Eskom	Scope of work	Duvha Power Station

Title: **Main Turbine Condenser Acid Cleaning**

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.....	.....	.....
W Huyser	**K Nzimande**	**T Madonsela**
Senior Engineer	**Turbine Engineering Manager**	**Engineering Manager**
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1. INTRODUCTION

Due to severe scaling inside the main turbine condenser tubes at Duvha power station a decision was made to acid clean the condenser cooling water side to ensure sufficient heat transfer.

1.1 SCOPE

This scope entails the acid cleaning of the main turbine condenser tubes at Duvha power station as well as preparation for the activity such as coating of tubesheets, waterboxes and once off supply of CW spades/Blank flanges. The intent of this contract is to run over an extended period, similar as a maintenance contract, to do acid cleaning on Duvha power station as and when required. Please refer to the NEC contract data for details.

1.2 APPLICABILITY

This document shall apply to Duvha 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] 240-162132332 Tender Technical Evaluation Strategy – Condenser acid cleaning

[4] 240-107677940 Specification Standard for High Pressure water jetting of Condenser and Heat Exchanger Tubes Rev 2

1.4 DRAWINGS

[5] 0.57-244 Condenser water boxes

[6] 0.57-581 Tube bundle side view

[7] CC left inlet

[8] CC right inlet

[9] HC left outlet

[10] HC left outlet

1.5 DISCLOSURE CLASSIFICATION

Public domain: published in any public forum without constraints (either enforced by law, or discretionary).

2. SCOPE OF WORK

2.1 DUVHA CONDENSER INFORMATION

TECHNICAL DATA

Height	
Overall	10300 mm
Neck	5450 mm
Shell	4850 mm
Length	
Overall (between waterbox centres)	24600 mm
Cold condenser	12000 mm
Hot condenser	12600 mm
Tube length	
Cold condenser	9995 mm
Hot condenser	10925 mm
Tube outer diameter	19 mm
Tube wall thickness	1 mm
Tube volume	103 m^3
Number of tubes	
Cold condenser	22552
Hot condenser	23730
Condensing surface	
Cold condenser	13364 m^2
Hot condenser	15384 m^2

Tube test pressure	0.3 MPa (g)
Tube design pressure	0.25 MPa (g)
Tube temperature	40°C
Weight of tubes	
Cold condenser	108200 Kg
Hot condenser	124500 Kg
Cooling water system details	
Inlet/outlet pipe bore diameter	1600 mm
Cooling water flow	10.231 m^3/s
Supply temperature	22°C
Temperature increase across	
Hot Condenser	8.75°C
Cold condenser	8.75°C
Number of passes	
Cold condenser	1
Hot condenser	1
Water velocity in tubes	
Cold condenser	2 m/s
Hot condenser	1.9 m/s
Steam flow	168.73 Kg/s
By-pass steam flow (maximum)	125 Kg/s
Shell volume (Steam space)	
Cold condenser	640 m^3
Hot condenser	680 m^3
Shell design temperature	100°C
Shell test pressure	0.3 MPa (g)
Material	

Tube material	
Unit 1	Admiralty brass & Copper Nickel. Full length coated on internal surface)
Unit 2	Admiralty brass & Copper Nickel
Unit 4	Admiralty brass & Copper Nickel
Unit 5	Admiralty brass, Copper Nickel and Titanium
Unit 6	Admiralty brass & Copper Nickel
Tubesheets	BS 1501 – 151 Gr 23A cladded with Stainless steel AISI 304
Corrosion protection	
Waterboxes	Coated/some might be rubber lined
Tubesheet coating	
Unit 1	Coated in 2011
Remaining units	None

2.1 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. The *Employer* shall also install spading on the inlet and outlet waterboxes to prevent acid in the CW ducting and valves as well as the tube cleaning system strainers.
3. 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 acid cleaning.

4. 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.
5. The *Contractor* to take note that this work shall happen during outages. The *Contractor* shall attend daily outage meetings to be aware of other activities happening on the plant.
6. It is the responsibility of the *Contractor* to familiarize him/her self with the layout of the plant and the area of where the condenser is relative to the turbine hall.
7. If compressed air is required, the contractor shall provide dedicated compressors.
8. Only unit 5 Cold condenser has Titanium tubes installed in the second air cooling zone (252 tubes). On this unit the *Contractor* shall plug the titanium tubes and clean the remainder of the condenser with chemical as mentioned in section 2.1.2. The titanium tubes shall be cleaned using HPWJ as described in [4]. The

2.1.1 COATING REQUIREMENTS

1. Refer to Appendix A: Tubesheet coating and Appendix B: Condenser water box coating for details on the coating specification.
2. Before acid 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. For each condenser this contract shall include a minimum of 80 m^2 of coating. Additional coating of the waterboxes shall be priced per m^2. Only unit 1 tubesheets are coated and the condition thereof is uncertain. The contract shall therefore include tubesheet coating as part of the tender price.
4. Eskom engineering suspect that there are no rubber lining in the waterboxes. As part of the tender the *Contractor* shall supply a price for removal of the existing rubber lining and coating of the waterboxes.
5. All waterbox sacrificial anodes shall be removed prior to coating of the condenser waterboxes and tubesheets. The anodes shall not be reinstalled after the work has been completed.
6. Inspect the condition of corrosion protective coatings on the waterbox, tubesheet and other surfaces such as stay bars/rods. 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. Patch repairs shall be performed as instructed

by Eskom and with the coating systems as specified in 240-101712128: Standard for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings. All requirements 4.1 to 4.15 of 240-101712128 shall apply.

7. In the case of weld repairs on waterboxes or tubesheets the *Employer* shall arrange that the repairs are completed before coating is applied.
8. For coating either recoating or patch repairs, the *Contractor* is required to submit a method statement at the time of tender. The method statement shall explain in sufficient detail all required steps as specified in the above specifications. The steps to be considered includes surface preparation, dust and debris removal, system application (number of coats, application method, environmental factors, over-coating and curing time), repairs and all inspection interventions during and after completion of all coats.
9. The intermediate waterboxes on Duvha consist of stainless steel stay bars with drain holes/ weeping hole at the bottom of the stay bar. These stay bars shall be coated and the drain holes will be temporary plugged to stop any of the chemical entering the stay bar.
10. The CW gratings inside the inlet and outlet waterboxes shall be coated or patch repaired as necessary.
11. The *Contractor* is required to perform coating repairs due to any mechanical damage after acid cleaning.

2.1.2 ACID CLEANING

1. Fit any necessary temporary connections and blank spades as required by the *Contractor* to allow for proper circulation of the cleaning solvent through all the condenser tubes. In addition to coating above the *Contractor*'s Method statement shall consider flow of cleaning solution through condenser passes. The *Contractor* shall consider his particular pumping capabilities to ensure immersion and circulating flow of cleaning solvent through ALL tubes. The Method statement shall consider venting of air pockets and build-up of gasses.
2. The *Employer* shall fit the condenser support jacks as required.
3. Fill the steam side of the condenser with demineralised quality water to just above the uppermost condenser 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. Filling of the steam side with demineralised quality water is also required during the chemical cleaning process to ensure

dilution of any acid that may escape into the steam side of the condenser due to leaking tubes and ensure that the risk of damage to equipment is minimized.

4. Fill the cooling water side of the condenser 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 water boxes. 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 m^3/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 condenser 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 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 for the particular tube material 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 later 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.

The following specify the specific type/composition of the chemical cleaning solvents to be used for the Duvha copper based alloys (brass and copper nickel).

- Brass & Copper Nickel: ≤ 7.5% Hydrochloric acid (HCl) for calcium carbonate based scale OR HCl with an addition of up to 0.5% Ammonium Bi-fluoride (ABF) where silicate is a significant phase and/or in a continuous layer. Phosphoric acid at a strength of 0.25 to 0.5% is to be added when hydrochloric acid is used as the primary solvent, as it has been found to function as a dezincification inhibitor..

8. 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 condenser 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.

9. Stop circulation and drain the spent solvent to the designated area, usually the ash sump of the appropriate unit. N.B.: All mineral acids must be neutralised with lime at the discharge point.
10. Commence filling and flushing cooling water side of the condenser with potable water or raw water quality until the residual conductivity is less than 100 µS/cm above the potable water conductivity.
11. 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.

12. The *Contractor* shall remove any temporary connections and plugs from the intermediated waterbox stay bars. Spades shall be removed by the *Employer*.
13. Repeat this process (Steps 1 – 12) for any condenser paths that could not be connected into the cleaning path in series.
14. Drain the steam side of the condenser. 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).
15. Perform a high level test and plug any tubes that have developed leaks during the cleaning process.
16. Drain the steam side. If fluorescein was used for the high level test, flush (Step 14) until concentrations of Na < 10ppb.
17. 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. Pressures of >350 Bar should be avoided in the case of full length coated tubing. Experience has indicated that higher pressures could remove tube coating. 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.
18. After HP water washing an endoscope shall be provided by the Contractor that will be used to ensure that all the scaling was removed.
19. At the appropriate time the *Employer* shall remove the condenser jack supports.
20. Inspect the waterbox coating and tubesheet and report any signs of damage and deterioration. Repair any damage to coatings.
21. 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.

2.1.3 BLANK FLANGE SUPPLY

1. This scope shall include the supply of blank flanges/Spades (4 off) to install during the acid cleaning. These flanges shall however remain the property of the *Employer* after the contract expires.

2. It will be the responsibility of the *Employer* to install these flanges even though it shall be supplied by the *Contractor*.
3. The blank flange shall have 2 lifting lugs/attachments for lifting the spade into position. These shall not be thicker than the flange thickness. See figure below.

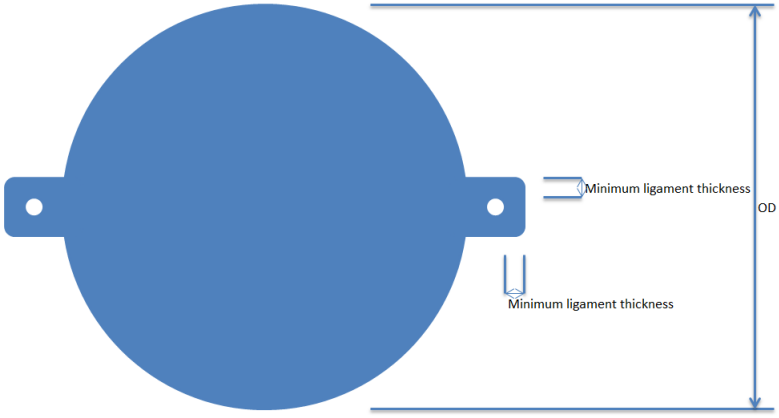

Figure 1: Typical Blank flange

4. Flange details
    a. OD = 1760 mm
    b. Thickness = 12 mm
    c. Material = ASME II SA-516 Gr 70 or BS EN P265GH
    d. Minimum ligament thickness = 20 mm
5. The blank flanges shall fit inside the PCD of the mating flanges
6. Mating flange details
    a. 1600 NB BS 4504 PN 10
    b. Bolt circle = 1820 mm
    c. M45 bolts
7. The blank flanges shall be manufactures from a single sheet of material i.e. no welding will be allowed on the flange except the welding of the lifting lugs.
8. One side of the flange shall be completely covered with a 3 mm rubber gasket to protect against the acid during the cleaning process.

9. The edges of the flange shall be chamfered to reduce the possibility of damaging mating flanges during installation.
10. Material certificates for the plate material shall be supplied.

2.1.4 ROLES AND RESPONSIBILITIES

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

2.2 DOCUMENTATION

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

1. A method statement detailing the acid cleaning process shall be approved by the *Employer* before any work commence.
2. A method statement 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 shall start. Hold points for engineering will be added after each major activity. *Contractor* QC will have hold points for each activity on the QCP.
4. A tube map indicating all tube plugs will be submitted after the final high level test was concluded.
5. Calculation of mass of scale removed per CW pass.

3. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
K Nzimande	Turbine Engineering Manager
H van Niekerk	Senior Consultant
F Mlangeni	System Engineer
N Hallatt	Chief Engineer
N Pheta	Senior Advisor

4. REVISIONS

Date	Rev.	Compiler	Remarks
March 2021	0.1	W Huyser	Initial draft
May 2021	1	W Huyser	First revision

APPENDIX A: TUBESHEET COATING

Tube sheet coatings are applied to tubesheets and tubesheet-to-tube joints that have been damaged by corrosion. The tubesheets can be coated to prevent any further corrosion taking place. Coatings can fail because of: misapplication, physical damage in service or due to scaffolding damage during inspections, cracking due to flexing or movement of the tube sheet during operation. The coating can also be severely damaged due to inadequate protection of the coating during high-pressure water cleaning. If damage occurs to the coating, the area may be subject to selective galvanic attack with potentially catastrophic results. Coating is also done on tubesheet faces after retube to eliminate the galvanic effect between dissimilar tubesheet materials and tube materials and will also prevent dezincification of brass tubesheets.

The Project Engineer shall issue the relevant Eskom Protective Coating Specification with the enquiry document. These documents include 240-101712128: Specification for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings [27] as well as the project specific Corrosion Protection Specification as attached below.

Table 1: Protective coating specification – Condenser Tubesheet Coating

Table to be considered as Annexure D of 240-101712128: "Specification for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings"	
Component/s	Condenser Tubesheets
Internal Immersed (Material/Substrate)	Tubesheets: Austenitic Stainless steel cladding with galvanically incompatible tubing i.e. Admiralty brass and copper nickel or titanium.
Internal Immersed (Environment)	• Operating Temperature: 25°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 160$mg.kg^{-1}$

	as $CaCO_3$
Generic System	• (Optional) Two component Solvent Free Amine Cured Epoxy Primer or as specified by coating manufacturer. • Two component solvent free amine cured epoxy coating 2 coats. • Coating dry film thicknesses in this specification shall be adhered to.
Step 1 <u>High Pressure Water Washing</u>	All tubesheet and protruding tube surfaces shall be high pressure water washed to remove salt and other loose contaminants. Washing may need to be repeated in accordance with requirements of 240-101712128 in order to cater for possible soluble salts. 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.
Step 2 <u>Plugging of 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.
Step 3 <u>Surface Preparation</u>:	Remove all traces of corrosion product, scale and other foreign matter by abrasive blast cleaning to Grade Sa 3 - a bright metal colour. Surface profile as specified by coating manufacturer. 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.
Step 4 <u>Plugging of Condenser Tubes:</u>	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 plug 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.
Step 5 Application of Primer (Optional)	Apply by brush, one coat – Two component Solvent Free Amine Cured Epoxy Primer. Dry film thickness **50 to 75 microns**
Step 6 Plugging of Condenser Tubes:	Remove all temporary plugs before complete curing of the primer. Once the primer coat has cured sufficiently as per manufacturer's recommendation install a new set of temporary plugs for the next coating step.
Step 7 Application of First Coat:	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 Coating. Dry film thickness **250 to 300 microns**
Step 8 Plugging of Condenser Tubes:	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.
Step 9 Application of Second Coat:	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 Coating. The second coat shall be of a different colour than the first coat for easy identification. Dry film thickness **250 to 300 microns** Total dry film thickness of the coating system: **from 500 to 600 microns**
Step 10 Plugging of Condenser Tubes:	Remove all temporary plugs before complete curing of the coating in Step 9 above.

Step 11 Sealing of Tubesheet/Waterbox Interface Areas:	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).
Step 12 Coating Inspection:	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. Any faults located shall be marked up and repaired to Eskom's satisfaction.
Final DFT's as estimated/correlated with "Wet Film" comb monitoring.	Two Component Solvent Free Amine Cured Epoxy Coating 2 coats @ 300 micron per coat Total dry film thickness of the coating system: **from 550 to 675 micron (with the use of a primer).** Total dry film thickness of the coating system: **from 500 to 600 micron (without the use of a primer).**

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.

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.

Specific Project Requirements

1. A detailed visual inspection shall be carried out by the Eskom engineer and contractor to identify tube ends that may require re-flaring, mark-up of tubesheet surfaces that need to be repaired/reinstated OR completely coated/recoated.
2. Care should be taken when re-flaring the damaged condenser tubes as incorrect flaring can lead to cracking of tubes. Prior to any work the Contractor shall successfully demonstrate the ability

to re-flare condenser tubes.

3. Eskom will instruct the applicator whether to perform patch repairs of the coating or complete recoating. Specific requirements for patch repairing a coating system are defined further in this specification sheet and in section 4.8.6 of 240-101712128.
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) 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 method of surface preparation shall be by conventional sweep blasting and coating application by brush.
7. In cases where the existing lining/coating is significantly deteriorated or completely removed and the substrate badly corroded then the substrate shall be tested for chloride contamination, according to ISO 8502-6.
8. 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 100mg/m^2), 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.
9. 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.
10. 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.
11. 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.

12. 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.
13. A black light test shall be used to check for oil contamination. Zero oil and grease contamination is 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.
14. 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.
15. 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.
16. The level of cleanliness required shall be less than “dust quality rating” 2 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 in order to create a required surface profile.
3. Cleaning by means of hand or power-tools, i.e. wire brushes, chipping hammers, scrapers, grinders, sanders, needle descalers, bristle blasters etc. may only be used where accepted by the Eskom engineer and where the position and condition of the substrate metal is such that efficient cleaning can be achieved.
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.

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 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.
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" 2 when tested in accordance with ISO 8502-3.
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.

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.

14. 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.
15. In order to avoid recontamination and flash rusting of the surfaces, the primer or first coat shall be applied within 8 hours after final surface preparation of the steel surfaces. Under no circumstances shall the blast be permitted to stand overnight.
16. 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.
17. It is not possible to measure DFT's due to the area/surface/tube protrusion. The coating applicator 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.
18. Multiple coats shall be applied as per the table at the top of this specification sheet. Single coat systems are not permissible.
19. Where more than one coat is applied, the colour of each coat shall be different from the previous coat.
20. 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.
21. 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.

22. 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.

23. 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.

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.
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 coating. 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 Duvha 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.
   - 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. Prior to the application of any of the corrosion protection systems, the Product Data Sheet/s shall be signed by the manufacturer and applicator. 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.
3. The signed Product Data Sheet/s shall be deemed to be a binding reference document (as part of the QCP). It shall be specific to this project and any further/other subsequent revisions of the Product Data Sheet/s shall be submitted to Eskom for reacceptance clearly stating the variations/deviations. No further use/application of the related product, for this project, is permitted until acceptance is granted by Eskom.
4. 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.

- 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.

5. Given that the single most limiting aspect of working in CSs is access, the Method Statement shall describe and indicate how and where access will be established for (1) personnel, (2) general equipment – buckets, shovels, etc. (3) lighting equipment, (4) blast equipment, (5) grit removal and cleaning etc. in relation to and considering the manhole/access points already used for ventilation purposes.
6. 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.
7. 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.
8. Under no circumstances shall any work be performed until the QCP and Method Statement have been accepted by the Eskom engineer.
9. The coating manufacturer shall provide technical surveys during the execution of the project.

The applicator shall commit to this requirement in the Method Statement.

Reference Documents:

Since the compilation of the Eskom Standards 240-101712128: Standard for the internal corrosion protection of water systems, Chemical Tanks and Vessels and Associated Piping with Coatings there have been changes in terms of the referenced documents i.e. some documents have been withdrawn, replaced or superseded. The following list of references shall apply in addition to the requirements of 240-101712128. 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).
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).

APPENDIX B: CONDENSER WATER BOX COATING

Table 2: Protective coating specification – Condenser Waterboxes

Table to be considered as Annexure D of 240-101712128: "Specification for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings"	
Vessels	Main Condenser Waterboxes
Internal Immersed (Material/Substrate)	Steel/cast iron – previously rubber lined/coated
Internal Immersed (Environment)	• Operating Temperature: 25°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 160$mg.kg^{-1}$ as $CaCO_3$
Internal Immersed (Surface Preparation and coating)	Abrasive blast clean to Grade Sa 3 (ISO 8501-1). The surface profile as specified by the coating manufacturer.
Generic System	Solvent Free Epoxy
First Coat	Apply by brush, one coat Two Component Solvent Free Amine Cured Epoxy coating from **350 - 450 micron.**
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.
Final Coat	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 brush, one coat Two Component Solvent Free Amine Cured

	Epoxy coating from **350 - 450 micron**. **Total System Minimum Dry Film Thickness (DFT) = 700 microns.**

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.

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.

Specific Project Requirements:

1. In the case of any existing rubber lining then the lining shall be completely stripped and removed in preparation for coating.
2. A detailed visual inspection shall be carried out by the Eskom engineer and the contractor to identify and mark-up all areas that need to be repaired/reinstated OR completely coated/recoated. Based on the inspection (section 4.13 of 240-101712128 can assist in providing guidance) Eskom will instruct the applicator whether to perform patch repairs of the coating or complete recoating. Specific requirements for patch repairing a coating system are defined further in this specification sheet and in section 4.8.6 of 240-101712128.
3. The applicator shall take cognisance of the fact that after initial surface preparation as above, Eskom may require access for a further inspection and assessment to determine the need for possible mechanical repairs i.e. welding which will be done by Eskom. Unfortunately, this inspection can only be carried out once the surfaces have been blast cleaned in preparation for coating. 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:
    - 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 (welding repairs will be done by Eskom). 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. 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.

   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.

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 method of surface preparation for the waterbox internal surfaces shall be by conventional hand held equipment.

7. Corrosion Protection shall only proceed once all mechanical activities have been completed and released in terms of the manufacturing/fabrication Quality Control Plan (QCP).

8. In cases of recoating waterboxes where the existing lining/coating significantly deteriorated and the substrate badly corroded then the substrate shall be tested for chloride contamination, 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.

9. 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.

10. 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.

11. 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.
12. 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.
13. The level of cleanliness required shall be less than “dust quality rating” 2 when tested in accordance with ISO 8502-3.
14. 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.

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. Cleaning by means of hand or power-tools, i.e. wire brushes, chipping hammers, scrapers, grinders, sanders, needle descalers, bristle blasters etc. may only be used where accepted by the Eskom engineer and where the position and condition of the substrate metal is such that efficient

cleaning and surface profile can be achieved and where the protective coating system is designed for application to brushed or ground surfaces i.e. specifically formulated surface tolerant coatings.

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.
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.

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. 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. 23. Immediately before coating, blast cleaned steel shall not exhibit more than “dust quantity rating” 2 when tested in accordance with ISO 8502-3 [13].
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. During periods of inclement or cold weather conditions the environmental parameters shall be measured and recorded hourly. 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 coating application shall be permitted. All measurements shall be recorded at the steel surface. Dew point requirements shall be as per the Product Datasheet or 240-101712128.

25. 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.

26. In order to avoid recontamination and flash rusting of the surfaces, the primer or first coat shall be applied within 8 hours after final surface preparation of the steel surfaces. Under no circumstances shall the blast be permitted to stand overnight.

27. 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.

28. The coating applicator shall be equipped with a “wet comb” and frequently monitor the wet film thickness to prevent/reduce a wide spread of DFT’s.

29. 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.

30. Multiple coats shall be applied as per the table at the top of this specification sheet. Single coat systems are not permissible.

31. Where more than one coat is applied, the colour of each coat shall be different from the previous coat. In the case where aesthetic requirements are secondary, repairs after final testing shall be carried out using a different colour. In other cases two finishing coats of the same colour may be applied to achieve complete colour uniformity.

32. 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.
33. 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.
34. 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.
35. 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.
36. 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.
37. 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.
38. 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.
39. It is imperative that wherever possible pinhole detection and general patch repairs are to be performed before final cure of the coating system.
40. 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. 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.

41. 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.
42. 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.
43. 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.
44. 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.

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.
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 coating. 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 Duvha 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.
   - 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. Prior to the application of any of the corrosion protection systems, the Product Data Sheet/s shall be signed by the manufacturer and applicator. 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.
3. The signed Product Data Sheet/s shall be deemed to be a binding reference document (as part of the QCP). It shall be specific to this project and any further/other subsequent revisions of the Product Data Sheet/s shall be submitted to Eskom for reacceptance clearly stating the variations/deviations. No further use/application of the related product, for this project, is permitted until acceptance is granted by Eskom.
4. 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.
- 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.

5. Given that the single most limiting aspect of working in CSs is access, the Method Statement shall describe and indicate how and where access will be established for (1) personnel, (2) general equipment – buckets, shovels, etc. (3) lighting equipment, (4) blast equipment, (5) grit removal and cleaning etc. in relation to and considering the manhole/access points already used for ventilation purposes.
6. 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.
7. 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.

8. Under no circumstances shall any work be performed until the QCP and Method Statement have been accepted by the Eskom engineer.
9. The coating manufacturer shall provide technical surveys during the execution of the project. The applicator shall commit to this requirement in the Method Statement.

Reference Documents:

Since the compilation of the Eskom Standards 240-101712128: Standard for the internal corrosion protection of water systems, Chemical Tanks and Vessels and Associated Piping with Coatings there have been changes in terms of the referenced documents i.e. some documents have been withdrawn, replaced or superseded. The following list of references shall apply in addition to the requirements of 240-101712128. 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).
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).