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400 kV and 220 kV Harmonic Filter

Functional Specification

Revision	Date	Description	Originator	Reviewer	Checker	Approver
R0	13/06/2022	First Issue	Vitali Garon	Daniele Giustini Niall McMahon	Leon Notkevich Neil Cowap	Aidan Corcoran, Richard Blanchfield
R1	07/10/2022	Issued for use after industry feedback	Vitali Garon	Daniele Giustini James Staunton	Neil Cowap	Louise O'Flanagan

1 PURPOSE AND SCOPE

This Functional Specification is applicable for use in offshore wind transmission links delivered by the Customer as Contestable Works, to be owned and operated by EirGrid.

The following specification outlines the requirements for the design, procurement, construction and commissioning of Harmonic filters) for use in onshore compensation compounds (OCC).

This specification should be read in association with OFS-SSS-400 “Onshore Compensation Compound General Requirements”, OFS-GEN-005 “Network Engineering Studies Specification”, the project specific contestable works pack and project documentation and all other relevant functional specifications as issued by EirGrid.

For the purpose of this specification the term Customer shall refer to Offshore Wind Power Developers, Independent Power Producers responsible for the design and build of assets to be handed over to EirGrid.

The document ‘Harmonic Filter Technical Schedule’ OTS-SSS-414 sets out the particular technical requirements of this application. Note that most parameters of the Technical Schedule shall be completed during the design by Customer in consultation with EirGrid.

1.1 DEFINITION OF HARMONIC FILTER

The term Harmonic Filter (HF) used in this document refers to the term ‘filter’ as defined in IEC and IEEE standards

The IEC 61642 (ed 1.1)) definition of a filter is:

‘An equipment generally constituted of reactors, capacitors and resistors if required, tuned to present a known impedance over a given frequency range’.

The IEEE (IEEE519-1992) definition of a filter is:

‘A generic term used to describe those types of equipment whose purpose is to reduce the harmonic current or voltage flowing in or being impressed upon specific parts of an electrical power system, or both.’

Per IEEE519-1992 an HF can describe either an active device, that is containing electronic components, or a passive type that is containing a combination of reactors, capacitors and if required resistors. For the purpose of this functional specification reference is made only to passive filters. These filters will have one or more tuned frequencies and may be tuned, detuned, damped or a combination of all three depending on their applications.

The following definitions apply per IEC 61642 (ed1.1)

tuning frequency: The frequency for which the filter impedance, calculated from the rated values, has a minimum or maximum value.

tuned filter: A filter with a tuning frequency which differs by no more than 10% from the

frequency which is to be filtered.

detuned filter: A filter with a tuning frequency more than 10% below the lowest harmonic frequency with considerable current/voltage amplitude.

damped filter: A filter with low, predominantly resistive, impedance over a wide band of frequencies.

1.2 UTILISATION

HF may be proposed for the following applications subject to design review, risk assessment and review by EirGrid and any conditions listed herein:

- Where existing levels of harmonic voltage distortion are shown by measurement to be approaching or greater than those set out in 'indicative planning levels' under IEC61000-3-6, less EirGrid's planning margin
- Where the planned connection of renewable generation plant or FACTS devices is calculated to give rise to harmonic distortion levels approaching or greater than those set out in 'indicative planning levels' under IEC61000-3-6, less EirGrid's planning margin
- If after the system studies are completed and EirGrid identify a requirement for a larger filter for transmission system support this will be discussed with the Customer. It is anticipated that the additional cost would be borne by EirGrid

2 DEFINITIONS, ACRONYMS ABBREVIATIONS AND LEGISLATION

AC	Alternating Current
AIS	Air Insulated Switchgear
CT	Current Transformer
DC	Direct Current
EMC	Electromagnetic Compatibility
EU	European Union
FAT	Factory Acceptance Test
FACTS	Flexible AC Transmission Systems
FVT	Factory Verification Tests
HF	Harmonic Filter
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
HVDC	High Voltage Direct Current
IEC	International Electro-technical Committee
ICNIRP	International Commission on Non-Ionizing Radiation Protection (ICNIRP)
IGBT	Insulated Gate Bipolar Transistor
IP	Ingress Progression
LV	Low Voltage
LVAC	Low Voltage Alternating Current
P&C	Protection & Control
PLC	Power Line Carrier
rms	root mean square
SAT	Site Acceptance Tests

STATCOM	Static Synchronous Compensator
SCADA	Supervisory Control And Data Acquisition
TARGET VOLTAGE	Defined as the target voltage the system is trying to keep the voltage as close as possible to.
SCADA	Supervisory Control And Data Acquisition
TAO	Transmission Asset Owner
US	United States
UV	Ultraviolet
VSC	Voltage Source Converter
VT	Voltage Transformer
SSCI	Sub-Synchronous Control Interaction

2.1 LEGISLATION

Equipment offered shall be compliant with the provisions of the latest applicable versions of all relevant Irish legislation and directives of the European Union.

These include the following or latest versions/ amendments as appropriate:

SI No. 132	Safety signs regulations 1995 (implements EEC Directive 92/58)
SI No. 291	Safety, Health and Welfare at Work (Construction) Regulations
SI No. 299	Safety, Health and Welfare at Work (General Application) Regulations 2007
SI No. 445	Safety, Health and Welfare at Work (General Application) (Amendment) Reg. 2012
Reg (EC) No 1907/2006	Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
Reg (EC) No 1272/2008	Classification, Labelling and Packaging of Substances and Mixtures (CLP)
Reg (EU) No 517/2014	Fluorinated greenhouse gases and repealing regulation (EC) No 842/2006
Reg (EU) 2015/2068	Format of labels for products and equipment containing fluorinated greenhouse gases
Reg (EU) 2015/2065	Format for notification of the training and certification programmes of the Member States
Reg EU 2015/2066	Minimum requirements and the conditions for mutual recognition for the certification of natural persons carrying out installation, servicing, maintenance, repair or decommissioning of electrical switchgear containing fluorinated greenhouse gases or recovery of fluorinated greenhouse gases from stationary electrical switchgear
Directive 2011/65/EU	Restriction of the use of certain hazardous substances in electrical and electronic equipment (ROHS)
Directive 2012/19/EU	Waste electrical and electronic equipment (WEEE)
Directive 2014/30/EU	Harmonisation of the laws of the Member States relating to electromagnetic compatibility
ECE/TRANS/275	Vol. I and II ("ADR 2019") European Agreement Concerning the International Carriage of Dangerous Goods by Road

ICNIRP	International Commission on Non-Ionizing Radiation Protection (ICNIRP)
Directive 2013/35/EU	Minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)

Equipment shall carry the CE Mark in accordance with Directive 768/2008/EC and the EU Construction Products Regulation (No. 305/2011 – CPR) and adequate documentation to demonstrate full compliance should be retained.

In order to prove compliance, the equipment shall carry the CE Mark in accordance with Direction 768/2008/EC and the EU Construction Products Regulation (No. 305/2011 – CPR) where required.

.Except where otherwise stated in the functional specification, materials shall be designed, manufactured, tested and installed according to relevant IEC and/or EN standards.

Where available, the Irish adaptation of European standards (IS EN version), including any national normative aspects shall be applied.

Where no IEC standard or EN standard has been issued to cover a particular subject then an international or British Standard shall be applied. The latest edition and amendments shall apply in all cases.

The equipment shall comply with the latest editions of the international standards, codes and normative references indicated below, and the latest editions of the standards that they reference.

IEC 60060	High Voltage Test Techniques - Series
IEC 60068	Environmental testing - Series
IEC 60071-1	Insulation co-ordination - Part 1: Definitions, principles and rules
IEC 60071-2	Insulation co-ordination - Part 2: Application guide
IEC 60076-1	Power transformers - All Parts
IEC 60099-1	Surge Arresters Part 1: Non-linear resistor type gapped arresters for A.C systems
IEC 60099-3	Surge Arresters Part 2: Artificial pollution testing of surge arresters
IEC 60099-4	Surge Arresters Part 4: Metal-oxide surge arresters without gaps for a.c. systems
IEC 60255	Measuring relays and protection equipment - Series
IEC 60270	High-voltage test techniques - Partial discharge measurements
IEC 60273	Characteristics of Indoor and Outdoor Post Insulators for System with nominal voltages greater than 1000V
IEC 60437	Radio interference test on high-voltage insulators
IEC 60507	Artificial Pollution Tests on High-Voltage ceramic and glass insulators to be used on a.c. systems
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)

IEC 60551	Determination of transformer and reactor sound levels
IEC 60549	High voltage fuse for external protection of shunt capacitors
IEC 62271-1	High Voltage switchgear and control gear – Part 1: Common Specifications
IEC 60721-2-6	Classification of environmental conditions - Part 2: Environmental conditions appearing in nature. Earthquake vibration and shock
IEC/TS 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Series
IEC 60871-1	Shunt Capacitors for a.c. power systems having a rated voltage above 1000V - Part 1: General
IEC 60871-2	Shunt Capacitors for a.c. power systems having a rated voltage above 1000V - Part 2 Endurance testing
IEC 60871-3	Shunt Capacitors for a.c. power systems having a rated voltage above 1000V - Part 3: Protection of shunt capacitors and capacitor banks
IEC 60871-4	Shunt Capacitors for a.c. power systems having a rated voltage above 1000V - Part 4: Internal fuses
IEC 60943	Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals
IEC 61000-4-1	Electromagnetic compatibility (EMC) – Part 4-1: Testing and measurement techniques – Overview of IEC 61000-4 series
IEC 61462	Composite hollow insulators – Pressurized and un-pressurized insulators for use in electrical equipment with rated voltage greater than 1000 V – Definitions, test methods, acceptance criteria and design recommendations
IEC 61869	Instrument transformers - Series
IEC 61642	Industrial a.c. networks affected by harmonics - Application of filters and shunt capacitors
IEC 62474:	Material declaration for products of and for the electro technical industry
IEEE519	IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
IEEE Standard 18	Standard for Shunt Power Capacitors
IEEE Std 1531	IEEE Guide for Application and Specification of Harmonic Filters.
EN ISO 3746	Acoustics – determination of sound power levels and sound energy levels of noise sources using sound pressure – survey method using and enveloping measurement surface over a reflecting plane.
EN ISO 9614	Acoustics – determination of sound power levels of noise sources using sound intensity - Series
EN ISO 9001	Quality Management Systems
IEC 60076-1	Power transformers - Part 1: General Amendment 1 (1999)
IEC 60076-2	Power transformers - Part 2: Temperature rise
IEC 60076-3	Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air

IEC 60076-4	Power transformers - Part 4: Guide to lightning impulse and switching impulse testing - Power transformers and reactors
IEC 60076-5	Power transformers - Part 5: Ability to withstand short-circuit
IEC 60076-6	Power transformers - Part 6: Reactors
IEC 60076-8	Power transformers - Part 8: Application guide
IEC 60076-10	Power transformers - Part 10: Determination of sound levels
IEC 60551	Determination of transformer and reactor sound levels
IEC 60943	Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals
IEC 60076-1	Power transformers - Part 1: General Amendment 1 (1999)
IEC 60076-2	Power transformers - Part 2: Temperature rise
IEC 60076-3	Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air
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IEC 60076-5	Power transformers - Part 5: Ability to withstand short-circuit
IEC 60076-6	Power transformers - Part 6: Reactors
IEC 60076-8	Power transformers - Part 8: Application guide
IEC 60076-10	Power transformers - Part 10: Determination of sound levels
IEC 60551	Determination of transformer and reactor sound levels
IEC 60943	Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals
IEC/TS 60815	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Series
IEC 60694	Common specification for high voltage switchgear and control gear standards
IEC 60529	Degree of protection provided by enclosures
IEC 60943	Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals
IEC 60071-1	Insulation co-ordination - Part 1: Definitions, principles and rules
IEC 60071-2	Insulation co-ordination- Part 2: Application guide
IEC 60071-4	Insulation co-ordination - Part 4: Computational guide to insulation co-ordination and modelling of electrical networks
IEC 60099-4	Surge Arresters Part 4: Metal-oxide surge arresters without gaps for A.C. systems
IEC 60099-5	Surge arresters - Part 5: Selection and application recommendations
IEC 61869	Instrument transformers
IEC 60255	Measuring relays and protection equipment – Series

In addition, there shall be compliance with the provisions of all relevant Directives of the European Communities relating to work equipment, i.e. in regard to safety of personnel who operate and maintain the equipment, in regard to Electromagnetic Compatibility

(EMC) of the equipment (Directive 2004/108/EC) and in regard to 'the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)' (Directive 2004/40/EC).

2.2 EirGrid Grid Code

The proposed Harmonic Filter shall comply with the EirGrid Grid Code requirements.

The Grid Code is the technical document which establishes the rules governing the operation, maintenance and development of the transmission system and sets out the procedures for governing the actions of all transmission system users.

3 Health And Safety

Please refer to Health and Safety requirements as outlined in EirGrid Safe by Design Methodology XDS-SDM-00-001-R0.

It is the responsibility of the customer to produce a suitable & sufficient design risk assessment.

A register of the hazards shall be submitted and shall include those hazards associated with the physical arrangement of the equipment (e.g. trip/fall hazards) which may pose a danger during off-load maintenance access, and those associated with the in-service operation of the equipment (e.g. stray magnetic fields, high temperatures, fluid leaks, presence of dangerous voltages).

The risk assessment must ensure that the design is safe and without risk to health when properly used by a person at a place of work, considering the initial installation, time-based inspection, time-based maintenance requirements, operation activities and decommissioning.

4 Service Conditions

Service conditions shall be as set out in EirGrid's functional specification OFS-SSS-400, Onshore Compensation Compound General Requirements.

4.1 Service Experience

The proposed Harmonic Filter supplier shall have:

At least 4 years' experience in the design and installation of the relevant voltage/current range (or higher) of the Harmonic Filter as specified herein and is in use in at least one EU utility.

As an alternative to such experience within the EU, similar experience with British, Swiss, Japanese, Australian, Korean or US/Canadian utility would be considered.

If the design team and production facilities proposed are relocated existing facilities using substantially the same workforce and equipment, the combined time of both plants would be considered.

4.2 NETWORK PARAMETERS

The equipment shall be suitable for installation on the Transmission system. The design parameters are specified in EirGrid's functional specification OFS-SSS-400, Onshore Compensation Compound General Requirements.

4.3 CLEARANCE FROM LIVE PARTS

Clearances from live parts shall be as set out in the latest revision of the EirGrid Onshore Station General Requirements functional specification OFS-SSS-400 and Grid Code.

The Customer shall design ensure maximum safety of personnel during operation, maintenance, repairing/replacement and decommissioning.

The general layout of the Harmonic Filter plant shall be such as to permit sufficient clearance for accessibility, necessary maintenance activities and replacement of Harmonic Filter components. The Customer shall supply fully documented method statements for the maintenance and replacement procedures for the system.

Suitable space shall be provided in the relay room to enable replacement equipment to be built and installed off-line which will minimise future outage requirements.

Access gates or panels to low level mounted HV AIS equipment (bottom of insulator <2300 mm above ground, and >1 kV) e.g. HV capacitor banks, Resistors, SVC, HV reactors etc. shall be secured using fixing bolts at minimum of 2 no. fixing points and shall not be secured with a lock; so that to access to the mini compound (HF Filter fenced compound) one or two section of the mini-compound fence have to be removed.

4.4 SITE & ENVIRONMENTAL DATA

The customer shall design and demonstrate mechanical adequacy to deal with the following loading effects (electrical and mechanical):

- Wind and ice loading.
- Forces due to expansion and contraction due to ambient temperature and load variations.
- Electromagnetic forces including those arising from short circuit or fault conditions.

Functional requirements with respect to environmental conditions are as set out in EirGrid functional specification OFS-SSS-400, Onshore Compensation Compound General Requirements.

Environmental conditions according to OFS-SSS-400, including effects of solar gain and wind speeds, shall be considered by the overall design.

A 40-year lifetime in a marine/coastal environment is required. Please refer to sections on corrosion protection for further detail.

5 TYPE AND DUTY

The HF shall be designed and rated for the specific project application with connection to underground cables, busbar section and generator transformers.

The performance requirements of the HF shall be detailed in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule'.

All substances used shall be classified in accordance with European Community regulations for Hazardous Substances. Safety Data Sheets shall be submitted where appropriate.

6 HF NETWORKS

6.1 GENERAL REQUIREMENTS

This specification describes EirGrid's technical requirements for Capacitor Banks, Resistors, Reactors for Harmonic Filter Banks to be connected at 400 kV and 220 kV. This specification does not cover associated circuit-breakers, isolators, earth switches.

HF networks shall consist of capacitors, reactors, resistors and surge arresters, or networks consisting of two or more of these components designed to provide harmonic voltage and current mitigation as set out in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule' may consist of single tuned filters, C-type filters or high-pass (second order) filters.

6.1.1 SINGLE TUNED FILTERS (2ND ORDER)

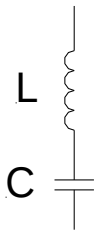

Figure 1

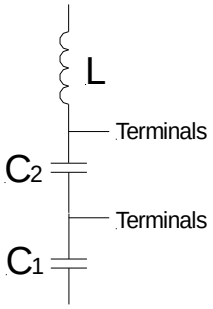

Figure 2

Single tuned HF consisting of capacitor banks and series reactors.

Filter dimensioning is responsibility of the Customer, for Harmonic performance studies requirements refer to OFS-GEN-005.

HF shall be provided with suitable lightning protection and unbalance protection as described in this specification. A required feature for some single tuned filters may be the ability to convert the HF at a later stage to either C-type of High-pass filter by means of the connection of a suitable resistor within the network, using a C1 and C2 capacitor arrangement, see Figure 2. This arrangement is to allow for future expansion of the

Asset.

6.1.2 C-TYPE FILTERS (3RD ORDER)

IEC 1219/97

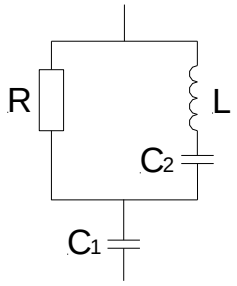

Figure 3

C-type HF consists of capacitor banks series reactors and resistors. Filter dimensioning is responsibility of the Customer, for Harmonic performance studies requirements refer to OFS-GEN-005.

HF shall be provided with suitable lightning protection and unbalance protection as described in this specification.

6.1.3 HIGH-PASS FILTERS (2ND ORDER)

IEC 1217/97

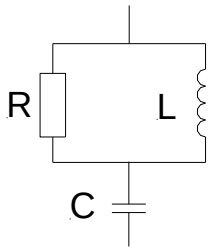

Figure 4

High-pass HF is consisting of capacitor banks series reactors and resistors. Filter dimensioning is responsibility of the Customer, for Harmonic performance studies requirements refer to OFS-GEN-005.

HF shall be provided with suitable lightning protection and unbalance protection as described in this specification.

6.2 HF COMPONENTS

HF networks shall consist of capacitors, reactors, or resistors, or networks consisting of two or more of these components.

6.2.1 CAPACITORS

Section 7 details the requirements for shunt capacitors and capacitor banks for use within HF installed by Customers in the OCC. A detailed Capacitor Performance Schedule shall be completed by the manufacturer / customer as set out in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule'.

6.2.2 REACTORS

Section 0 details the requirements for reactors for use within HF installed by Customers in the OCC. A detailed Inductor Performance Schedule shall be completed by the manufacturer / customer as set out in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule'.

6.2.3 RESISTORS

Section 1 details the requirements for resistors for use within HF installed by Customers in the OCC. A detailed Resistor Performance Schedule shall be completed by the manufacturer / customer as set out in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule'.

6.2.4 SURGE ARRESTERS

Specification OFS-SSS-425 - 220kV Surge Arresters details the requirements for surge arresters for use within HF installed by Customers in the OCC .

6.3 RATINGS

The guaranteed ratings and characteristics of the HF shall be as follows:

6.3.1 VOLTAGE AND INSULATION LEVEL

The rated voltages of the HF shall be the highest network voltages as specified under NETWORK PARAMETERS (i.e. as per EirGrid's functional specification OFS-SSS-400, Onshore Compensation Compound General Requirements).

The insulation withstand levels, minimum creepage distances and insulation level of auxiliary circuits shall be as specified in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule', for the particular application. In the case of creepage, it will be specified whether the normal or higher creepage value is required.

6.3.2 HF NORMAL RATED CURRENT

This shall be as calculated and designed by the Customer. Design to be reviewed by EirGrid.

6.3.3 HF NORMAL HARMONIC CURRENTS

This shall be as calculated and designed by the Customer. Design to be reviewed by EirGrid.

6.3.4 PARTIAL DISCHARGE

The partial discharge levels for individual items of HF shall not exceed the value given in the relevant IEC Publication, e.g. bushings covered by IEC 60137. Evidence shall be submitted by the Customer showing that the proposed HF components have passed the partial discharge tests in accordance with IEC 60270.

6.3.5 RADIO INTERFERENCE VOLTAGE (RIV)

The radio interference level at 1.1Un/√3 of the HF components offered, when measured in accordance with IEC 62271-1, shall not exceed 2500 µV, where Un is the nominal system voltage.

6.4 IMPULSE WITHSTAND

The Customer shall propose a lightning impulse rating based on insulation coordination studies undertaken by them.

The Customer shall be responsible for the 'internal' insulation coordination of the HF bank and, shall fit internal surge arresters in order to reduce the level of lightning impulses induced on the bank and its components.

6.5 BUSHINGS AND OUTDOOR INSULATORS

Bushings and outdoor insulators forming part of the filter assembly shall:

1. Not emit radio interference in excess of that set out in Section 6.3.5 of this specification.
2. Bushings/insulators forming part of the HF shall have mechanical characteristics appropriate to their application.
3. Bushings/insulators shall have a mechanical strength appropriate to the application.
4. Have a lightning impulse with stand voltage as set out in OFS-SSS-400, Onshore Compensation Compound General Requirements.
5. Have a power-frequency withstand voltage as set out in OFS-SSS-400, Onshore Compensation Compound General Requirements.
6. Have been tested for application in polluted atmospheres according to standards:
    a. IEC 60507:2013, Artificial pollution tests on high-voltage ceramic and glass insulators to be used on a.c. systems
    b. IEC/TS 60815-1, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles
    c. IEC/TS 60815-2, Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 2: Ceramic and glass insulators for a.c. systems

6.6 RELIABILITY AND LIFE EXPECTANCY

The HF filter shall have a minimum design life (life expectancy) of 40 years and an overall reliability not less than overall OCC, including planned maintenance. Any components the Customer considered to be unable to meet this life expectancy shall be listed in the deviations schedule in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule' as well as the reason for non- compliance.

Capacitors shall be subjected to endurance testing as set out in IEC 60871-2, Shunt capacitors for a.c. power systems having a rated voltage above 1000 V, Part 2: Endurance testing. Test results shall be supplied by the Customer.

6.7 MAGNETIC FIELDS

The Customer shall advise on minimum magnetic clearance distances for the installed reactor from all metallic objects.

The Customer shall provide magnetic field contour plots covering all points external to the HF footprint area, confirming compliance with EirGrid EMF policy and ICNIRP. It is a preference that EMF shall not exceed 100 µT at rated power outside the mini compound fence.

6.8 CONSTRUCTION

The HF shall be constructed with a capacitor arrangement configuration to allow the inclusion of capacitor failure protection using current transformers connected to unbalance/overload relays.

Where the HF specified consists of a single tuned filter, the capacitor configuration and terminal layout shall allow for the future conversion of this filter to a C-type HF or a High –pass HF. The capacitor bank shall be split into C1 and C2 elements with the junction connected at an external terminal point. This external terminal point shall be calculated to provide a voltage tap at line voltage to which a resistor can be connected at a future time if required.

There shall also be a terminal point at the junction between the reactors and capacitor banks to allow conversion to a High-pass HF.

Reactors shall be provided with winding taps of -/+10% of the reactor inductance value so as to allow for future HF retuning as a result of connection changes.

6.9 ERECTION REQUIREMENTS

The HF banks shall be suitable for outdoor, free-standing installation on a concrete base. The Customer shall demonstrate mechanical adequacy to deal with the following loading effects (electrical and mechanical):

- Wind, ice and seismic loading.
- Forces due to expansion and contraction due to ambient temperature and load

variation.

- Electromagnetic forces including those arising from short circuit or fault conditions.

6.10 TOLERANCE

The equipment provided shall comply with the component tolerance values in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule'. The manufacturer shall state the tuning frequency tolerance for the range of temperatures outlined in Section 4 Service Conditions.

6.11 EARTHING

The HF earthing arrangement shall follow EirGrid's functional specifications and shall consider particular and specific design required for HF filter.

6.12 TEST REQUIREMENTS

If applicable the manufacturer/customer shall propose a maintenance and test programme for discussion with EirGrid and shall produce a report detailing all necessary, test equipment required to complete these activities.. .

6.13 FILTER PERFORMANCE

The design proposed by the Customer shall comply with the requirements set out in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule'.

7 CAPACITORS

7.1 DESIGN AND CONSTRUCTION

7.1.1 STEADY-STATE VOLTAGE

Steady state voltage rating of HF capacitor components shall be sufficient to allow the HF to comply with the Network Parameters section of EirGrid OFS-SSS-400 Onshore Compensation Compound General Requirements, taking account of voltage levels likely to arise due to filter configuration and the harmonic mitigation designed by the Customer. Capacitors shall also comply with Section 19.1 Long duration voltages as set out in IEC 60871-1:2014.

7.1.2 LIGHTNING IMPULSE

Capacitors shall be subjected to a lightning impulse test as set out in Section 5, of IEC 61871-1:2014.

7.1.3 RATED POWER FREQUENCY CURRENT

The rated power frequency and harmonic current spectrum shall be sufficient to meet

the requirements designed by the Customer .

7.1.4 INRUSH AND DISCHARGE CURRENT

Inrush transient current shall be limited to the values set out in Section 27.6.2 Transient overcurrent's, of IEC 60871-1.

Capacitors shall be able to withstand the inrush current (amplitude and frequency) resulting when one bank is connected to a busbar to which one or more other banks are already connected.

Capacitor fuses shall be able to carry the number of inrush current surges due to switching, during the life of the capacitor. The peak value of the inrush current shall not exceed 100 times the rated (r.m.s.) current.

Capacitors shall comply with Section 27.6.2, Transient overcurrent's and Section 22 Safety requirements for container connections of IEC 60871-1:2014.

The capacitor banks and individual capacitors shall comply with the discharge times set out in IEC 60871-1.

7.1.5 INSULATION REQUIREMENTS

The insulation levels of the capacitor installation shall be in accordance with the standard values prescribed in IEC 60071-1, Part 1: Definitions, principles and rules, Part 2: Application guide, and shall conform to EirGrid specification OFS-SSS-400 Onshore Compensation Compound General Requirements.

7.1.6 CAPACITOR ELEMENT TOPOLOGY

The Customer shall include details of the proposed capacitor bank element topology including how the requirement for unbalance protection shall be met.

In the case of a single tuned HF this shall be designed to provide a split bank arrangement comprising C1 and C2 configurations complete with a voltage points and connection terminals suitable for the future conversion of the HF to a C-type by means of the connection of appropriately dimensioned resistors, see Figure 2

7.2 FUSING REQUIREMENTS

7.2.1 INTERNALLY/EXTERNAL FUSED CAPACITORS

Capacitors fitted with internal fuses shall conform to IEC 60871-3 Shunt capacitors for AC power systems having a rated voltage above 1000 V, Part 3: Protection of shunt capacitors and shunt capacitor banks (section 4, Internal fuses). They shall also comply with IEC 60871-4 Part 4 Internal fuses and have been tested according to section 5 of this standards and Annex A thereof.

External fuses if used shall comply with IEC 60871-3, Part 3 Protection of shunt capacitors and shunt capacitor banks, section 5 External fuses.

7.3 TESTING

The Customer shall provide test results as follows for the proposed capacitors. These shall be carried out as indicated in IEC 60871-1.

7.3.1 ROUTINE TESTS

The manufacturer / customer shall also provide the following routine test results:

a) Capacitance measurement
b) Measurement of the tangent of the loss angle (tan S) of the capacitor
c) Voltage test between terminals
d) AC voltage test between terminals and container
e) Test of internal discharge device
j) Sealing test
g) Discharge test on internal fuses

7.3.2 TYPE TESTS

The manufacturer / customer shall also provide the following routine test results:

a) Thermal stability test
b) Lightning impulse voltage test between terminals and container
c) Overvoltage test
d) Short-circuit discharge test

Disconnecting test on internal fuses

8 INDUCTORS

8.1 REACTOR DESIGN

8.1.1 STEADY-STATE VOLTAGE

Steady state voltage rating of HF reactor components shall be sufficient to allow the HF to comply with the Network Parameters section of EirGrid OFS-SSS-400 Onshore Compensation Compound General Requirements, taking account of voltage levels likely to arise due to filter configuration and the harmonic mitigation requirements designed by the Customer'. Reactors shall also comply with Section 7.4.1 Rated Voltage and 7.4.2 Maximum operating voltage as set out in IEC 60076-6, Power transformers - Part 6: Reactors.

8.1.2 Rated Power Current And Spectrum

The continuously rated current of the reactors shall be sufficient to carrying the rated power frequency and harmonic currents arising in those components from the connection of the HF to the EirGrid System. The currents arising shall be those calculated by the Customer to flow due to the connection of the HF to the EirGrid System given the voltage and impedance data designed by the Customer.

8.1.3 Inrush And Discharge Current

The inrush and discharge current capability of the reactor shall be a set out in document 'OTS-SSS-414, HARMONIC FILTER (HF) Technical Schedule'.

8.1.4 Temperature Rise Limits

The temperature rise of the reactor supporting structures shall not exceed 30°C if they are accessible during normal operation or 50°C otherwise, these temperature shall be discussed and agreed with the manufactures in consideration of the expected life duration of the HF filter.

Temperature rise tests shall be performed as set out in IEC 62271 Part 1 Common specifications for high-voltage switchgear and controlgear standards.

Temperature tests shall be carried out by the manufacturer and the results shall be provided by the manufacturer / customer.

8.1.5 Insulation Requirements

The insulation level provided shall be appropriate to the voltage developed across the reactor when carrying short-circuit current or the maximum voltage developed during switching, discharge or continuous operating whichever is the greater.

Insulation levels shall comply with IEC 60076-3, Insulation levels, dielectric tests and external clearances in air and with EirGrid standard OFS-SSS-400 Onshore Compensation Compound General Requirements.

8.2 Magnetic Field Clearances

Measurement of magnetic characteristics up to the maximum voltage levels stated in EirGrid standard OFS-SSS-400 Onshore Compensation Compound General Requirements shall be conducted and included in a specific report.

The manufacturer / customer shall provide magnetic clearance distances for the installed reactor from all metallic objects, this to be included in the report.

The manufacturer / customer shall provide, within the report, the magnetic field contour plots covering all points external to the HF footprint area at which the magnetic field exceeds 100 µT.

8.3 TEST REQUIREMENTS

The manufacturer / customer shall provide test results as follows for the proposed reactors. These shall be carried out as indicated in IEC 60076-1 and IEC 60076-6.

8.3.1 ROUTINE TESTS

The manufacturer / customer shall also carry out and provide the following routine test results:

a) Measurement of winding resistance

b) Measurement of inductance

c) Measurement of loss and quality factor

d) Winding overvoltage test

8.3.2 TYPE TESTS

The manufacturer / customer shall also carry out and provide the following type tests results:

a) Temperature rise test

b) Lightning impulse test

9 RESISTORS

9.1 PERFORMANCE REQUIREMENTS

9.1.1 VOLTAGE RATING

Steady state voltage rating of HF resistor components shall be sufficient to allow the HF to comply with the Network Parameters section of EirGrid OFS-SSS-400 Functional Specification Onshore Compensation Compound, taking account of voltage level likely to arise due to filter configuration and the harmonic mitigation requirements designed by the Customer.

9.1.2 CURRENT RATING

The continuously rated current of the resistors shall be sufficient to carrying the rated power frequency and harmonic currents arising in those components from the connection of the HF to the EirGrid System. The currents arising shall be those calculated by the manufacturer / customer to flow due to the connection of the HF to the EirGrid System given the voltage and impedance data designed by the Customer.

9.1.3 TEMPERATURE RISE LIMITS

The temperature rise of the resistor supporting structures shall not exceed 30°C if they are accessible during normal operation or 50°C otherwise, these temperature shall be discussed and agreed with the manufactures in consideration of the expected life duration of the HF filter.

Temperature rise tests shall be performed as set out in IEC 60694:1997, Common specifications for high-voltage switchgear and controlgear standards.

Temperature test results shall be provided by the manufacturer / customer.

9.2 TEST REQUIREMENTS

The manufacturer / customer shall undertake the following routine and type tests for the proposed resistors. Resistor banks shall first be subjected to the routine test and then on completion of the type tests shall be subjected to the same routine tests again.

9.2.1 ROUTINE TESTS

9.2.1.1 MEASUREMENT OF RESISTANCE

Resistance measurements for the following components shall be performed at D.C and to an accuracy of 0.5%. This shall be compensated, where necessary, for an ambient temperature of 20°C.

- The resistance of each resistor within a unit enclosure
- The resistance of each resistor sub-assembly
- The resistance of each terminal of a sub-assembly to its frame.

9.2.1.2 INSULATION TESTS

The following tests with reference to the resistor ‘operating voltage’ shall be conducted.

- The voltage withstand of all insulation within the resistor assembly; the elements to the sub- frame, between sub-frames, all insulators; shall withstand a 10 second test of either 1.1 times the corresponding r.m.s. voltage appearing across the insulation, or a d.c. test equal to the peak of that voltage.
- The insulation of the resistor from the enclosure, with the connection between the resistor and the enclosure removed, shall withstand a 10 second test of either 1.1 times the corresponding r.m.s. voltage appearing across the insulation, or a d.c. test equal to the peak of that voltage.
- The ‘operating voltage’ appearing across each insulator shall be calculated from the resistor voltage rating, with the nominal value increased to allow for harmonic current flow included in the manufacturing design, the manufacturing tolerance allowed by the design, the temperature rises of the various parts when operating at rated current and, allowing for the highest network voltage as defined in EirGrid specification OFS-SSS-400, Online Station General Requirements.

9.2.2 TYPE TESTS

9.2.2.1 TEMPERATURE RISE TEST

The assembled resistor bank shall be mounted within a vertical enclosure (with open top and bottom) that extends from below the lowest resistor to above the highest resistor, either within a building, or outside). If the test is being performed outdoors, then the wind speed shall not exceed 2 metres/sec. The dimensions of the enclosure used during the test shall be provided by the Customer.

The following temperature points shall be measured:

- The highest temperature of the hottest element.
- The ambient temperature.
- The exit air temperature.
- The inlet air temperature.
- The air midway between the side of the resistor hottest element and the corresponding side of the unit enclosure.
- The temperature of the hottest surface of the bushings.
- The temperature of each connection that is not welded.

The resistor shall be subjected to a current that will give rise to power dissipated during the test being equal to that corresponding with the resistor rated current, and with the resistance at a value that is at the maximum positive tolerance.

The resistor shall be subjected to the test current for a period (not less than two hours) prior to the test to ensure thermal equilibrium has been reached. Thermal equilibrium is deemed to have been reached when the measured temperature of the hottest element is stable within 2°C for more than 15 minutes.

During the test:

- The resistance of the resistor shall not change by more than 2% when corrected to 20°C.
- The resistor elements shall not sag or distort.
- There shall be no significant change in colour in the resistor elements.
- The insulation shall be undamaged.
- All temperature measurements shall be converted to temperature rise above ambient.

9.2.2.2 MEASUREMENT OF INDUCTANCE

The inductance of the resistor shall be measured at 50 Hz, 550 Hz, 1250 Hz and 2,500 Hz.

10 CAPACITANCE PROTECTION

10.1 INTRODUCTION

The manufacturer / customer shall propose a system of protection designed to create an alarm or trip signal in the event that there is loss of capacitance on any capacitive

element of the HF. The protection shall consist of an unbalance scheme, except where the Customer considers that current levels are too low to detect without causing nuisance tripping. The Customer shall supply protection scheme as requested in the Project Protection Specification OFS-GEN-016.

10.2

10.2 CURRENT TRANSFORMERS

Current transformers shall comply in general with the requirements of IEC Publications 61869-2 and EirGrid specification OFS-SSS-424 and the project protection specification.

Suitable measures shall be taken to prevent induced current in the enclosure interfering with the performance of the current transformers. The method shall be described in a report to be issued to EirGrid for review.

A marshalling cabinet for current transformer secondaries shall be located outside the HV enclosure (HF compound internal fencing).

All terminals of the secondary windings shall be wired and connected to the terminal boxes and from there to the marshalling cabinet. Means for short circuiting and earthing the current transformer secondary circuits shall be provided in the marshalling cabinets. Details of the terminals and their arrangement shall be submitted to EirGrid for review.

11 HF CONNECTION TO HV CABLES

The Customer is responsible for the HF/HV cable interface.

The Customer is required to co-ordinate the design of the cable termination with the HV cable supplier.

Proposed cable terminations shall comply with requirements set out in OFS-CAB-101 Specification.

The design shall take account of the movement, vibration and expansion variations. If the earthing system of the HF and the HV cable are isolated from each other the open connection shall be protected against over-voltages.

Provision shall be made at the HV cable termination to allow isolation of the cable from the HF circuit with the minimum of dismantling of plant.

The HV cable terminations shall also have provision for connection of a HV cable test adaptor.

External or flange cable spacers shall be the right length and be made of correct material type for the connection. These spacers shall be corrosion-proof and shall meet the requirements set out in the Corrosion Protection section.

12 COMPOSITE AIR-INSULATED BUSHINGS

The HF/Air Bushings shall comply in general with IEC 60137, Insulated bushings for alternating voltages above 1000 V.

The bushings shall be condenser type or insulated with SF6 gas. Condenser bushings shall be equipped with a measuring tap for the measurement of the capacitance and power factor of the bushing.

High Voltage bushing insulator housings shall be of composite insulation and silicone rubber shields.

The insulator shall have stable leakage currents to ground during 10 kV insulation tests, in different weather conditions and throughout the life of the bushing. If a single insulator is not offered the preference is for stacked, horizontal jointed insulators, rather than a continuous top to bottom joint.

The acceptable limits for site % pf measurements for the HV winding insulation at 20 degrees C are as follows:

- % Pf and capacitance to test tap at 10 kV --- to be less than 0.5 % and reproducible on site.
- Values are to be stamped on the bushing nameplate.

Outdoor insulators shall be suitable for site pollution severity (SPS) class e – Very Heavy in accordance with IEC 60815-1 (RUSCD 53.7 mm/kV).

The final minimum creepage distance shall be calculated using the method given in IEC 60815-2 or 60815-3 for HV plant.

12.1 HIGH VOLTAGE TERMINALS

The terminals, which shall comply with IEC 62271-301, shall be flat aluminium with hole/holes 14 mm diameter at 50 mm centres or, alternatively, 30 mm diameter round aluminium terminals.

12.2 MECHANICAL TERMINAL LOAD

The rated static withstand loads in a horizontal direction shall be as required for the specific application and shall be stated by the manufacturer / customer.

The HF shall be capable of withstanding the specific static loads which include for the effects of wind and ice and shall be able to perform their switching duties while subjected to such loads. Under normal conditions, the sum of the loads acting should not exceed 50 % of the specified withstand load. The equipment shall withstand rarely occurring extreme dynamic loads (e.g. short circuits) not exceeding 1.4 times the static withstand load.

Mechanical loading shall follow EirGrid's functional specification OFS-SSS-400, Onshore Compensation Compound General Requirements.

12.3 CLEARANCES

Clearances shall follow EirGrid's functional specification OFS-SSS-400, Onshore Compensation Compound General Requirements.

13 EARTHING

Earthing arrangements shall follow EirGrid's functional specification OFS-SSS-407 and shall consider the specific requirements for HF filter earthing, these requirements shall be discussed and agreed with the manufacturer.

14 SUPPORTING STEEL WORK

All supporting steelwork and access platforms where required shall be supplied and shall be designed for fixing to the foundations. Steel work shall follow EirGrid functional specifications OFS-SSS-421, OFS-SSS-420 and OFS-SSS-419.

15 FOUNDATIONS AND LOADING

The equipment shall be designed for mounting on outdoor foundations.

Areas within the HF boundary and enclosure not forming part of the concrete foundations shall be sealed with a covering to tarmac.

The Customer shall supply a mechanical loading report and foundation drawings for design review.

The loading report shall include:

- Mechanical loads during operation and installation.
- Electromagnetic forces include those arising from fault or short time loading conditions
- Wind and ice conditions.
- Forces due to expansion and contraction due to both ambient temperature and load variation.

16 MAINTENANCE LAYOUT

The plant shall be arranged to give safe personnel access to all maintenance staff when the plant is not energised. The layout shall be designed to minimise the impact of maintenance on the availability of the HF Filter.

Platforms or catwalks with handrail shall be provided where necessary. A catwalk serving two or more operating positions shall have two stairways to the operating floor.

The general layout of the plant shall be such as to permit replacement or maintenance of any sub-components of the plant. Fixed platforms or catwalks shall have removable sections to permit replacement or maintenance of any sub-components if required. The layout shall also allow for the provision of vehicular access for maintenance purposes if required.

The general layout of the plant shall be such as to permit replacement of any complete HF unit components by crane or other suitable lifting machinery. Access arrangements shall be subject to review by EirGrid.

Lifting eyes shall be provided on all HF components and also on removable catwalk sections which cannot be lifted safely by other means.

The exact location and layout of the HF on site will be reviewed by EirGrid and shall take into account the physical constraints of the site and the system constraints in de-commissioning any existing equipment.

To ensure safety of personnel during maintenance:

- All parts of main circuits to which access is required shall be capable of being earthed.
- Provision shall be made for carrying out primary injection tests on all current transformers.
- Provision shall be made to allow component testing according to the maintenance procedure.

17 CORROSION PROTECTION

Corrosion of both ferrous metals, aluminium and aluminium alloys is a particular problem in Ireland.

Experience has shown that because of high humidity, extreme precautions are necessary, to prevent the aggressive ingress of moisture between flange plates, around gaskets and O-rings, at insulator/flange interfaces, etc. All necessary precautions shall be taken to prevent this. Tactile 506 type grease or equivalent should be used if required. This level of attention shall also be paid to all devices bought from sub-suppliers.

The Customer shall clearly state the corrosion protection applied to all aluminium or aluminium alloy parts. This corrosion protection shall be suitable for the environmental conditions listed in OFS-SSS-400 Specification.

Any aluminium or aluminium alloy exposed to the environmental conditions shall be of a suitable grade for the environment. The Customer shall draw attention to all exposed points in their equipment at which aluminium or aluminium-alloy parts are in contact with or in close proximity to other metals and shall detail the protection employed at each point to exclude air and moisture.

The Customer shall confirm that all paint systems employed for corrosion protection of steel parts meet or exceed the requirements of ISO 12944-5 (Corrosion Protection of Steel Structures), to provide high durability (minimum 15 years) coating with category C5-M corrosion protection, suited to environments with high condensation, pollution and salinity as per ISO 12944-2.

Minimum requirements for the painting and corrosion protection systems for Hot Dip Galvanised Steel are as follows:

- Hot dip galvanising of steel shall be compliant with the requirements of EirGrid's specification OFS-SSS-420 for hot-dip galvanising of iron and steel other than wire.
- Paint system for hot-dip-galvanised steel surfaces shall meet or exceed the requirements of Paint System A7.13 of ISO 12944-5, to provide high durability (above 15 years) coating with category C5-M corrosion protection, suited to environments with high condensation, pollution and salinity as per ISO 12944-2.

The process for painting hot-dip galvanised steel is detailed below:

PROCESS	MATERIALS	MINIMUM REQUIREMENTS
Clean	Appropriate solvents or other cleaning agents	A grease / oil free substrate
Sweep blast	Aluminium oxide or another inert abrasive medium	A light texture on the zinc layer with no more than 3 % of the zinc removed by the process
Priming	As per Paint System A7.13 of ISO 12944-5	As per Paint System A7.13 of ISO 12944-5
Undercoating	As per Paint System A7.13 of ISO 12944-5	As per Paint System A7.13 of ISO 12944-5
Finish coating	As per Paint System A7.13 of ISO 12944-5	As per Paint System A7.13 of ISO 12944-5

Table 1 - Table Process for Painting Hot-Dip Galvanised Steel

The minimum requirements acceptable to EirGrid for individual items are as follows:

(a) Hot-Rolled Steel, Mechanism Boxes, Marshalling Cabinets, Fasteners larger than 12 mm Diameter and pipes:

i. Hot-dip galvanising, in accordance with EirGrid Specification,

and

ii. Painting system as per painting and corrosion protection for Hot Dip Galvanised Steel stated above.

(b) Smaller Fasteners, Cable Clips:

i. Non-ferrous material or stainless steel of suitable grade for the environmental conditions stated in Section 22 above.

(c) As a minimum all exposed non-stainless ferrous parts, including supporting steel work for HF, kiosks, nuts and bolts, shall be hot-dip-galvanised to comply with EirGrid specification OFS-SSS-419.

17.1 MINIMUM REQUIREMENTS

The following are the minimum requirements of the painting and corrosion protection

systems for Hot Dip Galvanised Steel and for Thermally Sprayed Zinc Coated Steel:

17.1.1 HOT DIP GALVANISED STEEL

Hot dip galvanising of steel shall be fully compliant with the requirements of OFS-SSS-420.

17.1.2 THERMALLY SPRAYED ZINC COATED STEEL

The minimum thickness of the zinc coat shall be 150 µm.

The paint system for thermally sprayed metal surfaces shall meet or exceed the requirements of Paint System A8.02 of ISO 12944-5 (Corrosion Protection of Steel Structures), to provide high durability (minimum 15 years) coating with category C5-VH corrosion protection, suited to environments with high condensation, pollution and salinity as per ISO 12944-2.

The process for thermally sprayed zinc coating and application of the required painting system shall be as detailed below:

PROCESS	MATERIALS	MINIMUM REQUIREMENTS
Metal spraying to EN 22063	Zinc	150 µm
Sealer coating	As per Paint System A8.02 of ISO 12944-5	As per Paint System A8.02 of ISO 12944-5
Undercoating	As per Paint System A8.02 of ISO 12944-5	As per Paint System ISO 12944-5
Finish coating	As per Paint System A8.02 of ISO 12944-5	As per Paint System A8.02 of ISO 12944-5

Table 2 - Painting process for zinc coated steel

The minimum requirements acceptable to EirGrid for individual items shall be as follows:

a) Hot-Rolled Steel:
   i. Grit blasting to SIS 05 59 00 or to BS 7079 to achieve a second quality 50-micron finish.
   ii. As per ‘Thermally Sprayed Zinc Coated Steel’ .

b) Radiators, Mechanism Boxes, Marshalling Cabinets, Fasteners larger than 1 2mm Diameter and pipes:
   i. Hot-dip galvanising, in accordance with OFS-SSS-420.
   ii. As per ‘Hot Dip Galvanised Steel’

c) Smaller Fasteners, Cable Clips:

   Non-ferrous materials or stainless steel to be used otherwise use of appropriately plated components to be used.

d) Nuts and Bolts:

All nuts, bolts and washers shall be stainless steel with grade A4 as per ISO 3506-1 (AISI 316) or better. Where they are in contact with aluminium, they shall be galvanised type and shall have grease applied to help prevent galvanic corrosion. All nuts, bolts and/or washers shall all be manufactured in one factory.

All external surfaces shall be primed and finished in grey colour RAL 7033. The standard applicable to seals and gaskets shall be subject to review of EirGrid.

All necessary precautions shall be taken to prevent the aggressive ingress of moisture between flange plates, around gaskets and O-rings, at insulator/flange interfaces, etc. Tactile 506 type grease or equivalent shall be used if required.

The Customer shall protect all exposed points in their equipment at which aluminium or aluminium-alloy parts are in contact with or in close proximity to other metals and shall ensure that air and moisture are excluded from such situations.

If there are aluminium or aluminium alloy parts used such parts shall be anodised with painted or equivalent finish.

18 TESTING STEEL CORROSION PROTECTION

The painting and corrosion protection system shall be type tested as per ISO 12944-6.

In addition, the following type and routine tests shall be carried out where not covered by ISO 12944-6:

- The required tests of appearance on the painting and corrosion protection system for hot dip galvanised steel and thermally sprayed zinc coated steel are detailed below and shall be carried out as part of type and routine tests.

TEST METHOD	GLOSS	COLOUR	GENERAL APPEARANCE
ISO 2813	80 $^{+/-}$ 10 Units @ 60 ^{o}		
ISO 7724		ΔE CIELAB of not more than 1.5 under D65 light source from the master chip.	
Viewed in clear north light with the unaided eye at a distance of 2m.			The coating shall be of smooth uniform appearance, with no inclusions, voids, or other blemishes, which mar the surface.

Table 3 - Tests of Painting and Corrosion Protection System Appearance

The required type and routine tests of performance characteristics on the painting and corrosion protection system for hot dip galvanised steel are detailed below:

TYPE TESTS				
TEST	**METHOD**	**REQUIREMENTS**		
480 HOUR SALT SPRAY	ISO 9227	MAXIMUM ADHESION LOSS AT SCRIBE	BLISTERING REMOTE FROM SCRIBE	OTHER DEFECTS
		2 mm	None	None
480 HOUR HUMIDITY	ASTM D 2247	BLISTERING	COLOUR CHANGE	OTHER DEFECTS
		None	None	None
SOLVENT RESISTANCE RUB TEST	ASTM D 4752	CORROSION	BLISTERING	OTHER DEFECTS
		None	None	None
1,000 HOURS UVA ARTIFICIAL WEATHERING	ISO 4892-3	MAXIMUM COLOUR CHANGE	MAXIMUM LOSS OF GLOSS @ 60 ^{0}	OTHER DEFECTS.
		ΔE = < 2.6	< 25 %	None
ROUTINE TESTS				
TEST	**METHOD**	**REQUIREMENTS**		
Initial adhesion. Cross Hatch Test	ISO 2409 ASTM D 3359	MINIMUM RATING		
		0		
Hardness Test	ASTM D 3363	MINIMUM RATING		
		0		
DIRECT IMPACT	ASTM D 2794	FAILURE AT 56 INCH / LB		
		None		

Table 4 - Painting and Corrosion Type Tests and Routine Tests

19 ELECTROMAGNETIC COMPATIBILITY (EMC)

Attention should be given to the design of the earthing system and to the layout of the HF and its components to reduce the risk of EMC problems.

20 PADLOCKING

All items which require padlocking shall be provided with a hole, approximately 7 mm diameter for accepting padlocks with a shackle diameter of 30 mm, shackle length of 23 mm and 6.3 mm diameter cross-section for this padlocking.

21 LABELS AND MARKINGS

21.1 EQUIPMENT NAMEPLATES AND LABELLING

The equipment shall be labelled so that each component and each piece of main equipment may be identified. Each individual HF component shall be provided with a name plate bearing information as specified by relevant IEC Publication. Individual equipment nameplates shall contain the actual current, voltage, resistance, inductance, capacitance, CT ratio ratings of the equipment.

All labels printed shall survive the equipment's anticipated lifespan and shall be clear and indelibly printed in English. The labels shall be engraved and resistant to UV light. The labelling shall also include EirGrid's designations as required.

The following indications shall be supplied as minimum:

a) Each HF component connection shall be clearly labelled to indicate its function and connection point.

b) Each phase of the HF bays shall be identified with appropriate phase reference at each point where it may be accessed.

c) Each HF component shall be labelled and referenced to its identification code contained in the Suppliers drawings and in the EirGrid Single Line Diagram.

All labelling shall be subject to review by EirGrid to confirm clarity and understanding of all texts.

22 TESTING

22.1 GENERAL TEST REQUIREMENTS

Tests shall be carried out in accordance with the appropriate IEC publications and OEM recommendations, unless stated otherwise. Customer shall submit ITPs (inspection and test plans) and testing / commissioning procedures to EirGrid for review.

Type tests shall be performed on one of each type to be delivered. Type tests are not required if the Customer provides type test reports for the specific equipment, provided the type tests are fully applicable to the specific equipment.

All equipment must be subjected to and pass the specified type tests at an accredited testing laboratory in accordance with the relevant IEC Publication, and the test certificates or reports obtained shall be submitted to EirGrid for review.

As EirGrid may wish to witness type, routine and special tests, or visit the factory during the manufacture of the HF Filter System, adequate notice of tests and manufacturing programmes shall be given.

All functional testing shall be executed and recorded.

All the individual items of equipment that form part of this functional specification such as

capacitors, reactors, resistors, current transformers, relays and surge arresters shall have been fully type-tested at an accredited testing station in accordance with the relevant IEC Publication, and the test certificates or reports obtained shall be submitted for review.

22.2 TESTING RESPONSIBILITIES

The Customer shall perform all tests that require connection of the HF Filter System to EirGrid's system may be witnessed by EirGrid. Energised system testing shall be kept to a minimum.

The Customer shall provide all necessary labour and test equipment / material to perform all tests and inspections that are the Customer's responsibility.

22.3 INSPECTION AND TEST PLAN (ITP)

The Inspection and Test Plan shall be in accordance with OEM recommendations, IEC standards, these EirGrid's Requirements and shall cover all aspects of testing and inspections. The preliminary and detailed ITP shall be submitted to EirGrid and shall include a schedule of all pre-commissioning and commissioning tests. All plant and material forming part of the HF Filter System shall be included in the ITP.

Test procedures shall be developed and submitted to EirGrid for review.

The Customer shall provide Declaration of Fitness for the HF Filter System that have been commissioned.

22.4 TYPE AND ROUTINE TESTS

All the type tests prescribed in the relevant IEC Publication shall be made on HF Filter System components. These tests shall have been carried out at a recognised testing station or alternatively shall have been witnessed by a representative of an independent testing agency or other independent witness.

Certificates/Reports containing full details of type tests shall be issued to EirGrid for review.

Full details of any modifications (no matter how minor) which have been made to the HF Filter System since the full set of type test was carried out shall be submitted together with the reports on the tests which were carried out to prove the modification.

. The equipment available for type tests shall be identical in all respects to those to be supplied to EirGrid.

In the event of a type test failure, EirGrid shall not be charged for any additional type tests.

All of the routine tests prescribed in the relevant IEC Publication shall be made on each assembled unit before shipment.

In addition, routine tests shall include verification of the IP rating and operational tests

before shipment. EirGrid may witness these tests.

Measurement of insulator creepage on a representative sample shall be included in the test results.

Routine tests for HF Filter System designs shall be in accordance with IEC 61954, Draft BS EN 62927 (IEC 22F/380/CD)

22.5 Special Type Tests

EirGrid may elect to have one or both of the following type tests performed:

- Dielectric Tests
- A complete HF may be subjected to impulse voltage tests at the prescribed insulation withstand levels. The test assembly shall include at least one item of each component of HF.

22.6 Tests After Erection

The Customer shall, as required, subject the complete HF to the IEC recommended HV tests.

These tests shall include Partial Discharge measurements.

If the HF Modules are to be connected by cable, then site HV tests may be required depending on the scale of the site assembly. The level of testing to be carried out after erection shall be subject to EirGrid review.

The necessary plant to carry out the prescribed test must be provided by the Customer of the HF for the duration of the test.

No changes to the equipment shall occur on site without review in advance with EirGrid. Any proposed changes to the technical records provided prior to equipment delivery must be communicated clearly to EirGrid.

23 Installation

While installation is the responsibility of the Customer, EirGrid requires that a copy of the manufacturer's installation instructions be provided. The instructions shall be in English and shall cover all aspects of equipment installation up to and including putting into service. The Customer shall ensure that the information supplied is clear and specific to the equipment being provided.

24 Erection And Maintenance

24.1 Special Tools And Equipment

The Customer shall list in an attached schedule of Special Tools (part of Technical Schedule OTS-SSS-414) any special tools or equipment required for the erection and subsequent maintenance of the equipment. These shall be included in the supply and

shall not be returnable. These shall include any hoists, jigs, gauges, templates, meters, etc.

24.2 SPARE PARTS

The Customer shall, in consultation with the manufacturers, list in an attached schedule of Recommended Spares those spare parts which they recommend should be held by EirGrid. All such spare parts, their type and quantity and any additional requirements shall be agreed with EirGrid.

All recommended spare parts shall be provided with a description of their function and complete installation instructions and associated drawings.

24.3 MAINTENANCE INSTRUCTIONS

The Customer shall provide a complete set of maintenance instructions. The instructions shall be complete, in English and contain all associated instructions and drawings pertaining to the continuing maintenance of the equipment throughout its lifecycle.

25 COMPLIANCE WITH SPECIFICATION

All deviations from the requirements of this specification shall be listed in the “Deviations Schedule” included in the Technical Schedule.

26 DOCUMENTATION

All documents and communication shall be in English.

26.1 TO BE SUBMITTED

The following documents shall be submitted as minimum for review by EirGrid:

- Fully completed copy of the SCHEDULES attached to this Specification including Deviations from Specification, quoting relevant section numbers of this specification. Proposed filter configuration, rating of components.
- Fully detailed Type Test Certificates/Reports.
- Full technical particulars, detailed electrical connection diagram including internal wiring, detailed physical drawings, technical literature, photographs, catalogues, , etc. to enable review of the offered equipment.
- Details of corrosion protection and associated type test details.
- Details of routine, type and special tests to which all units will be subjected before dispatch.
- Storage, Installation, Operation and Maintenance instructions.
- Reference list for equipment similar to the proposed HF including details of quantities already in service, location and contact person.

- Service experience to date including defects history.
- A short description of the Quality Control philosophy of the manufacturer including sampling techniques, statistical parameters etc. plus tests carried out on raw materials employed.
- Factory production experience of HF in general and specific HF proposed under this specification
- Service Experience as required in Section 4.1 above.

26.2 DESIGN DOCUMENTS

Primary and secondary design documents and drawings to be submitted during project detail design stage shall include:

- Outline dimensioned drawings of complete equipment.
  - arrangement complete with fittings
  - arrangement for transport and shipping
  - Schematic diagrams of the complete HF showing enclosures and components including CT wiring and terminations
  - A three-dimensional model in REVIT or equivalent of the physical layout of the HF and all its components.
- Data sheets for complete equipment and for all individual components including weight of all units.
- Earthing details / report.
- Report for magnetic clearance distances for the installed reactor from all metallic objects.
- Mechanical loading report and foundation drawings (see also section 22)
- Report of measures to prevent induced current in the enclosure interfering with the performance of the current transformers.
- Details of HV terminations, Recommendation for installation, operation and maintenance, including list of tools and equipment required e.g. test equipment. Equipment walkways, maintenance access and stairs/steps
- At the handover, all technical documents (e.g. drawings, instruction manuals, etc.) shall also be provided in electronic format and drawings shall be delivered in one of the following formats:
  - Microstation.dgn – compatible with latest version MicroStation (if available)
  - ACAD-dwg – latest release
  - Misc.dxf – compatible with latest version MicroStation

26.3 TEST PROGRAMME

The Customer shall submit a proposed test and inspections programme / plan and test procedures to EirGrid for review prior to commencement of the tests, inspections.

26.4 TECHNICAL RECORDS

The following documents to be submitted to EirGrid:

- Guaranteed rated values and characteristics i.e. the Technical Schedules that accompany the submission, modified where necessary.
- Detailed physical and electrical drawings.
- Detailed installation, operation and maintenance instructions.
- Certificates relating to the insulating material.
- Summary of type tests, routine tests and special tests, with copies of the Test Certificates.
- Full details of all auxiliary equipment.

27 TRAINING

The Customer shall submit a training plan which shall describe in detail how the Customer proposes to train EirGrid staff for operation of future EirGrid assets.

Training requirements will be detailed further in OFS-GEN-009 - Operation and Maintenance General Specification.