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# Hot Dip Galvanising of Iron and Steel Other Than Wire

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## 1 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.

This functional specification defines requirements for hot-dip galvanised coatings on structural steel, structural and sheet steel fabrications, tube assemblies, bolts, nuts, screws and other small articles processed in bulk, steel castings, steel forgings, steel stampings, iron castings and similar products for use in Onshore Compensation Compounds.

It does not apply to products such as wire, sheet steel or tubing which will later be made into finished articles.

This specification should be read in association with 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.

## 1 LEGISLATION CODES AND STANDARDS

#### **1.1 LEGISLATION**

Galvanised steel fabrication

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

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				

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

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/27 5	Vol. I and II ("ADR 2019") European Agreement Concerning the International Carriage of Dangerous Goods by Road

There shall be compliance with the provisions of all current relevant Directives of the European Communities and the Republic of Ireland relating to design, workmanship, materials and equipment. It is the responsibility of the Customer to oversee compliance with current Codes and Standards.

### **1.2 HEALTH AND SAFETY**

The Customer is considered to undertake the role of "Client" under the Safety, Health and Welfare at Work (Construction) Regulations 2013 (referred to as the "Regulations" in this document) and responsible for the design. The Customer shall take due account of EirGrid's Safe by Design Methodology XDS-SDM-00-001-R0.

The Customer is solely responsible for Safety on Site. The project shall be managed in accordance with the Safety Health & Welfare at Work Act 2005 as amended and in compliance with the Safety Health and Welfare at Work (Construction) Regulations 2013.

The Customer and their appointed PSDP and PSCS shall be responsible for compliance, preparation of and liaison with relevant bodies in respect of all documentation associated with the above regulations including but not limited to:

- Design Risk Assessments
- Temporary and Permanent Works Certificates
- Notifications to the HSA (AF1 & AF2)
- Preliminary and Construction Stage Safety & Health Plans
- Risk Assessments and Method Statements (RAMS)
- Safety File and as built steel fabrication drawings

#### **1.3 SUSTAINABILITY**

The Customer shall ensure that the principles of sustainable steelwork protection for civil and building construction are employed and that the hot dip galvanizing will protect against corrosion and prolongs the life of steel that will lower the environmental and economic cost and contribute to the sustainability, robustness, economy, and health and safety of the works.

The Steelwork hot dip galvanised protection process shall provide methods that are sustainable and safer through the design and construction phases including .-

- steel fabrication and protection treatment
- transportation / handling
- testing and repairs

The Customer shall demonstrate through their Environmental Management Systems that all parties in their supply chain have taken practical steps to reduce the greenhouse gas emissions of the processes over which they have control.

The Customer and their associated parties should design, procure, detail through the fabrication of the structural and ancillary steelwork to ensure that the hot dip galvanised system will minimise material use and reduce waste. The design and detailing of the OCC galvanised steelwork should facilitate its recovery for reuse at its end-of-life stage as part of the circular economy and that all steel making processes makes full use of available scrap material.

#### **1.4 QUALITY CONTROL AND QUALITY ASSURANCE**

For all the galvanising of steelwork required for the OCC, the Customer in a timely manner, shall make available in the factory, and/or at site works locations in advance of any works as applicable, for each of the areas as requested, for review/ inspection by EirGrid.

This will cover but not limited to the following areas and associated activities:

Access to QC/QA documents including RAMS (Risk Assessments and Method Statements), work procedures, drawings. checklists, samples, Inspection schedules & test plan, Project Quality Control plan, certifications, audits and other documents for steel materials that require welding, components /mechanical fasteners, structural and ancillary steel fabrication undertaken for the civil, structural and building processes required for the delivery of the OCC.

An inspection report of the galvanised steel shall be submitted to EirGrid for review to ensure the Customers quality of the design and manufacture in relation to finishes and corrosion resistance has been carried out.

#### **1.5 NATIONAL INTERNATIONAL AND OTHER APPLICABLE STANDARDS**

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.

CODE REF	DESCRIPTION
IS EN 11124	PREPARATION OF STEEL SUBSTRATES BEFORE APPLICATION OF PAINTS AND RELATED PRODUCTS - SPECIFICATIONS FOR METALLIC BLAST CLEANING ABRASIVES
IS EN ISO 11126	PREPARATION OF STEEL SUBSTRATES BEFORE APPLICATION OF PAINTS AND RELATED PRODUCTS - SPECIFICATIONS FOR NON-METALLIC BLAST- CLEANING ABRASIVES
IS EN ISO 8501-3	PREPARATION OF STEEL SUBSTRATES BEFORE APPLICATION OF PAINTS AND RELATED PRODUCTS - VISUAL ASSESSMENT OF SURFACE CLEANLINESS
IS EN ISO 8501-1	PREPARATION OF STEEL SUBSTRATES BEFORE APPLICATION OF PAINTS AND RELATED PRODUCTS - VISUAL ASSESSMENT OF SURFACE CLEANLINESS
BS 7079	GENERAL INTRODUCTION TO STANDARDS FOR PREPARATION OF STEEL SUBSTRATES BEFORE APPLICATION OF PAINTS AND RELATED PRODUCTS
IS EN ISO 12944-4.	PAINTS AND VARNISHES - CORROSION PROTECTION OF STEEL STRUCTURES BY PROTECTIVE PAINT SYSTEMS
IS EN 1090-2	EXECUTION OF STEEL STRUCTURES AND ALUMINIUM STRUCTURES - PART 2: TECHNICAL REQUIREMENTS FOR STEEL STRUCTURES
EN ISO 1461	HOT DIP GALVANISED COATINGS ON FABRICATED IRON AND STEEL ARTICLES — SPECIFICATIONS AND TEST METHODS
IS EN 1090-1	EXECUTION OF STEEL STRUCTURES AND ALUMINIUM STRUCTURES - PART 1: REQUIREMENTS FOR CONFORMITY ASSESSMENT OF STRUCTURAL COMPONENTS
ISO 10474:2013	STEEL AND STEEL PRODUCTS INSPECTION DOCUMENTS
ISO 14713-1	ZINC COATINGS — GUIDELINES AND RECOMMENDATIONS FOR THE PROTECTION AGAINST CORROSION OF IRON AND STEEL IN STRUCTURES — PRINCIPLES
ISO 14713-2	ZINC COATINGS GUIDELINES AND RECOMMENDATIONS FOR THE PROTECTION AGAINST CORROSION OF IRON AND STEEL IN STRUCTURES PART 2: HOT DIP GALVANIZING
IS EN ISO 10684	FASTENERS HOT DIP GALVANISED COATINGS
NSSSBC	NATIONAL STRUCTURAL STEELWORK SPECIFICATION FOR BUILDING CONSTRUCTION
BS EN ISO 4157	CONSTRUCTION DRAWINGS

CODE REF	DESCRIPTION
ISO 2808	PAINTS AND VARNISHES DETERMINATION OF FILM THICKNESS
ISO 2178	NON-MAGNETIC COATINGS ON MAGNETIC SUBSTRATES MEASUREMENT OF COATING THICKNESS MAGNETIC METHOD
ISO 3882	METALLIC AND OTHER INORGANIC COATINGS REVIEW OF METHODS OF MEASUREMENT OF THICKNESS

Codes and standards appear as they are referenced in the specification. for undated references, the latest edition of the referenced document (including any amendments) applies.

#### **2** SERVICE CONDITIONS

The OCC and associated buildings, plant and equipment will be in exposed locations, likely to be less than 1,000 metres above sea-level. The Customer's design for the protection of the exposed Steelwork for the OCC works shall consider the structural and environmental impact on ferrous metals for the OCC based on temperatures, humidity and wind speeds bespoke to the project's location. As a guide the following climate and weather conditions may apply: -

Maximum ambient temperature 40°C

Maximum daily average ambient temperature 30°C

Annual average ambient temperature 20°C

Minimum ambient temperature - 25°C

The maximum wind (3 sec gust) velocity > 50 metres per second.

The coastal atmosphere conditions will generally be of a high humidity and salt laden.

For more site-specific weather and temperature for OCC project locations may be obtained from the Met Eireann, Ireland's National Meteorological Service, (Department of Housing, Local Government and Heritage)

#### **3 GALVANISING REQUIREMENTS**

#### **3.1 PREPARATION OF STEELWORK**

Before blast cleaning or abrading steel surfaces or hot dip galvanised surfaces, any contamination including by oil or grease shall be removed. Solvents shall not be used.

Metallic blast cleaning abrasives complying with IS EN 11124 or non-metallic blast cleaning abrasives complying with IS EN ISO 11126 shall be used.

Steelwork shall be blast cleaned to remove all mill scale and other contamination to IS EN ISO 8501-3 and BS 7079.

The surface finish shall be to standard preparation grade Sa 2<sup>1</sup>/<sub>2</sub> in accordance with IS EN ISO 8501-1 and IS EN ISO 12944-4.

Abrasive used during blast cleaning shall be selected in accordance with IS EN ISO 11124 and IS EN ISO 8501-3 and BS 7079. Sand blasting shall not be used.

Any contamination of the treated steelwork surface shall be removed, using an approved solvent solution, before further protective coatings are applied.

#### **3.2 HOT DIP GALVANISED PROTECTION OF STEELWORK**

All exposed steelwork, , including externally exposed holding down bolts and internal steelwork below ground floor level shall be hot dipped galvanised.

The requirements for the execution of steel structures galvanising protection for steelwork shall comply with IS EN 1090-2 as applicable.

The steelwork and components including nuts (excluding treads ), bolts and washers, that are to be hot dip galvanised shall comply with IS EN ISO 1461. (Refer to EirGrid Specification OFS-SSS-419-R0).

#### 3.3 HOT DIP GALVANISED COATINGS

Hot dip galvanised coatings shall, comply with IS EN ISO 1461 and with the following:

Inhibited hydrochloric acid with a strength not exceeding 18% and within a temperature range of 15°C to 25°C or inhibited sulphuric acid with a strength not exceeding 18% and within a temperature range of 60°C to 80°C shall be used for pickling.

Components shall not be immersed in the pickling acid longer than is necessary for cleaning the surfaces prior to hot dip galvanizing. Components shall receive a freshwater rinse between pickling and the galvanising bath.

The surfaces of components to be hot dip galvanised shall be dried before immersion in the molten zinc.

When an aqueous flux is to be used, all traces of acid shall be washed off immediately after pickling.

Hot dip galvanised coatings shall be relatively smooth, continuous and free from flux staining.

Detrimental contamination of hot dip galvanised coatings which are to be painted shall be removed by wet cleaning in compliance with Section 3.1. Surfaces to be painted shall not receive chromate passivation treatment.

Vent holes drilled in hollow sections prior to hot dip galvanizing shall have the surface treated and plugged after hot dip galvanizing and before any painting in accordance with IS EN 1090-2:2008.

The Customer shall take measures to minimise the potential for liquid metal assisted cracking occurring during the galvanizing process and to identify any cracks that may have occurred in galvanised steelwork.

#### 3.3.1 CERTIFICATION AND QUALITY CONTROL

Customer shall ensure that all factory and on-site testing, samples and records of inspection including two copies of the manufacturer's factory test certificate certification of compliance (refer to ISO 10474) for the hot dip galvanising process for all steelwork are made available to EirGrid for review as part of the Customer's Quality management system.

## 3.4 HOT-DIP GALVANISING BATH

The zinc of the hot-dip galvanising bath shall contain not less than 98.5% by mass of zinc maintained at approximately 449 °C complying with IS EN ISO 1461.

After the steel has immersed and the fabricated items' coating growth is complete, they are withdrawn slowly from the galvanizing bath, and the process shall ensure that all excess zinc is removed by draining, vibrating, and/or centrifuging.

No zinc impurities or additives, which could have a deleterious effect on the durability of the zinc coating, shall be acceptable. All steel galvanised coating shall be inspected and tested to determine thickness, uniformity, adherence, and appearance.

## 3.5 APPEARANCE OF FINISHED COATING

At acceptance inspection shall comply with IS EN ISO 1461:2009. The significant surface(s) of all the hot dip galvanised article(s), when first examined by normal or corrected vision from a distance of not less than 1 m, shall be free from nodules, blisters (i.e. raised areas without solid metal beneath), roughness and sharp points (if either can cause injury) and uncoated areas.

The galvanising coating shall be smooth, continuous, uniform and free from anything that is detrimental to the stated use of the coated article. It shall be free from acid spots, flux stains and shall not scale or blister, or be removable by normal handling or packing. Shiny, dull grey or spangled surface appearance shall be generally acceptable.

Flux residues shall not be permitted. Lumps and zinc ash shall not be permitted where they might affect the intended use of the hot dip galvanised article or its corrosion resistance requirement (see ISO 14713-1 for corrosion protection performance data).

Aesthetic effects (e.g. weld seepage) resulting from the use of intermittent welds around overlapping surfaces in the fabrication should not be a cause for rejection. Use of this type of welding pattern often results from consideration of health and safety issues. Further guidance is given in ISO 14713-2.

Presence of white rust shall be validated by the Customer. Articles that fail any visual inspection shall be renovated in repaired. Otherwise, the articles shall be re-galvanised and resubmitted for inspection.

#### **3.6 THICKNESS OF COATING**

The thickness of the galvanising coating shall comply with the minimum mean values given in Table 3 and Table 4 complying with IS EN ISO 1461:2009 when tested in accordance with the requirements of this Specification. The length of time of corrosion protection by such coatings is approximately proportional to the coating thickness (see ISO 14713-1.

#### 3.7 MASS OF COATING

The mass of the galvanising coating per square metre of the surface area shall comply with the minimum values when tested in accordance with IS EN ISO 1461:2009 and the requirements of Section 4 of this Specification.

#### **3.8 TREATMENT AT JOINTS**

All material at joints shall be hot dip galvanised. When an adhesion promoter and a first undercoat are applied before a joint is made, they shall be taken 10 mm to 15 mm inside the perimeter of the joint; these coats shall also be applied to edges and outer surfaces of the joint material.

Unless otherwise specified by the Customer, threaded fasteners at joints in hot dip galvanised steelwork or in hot dip galvanised steelwork, which is to be painted, shall be hot dip galvanised in accordance with IS EN ISO 10684. Hot dip galvanised fasteners which are to be painted shall be treated with an adhesion promoter.

At Welded Joints ;-Thermally sprayed aluminium metal coating shall be kept clear of the weld by a distance of at least 15 times the thickness of the steel in the area to be welded, with a minimum of 150mm and maximum of 300 mm from the joint. The restricted area shall be masked during metal spraying.

Hot dip galvanizing shall be removed a minimum of 5 mm back from the edges of weld areas. Paint coats shall be stepped back at 30 mm intervals commencing at least 150 mm from the joint, or from the edge of the thermally sprayed aluminium metal coating, starting with the 2nd coat of paint.

Steelwork surfaces that are to be in contact with concrete, including parts of the undersides of baseplates, shall be coated with a protective treatment where the concrete is cast against a surface, for a distance of at least 25mm.

#### **3.9 REPAIRS TO GALVANISING**

Hot dip galvanised components showing signs of failure, e.g. blisters and rust, of the coating shall be re-galvanised. Repairs shall have corrosive protection applied in accordance with IS EN 1090-2. The exposed steelwork shall then be treated and protected with hot dip galvanisation in accordance with EN ISO1461

Failed paint coatings over hot dip galvanizing shall be restored. Surface preparation of affected areas shall be by abrading. Areas of sound hot dip galvanizing exposed through a paint system shall be abraded only as necessary to ensure satisfactory application of an adhesion promoter and paint as per Customer design. If the hot dip galvanizing is damaged or reduced to less than 80% of the specified minimum thickness during abrading, the component shall be re-galvanised.

In the workshop:- for hot dip galvanizing, small, isolated areas of up to 40 mm2 and not exceeding 0.5% of the total surface area of the component, whichever is the lesser, may after surface preparation, be repaired with low melting point zinc alloy, providing that the total area of any damage on a component does not exceed 0.5% of the total surface area of the component. Components with damaged areas greater than the above limits shall be re-galvanised.

Isolated areas of damage larger than 40 mm<sup>2</sup> in hot dip galvanizing which is to be painted later or which has already been painted may be repaired with low melting point zinc alloy after surface preparation.

Alternatively, the whole of the affected area including exposed steel substrate shall, after surface preparation, be overcoated with two coats of Zinc Rich Epoxy Blast Primer with a minimum dry film thickness of 50 microns for each coat.

On site:- surfaces of hot dip galvanised steel and components which the Customer has

deemed to have minor damage shall ensure that the steel protection system is repaired by : -.

- a) Cleaning the bare steel or steel-zinc alloy using needle gun and/or rotary wire brush.
- b) Cleaning , degreasing, washing down/ drying to thinned and adjacent sound galvanised surfaces
- Then Immediately apply zinc-rich paint to bared steel or steel-zinc alloy and thinned galvanising, overlapping sound galvanised surfaces by minimum 20 mm,

to give protection equal to that on undamaged surfaces with two coats of Zinc Rich Epoxy Blast Primer, minimum dry film thickness of 50 microns for each coat.

- d) When hot dip galvanised steel is to be protected by a paint system, the adhesion promoter shall be applied not later than 14 days after delivery to site
- e) Alternatively, the Customer where members have been originally galvanised and display signs of deterioration shall be replaced by newly galvanised members.

#### **3.10 STORAGE AND TRANSPORT OF GALVANISED STEEL STEELWORK**

Galvanised steelwork shall be adequately protected from contaminants liable to cause failure of the protective coating, rusting and possibly pitting of the surfaces.

Galvanised steelwork shall not be loaded for transport until the galvanised steelwork has cured sufficiently for handling.

During storage, galvanised steelwork shall be kept clear of the ground and shall be laid out or stacked to prevent water or dirt accumulating on or against any of the surfaces.

Suitable packings shall be placed between layers of stacked galvanised steelwork. When cover is provided it shall be ventilated sufficiently to keep condensation to a minimum.

Components weighing less than one tonne shall be kept in a storage area away from their erection point to minimise damage to protective coatings.

Lengths of parapet and individual galvanised steel lighting columns and masts shall be supported on timber, and precautions taken to prevent damage to their galvanised protective coatings and ingress of water. They shall only be positioned adjacent to their erection point immediately before erection. If the planned erection time is delayed by more than 72 hours the galvanised components shall be returned to the storage area.

Galvanised components shall be transported and stored under dry and well-ventilated conditions, to avoid wet storage staining. If stored outdoors, close contact of surfaces of components shall be avoided, and suitable packing shall be placed between components, and to keep the components clear of the ground.

Galvanised Components shall be stored wherever possible at a slight angle to allow water run-off. When cover is provided it shall be ventilated sufficiently to keep condensation to a minimum.

If damage to galvanised coatings is deemed excessive or may be difficult to deal with after erection, the Customer shall repair the coatings before erection or alternatively ensure the components are re-galvanised as specified.

## 4 **TESTING PROCEDURE**

The tests detailed in this specification shall be carried out on the first consignment of each article supplied by the Galvaniser, if there are more than one galvaniser supplying articles then this clause shall apply each galvaniser thereafter.

In addition, EirGrid shall have the right to nominate further consignments for test at random. The results must be recorded on the standard test certificate and submitted by the Customer to EirGrid.

EirGrid representative shall have the right to witness the tests and to inspect the parts of the Galvaniser's works used during the work on the consignment.

The Customer shall notify EirGrid in a timely manner in advance of the date of testing.

The following tests shall be carried out on each of the selected samples: -

- Visual Inspection
- Thickness of Coating
- Uniformity of Coating

Testing shall be carried out in accordance with this Specification. The result of this test shall be definite and binding.

#### 4.1 SAMPLING

The customer shall ensure control samples for thickness testing as per IS. EN ISO 1461 shall be taken randomly from each lot selected for testing. The minimum number of articles from each inspection lot that forms the control sample shall be in accordance with Table 1

Number of articles in lot	Minimum number of articles in the control sample
1 to 3	All
4 to 500	3
501 to 1200	5
1201 to 3200	8
3201 to 10000	13
> 10 000	20

Table 1 Control sample size related to lot size

#### 4.2 INSPECTIONS

Inspections shall measure zinc thickness with magnetic or the single value from a gravimetric test and shall be re-galvanised if thickness is deficient. All galvanised components shall be subjected to 100% post-galvanizing inspection in accordance with procedure PGI-1 in Table 10.1 of NSSSBC (National Structural Steelwork Specification for Building Construction) unless otherwise specified by the Customer.

The drawings shall conform to BS EN ISO 4157 and identify: -

- i. Any components for which post-galvanizing inspection is not required (PGI-0).
- ii. Any components that shall be subjected to procedure PGI-2A
- iii. Any specific locations that shall be subjected to procedure PGI-2B.

The customer shall ensure control sample for thickness testing shall be taken randomly from each lot selected for testing. The minimum number of articles from each inspection lot that forms the control sample shall be in accordance with Table 1.

Inspections shall include the following elements: -

- Smoothness: No exposed spots, spikes or anything detrimental to stated use of the articles or to personnel handling them.
- Welded areas
- Stains: No acid spots or flux/dross stains.
- Adhesion: No blisters, peeling or flaking. Must be able to withstand normal handling without deterioration.
- Wet Storage Stain (White rust): Storage/stacking conditions should not encourage this. Any signs of white rust shall be recorded and assessed by the Customers Quality procedures and may cause the consignment to be rejected.
- Threading: Free travel on threads by nuts (with oiled uncoated female threads). The threads of the nuts to be cut oversize to allow for the galvanising coating on the standard bolt threads.
- Any on site galvanised repairs.

#### 4.3 MAGNETIC THICKNESS MEASUREMENT

#### 4.3.1 INSTRUMENT

Thickness measurements shall be determined by one of the magnetic methods as set down in ISO 2808 and ISO 2178 (also specified in ISO 3882).

The instrument used shall have the necessary degree of accuracy, range of probes and probe adaptors to enable reliable readings to be obtained consistently.

Before commencement of the measurements, the instrument shall be calibrated, preferably of an un-galvanised sample of the article under test. The steel surface used for the calibration should be cleaned by machine process or abrasive.

#### 4.3.2 THICKNESS OF COATING

In accordance with IS. EN ISO 1461, measurements shall be taken per samples from reference areas as per Customers Design and shall be taken as quantified in Table 2. The thickness figure shall be the mean of all the readings for that sample.

The minimum mean coating thickness and mass requirement by article are given in and Table 4 and is defined as the lowest of the individual average thickness values for the number of samples under test

Category	Size of significant surface area	Number of reference areas to be taken per article
а	>2 m2	W 3
b	> 100 cm2 to ≤ 2 m2	W 1
с	>10cm2 to ≤ 100 cm2	1
d	≤ 10cm2	1 on each of N articles

#### Table 2 Required number of reference areas for testing

For articles in category "a" in Table 2, with a significant surface area greater than 2 m2 ("large" articles) for each article (taken separately) in the control sample, the mean coating thickness within the reference areas shall be equal to or greater than the mean coating thickness values in or Table 4.

In categories b, c and d in Table 2, the average coating thickness on each reference area shall be equal to or greater than the "local coating thickness" values given in or Table 4 as appropriate. The average coating thickness on all reference areas in a sample shall be equal to or greater than the "mean coating thickness" values given in Table 3 or Table 4, as appropriate.

For category d in Table 2 only, N is the sufficient number of articles to provide a minimum of 10 cm2 of significant surface for an individual reference area. The total number of articles tested equals the number of articles required to provide one reference area, N, multiplied by the appropriate number from the second column of Table 2 related to the size of the lot (or the total number of articles galvanised if that is less). Alternatively, sampling procedures selected from ISO 2859-1, ISO 2859-2 or ISO 2859-3 shall be used.

When the zinc coating thickness is determined by the magnetic method in accordance with ISO 2178, the reference areas shall be within, and representative of, those that would have been chosen for the gravimetric method.

When more than five articles have to be taken to make up a reference area of at least 10 cm2, a single magnetic measurement shall be taken on each article if a suitable area of significant surface exists; if not, the gravimetric test shall be used.

Within each reference area of 10 cm2, a minimum of five magnetic test readings shall be taken on coated areas. If any of the individual readings is lower than the values in Table 3 or Table 4, this is irrelevant, as only the mean value over the whole of each reference area is required to be equal to or greater than the local thickness given in the table. The mean coating thickness for all reference areas shall be calculated by the magnetic test as for the gravimetric test (see ISO 1460).

Thickness measurements shall not be taken on cut surfaces or areas less than 10 mm from edges, flame-cut surfaces or corners (see ISO 14713-2).

Article and its thickness	Local coating thickness (minimum)(a)	Local coating mass (minimum) (b)	Mean coating thickness (minimum)(c)	Mean coating mass (minimum)
Steel > 6 mm	70	505	85	610
Steel >3 mm to $\leq$ 6 mm	55	395	70	505
Steel $\geq$ 1,5 mm to $\leq$ 3mm	45	325	55	395
Steel <1,5 mm	35	250	45	325
Castings ≥ 6 mm	70	505	80	575
Castings <6 mm	60	430	70	505

#### Table 3 Minimum coating thickness and mass on samples that are not centrifuged

NOTE This table is for general use: individual product standards may include different requirements including different categories of thickness -refer to Customers Design. Local coating mass and mean coating mass requirements are set out in this table for reference in such cases of dispute

(a) Refer to Cl 3.8 IS. EN ISO 1461:2009

(b) Equivalent coating mass using a nominal coating density of 7,2 g/cm3)

(c) Refer to Cl 3.9 IS. EN ISO 1461:2009

The local coating thickness in Table 3 shall only be determined in relation to reference areas selected and agreed for testing by the Customer. In cases of dispute, the results of gravimetric tests (coating mass) take precedence over the results of coating thickness tests.

Table 4 Minimum coating thickness and mass on samples that are

The local coating thickness in Table 4 shall only be determined in relation to reference areas selected and agreed for testing by the Customer. In cases of dispute, the results of gravimetric tests (coating mass) take precedence over the results of coating thickness tests.

#### 4.4 REJECTION

If any sample fails to meet the requirements of this Specification, the intensification of testing will increase by 50% based on Table 2.

Any failed galvanised coatings on steel that is deemed excessive or may be difficult to repair, the Customer shall ensure that the relevant consignments with defects are regalvanised as specified. These records and testing shall form part of the Customers Quality procedures which EirGrid may review as required (Refer to Section 1.4).