Eskom	Standard	Asset Management

Title: **Specification Standard for High Pressure Water Jetting of Condenser and Heat Exchanger Tubes**

Unique Identifier:	**240-107677940**
Alternative Reference Number:	**N/A**
Area of Applicability:	**Generation**
Documentation Type:	**Standard**
Revision:	**2**
Total Pages:	**16**
Next Review Date:	**March 2026**
Disclosure Classification:	**PUBLIC**

APPROVED FOR AUTHORISATION
☑ GENERATION ENGINEERING
DOCUMENT CENTRE ☎ X4962

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TABLES

1. INTRODUCTION

This Specification was compiled to assist technical, procurement and managerial personnel in sourcing suitable service providers for performing and successfully cleaning condenser and heat exchanger tubing by High Pressure Water Jetting (HPWJ). The minimum requirements in this Specification including the request for tender returnables which are intended to facilitate the fair and unbiased evaluation of tenders.

2. SUPPORTING CLAUSES

2.1 SCOPE

The aim of this document is to provide specific requirements regarding the methodology, quality and safety aspects to be considered when planning and executing HPWJ of condenser and heat exchanger tubing.

2.1.1 Purpose

This standard is intended to aid system engineering personnel in ensuring that the highest levels of cleaning effectiveness is achieved, while ensuring that these processes are selected, planned, performed and controlled suitability to minimise any possible consequential damage to the particular heat exchanger.

2.1.2 Applicability

This standard is applicable to all of Eskom's wet cooled shell and tube condensers and shell and tube heat exchangers using an evaporative cooling water media and where:

- Tubing is not coated with a protective coating. HPWJ will most likely result in damage of the existing protective coating.
- Tubing has an ID greater than 15mm.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] 240-56030499: Condenser Healthcare Guideline, Revision 1.

[2] 240-62196227: Life Savings-Rules, Revision 6.

[3] 240-101712128: Standard for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings, Revision 1.

2.2.2 Informative

[4] WJA & WJTA affiliated training in South Africa.

http://www.rtmuhp.com/services/training/

http://www.totalproducts.co.za/Admin/Training

2.3 DEFINITIONS

Definition	Description
bar	A unit of pressure equivalent to 100 000 Pa or approximately one atmosphere.
SI units	A system of physical units (SI units) based on the metre, kilogram, second, ampere, kelvin, candela, and mole, together with a set of prefixes to indicate multiplication or division by a power of ten.
Pascal	The Pascal (abbreviated Pa) is the unit of pressure or stress in the International System of Units (SI). One Pascal is equivalent to one newton (1 N) of force applied over an area of one meter squared.

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
BFPT	Boiler Feedpump Turbine
CE	European Economic Area Conformity Marking
HD	High Definition
HPWJ	High Pressure Water Jetting: Pressure from 700 – 1700 bar
ID	Internal Diameter
IP	Internet Protocol
MP	Mega Pixel
MPa	Mega Pascal
OD	Outside Diameter
p	Pixel
psi	Pounds per Square inch
QCP	Quality Control Plan
RAW	Unprocessed Format of an Image
TIFF	Tagged Image File Format
WJA	Water Jetting Association UK
WJTA	Water Jet Technology Association

2.5 ROLES AND RESPONSIBILITIES

The System Engineer shall ensure that this specification is utilised for sourcing suitable service providers for performing and successfully cleaning condenser and heat exchanger tubing by High Pressure Water Jetting (HPWJ).

This Specification will form the basis for fair and accurate tender evaluations by the evaluation team.

In addition to the above, specific responsibilities of the Engineer include:

- Completion of all required information fields in Table 1 in section 3 with technically correct and adequately detailed information.
- Ensure that no part of this Standard is modified in any way.
- Ensure that the entire Standard accompanies the enquiry document.

2.6 PROCESS FOR MONITORING

Monitoring and maintenance processes and requirements are described in subsequent sections of this Specification.

2.7 RELATED/SUPPORTING DOCUMENTS

A Microsoft Word version of Table 1 in Section 3 below is available at:

http://hyperwave.eskom.co.za/0x936e3246_0x06c7359b

3. WORKS INFORMATION FOR CONDENSER AND HEAT EXCHANGER TUBE CLEANING

240-56030499 [1] Annex containing “Off Load Tube Cleaning” provides instructions on the completion of the input data fields indicated in grey below.

Table 1: HPWJ Works Information for Condenser and Heat Exchanger Tube Cleaning

GENERAL INFORMATION:			
Power Station:			
Unit:			
Component:			
Scope:			
Access date:			
Outage Duration:			
Reference drawings:			
HEAT EXCHANGER SPECIFIC INFORMATION:			
Tube details:	Main Bundle “Condensing Zone”	Secondary Bundle “Air Extraction”	Impact Tubes “Peripheral tubes”
Tube material:			
Number of Tubes:			
Tube Length:			
Tube OD:			

Tube Wall Thickness:			
Tube Profile:			
Anticipated Scale Thickness:			
Tube Stick-Out from Tubesheet (Inlet/Outlet)			
Tubesheet Coating			
Waterbox Access:			
EMPLOYER INFORMATION TO BE SUPPLIED WITH TENDER ENQUIRY DOCUMENT:			
Water supply and drainage facilities:			
Electricity supply:			
Scaffolding:			
Station Air:			
Isolation and Permitting:			
Provision of tube samples for performing tests and optimization (prior to full scale cleaning) as per section 4.6:			
Definition of “Roles and Responsibilities” for the removal of manhole covers on waterboxes:			
Definition of “Roles and Responsibilities” for the supply and installation of fans on the waterboxes for ventilation purposes:			

4. HPWJ REQUIREMENTS FOR CONDENSER AND HEAT EXCHANGER TUBING

4.1 ACCEPTANCE CRITERIA

The internal surfaces of all tubes as described above in section 3 shall be cleaned by means of High Pressure Water Jetting (HPWJ). The acceptance criteria is that all scale shall be removed from the internal surfaces of the tubes, i.e. the entire internal tube surface of all the tubes shall be completely cleaned to a uniform metallic colour with no traces of corrosion product or other scales and deposits. This shall be validated by means of high resolution endoscope inspection (with minimum endoscope specifications as outlined in Table 2) and / or destructive analysis of “cleaned tube” where applicable.

Non achievement of the aforementioned acceptance criteria shall be considered as non-performance with respect to the contract.

4.2 CONTRACTOR EXPERIENCE

The Contractor shall provide verifiable Reference list of HPWJ cleaning contracts using a minimum of 800 bar working pressure, of industrial heat exchangers in the last 5 years. Verifiable references of at least three (3) projects successfully conducted in the past 5 years are required.

4.3 SAFETY REQUIREMENTS

The safety of the Contractor personnel is of extreme importance. The following minimum safety requirements shall apply:

- Operators shall wear CE (European Economic Area Conformity Marking) certified water jetting suits, and face shields rated for the working pressure stated in section 4.5.
- All foot and leg protection equipment to be appropriately rated for the working pressure stated in section 4.5.
- The Contractor shall work in accordance with a safety procedure/instruction aligned to industry recognised HPWJ practices and standards to protect personnel using HPWJ equipment.
- HPWJ operators shall be trained and certified by an independent industry recognised HPWJ authority affiliated to either WJA, WJTA as per reference [4]. No operator will be allowed to use HPWJ lances on site without the required certification as defined in section 4.6 of this document.
- All HPWJ hoses, pressure accessories, pressure equipment and pressure vessels in the HPWJ system to be designed for a minimum design pressure of 1 000 bar (100 MPa). All previously mentioned equipment shall be pressure tested to 1.25 times the design pressure of the equipment.
- All hose end connections to be fitted with the appropriate “hose checks” to prevent injury by restraining the hose in the event of an end fitting failure.
- The HPWJ pump discharge shall be fitted with a calibrated pressure gauge and safety relief valve or rupture diaphragm.
- Any manholes which are open for ventilation purposes shall be properly barricaded by the Contractor to eliminate unauthorised entry while cleaning is in progress.
- Barriers and Warning notices must be in place before any work commences.
- Compliance with Eskom’s Life Saving Rules [2] as applicable to this activity.
- The Contractor’s operator shall use a hand held pneumatic powered feeder, which incorporates a sleeve into which the nozzle retracts as it exits the tube. The feeding speed and dwell time shall be set during commissioning as defined in section 4.5. This equipment/device shall be used at all times to ensure operators are not exposed to water jets when moving the lance from one tube to another.

4.4 MINIMUM EQUIPMENT REQUIREMENTS

- For tubes with an internal diameter of 20.5 mm up to 25 mm, the minimum nozzle flow rate shall be 50 litre/min at 1 000 bar working pressure. For tubes with an internal diameter between 15 and 20.5 mm the minimum nozzle flow rate shall be 33 litre/min at 1 000 bar working pressure.
- Rotating tube cleaning nozzles with multiple radial water jets or polishing nozzles shall be used. The cleaning nozzles shall be obtained from a recognised HPWJ equipment supplier including technical datasheets, providing technical information for a range of nozzle sizes, shall be available for all the types of nozzles used on site. The maximum pressure rating of the nozzle shall be 1 035 bar or 15 000 psi. Nozzles with a higher pressure rating are not acceptable. The minimum number of nozzles available on site for the main and BFPT condensers are 6 and 2 respectively.
- A technical data sheet shall be provided for the HPWJ pumps. The HPWJ pump shall maintain a minimum continuous working pressure of 1 000 bar at a flow rate of 50 litre/minute. This requirement assumes one pump will supply one cleaning nozzle. If a single pump is to supply more than one nozzle simultaneously, the pump shall maintain a minimum continuous working pressure of 1 000 bar and a minimum volume flow of 50 (litre/min) per each of the cleaning nozzles attached simultaneously to the pump.
- The nozzles shall travel the full length of all the tubes.
- The HPWJ flexible hose from the foot valve to the tube cleaning nozzle shall have a minimum internal diameter of 6 mm for tubes with an internal diameter between 15 and 20.5 mm. For tubes with an internal diameter of more than 20.5 mm, the HPWJ flexible hose from the foot valve to the tube cleaning nozzle shall have a minimum internal diameter of 7 mm. The maximum hose length is the condenser tube length plus an additional 7 m. If the tube length is more than 12 meters, the tubes shall be cleaned from both ends to avoid excessive long hoses. The foot valve shall be positioned in the waterbox. The minimum number of hoses available on site for the main and BFPT condensers are 4 and 2 respectively.
- The flexible hose from the pump outlet to the foot valve shall have a minimum internal diameter of 10 mm.
- The Contractor shall make provision for a reasonable set/number of spare equipment and tooling, particularly, nozzles, hoses, couplings, all wear and tear parts such as seals etc. These spares shall be available on site. In the event of HPWJ Pump breakdown then repair or suitable replacement shall be affected within 2 hours. The latter shall only apply to eventualities involving unexpected major breakdown of HPWJ Pumps.
- Under no circumstances will the tubesheet coating or tube ends be damaged by the HPWJ cleaning. The Contractor shall establish a system or method to ensure impinging water jets from the nozzle are not directly focused towards the tubesheet or onto the outside diameter of the exposed tube ends. Prior to any HPWJ cleaning activities and inspection shall be performed by the Contractor supervisor and the Engineer to record the existing condition of the tubesheet and tube ends. This activity shall be included in the QCP as a hold point. Any damage to coating will be for contractor's expense to repair; Eskom's coating standard [3] shall be applied for any coating repairs.
- The Contractor shall make provision of adequate number of hand held pneumatic powered feeders as described above in section 4.3.

- The Contractor's selection of all lances, nozzles, sleeves and hosing shall be suitable for the tubing diameters as defined above in "Table 1: HPWJ Works Information for Condenser and Heat Exchanger Tube Cleaning".
- The endoscope used for inspection of the tubes after HPWJ shall have a minimum length of 6m and a camera with minimum specifications as outline in Table 2.

Table 2: Specification for Minimum Requirements for Endoscope

Camera Minimum Requirements	
Camera Lens	*Dual (front and side)*
Video Resolution	*1080p HD (1920 x 1080 pixel) resolution*
Picture Resolution	*A4 page resolution: 2480 x 3508 pixels*
Megapixel (MP)	*2.1*
Image Format	*RAW or TIFF*
Video Format	*MP4*
Focal Length	*30 mm*
Magnification	*2x*
Waterproof	*IP67*
Bore hole minimum size	*10 m*

4.5 COMMISSIONING TESTS AND OPTIMIZATION

Before any work is performed the Contractor shall demonstrate the following to the Engineer:

- Provide all required certificates (equipment pressure tests, pressure gauge calibration, personnel training) as stipulated in section 4.3 above.
- The Engineer shall verify that the equipment on site complies in all respects to the technical data sheets provided with the tender as well as that the number of pumps, hoses, foot valves, cleaning nozzles, etc. on site corresponds in all respects to the information provided in the tender returnables.
- The Contractor shall demonstrate to the Engineer that the HPWJ pump, hose and nozzle combination can supply a volume flow rate of 50litre/min by means of a container and stopwatch method for a pump outlet pressure of 1000 bar.
- The Contractor shall demonstrate that the lance safety device (with a hand held pneumatic powered feeder) prevents the lance from withdrawing from the tube during HPWJ and hence is safe for operators.

- Before starting with the production cleaning activity the contractor in consultation with the engineer shall establish an acceptable nozzle resident/dwell time (cleaning a minimum of 10 tubes) demonstrating the capability of meeting the acceptance criteria stipulated in section 4.1 of this document. During cleanliness sampling inspections, it may be found that cleaning with the pre-established nozzle resident/dwell time is ineffective (scale not being entirely removed). In such an event the nozzle resident/dwell time may be further increased by virtue of a 10 tube cleaning test. This shall only be performed in consultation with the engineer, and actual high definition endoscope inspections of 'cleaned tube sections"
- If available, the Engineer shall provide the contractor with a short piece, typically 1m, of new condenser tube of the same material of construction as that in the condenser or heat exchanger The Contractor shall demonstrate to the Engineer that the working pressure and cleaning nozzle combination does not damage the tube internal surface.

4.6 ADDITIONAL REQUIREMENTS

- The Contractor shall supply suitable Endoscope/Fiberscope equipment to facilitate post cleaning inspection. The fibre scope shall have a reach length of at least 6 m with a digital display that includes image capture and/or and recording capabilities.
- The Contractor shall supply and install suitable protection or covers on the main cooling water inlet duct to eliminate any of the debris removed from the condenser tube falling down the CW inlet duct.
- The Contractor shall compile a final method statement, safety work procedure and Quality Control Plan (QCP) and submit these to the Engineer for approval before cleaning may commence. The Engineer shall have the opportunity to add witness or hold points on the QCP.
- All tubes which are blocked or obstructed and which cannot be unblocked by HPWJ shall be marked on the tubesheet drawing.
- The Contractor shall maintain a daily logbook where the number of tubes cleaned, working pressures, etc. are logged.
- As stated in section 4.1 above the minimum acceptance criteria is that all scale shall be removed from the internal surface of the tubes, i.e. the entire internal tube surface of all the tubes shall be completely clean with no traces of corrosion product or other scales and deposits on the tube inner surfaces.
- The Contractor shall clean the waterboxes and drain pipes connected to waterboxes after cleaning the tubes. All foreign materials and debris shall be removed from the waterboxes.

5. TECHNICAL TENDER RETURNABLES

5.1 TECHNICAL RETURNABLES REQUIRED AT TENDER STAGE

5.1.1 Exclusions or deviations from the above specification. If no exclusions or deviations, a specific statement to this effect is to be included in the tender.

5.1.2 Verifiable Reference list of HPWJ cleaning contracts using a minimum of 800 bar working pressure, of industrial heat exchangers in the last 5 years.

5.1.3 The Contractor shall complete Tables 3 to 6 below with the details of the equipment that will be available on site for the full duration of the contract to complete the cleaning of the condenser/heat exchanger within the allowed time period. (Example: If only two pumps will be used only the first two lines of Table 3 below are to be completed).

5.1.4 Technical datasheets for the rotating tube cleaning nozzles, HPWJ pumps and flexible hoses for cleaning the tubes as described in Table 1.

5.1.5 The Contractor provides a preliminary method statement for cleaning the heat exchanger/condenser tubes. The method statement includes amongst others items like safety requirements, commissioning, monitoring during the cleaning process, equipment, etc.

Table 3: HPWJ Nozzle Inventory

HPWJ nozzle #	Part number	Supplier name	Pressure rating or range, bar	Flow range, l/min
1				
2				
3				
4				
5				
6				

Table 4: HPWJ Pumping Capacity/Resource

HPWJ pump #	HPWJ pump identification	HPWJ Pump flow rate (in litre/minute) at 1000 bar working pressure	Number of cleaning sets, i.e. cleaning nozzles, hoses, foot valves, etc., which will be connected simultaneously to the pump
1			
2			
3			
4			
5			
6			

Table 5: HPWJ Hose Inventory

HPWJ hose #	HPWJ hose series or part number	Hose internal diameter, mm	Hose external diameter, mm	Maximum working pressure, bar
1				
2				
3				
4				
5				
6				

Table 6: Endoscope Minimum Requirements

Parameter	Specification	Yes / No If No, provide specification
Camera Lens	Dual (front and side)	
Video Resolution	1080p HD (1920 x 1080 pixel) resolution	
Megapixel (MP)	2.1	
Image Format	RAW or TIF	
Video Format	MP4	
Focal Length	30 mm	
Magnification	2x	
Waterproof	IP67	
Bore hole minimum size	10 mm	
Long Range Semi-rigid Reinforced Cable Length	6 m	

6. TECHNICAL TENDER EVALUATION CRITERIA

6.1 TECHNICAL GATEKEEPERS

Verifiable Reference list of HPWJ cleaning contracts using a minimum of 800 bar working pressure, of industrial heat exchangers in the last 5 years. Verifiable references of at least 3 projects successfully conducted in the past 5 years are required.

6.2 QUALITATIVE EVALUATION CRITERIA

Technical Evaluation Criteria		Weighting [%]
1	Exclusions or qualifications made by the contractor to the technical specification detailed in section 4. As part of the this section, the technical datasheets of the nozzles, hoses and pump as well as completed tables 2-4 as provided in the tender are considered and evaluated.	70
2	Preliminary method statement for cleaning the heat exchanger/condenser tubes	30
	TOTAL	**100%**
NB: A minimum total of 70 % is required in this section for further consideration. The contractor shall ensure that all the returnables are submitted as required in section 5.		

7. FORESEEN ACCEPTABLE / UNACCEPTABLE QUALIFICATIONS

Table 7: Acceptable Technical Risk

Risk	Description
1	Minor deviations or clarifications to the technical specification

Table 8: Unacceptable Technical Risk

Risk	Description
1	Any significant deviations from the safety requirements specified in section 4.3
2	Any of the equipment does not meet the requirements as detailed in section 4.4
3	The technical datasheets do not demonstrate compliance to the requirements detailed in section 4.4
4	Completed tables 2-4 do not demonstrate compliance to the requirements detailed in section 4.4
5	The Contractor does not provide an endoscope or the endoscope does not meet the requirements of section 4.6

8. TECHNICAL EVALUATION SCORING GUIDE

Table 9: Scoring Guide

GATEKEEPERS						
Section	**Criteria**					**Yes / No**
4.2	Verifiable Reference list of HPWJ cleaning contracts using a minimum of 800 bar working pressure, of industrial heat exchangers in the last 5 years. Verifiable references of at least 3 projects successfully conducted in the past 5 years are required**.**					
Technical evaluation						
NB: Tenders which do not satisfy these gatekeepers will not be given further consideration. Contractors need to comply with all three gate keepers ***Section references below refers to the technical specification outlined in section 6.**						
Minimum score of 70% required			**Score**			
No	**Criteria**	**Weight [%]**	**0/5**	**2/5**	**4/5**	**5/5**
1	Exclusions or qualification to technical specification detailed scope of work **(Section 4)**	70	Deficient or non-responsive	Unacceptable risks	Acceptable risks	Fully compliant and no technical risks
2	Preliminary method statement for cleaning the tubes	30	Deficient or non-responsive	Unacceptable risks or omissions in accordance with the requirements on the scope of work	Acceptable risks	Fully compliant and no technical risks

9. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
All members as at January 2021	Condenser and Feed-heating Care Group
All members as at February 2021	Turbine Study Committee

10. REVISIONS

Date	Rev.	Compiler	Remarks
May 2016	0.1	K. Northcott	New document drafted for Internal Comments review Process
August 2016	0.2	K. Northcott	Final Draft for Formal Comments Review Process
August 2016	0.3	K. Northcott	Updated Final Draft after Comments Review Process
August 2016	1	K. Northcott	Final Document for Authorisation and Publication
December 2020	1.1	K. Moloko	Draft of the 2nd review for Internal Comments review Process
January 2021	1.2	K. Moloko	Final Draft for Formal Comments Review Process – Condenser and Feed-heating Care Group
February 2021	1.3	K. Moloko	Final Draft for Formal Comments Review Process - Turbine Study Committee
March 2021	2	K. Moloko	Final Rev 2 Document for Authorisation and Publication

11. DEVELOPMENT TEAM

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

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- Keith Northcott – Senior Consultant
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12. ACKNOWLEDGEMENTS

Vusi Ralefeta – Senior Advisor.