Eskom	Scope of Work	Hendrina Power Station

Title: **Condenser High/Low Pressure Water Jetting and Chemical Cleaning**

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1. SCOPE OBJECTIVE

The key objective of this outage scope is to assist the ESKOM business unit at Hendrina Power Station in achieving as well as sustaining 80% UCF, 10% PCLF and 10% UCLF to ensure the long-term availability and reliability of all its running Units.

1.1. SCOPE SUMMARY

This scope is provided as a guideline for Hendrina Power Station to conduct high or low pressure water jetting as well as chemical cleaning on all wet cooled shell-and-tube main turbine condensers in order to improve condenser performance, reduce/eliminate any load-losses which are allocated to poor condenser vacuum as well as to ensure the ongoing operation of Units 2, 4, 5, 6, 7, & 10 for years to come.

1.2. AIM OF SCOPE

The aim of this scope is to provide specific requirements regarding methodology, quality assessment, equipment & safety preconditions, as well as testing and optimization criteria to be considered when planning for either high- or low-pressure water jetting and chemical cleaning on main turbine condensers at Hendrina Power Station.

1.3. MAIN REQUIREMENT OF CONTRACT

Based on condenser performance trends, Hendrina Power Station may at any point in time call on the tendered *Contractor* to perform either high- or low-pressure water jetting, or chemical cleaning at any one of its running Units to reduce/eliminate any load-losses caused by poor condenser performance. The work will be planned for either long-term outage periods or short-term opportunity outages, based on the directive of the business unit.

2. BATTERY LIMITS

PLANT	START	END	EXCLUSIONS	INCLUSIONS	P&ID DRAWINGS
Condenser System	As per P&ID	As per P&ID	Piping	Valves, Waterboxes & Tubing	25.15/24245 & 24185

3. GENERAL ARRANGEMENT AND LOCATION DRAWINGS

№	DRAWING NUMBER	TITLE
1	18.5100.0226	Main Turbine Condenser

3.1. APPLICABLE CORPORATE/GENERATION GUIDELINES & STANDARDS

№	REFERENCE NUMBER	DOCUMENT TITLE
1	240-62196227	Eskom's Life Saving Rules
2	240-46243165	Procedure for Outage Management Plan for Execution & Finalisation Phases of an Outage
3	240-107677940	Specification Standard for High Pressure Water Jetting of Condenser and Heat Exchanger Tubes
4	240-56030499	Condenser Healthcare Guideline
5	240-56176026	Condenser Healthcare Standard
6	240-95112942	Condenser Process Design Guideline
7	240-56030508	Cooling Water System Healthcare Guideline

3.2. APPLICABLE HENDRINA POWER STATION PROCEDURES

№	REFERENCE NUMBER	DOCUMENT TITLE
1	HSPPM016	Outage Philosophy for Hendrina Power Station
2	HSIPMM580	Condenser and CW Side Water-box Inspection Procedure
3	HSPPO256	Condenser Flood Test Procedure
4	HSPPO216	Operating on CW System Procedure
5	HSPPO310	Minimum Requirements for Standard Isolations Units 1 to 5 Procedure – CW System (Includes Auxiliary Cooling)
6	HSPPO282	Minimum Requirements for Standard Isolations Units 6 to 10 Procedure – CW System (Includes Auxiliary Cooling)
7	HSPPMM280	Chemical Cleaning of the Main Turbine Condensers Procedure

4. GENERAL REQUIREMENTS

1. Ensure permits to work are issued for all covered plant areas.
2. Production and/or safety risk assessments to be compiled and approved before commencing with the execution of this scope.
3. ITPs (Inspection & Test Plans) or PQPs (Process Quality Plans) or QIPs (Quality inspections Plans) must be submitted to, and approved by, *Turbine Engineering* prior to executing the work.
4. All inspections, as required, must be captured via report documentation and must be made available to the appointed site *Engineer* as soon as possible.
5. Erect scaffolding as per the requirements of this SOW. Remove scaffolding upon completion of this SOW.
6. 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.
7. Upon box-up of plant equipment, the responsible *Contractor* is to reinstate the equipment labels to their correct designated locations, ensure proper housekeeping, and lastly submit a “Box-up certificate” to the appointed site *Engineer* for clearance.

INTERPRETATION AND TERMINOLOGY

The following abbreviations are used in this Service Information:

Abbreviation	Meaning	Abbreviation	Meaning
SOW	Scope of Work	MSDS	Material Safety Data Sheet
NEC	New Engineering Contract	HECR	Heat Exchanger Cleaning Report
HPWJ	High Pressure Water Jetting	MPI	Magnetic Particle Inspection
LPWJ	Low Pressure Water Jetting	DPT	Dye Penetrant Testing
QCP	Quality Control Plan	FAC	Flow Accelerated Corrosion
PPE	Personal Protective Equipment	TED	Turbine Engineering Department
OD	Outer Diameter	PS	Power Station

5. 1ST DETAIL SCOPE OF WORK

5.1. HIGH & LOW PRESSURE WATER JETTING REQUIREMENTS FOR CONDENSER TUBING

5.1.1. ACCEPTANCE CRITERIA

Note that for both HP and LP water jetting the acceptance criteria is that all foreign material must be removed from the inner walls of condenser tubing, i.e., in the case of HPWJ, the entire internal tube surface of every single condenser tube shall be completely cleaned to a uniform metallic colour with virtually no traces of hard scale & foreign deposits found on the inner surfaces of the tubes. And similarly, in the case of LPWJ, that all traces of mud and soft scale be completely removed from the entire internal tube surface of every single condenser tube.

This shall be validated by means of high-resolution endoscope inspections, which is to be provided by the *Contractor*. **Note that non-achievement of the aforementioned acceptance criteria shall be considered as non-conformance with respect to the contract.**

5.1.2. CONTRACTOR EXPERIENCE

Only *Contractors* experienced and specialised in the high & low pressure water jetting of turbine plant industrial grade heat exchangers will be considered for tender technical evaluation; i.e., heat exchangers located on coal fired power plants with a Unit capacity of 150MW or greater. Furthermore, the *Contractor* shall provide a verifiable reference list of any HP & LP water jetting cleaning contracts of which they used a minimum of a 1000bar & 150 - 350bar working pressure, respectfully, on industrial grade heat exchangers in the last 5 years. Note that verifiable references of at least three (3) projects successfully conducted in the past 5 years are required.

5.1.3. HP & LP WATER JETTING 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 HP & LP water jetting practices & standards to protect all personnel using high pressure equipment.
- ✓ HP & LP water jetting *Contracted Operators* shall be trained and certified by an independent industry recognised authority affiliated to either WJA or WJTA. No operator will be allowed to use water jetting lances on site without the required certification.
- ✓ All water jetting hoses, pressure accessories (e.g., nozzles), and pressure equipment (e.g., pumps) to be used on site must be able to withstand a minimum working pressure of 1000bar (100MPa). The general safety standard is that all equipment be pressure tested to 1.25 times its design pressure. Note that pressure test certificates no older than 6 months will be required for all high-pressure equipment to be used on site.

- ✓ All hose-end connections must be fitted with the appropriate "*hose-whip-checks*" to prevent injury to operating personnel by restraining the hose in the event of nozzle failure or an accident.
- ✓ The water jetting pump discharge lines shall be fitted with a calibrated pressure gauge and safety relief valve or rupture diaphragm to further ensure safety of personnel when working on the plant.
- ✓ 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 (240-62196227) is mandatory for all personnel involved with the cleaning 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 5.1.5. on page 5 of this document. The handheld pneumatic powered feeder shall be used at all times to ensure operators are not exposed to water jets when moving the lance from one tube to another.

5.1.4. HP & LP WATER JETTING MINIMUM EQUIPMENT 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 when performing HPWJ and 150 - 350bar working pressure when performing LPWJ. For tubes with an internal diameter between 15 and 20.5 millimetres the minimum nozzle flow rate shall be 33 litres/min.
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 HP & LP water jetting equipment supplier and must include technical datasheets for all types to be used on site. Those technical datasheets (in as much detail as possible) should indicate the maximum & minimum pressure rating of the HP & LP water jetting nozzles to be used on site, the outside diameter of the nozzles, and the tube inner diameter range the nozzle is intended for. The cleaning nozzle datasheets shall furthermore detail the design features of the cleaning nozzles for unblocking tubes and removing thick deposits of scale from inner tube walls when considering HPWJ. 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 datasheets shall be provided for HP & LP water jetting pumps to 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 and 350bar, respectfully, at a flow rate of 50 litres/min. Note that 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 volume flow of 50 litres/min per each of the cleaning nozzles attached to the pump while maintaining the specified discharge pressure.

4. The water jetting flexible hose from the foot-valve to the tube-cleaning-nozzle shall have a minimum internal diameter of 7 millimetres for tubes with an internal diameter of more than 20.5 millimetres. The maximum hose length is the condenser tube length (9 meters) plus an additional 7 meters, i.e., 16 meters in total. The foot-valve shall be positioned in the water-box at all times while water jetting is being performed. 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 / 1 centimetre.

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 a pump breakdown then a suitable replacement shall be affected within 2 hours.

6. **Under no circumstances is the tube-sheet or protruding tube-ends to be damaged during the HP & LP water jetting activities.** 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 water jetting cleaning activities an inspection shall be performed by the *Contractor Supervisor* and the appointed site *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 water jetting cleaning activity has been completed, any discovered damages thereafter will be at 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 5.1.3.

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" located on page 9.

9. The *Contractor* shall supply a suitable endoscope machine which complies, as far as possible, with the specifications listed in Table 1 on page 8 of the **SOW** to facilitate pre- and post-cleanliness inspections of the condenser tubes. At the very least, the endoscope shall have a 'reach-length' of no less than 9m, a camera diameter < 23mm, and should have a digital display that is capable of capturing images and recording videos in full detail. Equipment technical datasheets must be submitted for cross referencing.

Table 1: Specification for Minimum Requirements for Endoscope Machine

CAMERA MINIMUM REQUIREMENTS	
Camera Diameter	*< 23mm (condenser tube internal diameter)*
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; that being the North & South Inlets and the North & South Outlets.*		

5.1.5. COMMISSIONING TESTS AND OPTIMIZATION

Before any work can take place, the *Contractor* shall demonstrate the following to the appointed site *Engineer*:

- Provide all required certificates (equipment pressure tests, pressure gauge calibration, personnel training) as stipulated in section 5.1.3 on page 5.

- The appointed site *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 technical evaluation strategy (Document Number: 380-136359).

- The *Contractor* shall demonstrate to the *Engineer* that the water jetting 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 when considering HPWJ and 150 - 350bar when considering LPWJ. 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 while maintaining the specified discharge pressure.

- The *Contractor* shall demonstrate that the lance safety device (with a handheld pneumatic powered feeder) prevents the lance from withdrawing from the tube during a water jetting exercise to exhibit that it is safe for operators to use.

- Before starting with this production cleaning activity, the *Contractor* in consultation with the appointed site *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 5.1.1 of this document. *Engineering* will provide the 5 tubes for the exercise and as part of the test the *Contractor* must also demonstrate to the *Engineer* that the working pressure of the water jetting 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 as required. In such an event the nozzle resident/dwell-time may be further increased, and the '*bucket-test'* repeated. **This test must be performed in the presence of the appointed site *Engineer* and actual high-definition endoscopic inspections of all the cleaned tube sections will be required.** 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 tubes is evident once the test has been completed.

  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.

5.2. HIGH & LOW PRESSURE WATER JETTING

- As highlighted under point 4: “MAIN REQUIREMENT OF CONTRACT”, on page 2 of this document, the Station reserves the right to any point in time call on the tendered *Contractor* to perform either high- or low-pressure water jetting, or chemical cleaning at any one of its running Units to reduce/eliminate any load-losses caused by poor condenser performance. The scope below details the exact work orders to be followed to properly execute high- or low-pressure water jetting on main turbine condensers at Hendrina Power Station; the only difference being the required working pressure of the water jetting pumps. If high pressure water jetting is required, then a working pressure of 1000bar must be used. If low pressure water jetting is required, then a working pressure of 150 - 350bar must be used.

- High pressure water jetting is required to remove layers of hard scale from condenser tubing, while low pressure water jetting is simply a flushing exercise to remove mud and soft scale from condenser tubing. At Hendrina Power Station, North side Units typically require HPWJ and the South side Units LPWJ due to differences in cooling water chemistry.

5.2.1. SCOPE OF WORK

SUBSYSTEM		**MAIN TURBINE CONDENSER (CW SECTION)**				
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	Operating MMD Turbines

SUBSYSTEM		MAIN TURBINE CONDENSER (CW SECTION)				
COMPONENT ACTIVITIES						
№	COMPONENT FLOC (KKS CODE)	COMPONENT DESCRIPTION	ACTIVITY TYPE (INSPECTION / TEST / REFURBISH / REPLACE)	PROCEDURES	INTERVENTION POINTS (H/W/R)	TASK OWNERS
2	#0MAG10	Main Turbine Condenser	Install blank flanges on the main CW inlet ducting to the condenser, i.e., blanks must be installed at the T1's. Refer to Figure 1 on page 17.	HSPPMM280	S	MMD Turbines
3	#0MAG10	Main Turbine Condenser	TED to conduct initial 'dirty' inspection of the condenser inlet, return, and outlet water-boxes.	HSIHOS001 HSIPMM580	H	Turbine Engineering Department 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 HP / LP water jetting. Unblocking is required to allow free movement of the waterjet hand 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 expandable 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 Engineering Department

SUBSYSTEM		MAIN TURBINE CONDENSER (CW SECTION)				
COMPONENT ACTIVITIES						
№	COMPONENT FLOC (KKS CODE)	COMPONENT DESCRIPTION	ACTIVITY TYPE (INSPECTION / TEST / REFURBISH / REPLACE)	PROCEDURES	INTERVENTION POINTS (H/W/R)	TASK OWNERS
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	MMD Turbines
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 Engineering Department MMD Turbines Contractor
9	#0MAG10	Main Turbine Condenser	Close the four (4x) return water-box manhole covers in preparation for HP / LP water jetting of all 16444 condenser tubes.		S	MMD Turbines
10	#0MAG10	Main Turbine Condenser	Commence HP / LP water jetting on all condenser tubes. Ensure that the specified pump discharge pressure is **1000bar / 150 - 350bar** and that rotating nozzles are used. **Note: The specified pressure must not be exceeded!** 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.	240-56030530	S	Contractor Contractor

SUBSYSTEM		MAIN TURBINE CONDENSER (CW SECTION)				
COMPONENT ACTIVITIES						
№	COMPONENT FLOC (KKS CODE)	COMPONENT DESCRIPTION	ACTIVITY TYPE (INSPECTION / TEST / REFURBISH / REPLACE)	PROCEDURES	INTERVENTION POINTS (H/W/R)	TASK OWNERS
11	#0MAG10	Main Turbine Condenser	Post HP / LP water jetting, clean residual mud, fragments of scale, and all other debris out of the condenser's inlet and outlet water-boxes.		S	Contractor
12	#0MAG10	Main Turbine Condenser	TED to perform cleanliness inspection of all four condenser water-boxes as well as tube-sheets and conduct 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 Engineering Department MMD Turbines Contractor
13	#0MAG10	Main Turbine Condenser	Remove all scaffolding and plastic sheets from the two (2x) condenser inlet water-boxes.	HSIPMM580	S	MMD Turbines
14	#0MAG10	Main Turbine Condenser	Inspect all eight (8x) water-box manhole covers for damage / deteriorated seals. Repair / replace as required.	240-56030530	S	MMD Turbines
15	#0MAG10	Main Turbine Condenser	Perform a condenser high-level flood test **WITHOUT** fluorescein. Fill the condenser steam-space up until the neck of the condenser (See Table 3 on page 18). As per procedure HSPPO256, do not exceed the specified water level. Allow a 24-hour soaking period and then inspect for defects according to check-sheet with	HSPPO256 HSIPO075	W	Operating MMD Turbines Turbine Engineering Department

SUBSYSTEM		MAIN TURBINE CONDENSER (CW SECTION)				
COMPONENT ACTIVITIES						
№	COMPONENT FLOC (KKS CODE)	COMPONENT DESCRIPTION	ACTIVITY TYPE (INSPECTION / TEST / REFURBISH / REPLACE)	PROCEDURES	INTERVENTION POINTS (H/W/R)	TASK OWNERS
			document identifier HSIPO075, and list all visible defects/leaks which require repairing.			
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.	HSPPO256 HSIPO075	S	Operating MMD Turbines
17	#0MAG10	Main Turbine Condenser	As soon as the water level has been verified through the LP turbine inspection doors to be just above the tubes, climb into all the condenser waterboxes, one by one, and immediately plug any obvious leaking tubes with expandable rubber plugs to prevent the fluorescein from running down the tubesheet and contaminating the lower tubes. This will prevent false indications of tube leaks. Once completed, allow a 12-hour soaking period before the tubes and tube-sheets are to be inspected for small leaks.		W	MMD Turbines Turbine Engineering Department
18	#0MAG10	Main Turbine Condenser	After the 12-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. **The tube-map diagram must be updated during this activity.**	HSPPO256 HSIPO075	S	MMD Turbines

SUBSYSTEM		MAIN TURBINE CONDENSER (CW SECTION)				
COMPONENT ACTIVITIES						
№	COMPONENT FLOC (KKS CODE)	COMPONENT DESCRIPTION	ACTIVITY TYPE (INSPECTION / TEST / REFURBISH / REPLACE)	PROCEDURES	INTERVENTION POINTS (H/W/R)	TASK OWNERS
19	#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 Engineering Department
20	#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	Operating
21	#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
22	#0MAG10	Main Turbine Condenser	De-isolate the condenser by removing blank flanges on the main CW ducting (i.e., at the T1's) and charge the condenser with CW to service weight to allow for turbine centreline alignment.	HSPPO216 HSPPO222	S	MMD Turbines Operating

CONDENSER CW SPADES

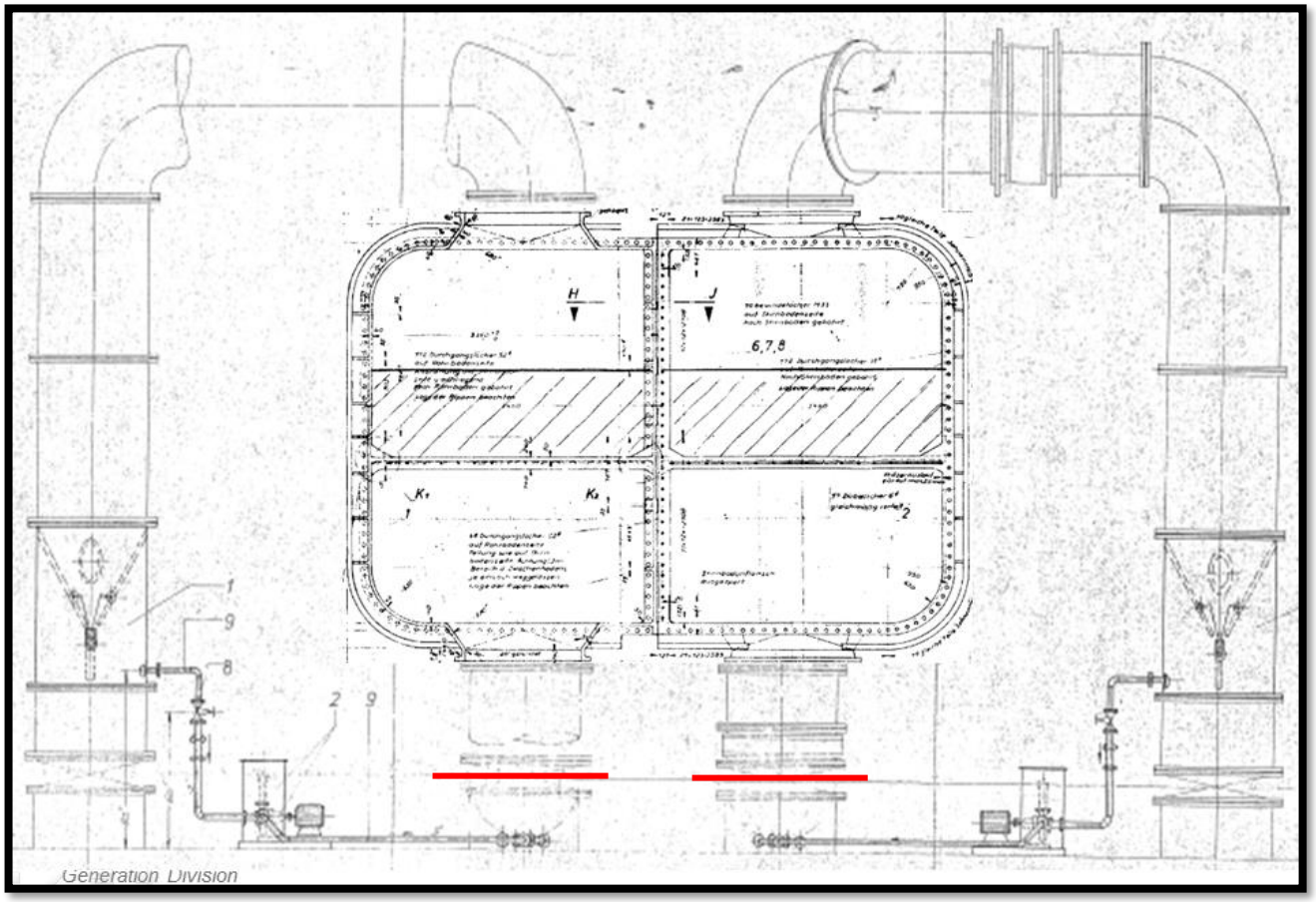


Figure 1: Blanks Positioning for Condenser CW Inlet Ducting (Indicated in Red)

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

6. 2ND DETAIL SCOPE OF WORK

6.1. CHEMICAL CLEANING REQUIREMENTS FOR CONDENSER TUBING

6.1.1. ACCEPTANCE CRITERIA

Note that the internal surfaces of all stainless-steel tubes contained within the condenser air-extraction zones shall be cleaned by means of HPWJ and LPWJ shall be performed on all remaining admiralty brass tubing to flush out the residual sludge that is left behind after chemical cleaning.

The acceptance criteria is that all foreign material must be removed from the inner walls of condenser tubing, i.e. the entire internal tube surface of every single tube shall be completely cleaned to a uniform metallic colour with no traces of corrosion product and/or scale deposits to be found on the tube inner surfaces after the chemical cleaning activity has been completed.

This shall be validated by means of high-resolution endoscope inspections which will take place at regularly occurring intervals during the cleaning activity as per QCP requirements. **Note that non-achievement of the stipulated acceptance criteria shall be considered as non-performance with respect to the NEC.**

6.1.2. CONTRACTOR EXPERIENCE

The *Contractor* shall provide a verifiable reference list of chemical cleaning contracts which includes HPWJ at minimum of 1000bar working pressure and LPWJ at minimum of 150 - 350bar working pressure of industrial grade heat exchangers in the last 5 years, i.e., heat exchangers located on coal fired power plants with a Unit capacity of 150MW or greater. Note that verifiable references of at least three (3) projects successfully conducted in the past 5 years are required.

Contractors who have been evaluated and pre-qualified to conduct chemical cleaning works by the *Employers* GT chemistry specialist in accordance with the requirements of the *Employers* guideline 240-107677940: “Specification Standard for High Pressure Water Jetting of Condenser and Heat Exchanger Tubes” shall submit the date, location and outcome of such an evaluation so that it may be properly reviewed and approved by the *Employer.*

6.1.3. CHEMICAL CLEANING MINIMUM SAFETY REQUIREMENTS

1. Access of personnel into condenser waterboxes shall only be authorised after the air oxygen levels inside each waterbox has been verified and determined to be suitable for safe access. The *Employer* will be responsible to conduct the air oxygen test.

2. The *Employer* ensures that suitable scaffolding is constructed to ensure safe access to the cleaning area.

3. The *Contractor* is required to familiarise all employees with the baseline health and safety risk assessment for the *works.*

4. The *Contractor* ensures compliance to the Occupational Health and Safety Act, 1993 Hazardous Chemical Substances Regulations, 1995 and that the appropriate procedures are available for the handling and disposal of hazardous chemicals proposed for the chemical cleaning operation. Contingency plans shall be in place to cater for any unforeseen accident, or chemical spillage.

5. The *Contractor* employed to conduct the chemical cleaning is subject to Section 10(3) of the Occupational Health and Safety Act, 1993 Hazardous Chemical Substances Regulations of 1995. The *Contractor* shall, as far as is reasonably practicable, provide the *Employer* receiving such substance, free of charge, with a MSDS in the form of Annexure 1 of the Act.

6. The *Contractor* with the assistance of the *Employer* ensures that every possible precaution is taken to minimise the risk of accidental physical contact with the cleaning solutions / chemical solvent or concentrated chemicals. In such incident, the contingency planning shall fully provide for decontamination as well as adequate first aid and medical facilities.

7. The following additional mandatory safety requirements are prescribed for every chemical cleaning operation:
(Refer to the *Employer's* Specification 36-149 "Coal fired boilers – post operation chemical cleaning"):

   - The *Contractor* will supply a safety shower close to the chemical pump station. The supplied safety shower will be tested prior to the commencement of chemical cleaning activity.

   - The *Contractor* will erect a shark net barricade to restrict entry to the pump station and concentrated chemical storage area and a hazard tape barricade around the entire area dedicated to the clean.

   - All personnel within the barricaded operational area are required to wear the appropriate safety equipment/clothing at all times:
     - Chemical Resistant Overall
     - Face Shield / Safety Glasses
     - Rubber Gloves
     - Chemical Resistant Apron
     - Safety Boots

   - The *Contractor* ensures that all of their personnel involved in the operation are issued suitable protective clothing.

   - All personnel involved in the chemical cleaning operation will wear clearly visible identity tags.

   - The *Employer's Safety Officers* are required to control access to the operational area during acid injections.

   - The *Contractor* will ensure flanged temporary connections are fitted with plastic sleeves to prevent acid sprays in the event that leaks occur.

   - The *Contractor* will provide lime or soda ash to neutralize acid spills and leaks.

- The *Contractor* will place warning signs at the appropriate locations as discussed with all stakeholders.
- The *Employer* ensures a first aider is present and medical staff is on stand-by during acid injections.
- The *Contractor* with the assistance of the *Employer* shall repair leaks that may occur during the clean.
- Solvent injection should preferably commence early in the morning, during normal office hours, to ensure the availability of resources should a solvent leak occur. Chemical injection is the most crucial step in the cleaning operation and the availability of adequate human resources is of great importance.
- A safety co-ordination meeting shall be held a week prior to the chemical clean: The following personnel or their representatives are required to attend:
    - *Employer's* System Engineer
    - *Employer*'s Project Coordinator (Maintenance or Outage Coordinator)
    - *Employer's* Chemical Services Manager
    - *Employer's* Generation Group Specialist
    - *Employer's* Power Station Safety Officer
    - Chemical Cleaning *Contractor*
    - *Employer's* Industrial Nurse
    - *Employer's* Environmental Officer

6.1.4. CHEMICAL CLEANING MINIMUM EQUIPMENT REQUIREMENTS

1. The *Contractor* shall provide the technical information and calibration certificates on the chemical cleaning equipment and indicate in a method statement how circulation flow will be sufficient to flow through all the tubes of the condenser but not exceed 0.3 m/s through individual tubes.
2. The *Contractor* shall provide the *Employer* with details and proof of calibration for the electronic recorder to be used to record the water-box pressures.
3. The *Contractor* shall state how the chemical cleaning pump(s) to be used on site could potentially discharge at a pressure of 2.5 bar or greater at 0m3/h flow during operation and shall specify the equipment that will be used to cut the power source to the pump(s) should the water-box pressure exceed 2.5 bar. The *Contractor* is expected to supply all calibration certificates for the equipment to be used.
4. The *Contractor* shall supply technical datasheets to the *Employer* for all the equipment that will be used to conduct chemical analysis for the dissolved species comprising of the primary alloying constituents of condenser tube material.

5. The *Contractor* shall also supply technical datasheets to the *Employer* for all the equipment that will be used to conduct analysis of the pH of the cleaning solution.

6. The *Contractor* shall provide the *Employer* with the Material Safety Data Sheet of the proposed solvent to be used for chemical cleaning operations.

7. The *Contractor* shall provide demonstrable evidence that key personnel working for the *Contractor* or *Sub-contractor*, whom will be responsible for the application of the corrosion resistant epoxy coating to the ends of the stainless-steel condenser air-extraction-zone tubes which protrude out from the tube-sheets, have previously, successfully, applied a corrosion resistant epoxy in power plant condenser water-boxes of a similar size in the previous 6 years. Additionally, the contractor shall supply expandable rubber plugs which have brass-bolts (or that of a suitable alternative) so that all 1512- stainless-steel tubes may be temporarily plugged at both ends of the condenser, i.e., 3024 plugs will need to be installed in the inlet and return condenser water-boxes before the chemical solvent can be administered into the condenser in order to protect the sections of stainless steel in the inlet waterboxes from chemical deterioration.

6.1.5. CHEMICAL CLEANING METHODOLOGY

A detailed description of the chemical cleaning *works* and constraints on how the *Contractor* conducts the cleaning *works* is provided below:

1. The *Employer* and *Contractor* conduct an initial inspection of the internals of the condenser to be cleaned. Using an endoscope machine, the *Employer* in consultation with the *Contractor* video-graphically documents the inner surface condition of the condenser tubes as well as photographically documents the amount of fouling and scaling on the tube-sheets and water-box walls. The *Contractor* includes the initial inspection findings and endoscope videos/photos in the Heat Exchanger Cleaning Report as discussed at the end of section 6.1.6 on page 25 of this document.
2. The *Contractor* removes all loose debris/foreign material from the water-boxes and tube-sheets to ensure all tubes are clearly visible prior to solvent injection. The *Contractor* ensures that water-boxes are free of debris as well as any additional objects that can hinder venting during the chemical cleaning operation.

3. The *Contractor* inspect vent and drain lines on the selected condenser to determine the risk of blockage and possible pressure build-up inside the condenser during a chemical cleaning operation. The *Employer* will, where necessary, remove strainers on the vent and drain lines prior to cleaning to mitigate the risk of blockage.

4. The *Contractor* unblocks all tubes of the condenser to be cleaned by means of rodding (using flexible tube rods). Tube unblocking is required to allow adequate circulation of the solvent and prevent possible tube leaks during the cleaning process.

5. The *Contractor* clearly marks all tubes which are identified as blocked, restricted, or obstructed during the rodding activity (using a permanent white marker) as well as on the tube-map diagram provided by the *Employer.*

Note: Marking of blocked tubes on the tube sheet by placing foreign debris (bolts, wires, etc.) in the tubes is regarded as unacceptable.

6. The *Contractor* assists the *Employer* in installing blank spades or flanges as required to allow for proper circulation of the solvent through all the condenser tubes. Blank-spades and isolating devices are required to prevent aggressive chemicals from contacting materials that are incompatible with the selected solvent.

    7.1. Additional precautions are required when chemical cleaning is conducted on the main condensers because of different tube materials (i.e., 304H stainless-steel tubes in the air extraction zones and general admiralty brass tubes).

    7.2. After the *Contractor* has completed HPWJ of the 1512 stainless-steel tubes the *Contractor* shall ensure that all protruding tube faces of the 1512 stainless-steel tubes are coated with a protective epoxy coating prior to the commencement of the chemical cleaning operation.

    7.3. The *Contractor* shall also ensure that the 1512 tubes of the extraction zone are plugged with suitable temporary rubber plugs prior to any chemical cleaning operation on the condensers, i.e., 3024 temporary plugs need to be installed in the inlet and return condenser water-boxes before the chemical solvent can be administered into the condenser.

    7.4. **The *Contractor* does not proceed with chemical cleaning of a main condenser unless these precautionary measures have been taken.**

7. The *Contractor* fits the necessary temporary connections of the pumping station to the main turbine condenser.

8. In all cases the water-box pressures shall be recorded by means of an electronic recorder with a recording frequency of no more than 30 seconds.

9. The *Employer* ensures that the required supports (‘condenser jacks’ – 8 off) are correctly fitted to the condenser in order to conduct the chemical cleaning operation.

11. The *Contractor* verifies that the shell-side of the condenser is filled with demineralized water prior to chemical cleaning. The *Employer* is responsible for the shell-side filling activity in order to ensure that any solvent which escapes from the tubes into the shell-side of the condenser is diluted and the risk of damage is minimised.

12. The tube-side of the condenser is filled with potable/raw water using the chemical cleaning pump station supplied by the *Contractor* and circulation is established without exceeding the specified discharge pressures, noting that the maximum water-box pressure is 2.5 bar.

13. The *Contractor* inspects the closed-loop system for any leaks and addresses defects prior to chemical injection.

14. An amount of water equivalent to the amount of solvent to be added to achieve the desired concentration is drained from the tube-side of the condenser by the *Contractor.*

15. Solvent injection occurs according to the reviewed chemical cleaning procedure / method statement supplied by the *Contractor*.

16. The *Contractor* proceeds with the solvent circulation and ensures adequate gas release. The process is terminated on the basis of chemical analysis, which indicates stability of the residual solvent strength of the bulk solution and there is no further increase in the concentration of the scale/deposit species in the bulk solution. Chemical analysis is conducted by both the *Contractor* and *Employer* during the cleaning operation.

17. The *Contractor* stops circulation and drains the spent solvent to the area designated by the *Employer* (usually the ash sump of the appropriate unit). The *Contractor* ensures all mineral acids are neutralised with lime at the discharge point.

18. The *Contractor* is required to fill and flush the condenser with potable/raw water until the residual conductivity is less than 100µS/cm above the potable/raw water quality.

19. The *Contractor* circulates the water and adds sufficient soda ash or tri-sodium phosphate to elevate the pH of this solution to 9.0 (±0.2). When the required pH is reached the *Contractor* circulates the solution for an additional 70 minutes to neutralise any residual acids and then drains the condenser.

20. The *Contractor* removes the temporary connections and temporary plugs from the condenser, and the *Employer* removes blank spades from the condenser.

21. The *Employer* drains the shell-side of the condenser. Should shell-side in-leakage have occurred during the cleaning operation, then the shell of the condenser will be flushed with demineralised water dosed with ammonia to elevate the pH to 9.1 (±0.2).

10. The *Contractor* flushes all tubes of the cleaned condenser to remove any remaining sludge, debris and scale fragments from the condenser.

11. The *Contractor* shall clean all water-boxes post chemical cleaning. All foreign materials and debris shall be removed from the water-boxes.

22. A condenser flood test is conducted by the *Employer* and tubes that have developed leaks are plugged with the appropriate plugs. The tube-map diagram shall be updated during this activity.

12. The *Employer* and *Contractor* conduct a post cleanliness inspection of the internals of the chemically cleaned condenser. Using an endoscope machine, the *Contractor* documents the condition and amount of fouling on the tube-sheets and tubes. The *Contractor* includes the final inspection findings and endoscope photos in the Heat Exchanger Cleaning Report.

13. The *Contractor* updates the tube-map diagram to include all plugs added post chemical cleaning and includes the final marked-up diagram in the Heat Exchanger Cleaning Report.

To ensure full comprehension of what is required, a more in-depth description of the chemical cleaning methodology has been included in the Appendix

6.1.6. ADDITIONAL REQUIREMENTS

1. 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.
2. The Contractor shall compile a final method statement, safety-works procedure and Quality Control Plan (QCP) and submit these documents to the Engineer for approval before chemical cleaning and HP-cleaning may commence. The Engineer shall have the opportunity to add witness or hold points on the QCP a week before the activity's scheduled start date.
3. All tubes which are blocked or obstructed, and which cannot be unblocked by HPWJ shall be marked on the tube-map diagram and shall be plugged using expandable rubber plugs which have brass-bolts (or that of an acceptable alternative).
4. The Contractor ensures sufficient flow during a chemical cleaning activity. Circulation flow shall be sufficient to flow through all the tubes of the condenser but shall not exceed 0.3 m/s through individual tubes.
5. The chemical cleaning pump/s of the Contractor shall produce a maximum pressure of 2.5 bar at 0 m3/h flow OR the equipment will contain electrical protections that will cut the power source to the pump/s should the water-box pressure exceed 2.5 bar. The correct operation of the protection equipment shall be confirmed by the Employer prior to each chemical cleaning operation
6. The Contractor shall maintain a daily logbook where all the required information (chemical analysis, water-box pressures, etc.) are logged.
7. 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.
8. The Contractor will not be allowed to use compressed air in order to assist in draining of a condenser.
9. The Contractor ensures the solvent concentration does not at any time exceed the prescribed concentration of 7.0% by mass and also ensures adequate reaction gas release during the cleaning operation.
10. The Contractor ensures that the free residual acidity of the cleaning solution does not decrease to below 4.0 % by mass at any time.
11. The Contractor shall add phosphoric acid at a strength of 0.25 to 0.5% when hydrochloric acid is used as the primary solvent, as it has been found to function as an inhibitor of the brass dezincification corrosion process.
12. The Contractor assists in the chemical analysis appropriate to the constituents in the type of scale being dissolved, as well as residual acid strength, performed by the Employer at a frequency of not less than once every 30 minutes.
13. The Contractor assists the Employer with the chemical analysis for the dissolved species comprising the primary alloying constituents of condenser tube material which shall be performed at a frequency not less than once every 70 minutes to monitor corrosion protection by the selected inhibitor.
14. The Employer will conduct analysis of the pH and K25 of the demineralised water in the steam space every 70 minutes to check for acid in leakage and may choose to stop the cleaning operation should excessive leakage occur.

15. The Contractor ensures that all mineral acids is neutralised with lime at the discharge point. All spills shall also be neutralised with lime / soda ash.

16. The Contractor ensures that records of all chemical analysis are kept and made available in the heat exchanger cleaning report.

17. The Contractor shall supply suitable endoscope machine to facilitate pre- and post- cleanliness inspections of condenser's stainless steel air extraction zone tubes before and after HPWJ, and of the condenser's admiralty brass tubes before and after chemical cleaning. After the inspections have been completed the Contractor shall capture all the video recorded inspection imagery within the Heat Exchanger Cleaning 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 shall be included within the Heat Exchanger Cleaning Report:

    1. The first section capturing the video recorded inspection imagery of the original condition of the tube-sheet and protruding tube-ends, taken before HPWJ and chemical cleaning commences.
    2. The second section capturing the 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 video recorded inspection imagery of the initial 'dirty' condition of the stainless-steel air-extraction zone condenser tubes in the inlet and return water-boxes, taken before HPWJ commences.
    4. The fourth section capturing the video recorded inspection imagery of the final clean-condition of the stainless-steel air-extraction zone condenser tubes in the inlet and return water-boxes after HPWJ has been completed.
    5. The fifth section capturing the video recorded inspection imagery of the initial 'dirty' condition of the admiralty brass condenser tubes in the inlet, return and outlet water-boxes, taken before chemical cleaning commences.
    6. The sixth section capturing the video recorded inspection imagery of the final clean-condition of the admiralty brass condenser tubes in the inlet, return and outlet water-boxes, taken after chemical cleaning 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 and chemical cleaning production activities. As specified at the end of section 6.1.5., the final marked-up tube-map diagram shall also be included in the Heat Exchanger Cleaning Report.

6.2. CHEMICAL CLEANING

6.2.1. DETAIL SCOPE OF WORK

SUBSYSTEM		MAIN TURBINE CONDENSER				
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	MAG10	Main Turbine Condenser	Scaffolding will be required at the locations listed below in order to allow for chemical cleaning of the condenser: 1. North & South CW outlet bellows (T2's) 2. North & South outlet water-box vents. 3. North & South return water-box vents. 4. North & South return water-box drain-lines. 5. North condenser air extraction pipework. 6. North CDT outlet to condenser connection. 7. Condenser level sight glasses.		S	Outages
2	MAG10	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	H	Operating Outages

SUBSYSTEM		**MAIN TURBINE CONDENSER**				
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)**
3	MAG10	Main Turbine Condenser	Install blank flanges on the main CW inlet and outlet ducting of the condenser, i.e., blanks must be installed at the T1's & T2's. Refer to Figure 1 on page 43.	HSPPMM280	S	Outages
4	MAG10	Main Turbine Condenser	Turbine Engineering to conduct initial 'dirty' inspection of the condenser inlet, return, and outlet water-boxes.	HSIHOS001 HSIPMM580	H	Turbine Engineering Department Outages Contractor
5	MAG10	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	Outages Contractor
6	MAG10	Main Turbine Condenser	Rod all the condenser tubes to ensure these tubes are not completely or partially blocked prior to chemical cleaning. Unblocking is required to allow adequate solvent circulation.	240-56030530	S	Outages Contractor
7	MAG10	Main Turbine Condenser	Tubes that cannot be unblocked shall be plugged with expandable rubber plugs which have brass-bolts. **The tube-map diagram shall be updated during this activity** (will be provided by Turbine Engineering).	HSIPMM580	S	Outages Contractor Turbine Engineering Department

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
8	MAG10	Main Turbine Condenser	Turbine Engineering to conduct preliminary endoscopic inspection of condenser tubes. **Contractor to make sure that they provide an endoscopic machine, the camera of which shall be able to travel the full-length of the tubes (i.e., 9 meters).**	HSIPMM580	H	Turbine Engineering Department Outages Contractor
9	PAB10 AA401	North Return Water-box Drain	Remove the two return water-box drain-lines and ensure these drains are unrestricted.	HSPPMM280	S	Outages
	PAB20 AA401	South Return Water-box Drain				
10	PAB15 AA503	North Inlet Water-box Drain	Remove the two inlet water-box drain-line strainers situated inside the inlet water-boxes, as well as the T-piece of the drain-lines located below the condenser and ensure pipework is unrestricted.	HSPPMM280	S	Outages
	PAB15 AA504	South Inlet Water-box Drain				
11	MAG10	Main Turbine Condenser	Install scaffolding in the two inlet water-boxes to cover the cooling water ducts.	HSIHOS001	S	Outages
12	MAG10	Main Turbine Condenser	Ensure all safety requirements such as barricading, notices, safety shower, etc. are met prior to high pressure water jetting and chemical cleaning.	HSPPMM280 36-149	H	Outages Contractor
13	MAG10	Main Turbine Condenser	Tubes that cannot be unblocked shall be plugged with expandable rubber plugs which have brass-bolts.	HSIPMM580	S	Outages Contractor

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
			Again, the tube-map diagram shall be updated during this activity.			
14	MAG10	Main Turbine Condenser	Install blanks on the steam space section of the condenser, as specified in Table 3 on page 45. Disconnect lines for sampling as indicated in Table 4 on page 46.	HSPPMM280	S	Outages
15	MAG10	Main Turbine Condenser	Close the 4x return water-box manhole covers in preparation for low- and high-pressure water jetting.		H	Contractor
16	MAG10	Main Turbine Condenser	Commence LPWJ on all 14928-condenser admiralty-brass tubes at a working pressure of 150 - 350bar. Forward facing nozzles are to be used. The purpose of LPWJ is not to remove scale from the tubes, but instead, to clear the tubes of any mud debris and/or blockages in preparation for chemical cleaning.	240-56030530	W	Contractor

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
17	MAG10	Main Turbine Condenser	Commence HPWJ on all 1512- stainless-steel tubes of the air extraction zones at 1000bar (see Figure 2, page 44). Rotating nozzles to be used. 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. Ensure that virtually all the scale is removed from these tubes as they will not form part of the acid cleaning. This to be confirmed by endoscope with Engineering representative present.	240-56030530	W	Contractor
18	MAG10	Main Turbine Condenser	Post HPWJ clean mud, fragments of scale, and any other anomalies out of the condenser's inlet and outlet water-boxes.	HSIPMM580	S	Outages Contractor
19	MAG10	Main Turbine Condenser	Contact Turbine Engineering to inspect stainless-steel tubes for cleanliness. **Contractor to make sure that they provide an endoscopic machine, the camera of which shall be able to travel the full-length of the tubes (i.e., 9 meters).**	HSIPMM580	H	Turbine Engineering Department Outages Contractor
20	MAG10	Main Turbine Condenser	Perform a condenser low level flood test **WITHOUT** fluorescein. Fill the condenser steam-space to a point just above the tubes (See Table 5 on page 47). As per procedure HSPPO256, **do not exceed the specified water level.**	HSPPO256 HSIPO075	H	Operating

SUBSYSTEM		**MAIN TURBINE CONDENSER**				
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)**
21	MAG10	Main Turbine Condenser	The plant shall be checked when filling the condenser steam space to identify any demineralized water leaks. If a leak is detected, filling shall be halted, and the leaks repaired.	HSPPO256 HSIPO075	W	Outages Turbine Engineering Department
NOTE: *The condenser steam space should NOT be filled up to the v-beam, as this requires additional blanks to be installed on the pipework entering the condenser neck. The water level should only cover the tube bundles and* ***florescence shall not be added as this will interfere with the steam space sampling.***						
22	MAG10	Main Turbine Condenser	Conduct a visual inspection of all 1512-stainless-steel tubes of the air extraction zones to identify any obvious tube-leaks. All leaking tubes to be plugged prior to chemical cleaning. Only use expandable rubber plugs which have brass-bolts. Also plug any leaking brass tubes. **Mark all permanent plugs** installed on the air extraction zone tubes and ensure the tube map is updated.	HSIPMM580	H	Outages Contractor
23	MAG10	Main Turbine Condenser	After leaking tubes have been plugged contact Turbine Engineering to verify that there are no remaining leaking tubes and that the tube map has been updated correctly.	HSPPO256 HSIPO075	H	Turbine Engineering Department Outages Contractor
24	MAG10	Main Turbine Condenser	Leave the demin-water used to conduct the tube leak test in the steam space in preparation for chemical cleaning.	HSPPO256 HSIPO075	W	Operating

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
25	MAG10	Main Turbine Condenser	Install temporary tube plugs on both the inlets and outlets of all 1512- stainless-steel tubes of the air extraction zones. Note that 3024 temporary plugs shall be installed, and all plugs shall have brass bolts.	HSPPMM280	H	Outages Contractor
26	MAG10	Main Turbine Condenser	Turbine Engineering to inspect that all temporary plugs have been fitted correctly to the stainless-steel tubes of the air extraction zone and will not dislodge during the chemical cleaning operation.	HSPPMM280	H	Turbine Engineering Department Outages Contractor
27	MAG10	Main Turbine Condenser	Blow-dry the protruding ends of all 1512-stainless-steel tubes as well as their respective tube plates so that epoxy coating can be applied to the moisture-free exposed surfaces. **Contractor to specify methodology for coating, including surface prep technique and type of coating to be used. Datasheets shall be included.**	36-1126 GSP36-1126	W	Contractor
28	MAG10	Main Turbine Condenser	Paint epoxy coating on the protruding ends of all 1512- stainless-steel tubes as well as their respective tube plates. Also coat any other exposed stainless-steel attachments which can be seen inside the condenser water-boxes (i.e., any stainless-steel supports or tube plugs with stainless-steel bolts, etc.)	36-1126 GSP36-1126	W	Contractor

SUBSYSTEM		**MAIN TURBINE CONDENSER**				
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)**
29	MAG10	Main Turbine Condenser	Ventilate the condenser to allow the epoxy coating to cure (**contractor to specify required curing time**).	36-1126 GSP36-1126	W	Contractor
30	MAG10	Main Turbine Condenser	Contact Turbine Engineering to inspect that coating has been applied correctly and that any other exposed stainless-steel attachments have been coated.	HSIPMM580	H	Turbine Engineering Department Outages Contractor
NOTE: *The material of the air extraction zone tubes, ducting expansion joints and water-box vent and drain strainers is Stainless Steel. This material is not compatible with chemical cleaning that uses hydrochloric acid as solvent. If these components are not protected from the solvent, chloride pitting damage will be the consequence.*						
31	PAB10 BR030	North Return Water-box Vent	Disconnect all condenser water-box vents upstream of the valves to allow chemical cleaning contractor to connect temporary pipework. 4x vents are to be disconnected. Refer to Table 6 on page 48. **All fasteners and gasket material shall be supplied to the contractor to connect temporary pipework.**	HSPPMM280	S	Outages
	PAB20 BR030	South Return Water-box Vent				
	PAB10 BR040	North Outlet Water-box Vent				
	PAB20 BR040	South Outlet Water-box Vent				
32	PAB10 AA401	North Return Water-box Drain	Connect / rig temporary pipework of the chemical pumping station to the vents and drains of the main condenser. 4x drains & 4x vents. Again, refer to Table 6 on page 48. Circulation shall be established with the Contractor's pump station, without exceeding the recommended operating pressure of the condenser water-boxes (i.e., 2.0 Bar).	HSPPMM280	S	Contractor
	PAB20 AA401	South Return Water-box Drain				
	PAB15 AA503	North Inlet Water-box Drain				
	PAB15 AA504	South Inlet Water-box Drain				
	PAB10 BR030	North Return Water-box Vent				
	PAB20 BR030	South Return Water-box Vent				

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
	PAB10 BR040	North Outlet Water-box Vent				
	PAB20 BR040	South Outlet Water-box Vent				
33	MAG10	Main Turbine Condenser	Box-up the condenser for chemical cleaning. Remove all scaffolding from the two condenser inlet water-boxes.	HSPPMM280	S	Contractor
34	MAG10	Main Turbine Condenser	A total of 8x manhole covers to be closed.		H	Contractor
35	MAG10	Main Turbine Condenser	Fill condenser cooling water side with potable / firewater and circulate. Turbine Engineering to witness the functionality of pump station 'over-pressure- protections', set at 2.5Bar.	HSPPMM280	W	Contractor Turbine Engineering Department
36	MAG10	Main Turbine Condenser	Inspect all temporary pipework connected to the pump, mixing tank and condenser vents and drains for leaks and fix accordingly.	HSPPMM280	I	Contractor Chemical Services
37	MAG10	Main Turbine Condenser	Commence solvent / acid injection. Chemical Services to be present during chemical injection.	HSPPMM280	W	Contractor Chemical Services
38	MAG10	Main Turbine Condenser	Monitor the chemical reaction as per procedure. Chemical services to indicate when draining and flushing can commence.	HSPPMM280	S	Contractor Chemical Services

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
39	MAG10	Main Turbine Condenser	Drain the cooling water side of the condenser and neutralise the waste according to procedure.	HSPPMM280	S	Contractor Chemical Services
40	MAG10	Main Turbine Condenser	Re-fill / flush the main condenser with potable or fire water and prepare for passivation.	HSPPMM280	S	Contractor Chemical Services
41	MAG10	Main Turbine Condenser	Inject passivation chemicals and commence final passivation of the condenser.	HSPPMM280	S	Contractor Chemical Services
42	MAG10	Main Turbine Condenser	Drain the cooling water side of the main condenser once the required conductivity and pH has been reached.	HSPPMM280	S	Contractor Chemical Services
43	PAB10 AA401	North Return Water-box Drain	Disconnect all temporary pipework attached to the condenser water-box vents and drains. 4x drains and 4x vents. Refer to Table 6 on page 48.	HSPPMM280	S	Contractor
	PAB20 AA401	South Return Water-box Drain				
	PAB15 AA503	North Inlet Water-box Drain				
	PAB15 AA504	South Inlet Water-box Drain				
	PAB10 BR030	North Return Water-box Vent				
	PAB20 BR030	South Return Water-box Vent				
	PAB10 BR040	North Outlet Water-box Vent				
	PAB20 BR040	South Outlet Water-box Vent				
44	MAG10	Main Turbine Condenser	If the demin water inside the steam-space is still found to be within spec (i.e., isn't severely contaminated with acid) after chemical cleaning then leave the water within for final high-level	HSPPO256 HSIPO075	S	Chemical Services Operating

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
			flood test inspection. Otherwise, drain the steam space of the main condenser. Ensure sufficient capacity of the outside plant dams prior to draining.			
45	MAG10	Main Turbine Condenser	Remove blank flanges / spades and reconnect sampling lines on the condenser steam space. Again, refer to Tables 3 & 4 on pages 45 & 46.	HSPPMM280	S	Outages
46	MAG10	Main Turbine Condenser	Open a total of 8 manhole covers on the inlet, return and outlet water-boxes. Manhole cover ø = 500mm	HSIHOS001	S	Outages
47	MAG10	Main Turbine Condenser	Install scaffolding in the two inlet water-boxes to cover the cooling water ducts.	HSIHOS001	S	Outages
48	MAG10	Main Turbine Condenser	Commence LPWJ on all 14928-condenser admiralty-brass tubes for the second time at a working pressure of 150 - 350bar. Forward facing nozzles are to be used. The purpose of LPWJ this time around is to clean residual sludge out of the inlet, outlet and return water-boxes of the condenser.	240-56030530	W	Contractor

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
49	MAG10	Main Turbine Condenser	Turbine Engineering to inspect main condenser water-boxes, tube-sheets, and to perform final endoscopic inspection of condenser tubes, post chemical cleaning. **Contractor to make sure that they provide an endoscopic machine, the camera of which shall be able to travel the full-length of the tubes (9m). Endoscope shall have video storage capability for record keeping, Files to be given to TED**	HSIPMM580	H	Turbine Engineering Department Outages Contractor
50	MAG10	Main Turbine Condenser	Remove the temporary plugs installed in the stainless-steel tubes of the air extraction zones.	HSPPMM280	H	Outages Contractor
51	PAB10 AA401	North Return Water-box Drain	Re-install the two return water-box drain lines to ensure these drains are unrestricted.	HSPPMM280	S	Outages
	PAB20 AA401	South Return Water-box Drain				
52	PAB15 AA503	North Inlet Water-box Drain	Re-install the two inlet water-box drain-line strainers situated inside the inlet water-boxes.	HSPPMM280	S	Outages
	PAB15 AA504	South Inlet Water-box Drain				
53	MAG10	Main Turbine Condenser	Turbine Engineering to inspect all water-box manhole covers (8x) for damage / deteriorated seals. Turbine Engineering to provide repair recommendations based on inspection findings.		H	Turbine Engineering Department
54	MAG10	Main Turbine Condenser	Perform a condenser high-level flood test **WITHOUT** fluorescein. Fill the condenser steam-space up until the neck of the condenser	HSPPO256	H	Operating

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
			(See Table 5 on page 47). As per procedure HSPPO256, **do not exceed the specified water level.** Allow a 24hours soaking period and then inspect for defects according to check-sheet with document identifier HSIPO075 and list all visible defects/leaks which require repairing.	HSIPO075		
55	MAG10	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.	HSPPO256 HSIPO075	W	Outages Turbine Engineering Department
56	MAG10	Main Turbine Condenser	As soon as the water level has been verified through the LP turbine inspection doors to be just above the tubes, climb into all the condenser waterboxes, one by one, and immediately plug any obvious leaking tubes with expandable rubber plugs to prevent the fluorescein from running down the tubesheet and contaminating the lower tubes. This will prevent false indications of tube leaks. Once completed, allow a 12-hour soaking period before the tubes and tubesheets are to be inspected for small leaks. After the 12-hour soaking period, visually inspect the condenser tubes with a blacklight (UV-A light) and try to identify any noticeable	HSIPMM580	W	Outages Contractor

SUBSYSTEM		MAIN TURBINE CONDENSER				
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)
			tube leaks. If any leaking tubes are evident, plug those tubes. **The tube-map diagram must be updated during this activity.**			
57	MAG10	Main Turbine Condenser	After leaking tubes have been plugged contact Turbine Engineering to verify that there are no remaining leaking tubes and that the **tube map has been updated correctly.**	HSPPO256 HSIPO075	H	Turbine Engineering Department Outages Contractor
58	MAG10	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.	HSPPO216 HSPPO222	H	Operating Chemical Services
59	MAG10	Main Turbine Condenser	Remove blank flanges / spades and reconnect sampling lines on the condenser steam space. Again, refer to Tables 3 & 4 on pages 45 & 46.	HSPPMM280	S	Outages
70	MAG10	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 waterboxes. **Contact TED to sign the box-up certificate thereafter.**	HSIPMM580	W	Outages Contractor
61	MAG10	Main Turbine Condenser	De-isolate condenser and charge with CW to service weight to allow for centreline alignment.	HSPPO216 HSPPO222	S	Operating

A. CONDENSER PREPERATION FOR CHEMICAL CLEANING

CONDENSER COOLING WATER SIDE:

1. Fix blank to the flange above the stainless-steel bellow of the left hand (LH) cooling water inlet pipework (LH T1 Line above Isolating Valve). Pipe OD = 1400mm.
2. Fix blank to the flange above the stainless-steel bellow of the right hand (RH) cooling water inlet pipework (RH T1 Line above Isolating Valve). Pipe OD = 1400mm.
3. Fix blank to the flange before the stainless-steel bellow (Condenser Side) of the LH cooling water outlet pipework (LH T2 line above the condenser water-box). Pipe OD = 1400mm.
4. Fix blank to the flange before the stainless-steel bellow (Condenser Side) of the RH cooling water outlet pipework (RH T2 line above the condenser water-box). Pipe OD = 1400mm.

NOTE: *If chemical cleaning of the turbine coolers is required, then the cooler CW supply and return lines will also require blank spades.*

CONDENSER STEAM SPACE:

1. North air suction Pipework on the condenser shell to be blanked at the condenser side inter-connecting flange. Pipe OD = 100mm.
2. South air suction Pipework on the condenser shell to be blanked at the condenser side inter-connecting flange. Pipe OD = 100mm.

NOTE: *Some units, e.g., Unit 07, do not have flanges on the air ejector suction pipework from the condenser. In this case, blanks should be installed on the Suction Valves of the North, South and Quick Start Air Ejectors.*

3. Drain-pipe from the clean drains tank on the North side of the condenser shell to be blanked at the shell interface (Condenser side). Pipe OD = 100mm.
4. The North condenser flash-box at basement level requires a blank at the bottom flange (Flash-box Condensate to Hot-well). Pipe OD = 300mm.

NOTE: *The steam from the flash-box enters the condenser neck and is above the tube bundles at the same level as the condenser filling valve and blanking of the top section of the flash box is not necessary.*

5. The condenser Filling Line that is situated on the North side of the condenser next to the North flash-box is utilised during the chemical cleaning and **SHOULD NOT BE BLANKED**. Pipe OD = 200mm. Ensure the filling line valve at the basement level is installed and the condenser can be filled with demineralized water.
6. The hot-well make up regulator situated on the hot-well on the Extraction Pump Side of the condenser is to be removed and blanked at top and bottom connection flanges with the condenser.
7. Both Extraction Pump A & B inlet isolating valves and bypasses are to be blanked off. The extraction inlet isolating v/v bypass valves are to be blanked on the condenser side.

8. The steam space drain situated underneath the condenser hot-well is to be blanked off at the valve outlet. The other blank flange & gasket underneath the hot-well is to be inspected and re-sealed if necessary.
9. Mowbrey Alarmer (Low Level) situated on the South side of the condenser hot-well **REMAINS** in place.
10. Mowbrey Alarmer (High Level) situated on the South side of the condenser hot-well **REMAINS** in place.
11. Mowbrey Alarmer (Emergency Trip) situated on the South side of the condenser hot-well **REMAINS** in place.
12. The bottom water level indication glass on the South side of the condenser is to be blanked off at the top and bottom after the isolation valves. Pipe OD = 20mm
13. The top water level indication glass on the South side of the condenser to be blanked off at the top and bottom after the isolation valves. Pipe OD = 20mm
14. Blank the two gland steam piping drains at the orifice flanges leading to the South condenser blow down vessel.
15. Blank the three turbine drain orifices leading to the HP Turbine Blowdown Vessel on the South Side of the condenser.
16. Ensure all turbine chest-drain valves are fully functional and in the closed position.
17. Ensure all the spray-water valves to the HP Turbine Blowdown vessel is fully functional and in the closed position.
18. Ensure all the silt trap flanges on the chest drain lines have been opened.

SAMPLING POINTS FOR CHEMICAL SERVICES:

1. Split the two ammonia dosing lines underneath the hot-well located on condensate extraction lines A & B after their isolating valves.
2. The line protruding from the lower sight glass to the level transmitter is to be split after the isolation valve.
3. The line protruding from the upper sight glass to the level transmitter is to be split after the isolation valve.

PREPERATION OF TEMPORARY CONNECTION POINTS:

1. Disconnect the T-Piece connecting the two inlet water-box drain lines at the flanges below the isolating valves. Pipe OD = 150mm.
2. Remove the two return water-box drain lines from the condenser water-box. Pipe OD = 50mm.
3. Disconnect the two return water-box vent lines. These vents should be split at the water-box interface. Pipe OD = 50mm.
4. Disconnect the two vent lines from the CW return ducting. The vents are situated before the stainless-steel bellows on the T2 pipework.

C. TECHNICAL PARTICULARS

CONDENSER CW SPADES

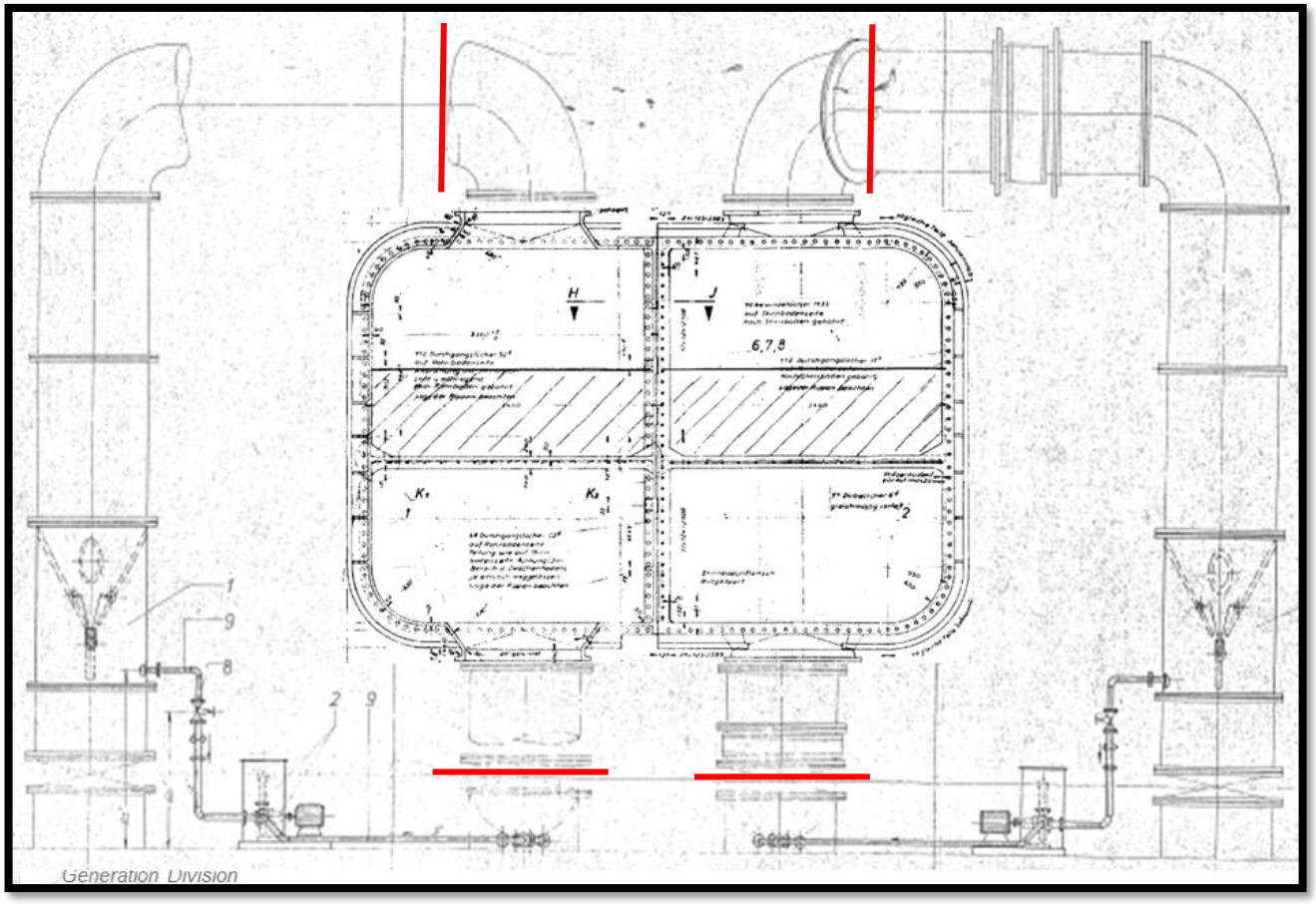


Figure 1: CW Ducting Blanks (Indicated in Red)

CONDENSER AIR EXTRACTION ZONE TUBES

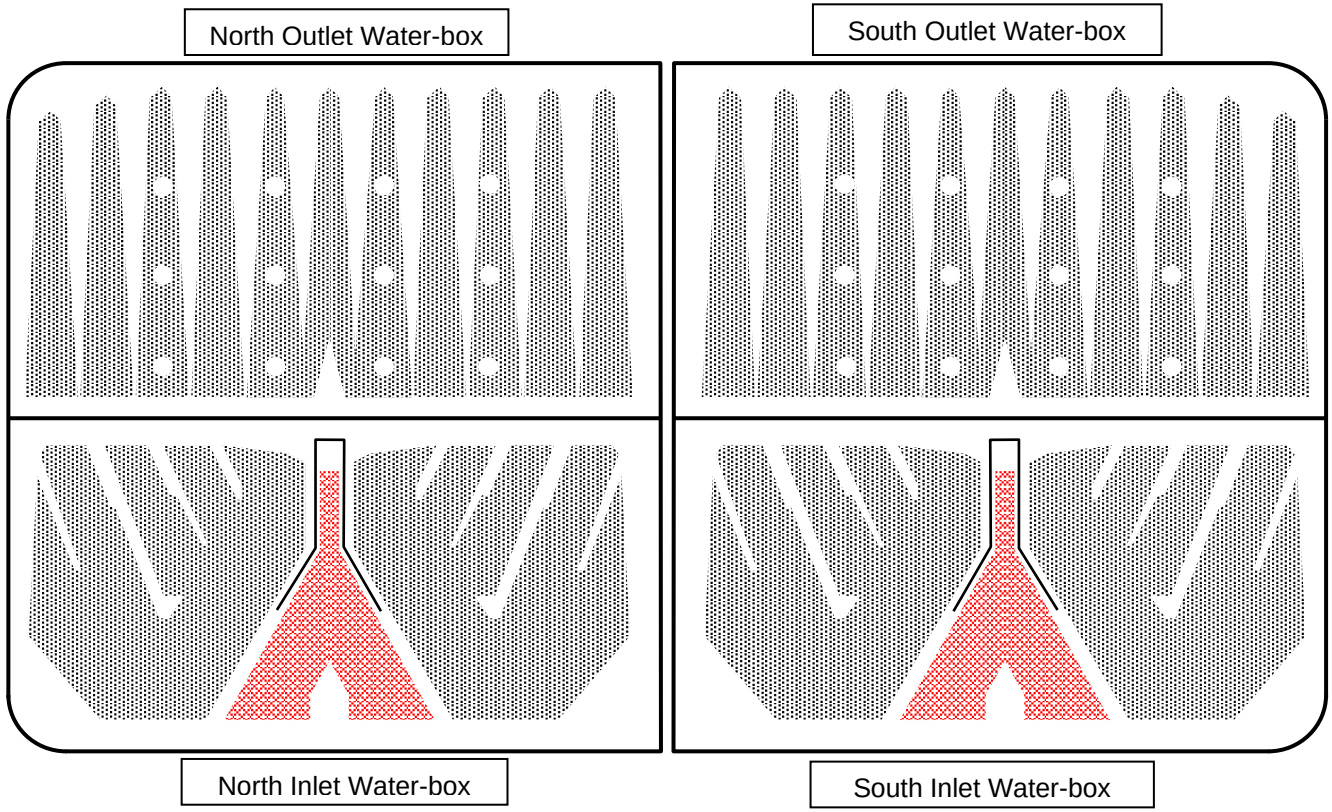


Figure 2: Stainless Steel Air Extraction Zone Tubes (Indicated in Red)

TABLE 3: CONDENSER STEAM SPACE ISOLATION FOR CHEMICAL CLEANING:	
Flanges to be blanked on the main condenser for chemical cleaning:	
Nr.	**Flange Description:**
1	North condenser air suction manifold at manifold connection
2	South condenser air suction manifold at manifold connection
3	CDT outlet pipe at condenser shell connection
4	North condenser flash-box at distillate outlet connection
5	Ensure the condenser make-up regulator is installed and secured.
6	Ensure blank flange below condenser make-up regulator is not leaking.
7	Extraction pump A at the condensate inlet isolating valve.
8	Extraction pump B at the condensate inlet isolating valve.
9	Extraction pump A condensate inlet isolating valve, bypass valve.
10	Extraction pump B condensate inlet isolating valve, bypass valve.
11	Ensure blank flange under condenser hot-well is not leaking.
12	Ensure blank flange is fitted to the outlet of the condenser hot-well drain valve.
13	Ensure the low level mowbrey alarmer is installed and secured.
14	Ensure the high level mowbrey alarmer is installed and secured.
15	Ensure the emergency trip mowbrey alarmer is installed and secured.
16	Remove the upper condenser sight glass – install 2x blanks at the top and bottom isolation valves.
17	Remove the lower condenser sight glass – install 2x blanks at the top and bottom isolation valves.
18	All steam chest-drain valves to be isolated / closed. Consult engineering should these valves have been removed during the outage.

TABLE 4: CONDENSER CHEMICAL CLEANING ANALYSIS POINTS:	
Flanges / Pipework to be split at the following location to allow chemical analysis:	
Nr.	**Flange Description:**
1	West condensate extraction ammonia dosing at isolation valve.
2	East condensate extraction ammonia dosing at isolation valve.
3	Lower condenser sight glass indication at isolation valve.
4	Upper condenser sight glass indication at isolation valve.

TABLE 5: VALVES TO BE IN PLACE TO ALLOW FOR CONDENSER STEAM SPACE FILLING	
KKS:	**Valve Description:**
LAB02 AA504	RFT Outlet Isolating Valve
LAB02 AA505	Condensate Make-Up Isolating Valve
LAB02 AA506	Condensate Make-Up C/V Inlet Isolating Valve
LAB02 AA002	Condensate Make-Up Control Valve
LAB02 AA402	Condensate Make-Up Drain Valve
LAB02 AA507	Condensate Make-Up C/V Outlet Isolating Valve
LAB02 AA508	Condensate Make-Up C/V Bypass Valve
LAB02 AA101	Condenser Over-rider Control Valve
LAB02 AA509	Condenser Over-rider Isolating Valve
LAB02 AA502	Condensate Dumping C/V Outlet Isolating Valve
LAB02 AA401	Condensate Dumping Drain Valve
LAB02 AA001	Condensate Dumping Control Valve
LAB02 AA501	Condensate Dumping C/V Inlet Isolating Valve
LAB02 AA503	Condensate Dumping C/V Bypass Valve
LAB02 AA301	Condensate Dumping Vent Valve
LAB02 AA512	Condensate Dumping Vent Valve

TABLE 6: CONDENSER CW VENT AND DRAIN CONNECTION POINTS

Component Description:	KKS Codification:
CONDENSER NORTH COOLING WATER BOX DRAIN VALVE	PAB10AA401
CONDENSER SOUTH COOLING WATER BOX DRAIN VALVE	PAB20AA401
CONDENSER NORTH COOLING WATER FILLING ISOLATING VALVE	PAB15AA503
CONDENSER SOUTH COOLING WATER FILLING ISOLATING VALVE	PAB15AA504
COOLING WATER RETURN NORTH VENT PIPE	PAB10BR030
CONDENSER WATER BOX NORTH VENT PIPE	PAB10BR040
COOLING WATER RETURN SOUTH VENT PIPE	PAB20BR030

7. DOCUMENTATION REQUIRED

- The *Contractor* shall compile a final method statement, safety work procedure and QCP and submit these documents to the *Engineer* for approval before HP-cleaning & LP-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 safety and equipment requirements (as defined in sections 5.1.3. (page 5), 5.1.4. (page 6), 6.1.3. (page 19) and 6.1.4.(page 21)) 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 HP / LP water jetting equipment suppliers will be regarded as acceptable.
- Technical datasheets for all the HP / LP water jetting pumps to be used on site which must indicate as a minimum, the flow rate of the pumps at 1000bar working pressure and 150 - 350bar working pressure, respectfully.
- 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).

8. TECHNICAL TENDER RETURNABLES

Please refer to the attached document: **"Tender Technical Evaluation Strategy – Condenser High/Low Pressure Water Jetting and Chemical Cleaning"** (Document Number: **380-136359**; Rev 1) 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, low pressure water jetting, and chemical cleaning 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 sections 7.2 to 7.7 of this scope of work (pages 5 to 48) before they commit to any three of the aforementioned on-site cleaning activities.

LP / HP Water Jetting Pumping Capacity/Resource

Pump #	Pump Identification	Pump Flow Rate (litres/min) at 1000bar / 150 - 350bar 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			

LP / HP Water Jetting Hose Inventory

Hose #	Hose Series or Part Number:	Hose Internal Diameter (mm):	Hose External Diameter (mm):	Maximum Working Pressure (bar):
1				
2				
3				
4				
5				
6				

LP / HP Water Jetting Nozzle Inventory

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

8. APPENDIX

IN-DEPTH CHEMICAL CLEANING METHODOLOGY

Activity	Responsible Department
1. Condenser Shutdown & Isolation: Chemical cleaning of the main condensers is only conducted during extended outages as all activities requires approximately 24 days. The unit shall be shut down prior to the cleaning operation. • Shut down the unit according to the specific operating procedure HSPPO353-R10: “Units 1-5 shut down and boiler force cooling” HSPPO218-R14 “Units 6-10 shut down and boiler force cooling”	Operating
Isolate the main condenser according to the relevant isolation procedure in order to obtain a PTW. • HSPPO310-R2: ”Standard Isolations Units 1-5 CW Systems” • HSPPO282-R2: ”Standard Isolations Units 6-10 CW Systems”	Operating
NOTE: *CW Back-up isolation is required to install the necessary blanks on the main condenser. A risk assessment is recommended to determine the impact of the reduction in CW flow to inter-connected running units.*	
2. Pre-Cleaning Activities: The following activities shall be completed once the main condenser has been isolated and drained in preparation for the chemical cleaning: • Install 4x blanks spades on the main CW ducting. The blanks shall be installed at the stainless-steel expansion joints of the ducting.	Outages

• Open all 8 access manholes on the condenser water-boxes. It is recommended to clean the Taprogge screens while the CW back-up isolation is enforced.	Outages
• Manually clean the water-boxes and tube-sheets of all foreign debris.	Outages
• Visually inspect the inlet/outlet and return water-boxes. The coating of the water-boxes shall be in a good condition prior to chemical cleaning.	Outages & Turbine Engineering Department
• The deflector plates in the outlet water-boxes shall be in a good condition. Remove any damaged deflector plates and manually clean the water-box area underneath the removed plates prior to chemical cleaning.	Outages
• Remove all stainless-steel CW vent and drain strainers from the water-boxes and ensure the associated pipework is unrestricted (Refer to Table 6 on page 48).	Outages
• Unblock all condenser tubes by means of rodding. Unblocking is required to allow adequate solvent circulation.	Outages
• Tubes that cannot be unblocked shall be plugged with suitable plugs. The relevant tube map diagram shall be updated.	Outages / Contractor
• Inspect the protruding ends of all condenser air extraction zone tubes on the inlet and outlet. The epoxy coating on the external tube surfaces shall be in a good condition. Touch-up or re-coat the tube ends if required (refer to Figure 3 on the next page).	Turbine Engineering Department

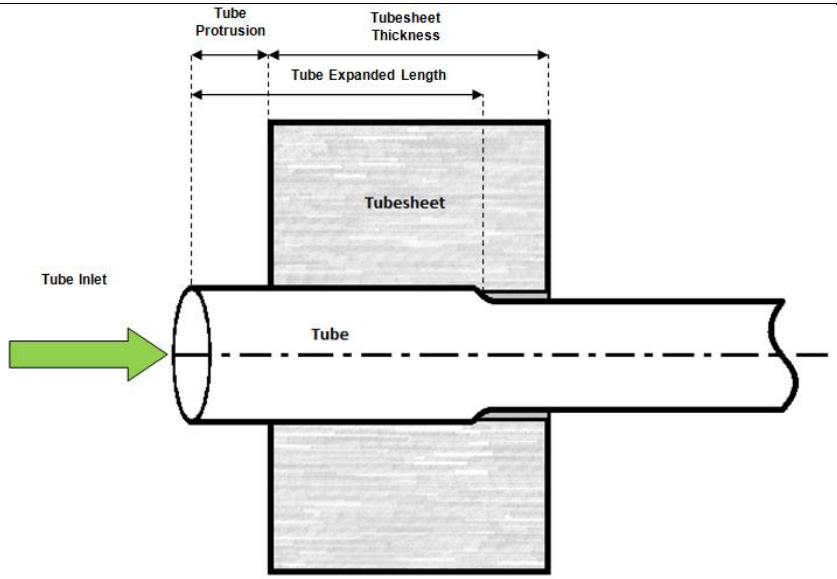


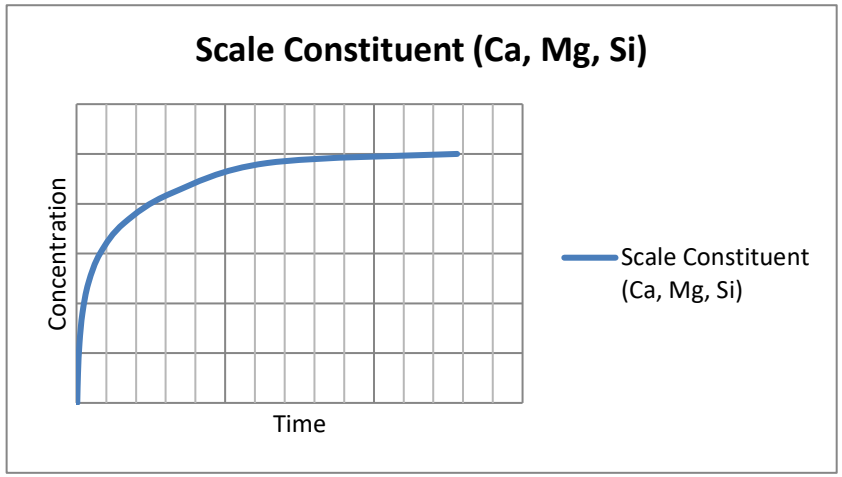
Figure 3: Tube Protrusion

NOTE: *The material of the air extraction zone tubes, ducting expansion joints and water-box vent and drain strainers is Stainless Steel. This material is not compatible with chemical cleaning that uses hydrochloric acid as solvent. If these components are not protected from the solvent, chloride pitting damage will be the consequence.*

• HPWJ shall be conducted on all air extraction zone tubes as the tube material is not compatible with hydrochloric chemical cleaning. Pressure washing of the general tubes is recommended to remove sedimentation and excess fouling.	Contractor
• Mark all permanent plugs installed on the air extraction zone tubes and ensure the tube map is updated and correct.	
• Install temporary tube plugs on both the inlets and outlets of all 1512 air extraction zone tubes. 3024 temporary plugs are to be installed.	Contractor / Turbine

• Inspect all temporary tube plugs installed. Ensure the plugs are secure and will not dislodge during the cleaning operation.	Engineering Department
• Install blank spades and disconnect select points for sampling on the steam side of the main condenser (see Tables 3 & 4 on page 45 & 46.	Contractor
• Inspect all steam space blanks prior to filling the condenser steam space.	Turbine Engineering Department
• Fill the condenser steam space with demineralized water until the tubes bundles are covered according to HSPPO256-R12 "Condenser Flood Test" (see Table 5 on page 47).	Outages
NOTE: *The condenser steam space should NOT be filled up to the v-beam, as this requires additional blanks to be installed on the pipework entering the condenser neck. The water level should only cover the tube bundles and florescence shall not be added as this will interfere with the steam space sampling.*	Turbine Engineering Department
• The plant shall be checked when filling the condenser steam space to identify any demineralized water leaks. If a leak is detected, filling shall be halted, and the leaks repaired.	Operating
3. Temporary Connections: Temporary connections are required to allow solvent circulation, adequate venting and drainage once the cleaning operation is completed. All fasteners and gasket material shall be supplied to the Contractor to connect temporary pipework.	
• The Contractor temporarily connects the chemical pump station to all the points specified in Table 6 on page 48.	Operating / Outages
• The CW side of the condenser is filled with potable / raw water using the chemical pump station.	

• Circulation shall be established with the Contractor's pump station, without exceeding the recommended operating pressure of the condenser water-boxes (2.0 Bar).	Contractor
• Witness correct operation of the electrical pressure protections on the pump station. The pressure may not exceed 2.0 Bar and the protections are required to trip the chemical circulation pumps, should this occur.	Contractor
• Inspect all temporary pipework for possible leaks. All leaks found shall be addressed prior to solvent injection.	Contractor
4. Chemical Cleaning:	
• Circulation is stopped and the amount of water, equivalent to the amount of acid to be added to achieve the desired concentration of 7.0% by mass, is drained off. The approximate treatment volume is 148.1 m^3	Turbine Engineering Department
• Commence circulation and acid injection. The acid concentration shall not be allowed to exceed 7.5% by mass at any time. Chemical analysis of the residual acid strength shall be conducted every 10 minutes until strength of 7.0% is reached.	Outages / Turbine Engineering Department / Contractor
• Acid injection should be stopped if the formation of excessive gas occurs in the solvent mixing tank. Injection can continue once the gas formation has been allowed to subside.	
• During acid circulation the chemical analysis shall be conducted to monitor the acid strength as well as the scale constituents (Ca, Mg & Si) no less than once every 30 minutes.	Contractor / Chemical Services
• Chemical analysis to monitor the pH of the demin water as well as the primary alloying constituents (Cu & Zn) shall be conducted no less than once every 70 minutes. ***NOTE:*** *Demineralized water samples are taken from the ammonia dosing connections, as well as the condenser sight glass connections.*	Contractor / Chemical Services
• Ensure adequate reaction gas release during solvent circulation.	

• Circulation is terminated when chemical analysis indicate that the residual acid strength of the bulk solution is stable at 4%, with no further increase in the concentration of calcium, magnesium and silica (see Figure 4 below).	Contractor / Chemical Services
	Chemical Services
Figure 4: Stable Scale Constituent Concentration	Chemical Services
• Drain the spent solvent to the ash sump of the appropriate unit and ensure that the waste is neutralised with lime at the discharge point.	Contractor
• Commence filling and flushing of the CW side with potable or raw water until the residual conductivity is less than 100 µS/cm above the raw or potable water conductivity. Ensure the CW vents are operated accordingly. • Circulate this water and add sufficient tri-sodium phosphate to elevate the pH of this solution to 9.0 (± 0.2).	Chemical Services / Contractor
• Circulate for a further 70 minutes to neutralise any residual acid then drain the solution.	
• Remove the temporary connections from the CW side of the condenser.	Contractor / Chemical Services

• Drain the demin water from 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).	Contractor / Chemical Services
NOTE: *Should tube leaks develop during solvent circulation, it is recommended to stop the cleaning operation as a preventative measure.*	Contractor / Chemical Services
• Remove all temporary steam side blanks and open the access manholes on the water-boxes of the main condenser.	Contractor / Chemical Services
• Flush any remaining sludge / dissolved scale from the tubes and clean the condenser water-boxes.	Contractor
• Remove all temporary plugs from the air extraction zone tubes. Take care to note dislodged plugs and ensure permanent plugs are not removed.	Chemical Services
• Inspect the water-box coating/lining and tube-sheet and report any signs of damage and deterioration.	
• Replace all removed outlet water-box deflector plates.	Outages
• Conduct a standard tube leak test as per HSPPO256-R12 “Condenser Flood Test”. All tubes identified as damaged / leaking shall be permanently plugged and the associated tube map updated.	Outages / Contractor
5. Commissioning:	Turbine Engineering Department / Contractor
• Re-install the two return water-box drain lines to ensure these drains are unrestricted.	
• Re-install the two inlet water-box drain line strainers situated inside the inlet water-boxes.	Turbine Engineering Department / Outages
• Re-instate all components removed for temporary connections.	
• Clean the inlet, return and outlet water-boxes of foreign debris and box-up for centre-line activities. A total of 8x manhole covers to be closed.	Outages

• Remove all scaffolding from within the two inlet condenser water-boxes. • Inspect all water-box manhole covers (8x) for damage / deteriorated seals. Repair recommendations based on inspection findings. • Establish Back-up isolation and remove CW blanks. Charge with CW to service weight once all access manholes have been closed and permits have been cleared.	Outages / Turbine Engineering Department Outages Outages Outages Outages / Contractor Outages Outages Operating