Hendrina Power Station **Outage Scope of Work**	**Unit**	1 - 10
	Genix ID	TBA
	Date	11/10/2022

Outage type	TBA	**Planned Start Date**	TBA
Department	Turbine Engineering	**Planned End Date**	TBA
System	Condensate Plant & Auxiliaries	**Planned Duration**	TBA

Details	**SCOPE COMPILATION**	**SCOPE RECOMMENDATION**	**SCOPE APPROVAL**
	System Engineer	**Acting Engineering Line Manager**	**Acting Engineering Manager**
Name & Surname	Deven Dieter Bodenstedt	Thabo Nkuna	Bezi Mvula
Signature			
Date	11/10/2022		

SCOPE COMPILATION REFERENCES				
SOURCE & Ref No.	**Yes**	**No**	**N/A**	**Comments**
Previous outage service reports		X		
Return to service data packages		X		
Maintenance Strategy with Rev number	X			HSSTPMM014
SAP defects (attach list as appendix)		X		
GHRMS (STEP) report		X		
Online Condition Monitoring		X		
Pre-outage performance test results		X		
Post outage performance test results		X		
GPSS/ Plant Performance data - UCLF incurred		X		
OMS / IIRMS recommendations (Audits Reports)		X		
Risk controls (IRM system)		X		
Previous audits and reviews (e.g. ERAP)		X		
Engineering Change Requests (Projects)		X		
LOPP strategy reports		X		
URS		X		
Philosophy (Outage)	X			240-49346331
Condition Monitoring Report		X		
VA/PHD Viewer trends		X		
Corrective Actions		X		
CARAB reports			X	
Statutory Requirements			X	
Grid code requirements			X	
Waivers and Exemptions		X		
Calibration requirements		X		
Previous Outage SOW variations		X		
Post Mortems Actions from previous outages		X		
Pre–Outage plant walks		X		
Risk based inspection (RBI) report			X	
Simulation, TOIs, OON, SI			X	

CONTENTS OF THIS DOCUMENT

LIST OF TABLES

1. GOAL

The key objective of this outage is to help the business unit at Hendrina Power Station to achieve and sustain 80% UCF, 10% PCLF and 10% UCLF, and to approve the availability/reliability of Units 1 to 10.

2. SUMMARY OF THE SCOPE

This scope is provided for inspection purposes to conduct critical repairs in order to prevent plant failures until the next outage. This SOW includes inspection and repairs on critical components within the Main Turbine Condensate Plant.

2.1 BATTERY LIMITS

PLANT	START	END	EXCLUSIONS	INCLUSIONS	P&ID DRAWINGS
LP Condensate System	As per P&ID	As per P&ID	Valves	Vessels & Piping	25.15/24138/001&002

2.2 GENERAL ARRANGEMENT AND LOCATION DRAWINGS

№	DRAWING NUMBER	TITLE
1	18.5100.0226	Main Turbine Condenser
2	ISO 0.15/2982	Ejector A Primary Stage Cooler (Shell -Side)
3	ISO 0.15/2982	Ejector A Secondary Stage Cooler (Shell-Side)
4	ISO 0.15/2982	Ejector B Primary Stage Cooler (Shell-Side)
5	ISO 0.15/2982	Ejector B Secondary Stage Cooler (Shell-Side)
6	ISO 0.15/2982	Ejector A Primary Stage Cooler (Water-box Side)
7	ISO 0.15/2982	Ejector A Secondary Stage Cooler (Water-box Side)
8	ISO 0.15/2982	Ejector B Primary Stage Cooler (Water-box Side)
9	ISO 0.15/2982	Ejector B Secondary Stage Cooler (Water-box Side)

3. APPLICABLE CORPORATE/GENERATION/INTERNATIONAL GUIDELINES ANDSTANDARDS

№	REFERENCE NUMBER	DOCUMENT TITLE
1	36-557	Outage Management Procedure
2	36-1121	Condenser Health Care Policy
3	36-1126	Specification for Corrosion Protection of Plant Equipment with Coatings
4	240-107677940	Specification Standard for High Pressure Water Jetting of Condenser and Heat Exchanger Tubes

4. APPLICABLE HENDRINA POWER STATION STANDARDS AND PROCEDURES

№	REFERENCE NUMBER	DOCUMENT TITLE
1	240-49346331	Outage Philosophy for Hendrina Power Station
2	240-56030499-R3	Condenser Healthcare Guideline
3	240-56030508-R3	Cooling Water System Healthcare Guideline
4	HSIPMM580-R0	Condenser and CW Side Water-box Inspection Procedure

№	REFERENCE NUMBER	DOCUMENT TITLE
5	HSPPO256-R12	Condenser Flood Test Procedure
6	HSPPO216-R7	Operating on CW System Procedure
7	HSPPO310-R2	Standard Isolations Procedure – Units 1 to 5 – CW System (Includes Auxiliary Cooling)
8	HSPPO282-R2	Standard Isolations Procedure – Units 6 to10 – CW System (Includes Auxiliary Cooling)

5. GENERAL CONSIDERATIONS

ACTIVITIES	SPECIFICATIONS
PRE-REQUISITES / PRE-CONDITIONS	
SAFETY	
Eskom Health, Safety and Environmental Policy	32-94
ENVIRONMENT	
Hendrina Power Station Waste Management Procedure	HSPPIN003
QUALITY	
Quality Management Manual	QMM001
Process Quality Process/Procedure (PQP/QCP) Work on the condensate and feed-heating system shall be carried out in accordance with the relevant approved PQP. The PQP shall be compiled by the contractor based on this scope of work and submitted to Hendrina Engineering at least 2 months before the outage for approval. The QCP shall include the work that will be performed both outside the Power Station as well as on site.	
Hold and witness points H&W points that form part of the QCP and have been approved prior to the start date, shall not be by-passed under any circumstances without the written concession of an authorised member of the Engineering Department. It is the Contractors responsibility to inform the Plant Engineer or his representative at the daily progress meetings when an activity will be ready for QC.	

Check Sheets Inspections to be carried out in accordance with check sheets as attached in master quality plan (QCP). All disassembly and assembly values to be recorded in relevant check sheets. No incomplete check sheets will be accepted unless the prior exemption in terms of the technical notification is obtained from Engineering. Note that an NCR will be issued for incomplete check sheets. Repair or replace all damaged/worn components out of specification or obtain a concession from engineering staff. All abnormalities to be recorded and reported with technical notifications.	OEM requirements specifications to be used on specifications unless approval to use an alternative specification has been granted by Turbine Engineering.
Quality technicians QC Technicians will be delegated by Plant Engineers to ensure quality standards and quality assurance is exercised during all repair, replacement and/or refurbishment activities.	
Experience of staff All Engineers, technicians, supervisors and quality assurance related staff should have adequate experience to work on specified activities. Furthermore, all artisans should have adequate experience on specified activities, and it is the responsibility of the contractor to provide assurance to Eskom that the artisan has the required experience to perform work at Hendrina Power Station.	Short CVs of all supervisors, quality technicians and artisans, stating qualifications and relevant experience, must be provided at least two weeks before the commencement of the outage.

GENERAL REQUIREMENTS	
The importance of correct equipment spares, and procedures should be included in structured toolbox talk sessions with all contractors.	
Spares It should be kept in mind that lead-time of turbine spares required during major overhauls can be as much as 12 months. Therefore, all the spares required must be ordered on time so as not to delay the outage plan. Spares ordered and used will be reported by always quoting the ESKOM stock number (if applicable) as well as the Group and item number from the spare's manuals.	
Documentation Full-service reports must be compiled and submitted to the documentation centre for safe keeping and approval 40 days after unit is synchronised on load	
Equipment **Lifting equipment:** an up-to-date test certificate must be available for all lifting equipment that will be used (applies to contractor). **Measuring equipment:** An up-to-date calibration certificate must be available for all measuring equipment that will be used (applies to contractor). Contractor Special tools must be serviced before the outage, must be available on site, and must be in a good-working condition. A list of all special tools must be compiled before the outage and submitted to Turbine Engineering. Moreover, the special tools must be readily available for inspection by QC and Engineering.	
Use of SAP PM to record history and costs SAP PM will be used to record history of work done as well as the related costs to at least the second level of headings as listed in this document.	

6. GENERAL REQUIREMENTS

SUBSYSTEM		ALL SYSTEMS				
COMPONENT ACTIVITIES				GOVERNING DOCUMENTS		
№	COMPONENT FLOC (KKS CODE)	COMPONENT DESCRIPTION	ACTIVITY TYPE (INSPECTION / TEST / REFURBISH / REPLACE)	WORK SPECIFICATION	CHECK SHEET NO.	INTERVENTION POINTS (H/W/R)
1	Various	All Turbine Auxiliaries Systems outlined in this scope of work	Compile QCPs / ITPs / QIPs for all the activities required. Submit to Turbine Engineering for review, acceptance, and approval.	HSPPA014		R
2	Various	All Turbine Auxiliaries Systems outlined in this scope of work	All inspections, as required, must be captured via report documentation and must be made available to the System Engineer as soon as possible (Cutting Instructions, Non-Destructive Testing, Wall Thickness Measurement Reports, etc.).			W
3	Various	All Turbine Auxiliaries Systems outlined in this scope of work	Remove lagging and cladding and erect scaffolding on all systems to the requirements of this SOW. Replace all lagging and cladding and remove scaffolding upon completion of this SOW.			S
4	Various	All Turbine Auxiliaries Systems outlined in this scope of work	All plant component labels that are removed from the plant during disassembly of equipment are to be kept safe and free of damage. All damaged/missing plant labels are to be reported to Hendrina TSS (Technical Support Services) for new labels to be manufactured and installed.			S

5	Various	All Turbine Auxiliaries Systems outlined in this scope of work	Upon box-up of plant equipment, the responsible contractor is to reinstate the equipment labels to their correct designated locations and ensure that the associated “Box-up certificate” is completed.			H
6	Various	All Statutory Vessels, Piping & Components	All Contractors must ensure that statutory RBI inspections and repairs are tracked, executed and captured as detailed in this SOW. Note that documentation will be subject to a post outage audit.			H
7	Various	All Turbine Auxiliaries Systems outlined in this scope of work	All defects loaded before the submission of this SOW are to be addressed.			R

7. DETAIL SCOPE OF WORK

7.1. DECOMMISSIONING AND PRESERVATION

SUBSYSTEM		CONDENSER WATER SIDE				
COMPONENT ACTIVITIES				GOVERNING DOCUMENTS		
№	ASPECT	COMPONENT DESCRIPTION	ACTIVITY	WORK SPECIFICATIONS	CHECK SHEET NO.	INTERVENTION POINTS (H/W/R)
	BEFORE OUTAGE		a. Biocide dose at cooling towers and agitate with main CW pumps (**Action** -Chemical Services)			
	DURING OUTAGE		**CW isolation not possible:** a) Maintain full CW flow (**Action** – Operating). b) Monitor online condensate chemistry for signs of chemistry excursions indicating a possible condenser tube leak (**Action** – Operating & chemical services) **CW isolation possible:** a) Isolate CW system supply to Unit and drain condenser water-box. (**Action** – Operating) b) Open manholes. Inspect and remove debris from tube-sheets within condenser water-boxes. (**Action** – Maintenance) c) Store with manhole covers in open position. (**Action** – Maintenance)			

SUBSYSTEM		CONDENSER WATER SIDE				
COMPONENT ACTIVITIES				GOVERNING DOCUMENTS		
№	ASPECT	COMPONENT DESCRIPTION	ACTIVITY	WORK SPECIFICATIONS	CHECK SHEET NO.	INTERVENTION POINTS (H/W/R)
			d) Conduct condenser high-level flood-test prior to the Unit's return to service to allow for defect & tube-leak detection tests to be carried out. (**Action** – Operating)			
	POTENTIAL STORAGE RISKS WHICH NEED TO BE MITIGATED		a) General corrosion of feed heating system. b) Microbiologically induced corrosion of condenser tubes and main CW ducts. c) Dezincification. d) Valve seizure. e) Cooling tower packings being damaged once main CW water circulation is stopped.			

SUBSYSTEM		CONDENSER STEAM SIDE				
COMPONENT ACTIVITIES				GOVERNING DOCUMENTS		
№	ASPECT	COMPONENT DESCRIPTION	ACTIVITY	WORK SPECIFICATIONS	CHECK SHEET NO.	INTERVENTION POINTS (H/W/R)
	BEFORE OUTAGE					
	DURING OUTAGE		a) Use residual heat and vacuum to facilitate drying. (**Action** - Operating) b) Monitor humidity levels daily (**Action** -Performance and Testing) c) Rotor barring using the jacking oil system shall be done once a week and the rotor rotated one-and-a-quarter turns. (**Action** - Operating) d) Take weekly lube oil samples to check for contamination. (**Action** -Chemical Services) e) Turbine oil purifier to be kept in service to maximise water in oil removal. (**Action** - Operating) f) Operate all bled steam valves once a month. (**Action** - Operating)			

SUBSYSTEM		CONDENSER STEAM SIDE				
COMPONENT ACTIVITIES				GOVERNING DOCUMENTS		
№	ASPECT	COMPONENT DESCRIPTION	ACTIVITY	WORK SPECIFICATIONS	CHECK SHEET NO.	INTERVENTION POINTS (H/W/R)
	POTENTIAL STORAGE RISKS WHICH NEED TO BE MITIGATED		a) Stress corrosion cracking. b) General corrosion c) Corrosion fatigue. d) Thermal fatigue.			

7. DETAIL SCOPE OF WORK

7.2. HIGH PRESSURE WATER JETTING REQUIREMENTS FOR CONDENSER TUBING

7.2.1. ACCEPTANCE CRITERIA

The internal surfaces of all tubes shall be cleaned by means of HPWJ. The acceptance criteria is that all scale be removed from the inner walls 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 to be found on the tube inner surfaces after the production cleaning activity has been completed. This shall be validated by means of high-resolution endoscope inspection. **Note that non-achievement of the aforementioned acceptance criteria shall be considered as non-performance with respect to the contract.**

7.2.2. CONTRACTOR EXPERIENCE

Only *Contractors* experienced and specialised in the high-pressure water jetting of turbine plant heat exchangers will be considered for tender. Furthermore, the *Contractor* shall provide a verifiable Reference list of HPWJ cleaning contracts using a minimum of 800bar working pressure on industrial heat exchangers, in the last 5 years. Verifiable references of at least five (5) projects successfully conducted in the past 5 years are required.

7.2.3. HPWJ MINIMUM SAFETY REQUIREMENTS

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

- ✓ *Contracted Operators* shall wear CE (European Economic Area Conformity Marking) certified water jetting suits, and face shields rated for a working pressure of at least 1000bar.
- ✓ All foot and leg protection equipment to be appropriately rated for a working pressure of at least 1000bar.
- ✓ 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 *Contracted Operators* shall be trained and certified by an independent industry recognised HPWJ authority affiliated to either WJA or WJTA. No operator will be allowed to use HPWJ lances on site without the required certification as defined in section 7.2.6 on page 22 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 1000bar (100MPa). 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 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 as applicable to this activity.
- ✓ The *Contracted Operators* shall use a handheld 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 7.2.5 on page 21 of this document. 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.

7.2.4. HPWJ MINIMUM EQUPIMENT REQUIREMENTS

1. For tubes with an internal diameter of 20.5 up to 25 millimetres the minimum nozzle flow rate shall be 50 litres/min at 1000bar working pressure. For tubes with an internal diameter between 15 and 20.5 millimetres the minimum nozzle flow rate shall be 33 litres/min at 1000bar working pressure.
2. 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 and must include technical datasheets for all types to be used on site which show the pressure rating of the HPWJ nozzles, the outside diameter of the nozzles, and the tube inner diameter range the nozzle is intended for. The HPWJ cleaning nozzle datasheets shall furthermore detail the design features of the cleaning nozzles for unplugging tubes and removing deposits of scale from the inner tube walls. The maximum pressure rating of the nozzle shall be 1035bar or 15000 psi. **Nozzles with a higher-pressure rating are not acceptable.** The minimum number of nozzles available on site for the main turbine condenser is 6. Furthermore, the nozzles shall travel the full length of all the tubes, i.e., 9 meters.
3. Technical data sheets shall be provided for the HPWJ pumps too be used on site and as a minimum should show evidence that the pumps are able to maintain a minimum continuous working pressure of 1000bar at a flow rate of 50 litres/min. 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 1000bar and a minimum volume flow of 50 litres/min per each of the cleaning nozzles attached simultaneously to the pump.
4. The HPWJ flexible hose from the foot-valve to the tube-cleaning-nozzle shall have a minimum internal diameter of 6 millimetres for tubes with an internal diameter between 15 and 20.5 millimetres. For tubes with an internal diameter of more than 20.5 millimetres, the HPWJ flexible hose from the foot-valve to the tube-cleaning-nozzle shall have a minimum internal diameter of 7 millimetres. The maximum hose length is the condenser tube length (9 meters) plus an additional 7 meters. The foot-valve shall be positioned in the water-box. The minimum number of hoses available on site for the main turbine condenser is 4. Furthermore, the flexible hose from the pump outlet to the foot-valve shall have a minimum internal diameter of 10 millimetres.
5. The *Contractor* shall make provision to have an appropriate amount of spare equipment and tooling on-site during the outage, particularly nozzles, hoses, couplings, all wear and tear parts such as seals/gaskets/o-rings, etc. 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 an unexpected major breakdown of HPWJ Pumps.

6. Under no circumstances is the tube-sheet or protruding tube-ends to be damaged during the HPWJ cleaning activity. The *Contractor* shall establish a system or method to ensure impinging water jets from the nozzle are not directly focused on the tube-sheet or onto the outside diameter of the exposed tube-ends. Prior to any HPWJ cleaning activities an inspection shall be performed by the *Contractor Supervisor* and the *Engineer* to photographically record the existing condition of the tube-sheet and protruding tube-ends. Thereafter the *Contractor* must compile and provide *Engineering* with a visual report containing the photographic evidence and the *Contractor's* signature, in acknowledgment of the existing condition.

   NB! This activity shall be included in the QCP as a hold point. Note that once the HPWJ cleaning activity has been completed, any discovered damages will be for the *Contractor's* expense to repair.

7. The *Contractor* shall make provision of adequate number of handheld pneumatic powered feeders as described on the previous page, at the end of section 7.2.3.

8. The *Contractor's* selection of all lances, nozzles, sleeves and hosing shall be suitable for the tubing diameters as defined in "Table 2: Main Turbine Condenser Technical Information" below.

9. The *Contractor* shall supply suitable endoscope/fiberscope equipment to facilitate pre- and post-cleanliness inspections of condenser tubes. The endoscope used for inspection of the tubes shall have a minimum length of 9 meters and digital display that includes image capture and recording capabilities with the minimum specifications as outlined in Table 1 below.

Table 1: Specification for Minimum Requirements for Endoscope/Fiberscope Machine

CAMERA MINIMUM REQUIREMENTS	
Camera Lens	*Dual (Front & 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	*JPEG or TIF*
Video Format	*MP4*
Focal Length	*30 mm*
Magnification	*2x*
Waterproof	*IP67*
Bore hole minimum size	*10 m*
Long Range Semi-rigid Reinforced Cable Length	*9 m*

Table 2: Main Turbine Condenser Technical Information at Hendrina PS

HEAT EXCHANGER SPECIFIC INFORMATION			
Tube Details:	Main Bundle "Condensing Zone"	Secondary Bundle "Air Extraction"	Impact Tubes "Peripheral tubes"
Tube Material:	*SoMs71F38*	*304L Stainless Steel*	*SoMs71F38*
Number of Tubes:	*6908*	*1512*	*8020*
Tube Length:	*9000mm*	*9000mm*	*9000mm*
Tube OD:	*25.4mm*	*25.4mm*	*25.4mm*
Tube Wall Thickness:	*1.219mm*	*1.0mm*	*1.219mm*
Tube Profile:	*Straight*	*Straight*	*Straight*
Anticipated Scale Thickness:	*2mm – 3mm*	*2mm - 3mm*	*2mm - 3mm*
Tube Protruding End Lengths	*3mm (Inlet & Outlet)*	*20mm (Inlet & Outlet)*	*3mm (Inlet & Outlet)*
Water-box Access:	*Water-boxes will not be removed from the condenser – access to the tube ends is from within the confined space of the water-box. Simultaneous access is available in 4 water-boxes.*		

7.2.5. 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 7.2.3 on page 17.
- 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 cleaning nozzle combination can supply a volume flow rate of 50 litres/min by means of a container & stopwatch method for a pump outlet pressure of 1000bar. This test 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 volume flow of 50 litres/min per each of the cleaning nozzles attached to the pump.
- The *Contractor* shall demonstrate that the lance safety device (with a handheld pneumatic powered feeder) prevents the lance from withdrawing from the tube during HPWJ and hence is safe for operators to utilize.
- 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 5 'pulled' condenser tubes during an on-site *'bucket test',* thereby demonstrating the *Contractor's* true capability of meeting the minimum acceptance criteria stipulated under section 7.2.1 of this document. *Engineering* will provide the 5 tubes and as part of the test the *Contractor* must also demonstrate to the *Engineer* that the working pressure of the HPWJ pump, hose and cleaning nozzle combination does not damage the tube internal surface.
- Dwell-times shall typically not exceed 40 seconds per tube, and the rate of lance travel should not be slower than 6 seconds per meter. After the *'bucket test*' has been conducted and during cleanliness visual inspections it may be found that cleaning with the pre-established nozzle resident/dwell-time is ineffective, i.e., the scale is not being entirely removed from the inner walls of the tubes. In such an event the nozzle resident/dwell-time may be further increased, and the '*bucket-test'* repeated. This test must be performed in consultation with the *Engineer* and actual high-definition endoscopic inspections of all the cleaned tube sections must be performed. Thereafter, the *Contractor* shall capture all the video recorded inspection imagery (to be taken both before and after cleaning commences) within a visual report and both a physical and digital copy of said report is to be handed over to *Engineering* for cleanliness evaluation and record keeping purposes.

  To clarify, the *Contractor* must demonstrate that these tube sections can be cleaned in a single nozzle pass to the point where no traces of products of corrosion or scale/debris deposits are visible, and no immediate damage to the internal surfaces of the tube(s) is evident once the test has been completed. In cases where excessive scale thickness prohibits the use of a nozzle capable of 50 litre/min at 1000 bar working pressure, then a nozzle with capability of no less than 33litre/min at 1000 bar working pressure shall be used.

  NB! This activity shall be included in the QCP as a hold point. Note that failure to pass the 'bucket-test' shall be considered as non-performance with respect to the contract.

7.2.6. ADDITIONAL REQUIREMENTS

- The *Contractor* shall supply suitable plastic sheeting and place it over the scaffolding which covers the main condenser cooling water inlet ducts to prevent any of the debris removed from the condenser tubes during HP-cleaning from falling down into the CW inlet duct.
- All tubes which are blocked or obstructed, and which cannot be unblocked by HPWJ shall be marked on the tube-map diagram and must be plugged using expanded rubber plugs which have brass-bolts.
- The *Contractor* shall maintain a daily logbook where the number of tubes cleaned, time elapsed to clean said number of tubes, changes in working pressure, etc. are logged.
- The *Contractor* shall clean all the water-boxes as well as the drainpipes connected to the inlet and return water-boxes after cleaning the tubes. Moreover, all foreign materials and debris shall be removed from the water-boxes.
- The *Contractor* shall supply suitable endoscope/fiberscope equipment to facilitate pre-HPWJ and post-HPWJ cleanliness inspections of condenser tubes. After the endoscopic inspections have been completed the *Contractor* must capture all the video recorded inspection imagery within the Heat Exchanger Inspection Report and both a physical (/hard copy) and digital copy of said report is to be handed over to the *Employer* for cleanliness evaluation and record keeping purposes.

Therefore, as per the requirements of this document a total of six (6x) sections must be included within the Heat Exchanger Cleaning Report:

1. The first section capturing the photographic evidence of the original condition of the tube-sheet and protruding tube-ends, taken in consultation with *Engineering* before HPWJ commences.
2. The second section capturing the endoscopic video recorded inspection imagery of the 5 ‘pulled’ condenser tubes both before and after they have been cleaned as part of the preliminary ‘*bucket test*’.
3. The third section capturing the endoscopic video recorded inspection imagery of the initial ‘dirty’ condition of the condenser tubes in the inlet and outlet water-boxes, taken before HPWJ commences.
4. The fourth section capturing the endoscopic video recorded inspection imagery of the first intermediate condition of the condenser tubes in the inlet and outlet water-boxes, taken a quarter-way through the HPWJ production activity.
5. The fifth section capturing the endoscopic video recorded inspection imagery of the second intermediate condition of the condenser tubes in the inlet and outlet water-boxes, taken a half-way through the HPWJ production activity.
6. The sixth section capturing the endoscopic video recorded inspection imagery of the final clean-condition of the condenser tubes in the inlet and outlet water-boxes after HPWJ has been completed.

Note that inspection findings are to be included at the end of each section and as a minimum should expertly detail the actual degree of cleanliness before and after the completion of the HPWJ production activity. Moreover, the final marked-up tube map diagram must also be included in the Heat Exchanger Cleaning Report.

7.2.7. DOCUMENTATION REQUIRED

- The *Contractor* shall compile a final method statement, safety work procedure and Quality Control Plan (QCP) and submit these documents to the *Engineer* for approval before HP-cleaning may commence. The *Engineer* shall have the opportunity to add witness or hold points on the QCP.
- A statement from the Contractor that the minimum equipment and safety requirements (as defined in sections 7.2.3. and 7.2.4. on pages 17 & 18) will be met without exception.
- Contractor to submit a detailed list of exclusions or deviations from the above specification (if any).
- All technical datasheets for the forward-facing and rotating tube cleaning nozzles to be used for cleaning of the condenser tubes as well as the nozzles to be used for testing purposes (if the same nozzle is not used for both). The minimum information to be shown on a datasheet is the following:
    - Names of supplier of nozzle,
    - Pressure rating of the nozzle.
    - Outside diameter of nozzle and tube inner diameter range the nozzle is intended for.

  Note: The cleaning nozzle datasheets shall furthermore detail the design features of the cleaning nozzles for unplugging tubes and removing deposits from the inner tube walls. Note that only nozzles from recognized HPWJ equipment suppliers will be regarded as acceptable.
- Technical datasheets for all the HPWJ pumps to be used on site which indicate the flow rate of the pumps at 1000bar working pressure as a minimum.
- Technical datasheets for flexible hoses stating pressure rating and internal diameter as a minimum. The datasheets for both the flexible hose from pump outlet to foot-valve and the hose from foot-valve to rotating tube cleaning nozzle shall be supplied.
- The Contractor shall indicate in the tables shown on the next page what equipment will be available on site for the full duration of the HPWJ cleaning process to be executed on the condenser in the allocated outage time period. (Example: If only two pumps will be used then only the first two lines of the table are to be completed).

7.2.8. TECHNICAL TENDER RETURNABLES

Please refer to the attached document: “Tender Technical Evaluation Strategy – High Pressure Water Jetting of Main Turbine Condensers” (Unique Identifier: 240-107677940; Rev 3) for information, written in full detail, regarding the technical returnables required at the tender stage as well as the tender evaluation criteria for high pressure water jetting at Hendrina Power Station. It is recommended that the *Contractor* read the document from beginning to end to make sure that there are no exclusions or deviations to section 7.3 of this scope of work (page 25) before they undertake to proceed in the HPWJ production activity.

HPWJ Pumping Capacity/Resource

HPWJ Pump #	HPWJ Pump Identification	HPWJ Pump Flow Rate (litres/min) at 1000bar 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			

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				

HPWJ Nozzle Inventory

Nozzle #	Part Number:	Supplier Name:	Design (Unplugging / Polishing / Universal):	Pressure Rating (bar):	Flow Range (litres/min):
1					
2					
3					
4					
5					
6					

7. DETAIL SCOPE OF WORK

7.3. ACTIVE WORK ORDERS

SUBSYSTEM		**MAIN TURBINE CONDENSER (CW SECTION – HIGH PRESSURE WATER JETTING)**				
COMPONENT ACTIVITIES						
№	**COMPONENT FLOC (KKS CODE)**	**COMPONENT DESCRIPTION**	**ACTIVITY TYPE (INSPECTION / TEST / REFURBISH / REPLACE)**	**PROCEDURES**	**INTERVENTION POINTS (H/W/R)**	**TASK OWNERS**
1	#0MAG10	Main Turbine Condenser	Isolate the condenser: **Ensure back-up permit is enforced**, condenser is drained, and that all 8 CW manhole covers are opened (i.e., those at the inlet, return, and outlet water-boxes). (Manhole cover ø = 500mm)	HSPPO216 HSPPO222	W	OPS MMD Turbines
2	#0MAG10	Main Turbine Condenser	Install blank flanges on the main CW ducting. A total of 4 blanks must be installed on the upper and lower bellows (i.e., stainless-steel expansion joints) of the ducting. Refer to Figure 1 on page 28.	HSPPMM280	S	Steinmuller
3	#0MAG10	Main Turbine Condenser	TED to conduct initial 'dirty' inspection of the condenser inlet, return, and outlet water-boxes.	HSIHOS001 HSIPMM580	H	Turbine Eng. MMD Turbines Contractor.
4	#0MAG10	Main Turbine Condenser	Manually clean all foreign debris (i.e., splash-packing material, large fragments of scale, metal, wood, stones, etc.) out of the inlet and outlet condenser water-boxes. Also ensure that all the tube-plates are cleaned of foreign debris.	HSIPMM580	S	MMD Turbines Contractor

5	#0MAG10	Main Turbine Condenser	Rod all the condenser tubes to ensure these tubes are not completely or partially blocked prior to HPWJ. Unblocking is required to allow free movement of HP lance across full length of the tubes.	240-56030530	S	MMD Turbines Contractor
6	#0MAG10	Main Turbine Condenser	Tubes that cannot be unblocked must be plugged with expanded rubber plugs which have brass-bolts. **The tube-map diagram must be updated during this activity** (copy will be provided by TED).	HSIPMM580	W	MMD Turbines Contractor Turbine Eng.
7	#0MAG10	Main Turbine Condenser	Install scaffolding inside the two-inlet water-boxes to completely cover the CW inlet ducts. Thereafter, lay a plastic sheet over the scaffolding to cover the entire floor of the inlet water-boxes.	HSIHOS001	S	ORAM
8	#0MAG10	Main Turbine Condenser	TED to conduct preliminary endoscopic inspection of condenser tubes. Contractor to make sure that they provide an endoscopic machine, the camera of which must be able to travel the full-length of the tubes (9m). Endoscope must have video storage capability for record keeping and a copy of all recorded files must be handed over to TED.	HSIPMM580	H	Turbine Eng. MMD Turbines Contractor
9	#0MAG10	Main Turbine Condenser	Close the four (4x) return water-box manhole covers in preparation for HP lancing of all 16444 condenser tubes.		S	MMD Turbines
10	#0MAG10	Main Turbine Condenser	Commence HP Lancing on all condenser tubes. Ensure that the specified pump discharge pressure is **1000 bar** and that rotating nozzles are used. **Note: The specified pressure must not be exceeded!**	240-56030530	S	Contractor

			Dwell-times shall typically not exceed 40 seconds per tube, and the rate of lance travel should not be slower than 6 seconds per meter.			Contractor
11	#0MAG10	Main Turbine Condenser	Post HPWJ clean mud, fragments of scale, and any other anomalies out of the condenser's inlet and outlet water-boxes.		S	Contractor
12	#0MAG10	Main Turbine Condenser	TED to inspect main condenser water-boxes as well as tube-sheets for cleanliness and to perform final endoscopic inspection of condenser tubes. Contractor to make sure that they provide an endoscopic machine, the camera of which must be able to travel the full-length of the tubes (9m). Endoscope must have video storage capability for record keeping and a copy of all recorded files must be handed over to TED.	HSIPMM580	H	Turbine Eng. MMD Turbines Contractor
13	#0MAG10	Main Turbine Condenser	Remove all scaffolding and plastic sheets from the two (2x) condenser inlet water-boxes.	HSIPMM580	S	ORAM
14	#0MAG10	Main Turbine Condenser	Inspect all eight (8x) water-box manhole covers for damage / deteriorated seals. Repair / replace if required.	240-56030530	S	MMD Turbines
15	#0MAG10	Main Turbine Condenser	Perform a condenser high level flood test **WITHOUT** fluorescein. First ensure that the turbine shaft temperature is below 155^{o}C, then fill the steam space up until the neck of the condenser (see Table 3 on page 30), inspect for defects according to check-sheet with document identifier HSIPO075, and list all visible defects/leaks which require repairing.	HSPPO256 HSIPO075	W	OPS MMD Turbines ROTEK Turbine Engineering

16	#0MAG10	Main Turbine Condenser	After all uncovered defects have been accounted for, drain the water in the steam space to a level just above the condenser tubes. Now perform a condenser low level flood test **WITH** fluorescein. Allow an 8-hour soaking period before the tubes and tube-sheets are to be inspected for leaks.	HSPPO256 HSIPO075	S	OPS MMD Turbines
17	#0MAG10	Main Turbine Condenser	After the 8-hour soaking period, visually inspect the condenser tubes with a blacklight (UV-A light) and try to identify any noticeable tube leaks. If any leaking tubes are evident, plug those tubes using expanded rubber plugs which have brass-bolts. **The tube-map diagram must be updated during this activity**	HSPPO256 HSIPO075	S	MMD Turbines
18	#0MAG10	Main Turbine Condenser	After leaking tubes have been plugged contact TED to verify that there are no remaining leaking tubes and that the tube map has been updated correctly.	HSPPO256 HSIPO075	H	MMD Turbines Turbine Eng.
19	#0MAG10	Main Turbine Condenser	Drain the steam space of the main condenser and flush to remove residual fluorescein. Ensure sufficient capacity of the outside plant dams prior to draining.	HSPPO256 HSIPO075	W	OPS
20	#0MAG10	Main Turbine Condenser	Ensure proper housekeeping by making sure the inlet, return and outlet water-boxes have been sufficiently cleaned. Thereafter box-up the condenser for centre-line activities. A total of 8x manhole covers to be closed on the inlet, return and outlet water-boxes. **Contact TED to sign the box-up certificate thereafter.**	HSIPMM580	W	MMD Turbines Contractor
21	#0MAG10	Main Turbine Condenser	De-isolate the condenser by removing blank flanges on the main CW ducting and charge the condenser with CW to service weight to allow for centreline alignment.	HSPPO216 HSPPO222	S	Steinmuller OPS

CONDENSER CW SPADES

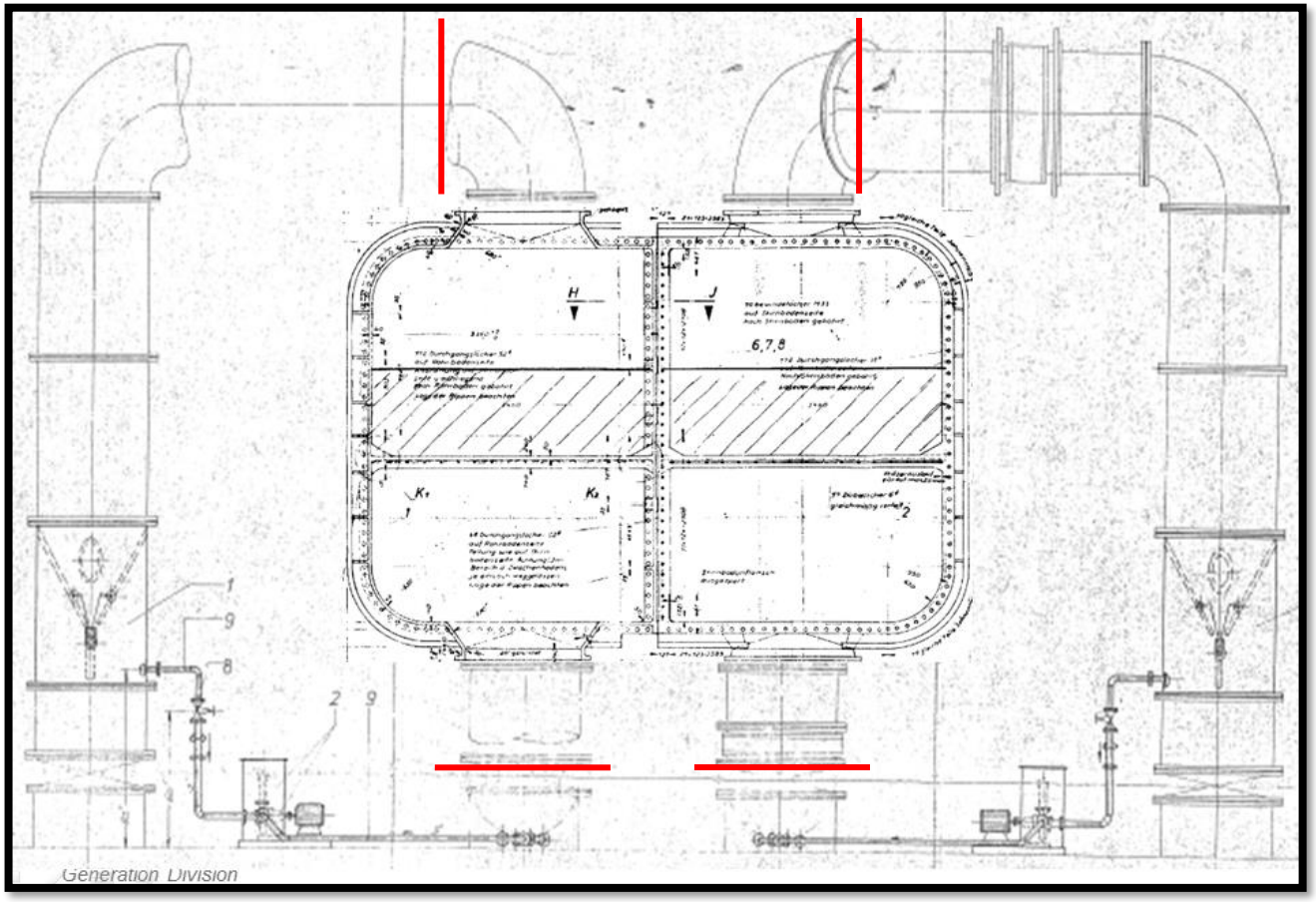

Figure 1: CW Ducting Blanks (Indicated in Red)

TABLE 3: VALVES TO BE IN PLACE TO ALLOW FOR CONDENSER STEAM SPACE FILLING	
KKS:	**Valve Description:**
#0LAB02 AA504	RFT Outlet Isolating Valve
#0LAB02 AA505	Condensate Make-Up Isolating Valve
#0LAB02 AA506	Condensate Make-Up C/V Inlet Isolating Valve
#0LAB02 AA002	Condensate Make-Up Control Valve
#0LAB02 AA402	Condensate Make-Up Drain Valve
#0LAB02 AA507	Condensate Make-Up C/V Outlet Isolating Valve
#0LAB02 AA508	Condensate Make-Up C/V Bypass Valve
#0LAB02 AA101	Condenser Over-rider Control Valve
#0LAB02 AA509	Condenser Over-rider Isolating Valve
#0LAB02 AA502	Condensate Dumping C/V Outlet Isolating Valve
#0LAB02 AA401	Condensate Dumping Drain Valve
#0LAB02 AA001	Condensate Dumping Control Valve
#0LAB02 AA501	Condensate Dumping C/V Inlet Isolating Valve
#0LAB02 AA503	Condensate Dumping C/V Bypass Valve
#0LAB02 AA301	Condensate Dumping Vent Valve
#0LAB02 AA512	Condensate Dumping Vent Valve

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