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This revision cancels and replaces revision no 1 of document no. TSP41-220.

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This document shall apply throughout Eskom Holdings Limited, its divisions, subsidiaries and entities wherein Eskom has a controlling interest.

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Introduction

This document details the materials, surface preparation and application for the corrosion protection and maintenance painting of new and in-service transformers and reactors.

1 Scope

The purpose of this document is to formalise a uniform instruction for the corrosion protection and maintenance painting of new and in-service transformers and reactors.

This document details the materials, surface preparation and application for the corrosion protection and maintenance painting of new and in-service transformers and reactors.

2 Applicability

This applies to all new, refurbished, maintained, repaired and completely repainted transformers and reactors.

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3 Normative References

The following specifications shall be read in conjunction with this document. The latest revision available at the time of contract award shall be applicable and shall remain applicable for the duration of the contract unless the *Purchaser* and *Contractor* mutually accept new revisions. In case of conflict the provisions of this Quality Document shall take precedence.

- SABS SM 772: 1978 / SANS 5772 *Profile of blast-cleaned steel surfaces for painting (determined by micrometer profile gauge).*
- SABS SM 769: 1978 / SANS 5769 *Cleanliness of blast-cleaned steel surfaces for painting*.
- SABS 1091:2004 *National Colour Standard*
- SABS ISO 1461 *Hot-dip galvanised coating on fabricated iron and steel articles – Specification and test methods*.
- SABS ISO 2808: 1999 / SANS 2808 *Paints and Varnishes: Determination of film thicknesses*.
- SABS 763: 1988 *Hot-dip (galvanised) zinc coatings (other than on continuously zinc coated sheet and wire).*
- SABS 1091: 1975 *Colour reference chart*
- SANS 121 (ISO 1461) Hot-dip galvanised coatings on fabricated iron and steel articles
- SANS 10064 Preparation of steel surfaces for coating

4 Requirements

4.1 Coating Material Composition

A signed copy of the coating manufacturer's data sheet(s) shall be submitted with the tender. This is to ensure that the manufacturer is aware of this specification, the conditions under which it will be applied and to allow for technical back-up where required.

All paint systems shall allow for protection in C5-M (Very High Marine) environments as classified by ISO. The paint system shall have high durability and only allow for maintenance after more than 15 years in a C5-M environment.

All coats on a given system shall come from the same coating manufacturer. In the case of items of plant or equipment being painted overseas, compatible alternatives locally available, shall be provided by the *Original Equipment Manufacturer (OEM)*.

Where the substrate had received a primer coat in the factory, the *Contractor* shall check the compatibility of the coatings, which he proposes with the primer coat.

NOTE: All coatings for Eskom shall be solvent based, water based coatings shall only be allowed with special consideration and approval shall be made in writing.

5 Preparation of Metal Surfaces

5.1 Degreasing

All harmful deposits of oil or grease spots and all other matter, which is detrimental to the adhesion of coatings to the surface, shall be removed. Bonding of the first coat / primer to the prepared metal surface is extremely important and special care shall be taken to ensure that the surface is properly degreased.

According to the degree and nature of contamination, degreasing shall be carried out using a water-based degreaser. High-pressure washing with water to remove all traces of residues shall follow the degreasing operation. Items shall be allowed to dry completely prior to coating.

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Only Municipal grade water shall be used for washing surfaces. Water with high mineral content shall not be used for degreasing or washing of equipment surfaces.

5.2 Abrasive Blast Cleaning

Prior to blast cleaning, all welds shall be free of slag, slag inclusions and pinholes. Adjacent areas shall be free of weld spatter, which shall be removed by grinding or scraping. All oil and grease deposits shall be removed prior to blast cleaning as detailed in *Section 5.1*. In this regard special attention shall be paid to drillings, bolt holes, valve stems, etc.

Blast cleaning shall be carried out on dry surfaces using dry air, free from impurities (in particular grease or oils), in an atmosphere where relative humidity is less than 85 %, and the ambient temperature above +5°C. The *Purchaser* may require the *Contractor* to demonstrate that the air is clean and dry.

All surfaces that are blast cleaned shall be coated with a primer coat within 4 hours. Alternatively, provided the surface cleanliness requirements of ISO 8501-1 or SIS 055900 are maintained, the primer coat may be applied within the same working shift. Under no circumstances shall blast cleaned surfaces be left uncoated overnight.

Blast cleaning may be carried out using grit or slag that shall comply with the following quality requirements:

- The abrasive blasting media shall not have a pH below 6,20.
- The conductivity of the water-soluble salts of the abrasive shall not exceed 150 µS/cm.
- The conductivity shall be less than 100 µS/cm.
- The moisture content for the material when delivered in bags or in bulk shall not exceed 0,5%.
- The abrasive shall not be polluted with oil and grease.
- The abrasive shall have a minimum hardness of 6 on MOH's scale.
- The Specific Gravity shall be a minimum of 2,5.
- The maximum free silica content of the abrasive shall be 1 % by weight.

Irrespective of the material used for blast cleaning, it shall in all cases be free of foreign matter such as clay, humus, chlorides and bitumen.

In all cases, after blast cleaning, all traces of blasting media and dust shall be removed from the surface by compressed air or vacuum cleaning. Cleaned surfaces shall not be contaminated with oil, grease, rust or other deposits before coating. After completion of blasting all used and unused blast media shall be removed from site and disposed off at approved disposal facility.

Where blasting is performed on site installed units the cables, protective devices, bushings, nameplates, gauge glasses, aluminium tapchanger head covers and all other equipment that can be damaged by the effects of blasting shall be protected.

5.3 Mechanical Wire-Brushing or Grinding

Surface preparation by mechanical wire brushing or grinding may only be used for coating repairs and maintenance on already painted units. All oil and grease deposits shall be removed prior to wire brushing as detailed in *Section 5.1*. Special attention shall be paid to bolt and other holes.

In all cases, after wire brushing or grinding, all traces of loose material shall be removed from the surface. Bushing base flanges, aluminium tapchanger head covers, hot dipped galvanised parts and protective devices shall not be prepared for painting.

Where units are completely repainted, old paint residue shall be removed by sanding of the entire surface area of the transformer or reactor. Cleaned surfaces shall not be contaminated with oil, grease, rust or other deposits before coating.

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6 Application of Coatings

6.1 General Conditions of Workmanship

All work shall be carried out under the supervision of an experienced supervisor.

All coatings shall be evenly applied to form a smooth, continuous, unbroken coating free from sags, runs and other defects. Care shall be taken to ensure adequate coating of all boltholes, edges and other areas normally prone to corrosion attack. Where appropriate, these areas shall be stripe coated.

Steel surfaces, which are to rest on concrete or other floors, and any other surfaces inaccessible after erection shall receive the full specified coating system prior to erection. Additional stripe coating of final coat paint shall be applied to the base edges that rest on the concrete plinth before lowering the unit into final position.

The *Contractor* shall touch-up paintwork damaged during transport or erection. When site repainting is necessary, labels and all other areas not to be painted shall be carefully masked. The *Contractor* shall remove any over spray, which occurs despite this masking.

Spot repairs shall be carried out such that the patch painting extends at least 25 mm beyond the damaged areas. Spot repairs shall reinstate each of the previous coats and shall commence directly after surface preparation.

No cleaning or coating applications shall take place when site conditions are likely to adversely affect these operations. The *Contractor* shall be responsible for providing all protective equipment necessary to prevent contamination of the coatings and to minimize delays due to such site conditions.

All newly primed steelwork, prior to erection, shall be stored clear of the ground on trestles or other suitable structures. The steelwork shall be placed in such a manner as to ensure adequate drainage of rainwater and condensation. The storage of galvanized components shall comply with SABS ISO 1461.

Equipment nameplates and identification plates shall be protected from coatings. No coatings shall be applied over any surfaces where it will adversely affect the performance of auxiliary components.

For site installed units the cables shall be removed from cable rails before surface preparation starts. Cables shall be secured by stainless steel strapping after completion of final coat. Cables may be painted the same colour as the main tank after refitting, if requested by the *Purchaser*.

6.2 Coating Application and Thickness – New Units

Surface preparation:	Blast cleaning to comply with SA 2.5 (ISO 8501-1:2007)
First coat / Primer:	Twin-pack, zinc rich or general purpose epoxy primer, >80% by weight total zinc in dry film. Typical 90 microns dry film thickness (Tolerance 70 - 110 microns).
Stripe coating:	All edges, weld seams, bolts and nuts, and other crucial areas shall be given an additional stripe coat with the same material as the primer but a different colour.
Second coat / Intermediate:	Twin Pack, High Build Micaceous Iron Oxide (MIO) Pigmented Recoatable Epoxy Coating. Typical 150 microns dry film thickness (Tolerance 140 - 160 microns).
Final coat / Top coat:	Twin Pack High Build Aliphatic Polyurethane Acrylic. Typical 70 microns dry film thickness (Tolerance 60 - 80 microns).
Total dry film thickness:	Typical 310 microns (Tolerance 270 – 350 microns).

6.3 Coating Application and Thickness – Maintenance

Surface preparation:	Mechanical wire-brushing, blast cleaning or grinding.

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First coat / Primer:	Twin-pack, zinc rich or general purpose epoxy primer, >80% by weight total zinc in dry film. Typical 90 microns dry film thickness (Tolerance 70 - 110 microns).
Stripe coating:	All edges, weld seams, bolts and nuts, and other crucial areas shall be given an additional stripe coat with the same material as the primer but a different colour.
Second coat / Intermediate:	Twin Pack, High Build Micaceous Iron Oxide (MIO) Pigmented Recoatable Epoxy Coating. Typical 150 microns dry film thickness (Tolerance 140 - 160 microns).
Final coat / Top coat:	Twin Pack High Build Aliphatic Polyurethane Acrylic. Typical 70 microns dry film thickness (Tolerance 60 - 80 microns).
Total dry film thickness:	Typical 310 microns (Tolerance 270 – 350 microns).

6.4 Coating Application and Thickness – Internal

Interior surfaces shall be protected by coating with paint that is unaffected by transformer oil in the temperature range of operation of the transformer or reactor. Furthermore the paint shall not influence the dissolved gas analysis of the oil in any way.

Surface preparation:	Blast cleaning to Grade SA 2.5 (ISO 8501-1:2007).
Internal Coating:	Twin-pack, high-solid high-build epoxy primer. Typical 40 microns dry film thickness (Tolerance 30 - 50 microns).

6.5 Coating Application and Thickness – Blanking covers

Blanking covers shall be hot-dipped galvanised according to SABS ISO 1461.

6.6 Coating Application and Thickness – Terminal boxes and Marshalling kiosks

Surface preparation:	Blast cleaning to comply with SA 2.5 (ISO 8501-1:2007)
External Coating:	Shall comply with specification in *Section 6.2*.
Internal Coating:	Twin-pack, high-solid high-build epoxy primer. Typical 50 microns dry film thickness (Tolerance 40 - 60 microns).

6.7 Coating Colour

The colour of each coat shall be different from the previous coat. The type of paint used for stripe coating shall be the same as the first coat but of different colour.

The colour of the Polyurethane topcoat shall be Cloud Grey SABS F48 for all new, refurbished and completely repainted units. The colour for the complete transformer i.e. main tank, pipe work and conservator tank shall be the same.

The colour of older transformers is Dark Admiralty or Battleship Grey G13 and the conservator tank White. Where maintenance is done on these transformers and reactors the same paint colour as the original shall be used.

The colour for the primer for coating of internal main tank surfaces shall be white.

Paint application for external surfaces of terminal boxes and Marshalling kiosks shall be the same colour as the main tank. The internal surfaces shall be painted white.

7 Quality Control

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7.1 General Quality Requirements

During blast cleaning, the relative humidity shall not exceed 85% and the ambient temperature shall be above 5°C.

The standard of finish for wire brushed and blast cleaned surfaces shall be in accordance with ISO 8501-1 or SIS 055900.

Where surfaces are blast cleaned, the roughness of the blast profile shall be measured in accordance with SABS 772 and shall be as specified by the material manufacturer's technical note. The blast profile (Sa 2,5) shall not exceed the specified thickness of the primer or first coat. Blast cleaning of severely corroded surfaces may result in high roughness profiles (i.e. > than 40 microns). In these cases, an additional first / primer coat will be required. However, agreement should be reached between the *Contractor* and *Coating Manufacturer* as to the most suitable profile range for a specific coating application/system. Section 5.2 is to be used as a guideline with respect to blast profile requirements.

7.2 Quality Control of Coating Applications

The application, method of application and drying times shall be as specified in the product data sheet submitted with the tender and approved by the *Purchaser*.

Coating thickness on metal substrates shall be measured in accordance with ASTM E376 or SABS ISO 2080. These measurements shall be made on surfaces free of all contaminants. Calibrated electronic instruments shall be used for determination of film thicknesses. In cases of dispute, both the *Purchaser's* and *Contractor's* appointed inspectors dry film thickness testers shall be re-calibrated and the percentage variation between the two testers shall be applied as being the standard deviation for each reading.

The thicknesses of each coat shall be as defined in *Sections 6.2, 6.3, 6.4 & 6.6*. No individual reading shall be less than the minimum or exceed the maximum specified values.

All deficient film thickness shall be rectified to the *Purchaser'*s approval at the *Contractor*'s expense.

Where excessive film thickness can be detrimental to the integrity of the coating, the Manufacturer's recommended maximum shall apply.

7.3 Defects During the Guarantee Period

Paintwork will be considered defective if, during the guarantee period, latent defects appear which could lead to a general breakdown of the coating system.

8 Technical Evaluation and Final Approval

This specification serves as a minimum requirement for Contractors that supply new transformers and reactors, perform complete refurbishment and / or do site repairs and maintenance. Any deviation from this specification has to be approved by Eskom in writing.

Alternatives will be considered and final written approval shall be provided once a technical evaluation has been completed and the paint application system found in compliance with this specification and Eskom requirements.

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