromagnetic Compatibility (EMC) - General Standards - Emission standard for industrial environments

 ISO 9223 Corrosion of metals and alloys – Corrosivity of atmospheres – Classification, determination and semantics

# ELECTROMAGNETIC COMPATIBILITY

The active filter shall comply with electromagnetic compatibility standards IEC 61000-6-4 and IEC 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 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

## 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.

1. Filter short circuit protection device
2. Surge diverters
3. A filter capacitor precharging network
4. Line reactors
5. An inverter switching frequency filter
6. An IGBT inverter
7. An IGBT inverter controller
8. A filter system HMI
9. A filter cooling system
10. An overall enclosure

## Construction of Active Filter

The construction of the active filter assembly shall be in accordance with AS 60439.1.

## 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 60269.4.0. Alternatively the active filter shall be protected against short circuits by a fast acting circuit breaker having an adequate short time current rating.

## Surge Diverters

The active filter shall be fitted with surge diverters with a residual voltage of not more than 2 kV at 5 kA discharge current.

## Filter Capacitor Precharging Network

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

## Line Reactors

Line reactors shall be in accordance with AS 60146.1.3. Line reactors shall be air cooled.

## Inverter Switching Frequency Filter

The inverter switching frequency filter shall be of the L/C type (or L/R/C type) and shall prevent inverter switching frequency currents being injected into the supply network. The high frequency power port disturbance voltage emission shall not exceed the limits specified for Class 3 in AS 61800.3 (IEC 61800-3).

## Inverter

The inverter shall be in accordance with AS 60146.1 Part 1.

The inverter shall be of the pulse width modulated type employing IGBT power transistors. The power circuits in the inverter shall be optically isolated from the control circuits.

## Controller

Low voltage current transformers measuring the harmonic currents being taken from the incoming power supply shall provide the input signal to the controller.

If the controller filtering algorithm is of the wide band type, the controller shall operate to reduce the level of these harmonic currents to zero.

If the controller is capable of measuring and reducing individual harmonic currents, the controller shall operate to reduce the level of these harmonic currents to preset specified levels. Such controllers shall be capable of measuring and reducing individually not less than 20 harmonic currents. The controller shall operate under closed loop control to reduce the level of these harmonic currents to preset levels.

Preferably the controller shall incorporate digital control algorithms exclusively.

## HMI

The active filter shall be fitted with a HMI including a key pad and alphanumeric or graphics display.

The HMI shall enable complete programming of the active filter including the degree to which each individual harmonic current is to be reduced.

The HMI shall measure and display a wide range of active filter parameters including those listed hereunder.

1. Line voltages
2. Line currents
3. Filter currents
4. Frequency
5. Voltage distortion
6. Current distortion
7. Power factor
8. Displacement power factor

Voltages and current values shall be able to be displayed as waveforms and either harmonic charts or harmonic tables.

The HMI 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

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. 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. 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.

##  Enclosure of Active Filter

The enclosure for the active filter shall be floor mounted and shall be protected in accordance with AS 60529 to a degree not less than IP21 with the doors closed and not less than IP20 with the doors open.

## Locking

All active filter doors shall be keyed alike.

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.

Such access shall be controlled either by the active filter doors being fitted with locks matched to the above Water Corporation key, or by providing a key interchange box between the above Water Corporation key and the active filter door key.

Insertion and turning the Water Corporation standard key shall release the active filter door key while the former shall remain trapped. Similarly insertion and turning the active filter door key shall release the Water Corporation standard key while the active filter door key shall remain trapped.

## Corrosion Protection

All metallic parts shall be provided with appropriate corrosion protection either by metallic plating or by paint finishes.

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

If so specified in the Annexure, software shall be provided to enable programming and monitoring of the active filter using a separate portable computer. Such software shall enable enhanced displays of the parameters provided on the HMI.

## Current Transformers

Current transformers will be metering current transformers complying with AS 61869.2.

Current transformers will be matched to the active filter controller and the non linear load.

Current transformers will be rated for operation via secondary connecting cables of the type, size and length specified in the Annexure. The current transformers will be suitable for bus bar mounting on bus bars as specified in the Annexure.

# FILTER SYSTEM RATINGS AND PERFORMANCE

## Active Filter Current Rating

The predicted maximum levels of harmonic currents to be taken by the non linear loads shall be as shown in the Annexure.

If the controller filtering algorithm is of the wide band type, these harmonic currents shall be the required filter load, i.e. the active filter shall be rated to reduce to zero all harmonic currents being taken from the incoming supply.

If the controller is capable of measuring and reducing individually harmonic currents, the filter load shall be the harmonic currents to be filtered out so as to reduce, by the percentage specified in the Annexure, the harmonic currents being supplied from the incoming supply.

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.

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.

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 4 wire with the neutral solidly grounded
2. Phase sequence: RWB
3. Line to line voltage: 415 Volts or 690 Volts as specified in the Annexure
4. Voltage tolerance: ± 10%
5. Fundamental frequency: 50 Hz ± 5%.

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

## Active Filter Harmonic Frequency Range

If filtering of zero sequence harmonic currents is specified as required in the Annexure, the active filter shall have a filtering range of 2nd to 25th harmonic.

If filtering of zero sequence harmonic currents is specified as not required in the Annexure, the active filter shall have a 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 preset filtering levels, i.e. for wide band active filters the harmonic currents taken from the overall installation incoming supply shall not exceed 5% of the harmonic current levels specified in the Annexure.

Similarly for active filters with individual harmonic filtering capability, the reduction in harmonic currents taken from the overall installation incoming supply shall be not less than 95% of the respective filter setting levels.

## 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 solely as a harmonic filter without any power factor correction function, the power factor of the active filter shall be within the range 0.9 inductive to 0.9 capacitive.

When operating to correct power factor, the active filter shall act so as to correct the power factor of the associated electrical installation in the manner specified in Clause 4.

## 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 70 dBA for a 100 Amp unit. The sound power upper limits for units of other sizes shall be proportional to unit full load Amp rating e.g. the sound power upper limit for a 25 Amp unit shall be 58 dBA.

## Mean Time Between Failure

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

## Capacitor Peak Voltage

When operating at the upper extreme of the specified input voltage range, the peak voltage across the inverter switching frequency filter capacitors shall not exceed the long term voltage rating of the capacitors.

## Current Transforming Ratings

The current transformers will have the following ratings:

1. Metering class : Class 0.5
2. Accuracy limit factor: > 120 %
3. Secondary current: 5 Amps
4. Power frequency withstand voltage: 3.5 kV
5. Other rating as shown in the Annexure

# PROTECTION AND ALARM FUNCTIONS

## Overhead Protection

The active filter shall be non overloadable.

## 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 or the inverter.

## Alarms

The active filter shall display warning messages on the HMI in respect to:

1. Over voltage
2. Under voltage
3. Control board over temperature
4. Inverter over temperature

## 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 IEC 61000-6-2.

## Electromagnetic Compatibility General Emission

The active filter shall have been successfully type tested to verify general EMC emission Class A in accordance with IEC 61000-6-4.

## 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.

# 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

The Contractor shall deliver, unload, unpack and assemble as necessary the complete active filter at the site. The Contractor shall inspect the unpacked active filter and shall ensure that the active filter is undamaged. The Contractor shall give the Principal seven days’ notice when the active filter will be ready for installation. The Contractor shall install the active filter in its permanent position ready for connection by others.

# ON SITE TESTING

Before the Contractor makes the active filter available to the Principal for connection to the electrical system, the Contractor shall carry out insulation resistance tests.

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, the contractor shall carry out tests necessary to confirm that the switching frequency filter capacitors are not being over stressed.

The Contractor shall supply all equipment, materials and labour for such testing and commissioning of the active filter.

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 detailing all changes and modifications made during the construction and installation phases of the project.

The contractor shall submit drawings in both AutoCAD and PDF formats in accordance with the Drawing Submission Process. Adequate contrast within the PDF image shall be maintained between drawing content and background to ensure the clarity and quality of the drawings.

# MANUALS

The Contractor shall supply 1 copy of comprehensive instruction manuals, written in English and covering the complete operation and maintenance requirements of all equipment supplied under the Contract.

The manuals shall be printed on high grade A4 size paper and shall be bound in a high grade A4 size loose leaf binder.

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
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**

**Low Voltage System Active Filter**

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

**Site Location:**

**Work by the Principal**

The following work will be carried out by the Principal:

**Cooling**

 Ducted Air Discharge *(required or not)*

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

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

**Filtering of Zero Sequence Harmonics** *(required or not)*

**Training** required for technicians

**Power Factor Correction (**required not required)

**Installation Power Factor Setting**

 **Annexure to Specification**

 **for**

**Low Voltage System Active Filter**

**Load Harmonic Currents** (to be filtered)

*Note 1 Filter setting = % by which harmonic is to be reduced.*

*Note 2: Filter settings apply only to filters with individual harmonic capability – refer clause 13.4*

 harmonic current of Amps; filter setting %

 harmonic current of Amps; filter setting %

 harmonic current of Amps; filter setting %

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 harmonic current of Amps; filter setting %

 harmonic current of Amps; filter setting %

**Annexure to Specification
for**

**Low Voltage System Active Filter**

**Current Transformers**

C.T. Primary Current Rating Amps

 C.T. Maximum Primary Continuous Operating Voltage Volts

 C.T. Secondary Wiring

 Conductor type – ***copper***

Conductor size mm2

 Length of cable run m

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| **Type Specification for Low Voltage System Active Filter Tender Technical Response Schedule** |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | **Comments** |
|  |  |  | **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.** | **Filter System Description** |  |  |  |  |
| 12.1 | General |  |  |  |  |
| 12.2 | Construction of Active Filter |  |  |  |  |
| 12.3 | Filter Short Circuit Protection |  |  |  | Fuses or ACB? |
|  |  |  |  |  | Fuse rated Amps =  |
|  |  |  |  |  | ACB rated Amps = |
|  |  |  |  |  | ACB rated short time kA = |
| 12.4 | Surge diverters |  |  |  |  |
| 12.5 | Filter capacitator precharging network |  |  |  |  |
| 12.6 | Line reactors |  |  |  |  |
| 12.7 | Inverter switching frequency filter |  |  |  |  |
| 12.8 | Inverter |  |  |  |  |
| 12.9 | Controller |  |  |  | Type of algorithm (i.e. wide band or individual harmonic) = |
|  |  |  |  |  | Highest harmonic filtered =  |
| 12.10 | HMI |  |  |  | Type of serial interface = |
| 12.11 | Cooling system |  |  |  |  |
| 12.12 | Arcing fault protection |  |  |  |  |
| 12.13 | Enclosure of active filter  |  |  |  |  |
| 12.14 | Locking |  |  |  |  |
| 12.15 | Corrosion protection |  |  |  |  |
| 12.16 | Software |  |  |  |  |
| 12.17 | Current transformers |  |  |  | C.T. overall dia. mm = |
|  |  |  |  |  | C.T. length mm = |
|  |  |  |  |  | C.T. aperture width mm = |
|  |  |  |  |  | C.T. aperture depth mm = |

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| **Type Specification for Low Voltage System Active Filter Tender Technical Response Schedule** |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | **Comments** |
|  |  |  | **Yes** | **No** |  |
| **13.** | **System Ratings & Performance** |  |  |  |  |
| 13.1 | Filter current rating |  |  |  | Rated Amps = |
|  |  |  |  |  | Max. Ih\*h/5 Amps = |
|  |  |  |  |  | Filtered RMS Amps = |
| 13.2 | Peak current capacity |  |  |  | Peak current Amps = |
| 13.3 | Active filter power supply |  |  |  | No. phases = |
|  |  |  |  |  | Max. line to line Volts = |
|  |  |  |  |  | Min. line to line Volts = |
| 13.4 | Filter harmonic frequency range |  |  |  | Max. Hz = |
|  |  |  |  |  | Min. Hz = |
|  |  |  |  |  | Max. filtered harmonic No = |
| 13.5 | Filtering efficiency |  |  |  | Filter efficiency % = |
| 13.6 | Filter response time |  |  |  | Response time, milliseconds = |
| 13.7 | Active filter inrush current |  |  |  | Inrush Amps = |
| 13.8 | Active filter power factor |  |  |  | P.f. = |
| 13.9 | Active filters losses |  |  |  | Full load losses, Watts = |
| 13.10 | Active filter noise level |  |  |  | Sound power dbA = |
| 13.11 | Mean time between failure |  |  |  | MTBF, hours = |
| 13.12 | Capacitor peak voltage |  |  |  | Rated line/neutral peak Volts = |
|  |  |  |  |  | Rated line/earth peak Volts = |
| 13.13 | Current transformers |  |  |  | C.T. primary Amps = |
|  |  |  |  |  | C.T. secondary Amps = |
|  |  |  |  |  | C.T. max. operating Volts = |
|  |  |  |  |  | C.T. rated burden VA = |
|  |  |  |  |  | C.T. PFWV kV = |
|  |  |  |  |  | C.T. rated Hz = |
| **14.** | **Protection and Alarm Functions** |  |  |  |  |
| 14.1 | Overload protection |  |  |  |  |
| 14.2 | Over temperature protection |  |  |  |  |
| 14.3 | Alarms |  |  |  |  |
| 14.4 | Output contacts |  |  |  |  |
| **15.** | **Type Tests** |  |  |  |  |
| 15.1 | EMC immunity |  |  |  |  |
| 15.2 | EMC emissions |  |  |  |  |
| 15.3 | Performance type tests |  |  |  |  |
| **16.** | **Routine Tests** |  |  |  |  |
| **17.** | **Delivery and Installation** |  |  |  |  |
| **18.** | **On Site Testing** |  |  |  |  |

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| **Type Specification for Low Voltage System Active Filter Tender Technical Response Schedule** |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | **Comments** |
|  |  |  | **Yes** | **No** |  |
| **19.** | **As Constructed Information** |  |  |  |  |
| **20.** | **Manuals** |  |  |  |  |
| **21.** | **Spare Parts** |  |  |  |  |
| **22.** | **Technical Support** |  |  |  | Technical support function location is |
|  |  |  |  |  | located in ………………………… |
| **23.** | **Training**  |  |  |  | Number of training days allowed = |
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