

 Eskom	Standard	Technology
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Title: **STANDARD FOR FABRICATION
STEELWORK USED IN ESKOM
TRANSMISSION SUBSTATIONS**

Unique Identifier: **240-94743192**

Alternative Reference Number: **N/A**

Area of Applicability: **Engineering**





Documentation Type: **Standard**

Revision: **1**

Total Pages: **31**

Next Review Date: **August 2020**

Disclosure Classification: **Controlled
Disclosure**

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1. Introduction

The purpose of this document is to assist persons involved in the fabrication of steelwork to perform this function more easily and efficiently to the specification set out by Eskom.

2. Supporting clauses

2.1 Scope

This specification sets out Eskom's requirements for substation steelwork. It includes certain sundry items such as stairs, ladders, hand railings and open grid flooring.

2.1.1 Purpose

This document standardises the fabrication requirements for the steelwork to be used in Transmission substations.

2.1.2 Applicability

This specification shall apply throughout all Eskom Transmission substations.

2.2 Normative/Informative References

2.2.1 Normative

The following documents contain provisions that, through reference in the text, constitute requirements of this specification. At the time of publication, the editions indicated were valid. In cases of conflict, the provisions of this specification shall take precedence. Parties using this specification shall apply the most recent edition of the documents listed below.

- [1] AWS D1.1/D1.1M:2006: Structural Welding Code - Steel
- [2] BS EN 876: Destructive tests on welds in metallic materials. Longitudinal tensile tests on welded metal fusion welded joints.
- [3] BS 1011: Recommendations for welding of metallic materials: parts 1 and 2
- [4] BS 5531: Code of practice for safety in erecting structural frames
- [5] TRMSCABG8: Transmission-Corrosion protection of new and weathered steel powerline structures
- [6] SANS 121:2000: Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
- [7] SANS 10044: Code of Practice for Welding: Part 1 – 7
- [8] SANS 10064: Preparing of steel surfaces for coating
- [9] SANS 10104: Hand and guard rails (safety aspects).
- [10] SANS 1200: Series of standardized specifications for Civil Engineering Construction.
- [11] SANS 1700 SERIES: ISO metric bolts, screws and nuts (hexagon or square) (coarse thread free fit series)
- [12] SANS ISO 9000 series: Code of Practice for Quality Systems.
- [13] SANS 10162: The structural use of steel: Parts 1 and 2.
- [14] SANS 14713: Protection against corrosion of iron and steel in structures-Zinc and aluminium coatings-Guidelines
- [15] SANS 455: Covered Electrodes for the manual arc welding of carbon and manganese

[16] SANS 2063: Metallic and other inorganic coatings-Thermal spraying-Zinc, aluminium and their alloys

[17] SANS 1431: Weldable structural steels

2.2.2 Informative

[18] South African Steel Construction Handbook, Fifth Edition 2005, The South African Institute of Steel Construction.

2.3 Definitions

2.3.1 General

Definition	Description
Acceptable / Approved (approval)	Acceptable to / Approved (Approval) by Eskom.
Agreed	Agreed in writing by Eskom
As detailed	As detailed on the drawings.
Authorized / ordered / rejected	Authorized / ordered / rejected by Eskom.
Bolt grade designation	The grade designations have the following significance: the first number multiplied by 100 is the minimum tensile strength of the bolt material in MPa and the second number multiplied by 10 is the ratio (expressed as a percentage) between the stress at permanent set of 0.2 per cent (yield stress) and the minimum tensile strength. Thus a Grade 4.6 bolt has a minimum tensile strength of 400 MPa and minimum yield stress of 60 percent of 400, viz. 240 Mpa.
Coat	A single layer of corrosion – protection material.
Coating System	The method and degree of surface preparation, the type of coating, the number of coats and their thickness, the method of application of the coats and the requirements of the completed system.
Designated	Shown on a drawing or otherwise specified by Eskom or, in relation to an item scheduled in the tender document, descriptive of an item to be priced by a tendered.
Deviation	The difference between the actual (i.e. measured) size or position and the specified size or position.
Hot – dip (galvanized) coating	A coating of zinc – iron alloy layers (or such layers and a layer of zinc) obtained by dipping a prepared iron or steel article in molten zinc.
Hot patching solder	A solder alloy that is based on zinc that includes other compatible elements and that is such that the melting point of the solder is low enough to allow the making of satisfactory repairs to a to-dip zinc coating.
Indicated	Indicated in or reasonably to be inferred from the contract, or indicated in writing by Eskom.
Instructed / Directed / Permitted	Instructed / directed / permitted by Eskom
Normal temperature	Denotes a temperature between 15°C and 32°C.

Definition	Description
Permissible deviation (PD)	The specified limit(s) of deviation.
Satisfactory	Capable of fulfilling or having fulfilled the intended function.
Service	Any pipeline, duct, cable or overhead wire for conveying, as appropriate, any fluid (including stormwater and gas), or electricity or other form of energy for lighting or power, or telecommunications transmissions.
Submitted	Submitted with the tender or submitted to Eskom as appropriate.
Tolerance	The range between the limits within which a size or position must lie.

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 Abbreviations

Abbreviation	Description
ASTM	American Society for Testing and Materials
BM	Benchmark
BS	British Standards
CP	British Standard Code of Practice
DFT	Dry film thickness
HDG	Hot – dip galvanizing
SANS	South African National Standards
SMTM	Standard Methods of Testing Materials for the Department of Transport Affairs of the Republic of South Africa.
PD	Permissible Deviation

2.5 Roles and responsibilities

This standard must be used by substation designers who are involved in the design of steel structures. The standard shall be issued as part of technical documents for tender enquiries.

2.6 Process for monitoring

None

2.7 Related/supporting documents

None

3. Requirements

3.1 General interpretations

3.1.1 Approval

No approval of any material or plant and its operation, or of any construction procedure to be used, will imply any relaxation of the requirements governing the quality of the materials or of the finished work, or relieve the Contractor of his responsibilities under the contract.

3.1.2 Specification drawings

Where reference by number to a standardized specification drawing is used instead of a written requirement, the drawing shall be deemed to be the drawing that bears that number and forms part of the specification.

3.2 Quantity

- a) The Contractor, when using materials that are required to comply with a standard specific specification shall, if so ordered, furnish Eskom with certificates showing that the materials do so comply.
- b) Materials shall bear the official mark of the appropriate standard.
- c) Samples ordered or specified shall be delivered to Eskom's office on Site.
- d) Unless otherwise specified, all proprietary materials shall be used and placed in strict accordance with the published instruction of the relevant manufacturer.

3.3 Structural Steel

- a) Subject to the provisions of 6.3, all steel used in the fabrication of structural steelwork shall be Grade 355J0.
- b) Steel shall comply with the requirements of SANS 1431 or EN 10025-2 unless otherwise specified in the specification data or the design drawings.
- c) The references to the use of Grade 350WA or lower grade of steel shall be taken to read 355J0 except for plates where 350WA shall be taken to read 300W.
- d) Steel of commercial quality may be used in the fabrication of items such as ladders, stairs, handrails, open grid flooring and similar sundry steelwork items provided that it has been explicitly approved by Eskom's design engineer.

3.3.1 Mechanical Properties for Plates

- a) The thickness of steels of Grades 300 WA, 350 WA and 450 WA shall not exceed 40mm.
- b) The thickness of steels of Grades 300 WC, 300 WDD, 350 WC, 350 WDD, 450 WC and 450 WDD shall not exceed the following values:

Grade	Plate	Sections & others
300 WC	63 mm	50 mm
300 WDD	63 mm	50 mm
350 WC	100 mm	40 mm
350 WDD	100 mm	40 mm
450 WC	100 mm	19 mm
450 WDD	40 mm	19 mm

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- c) For thickness in excess of those specified in a) and b) above, the Impact value applicable in the impact test shall be at least 27J at 0°C.
 - d) Steel section profiles shall comply with the requirements for dimensions and properties given in the latest edition of the South African Institute of Steel Construction Handbook.

3.4 Special Steels

- a) Steels complying with standard other than SANS 1431 may be specified by Eskom or used with Eskom's approval, provided that such standards lay down the required chemical composition and mechanical properties of the steel. These steels shall comply with the following requirements:
 - 1) The specified yield stress shall not exceed 700 MPa.
 - 2) The ratio of the tensile strength to the guaranteed yield strength, determined in accordance with SANS 1431, shall be at least 1,2 : 1.
 - 3) The elongation (on a gauge length of $5,65 \sqrt{A_0}$ mm) in a tensile test shall be at least 15%, where A_0 = cross-sectional area of tensile test specimen, mm².

3.5 Coatings and coated steelwork

3.5.1 Packaging

- a) All coating materials and constituents shall be delivered to the factory shop, in the manufacturer's original sealed containers which bear the manufacturer's labels.
- b) Each label shall display all the information necessary to ensure correct storage and traceability, and instructions for the application of the contents of the container.
- c) Any container showing traces of leakage shall, before use, be rejected together with its contents.

3.5.2 Contents of Containers

The contents of a container shall be in good condition for use. Eskom may require that they be subjected to sample testing.

3.5.3 Storage

- a) All coating materials held in storage prior to use shall be kept in an approved store which shall be dry and enclosed. Where temperatures are likely to exceed 40°C or drop below 0°C, means shall be adopted to maintain the store at a temperature compatible with conservation of the quality of the coating materials. Care shall be taken to avoid the accumulation of old stock.
- b) Material shall be used on a "first in first out" basis.
- c) All hot-dip galvanized and other meta-coated articles shall be stored in such a manner as to ensure that rainwater and condensation, which may give rise to storage staining or white rusting, drain away from the articles. Any articles which are stored on the ground should be raised as to allow for water to drain away and keep moisture from being trapped at the bottom of the stored articles.
- d) Unless otherwise permitted, all site stores used for the storage of coating material shall be provided with adequate fire extinguishers placed in a prominent and accessible position outside the entrances. "No smoking" signs shall be placed inside and outside such stores. No naked flames shall be permitted inside such stores.
- e) All containers shall remain closed in such stores, and rags soaked in any combustible materials shall not be kept in such stores.
- f) A separate store shall be provided for tools and equipment, and the store used for the storage of coating material shall not, at any time, be used for the accommodation of personnel.

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- 1) A deposit of wet storage staining may be removed (by means of non-metallic brushes or chemical techniques) provided that
 - a) The thickness of zinc coating in the affected area is not thereby reduced to less than the relevant specified minimum; and
 - b) Any remaining discoloration is acceptable.
 - 2) Unless otherwise agreed upon, cleaned areas shall be passivated in accordance with 7.3.8.

3.6 Welding consumables

3.6.1 Electrodes

Welding electrodes shall comply with the applicable requirements as listed in Table 2 of SANS 2001 CS1.

3.6.2 Storage and Handling

- a) The storage and handling of all consumables shall be in accordance with the manufactures recommendations.
- b) Any baking or drying out of consumables before use shall be carried out in accordance with the manufactures recommendations.

3.6.3 Quality

Welding consumables, in addition to complying with the requirements of 6.5.1 shall be such that they produce weld metal that, when tested in accordance with the applicable method given in AWS D1.1, has a minimum yield stress and minimum tensile strength at least equal to that of the parent metal.

3.7 Bolts, nuts and washers

3.7.1 Bolts and Nuts (other than friction-grip)

- a) Bolts and nuts other than fitted bolts, and other than bolts and nuts for friction-grip joints shall comply with the requirements of SANS 1700 for the type shown on the drawings.
- b) Nuts shall be of at least the strength grade appropriate to the grade of bolt or other threaded element with which they are used.

3.7.2 Holding-Down Bolts

Holding-down bolts shall be fabricated from round bars that comply with the requirements of SANS 1431 grade 300W. Where holding-down bolts are required as Grade 8.8 or are in excess of 40mm diameter, it is recommended that EN 19 Grade 709 M 40 Hardness T/V steel be used. The class of the nut must at least be the class of the bolt.

3.7.3 Washers

- a) Plain material washers shall be in accordance with the provisions of SANS 1700-16-2.
- b) Through –hardened washers shall be in accordance with the provisions of SANS 1700-16-3.

4. Manufacturing

4.1 Fabrication

4.1.1 General

- a) All structural steel shall, both before and after fabrication
 - 1) be within the tolerances specified in Clause 9; and

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- 2) unless required to be formed to a particular shape, be flat, straight and free from twists. Any necessary straightening or forming shall be carried out by methods that neither weaken nor deface the material.
- b) Methods used to rectify deformed steelwork, shall be approved by Eskom in writing.

4.1.2 General Workmanship

- a) All work shall be carried out by competent workmen under the supervision of an experienced supervisor.
- b) No cleaning or coating applications shall take place when Site conditions are likely to affect these operations adversely.
- c) All steelwork shall be supported at least 100 mm clear of the ground before, during and after preparation and coating of the surfaces of the steelwork and at all stages prior to its erection.
- d) Equipment, nameplates and identification plates shall be protected against damage or overcoating. Where complete corrosion protection of the substrate is required, the plates shall be removed, and replaced after the coating procedures have been completed.
- e) Any areas not required to be coated shall be masked in such a way that these surfaces are protected during all coating operations.

4.1.3 Welding

- a) Welding shall be metal-arc process and shall be carried out in accordance with the relevant recommendations of ANSI/AWS D1.1/D1.1M and SANS 2001.
- b) Welding techniques shall be such as to prevent undue distortion and minimize shrinkage stresses.
- c) Joints shall be fitted to the dimensional accuracy required by the welding procedure, depending on the process used.
- d) Fabrications assembled in jigs may be completely welded in the jig, or may be removed from the jig after tack welding.
- e) Tack welds that will form part of the finished weld shall be made using the same procedures as for the root of the main welds. The length of the tack shall be four times the thickness of the thicker part or 50mm, whichever is the lesser unless otherwise directed.
- f) All slag and spatter shall be removed.

4.1.4 Holes for Fasteners

- a) The spacing between holes for fasteners and distances between holes and edges shall comply with the relevant provisions of SANS 10162:1 clause 22.3.
- b) Except where otherwise provided for in 7.1.4 a) to 7.1.4 i), holes for fasteners shall be drilled.
- c) Holes for fasteners shall not be formed by flame-cutting, except that holes for holding-down bolts may be flame-cut if specifically approved by Eskom.
- d) Unless otherwise required in terms of the project specification, and provided that punching does not unduly distort the material beyond the tolerances specified in Clause 9, holes for bolts may be punched full size through material not thicker than the diameter of the hole plus 3mm, subject to the provisions of 7.1.4. e).
- e) Punching through material thicker than 12 mm shall be done only with prior approval by Eskom.
- f) The diameter of holes for fasteners excluding holding-down bolts shall, unless otherwise specifically required in terms of the design, not exceed the diameter of the fastener by more than one.
 - 1) 2mm in the case of fasteners of diameter up to 24 mm;

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- 2) 3 mm in the case of fasteners of diameter over 24 mm.
- g) The details of holes for holding-down bolts shall be as shown on the drawings.
- h) Slotted holes shall be formed by one of the following methods:
 - 1) punched in one operation subject to the provisions of 7.1.4 d) and 7.1.4 e); or
 - 2) formed by drilling two holes and completed by flame cutting between the holes; or
 - 3) machine operated cutting.
- i) All burrs shall be removed from holes before assembly except that, where holes are drilled in one operation through assembled parts that will not be separated after drilling, burrs on only the outside surfaces of such assemblies shall be removed.
- j) Where a sealed hollow member is holed for a fastener or pin, provision shall be made to prevent ingress of moisture to the interior of the member.

4.1.5 Cutting

- a) Cutting and shaping of steel may be done by sawing, shearing, cropping, laser cutting, plasma cutting, water jet cutting or machine flame cutting. Manual flame cutting is not permissible.
- b) Edges shall be free from any defects or distortions that may adversely affect the strength or serviceability of the member.
- c) All exposed burrs and similar defects shall be ground off and smoothed.
- d) The edges of flame-cut plates shall be dressed to remove notches or as much materials as specified.

4.1.6 Joints in Compression

- a) The abutting surfaces of a joint dependant on contact for the transmission of load shall be such that the areas necessary to transmit the load are in contact.
- b) A bearing face that is to be grouted direct to a foundation need not be machined but such a face shall be true and parallel to the upper face of the foundation.
- c) Where required, steel wedges or packer plates shall be used to support and level steelwork. These packer plates shall be hot-dip galvanized and shall be of adequate strength, size and rigidity as to prevent crushing of the concrete or distortion of the baseplate under load.
- d) Before grouting, the space and pockets under the steel shall be cleared of all debris and free of moisture.

4.1.7 Structural Hollow Sections

- a) Where so required in the design, the ends of hollow sections may be flattened, or otherwise formed, for welded or bolted connections provided that the method employed does not damage or deface the material.
- b) The change of shape of a section shall be gradual and to Eskom's approval.
- c) Unless special protection against corrosion is provided by other means, the interior of any hollow member, whether a structural hollow section or a fabricated member, shall be so sealed as to prevent the ingress of moisture.

4.1.8 Identification

The grade of structural steel shall be positively identifiable at all stages of manufacturer or fabrication.

4.1.9 Marking

- a) Each piece of steelwork shall be distinctly marked before delivery, in accordance with a marking diagram, and may bear such other marks as will facilitate erection.
- b) The markings shall be stamped or welded and should be legible after galvanizing.

4.1.10 Design Drawings

- a) All drawings shall be prepared according to the applicable Eskom drawing standards.
- b) The drawing(s) shall include a general arrangement of the proposed structure indicating all structural member sizes and special connections and will be sufficiently comprehensive to allow the detailing of all connections.
- c) Dimension figures on the drawings shall be deemed to be correct, even if the drawings are not to scale. No dimensions shall be obtained from a drawing by scaling.

4.1.11 Contractor Provides Shop Details

- a) Where the contractor is responsible for preparing shop details, Eskom will issue to the Contractor, within the period stated in the project specification after the date of the award of the contract, design drawings as specified in 7.1.10 and, in addition, the necessary design calculations (i.e. stress diagrams and the relevant calculation sheets or computer print-outs).
- b) Immediately on receipt of such drawings and calculations, the Contractor shall satisfy himself that the drawings contain all the information required for the preparation of his own shop details and supporting calculations. These shop detail drawings and supporting calculations, together with any other necessary drawings, shall be submitted in duplicate to Eskom for approval at least 1 week (or such other period as may be stated in the project specification) before commencement of fabrication.
- c) The Contractor's drawings shall be complete in every respect (including welding details, which shall be described fully, including details of shop splices) and shall be checked by the Contractor prior to submission.
- d) One copy of each drawing will be retained by Eskom and, within 1 week (or such other period as may be stated in the project specification) of the date of receipt by Eskom the other copy will be returned to the Contractor with Eskom's comments or written approval, as the case may be.
- e) Before the commencement of fabrication, the Contractor shall obtain from Eskom approval of the shop details, in writing. The approval given by Eskom relates to structural adequacy and does not absolve the contractor from responsibility for dimensional accuracy.

4.1.12 Eskom Provides Shop Details

- a) Where Eskom undertakes to prepare shop detail drawings, Eskom will issue general arrangements, marking and shop details drawings, together with necessary bolt and materials lists to the Contractor at agreed dates that will enable the Contractor to adhere to the agreed programme.
- b) The responsibility for the dimensional accuracy of these drawings shall rest with Eskom. The Contractor will, however, be required to examine the drawings. Should any figure or writing be unclear or should any description be ambiguous, the Contractor shall immediately request clarification from Eskom.

4.1.13 Variations from Drawings and Sections

- a) Except where otherwise authorized in writing by Eskom, the Contractor shall ensure that the work is carried out strictly in accordance with the drawings supplied to the contractor by Eskom, or supplied by the Contractor and approved by Eskom.

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- b) Steel sections shall be provided as specified on the drawings except that substitution will be permitted with Eskom's prior approval.
- c) Where the contractor wishes to make a substitution, the contractor shall submit reasons and alternative proposals in writing.

4.2 Surface Preparation for Coatings

4.2.1 General

The method of cleaning and preparing the substrate of steelwork prior to the application of the coating system shall be in accordance with the applicable provisions of SANS 10064 and shall take place at any approved location.

4.2.2 Removal of Contaminants

Prior to any other form of preparation, all obvious harmful deposits on the surfaces of steelwork, such as oil, grease, chemical deposits, clay, bitumen or mud, shall be removed.

4.2.3 Methods of Preparation

4.2.3.1 Abrasive blast cleaning

- a) General
 - 1) Blast cleaning of steelwork shall be carried out in accordance with the methods described in SANS 10064 to obtain a smooth, clean working surface.
 - 2) The blast profile, as measured in accordance with SANS 5772, shall be in accordance with the provisions of SANS 10064.
 - 3) Where samples have been called for in terms of 9.6.4 and have been approved, the standard of blast cleaning shall conform to that of the applicable sample.
- b) Dry abrasive blast cleaning
 - 1) Dry abrasive blast cleaning shall be carried out on dry surfaces. When air is used, it shall be oil-free, clean and dry. Eskom may require the Contractor to demonstrate that the air is clean and dry.
 - 2) Final blasting shall not be carried out if the steel temperature is less than 3°C above dew point. All blast-cleaned surfaces that are to be coated shall be coated within 8 hours of blasting unless otherwise dictated by circumstances and agreed to by all parties. At the time of coating, the surfaces shall comply with the specified standard of blast cleaning and cleanness.
 - 3) If blast-cleaned surfaces are left uncoated overnight, they may need to be flash blasted the next day prior to coating, in order to ensure that the specified standard is maintained.
 - 4) Blast cleaning may be carried out using sand, stone chips, steel, cast iron shot or grit, cut wire, or slag. The blast-cleaning medium shall comply with the appropriate requirements laid down by the local health authorities.
 - 5) Any material used for blast cleaning shall be free from oil, grease or harmful foreign matter such as clay, organics, water-soluble matter (e.g. chlorides and sulphates), or bitumen.
- c) Wet abrasive blast cleaning
 - 1) In addition to, or as an alternative to dry abrasive blast cleaning, it may be necessary to clean surfaces with a water-injected or water-shrouded blast-cleaning medium in order to remove soluble salts from the surfaces of steel that have been exposed to aggressive environments.
 - 2) Wet abrasive blast cleaning will only be allowed with special approval from Eskom.

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4.2.3.2 Cleaning By Hand or With Power Tools

Cleaning by hand or by means of power tools (e.g. wire brushing) shall be carried out in accordance with the methods described in SANS 10064 to obtain a smooth, clean working surface.

4.2.3.3 Degreasing

Liquid-solvent cleaning, solvent-vapour cleaning and alkali and emulsion cleaning shall be carried out in accordance with the provisions of SANS 10064.

4.2.3.4 Pickling

Acid cleaning shall be carried out in accordance with the provisions of SANS 10064.

4.2.4 Latent Material Defects

Before the application of the first coat of a protective system, unacceptable defects such as weld cracks or laminations, that become evident after preparation of the steelwork, shall be ground out, repaired or the material rejected, as decided by Eskom.

4.2.5 Cleaning of Surfaces About to be coated

- a) No coating shall be applied to a prepared steelwork surface that is contaminated with oil, grease, perspiration, rust or chemical deposits until such surface has been adequately cleaned. Uncoated steel shall not be touched with bare hands.
- b) Where contamination has occurred, it shall be removed using suitable emulsifiable detergent, aqueous detergent or alkaline cleaning solutions. In exceptional circumstances, for limited areas and to avoid spreading of the contaminants, contamination may be removed by repeated wiping of the area with clean rags soaked with fast-evaporating cleaning oil solvents.
- c) Degreasing of steelwork shall be followed by rinsing with water to remove residues (except where a limited area has been solvent wiped).
- d) Where any coat has oxidized or become excessively hard, it shall be abraded to a matt finish and cleaned prior to the application of further coats. Solvent wiping may be required where called for by the manufacturer, in which case only the manufacturer's approved solvent shall be used.
- e) Prior to the application of any coat, the quantity of dust and debris present on the substrate, when determined in accordance with SANS 5769, shall not exceed 0.3%. However, because of the difficulty in making comparisons with the reference standards given in the method, on-the-job tests, if deemed necessary, shall be carried out at the commencement of the contract, and reference tapes produced and agreed upon as reference standards. These tapes shall then serve as the agreed standard to be achieved for the contract.
- f) Unless otherwise approved, coatings shall only be applied to moisture-free surfaces.

4.3 Galvanising and Corrosion Protection

- a) All members, sections, hardware to be galvanized to a minimum of 600 g/m². See SANS 121. As an alternative to galvanized bolts & nuts, corrosion protection in the form of specialized electroplated coatings may be considered acceptable subject to approval by Eskom. (Traditional galvanized bolts are acceptable).
- b) The design of welds and fabricated articles may be such that more than one type classification is involved. In such cases, the coating on each part shall comply with the requirements applicable to the appropriate type classification for that part.

4.3.1 Type A Articles

Type A articles comprise steel profiles (such as angles, beams, tees, rods, channels), plate and welds and articles fabricated from these and from sheet and strip, excluding washers and including packer plates.

- a) Type A1: Articles of thickness at least 5 mm.
- b) Type A2: Articles of thickness at least 2 mm but less than 5 mm.
- c) Type A3: Articles of thickness less than 2 mm.

4.3.2 Type B Articles

Type B articles comprise steel tubes, tubular articles, and pole sections of circular or polygonal cross-section that may, except in the case of articles of polygonal cross-section, be threaded after hot-dip zinc coating:

- a) Type B1: Articles of wall thickness exceeding 5 mm.
- b) Type B2: Articles of wall thickness up to and including 5 mm.

4.3.3 Type C articles

Type C articles comprise bolts, other threaded articles (excluding tubes), pins, washer, rivets and nut blanks:

- a) Type C1: Articles of nominal diameter at least 12 mm or, in the case of washer, of thickness at least 2 mm.
- b) Type C2: Articles of nominal diameter less than 12 mm or, in the case of washers, of thickness less than 2 mm.

4.3.4 Thickness of coating

- a) Minimum thickness

The thickness of a zinc coating, when determined in accordance with 10.6.8, shall:

- 1) Be at least that the value given Table 1, appropriate to the type of article;
- 2) When required for heavy duty applications, on the written instruction from Eskom, be at least that value given in Table 1, appropriate to the type of article.
- b) Maximum thickness

When so required, in special cases, the thickness of a zinc coating for heavy duty applications, when determined in accordance with 10.6.8, shall not exceed the maximum agreed upon.

Table 1: Minimum thickness of zinc coatings for general and heavy duty applications (SANS 121)

1	2	3
Type of article	Thickness, μm , minimum	
	General applications	Heavy duty applications
A1	85	105
A2	65	80
A3	45	55
B1	85	100
B2	45	55
C1	55	-
C2	45	-

NOTE: Thicker coatings for heavy duty applications can usually be produced only on surfaces that have been grit blasted or are of a steel the composition of which induces high reactivity. These thicker coatings are more resistant to severe environmental conditions, tend to be more brittle and require special handling. The efficacy of corrosion protection of hot-dip galvanized coatings (whether light grey or dull grey) is approximately proportional to coating thickness.

4.3.5 Hot-Dip Zinc-Coating Bath

The molten metal in the bath shall, throughout the zinc coating operation, contain at least 98.5% (m/m) zinc.

4.3.6 Plant for Galvanizing

Plant and equipment shall be suitable for applying the specified coating system and for obtaining the specified result. If, however, consistent and satisfactory results are not achieved with the plant and equipment used by the Contractor, Eskom may order the Contractor to obtain and use such plant and equipment as may be necessary to achieve the required results. All plant, equipment and temporary works which are supplied by the Contractor shall at all times be maintained in good working order.

4.3.7 Freedom from Defects

- a) When examined with the unaided eye, the hot-dip galvanized surface(s) shall be of an acceptably smooth texture and free from blisters, sharp points and uncoated areas. There shall be no lumps, globules and heavy deposits that can interfere with the intended use of the galvanized item. The coated article shall be acceptably clean and free from damage
- b) The area of an individual bare spot or thin area shall not exceed 5 mm². the combined total area of bare spots or thin areas (or both) shall not exceed 25 mm² per metre of length or per square metre of surface of an article. There shall be minimum width of 10 mm of satisfactory zinc coating between adjacent bare spots or thin areas.
- c) For articles that have been hot-dip galvanized by the centrifuge method, touch marks shall not exceed two per article. The diameter and area of an individual touch mark shall not exceed 2,5 mm and 5 mm², respectively.

4.3.8 Adherence

4.3.8.1 Articles of types A1, A2, B1

- a) The zinc coating shall adhere tenaciously to the surface of the basis metal and shall not be liable to chip off when the coated article is transported by normal methods or is subjected to reasonable processes of handling and erection.
- b) When a hot-dip zinc-coated specimen is tested in accordance with 9.6.7, no removal or lifting of the coating shall occur in the areas between the impressions made during the test.

NOTE: The requirement for adherence applies to coatings of thickness up to 150 µm only.

4.3.8.2 Articles of type A3, B2, C1, C2

- a) The zinc coating shall adhere tenaciously to the surface of the basis metal.
- b) When an implement (such as a stout knife) is manually applied to the coating with considerable pressure in an attempt to cut (or penetrate) and remove a portion of the coating, it shall be possible to remove only small particles by paring or whittling and it shall not be possible to so peel off any portion of the coating as to expose the basis metal.

4.3.9 Repairs by Galvanizer to Coatings

4.3.9.1 General

No repairs shall have been made to coatings on the following:

- a) Type B articles (straight pipes, excluding fitments and flanges) of diameter not exceeding 51 mm.

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- b) Type C articles of nominal diameter not exceeding 35 mm or of length not exceeding 500 mm, or both.
- c) In the case of articles other than those listed in (a) above, repairable defects, the method(s) and extent of repair shall be as laid down in 7.3.9.2 and 7.3.9.3. In all cases, the coating in a repaired area shall comply with all the relevant requirements of the specification.

4.3.9.2 Coating Faults Caused by Surface Defects in the Basis Metal

- a) If, during final inspection of hot-dip zinc-coated articles, a fault in the coating (of any type and, unless otherwise required of any size) caused by a defect in the basis metal is found, it may be repaired. However, any repair that involves any removal of the basis metal (e.g. by grinding) shall be carried out only when approved by Eskom.

NOTE: Such approval shall be in writing, and include the maximum depth of grinding and permissible mechanical repair processes (e.g. welding)

- b) Coating repairs carried out in terms of (a) above shall be by zinc spraying in accordance with SANS 2063 to a coating thickness at least 25% greater than the appropriate minimum required in 7.3.4.

4.3.9.3 Coating Faults Not Caused by Surface Defects in the Basis Metal

Any type of coating fault not attributable to a defect in the basis metal may be repaired provided that:

- a) repairs of thinly coated areas and bare areas are carried out by zinc spraying as specified in 7.3.9.2 (b), or when approved, with a hot-patch soldering whilst the article is still hot and before it is quenched.
- b) the total area of repair does not exceed 5 000 mm² with any 1 m² of coating surface and no individual repair area exceeds 2 500 mm²; and
- c) removal of lumps does not reduce the thickness of the repaired coating (or of the zinc remaining after the removal of the lumps) to be less than the appropriate minimum thickness specified in 7.3.4.

4.3.9.4 Repair of Mechanical Damage Caused by Transportation and Erection

Notwithstanding all precautions, small areas of zinc coatings may still become damaged during transportation and erection or assembly. If so approved such damage may be repaired in-situ by zinc spraying, hot-patch soldering or coating with a zinc-rich paint complying with the requirements of SANS 121. Care should be taken to ensure that each area to be repaired is clean and that any loose flakes of the coating surrounding the area, have been removed.

4.3.9.5 Threads

- a) The zinc coating on external threads shall be free from lumps and shall not have been subjected to a cutting, rolling or finishing operation that could damage the zinc coating. The zinc coating of an external standard metric thread that has not been undercut shall be such as to enable the threaded part to fit a gauge made by over tapping a nut to the appropriate extent given in Table 2.

Table 2: Overcuts on gauge nuts (SABS 763)

1	2
Nominal size of thread *	Overcut, mm
M10	0,33
M12	0,33
M16	0,38
M20	0,38
M22	0,38

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M24	0,38
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*For other nominal sizes and other types of thread the overcut shall be as agreed upon

- b) Threaded articles shall fit their mating parts and, in the case of assemblies that contain both externally and internally threaded articles, it shall be possible to screw mating parts together by hand.

4.3.10 Protection (passivation) of coated articles types A, B, C

Unless otherwise agreed up, articles shall after galvanizing, be immersed in a bath containing an acceptable passivating solution. Alternatively, passivation may be achieved by other acceptable means, e.g. by applying a lacquer containing chromate salts.

4.3.11 Wet Storage Staining

A hot-dip zinc coating shall be free from gross deposits of wet storage staining.

4.4 Coatings (other than hot-dip galvanizing)

The coating system shall be as specified on the drawings.

No drilling, cutting, welding or machining shall be carried out after application of the coating system. Unavoidable damage shall be repaired in accordance with 7.4.3.

4.4.1 Application of Paint Coatings

- a) No coating shall be applied if the temperature of the steelwork is less than 3°C above dew point or outside the range 5°C to 35°C, unless otherwise specified in the project specification or agreed to by the paint manufacturer.
- b) The method of coating application shall comply with the manufacturer's recommendations and data sheets. Multicomponent materials shall be applied with due care, the specified application technique being used.
- c) All coatings shall be substantially free from tears, runs, curtailing, foreign inclusions, material surface defects and be free from misses.
- d) When tested in accordance with 8.6.9, coatings that are to be buried shall be free from electrical insulation defects, including pinholes and inclusions.
- e) Maximum and minimum intercoat intervals shall comply with the paint manufacturer's recommendations, taking cognizance of ambient conditions.
- f) All metal edges, upstands, welds, bolts and nuts shall be adequately coated.
- g) If specified in the project specification, stripe coating with an additional coat of paint shall be applied after the initial priming.
- h) The colour of each coat shall be different from that of the previous coat, except if two finishing coats of the same colour are necessary to achieve colour uniformity.
- i) Unless the primer is of a weldable type, steel edges that are to be welded after priming shall be left uncoated for a distance of 50 mm from the welding edge.
- j) Steel that is to be embedded in concrete shall be coated over a depth of at least 75 mm into the concrete unless otherwise specified in the project specification.
- k) Fasteners that are to be embedded in concrete shall be protected as specified in the project specification.
- l) Unless otherwise specified, mating steel surfaces shall each receive one coat of primer.
- m) Surfaces that will be inaccessible for coating after fabrication or erection shall receive the full specified coating system prior to final fabrication or erection.

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- n) All coating components, particularly two-component or multicomponent materials, shall be thoroughly mixed until a homogeneous mixture is achieved. The mixture shall be frequently agitated during application to keep the solids in suspension. The preparation time and pot life of these materials shall be closely adhered to.
 - o) Zinc-rich coatings shall be continuously agitated in a suitable pressure pot to ensure uniform dispersion of the zinc particles in the liquid component.

4.4.2 Application of Metal Coatings (Hot-Dip Galvanizing, Metal Spraying)

- a) All hot-dip galvanizing shall comply with the requirements of 7.3 as appropriate and the provisions of SANS 14713.
- b) All thermally sprayed metal coatings and the sealing thereof shall comply with the requirements of SANS 2063 and shall be applied in accordance with the information given in the appropriate appendices.
- c) If a galvanized surface is to be coated to provide a duplex system of coating, the galvanized surface shall first be cleaned and prepared as recommended in SANS 10064 or in accordance with the coating manufacturer's recommendations.

4.4.3 Repair of Damaged Coatings

- a) Damaged areas shall be cleaned down to a clean metal condition or to an undamaged coated surface.
- b) Spot repairs shall re-instate each of the previous coats, or shall be made using an approved patching material. The patch shall extend at least 25 mm over adjacent surfaces which shall have been prepared by feathering with suitable abrasive paper.
- c) The repairs of metal coatings shall be to a procedure approved by Eskom.

5. Tolerances

5.1 General Steelwork

5.1.1 Verification of Dimensions

- a) Verification of dimensions shall be carried out.
- b) Unless otherwise specified, the effects of temperature on the structure must be considered when measurements are made during setting out, erection or subsequent dimensional checks. The reference temperature shall be 20°C and the tension in the tape shall be 70N;
- c) For erection within 3 hours after sunrise or within 3 hours before sunset, or at such time when, in the opinion of Eskom, the effect of the sun is minimal. Distortion caused by the sun's rays striking one side of a member or structure shall be taken into account, and measurements shall be made only at times when this effect is non-existent or of no consequence.

5.1.2 Methods of Specifying Tolerances

Tolerances may be specified in several different ways as indicated in Figure 1, in the case of Linear dimensions, position, verticality, level, squareness and bow, permissible deviations shall, unless otherwise stated, be both positive and negative and of equal numerical value. This facilitates the insertion of correct tolerance values and allows for deviations occurring in opposite directions.

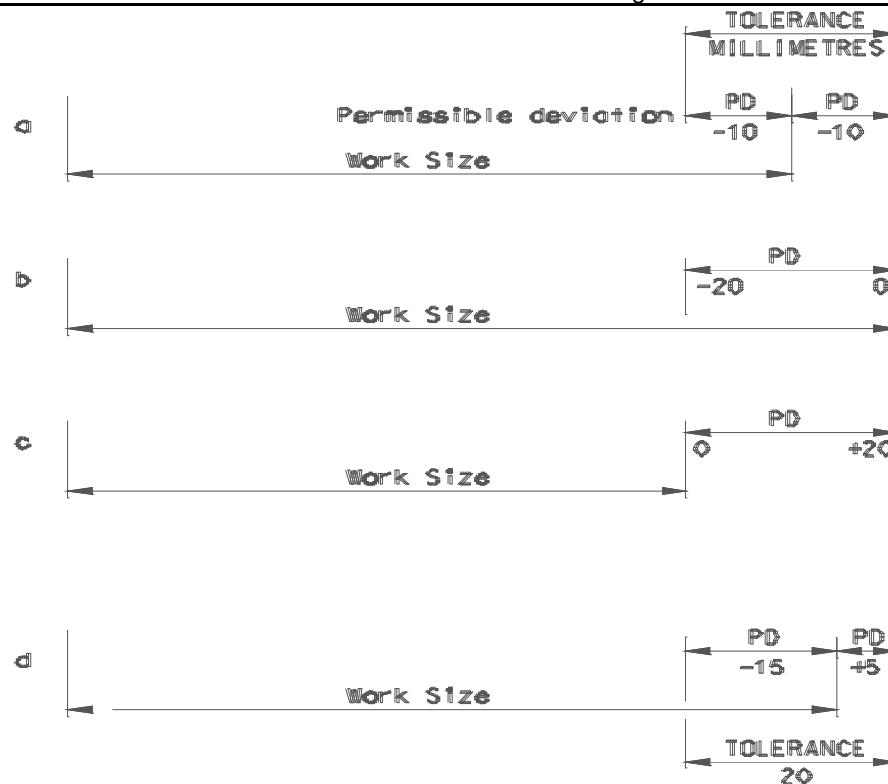


Figure 1: A Manufactured Component (SANS 1200 A – 1986)

In certain cases permissible deviations (PD) may be positive or negative but not equal (See Figure 1)

Deviations such as twist and bow edge do not usually have any positive or negative sense. In such cases the permissible deviation is assumed to be positive and is equal to the tolerance in numerical value. Figure 2 shows, on a larger scale, the deviation that may be found on site compared with the permissible deviation specified for the placing of a column.

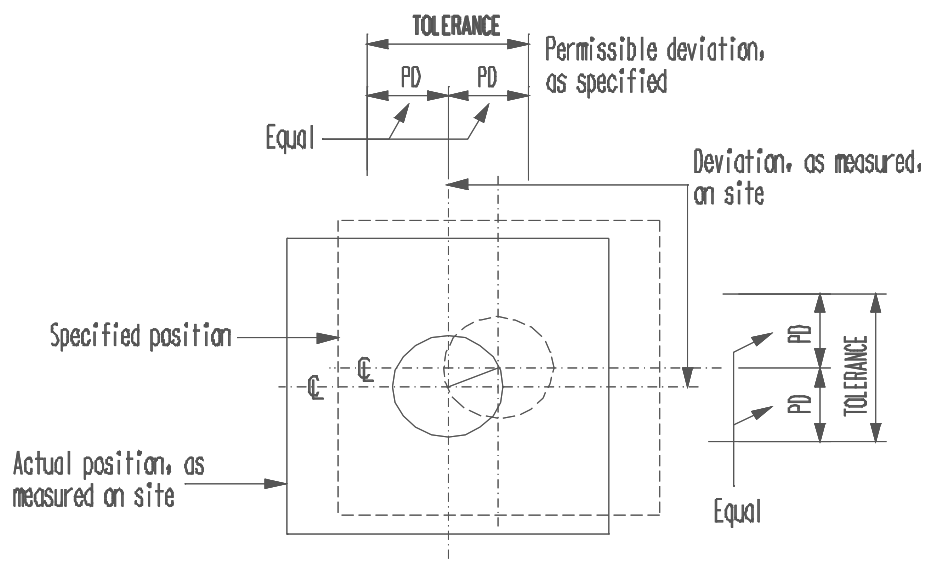


Figure 2: A Manufactured Component (SANS 1200 A – 1986)

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5.1.3 Degrees of Accuracy

- a) The Contractor shall construct each of the various parts of the Works to the degree of accuracy specified. The degree of accuracy may be one of the following:
- 1) Degree of Accuracy III is used where a high degree of accuracy is unnecessary, e.g. mass foundations.
 - 2) Degree of Accuracy II is for what is commonly called “good work”
 - 3) Degree of Accuracy I where the use of special, as opposed to normal, methods of materials (or both) is warranted despite the probability of higher costs than will be incurred by the application of Degree of Accuracy II.
- b) Except where another degree of accuracy is specified in a standardized specification or the project specification or given on the drawings, Degree of Accuracy II shall apply.

5.1.4 Precedence where Tolerances Conflict

Where a tolerance given in any specification covering an early stage of construction conflicts with any tolerance given in a specification covering a subsequent stage of construction, the tolerance applicable to the subsequent construction stage shall take precedence.

5.1.5 Fabrication and Assembly Tolerance

The permissible deviation on the dimensions of components (such as gussets and cross-bracing) and on the location of bolt holes in components and elements of a structure shall be 12 mm, (See also 5.1.4). Holes for connections shall be aligned as specified in Specification for the Erection of Steelwork in Eskom Transmission Substations, clause 6.5.

5.1.6 Rounding up of PDs

All calculated permissible deviations shall be rounded up to the next whole millimetre.

5.2 Tolerances on Dimensions and Accuracy of Erection

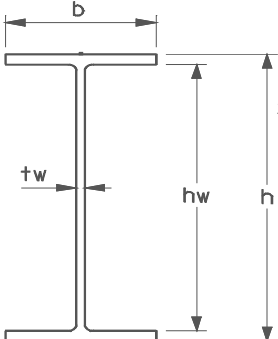
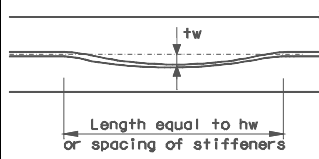
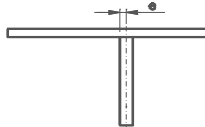
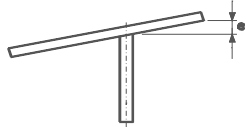
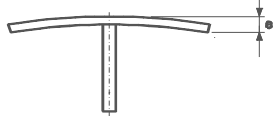
5.2.1 Rolled Sections

The tolerances on cross-sectional dimensions of rolled section shall be as specified in the latest issue of structural steel tables of the South African Institute of Steel Construction.

5.2.2 Other tolerances

The tolerances on all dimensions (other than of rolled sections), accuracy of erection, location of holding-down bolts, location of column bases, levels, etc, shall be as given below in Tables 4 and 5.

Table 3: PD Qualifications (SANS 1200 H- 1990)

Item	Permissible deviation, mm		
	Degree of accuracy		
	III	II	I
a) Cross sections  <p>1) Width of Flange (b) $b \leq 400\text{mm}$ $b > 400\text{mm}$</p> <p>2) Depth (h)[#] $h \leq 1000\text{mm}$ $h > 1000\text{mm}$</p>	* *	± 4 ± 6	* *
 <p>3) Flatness of web (δ) $t_w < h_w/150$</p> <p>Length equal to h_w or spacing of stiffeners</p>	* *	Lesser of 8 or $h_w/150$ Lesser of 8 or $h_w/150$	* *
 <p>4) Off centre (e)</p>	*	6	*
 <p>5) Tilt of flange (α)</p>	*	$b/200$	*
 <p>6) Warpage of flange (β)</p>	*	$b/200$	*

*as otherwise stated on the drawings

#all indicated permissible deviations from the specified depth (h) may occur simultaneously and be cumulative.

Table 4: PD Qualifications (SANS 1200 H- 1990)

Item	Permissible deviation, mm		
	Degree of accuracy		
	III	II	I
a) Length			
1) The PD of the length of a member from designated length.....	*	+1 -2	*
2) For such members as trusses and lattice girders, these tolerance apply to the member as a whole. The lengths of component parts shall be such that the member can be properly assembled with a PD of.....	*	+1 -2	*
b) Accuracy of erection			
1) Out of plumb over any vertical height (H).....	*	Lesser of 50 or H/500	*
2) Displacement of centerline of column in structures of more than one storey in height from designated position (total structure height, H).....	*	Greater of 6 or H/1000	*
c) Straightness (or specified shape) after erection			
1) For compression members and beams (other than purlins and sheeting rails) of length L, between points that are to be laterally restrained.....		Greater of 3 or L/1000	*
2) For other members of length L.....		Lesser of 25 or L/500	*
3) Handrails.....	*	++	*
d) Location of holding-down bolts			
1) The centerline of a holding-down bolt from its designated location in plan.....	*	±3	*
2) The top of the bolt from its designated elevation.....	*	+5 -3	*
e) Column bases	*	±3	*
Designated level and plan position of column bases.....			

* As otherwise stated on the drawings.

++ Handrails shall be visually straight (or of specified shape)

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5.3 Corrosion protection

5.3.1 Blast Profile

Blast profile limits shall be:

- a) for a 60 um profile : $\pm 15 \mu\text{m}$
- b) for a 100 um profile: $\pm 25 \mu\text{m}$

5.3.2 Weld Cracks and Laminations

Significant defects that appear after surface preparation of steelwork shall be repaired in accordance with an approved procedure, taking into account the structural integrity of the affected component.

5.3.3 Mixing and Thinning

Any deviation from the coating manufacturer's recommendation for the proportions of components in multipack mixes, or for the degree of thinning or for intercoat intervals shall be in accordance with Eskom's written instructions, as approved by the manufacturer.

5.3.4 Dry Film Thickness

- a) At least 90% of all coating thickness shall be more than required thickness as stated in Table 1. Up to 10% of all readings may be below the specified thickness but may not be less than 70% of the specified thickness. Where dry film thicknesses are less than those specified, remedial action shall be taken to build up the thickness to that specified.
- b) DFT in excess of the specified thickness shall not constitute a reason for rejection if the paint or galvanizing film is sound in all aspects.
- c) Owing to delayed solvent release, coatings of solvent-borne paints will shrink over a period of time, resulting in a lower film thickness. DFT measurements taken at times beyond the 7 day stipulation in 10.4 shall not constitute a valid claim against the original satisfactory and documented execution of the work.
- d) The method used to measure DFT and the significance of the readings shall be agreed upon between the parties prior to commencement of work.

6. Testing

6.1 Test Certificates

Test certificates or cast analysis certificates (or both), pertaining to the steel to be used shall be supplied to Eskom by the Contractor on request.

6.2 Inspection

Eskom shall have access at all reasonable times to all places where the work is being carried out and shall be provided with all the necessary facilities for inspection during all stages of construction and manufacture.

6.3 Sampling

Each article in the sample shall be inspected and tested. Any defective item shall be rejected. If at any stage during the inspection and testing, the number of defects found exceeds 25% of the items inspected and tested at that stage, the entire lot shall be rejected without further testing or inspection.

6.3.1 Sampling for Inspection

From the lot draw at random the number of articles given in Table 6, relative to the appropriate lot size.

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6.3.2 Sampling for Testing

After inspection of the sample taken in accordance with 9.3.1, take at random (from those acceptable) the appropriate number of articles given in Table 5.

Table 5: Sample Sizes * (SANS 5763)

1	2	3	4	5
	Sample for inspection *		Sample for testing	
Lot size	Sample size	Acceptance No. (AQL= 2,5)	Sample size	Acceptance No. (AQL= 2,5)
10 - 50	5	0	5	0
51 - 150	20	1	5	0
151 - 280	32	2	20	1
281 - 500	50	3	20	1
501 - 1 200	80	5	20	1
1 201 - 3 200	125	7	32	2
3 201 - 10 000	200	10	32	2
10 001 - 35 000	315	14	50	3
35 001 - 150 000	500	21	80	3

*Based on Table IIA of BS 6001 for General Inspection Level II.

Criteria of Compliance: Deem the lot to comply with the relevant requirements of this specification if, on inspection and testing of the samples taken in accordance with 9.3, the number of defectiveness does not exceed the relevant acceptance numbers given in Table 5.

6.4 Inspection and Testing of Welds

- a) The contractor shall examine welds as follows:
 - 1) Visual examination of all welds to check that
 - there are no uneven leg lengths and that there is no cracking or unacceptable undercutting or porosity, as recommended in SANS 10044; Part III, and
 - that full fusion is being achieved while welding is in progress
 - 2) Dimensional checks in accordance with AWS D1.1/D1.1M.
- b) Only where so required in terms of the project specification shall welders be tested or destructive or non-destructive tests be carried out.
- c) Welds done in the shop(s) shall be tested and, if necessary, rectified before dispatch.

6.5 Inspection and Testing by the Contractor

- a) The contractor shall maintain test results for all coating materials supplied. Certificates in accordance with Appendix A shall be made available by the contractor on request.
- b) Tests, as specified in 9.6, shall be carried out by the Contractor in the following stages, or when called for.
 - 1) after fabrication

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- 2) after surface preparation and before coating
- 3) after application of the primer coating
- 4) after application of each intermediate coat
- 5) after application of the finishing coat
- c) Test results shall be recorded, and made available on request.
- d) Items not meeting the specification shall be further treated or passed before remedial action has been taken and the items rechecked and passed.
- e) For the purposes of records and acceptance, all DFT measurements shall be taken within 7 days of the paint's becoming hard-dry in terms of the manufacturer's data sheets.
- f) Shop coats shall be measured before dispatch.
- g) The ambient temperature, relative humidity and dew point in the immediate vicinity of the coating operation and the surface temperature of steelwork shall be recorded daily at 08H00, 12H00 and 16H00.

6.6 Inspection by Eskom

Eskom's inspector shall be given reasonable advance notice of the availability of steel for inspection. Inspections by Eskom will be carried out timeously.

6.7 Tests, Instruments and Methods

Tests, instruments, methods and criteria shall be as scheduled below.

6.7.1 Cracks and Laminations

Steelwork shall be visually inspected for cracks and laminations (see 8.3.2)

6.7.2 Freedom from Oil and Grease

- a) A steelwork surface is water break-free if, when it is wetted with water, the water covers the entire surface in an unbroken film.
- b) Where water-soluble lubricants may be present, the surface shall be further tested by wiping it with a solvent-soaked clean cotton wool swab. No stains shall be evident on the swab after solvent wiping.

6.7.3 Water-Soluble Salt Contaminants

Steelwork shall be tested for the presence of water-soluble contaminants in accordance with SANS 5770 or any other approved method.

6.7.4 Blast Profile

- a) The blast profile of steelwork shall be determined in accordance with SANS 5772. Eskom will require from time to time two samples of each grade of blast cleaning used.
- b) The samples shall be suitably protected to prevent deterioration of their surfaces (e.g. the use of vapour phase inhibitor impregnated plastics bags or desiccant bags).
- c) The approved samples shall be used as the standard of blast cleaning to be achieved by the Contractor.

6.7.5 Residual Dust and Debris

Steelwork shall be tested for the presence of residual dust and debris in accordance with SANS 5769 (see also 7.2.5)

6.7.6 Dry Film Thickness

- DFT measurements and frequency of readings shall be measured in accordance with SABS Method 141. In the case of coats applied after the erection of steel on Site, the frequency at which measurements of the DFT are taken shall be at the discretion of Eskom's inspector and may be dictated by accessibility.
- As solvent-borne paint coatings shrink because of delayed solvent release, it is important that DFT measurements be taken within 7 days, as stipulated in 9.4.
- The method used to measure the DFT, and the significance of the readings for each particular job shall be as agreed upon by all parties to commencement of the work.

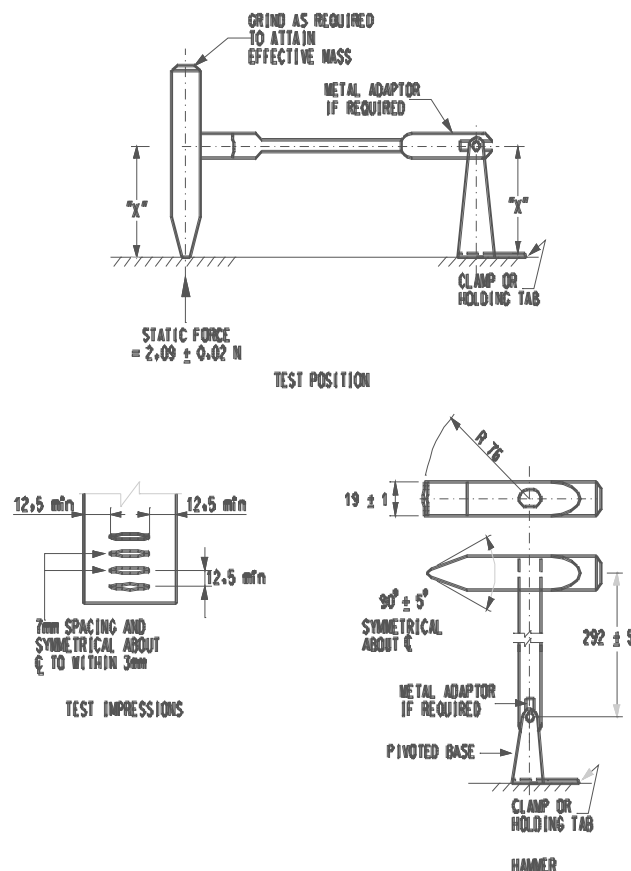
6.7.7 Test for galvanizing adherence (for coatings of thickness up to 150 m)**6.7.7.1 A Pivoted Hammer (See Figure 3)**

Figure 3: A pivoted hammer

NOTE: A commercial type riveting hammer of mass 213g can be modified to conform to the test requirements. A pivot joint with a minimum friction and play should be used to enable test impressions to be located accurately, and the lower surface of the base must be plane and parallel to the axis of the pivot.

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6.7.7.2 Procedure

- a) With the base on which the hammer is pivoted firmly held (or clamped) on a horizontal surface of the hot-dip zinc-coated specimen, deliver a controlled blow by allowing the hammer head so to swing freely through an arc from the vertical position that it strikes the horizontal surface of the specimen.
- b) Repeat this procedures to deliver at least two more standard blows such that parallel impressions are formed at 7 mm centres along an axis so located that no part of an impression is closer than 12,5 mm to an edge of the part of the article being tested.
- c) Test the specimen in this way at a minimum of two places throughout its length.

NOTE: Subject Type B1 articles to the test in such a manner that the longitudinal axis of the impressions and the longitudinal axis of the articles are parallel.

- d) Visually examine the areas between the impressions for signs of lifting or removal (or both) of the zinc coating. An extruded ridge of height less than 1,5 mm immediately adjacent to an impression shall not be considered as a sign of failure of the coating. Check for compliance with 7.3.8.1(b).

6.7.8 Determination of the Thickness of Zinc Coatings

6.7.8.1 Thickness Gauge

Use a thickness gauge that:

- a) utilizes the electromagnetic principle;
- b) is capable of minimizing errors in reading caused by the magnetic permeability, dimensions, surface finish and curvature of the article being tested;
- c) is capable of measuring the thickness of the coating being tested to an accuracy of 10% (or better), and
- d) has been calibrated by taking readings at zero (or near zero) thickness and at thickness of at least 100 um, on suitable non-ferrous shims placed on acceptable standard pieces of metal of composition, thickness and shape similar to those of the articles under test.

6.7.8.2 Procedure

- a) Articles of Types A and B (other than type A articles having large surfaces)
 - 1) By means of the thickness gauge, determine the thickness of the zinc coating at points that are approximately 1m apart along the length of the article, taking one reading at each point.
 - 2) If a reading less than the relevant minimum value (or greater than the relevant maximum value) is obtained at any point, take an additional five readings in a test area (see Figure 1) that includes that point, using the same thickness gauge and taking one reading at each corner and one at the centre of the test area. Record the arithmetic mean of the five readings as the thickness of the zinc coatings at that point.
 - 3) Check for compliance with the relevant requirements of 9.3.2

- b) Type C articles

By means of the thickness gauge, determine the thickness of the zinc coating at three points on more than one significant surface on the unthreaded parts of the article and record the arithmetic mean as the thickness of the coating. Check for compliance with the relevant requirements of 9.3.2

- c) Articles having large surfaces (type A)
 - 1) By means of the thickness gauge, determine the thickness of the zinc coating by taking one reading per square metre of surface of the article.

- 2) If a reading less than the relevant minimum value (or greater than the relevant maximum value) is obtained at any point, take an additional five readings in a test area (see Figure 4) that includes that point and record the arithmetic mean of the readings so obtained as the thickness of the zinc coating at that point.
- 3) check for compliance with the relevant requirements of 9.3.2

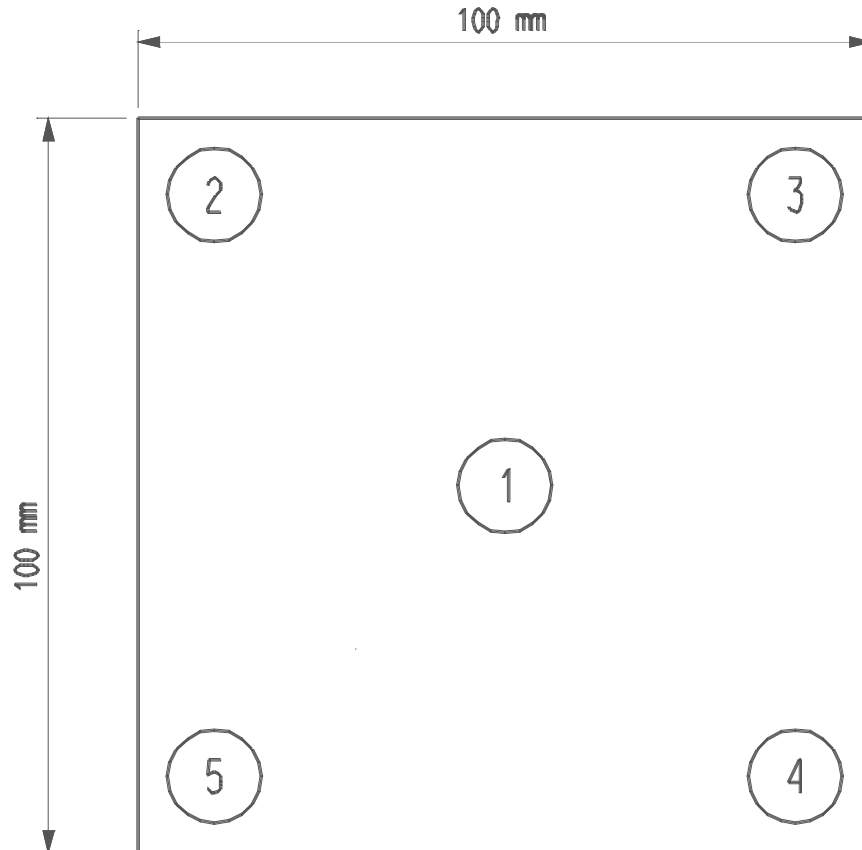


Figure 4: Measurement Points in a Test Area (SANS 5763)

7. Measurements

7.1 Basic Principles

Work involving steel members and platework will be measured by mass of steel. Sundry items will be measured by mass.

7.2 Computation of Quantities

- a) The mass of steelwork will be calculated on the basis of the nominal mass per unit length as stated in the structural steel tables of the South African Institute of Steel Construction Handbook or, where not stated, the mass will be calculated from a steel density of 7 850 kg/m³. The mass of fittings such as cleats, gussets, batterns and stiffeners will be added to the mass of the members.
- b) Tolerances for rolling margins and other permissible deviations will be ignored. No reductions will be made for holes for fasteners or for milling or planing, and no additions will be made for rolling margin, waste, weld metal or shop fasteners.

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- c) Unless otherwise stated, gussets will be measured on the basis of the minimum enclosing rectangle.

8. Authorization

This document has been seen and accepted by:

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P Tlhatlhetji	Senior Manager Substations Engineering
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9. Revisions

Date	Rev	Compiler	Remarks
Aug 2015	1	B Hajee	First issue

10. Development team

The following people were involved in the development of this document:

- Bilal Hajee

11. Acknowledgements

Not applicable.