

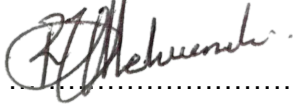



	Scope of work	Kriel Power Station
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1. INTRODUCTION

Due to severe scaling of heat exchanger tubes at Kriel power station, a recommendation by Kriel Turbine Engineering was made to chemically clean heat exchangers to ensure sufficient heat transfer.

1.1 SCOPE

This scope entails the chemical cleaning of the heat exchangers tubes at Kriel power station as well as preparation for the activity such as coating repairs/ re-coating of tubesheets and waterboxes.

1.2 APPLICABILITY

This document shall apply to Kriel Power Station.

1.3 REFERENCES

- [1] ISO 9001 Quality Management Systems.
- [2] 240-101712128 Standard for the internal Corrosion Protection of Water Systems, Chemical Tanks and Vessel and Associated Piping with Linings.
- [3] 15ENG GEN-2154 Tender Technical Evaluation Strategy – Condenser Chemical Cleaning.
- [4] 240-107677940 Specification Standard for High Pressure Jetting of condenser and Heat Exchanger Tubes.
- [5] RTD/MAT/19/249: Protective Coating Specification (by organic coatings) for Kriel Power Station – Condenser and Tube/Shell Heat Exchangers (HEX) Waterboxes
- [6] RTD/MAT/19/257: Protective Coating Specification (by organic coatings) for Kriel Power Station – Condenser Tubesheets

1.4 DRAWINGS

Non available

1.5 DISCLOSURE CLASSIFICATION

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2. SCOPE OF WORK

2.1 HEAT EXCHANGER INFORMATION

Main condensers – 6 off

Length	: 12 m
Tube outer diameter	: 24 mm
Tube wall thickness	: 0.7 mm
Number of tubes	: 26 000
Cooling water flow	: 35280 m ³ /h
Steam flow	: 1015 t/h
CW Supply temperature	: 24 °C
Number of passes	: 2
Water velocity in tubes	: 1.98 m/s
Tube material	: Unit 1 – Grade 2 Titanium : Unit 2 - Grade 2 Titanium : Unit 3 – Duplex stainless steel : Unit 4 - Grade 2 Titanium : Unit 5 - Grade 2 Titanium East and super ferritic stainless steel west side. : Unit 6 - Grade 2 Titanium East side and super ferritic stainless steel west side.
Tubesheets/Waterbox	: Coated
Test pressure (Waterbox)	: 0.5 MPa (g)
Test pressure (Steam space)	: 0.13 MPa (g)

BFPT condensers 6 off

Length	: 5.5 m
Tube outer diameter	: 24 mm
Tube wall thickness	: 0.7 mm
Number of tubes	: 2540

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Cooling water flow	: 3130 m ³ /h
Steam flow	: 61.2 t/h
CW Supply temperature	: 24 °C
Number of passes	: 2
Water velocity in tubes	: 1.8 m/s
Tube material	: Grade 2 Titanium
Tubesheets/Waterbox	: Coated
Test pressure (Waterbox)	: 0.5 MPa (g)
Test pressure (Steam space)	: 0.13 MPa (g)

Oil cooler (Main turbine) 12 off

Length	: 3 m
Tube outer diameter	: 24 mm
Tube wall thickness	: 1 mm
Number of tubes	: 253
Cooling water flow	: 145 kg/s
CW Supply temperature	: 24 °C
Number of passes	: 1
Water velocity in tubes	: 1.8 m/s
Tube material	: Admiralty brass with copper fins
Tubesheets/Waterbox	: Coated
Test pressure (Waterbox)	: 0.8 MPa (g)
Test pressure (shell side)	: 0.8 MPa (g)

Oil cooler (BFPT) 12 off

Length	: 3 m
Tube outer diameter	: 24 mm
Tube wall thickness	: 1 mm
Number of tubes	: 65

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Cooling water flow	: 40 kg/s
CW Supply temperature	: 24 °C
Number of passes	: 1
Water velocity in tubes	: 1.8 m/s
Tube material	: Admiralty brass with copper fins
Tubesheets/Waterbox	: Coated
Test pressure (Waterbox)	: 0.8 MPa (g)
Test pressure (shell side)	: 0.8 MPa (g)

2.2 GENERAL REQUIREMENTS

1. All the work mentioned in this scope of work is the responsibility of the Contractor except where specifically noted otherwise.
2. The Employer shall isolate the condenser from the main cooling water system and drain the system.
3. The Employer shall install spading on the CW inlet and outlet waterboxes to prevent acid in the CW ducting and valves as well as the tube cleaning system strainers.
4. The Contractor to inspect the condenser waterboxes and tubes. Remove any loose debris and unblock any tubes blocked with on-line cleaning balls or other debris. Remaining restricted tubes which cannot be cleared by rodding (by means of appropriate/suitable flexible cable/rod) shall be plugged prior to proceeding with chemical cleaning. The requirement is that tubing be “unblocked” to allow passage of the cleaning solution through the entire length of the tube. The practice of using HP water cleaning, of the entire condenser, for the purpose of rodding tubing shall not be allowed as it will affect the duration of the work negatively. If the Contractor decided to unblock some of the tubes by using HP cleaning it shall form part of the project schedule and costing should be included in the total price for chemical cleaning.
5. The risk of blockage on waterbox piping systems such as vent or drain lines and the consequence in terms of pressure build-up in the waterbox during the chemical clean shall be carefully evaluated and appropriately mitigated.
6. The Contractor to take note that this work shall either happen during opportunity maintenance or outages. In the case where the work is taking place during the outages the Contractor shall attend daily outage meetings to be aware of other activities happening on the plant.

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7. It is the responsibility of the Contractor to familiarize him/herself with the layout of the plant and the area of where the condenser is relative to the turbine hall.
8. If compressed air is required, the Contractor shall provide dedicated diesel compressors. The diesel compressors are not permitted in the turbine hall therefore the Contractor shall consider the length to the location where the compressors will be placed.

2.2.1 COATING REQUIREMENTS

1. Refer to attachments: GE/MAT/27/047: Protective Coating Specification (by organic coatings) for Kriel Power Station – Condenser and Tube/Shell Heat Exchangers (HEX) Waterboxes and GE/MAT/24/048: Protective Coating Specification (by organic coatings) for Kriel Power Station – Condenser Tubesheets.
2. Before chemical cleaning can commence the condenser tubesheets as well as the waterboxes and staybars need to be coated to protect the stainless steel against the corrosive effects of the acid that will be used.
3. The Contractor together with Eskom Engineer shall inspect the condition of corrosion protective coatings on the waterbox, tubesheet and other surfaces such as stay bars/rods. To assess the condition of existing coating it may be required to wash the surfaces with potable water to remove mud or dirt covering the surfaces. All coating defects shall be repaired prior to chemical cleaning. Based on an inspection, Eskom will decide whether to completely recoat the waterbox/tubesheet OR perform patch repairs.
4. Where patch repair of the waterboxes or repairing localised areas of the tubesheets care shall be taken to ensure adequate protection of any surfaces and parts of components or systems not requiring blast cleaning and coating and effort shall be taken to prevent grit, water and any other dirt entering the tubes and inlet/outlet of cooling water isolating valve.
5. Coating shall be performed as instructed by Eskom and with the coating systems as specified in attachments mentioned in 1 of this section. The Contractor shall include coating price per m².
6. In the case of weld repairs on waterboxes or tubesheets, the Employer shall arrange that the repairs are completed before coating is applied.
7. The Contractor is required to perform coating repairs due to any mechanical damage after chemical cleaning.

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2.2.2 CHEMICAL CLEANING SCOPE OF WORK

1. Fit any necessary temporary connections and blank spades as required by the chemical *Contractor* to allow for proper circulation of the cleaning solution through all the tubes. The *Contractor* shall consider his particular pumping capabilities to ensure immersion and circulating flow of cleaning solution through ALL tubes. The Method statement shall consider venting of air pockets and build-up of gasses.
2. The employer to fit the condenser support jacks as required.
3. Fill the shell side of the heat exchanger with demineralised quality water to cover uppermost tubes for the purpose of a high-level test to identify tube leaks. The water level shall be maintained for 24 hours before conducting a thorough inspection to identify any tube leaks. All tubes with leaks to be suitably plugged. Shell side to remain filled with demineralised quality water during the chemical cleaning process to ensure dilution of any acid that may escape into the shell side due to leaking tubes and ensure that the risk of damage to equipment is minimized.
4. Fill the cooling water side of the heat exchanger with potable or raw water using the *Contractor's* chemical cleaning pump station and establish circulation without exceeding the maximum permissible design pressure of the waterboxes. The circulation flow must be sufficient to flow through all the tubes but shall not exceed 0.3 m/s through individual tubes (the pressure shall not exceed 2.5 bar under any circumstances). Pump/s shall produce a maximum pressure of 2.5 bar at 0 m³/h flow OR the equipment will contain electrical protections (based on waterbox pressure) that will cut the power source to the pump/s should the waterbox pressure exceed 2.5 bar or pump discharge side shall be fitted with a mechanical safety relief valve that is sized to allow for the maximum output flow of the pump and set to a value not exceeding 2.5 bar. This shall be detailed in a procedure and accepted by the system engineer before the work commence.
5. The use of compressed air to assist in draining the heat exchanger is prohibited. The correct operation of the above-mentioned protection equipment shall be confirmed prior to the chemical cleaning operation. In all cases the waterbox pressure shall be recorded by means of an electronic recorder with a recording frequency of not less than once every 30 seconds. Pressure monitoring shall appear on the QCP and shall be monitored prior to cleaning up to when the condenser is drained. The *Contractor* shall designate a suitable employee to monitor this intervention accordingly and record this in the QCP documentation.
6. Circulate the potable or raw water for 1 - 2 hours and check for leaks on the system/temporary piping before injecting acid. Once satisfied that there are no leaks that would force premature

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termination of the chemical clean stop circulation and drain off an amount of water equivalent to the amount of acid to be added to achieve the desired acid concentration.

7. Commence circulation and begin acid injection strictly as per the compositions/concentrations as detailed below. The acid solution is required to be inhibited with the correct concentration of appropriate inhibitor. Only inhibitors that have previously been tested and approved by Eskom for the specific material selection shall be used. If new/untested inhibitors are proposed, then these shall be tested for effectiveness by Eskom before any use. A "steel wool" test shall be conducted hourly to ensure the effectiveness of the inhibitor is satisfactory. The test involves dropping a ball of steel wool into a sample of the cleaning solution and to monitor any bubble formation and/or physical rise of the ball to the surface. In the case of the latter more inhibitor shall be added to the solution circulating in the condenser and the "steel wool" test repeated. The acid concentration shall not at any time exceed 7.5% by mass. Continue circulation and ensure adequate gas release.

8. Acid injection

- a) Grade 2 Titanium Tubes (applicable only to main condensers at unit 1, 2, 4, 5 east, 6 east and unit 1 – 6 BFPTs condensers) : Commence circulation and begin acid injection (5 - 6% HCl and adding 0.2% of ferric chloride to protect the titanium). The acid solution is required to be inhibited with the correct concentration of appropriate corrosion inhibitor. The acid concentration shall not at any time exceed 7.5% by mass. Continue circulation and acid injection until the acid has been added. Ensure adequate gas release.
- b) Duplex Stainless Steel (applicable to unit 3 main condenser) : Commence circulation and begin acid injection: $\leq 5\%$ HCl. Continue circulation and acid injection until the acid has been added. Ensure adequate gas release.
- c) Superferritic Stainless Steel (applicable to unit 5 and 6 west side of the main condenser): Commence circulation and begin acid injection: 5 - 6% HCl. This cleaning solution is only suitable for removal of calcium carbonate deposits/scales. As indicated, the acid solution is required to be inhibited with the correct concentration of appropriate inhibitor. The acid concentration shall not at any time exceed 7.5% by mass. Continue circulation and acid injection until the acid has been added. Ensure adequate gas release.
- d) Brass tubes (applicable to all oil coolers): Commence circulation and begin acid injection: 5 - 6% HCl. This cleaning solution is only suitable for removal of calcium carbonate deposits/scales. The acid solution is required to be inhibited with the correct concentration of appropriate inhibitor. The acid concentration shall not at any time

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exceed 7.5% by mass. Continue circulation and acid injection until the acid has been added. Ensure adequate gas release. This is applicable to unit 1 to 6 oil coolers.

9. If the *Contractor* proposes a solvent different to the ones listed in 8, this chemical cleaning solvent shall be approved by Eskom (through testing and analysis) before it can be used for cleaning any heat exchanger.
10. The cleaning proceeds on the basis of circulation, usually for approximately 6 hours, although this could vary depending on the nature of the scale/deposit to be removed.

The cleaning process is terminated on the basis of chemical analysis, which indicates stability of the residual acid strength of the bulk solution and no further increase in the concentration of the scale/deposit species in the bulk solution as monitored on at least a 30-minute interval.

N.B.: Chemical analysis appropriate to the constituents in the type of scale being dissolved, as well as residual acid strength, shall be performed by the Eskom Laboratory at a frequency of not less than once every 30 minutes.

- The free residual acidity of the cleaning solution must not be allowed to decrease to below 2.0 % by mass at any time.
 - Chemical analysis for the dissolved species comprising the primary alloying constituents of the tube material shall be performed at a frequency not less than once every 60 minutes to monitor corrosion protection by the inhibitor.
 - Analysis of the pH of the demineralised water in the steam space to check for acid in-leakage.
11. Stop circulation and drain the spent solvent to the designated area, usually the ash sump of the appropriate unit.
 12. Commence filling and flushing cooling water side of the heat exchanger with potable water or raw water quality until the residual conductivity is less than 100 $\mu\text{S}/\text{cm}$ above the potable water conductivity.
 13. Circulate this water and add sufficient soda ash or tri-sodium phosphate to elevate the pH of this solution to 9.0 (± 0.2). Circulate for a further 60 minutes to neutralise any residual acid, then drain.
 14. The *Contractor* shall remove all temporary connections after chemical cleaning.
 15. Repeat this process (Steps **Error! Reference source not found.** – 14) for any tube paths that could not be connected into the cleaning path in series.

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16. As soon as possible after the chemical clean i.e., not at the end of a long duration outage the remaining sludge in the tubes shall be removed by HP water washing. In most cases Low Pressure washing will be required after chemical cleaning to remove sludge from the tubing. The equipment used during HP water washing is part of this contract and the *Contractor* need to provide all the equipment for this activity. Because this scope shall be implemented during outages the *Employer* cannot guarantee electrical power at all times therefore the *Contractor* shall provide alternative options such as diesel driven high pressure machines as part of this contract.
17. After HP water washing an endoscope shall be provided by the *Contractor* that will be used to ensure that all the scaling was removed.
18. Perform a high-level test and plug any tubes that have developed leaks during the cleaning process.
19. Drain the steam side of the heat exchanger. Should any acid in-leakage have occurred during the operation, flush the steam space with demineralised water dosed with ammonia to elevate the pH to 9.1 (± 0.2).
20. Drain the steam side. If fluorescein was used for the high-level test, flush (Step 19) until concentrations of Na < 10ppb.
21. At the appropriate time the *Employer* shall remove the condenser jack supports.
22. Inspect the waterbox coating and tubesheet and report any signs of damage and deterioration of coating. Repair any damage to coatings as per the GE/MAT/27/047: Protective Coating Specification (by organic coatings) for Kriel Power Station – Condenser and Tube/Shell Heat Exchangers (HEX) Waterboxes and GE/MAT/24/048: Protective Coating Specification (by organic coatings) for Kriel Power Station – Condenser Tubesheets.
23. As soon as possible, apply normal cooling water flow by charging and operating the cooling water system. Where applicable put the on-line ball cleaning system in service.

2.2.3 BLANK FLANGE

1. Blanks shall be supplied and installed by the employer before chemical cleaning.

2.2.4 ROLES AND RESPONSIBILITIES

1. The *Employer* shall obtain and conduct isolation by closing the T1 and T2 (CW isolation valves).
2. Opening of the manway covers and the installation of the CW spades/blanks shall be the responsibility of the *Employer*.

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3. Gas testing shall be performed by the *Employer* once requested by the RP (Responsible Person obtaining the permit to work).
4. The Contractor shall supply a resource 3 months before the work starts to obtain the necessary training to become an RP. Please refer to the NEC contract data for more information.
5. The Contractor will be responsible for the permits taken on the condenser. This includes the confined space permit.
6. The *Contractor* shall only start with coating surface preparation once the CW spades have been installed. Sandblasting grit shall not be allowed to be blown out of the waterboxes during the grit blasting activity. All the grit will be collected after blasting and disposed of. Grit inside the tubes shall be removed to allow for sufficient flow during the cleaning process.
7. Scaffolding required shall be the responsibility of the *Employer* and the requirements shall be discussed during project kick-off meeting.
8. Supply of vacuum tankers and transportation of acid waste to designated disposal area (ash disposal) shall be responsibility of the *Contractor*.
9. High level flood test inspection, plugging of the leaking tubes and updating of tube map shall be *Contractor's* responsibility.

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2.2.5 EQUIPMENT / TOOLS LISTS

The *Contractor* will complete the tables below to indicate the equipment as a tool list that will be used during the chemical cleaning activities.

Table 1: Tool list for chemical cleaning

Quantity provided by the <i>Contractor</i> per MTC condenser	Tool/Equipment Description	Description	Units
	Pumps		Head, m
			Flow m ³ /h
	Mixing tank		m ³
	Flexible hoses for conveying of chemical solutions		Number off
			Diameter, mm
	Valves related to isolation of chemical solution		Number off
			Diameter (DN)

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Table 2: Tool list for high pressure cleaning

Quantity provided by the Contractor per MTC condenser	Tool/ Equipment Description	Description	Units
	HP pumps		bar
			m ³ /h
	HP flexible hoses		Number off
			Internal Diameter, mm
			Length, m
	HP nozzles		Make
			Diameter, mm
	Foot Valves		Number off Size

2.3 DOCUMENTATION

The *Contractor* shall supply the following information after contract award and before any work is done.

1. A method statement detailing the chemical cleaning process shall be approved by the *Employer* before any work commence.
2. A method statement by the coating contractor detailing the waterbox and tubesheet coating shall be approved by the *Employer* before any work commence.
3. All QCP for both the Coating and cleaning shall be preapproved by the *Employer* before any work start. Hold points for engineering will be added after each major activity. *Contractor* QC will have hold points for each activity on the QCP.

The *Contractor* shall supply the following information after the work has been completed.

1. A tube map indicating all tube plugs will be submitted after the final high-level test is concluded.
2. Calculation of mass of scale removed per CW pass.

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2.4 TENDER RETURNABLES

The *Contractor* shall supply the following tender technical returnables information with his tender. Should the mandatory returnable not be supplied tender will be rejected and considered non-complaint.

The qualitative criteria will be used to evaluate the suitability and compliance of tender to the actual scope of work requirements.

- a) The *Contractor* shall provide verifiable evidence that the company has previously successfully chemical cleaned a Power Plant main turbine condenser ($\geq 200\text{MW}$) or heat exchanger with surface area of $\geq 11\,000\text{m}^2$ in the previous 5 years. At least three references shall be provided. References to contain details such as client name, contact person and contact number.
- b) List of exclusions, deviations or omissions to this Scope of Work (chemical cleaning), if no exclusions or deviations a clear statement must be provided as such. If no statement is provided then the tender scoring will be negatively affected.
- c) The completed list of equipment that will be used during the execution of the chemical clean as in Table 1 of this document Section 2.2.5 must be provided.
- d) The completed list of equipment that will be used for the high-pressure cleaning / flush as in Table 2 of this document Section 2.2.5 must be provided.

3. REVISIONS

Date	Rev.	Compiler	Remarks
July 2024	0	██████████	New document

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**GE/MAT/27/047: Protective Coating Specification (by organic coatings) for Kriel
Power Station – Condenser and Tube/Shell Heat Exchangers (HEX) Waterboxes**

To be considered as Annexure D of 240-101712128: Specifications for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Coatings	
Vessels	Main/BFPT Condenser Waterboxes & Oil Cooler Waterboxes
<u>Internal Immersed</u> (Material/Substrate)	Cast iron or carbon steel and previously epoxy coated or rubber lined
<u>Internal Immersed</u> (Environment)	<ul style="list-style-type: none"> • Operating Temperature: 45°C – 65°C • Flow rates of up to 2 metres per second. • pH: 8 to 8.6 • Medium: Raw or Cooling Water (CW) • Conductivity (K) < 4000 µS • Chloride < 400 mg.kg⁻¹ as Cl • Sodium < 500 mg.kg⁻¹ as Na • Sulphate < 1000 mg.kg⁻¹ • Calcium Carbonate Precipitate Potential (CCPP) 80 to 160mg.kg⁻¹ as CaCO₃
<u>Internal Immersed</u> (Surface Preparation and coating)	Abrasive blast clean to Grade Sa 3 (ISO 8501-1). The surface profile as specified by the coating manufacturer.
<u>Generic System</u>	Solvent Free Epoxy
First Coat	<p>Apply by airless spray, one coat Two Component Solvent Free Amine Cured Epoxy coating from 350 - 450 micron.</p> <p>Thinning in excess of 5% shall not be permitted.</p>
Stripe Coat	After allowing sufficient time (as recommended by coating manufacturer) for the first coat to cure, all accessible edges, weld seams, bolt holes and other crucial areas shall be given an additional stripe coat by brush.

**GE/MAT/27/047: Protective Coating Specification (by organic coatings) for Kriel
Power Station – Condenser and Tube/Shell Heat Exchangers (HEX) Waterboxes**

Final Coat	<p>After allowing sufficient time for the first coat and stripe coating to cure, the manufacturer's recommendations shall be adhered to in this regard, apply by airless spray, one coat Two Component Solvent Free Amine Cured Epoxy coating from 350 - 450 micron.</p> <p>Total System Minimum Dry Film Thickness (DFT) = 700 microns.</p>
<p>With respect to aspects not mentioned in the above coating specification table (e.g. mixing ratios, pot life, straining, thinning, induction times, over-coating and curing times), the manufacturer's recommendations shall be strictly adhered to.</p>	
<p>This specification sheet caters for repair to existing coatings or complete removal and recoating, and is applicable to heat exchanger waterboxes and other associated waterside components i.e. staybars. Depending on the size and type of heat exchanger the waterbox will either be coated in-situ or removed for corrosion protection in a designated laydown area. The Eskom engineer will provide information on a case by case basis.</p>	
<p>Specific Project Requirements</p> <ol style="list-style-type: none"> 1. In the case of any existing rubber lining then the lining shall be completely stripped and removed in preparation for coating/lining. 2. A detailed visual inspection shall be carried out by the Eskom engineer to identify and mark-up all areas that need to be repaired/reinstated OR completely coated/recoated. 3. The applicator shall take cognisance of the fact that Eskom may require access for a further inspection and assessment to determine the need for possible mechanical repairs i.e. welding. Unfortunately, this inspection can only be carried out once the surfaces have been rough blast cleaned. The depth and morphology of corrosion damage, extent of component wall thickness loss and pitting needs to be considered. For steel, the following guide (obviously dependent on installed wall thickness) can be applied to all areas of extensive deep pitting: 	

**GE/MAT/27/047: Protective Coating Specification (by organic coatings) for Kriel
Power Station – Condenser and Tube/Shell Heat Exchangers (HEX) Waterboxes**

- All pits less than 2mm in depth and all edges and weld seams shall be stripe coated after application of the primer/first coat.
 - All pits in excess of 2mm and up to 5 mm in depth shall be filled using a compatible two component solvent free epoxy filler. The filler to be used shall be supplied by the same supplier as the rest of the coating system and confirmed to be compatible to the specified coating system.
 - All severely grooved/corroded welds shall be filled by welding (repair procedure shall be submitted to Eskom for approval). Perforations and defects, pitting etc. which are close to approaching the wall thickness shall be repaired by welding in steel plate. The plate shall be welded onto the internal/immersed surface.
4. Final/finishing surface preparation to Grade Sa 3 (ISO 8501-1) followed by primer application shall only proceed once all mechanical work is completed. This requirement shall be strictly adhered to. The Contractor shall be wholly responsible for the decision-making to continue with final/finishing surface preparation and primer application.
 5. At all times care shall be taken to ensure adequate protection of any surfaces and parts of components or systems not requiring blast cleaning and coating (as an example valve seats/trim, pump inlets, condenser/heat exchanger tubes) and every effort shall be taken to prevent grit, water and other dirt entering drain systems, tank/vessel inlet/outlet piping or settling on isolating valves seats, shafts etc.
 6. Equipment name plates and identification plates shall be protected from coatings. No coatings shall be applied over any surfaces where these will adversely affect the performance of the item or component.
 7. All materials, i.e. paint, solvents and cleaning agents for a specific paint system shall be supplied by the same manufacturer. The solvents used shall be those recommended and manufactured by the paint manufacturer. Where the recommended 'solvent' and 'clean-up thinners' for a material differs, the 'clean-up' solvent must not be added to the paint for dilution purposes.

**GE/MAT/27/047: Protective Coating Specification (by organic coatings) for Kriel
Power Station – Condenser and Tube/Shell Heat Exchangers (HEX) Waterboxes**

8. Corrosion Protection shall only proceed once all mechanical activities have been completed and released in terms of the manufacturing/fabrication Quality Control Plan (QCP).
9. The waterboxes substrate shall be tested for chloride contamination in according to (ISO 8502-6). Casting substrates which may be pitted and/or rough and porous are inherently susceptible to soluble salt contamination. Testing shall be performed prior to final surface preparation.
10. Testing shall be performed by the Bresle soluble salt test method. If not within acceptable limits (as per the manufacturer requirement but not exceeding 100mg/m²), the surfaces shall be washed/decontaminated by High Pressure (HP) water washing using fresh/clean water (with a conductivity reading of maximum 100 µS/cm) at a minimum pressure of 300 bar. A salt decontamination chemical additive with demonstrated capability of removing salts may be used in conjunction with HP cleaning.
11. Testing shall be repeated on representative test patches which shall be blast cleaned to Grade Sa 3 (ISO 8501-1). If acceptable then proceed with blasting and application steps – if not then repeat HP washing until the salt contamination has been removed to within acceptable limits.
12. Surface preparation by abrasive blasting shall be performed by means of conventional hand held blasting equipment capable of removing mill scale, old coating, rust and suitably preparing the substrate to the required cleanliness of Grade Sa 3.
13. Removal of dust and debris shall be performed by vacuuming. The process shall be repeated until the required level of dust and debris removal is achieved.
14. The level of cleanliness required shall be less than “dust quality rating” 1 when tested in accordance with (ISO 8502-3).
15. If coating is to be performed downstream of a draft either naturally or by fans then the upstream area shall be completely grit and dust free to prevent any possible carry-over of the dust/grit contamination onto the downstream wet/curing coating.

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16. Plural spray equipment is not permitted. Coating application by airless spray shall be performed by means of conventional airless spray equipment with the capability of suitably pumping and atomising the paint over a 20 metre distance from the spray pump. The spray nozzle and spray pattern shall be as per the manufacturers recommendations.

General Requirements:

1. The applicator shall be wholly responsible for the surface preparation and coating application. The coated surfaces shall meet the DFT as required by this specification sheet and aspects thereof in referenced documents.
2. Rounded edges are required in order to be able to apply the protective coating uniformly and to attain adequate coating DFTs on sharp edges, refer to (ISO 12944-3) should more detail be required. All sharp edges from the original fabrication shall be rounded or chamfered and burrs around holes and along other cut edges shall be removed. All edges to be rounded off with a grinder to a radius of 3mm or more.
3. Weld beads with a surface irregularity exceeding 3mm or with sharp crests having a radius less than 3mm shall be ground.
4. Power and hand tool cleaning is only applicable to very localised touch ups or patch repairs. Specific requirements for patch repairing a coating system are defined in section 4.8.6 of 240-101712128. Hand-tool cleaning for isolated/localised areas may be utilised provided the required standard of finish is achieved. For all immersion applications final mechanical cleaning shall be by bristle blaster in order to create a required surface profile.
5. Bristle blasting is only to be used for small areas and conventional grit blasting shall be used for large areas. Conventional blasting provides a more angular anchor pattern compared to bristle blasting. Small areas are considered to be the equivalent of a A4 sheet, 0.05 m², approximately 25 cm x 25 cm. Bristle blasting shall not be confused with the use of a needle gun. A needle gun provides a peened surface and is not a suitable profiled surface.
6. 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.

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7. Oil and grease deposits shall be removed prior to cleaning. Special attention shall be paid to drillings, bolt holes, etc.
8. Burnishing of the surface shall not be permitted.
9. In all cases, after wire brushing or grinding, all traces of loose material 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 application.
10. Different grades and types of blasting media exist. It is important that the correct abrasive be used in combination with a specific coating system to achieve the specified surface profile. The required blast profile height should be carefully considered. The applicator shall select an appropriate abrasive type and mesh size to attain the specified surface profile.
11. Only inert mineral grit or steel grit abrasives shall be used. Steel grit is preferred in sensitive plant areas such as Water Treatment Plants in order to ensure no contamination of plant processes due to excessive dust. Sand or silica based abrasives shall not be used. Abrasive material for blast cleaning shall be used in line with local environmental regulations.
12. The abrasive shall be used in accordance to the manufacturer's specifications and shall be clean, sound, hard particles free from foreign substances such as dirt, oil, grease, toxic substances, organic matter and water soluble salts.
13. It is important that good quality abrasives are used in order to minimize the amount of waste grit and dust generated and contamination of the surfaces.
14. The use of re-cycled blasting media for the final blast is strictly prohibited.
15. All abrasive media shall be stored in an area that is completely dry, covered and protected from weather.
16. The profile height of the blasted surfaces should be within the range of the specified coating system. Refer to the manufacturers Product Data Sheets. Unless otherwise specified by the coating manufacturer, a profile height of 25 microns to 90 microns is recommended for most coatings systems.

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17. It is important that the blast profile does not exceed the specified DFT of the primer or first coat. Blast cleaning of severely corroded surfaces may result in high profiles i.e. > than 100 microns. In these cases, the primer or first coat shall be applied by brush/roller to ensure complete wet-out of the pitted/jagged surface. In addition a different primer or first coat may be required. However, agreement should be reached between the applicator and coating manufacturer as to the most suitable profile range, with due consideration of the application method, for a specific coating system.
18. The applicator shall consider and detail these potential scenarios or eventualities in the required Method Statement which shall be reviewed by Eskom for acceptance/rejection prior to any work. Ultimately, the applicator shall be responsible for any risk that could arise or be attributed to this choice.
19. The requirement for surface preparation of all metallic surfaces for immersion is strictly Grade Sa 3 (ISO 8501-1), in which case the surfaces shall be blast cleaned to white metal where all traces of rust, mill scale and other foreign matter are removed.
20. All compressed air for blasting activities shall be free from entrained moisture and oil. All traps shall be in a functional condition. The compressed air shall be tested at regular intervals using clean white clothes to assess cleanliness and dryness. This requirement shall be included in the QCP.
21. After surface preparation, all dust, grit blasting media or any other deleterious matter shall be removed from the surfaces by vacuuming. The process shall be repeated until the required level of dust and debris removal is achieved. It is imperative that all surface dirt and contaminants are completely removed before coating or the adhesion of the coating shall be impaired.
22. Cleaned surfaces shall not be contaminated with oil, grease, rust or other deposits before coating. Unnecessary traffic prior to painting shall be avoided.
23. Immediately before coating, blast cleaned steel shall not exhibit more than “dust quantity rating” 1 when tested in accordance with (ISO 8502-3).

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24. The applicator shall ensure that during surface preparation and coating activities the relative humidity (RH) in open, undercover shop environments is less than 80% RH and for waterboxes in-situ (confined spaces) is less than 60% RH. Ambient temperatures shall be between 5°C and 30°C or as per the manufacturer recommendations, whichever is the more stringent. The maximum/minimum substrate temperature at the time of coating application shall be strictly in accordance with the product data sheet. During stable weather conditions environmental parameters shall be measured and recorded at least 4 times per shift. All measurements shall be recorded at the waterbox surface. Dew point requirements shall be as per the Product Datasheet or 240-101712128.
25. During periods of inclement or cold weather conditions the environmental parameters shall be measured and recorded hourly, by the Contractor. In the event that the latest two readings of any of the parameters indicate a deteriorating trend which would likely exceed parameter/s limit then no final surface preparation or spray application shall be permitted. Dew point requirements shall be as per the requirements of the Product Datasheet or 240-101712128. Should the Contractor opt to continue final surface preparation and coating application during which time environmental parameters are exceeded then the Contractor shall be wholly responsible for any and all rectification/remedial and rework activities.
26. For all inspections of all surface preparation and coating activities the surfaces shall be clean allowing unhindered visual access to the surface. The applicator shall provide sufficient and adequate lighting (Cool White) to enable inspections. Cell phone lighting is not acceptable.
27. In order to avoid recontamination and flash rusting of the surfaces, the primer or first coat shall be applied within 4 hours after final surface preparation of the steel surfaces. Under no circumstances shall the blast be permitted to stand overnight.

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28. Many modern organic coatings can be applied without the use of a primer. However, should a primer coat be required for holding of the blast, or otherwise, the applicator shall indicate/describe the reasoning for the need of such a primer i.e. as a holding primer or as a means of enhancing adhesion of the system. Details shall be provided in the Method Statement for the type of primer, generic resin, solvent borne or free, maximum DFT and compatibility with subsequent coats. The detailed Method Statement shall be submitted and reviewed by Eskom for acceptance/rejection prior to any work. Ultimately, the applicator shall be responsible for any risk that could arise or be attributed to this choice.
29. The spray operator shall be equipped with a “wet comb” and frequently monitor the wet film thickness to prevent/reduce a wide spread of DFT’s.
30. After allowing sufficient time for the first coat to cure, all edges, weld seams, bolts and nuts, and other crucial areas shall be given an additional stripe coat, by brush application, with the same material as the following coat. Should the use of a primer be omitted, stripe coating shall be carried out between applications of the first coat and the subsequent coat.
31. Multiple coats shall be applied as per the table at the top of this specification sheet. Single coat systems are not permissible.
32. Where more than one coat is applied, the colour of each coat shall be different from the previous coat. Repairs after final testing shall be carried out using a different colour.
33. Where more than one coat is being applied in an open exposed yard environment, surface preparation and washing shall be carried out between coats. Where the coating has completely cured or allowed to age before finishing, before application of a subsequent coat the surface shall be prepared by light sanding, scrubbing with potable water using a bristle brush and drying before over-coating.
34. Application of subsequent coats shall be in accordance with the specified system. The required over-coating intervals as mentioned in the latest Product Data Sheet shall be observed and adhered to.

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35. The number of coats and DFT per coat required to achieve the total film DFT shall be agreed between the applicator and coating manufacturer and will be dependent upon the method of application chosen.
36. The total DFT of the applied coating system shall comply with the recommended minimum and maximum DFT limits as recommended in the latest Product System Data Sheet and this specification.
37. The range of DFTs of each coat shall be as follows; 90% of random readings shall be equal to or greater than the minimum specified DFT. No individual reading shall be less than 80% of the specified DFT. In the case of solvent borne coatings no individual reading shall be greater than 150% of the manufacturer's maximum specified DFT. All deficient film DFTs shall be rectified prior to release of components.
38. The coating shall be evenly applied to form a smooth, continuous, unbroken layer free from misses, sags, runs, tears and other defects that could affect the integrity of the coating.
39. Unless otherwise instructed by the Eskom engineer for flange surfaces at least one coat of the coating system shall be brought around onto a third of the surface area of the flange face. In the case of flange face (gramophone surface finish) with compressed fibre gaskets, blasting and coating is not permitted.
40. The applicator shall perform pinhole detection using appropriate "spark" testing equipment at a voltage setting as per the coating manufacturer's requirements. Wet sponge testing shall not be acceptable.
41. It is imperative that wherever possible pinhole detection and general patch repairs are to be performed before final cure of the coating system.
42. With the exception of access limitations or as instructed by the Eskom engineer all areas of coating damage shall be patch repaired in a different or contrasting colour and by brush application. The extent of the damage shall be carefully inspected to assess which coats in the system have been damaged and which surface preparation methods are most suitable and appropriate.

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43. The Eskom engineer shall accept/reject the applicator's recommended method of surface preparation i.e. mechanical power and hand tool cleaning. When more widespread repairs are required and when the damage extends to the steel substrate abrasive blast cleaning to Grade Sa 3 (ISO 8501-1) is required.
44. All coats in the system shall be re-instated. Areas to be primed shall be cleaned of dust, dirt, grease, salts or other deleterious matter and all edges of existing paint shall be feathered back to a hard edge. The patch primer used shall be in accordance with the requirements of the relevant coating system. The over-coating onto an existing coating by subsequent intermediate and finishing coats (where applicable) shall be stepped at 25 mm intervals to produce a feathered edge. Specifics of such instances shall be assessed on a case by case basis.
45. All shop coated surfaces shall be inspected and examined for coating damage on arrival at site. If the damage is excessive it may be preferable to repair the transport damage before installation/assembly/erection whilst access is easier.
46. Provision shall also be made for the repair of handling damage to the coating after installation/assembly/erection/scaffolding removal. Spot repairs shall reinstate each of the previous coats and shall commence directly after the localised surface preparation.
47. All immersed surfaces shall be pinhole tested (only after completion of all handling, moving, equipment and scaffolding removal) to ensure the coating is pinhole free and if required additional repairs shall be performed and once cured then the repair areas shall be retested. The process to be repeated until a pinhole free coating is achieved.
48. After completion of the coating activities sufficient curing time of the coating system shall be given prior to immersion as per the requirements of the Product Data Sheet. Accelerated curing is not permitted. All coated surfaces shall be adequately ventilated until full cure has been achieved. At the end of the curing period and before immersion the full cure of the applied coating shall be verified by the applicator and/or coating manufacturer.

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Safety Requirements and Considerations:

1. During the applications of all coatings/lining, care shall be taken to ensure adequate ventilation and lighting, to allow for good visibility and proper curing of the coatings and to avoid/minimise health and safety risks.
2. A confined spaces (CSs) may be defined as an enclosed, restricted, or limited space in which, because of its construction, location or contents, or any work activity carried on therein, a hazardous substance may accumulate and/or an oxygen-deficient atmosphere may occur, and/or in which a dangerous liquid or dangerous concentration of gas, vapour, dust or fumes may be present. It includes any chamber, tunnel, pipe, pit, sewer, container, valve, pump, sump, chute, bunker, silo, gearbox, tank, receiver, drum or any similar construction, equipment, machinery or object.
3. Flammable Atmospheres: Gases, vapours and dusts can become trapped in CSs and create flammable or explosive atmospheres, and include combustibles e.g. Hydrogen, Acetylene, Paint and thinning/cleaning solvents, etc.
4. Walking / Working Surfaces and Visibility: Poor lighting may add to hazards caused by an irregular, sloped, or constricted working surface.
5. Special care needs to be taken when working with all organic coatings. Prior to the use of any coating material, the Material Safety Data Sheets shall be obtained from the relevant coating manufacturer. The applicator shall be familiar with the contents of these safety data sheets and ensure that the necessary safety precautions are taken in order to comply with local and national safety and health requirements such as the OHS Act.
6. Any solid waste materials or liquids stripped or generated during the coating operations shall be discarded in accordance with the requirements of the appropriate national and/or local authorities or the requirements of Eskom.
7. The applicator shall ensure compliance with all statutory regulations, municipal by-laws, etc. concerning pollution and the health and safety of personnel and/or members of the public who may be affected by the work. The applicator shall provide the personnel with the appropriate required PPE.

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8. The applicator shall provide for all necessary safety precautions and risk assessments.
9. The applicator shall advise Eskom of all hazardous materials to be brought on site.
10. All painting materials on site shall be stored in designated areas in storage facilities that meet the storage requirements of the paint manufacturer and the safety requirements of the specific site. The contractor shall be responsible for the provision of appropriate storage/shipping containers as required. These containers shall include the appropriate refrigeration/conditioning systems for temperature control. This requirement shall be dependent on where the container will be located (indoors/outdoors), typical ambient temperature for the particular season of the year and the maximum storage temperature limits as per the manufacturers recommendations.
11. The applicator's Safety File for the area to be worked it shall address all the hazardous activities of abrasive blast cleaning and spray painting. The applicator shall verify that the personnel carrying out these activities are suitably qualified.
12. The applicator shall ensure that the abrasive materials used conform to all National Health and Safety Standards.

Specifically with respect to CSs and based on the descriptions and definitions of safety risks as per the above points it is imperative that the contractor's/applicator's Method Statement shall describe in detail, the measures and mitigation steps for the risks and hazards as identified in this specification sheet. It is compulsory that these safety risks/mitigation measures and any others as identified by the contractor/applicator be included in the Method Statement. Prior to the commencement of any work the Method Statement shall be submitted for review, acceptance/rejection by the respective Kriel Power Station Risk and Safety office/department.

Pre-job Method Statement and Quality Documentation review and acceptance:

1. The coating manufacturer/applicator shall supply individual product data sheets for all products, comprising the system which shall contain the following as a minimum:
 - A description of the generic type of paint.

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- Confirmation that the coating is suitable for the intended method of application.
- Recommended and non-recommended uses.
- **Maximum recommended service temperature which shall be a minimum of 30% greater than the maximum temperatures** as is indicated in the table at the top of this specification sheet. The coating rating shall consider the above temperatures as continuous service i.e. not intermittently.
- Chemical resistance limits.
- Surface preparation.
- Application conditions and details including but not limited to: application temperatures, dilutions, pot-life, application techniques and DFT for the particular application method, over-coating intervals, and curing times required before immersion.

2. A detailed Method Statement explaining all required steps as specified in this specification sheet shall be provided at the time of tender. The steps to be considered includes:

- The methods, steps, sequence and equipment required for ventilation and dust mitigation.
- Grease decontamination and washing.
- Soluble salt decontamination.
- The parameter setup for blasting and coating techniques i.e. conventional airless spray, dual/plural spray, flow coating, pigging etc. shall also be included in the Method Statement.
- Methods for dust and debris removal, maintaining and ensuring cleanliness between coats shall be described.
- The Method Statement shall detail the precise sequence and breakdown of work areas/activities in order to apply the system with due consideration of dust contamination, and possible overspray onto adjacent surfaces still requiring additional coats.

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- The Method Statement shall also consider the most efficient methods and sequencing to avoid unnecessary delays between coats that may have an impact i.e. time required for removal of spent abrasive grit and dust/debris, delay due to material handling, time required to handle, rig and move the component etc.
 - All inspection interventions during and after completion of final coats shall be considered and included.
 - Specifically for confined spaces i.e. CW ducts, condenser water boxes, etc., the Method Statement shall describe all measures and details for establishing and maintaining:
 - ✓ The environmental conditions as required by this specification.
 - ✓ The required ventilation for the prevention and/or management of fumes and dust build-up. The number of extraction fans; mounting diameters, sizes and mounting methods of fans to manholes; power rating of fans; positioning of fans and direction of intended air flow shall be described and detailed.
3. The detailed Method Statement shall be submitted to Eskom for review and acceptance/rejection prior to the commencement of any work. Eskom reserves the right to request further revision, clarification or additions in accordance with or as required by this specification sheet.
4. The applicator shall submit a detailed, project specific QCP. The QCP shall be based on the detailed Method Statement and shall contain all intervention points and relevant acceptance criteria as per the information as described in the Product Data Sheet/s and this specification sheet. Eskom reserves the right to request further revision, clarification or additions in accordance with or as required by this specification sheet.
5. Under no circumstances shall any work be performed until the QCP and Method Statement have been accepted by the Eskom engineer.

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Reference Documents:

The following list of references shall apply in addition to the requirements of 240-101712128 and this specification sheet (GE/MAT/24/047). The latest revision of the referenced standards shall apply. Where conflict exists between any of these documents the more stringent requirement shall apply.

1. 240-101712128: Standard for the internal corrosion protection of water systems, Chemical Tanks and Vessels and Associated Piping with Coatings.
2. ISO 9001: Quality Management Systems - "is defined as the international standard that specifies requirements for a quality management system (QMS). Organizations use the standard to demonstrate the ability to consistently provide products and services that meet customer and regulatory requirements."
3. ASTM D4414: Standard practice for measurement of wet film DFT by notch gauges.
4. ASTM D4541: Standard Method for Pull-off Strength of Coatings using Portable Adhesion Testers.
5. ASTM D5162: Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates.
6. ASTM E376: Measuring coating DFT by magnetic field or eddy current electro-magnetic test Methods.
7. ASTM F21: Standard Test Method for Hydrophobic Surface Films by the Atomizer Test.
8. ISO 2409: Paints and varnishes – Cross cut test.
9. ISO 4624: Paints and varnishes – Pull-off test for adhesion.
10. ISO 4628 – 1: Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 1: General introduction and designation system.
11. ISO 4628 – 3: Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 3: Assessment of degree of rusting.

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12. ISO 8501-1: Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
13. ISO 8502-3: Preparation of steel substrates before application of paint and related products – Test for the assessment of surface cleanliness – Part 3: Assessment of dust on steel surfaces prepared for painting (pressure sensitive tape method).
14. ISO 8502-6: Preparation of steel substrates before application of paint and related products – Test for the assessment of surface cleanliness – Part 6: Extraction of soluble contaminants for analysis – The Bresle method.
15. ISO 8503-4: Preparation of steel substrates before application of paint and related products – Surface roughness characteristics of blast-cleaned steel substrates-
Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile – Stylus instrument procedure. (May be used as an alternative to (SANS 5772).
16. ISO 12944-3: Paint and varnishes – Corrosion protection of steel structures by protective paint systems. Part 3: Design considerations.
17. ISO 9223: Corrosion of metal and alloys – Corrosivity of atmospheres – Classification.
18. SANS 10064: The preparation of steel surfaces for coating.
19. SANS / ISO 2808: Paints and Varnishes: Determination of film DFTs (Can be used as alternative to (ASTM E376).
20. SANS 5770: Preparation of steel substrates before the application of paints and related products – Test for the assessment of cleanliness of blast-cleaned steel surface – Freedom from certain soluble salts.

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21. SANS 5772: Preparation of steel substrates before the application of paints and related products – Surface roughness characteristics of blast-cleaned steel surfaces – Profile of blast-cleaned surfaces determined by a micrometer profile gauge (Can be used as alternative to ISO 8503-4).
22. SIS 055900: Swedish Code of Practice - Pictorial surface preparation standard for painted steel surfaces. (Can be used as alternative to ISO 8501 – 1).

Submitted by: 	Accepted by: 
Name: [REDACTED] Title: Senior Consultant Date: 8 July 2024	Name: [REDACTED] Title: Senior Advisor Date: 8 July 2024

**GE/MAT/24/048: Protective Coating Specification (by organic coatings) for Kriel
Power Station – Condenser Tubesheets**

To be considered as Annexure D of 240-101712128: Specifications for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Coatings	
Vessels	Condenser Tubesheets
<u>Internal Immersed</u> (Material/Substrate)	Tubesheets: Austenitic Stainless steel cladding or Muntz metal with galvanically incompatible tubing i.e., duplex stainless steel, super ferritic stainless steel, admiralty brass or titanium.
<u>Internal Immersed</u> (Environment)	<ul style="list-style-type: none"> • Operating Temperature: 45°C – 65°C • Flow rates of up to 2 metres per second. • pH: 8 to 8.6 • Medium: Raw or Cooling Water (CW) • Conductivity (K) < 4000 µS • Chloride < 400 mg.kg⁻¹ as Cl • Sodium < 500 mg.kg⁻¹ as Na • Sulphate < 1000 mg.kg⁻¹ • Calcium Carbonate Precipitate Potential (CCPP) 80 to 160mg.kg⁻¹ as CaCO₃
<u>Step 1</u> <u>High Pressure Water</u> <u>Washing</u>	All tubesheets and protruding tube surfaces shall be high pressure water washed to remove salt and other loose contaminants. Greases, lubricants etc. shall be removed during washing by including the use of a suitable degreaser/detergent. Ensure thorough rinsing with clean potable water followed by complete drying, in particular the interface of tubes and tubesheets, as far as practically possible.
<u>Step 2</u> <u>Plugging of</u> <u>Condenser Tubes</u>	In order to avoid damage as well as contamination of the internal surfaces of the condenser tubes, the tubes shall be temporarily plugged by a means that will provide adequate protection to unwanted abrasive blasting of the tube internal inlet surfaces.

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<p style="text-align: center;"><u>Step 3</u> <u>Surface Preparation</u></p>	<p>Remove all traces of corrosion product, scale and other foreign matter by abrasive blast cleaning to Grade Sa 3 (ISO 8501-1) – clean, bright metal. Surface profile as specified by the coating manufacturer.</p> <p>Abrasive material to be selected such that the surfaces are suitably profiled to ensure a good bond between coating and base metal. Remove all temporary plugs prior to final dust removal. In terms of final surface preparation and cleanliness refer to “General Requirement” below specifically for time duration between dust removal and application of the primer or first coat.</p>
<p style="text-align: center;"><u>Step 4</u> <u>Plugging of</u> <u>Condenser Tubes</u></p>	<p>In order to avoid inadvertent introduction of paint to the internal surfaces of the condenser tubes, the tubes shall be temporarily plugged by a means that allows easy removal once the coating has been applied. It is extremely important that the material used for protecting the internal surfaces of the tubes from paint ingress be removed prior to curing of the coating to avoid the temporary plugs permanently being stuck in the tube/s. Any build-up of paint inside the tubes will have to be removed prior to final acceptance of the work.</p>
<p style="text-align: center;"><u>Step 5</u> <u>Application of</u> <u>Primer (Optional)</u></p>	<p>Apply by brush, one coat – Two Component Solvent Free Amine Cured Epoxy primer.</p> <p>Dry film thickness from 50 to 75 microns</p>
<p style="text-align: center;"><u>Step 6</u> <u>Plugging of</u> <u>Condenser Tubes</u></p>	<p>Remove all temporary plugs before complete curing of the primer. Once the primer coat has cured sufficiently as per the manufacturer’s recommendation install a new set of temporary plugs for the next coating step.</p>

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<p align="center"><u>Step 7</u> <u>Application of First Coat</u></p>	<p>After allowing sufficient time for the primer coat to cure, the manufacturer's recommendations shall be strictly adhered to in this regard, apply by brush, one coat – Two Component Solvent Free Amine Cured Epoxy.</p> <p>Dry film thickness from 250 to 300 microns</p>
<p align="center"><u>Step 8</u> <u>Plugging of Condenser Tubes</u></p>	<p>Remove all temporary plugs before complete curing of the coating in Step 7 above. Once the coating in Step 7 above has cured sufficiently install a new set of temporary plugs for the next coating step.</p>
<p align="center"><u>Step 9</u> <u>Application of second coat</u></p>	<p>After allowing sufficient time for the coating in Step 7 to cure, the manufacturer's recommendations shall be strictly adhered to in this regard, apply by brush, one coat – Two Component Solvent Free Amine Cured Epoxy.</p> <p>Dry film thickness from 250 to 300 microns</p> <p>Total dry film thickness of the coating system: from 500 to 600 microns excluding primer,</p>
<p align="center"><u>Step 10</u> <u>Plugging of Condenser Tubes</u></p>	<p>Remove all temporary plugs before complete curing of the coating in Step 9 above.</p>
<p align="center"><u>Step 11</u> <u>Sealing of Tube sheet/Water Box Interface Areas</u></p>	<p>A combination of a viscous and permanently elastic mastic system (tape/bandage and paste form) may be used for sealing of the tubesheet/waterbox interface. The requirement is that the product does not cure or dry out - is permanently flexible and surface tolerant and easy to apply (no special skills needed).</p>

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<p align="center"><u>Step 12</u> <u>Coating Inspection</u></p>	<p>Since the close arrangement of the tubes precludes any holiday detection testing of the surfaces, all surfaces (especially at the tube/tubesheet interface) shall be thoroughly visually inspected to identify any areas where the coating is discontinuous or unclosed. At the end of the curing period the full cure of the applied coating shall be verified by the applicator and/or coating manufacturer.</p> <p>Any faults located shall be marked up and repaired to Eskom's satisfaction.</p>
<p align="center"><u>Final DFT's as estimated/correlated with "Wet Film" comb monitoring.</u></p>	<p>Two component solvent free amine cured epoxy coating 2 coats @ 300 micron per coat.</p> <p>Total dry film thickness of the coating system: from 550 to 675 micron (with the use of a primer).</p> <p>Total dry film thickness of the coating system: from 500 to 600 micron (without the use of a primer).</p>
<p align="center">With respect to aspects not mentioned in the above coating specification table (e.g., mixing ratios, pot life, straining, thinning, induction times, over-coating and curing times), the manufacturer's recommendations shall be strictly adhered to.</p>	
<p align="center">This specification sheet is applicable to the application of protective coating to the entire tubesheet surface with specific emphasis of ensuring continuous coating of the interface surfaces between the tubesheet and onto the protruding section of tubing.</p>	

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Specific Project Requirements

1. A detailed visual inspection shall be carried out by the Eskom engineer to identify tube ends that may require re-flaring, mark-up of tubesheet surfaces that need to be repaired/reinstated OR completely coated/recoated. Final/finishing surface preparation to Grade Sa 3 (ISO 8501-1) followed by primer application shall only proceed once all mechanical work is completed. This requirement shall be strictly adhered to. The Contractor shall be wholly responsible for the decision-making to continue with final/finishing surface preparation and primer application.
2. Eskom will instruct the applicator whether to perform patch repairs of the coating or complete recoating.
3. Care should be taken when re-flaring the damaged condenser tubes as incorrect flaring can lead to cracking of the tubes. Prior to any work the Contractor shall successfully demonstrate the ability to re-flare condenser tubes.
4. At all times care shall be taken to ensure adequate protection of any surfaces and parts of components or systems not requiring blast cleaning and coating (as an example valve seats/trim, pump inlets, tube internal surfaces) and every effort shall be taken to prevent grit, water and other dirt entering drain systems, tank/vessel inlet/outlet piping or settling on isolating valves seats, shafts etc.
5. All materials, i.e., paint, solvents and cleaning agents for a specific paint system shall be supplied by the same manufacturer. The solvents used shall be those recommended and manufactured by the paint manufacturer. Where the recommended 'solvent' and 'clean-up thinners' for a material differs, the 'clean-up' solvent must not be added to the paint for dilution purposes.
6. The tubesheet substrate shall be tested for chloride contamination in accordance with (ISO 8502-6).

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7. For soluble salts, testing shall be performed by the Bresle soluble salt test method. If not within acceptable limits (as per the manufacturer requirement but not exceeding 100 mg/m²), the surfaces shall be washed/decontaminated by High Pressure (HP) water washing using fresh/clean water (with a conductivity reading of maximum 100 µS/cm) at a minimum pressure of 300 bar. A salt decontamination chemical additive with demonstrated capability of removing salts may be used in conjunction with HP cleaning.
8. Testing shall be repeated on representative test patches which shall be blast cleaned to Grade Sa 3 (ISO 8501-1). If acceptable then proceed with blasting and application steps – if not, then repeat HP washing until the salt contamination has been removed to within acceptable limits.
9. Prior to any surface preparation all surfaces that are, or are likely to be contaminated with oil or grease as a result of the tube flaring process shall be solvent cleaned with a suitable water-soluble biodegradable alkaline cleaner/detergent or with appropriate organic solvents.
10. Cleaning may be performed by using rags for small areas, or a spray gun for large areas. The detergent/solvent-cleaned surfaces shall then be thoroughly washed down with fresh/clean water ensuring that the oil-water emulsion formed is completely removed from the metal.
11. Degreased and water washed surfaces shall be checked for residual oil and grease using the atomized water spray test as per (ASTM F21) and further degreasing shall be carried out if residual oil or grease is found to be present.
12. A black light test shall be used to check for oil contamination. Zero oil and grease contamination are the acceptable limit. Washing with fresh/clean water containing a suitable degreasing agent of partially painted components shall take place between coats, if surfaces are found to be contaminated.
13. Surface preparation by abrasive blasting shall be performed by means of conventional handheld blasting equipment capable of removing mill scale, old coating, rust and suitably preparing the substrate to the required cleanliness of Grade Sa 3 and then followed by coating application by brush.

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14. Removal of dust and debris shall be performed by vacuuming. The process shall be repeated until the required level of dust and debris removal is achieved.
15. The level of cleanliness required shall be less than “dust quality rating” 1 when tested in accordance with (ISO 8502-3).

General Requirements:

1. The applicator shall be wholly responsible for the surface preparation and coating application. The coated surfaces shall meet the DFT as required by this specification sheet and aspects thereof in referenced documents.
2. Power and hand tool cleaning is only applicable to very localised touch ups or patch repairs. Specific requirements for patch repairing a coating system are defined in section 4.8.6 of 240-101712128. Hand-tool cleaning for isolated/localised areas may be utilised provided the required standard of finish is achieved. For all immersion applications final mechanical cleaning shall be by bristle blaster to create a required surface profile.
3. Bristle blasting is only to be used for small areas and conventional grit blasting shall be used for large areas. Conventional blasting provides a more angular anchor pattern compared to bristle blasting. Small areas are considered to be the equivalent of a A4 sheet, 0.05 m², approximately 25 cm x 25 cm. Bristle blasting shall not be confused with the use of a needle gun. A needle gun provides a peened surface and is not a suitable profiled surface.
4. Different grades and types of blasting media exist. It is important that the correct abrasive be used in combination with a specific coating system to achieve the specified surface profile. The required blast profile height should be carefully considered. The applicator shall select an appropriate abrasive type and mesh size to attain the specified surface profile.

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5. Only inert mineral grit or steel grit abrasives shall be used. Steel grit is preferred in sensitive plant areas such as Water Treatment Plants in order to ensure no contamination of plant processes due to excessive dust. Sand or silica-based abrasives shall not be used. Abrasive material for blast cleaning shall be used in line with local environmental regulations.
6. The abrasive shall be used in accordance with the manufacturer's specifications and shall be clean, sound, hard particles free from foreign substances such as dirt, oil, grease, toxic substances, organic matter and water-soluble salts.
7. It is important that good quality abrasives are used in order to minimize the amount of waste grit and dust generated and contamination of the surfaces. The use of re-cycled blasting media for the final blast is strictly prohibited.
8. All abrasive media shall be stored in an area that is completely dry, covered and protected from weather.
9. For complete coating removal the requirement for surface preparation of all metallic surfaces for immersion is strictly Grade Sa 3 (ISO 8501-1), in which case the surfaces shall be blast cleaned to a bright metallic finish where all traces of rust, mill scale and other foreign matter are removed.
10. All compressed air for blasting activities shall be free from entrained moisture and oil. All traps shall be in a functional condition. The compressed air shall be tested at regular intervals using clean white clothes to assess cleanliness and dryness. This requirement shall be included in the QCP.
11. After surface preparation, all dust, grit blasting media or any other deleterious matter shall be removed from the surfaces by vacuuming. The process shall be repeated until the required level of dust and debris removal is achieved. It is imperative that all surface dirt and contaminants (such as oil, grease, rust, or other deposits) are completely removed before coating or the adhesion of the coating shall be impaired.
12. Immediately before coating, blast cleaned steel shall not exhibit more than "dust quantity rating" 1 when tested in accordance with (ISO 8502-3).

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13. The applicator shall ensure that during surface preparation and coating activities the relative humidity is less than 60% RH. Ambient temperatures shall be between 5°C and 30°C or as per the manufacturer recommendations, whichever is the more stringent.
14. The maximum/minimum substrate temperature at the time of coating application shall be strictly in accordance with the product data sheet. Environmental parameters shall be measured and recorded at least 4 times per shift. All measurements shall be recorded at the tubesheet surface. Dew point requirements shall be as per the Product Datasheet or 240-101712128.
15. During periods of inclement or cold weather conditions the environmental parameters shall be measured and recorded hourly, by the Contractor. In the event that the latest two readings of any of the parameters indicate a deteriorating trend which would likely exceed parameter/s limit then no final surface preparation or spray application shall be permitted. Dew point requirements shall be as per the Product Datasheet and 240-101712128. Should the Contractor opt to continue final surface preparation and coating application during which time environmental parameters are exceeded then the Contractor shall be wholly responsible for any and all rectification/remedial and rework activities.
16. For all inspections of all surface preparation and coating activities the surfaces shall be clean allowing unhindered visual access to the surface. The applicator shall provide sufficient and adequate lighting (Cool White) to enable inspections. Cell phone lighting is not acceptable.
17. In order to avoid recontamination and flash rusting of the surfaces, the primer or first coat shall be applied within 4 hours after final surface preparation of the steel surfaces. Under no circumstances shall the blast be permitted to stand overnight.
18. Many modern organic coatings can be applied without the use of a primer. However, should a primer coat be required for holding of the blast, or otherwise, the applicator shall indicate/describe the reasoning for the need of such a primer i.e., as a holding primer or as a means of enhancing adhesion of the system.

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19. Details shall be provided in the Method Statement for the type of primer, generic resin, solvent borne or free, maximum DFT and compatibility with subsequent coats. The detailed Method Statement shall be submitted and reviewed by Eskom for acceptance/rejection prior to any work. Ultimately, the applicator shall be responsible for any risk that could arise or be attributed to this choice.
20. It is not possible to measure DFT's due to the area/surface/tube protrusion. The coating spray operator shall be equipped with a "wet comb" and frequently monitor the wet film thickness to ensure DFT requirements in the table above in this specification sheet are achieved.
21. Multiple coats shall be applied as per the table at the top of this specification sheet. Single coat systems are not permissible.
22. Where more than one coat is applied, the colour of each coat shall be different from the previous coat.
23. Where the coating has completely cured or allowed to age before finishing, before application of a subsequent coat the surface shall be prepared by light abrasion, scrubbing with potable water using a bristle brush and drying before over-coating.
24. Application of subsequent coats shall be in accordance with the specified system. The required over-coating intervals as mentioned in the latest Product Data Sheet shall be observed and adhered to.
25. The coating shall be evenly applied to form a smooth, continuous, unbroken layer free from misses, sags, runs, tears and other defects that could affect the integrity of the coating.
26. After completion of the coating activities sufficient curing time of the coating system shall be given prior to immersion as per the requirements of the Product Data Sheet. Accelerated curing is not permitted. All coated surfaces shall be adequately ventilated until full cure has been achieved. At the end of the curing period and before immersion the full cure of the applied coating shall be verified by the applicator and/or coating manufacturer.

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Safety Requirements and Considerations:

1. During the applications of all coatings/lining, care shall be taken to ensure adequate ventilation and lighting, to allow for good visibility and proper curing of the coatings and to avoid/minimise health and safety risks.
2. A confined spaces (CSs) may be defined as an enclosed, restricted, or limited space in which, because of its construction, location or contents, or any work activity carried on therein, a hazardous substance may accumulate and/or an oxygen-deficient atmosphere may occur, and/or in which a dangerous liquid or dangerous concentration of gas, vapour, dust, or fumes may be present. It includes any chamber, tunnel, pipe, pit, sewer, container, valve, pump, sump, chute, bunker, silo, gearbox, tank, receiver, drum or any similar construction, equipment, machinery or object.
3. Flammable Atmospheres: Gases, vapours and dusts can become trapped in CSs and create flammable or explosive atmospheres, and include combustibles e.g., Hydrogen, Acetylene, Paint and thinning/cleaning solvents, etc.
4. Walking / Working Surfaces and Visibility: Poor lighting may add to hazards caused by an irregular, sloped, or constricted working surface.
5. Special care needs to be taken when working with all organic coatings. Prior to the use of any coating material, the Material Safety Data Sheets shall be obtained from the relevant coating manufacturer. The applicator shall be familiar with the contents of these safety data sheets and ensure that the necessary safety precautions are taken in order to comply with local and national safety and health requirements such as the OHS Act.
6. Any solid waste materials or liquids stripped or generated during the coating operations shall be discarded in accordance with the requirements of the appropriate national and/or local authorities or the requirements of Eskom.
7. The applicator shall ensure compliance with all statutory regulations, municipal by-laws, etc. concerning pollution and the health and safety of personnel and/or members of the public who may be affected by the work. The applicator shall provide the personnel with the appropriate required PPE.

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8. The applicator shall provide for all necessary safety precautions and risk assessments.
9. The applicator shall advise Eskom of all hazardous materials to be brought on site.
10. All painting materials on site shall be stored in designated areas in storage facilities that meet the storage requirements of the paint manufacturer and the safety requirements of the specific site. The contractor shall be responsible for the provision of appropriate storage/shipping containers as required. These containers shall include the appropriate refrigeration/conditioning systems for temperature control. This requirement shall be dependent on where the container will be located (indoors/outdoors), typical ambient temperature for the particular season of the year and the maximum storage temperature limits as per the manufacturer's recommendations.
11. The applicator's Safety File for the area to be worked it shall address all the hazardous activities of abrasive blast cleaning and spray painting. The applicator shall verify that the personnel carrying out these activities are suitably qualified.
12. The applicator shall ensure that the abrasive materials used conform to all National Health and Safety Standards.

Specifically with respect to CSs and based on the descriptions and definitions of safety risks as per the above points it is imperative that the contractor's/applicator's Method Statement shall describe in detail, the measures and mitigation steps for the risks and hazards as identified in this specification sheet. It is compulsory that these safety risks/mitigation measures and any others as identified by the contractor/applicator be included in the Method Statement. Prior to the commencement of any work the Method Statement shall be submitted for review, acceptance/rejection by the respective Kriel Power Station Risk and Safety office/department.

Pre-job Method Statement and Quality Documentation review and acceptance:

1. The coating manufacturer/applicator shall supply individual product data sheets for all products, comprising the system which shall contain the following as a minimum:
 - A description of the generic type of paint.

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- Confirmation that the coating is suitable for the intended method of application.
- Recommended and non-recommended uses.
- **Maximum recommended service temperature which shall be a minimum of 30% greater than the maximum temperatures** as is indicated in the table at the top of this specification sheet. The coating rating shall consider the above temperatures as continuous service i.e., not intermittently.
- Chemical resistance limits.
- Surface preparation.
- Application conditions and details including but not limited to: application temperatures, dilutions, pot-life, application techniques and DFT for the particular application method, over-coating intervals, and curing times required before immersion.

2. A detailed Method Statement explaining all required steps as specified in this specification sheet shall be provided at the time of tender. The steps to be considered includes:

- The methods, steps, sequence and equipment required for ventilation and dust mitigation.
- Grease decontamination and washing.
- Soluble salt decontamination.
- The parameter setup for blasting and coating techniques i.e., sweep blasting and coating by brush, shall also be included in the Method Statement.
- Methods for dust and debris removal, maintaining and ensuring cleanliness between coats shall be described.
- The Method Statement shall detail the precise sequence and breakdown of work areas/activities in order to apply the system with due consideration of dust contamination onto adjacent surfaces still requiring additional coats.

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- The Method Statement shall also consider the most efficient methods and sequencing to avoid unnecessary delays between coats that may have an impact i.e., time required for removal of spent abrasive grit and dust/debris, delay due to material handling, time required to handle, rig and move the component etc.
 - All inspection interventions during and after completion of final coats shall be considered and included.
 - Specifically for confined spaces i.e., condenser water boxes, the Method Statement shall describe all measures and details for establishing and maintaining:
 - ✓ The environmental conditions as required by this specification.
 - ✓ The required ventilation for the prevention and/or management of fumes and dust build-up. The number of extraction fans; mounting diameters, sizes and mounting methods of fans to manholes; power rating of fans; positioning of fans and direction of intended air flow shall be described and detailed.
3. The detailed Method Statement shall be submitted to Eskom for review and acceptance/rejection prior to the commencement of any work. Eskom reserves the right to request further revision, clarification or additions in accordance with or as required by this specification sheet.
4. The applicator shall submit a detailed, project specific QCP. The QCP shall be based on the detailed Method Statement and shall contain all intervention points and relevant acceptance criteria as per the information as described in the Product Data Sheet/s and this specification sheet. Eskom reserves the right to request further revision, clarification or additions in accordance with or as required by this specification sheet.
5. Under no circumstances shall any work be performed until the QCP and Method Statement have been accepted by the Eskom engineer.

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Reference Documents:

The following list of references shall apply in addition to the requirements of 240-101712128 and this specification sheet (GE/MAT/24/048). The latest revision of the referenced standards shall apply. Where conflict exists between any of these documents the more stringent requirement shall apply.

1. 240-101712128: Standard for the internal corrosion protection of water systems, Chemical Tanks and Vessels and Associated Piping with Coatings.
2. ISO 9001: Quality Management Systems - "is defined as the international standard that specifies requirements for a quality management system (QMS). Organizations use the standard to demonstrate the ability to consistently provide products and services that meet customer and regulatory requirements."
3. ASTM D4414: Standard practice for measurement of wet film DFT by notch gauges.
4. ASTM F21: Standard Test Method for Hydrophobic Surface Films by the Atomizer Test.
5. ISO 2409: Paints and varnishes – Cross cut test.
6. ISO 4628 – 1: Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 1: General introduction and designation system.
7. ISO 4628 – 3: Paints and varnishes – Evaluation of degradation of coatings – Designation of quantity and size of defects, and of intensity of uniform changes in appearance – Part 3: Assessment of degree of rusting.
8. ISO 8501-1: Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
9. ISO 8502-3: Preparation of steel substrates before application of paint and related products – Test for the assessment of surface cleanliness – Part 3: Assessment of dust on steel surfaces prepared for painting (pressure sensitive tape method).

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10. ISO 8502-6: Preparation of steel substrates before application of paint and related products – Test for the assessment of surface cleanliness – Part 6: Extraction of soluble contaminants for analysis – The Bresle method.
11. ISO 8503-4: Preparation of steel substrates before application of paint and related products – Surface roughness characteristics of blast-cleaned steel substrates.
12. Part 4: Method for the calibration of ISO surface profile comparators and for the determination of surface profile – Stylus instrument procedure. (May be used as an alternative to (SANS 5772).
13. ISO 12944-3: Paint and varnishes – Corrosion protection of steel structures by protective paint systems. Part 3: Design considerations.
14. SANS 5770: Preparation of steel substrates before the application of paints and related products – Test for the assessment of cleanliness of blast-cleaned steel surface – Freedom from certain soluble salts.
15. SANS 5772: Preparation of steel substrates before the application of paints and related products – Surface roughness characteristics of blast-cleaned steel surfaces – Profile of blast-cleaned surfaces determined by a micrometer profile gauge (Can be used as alternative to ISO 8503-4).
16. SIS 055900: Swedish Code of Practice - Pictorial surface preparation standard for painted steel surfaces. (Can be used as alternative to ISO 8501 – 1).

<p>Submitted by:</p>  <p>.....</p>	<p>Accepted by:</p>  <p>.....</p>
<p>Name: XXXXXXXXXX</p> <p>Title: Senior Consultant</p> <p>Date: 8 July 2024</p>	<p>Name: XXXXXXXXXX</p> <p>Title: Senior Advisor</p> <p>Date: 8 July 2024</p>