

	<b>Scope of Work</b>	<b>Duvha Power Station</b>
---	----------------------	----------------------------

Title: **Unit 1 Condenser Tube  
installation Scope of Work**

Unique Identifier: **ENS0077**

Alternative Reference Number: **N/A**

Area of Applicability: **Duvha Power  
Station**

Documentation Type: **Scope of Work**

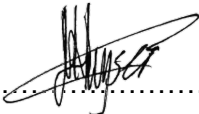
Revision: **2**

Total Pages: **58**

Next Review Date: **N/A**

Disclosure Classification: **CONTROLLED  
DISCLOSURE**

**Compiled by**



**W Huyser**

**Senior Engineer**

Date: 2022/03/01

**Functional Responsibility**



**H van Niekerk**

**Senior Consultant**

Date: 2022/03/01

**Authorised by**



**T Madonsela**

**Engineering Manager**

Date: 2022/03/03

## CONTENTS

	Page
<b>1. DESCRIPTION OF THE WORKS .....</b>	<b>5</b>
1.1 EXECUTIVE OVERVIEW .....	5
1.2 EMPLOYER'S OBJECTIVES AND PURPOSE OF THE WORKS.....	5
1.2.1 Scope of the Works .....	5
1.2.2 Overview of the plant.....	7
1.3 NORMATIVE/INFORMATIVE REFERENCES.....	8
1.4 DEFINITIONS.....	8
1.4.1 Disclosure Classification .....	9
1.5 ABBREVIATIONS.....	9
<b>2. THE CONSTRUCTION SITE .....</b>	<b>10</b>
2.1 SITE SERVICES AND FACILITIES .....	10
2.2 SUPPLY OF ELECTRICITY .....	11
2.3 SUPPLY OF WATER .....	11
2.4 SUPPLY OF COMPRESSED AIR.....	11
2.5 FACILITIES PROVIDED BY THE CONTRACTOR .....	11
2.6 HOOK UPS TO EXISTING WORKS .....	11
<b>3. EMPLOYER'S DESIGN .....</b>	<b>12</b>
<b>4. TO BE SUBMITTED BY THE CONTRACTOR.....</b>	<b>17</b>
4.1 DATA BOOK.....	17
4.2 QCP'S, METHOD STATEMENTS AND PROCEDURES .....	17
4.3 REQUIRED PROCEDURES .....	18
<b>5. GENERAL REQUIREMENTS FOR RE-TUBING THE CONDENSERS .....</b>	<b>19</b>
5.1 CODES AND STANDARDS .....	19
5.2 LUBRICANTS.....	19
5.3 ACCESS TO FACILITIES.....	19
<b>6. SPECIFIC REQUIREMENTS FOR RE-TUBING THE CONDENSERS .....</b>	<b>19</b>
6.1 TOOLING AND EQUIPMENT .....	19
6.2 STAKES INSTALLATION.....	20
6.2.1 Requirements for staking: .....	20
6.2.2 Contractor responsibility:.....	20
<b>7. RETUBE ACTIVITIES .....</b>	<b>21</b>
7.1 CONDENSER PREPARATION.....	21
7.1.1 General.....	21
7.1.2 Removal of Manway Covers .....	21
7.1.3 Scaffolding.....	21
7.1.4 Entry Points .....	22
7.1.5 Lighting.....	22
7.1.6 Water Spray System .....	22
7.1.7 Isolation of Cooling Water Supply .....	23
7.2 WATER BOXES .....	23
7.2.1 General.....	23
7.2.2 Piping and Water Box Removal .....	23
7.2.3 Water Box Repairs .....	23
7.3 TUBE PLUG REMOVAL.....	25
7.4 CONDENSER TUBE REMOVAL .....	26
7.4.1 Scrap Tubes .....	27

### CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

7.5 TUBESHEET INSPECTION AND PREPARATION .....	27
7.5.1 Tubesheet Cleaning .....	27
7.5.2 Tubesheet Inspection .....	28
7.5.3 Tubesheet Repairs .....	28
7.6 SUPPORT PLATE INSPECTION AND PREPARATION .....	29
7.6.1 Support Plate Cleaning .....	29
7.7 CONDENSER INTERNAL INSPECTIONS AND REPAIRS .....	30
7.8 CONDENSER TUBE INSTALLATION .....	31
7.8.1 General.....	31
7.8.2 Tube to Tubesheet Joint Expansion.....	33
7.8.2.1 The following formula will be used for wall thinning .....	33
7.9 TUBE-TO-TUBESHEET JOINT MOCK-UP TESTS.....	33
7.9.1 General.....	33
7.9.2 Min pull out force calculation .....	34
7.9.3 Mock-up / Pull out block test pieces .....	34
7.10 WATER BOX INSTALLATION .....	36
7.11 EMERGENCY DISTILLATE DRAIN MODIFICATION .....	37
<b>8. COMPLETION TESTING, COMMISSIONING AND CORRECTION OF DEFECTS .....</b>	<b>40</b>
8.1 SHELL FLOOD TEST AND WATERBOX LEAK TEST .....	40
8.2 FINAL INSPECTION .....	41
8.3 COMMISSIONING.....	41
8.4 ACCESS GIVEN BY THE EMPLOYER FOR CORRECTION OF DEFECTS .....	41
8.5 PERFORMANCE TESTS AFTER COMPLETION .....	41
8.6 TRAINING AND TECHNOLOGY TRANSFER .....	41
8.7 OPERATIONAL MAINTENANCE AFTER COMPLETION .....	42
<b>9. TESTS, TEST CERTIFICATES AND INSPECTION.....</b>	<b>42</b>
9.1 NDT .....	42
9.2 NON CONFORMANCES.....	42
9.3 QUALITY CONTROL PLAN .....	42
9.3.1 Inspections and Tests .....	43
9.3.2 Quality Responsibility .....	43
<b>10. MANDATORY RETURNABLES .....</b>	<b>44</b>
<b>11. RETURNABLES USED FOR TECHNICAL EVALUATION .....</b>	<b>44</b>
11.1 GENERAL: .....	44
11.2 STAKES SUPPLY AND INSTALLATION .....	45
11.3 COATING OF WATERBOXES.....	45
<b>12. AUTHORISATION .....</b>	<b>48</b>
<b>13. REVISIONS .....</b>	<b>48</b>
<b>14. DEVELOPMENT TEAM .....</b>	<b>48</b>
<b>APPENDIX A : STAKE SPECIFICATION .....</b>	<b>49</b>
<b>APPENDIX B : RTD/MAT/19/199 .....</b>	<b>53</b>
<b>APPENDIX C : RUBBER GASKET MATERIAL DATA SHEET .....</b>	<b>58</b>

## FIGURES

Figure 1: Tubesheet drill pattern.....	15
Figure 2: Hot condenser support plate spacing.....	15
Figure 3: Cold condenser support plate spacing .....	16
Figure 4: Layout of Inlet and Outlet Ducts .....	16

## CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Figure 5: Typical Spray Water System .....	23
Figure 6: Photograph of typical spherical carbide ball burr .....	30
Figure 7: Typical Pull-Out Test Apparatus.....	35
Figure 8: Typical Pull-Out Test Apparatus.....	36
Figure 9: Typical Gasket Dove tail jointing .....	37
Figure 10: Proposed Arrangement in Condenser.....	38
Figure 11: Cold Condenser Left Hand Side .....	50
Figure 12: Cold Condenser Right Hand Side .....	50
Figure 13: Hot Condenser Right Hand Side.....	50
Figure 14: Hot Condenser Left Hand Side .....	51
Figure 15: Stake length clarification and tubesheet drill pattern.....	51
Figure 16: Hot condenser support plate span length. ....	52
Figure 17: Cold condenser support plate span length.....	52

## TABLES

Table 1: High Level Scope of Responsibilities .....	6
Table 2: Current Nominal Condenser Design Data. ....	12
Table 3: Tube amounts supplied by the Employer for the Hot Condenser .....	13
Table 4: Tube amounts supplied by the Employer for the Cold Condenser.....	14
Table 5: Tube expansion data example .....	33
Table 6: Condenser Modification Schedule of Materials .....	38
Table 7: Tools list.....	45

## CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

## **1. DESCRIPTION OF THE WORKS**

### **1.1 Executive Overview**

The six steam condensers at Duvha Power Station contain admiralty brass tubes in the condensing zones and copper nickel tubes in the air- extraction zones. Over the decades since installation, these tubes have deteriorated to the point where replacement is necessary. It is therefore required that the remaining condensers be re-tubed.

The scope of work covers the refurbishment 100% of unit 1 main turbine condenser (one main condenser comprise of two CW passes), to ensure plant integrity and availability.

The scope will include the removal of old brass tubes and installation of new brass tubes in the condenser. The tubes will be free issue from the *Employer*. The scope will also include the refurbishment of the water boxes, shell, tubesheets, support plates, stay-bars, emergency drain baffles, air extraction lines and the expansion joints between the turbine and condenser. The replacement of the waterbox (inlet, outlet and intermediate) rubber lining with coating and waterbox door seals will be included.

### **1.2 Employer's Objectives and Purpose of The Works**

The objectives of the 100 % re-tube (Hot and Cold Condenser) project are to eliminate the UCLF caused by condenser tube leak incidents, reduce chemical excursions and to improve the main condenser availability and reliability.

#### **1.2.1 Scope of the Works**

This Works Information defines the minimum requirements to be achieved by the Contractor in carrying out the condenser re-tube work. The Contractor removes the old tubes and installs the new tubes supplied by the Employer as well as supply (cold condenser only) and install anti-vibration stakes (both hot and cold condenser).

The Contractor refurbishes the condenser shell, tube plates, tubesheets, stay bars and execute the drain baffles modification, as detailed elsewhere in this document. Replacement of door seals will be the responsibility of the contractor. Replacement of rubber lining with coating on the waterboxes and coating on the staybars in the intermediate waterbox, will also be the responsibility of the Contractor.

It is the Contractor's responsibility to acquaint him/her with the layout and construction of the condensers. All relevant and available condenser data is included in Table 2.

This Works Information details the minimum quality, testing, inspection, certification, and cleaning requirements, and these are to be supplemented by the Contractor's suggested actions based on inspections.

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

The Contractor is responsible for compliance with all of the detailed requirements presented in this Works Information. Approval of any drawings, specifications, and procedures by the Employer or its representatives shall in no way relieve the Contractor of these responsibilities.

Scale on the internal diameter of the tubes has reduced the tube inner diameter to the extent that it may be difficult the insert extraction spears. Scrap tubes remain the property of the Employer who will dispose of them. Contractor shall transport old tubes to indicated laydown area.

The following table outlines the high level scope of work:

**Table 1: High Level Scope of Responsibilities**

Scope of Work	Responsible Person
Transport of new tubes from storage area to condenser	Contractor
Application for permit to work	Employer
Issue permit to work for condenser	Employer
Isolation of condenser	Employer
Supply of new tubes	Employer
Installation of spades in CW ducts and installation of blanks in all pipe openings at the bottom of the condenser. Material for and spading of openings	Contractor
Opening of condenser doors will form part of the contractor scope. This includes new door seals and o rings for the stay bars. The sealing surface must be vacuum blasted and coated with a 50 micron epoxy coating before the seal is reinstalled	Contractor
Scaffolding	Contractor
Load test of temporary crawl beams and rigging structures <b>(NB. In case permanent crawl beams are not used)</b>	Contractor
Load test of permanent crawl beams and rigging structures	Employer
Waterbox door opening, removal and replacement	Contractor
Weld repairs	Contractor

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Tubesheet inspection, Blast 70 mm into each tube to remove scale and coating before tube removal	Contractor
Removal of existing tubes	Contractor
Support plate inspection	Contractor
Tube to tubesheet joint mock up tests	Contractor / Employer
Tube installation and tube to tubesheet joint seal	Contractor
Supply and Installation of anti-vibrational stakes (Contractor's responsibility to a design to satisfy the staking requirements) including the stakes installation tools (supply will be limited to stakes for the cold condenser as the Employer already has one set of Hot condenser stakes)	Contractor
Waterbox door seal procurement and installation	Contractor
Blow bullet test (fill factor 95%) on 10% of installed tubes after tube expansion before waterboxes are replaced. Replace tubes found to be restrictive of bullet test.	Contractor
Removal of spades and blanks in steam space as well as CW spades. Final cleaning of steam space	Contractor
Steam space (demin) high level test	Contractor/Employer
Tube side (CW) waterbox leak test	Contractor
Final inspection	Contractor/Employer
Removal of waterbox coating application	Contractor
Waterbox coating and waterbox repairs	Contractor
Wall thickness testing to be conducted on all the tie-rods, supports, inlet drain baffles, air cooling boxes and air extraction piping where visible erosion occurred. Repairs will be done on members with more than 30% wall loss.	Contractor
Transport of scrap brass tubes to on site storage area.	Contractor

### 1.2.2 Overview of the plant

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Each Duvha Power Station Unit has one main condenser, consisting of a hot and cold condenser. The cooling water is received from the cooling towers into the condenser inlet waterboxes from where it flows through the cold condenser tubes to the intermediate waterbox and then flows through the hot condenser tubes to the outlet waterbox where it returns to the cooling towers. Latent heat contained in the LP turbines exhaust steam is transferred to the cooling water flowing through the condenser tubes. By removing the heat from the steam inside the condenser, the steam condenses and creates a vacuum suitable for LP turbine operation.

### 1.3 Normative/Informative References

- [1] ISO 9001 Quality Management Systems.
- [2] GGR 0992 Plant Safety Regulations.
- [3] GGS0462 Quality Requirements for Engineering and Construction Work in Generation.
- [4] OHSACT Occupational Health and Safety Act of 1993
- [5] 240-106628253 Standard for Welding Requirements on Eskom Plant
- [6] 240-83539994 Standard for Non Destructive Testing (NDT) on Eskom Plant
- [7] 240-101712128 Standard for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings
- [8] 240-55864767 Chemistry Standards for Cooling Water
- [9] HEI 11<sup>th</sup> edition Heat Exchange Institute Standards for Steam Surface Condensers

### 1.4 DEFINITIONS

Definition	Description
Eskom	Eskom Holdings SOC Limited, its divisions and wholly owned subsidiaries.
Cold Condenser	The condenser bundles which receive the cooling water directly from the cooling towers and discharge the cooling water into the intermediate water boxes.
Hot Condenser	The condenser bundles which receive cooling water from the cold condenser via the intermediate water box and discharge cooling water back to the cooling towers.

### CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



Definition	Description
Intermediate Water box	The waterbox positioned between the hot and cold condensers and which transfers cooling water from the cold condenser to the hot condenser.
(Turbine Generator) Unit	Boiler, Turbine, generator, cooling system, precipitator and including all auxiliary and ancillary plant and systems associated with the above.

#### 1.4.1 Disclosure Classification

**Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

#### 1.5 Abbreviations

Abbreviation	Description
ASTM	American Society for Testing and Materials (Now ASTM International)
ANSI	American National Standards Institute
BS	British standard
CEP	Condensate Extraction pump
CC	Cold condenser
CW	Circulating (Cooling) Water
EDMS	Eskom Document Management System
HC	Hot Condenser
HEI	Heat Exchange institute
HPH	High Pressure Heater
ID	Internal Diameter
ISO	International Standards Organization
LP	Low Pressure
NEC	New Engineering Contract
NDT	Non Destructive Testing

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Abbreviation	Description
MPI	Magnetic Particle Inspection
OD	Outside Diameter
PPE	Personal Protective Equipment
PT	Dye Penetrant Non-destructive Test
PQR	Procedure qualification Record
QA	Quality Assurance
QC	Quality Control
QCP	Quality Control Plan
SANS	South African National Standards
SHEQ	Safety, Health, Environment and Quality
UCLF	Unplanned Capacity Loss Factor
UNS	Unified Numbering System
UT	Ultrasonic Testing
WBS	Work breakdown Structure
WPS	Weld Procedure Specification

## 2. THE CONSTRUCTION SITE

### 2.1 Site Services and Facilities

- The *Employer* provides a non-covered laydown area for boxes of tubes. Protection of these boxes against weather damage and theft is the *Contractors* responsibility. A Site for the *Contractor's* yard will be provided within a reasonable period after access to the *works* (the exact position will be determined on Site). The *Contractor* is responsible for further treatment of the yard area that he considers necessary. The *Contractor's* layout of its yard is subject to approval by the *Employer*. The *Contractor* shall not occupy areas other than that allocated to him by the *Employer*.
- The *Contractor* is responsible for the transport of the new tubes from Duvha stores to the site.
- The *Contractor* is responsible for all materials stored in his yard and for all activities which occur in his yard including compliance with environmental risks and conditions.

### CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- On completion of the works, the yard and all areas allocated to the *Contractor* shall be re-instated to their former condition to the satisfaction of the *Employer*.

## **2.2 Supply of Electricity**

The *Employer* shall supply the *Contractor* with a temporary 220/230/380 Volt AC electricity supply free of charge from the closest existing point of supply. The cost of cabling from point of supply to the *Contractor's* yard / offices shall be borne by the *Contractor*. The cost of additional connection or points shall be borne by the *Contractor*. The *Contractor* makes provision for the necessary extensions and plug points. Any changes made to existing supplies shall be for the *Contractor's* account.

## **2.3 Supply of Water**

The *Employer* shall supply the *Contractor* with reasonable quantities of raw water and potable water required for the purposes of this contract. Demin water will also be made available for the high level tests. The *Contractor* provides, at its own cost, all connection equipment necessary to lead the water from the *Employer's* point of supply to where it is required. Such fittings must be compatible with the *Employer's* fitting to prevent galvanic corrosion. The *Contractor* is responsible for maintaining the equipment and removing it on completion of the works.

## **2.4 Supply of Compressed Air**

The Employer will provide station air; however the continuous uninterrupted supply at minimum 4 Bar cannot be guaranteed. The *Contractor* shall make provision in the pricelist for air compressor to be used on site.

## **2.5 Facilities Provided by the Contractor**

The *Contractor* provides facilities within his own yard, office, storeroom, and canteen. He connects facilities such as water, electricity and communications, to points supplied by the *Employer*.

## **2.6 Hook Ups to Existing Works**

The *Contractor* to take cognisance of the fact that other work will happen in the turbine plant during this outage. The *Contractor* shall attend the daily outage meeting to give feedback on progress and attend to interfaces with other work.

Existing works will consist of the condenser shell and turbine. Work on the turbine will be done at the same time as the condenser is being re-tubed, and platforms to be erected to cover the steam entry channel separating the turbine and the condenser shell so that re-tube work can be carried out safely.

**3. EMPLOYER'S DESIGN****Table 2: Current Nominal Condenser Design Data.**

Design	Hamon Sobelco
Type	Double vacuum straight tube type
Tube material	Admiralty brass 70.29.1 – BS 2871 part 3 – CZ 111
Number of passes	2
Tube material (air extraction zone)	BS 2871 – part 3 – CB102 – CuNi 90/10
Cooling Surface	CC: 13364 m <sup>2</sup> ; HC 15384 m <sup>2</sup>
Number of tubes	CC: 22552 ; HC: 23730
Tube outside diameter	19mm (tolerance on diameter is $\pm 0.2032$ mm )
Tube inside diameter	17 mm
Tube length	CC: 9 995mm ; HC: 10 925mm
Steam quantity	168.73 kg/s
Water velocity in the tubes	2 m/s
Cooling water temperature	22 °C
Design vacuum	CC: 5.8 kPa ; HC: 8.7 kPa
Steam shell	Carbon steel BS1501-151 grade 23
Waterboxes	Carbon steel BS1501-151 grade 23 lined with rubber
Tubesheets	ACIER STEEL BS 1501 – 151 Grade 23A (26 mm thickness) complete with NOX STAINLESS STEEL AISI 304 (4 mm width), cladding on the carbon steel tube plate. The cladding is on the CW side of the tube plate.
Tubesheet and support plate tolerances	Tubesheet:  19mm+0.05mm (minimum)  19mm+0.25mm (maximum)  Support plates:

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

	<p>19mm+0.2mm</p> <p>19mm+0.5mm</p> <p>CC Tube support plates: 9 (for the spacing refer to Figure 3: Cold condenser support plate spacing)</p> <p>HC Tube support plates:10 (for the spacing refer to Figure 2)</p>
Tolerances of new tubes (For tube dimensions see table 4 below) – (free issue by Employer)	<p><b>Outside diameter:</b></p> <p>The outside diameter tolerance for the tubes will be:</p> <p>+ zero (plus tolerance)</p> <p>- 0.2032mm (minus tolerance)</p> <p><b>Wall thickness</b></p> <p>The thickness tolerance is to be a minimum thickness</p> <p>+ 0.1016mm (plus tolerance)</p> <p>- zero (minus tolerance).</p>

**Table 3: Tube amounts supplied by the Employer for the Hot Condenser**

Item nr	Description	Quantity
1	<p>Admiralty brass 70.29.1 – BS 2871</p> <p>part 3 CZ111</p> <p>Outside diameter: 19mm</p> <p>Wall thickness 1mm</p> <p>Length 10.960m</p>	22518+1%

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

2	CN102 – CuNi 90/10 BS 2871 part 3  Outside diameter: 19mm  Wall thickness: 1mm  Length: 10.960m	1212+1%
---	---	---------

**Table 4: Tube amounts supplied by the Employer for the Cold Condenser**

Item nr	Description	Quantity
3	Admiralty brass 70.29.1 – BS 2871 part 3 CZ111  Outside diameter: 19mm  Wall thickness 1mm  Length 10.030m	21340+1%
4	CN102 – CuNi 90/10 BS 2871 part 3  Outside diameter: 19mm  Wall thickness: 1mm  Length: 10.030m	1212+1%

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

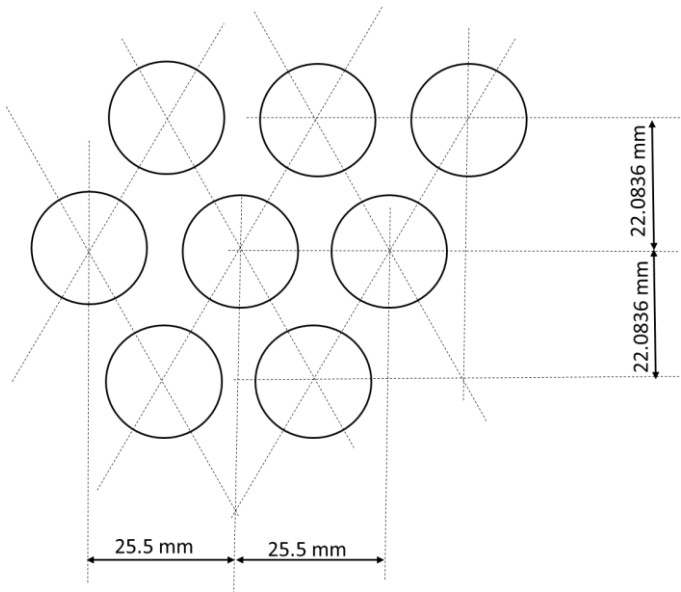


Figure 1: Tubesheet drill pattern

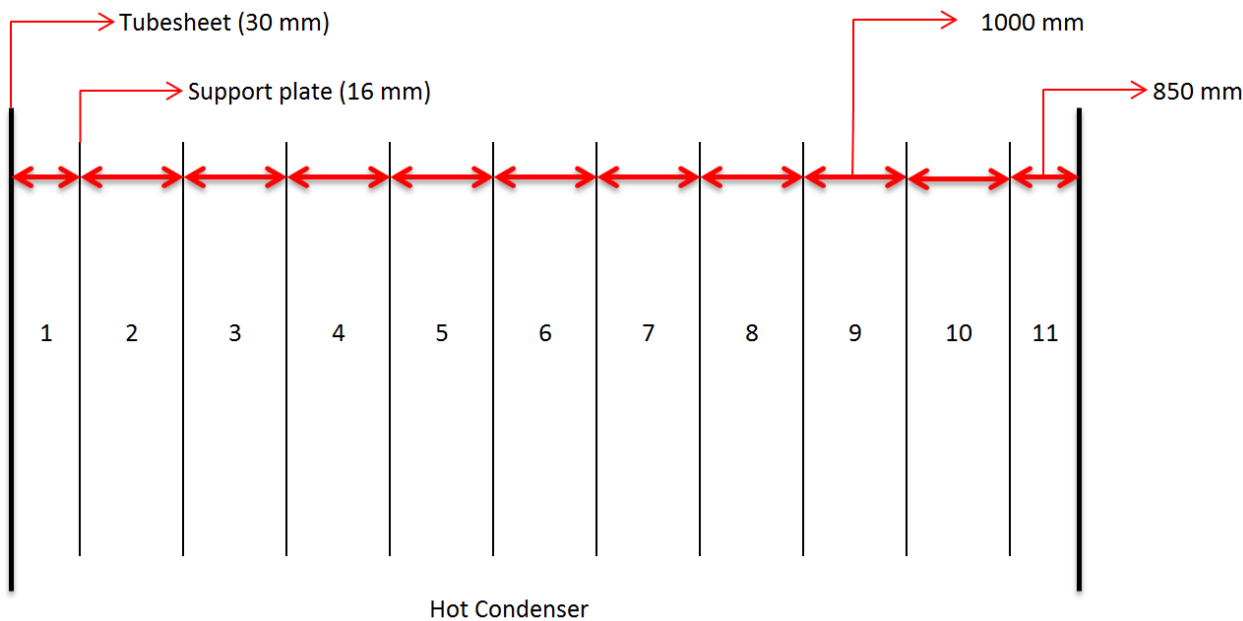
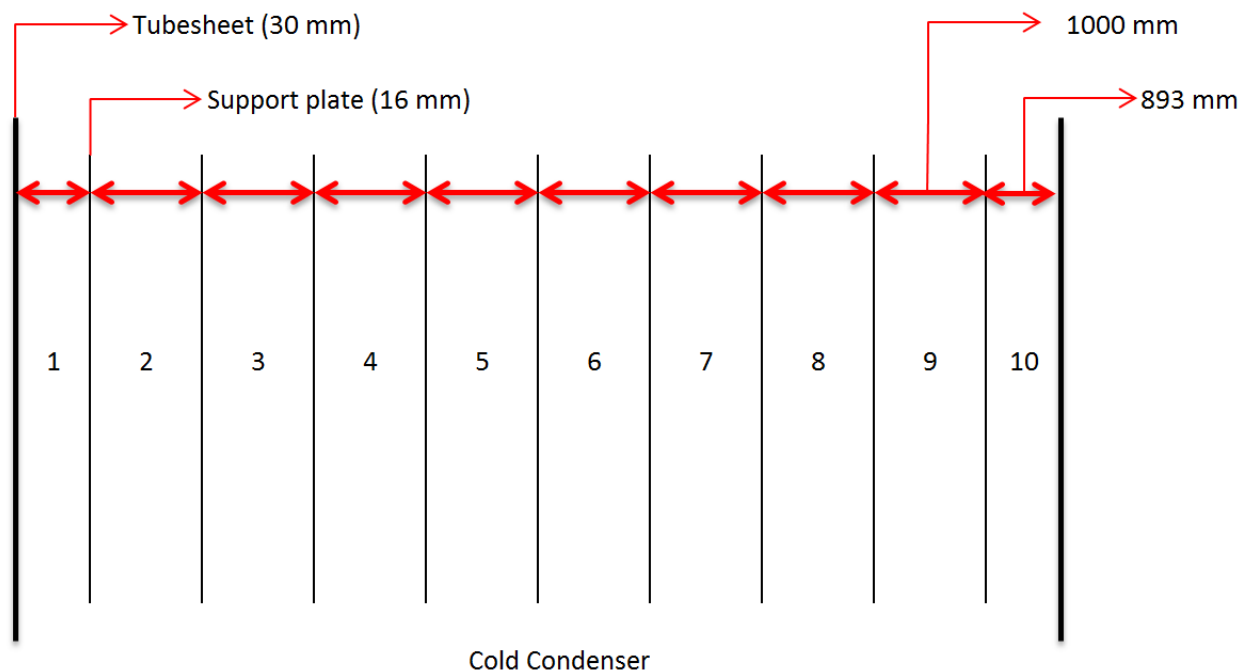


Figure 2: Hot condenser support plate spacing

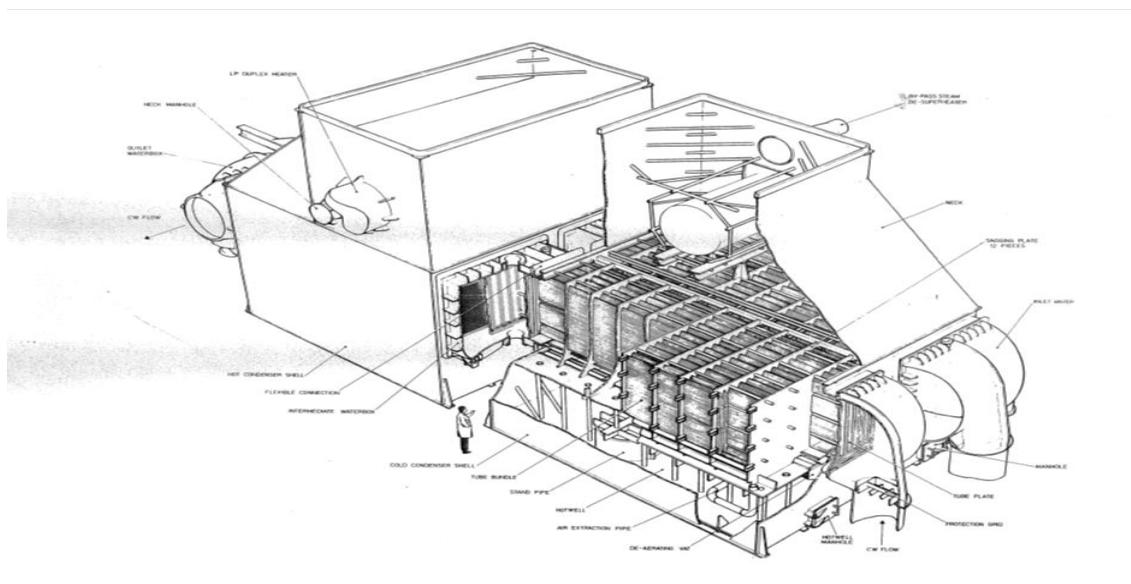
**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



### Figure 3: Cold condenser support plate spacing

The condensers consist of a total of four sections, namely two high pressure and two low pressure sections. Each section is of the single pass cooling water arrangement. There are two sections per water pass, one low and one high pressure as shown in Figure 4 below.



### Figure 4: Layout of Inlet and Outlet Ducts

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



## **4. TO BE SUBMITTED BY THE CONTRACTOR**

### **4.1 Data Book**

The *Contractor's* scope of work includes but is not limited to providing the following documentation in accordance with QM169:

- Set of drawings which record tube expansion and tube plugging maps as well as tube expansion records in Excel format.
- Copies of all inspections & test reports & photographs as specified.
- Non-conformance reports.
- Cleanliness clearance certificate.
- Generic reports on all other findings and corrective measures used.
- Blow 95% fill factor bullet test report
- Completed QCP's
- Copies of all procedures and method statements
- NDT operator qualifications
- WPS, PQR and welder qualifications
- Certificate of Manufacture, NDT Reports, Material certificates, consumable Certificates, Weld repair maps
- Organogram specific reference to be made to personnel performing expansions, QC and supervisors.
- List of names and signatures of employees that read the Works Information. The list should include site supervisor, safety supervisor, QC's supervisors, team leaders and new employees
- A Map indicating the length of welding that was performed to be included in data book.
- Certificates of free Issue tubes to be included in data book. Certificates will be supplied by Employer.

### **4.2 QCP's, Method Statements and Procedures**

QCP's, method statements and procedures shall be issued to the *Employer* for acceptance. QCPs shall be issued to the *Employer* to mark up with witness and hold points. The method statements shall address the following minimum key activities. Intervention points as per method statement will be indicated on a QCP.

- Approval of procedures
- Mock up and pull out test

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- Mark solid plug position on tube map
- Activities for tube removal
- Cleaning of support plates
- Cleaning of tubesheet and measure holes
- Go-No-Go test of tubesheet
- Condenser steam side inspection
- Condenser waterbox side inspection
- Activities as per tube installation
- Stakes installation (both condensers) and supply (cold condenser)
- Expansion register
- Tubesheet straightness checks (3 off)
- Blow 95% fill factor bullet test.
- Coating of tubesheets
- Flood test condenser steam space
- Leak test CW waterboxes and pipework

#### **4.3 Required Procedures**

- Waterbox removal rigging study
- Tube removal & scrap removal & storage
- Tube transportation & handling from storage
- Tubesheet hole cleaning
- Tube installation
- Tube expanding
- Tubesheet mock-up & tube pull out test
- Tube plugging
- Grit blasting and Coating
- Flood test of steam space
- Cooling water side leak testing
- Rigging of the doors
- Stake installation procedure
- Scaffolding
- Plug removal (solid and flexible)
- Welding related procedures

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

## 5. GENERAL REQUIREMENTS FOR RE-TUBING THE CONDENSERS

### 5.1 Codes and Standards

Editions of codes, standards, and recommended practices referenced herein shall be those in effect on the date of the purchase order. The fabrication, inspection, testing, and materials for all components, equipment, and apparatus shall be in full compliance with the following unless otherwise specified:

- Adherence to all state and local laws, codes and regulations shall be the responsibility of the *Contractor*.

In the event of any apparent conflict among codes and standards and this *Works Information*, the *Contractor* shall notify the *Employer* to obtain written resolution of such conflict prior to proceeding with work.

No departure from the *Works Information* shall be binding on any party until an addendum or revision to this *Works Information* has been issued by the *Employer*, or the *Employer* has approved the deviation through its Supplier Deviation Request Process.

### 5.2 LUBRICANTS

Lubricants used shall not result in inter granular or other forms of corrosion of the tubes, or carbonisation of lubricant during expansion process. Lubricant shall be water soluble.

### 5.3 Access to Facilities

The *Employer* and/or representatives of the *Employer* shall, during normal working hours, be provided with access to the *Contractor's* facilities for the purpose of obtaining information on production progress, determining status, visual inspection of materials and equipment to determine conformance to specifications and drawings, and witnessing tests and inspections. Such access shall include full access to inspection records and work areas directly concerned with the works.

## 6. SPECIFIC REQUIREMENTS FOR RE-TUBING THE CONDENSERS

### 6.1 Tooling and Equipment

All required tooling, as per Table 7, shall be available which has been developed against the specific requirements of large surface condenser re-tubing projects. Such tooling reduces the risk of damage to critical components (e.g. tubesheets and support plates) and also reduces outage duration required to complete the re-tubing process.

### CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

It is the responsibility of the *Contractor* to ensure the correct tooling and equipment is used in order to satisfactorily complete this project. The *Contractor* will be required to demonstrate knowledge of the operation and maintenance of the tooling and provide evidence that they have access to the required tooling and equipment to complete the project. The minimum tool quantities as indicated in Table 7 shall be submitted by the *Contractor* 8 weeks before the contract access date for the condenser, for inspection by the *Employer*. The minimum tool quantities shown in the table is the minimum compulsory equipment that needs to be on site for the total duration of the specific condenser under refurbishment. These tools will not be removed from site to assist any other condenser refurbishments project, which runs concurrent with this contract.

## **6.2 Stakes Installation**

The procurement of the stakes is specified in Appendix A of this contract. Supply of the stakes, stakes tooling and installation of these stakes will form part of this contract. The Supply of stakes shall be limited to the cold condenser stakes as the *Employer* will free issue a set of hot condenser stakes. The installation shall be done not only at the cold condenser but also at the hot condenser.

### **6.2.1 Requirements for staking:**

- Hot condenser has 10 sagging plates which equate to 11 bays. The bays next to the tube plates will not be staked – thus staking is required for 9 bays only.
- The Cold condenser has 9 sagging plates which equate to 10 bays. The bays next to the tube plates will not be staked – thus staking is required for 8 bays only.
- Staking is only required for every alternate row.
- Staking will be at least 20 rows deep into the bundle
- Stake must have at least half a pitch protrusion on either side
- Minimum stake width will be 25mm wide
- In all cases 3% additional stakes will be supplied (surplus) per length

### **6.2.2 Contractor responsibility:**

- The Contractor will be responsible for any tooling to install the stakes. If the procurement of the tooling might influence the project schedule it shall be indicated as such.
- The stake installation method statement shall be submitted for acceptance to the *Employer*. Refer to Appendix A for details
- During the stake installation a dedicated responsible person (Not the QC responsible for the quality requirements on the rest of the condenser) shall be responsible for all logistics regarding the

**CONTROLLED DISCLOSURE**

installation of the stakes. An inventory must be kept and be continuously updated. He will also ensure that the correct stake is installed as per drawings location.

- After each finger of the bundle is completely loaded and staked the responsible person will inform the *Employer* representative to come and inspect the completed work.

## **7. RETUBE ACTIVITIES**

### **7.1 Condenser Preparation**

#### **7.1.1 General**

Prior to the commencement of tube removal work, the condenser and surrounding area must be thoroughly prepared. The following elements of the Works Information are included to ensure that the *Contractor* is aware of the scope of preparation work required by the contract and *Employer's* expectations with regard to work area organization.

*The Contractor* is responsible for providing a solid cover for all openings in the condenser floor such as CEP suctions, cooling water ducts, drains and sidewalls to a height of 150 mm above the floor.

#### **7.1.2 Removal of Manway Covers**

The *Contractor* shall remove the manway covers from the intermediate water boxes and steam space for access.

The water box / tubesheet areas shall be cleared of all debris to allow the de-tube process to begin.

The areas around the tubesheets shall be cleared of all equipment, pipework etc. as necessary to ensure that the replacement tubing can be installed without bending of tubes... The *Contractor* is responsible for the removal of any such equipment and for re-instatement prior to contract completion.

#### **7.1.3 Scaffolding**

The *Contractor* shall supply and erect exterior and interior scaffolding to provide safe access to all levels of the condenser tubesheets.

All scaffolding is to be designed to bear such loads as will be imposed during use, including the load imposed by tube boxes where appropriate. The *Contractor* shall allow for spare scaffolding and scaffold personnel at all times to adjust scaffold needs at all times without delay.

All scaffolding has to comply with *Employer* safety standards and must be declared safe before any work commences. The *Contractor* provides scaffold proposals to the *Employer* to get the scaffold declared as a safe working platform to eliminate the need for safety harnesses.

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

**7.1.4 Entry Points**

The *Contractor* shall ensure that adequate entry into the steam space and hotwell space is available or created to satisfy both safe working requirements and the requirements of the refurbishment tasks as set out in this Works Information.

The *Contractor* shall prepare a contingency plan for creating access to the air- extraction zones if required. This access will only be required if difficulties are encountered in the de-tubing / re-tubing of the air-extraction zones. A method statement shall be submitted to the Employer for approval.

**7.1.5 Lighting**

Safe, waterproof lighting shall be installed by the *Contractor* in the steam space and other areas of the condenser as required facilitating contract execution. The use of electric grinders or drills is prohibited and only pneumatic power tools shall be used.

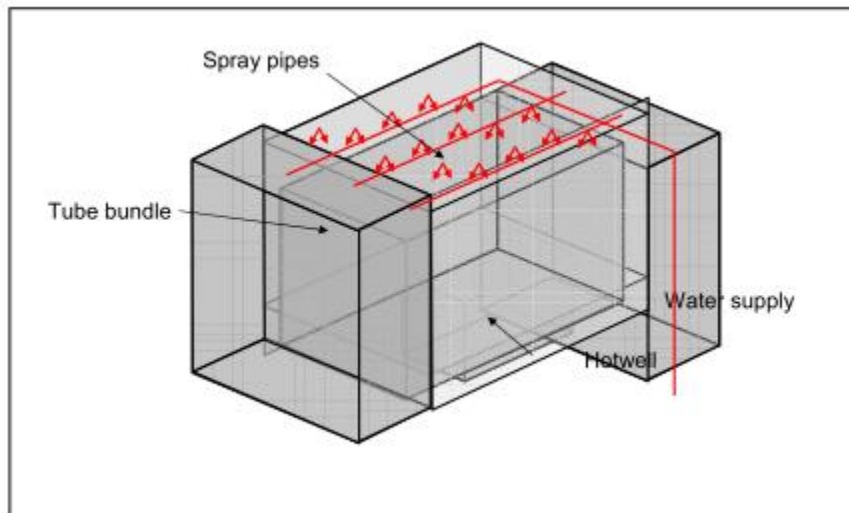
**7.1.6 Water Spray System**

The *Contractor* shall install a temporary water spray system to provide lubrication and therefore assist in the removal and replacement of tubes. The system should provide sufficient water so that lubrication will lessen the risk of support plate and tubesheet bending. The water must also be installed during installation of tubes in order, to minimise the tubes from scoring / scratching, or excessive friction between tube and sagging plates during insertion.

The *Contractor* is responsible for the design and installation of the spray system. An illustration is provided below in Figure 5: Typical Spray Water System as an example of a typical spray system consisting of water hose 25 to 30mm OD with sprays inserted 600mm intervals. The *Contractor* is responsible for implementing additional water lubrication of the support plates if required to reduce pulling loads on any problematic tubes. The *Contractor* is to connect a drain line on one of the hotwell drains to the nearest station drain.

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



**Figure 5: Typical Spray Water System**

#### **7.1.7 Isolation of Cooling Water Supply**

The condenser shall be isolated, drained and purged in order to allow safe access to its internals. If deemed necessary the *Contractor* will install spades to insure complete isolation. The spades on the hot and cold ducts will be installed between the inlet and outlet CW isolating valves and the waterboxes. These spades must be able to withstand 2.5 bar CW pressure, or mitigated with a continuous drain connection. The *Contractor* also cover the openings of the CW pipe connections on the outlet waterboxes to allow the *Employer* safe access to refurbish the Taprogge outlet screens in parallel with the condenser retube programme.

### **7.2 Water Boxes**

#### **7.2.1 General**

The *Contractor* should take note of the fact that any refurbishment work on water boxes will need to be integrated with the other refurbishment work on the condensers (i.e. the de-tube/re-tube process).

#### **7.2.2 Piping and Water Box Removal**

The *Contractor* shall remove the condenser inlet and outlet water boxes and move them to a location previously agreed to with the *Employer*. Any dismantling of the cooling water pipework shall be agreed to with the *Employer* and exposed ends of the pipework shall be protected throughout the re-tubing period.

#### **7.2.3 Water Box Repairs**

The level of repairs required will only be determined when the water boxes are removed. This section presents some of the options on scope of work with detailed specification guidelines on coating in Appendix B.

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

The *Contractor* will be required to present the possible options to the *Employer* once the unit is isolated and work has begun. However if the opportunity presents itself before this the *Employer* will notify the *Contractor* to visit Site.

The following shall apply once adequate access / waterbox removal is completed.

- Before waterboxes are removed. During grit blasting the first 70mm depth of tube should be blasted, to remove any deposits or previously applied internal tube coating that might hinder the tube extraction spear effectiveness.
- 100% NDT on the lifting lugs on waterbox / waterbox covers before removal.
- The *Contractor* is requested to take note of the *Employer's* specification for corrosion protection of plant and equipment with coating as per outlined in Appendix B. If the *Contractor* is using a sub-*Contractor* for coating then such sub-*Contractor* must be approved by that the *Employer*.
- Checking of external welds for any evidence of rusting and visual damage.
- Checking of external welds for any evidence of weld cracks / defects. Any suspect weld from visual inspection to be tested by means of surface NDT technique (MPI). Defective welds or areas should be reported to the *Employer* for review and acceptance; such report must include a repair procedure that outlines all the welds and what defect is to be repaired.
- Inspect manway and manway gasket sealing surface for mechanical defects, and also for corrosion damage, and repair as required. Ensure that gasket face is suitably finished to ensure gasket integrity after coating.
- Wall thickness inspection by UT inspection of manway plate if lining is worn, and record the plate thickness as compared to the as designed thickness. If indication is that all the corrosion allowance of 1mm has been used then the *Contractor* is to propose a suitable weld repair or component replacement for approval.
- The main waterbox sealing face on condenser shell / tube sheet interface will be vacuum blasted and coated with approximately 100 micron epoxy coating. Care to be taken to allow for flange interface integrity as above for manholes.
- All bolting / fasteners threads will be lubricated before assembly of fasteners, this apply to all items of bolted configuration.

**CONTROLLED DISCLOSURE**



- If any areas have suffered visible corrosion, the Contractor shall carry out wall loss measurements by means of a profile gauge, and provide an inspection report to the Employer for corrective action.
- Sacrificial anode backing plates will not be replaced, the threaded female connection in waterbox must be plugged with threaded plug and be over coated during the waterbox coating process

The Contractor is to supply the box-up procedure for approval, especially mentioning the envisaged bolting sequences. Waterbox to tubeplate retention stay bolts and rods are to be 100% visually inspected for signs of wear/corrosion. If the bolt/stay is reduced in diameter in any area by more than 10% it is to be either weld overlay repaired or replaced. Any wear or damage or erosion on threads must be repaired back to its original condition. Any visual signs of damage on the staybolt to tubesheet seal should be addressed by removing the staybolt and replacing the seal.

The Contractor will be responsible for carrying out the complete removal of the coating of the waterboxes and do patch repairs on the intermediate waterbox as the main offer. The Employer's coating specification minimum requirements are detailed in the Appendix B. It is the Contractor's responsibility to provide procedures and guarantees from their suppliers. In the event there is a conflict between the specification and the Contractor's coating supplier's specifications the Contractor is to present it to the Employer for review.

It is mandatory that all coating to the main waterbox is done after the re-tubing is completed and passed hydro test. The Contractor's accepted program should take into consideration that no sandblasting or solvent activities will be allowed while re-tubing takes place (Not be done in parallel). It is the responsibility of the Contractor to make sure the coating company check and accept the respective components regarding their conformity to being able to coat on site and or at the coating supplier's works. This includes the responsibility to obtain all the necessary information regarding corrosion protection, surface treatment etc. which could have an effect on the coating material. A conformance inspection certificate is to be submitted to the Employer.

### **7.3 Tube Plug Removal**

All tube plugs shall be removed prior to the de-tube process without damaging the tubesheet. In all cases where solid taper plugs (non-rubber) were used, the position of these plugs shall be recorded on a tubesheet drawing and photographs taken to indicate all solid plugs and initial condition of tubesheet. In general the number of tubes plugged per unit is relative low, typically less than 1 100 tubes per turbine unit. The majority of these tubes were plugged with rubber plugs and solid metal plugs were only used in

isolated cases. Special care must be taken when measuring these holes to ensure that the holes are not oversized. Oversized holes will be handled on a case by case basis with approval from the *Employer*, either by *sleeving or plugging*.

#### **7.4 Condenser Tube Removal**

The method used to remove tubes shall be to cut the tube internally that the cutting happens at least 6-10mm behind the tubesheet, and pull the resulting two sections through the tubesheets. External cutting of the tubes from the steam space shall not be employed except for those tubes where the pulling method has failed (e.g. as a result of a broken tube). The *Employer* shall be notified before any cutting inside of the steam space is being done.

The condenser tubes shall be cut via the intermediate water box with an internal tube cutter 6-10 mm behind the tubesheet. The short tube stubs shall be pulled into the intermediate water box. The main section of the tube shall be pulled from the opposite tubesheet (hot condenser outlet tubesheet).

The short tube stubs (at the intermediate water box tubesheets) shall be removed using a hand held tube stub puller (hand held hydraulic ram type with internal jaws). The tube stubs shall be removed from the condenser area and packaged for scrap as agreed with the *Employer*.

The long tube sections are to be extracted at the inlet/outlet water box ends by using hydraulic and/or pneumatic tube puller with tube extraction jaws. It is recommended that only jaw type extraction pullers are to be used as conventional spears will increase the possibility of the worn tubes snapping during pulling and damaging the tubesheets. Should the *Contractor* propose to use pulling spears he shall demonstrate that the tubesheets will not be damaged. No manual bending against tubesheets shall be allowed neither will rotating power tools be used to rotate the tube in the tubesheet as this damages the tube sheet and support plate ID's.

In the event that tubes break during extraction they shall be marked and left in situ until all other tubes are removed. The *Contractor* is required to later remove such tubes from inside the condenser steam space. This shall be done by cutting with a grinder in between each support plate and pulling out the resulting sections. Under no circumstances will any cutting by grinder be done closer than 200mm to a tubesheet.

All tubes and tube sections shall be removed from the condenser area and packaged for scrap as agreed with the *Employer*. The *Contractor* shall state in their proposal whether the *Employer's* overhead cranes will be required for this purpose.

The *Contractor* must at all times ensure that working areas are kept clean and free of debris, therefore pulled tubes must be immediately removed from the working platforms and working area kept free of debris.

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

The air- extraction zones shall be de-tubed on a remove-and-replace basis. The installation of new tubes shall conform to the requirements of tube installation as detailed elsewhere in this Works Information, with the exception that no feeders will be used for tubes in air extraction zone. As no tube feeders are used the tube ends shall be inspected for damage / deformation before any expansion will commence. The contractor will not continue working on the air extraction zone if a tube broke off. The tube will first be removed before the remainder of the tubes are loaded.

Where tubes in the air- extraction zone cannot be completely removed by the internal cutting and pulling method the *Contractor* shall inform the *Employer* before taking further action. The approval of the *Employer* is required before attempting to access the air- extraction zone steam space under the *Contractor's* contingency plan. For this reason it is imperative that air extraction zone is completely retubed before the condensing side tubes are loaded.

#### **7.4.1 Scrap Tubes**

- All scrap tubes remain the property of *Employer*, and will be removed on an on-going basis to the laydown area identified by the *Employer*. Tubes will not be stored in the turbine hall next to working area.
- Under no circumstances shall more than 20 scrap tubes be on the work site at any given time. The *Contractor* shall ensure that scrap tubes are frequently removed to the laydown area.

#### **7.5 Tubesheet Inspection and Preparation**

Once all the old tubes have been removed from the condenser, a cleanliness inspection will be conducted on the tubesheets and internals to determine whether any repairs are required. This shall be a hold point on the *Contractors* QCP.

The purpose of this section of the Works Information is to state the *Employer's* requirements for inspection, specify the methods to be used for any repairs and to provide the *Contractor* with criteria for decisions which must be taken at this point.

On completion of the inspection phase, the *Contractor* shall submit a proposal for repair scope of work subject to the *Employers* approved for any tubesheet repair.

##### **7.5.1 Tubesheet Cleaning**

The *Contractor* shall ensure that the condenser tubesheets are cleaned prior to inspection. This shall comprise the following as a minimum:

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- 100% of tube holes shall be cleaned with rotary wire /cylindrical flapper discs,
- Tubesheet face to be carefully cleaned by rotating stainless steel cup brushes.

### 7.5.2 Tubesheet Inspection

Where tubesheet holes were fitted with solid plugs, the tubesheet hole & ligament are to be tested by means of PT around the affected tube hole.

The *Contractor* shall provide a marked up tubesheet drawing indicating the tubes that will be used as calibration tubesheet holes to verify and test the wall thinning during expansion process, these will represent no less than 1% tubesheet hole quantity. Under no circumstances shall more than 300 tubes be expanded without a reference tube. These holes shall be clearly marked on the tubesheet, recorded on a tubesheet drawing, and measured with a 3 pin bore gauge before loading of tubes into tubesheet. These measurements are to be recorded on an electronic spreadsheet.

In addition to the tube hole measurement requirements, the *Contractor* shall test 100% of tube holes on each tubesheet with a go no-go gauge. This gauge shall be used to identify and mark all tube holes with a diameter greater than 19.7 mm. Tube holes with a diameter greater than 19.7 mm are considered oversized and the *Contractor* shall report to the *Employer's* for a decision. The tubesheets shall be further inspected for the following:

- Tube hole surface finish (longitudinal or spiral grooves in the tubesheet hole are not acceptable).
- Tubesheet surface erosion/corrosion/pitting (visual).
- Local and general distortion of tubesheet (using flat edge to assess).
- Tube-hole ovality (visual)
- Check tube-hole edges on cooling water side (SS cladding) for any sharp-edges
- Check tube-hole edges on steam side (CS) to see tube hole is edge rounded
- Tubesheet dis-bonding / SS clad pitting / CS clad erosion (visual)
- Visual check for any cracked or distorted tube hole ligaments
- Cladding thickness in the holes inspected (dimensional)

### 7.5.3 Tubesheet Repairs

#### CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

On completion of the inspection phase, the Contractor is responsible for determining the requirements for any tubesheet repair.

- Provided a tube hole is within HEI tolerance the Contractor can correct its surface finish or ovality by reaming up to a maximum of 19.5mm. The employer will approve any reaming before work retubing work start
- Any damaged, oval or scored tube holes can be reamed up to a maximum of 19.5mm. Sharp edges or burrs are to be removed (applicable to both the waterbox and steam side of tube plate faces).
- Where reaming cannot be used to bring a tube hole into a state for which an adequate expansion seal can be expected this to be reported to Employer for decision, one option to repair, can result is sleeving the tube hole, or alternatively as last resort plug the hole. Larger than 19.7mm tube sheet holes will require that these holes be restored to acceptable limits (19.3 to 19.5mm ID) my means of sleeving the tubesheet hole.
- Mutually agreed holes are to be plugged with expandable rubber plugs sized for the tubesheet hole size. The contractor will purchase plugs to cover a range of oversized holes as per Table 7: Tools list
- Where inspection of the tubesheet holes indicates that tube hole ligaments have cracked, the Contractor is to propose a procedure to plug, and or repair the respective area which may involve special procedures to repair a large damaged area. The tube holes surrounding this repair shall be thoroughly cleaned and checked for size to ensure no distortion or shrinkage has taken place during the repair process (as a minimum PT will be done).

Where inspection of the tubesheet holes indicates that disbonding / lamination of the stainless steel cladding on the carbon steel tubesheet has occurred, the Contractor shall propose corrective action by means of method statement for approval by the Employer. Welding on tubesheet is not allowed.

## **7.6 Support Plate Inspection and Preparation**

### **7.6.1 Support Plate Cleaning**

- Both surfaces of all the support plates shall be cleaned by means of wire cup bush.
- Spherical carbide ball burrs with an outside diameter 19.35mm and driven by a hand held pneumatic tool shall be used and passed through each support plate hole this ball burr will also act as a go / no go gauge.
- During cleaning a test block will be made available with a hole of minimum 19.25mm. After every 20 holes of cleaning with ball burr, the burr OD will be verified to be at least >19.25 by

**CONTROLLED DISCLOSURE**

testing the ball burr. The ball burr must not pass through the test block, if it does the ball burr must be discarded and replaced with new one, and the last 20 holes will then be re-addressed with the new ball burr.

- Should it be evident that the support plate holes are smaller than the 19.25mm, and that the ball burr actually removes support plate material, these holes to be clearly marked and agreement in form of site instruction must then be sourced from *Employer*. The holes can then be increased to a maximum of 19.5mm by means of a milling tool bit or by means of a mechanical reamer. Care must be taken to ensure that the hole is still parallel and not tapered.
- Each support plate hole will be cleaned thus with either a ball burr or by means of reamer / milling tool bit as in point above.
- Check edges of holes, de-burr as required
- Visual check for any cracked or distorted tube hole ligaments.
- Check all (100%) support plate stay bars and welds on the stay bars by PT or MPI to ensure no indications are evident, and report any erosion damage noted.



**Figure 6: Photograph of typical spherical carbide ball burr**

### **7.7 Condenser Internal Inspections and Repairs**

Prior to re-tubing visual inspections shall be carried out around the steam shell, hotwell, neck and other shell components for signs of damage, distortion, corrosion or erosion. Where visual inspection identifies a problem area, further ultrasonic testing may be required to determine whether actual metal thicknesses have depleted beyond safety margins. Minimum thickness based on Heat Exchange Institute (HEI), and drawings. The inspection scope includes but is not limited to the following:

- Visual inspection of internal shell plate checking for any erosion or mechanical damage.

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- Visual inspection on internal ribs, stay bars, stiffeners or other structural members.
- 10% attachment welds (excluding the areas specified below) to be surface tested by means of PT or MPI.
- 100% NDT on air extraction equipment (boxes and interconnecting pipes) weld areas.
- External Air- extraction section shroud and extraction pipe NDT (Pipe to shroud weld) & corrosion checks.
- After de-tubing wall thickness will be done on eroded sections
- Inspection on the integrity of any connections (such as stay bars) to the tubesheets on both cooling water and steam sides. Stay bar welds in intermediate waterbox to be 100% surface tested.

As soon as access is possible the Contractor shall do visual inspections for signs of damage, distortion, corrosion or erosion. The Contractor is responsible to analyse inspection results and propose repairs required. Specific repairs can only be clarified at the point of which damage is found. In the unlikely event that the air cooler sections will require repair the Contractor is required to submit an appropriate procedure to the Employer for approval. A method statement for this work should be submitted to the Employer for approval.

Following completion of the shell internal inspection the steam space area is to be cleaned and cleared of all debris, vacuum cleaned and all unnecessary materials and equipment, prior to the installation of the new tubes.

## **7.8 CONDENSER TUBE INSTALLATION**

### **7.8.1 General**

Internal surfaces of condensers and support plates shall be washed by means of a high pressure water washer before any tubes are loaded into condenser (air-extraction zone is excluded from this requirement)

Once the *Contractor* has satisfactorily completed all the inspections, repairs and preparatory work as required by this Works Information the *Contractor* obtains approval from the *Employer's* supervisor/inspector before commencing with tube installation. It is the responsibility of the *Contractor* to

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



ensure the condenser is fully cleaned and free of all debris before re-tubing begins. The exception is the tubes in the air- extraction zones which are inserted in conjunction with the tube removal process.

Provided that the tubesheets and support plates have been properly prepared the tube installation process should proceed without difficulty. Nevertheless there are critical procedures to be followed for tube installation and these are detailed below.

The stick out will be 2 to 3mm for the inlet and outlet tube plates.

The tube boxes shall be brought into the condenser area using adequate lifting and handling apparatus to avoid damage to the boxes and/or the tubes. The *Contractor* shall state in its proposal whether the *Employer's* overhead cranes will be required for this purpose.

An appropriate working platform shall be employed in order to facilitate the installation of the tubes through the cold condenser inlet and hot condenser outlet tubesheets. The working platform shall be kept clear of unnecessary materials. All waste materials shall be cleared from the platform and surrounding area promptly.

Tubes shall be installed into the condenser directly from their packaging, with each tube visually inspected for:

- Surface finish (no scoring or grooves on the tube inside or outside surfaces).
- Straightness.
- Absence of mechanical damage (dents, flat spots etc.).
- Tube length (checked after insertion into both tubesheets).
- Tube wall thickness (5% spot checks using a tube gauge micrometer).

Defective tubes shall not be installed in the condenser and shall be clearly marked as scrap and shall be removed from the working area. The Project Manager shall be informed of these defective tubes on a daily basis for record keeping. These tubes, depending on damage, can be used for the purpose of mock up testing.

The *Contractor* must ensure that spray water is operational before the tubes are loaded into the tubesheet. Under no circumstances will any other means of lubrication than water spray system and cloth drenched in water be used on tube outside surface, any other lubricant affects the joint strength, and could lead to tube joint slipping in service.

All tubes in the main bundle shall be fitted with aluminium tube feeder guides at the leading end to ensure the tubes readily self-align as they are pushed through the support plates and tubesheets.

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



The *Contractor* is responsible for positioning the necessary number of personnel inside the steam space to guide the tubes between support plates.

Tube feeder guides shall be removed once the tubes are positioned in both tubesheets.

All the requirements of the Works Information shall be met with regard to air- extraction zone tube installation, including tubesheet tube hole inspection and preparation, excluding baffle plate cleaning and tube feeders.

### 7.8.2 Tube to Tubesheet Joint Expansion

With all the replacement tubes loaded into the condenser and mock-up testing complete, the *Contractor* may proceed to make the tube-to-tubesheet joints. The joints will be created through the use of mechanical (5 pin roller) expansion. The contractor will start the expansion process by expanding a number of tubes in a predetermined holding pattern style for both tube plates of the loaded tubes.

#### 7.8.2.1 The following formula will be used for wall thinning

$$Tw = ((T-t)-(D-d))/(d-t) * 100$$

D= Diameter of tubesheet hole, mm

d= Outside diameter of tube, mm

T= Tube inside diameter after expansion, mm

t= Tube inside diameter before expansion, mm

Tw = % wall thinning

Example recording: The following is provided to the *Contractor* as an example of recording the tube expansion data.

**Table 5: Tube expansion data example**

	Tube Test Number	1	2	3
D	Tubesheet hole size	23.600	23.660	24.000
d	Tube outside diameter	23.000	23.200	23.200
t	Tube inside diameter before expansion	22.000	22.000	22.100
T	Tube inside diameter after rolling	22.640	22.520	22.950
Tw	% Expansion	4.00	4.85	4.600

### 7.9 Tube-To-Tubesheet Joint Mock-Up Tests

#### 7.9.1 General

#### CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Mock up test and pull out test must be completed 2 weeks before the contractual (actual retubing) start date and will be a key-date in programme.

There is considerable uncertainty in advance of the re-tubing project with regard to the ability to make adequate tube-to-tubesheet joints within the existing tubesheets. The condition of the tubesheets is not accurately known until the tubes have been removed, and the *Contractor* must be prepared to deal with a number of potential problems. The tube materials being considered for the re-tube present potential difficulties for roller expansion, especially with regard to over-size tube holes.

In order to prepare for all eventualities, as far as possible, a series of mock-up tests are specified to be completed ahead of the outage. These tests provide information regarding the torque settings required for the expansion tooling, and the largest tube hole size which can be successfully expanded and sealed. In order to conduct the mock-up tests the *Contractor* will require access to a quantity of replacement tubing from the bulk of the free-issue tubing supplied. The *Employer* will provide the tube samples for these tests while the *Contractor* must provide the material representing the tube sheets. This material supplied by the contractor will have available material certification to EN10204 3.1 as a minimum. Hardness in HB shall also be provided. If certification is not supplied the blocks will not be accepted.

#### **7.9.2 Min pull out force calculation**

The wall thinning will be calculated as per 7.8.2.1.

#### **7.9.3 Mock-up / Pull out block test pieces**

A set of test blocks (detailed below) shall be manufactured. These blocks shall be similar to the current condenser tubesheet, pitch, material hardness and thickness.

Min 6 blocks with ID of 19.2 mm (tolerance -0 mm and +0.05 mm).

Min 2 blocks with ID of 19.10 mm. (tolerance -0 mm and +0.05 mm).

Min 2 blocks with ID of 19.45 mm (tolerance-0 mm and + 0.05 mm).

Min 1 block with ID of 19.7 mm (tolerance-0 mm and + 0.05 mm).

After every expansion record the torque output of expander device and perform pull-out test. Record the pull-out values and wall thinning in the wall thinning/expansion spreadsheet. The desired wall thinning range will be 7-8%.

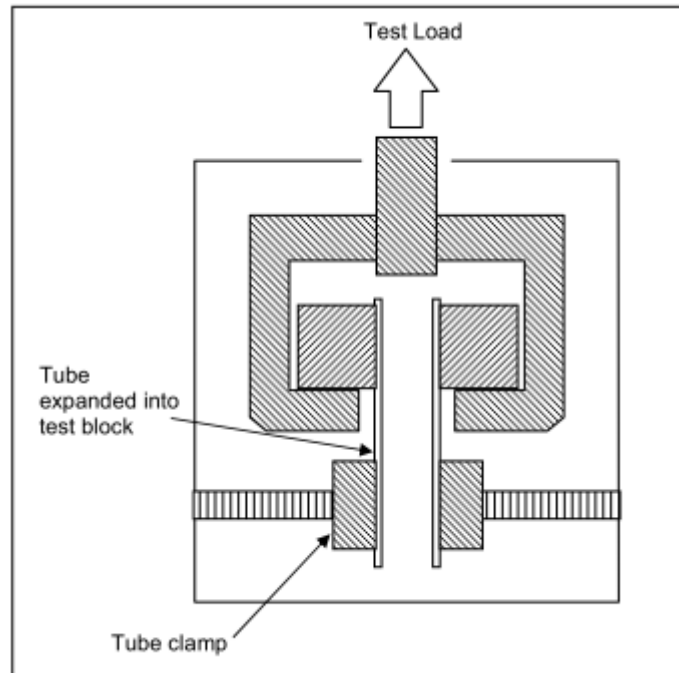
When the 19.2 mm tests are completed the remainder of the blocks (19.1 mm and 19.45 mm) need to be expanded with the within the selected wall thinning range as determined above, for at least 3 different wall thinning values within the selected range

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

Finally at same torque value per form test on 19.7 mm block.

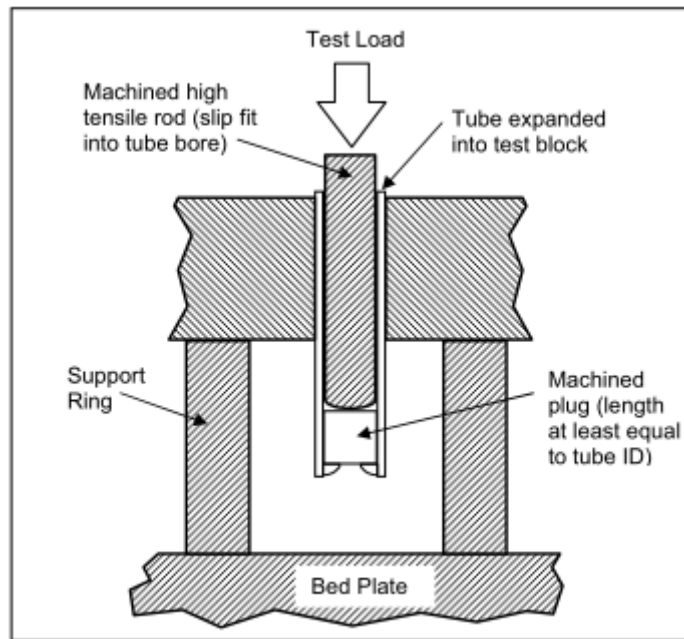
The option to perform additional tests with serrated (grooved) test blocks is left to the Contractor's discretion for acceptance by the Employer.



**Figure 7: Typical Pull-Out Test Apparatus**

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



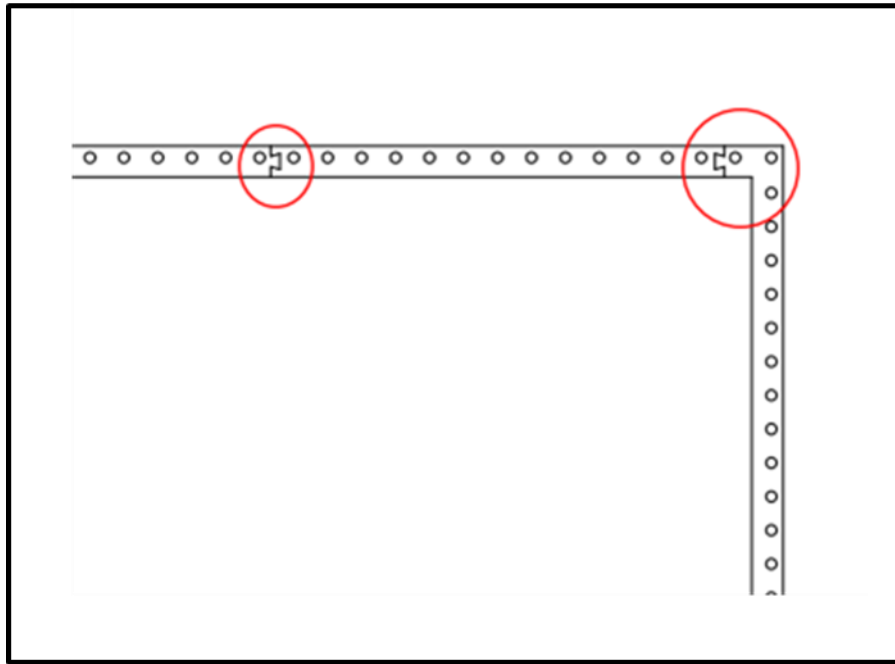
**Figure 8: Typical Pull-Out Test Apparatus**

#### 7.10 Water Box Installation

- Reinstall waterboxes with new Gasketing such as GP45 Natural rubber blend (see Appendix C). Gasket will be supplied with material certification.
- All joints on the gaskets will be by means of dove tail joints and not on 90° or axial jointing (See Figure 9)
- Remove blanks or covers on CW valves.
- Secure any CW connections that may have been dismantled during the outage and remove any blocking on bellows that might have been installed.
- Externally inspect waterbox gaskets & manway for any visual evidence of localised bulging (extrusion) from the waterbox cover to waterbox joint.
- If stagnant water is present in the inlet and outlet ducting the contractor shall be responsible to prove that the ducts are free of debris.

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



**Figure 9: Typical Gasket Dove tail jointing**

### 7.11 Emergency Distillate Drain Modification

Due to Flow accelerated corrosion (FAC) and erosion the emergency drains routed to the condenser from either Low pressure heater 3 or High pressure heaters (5.1, 5.2, 6.1 or 6.2), lead to wall thinning and also subsequently to damage of the condenser tube bundle and failure. The modification is to change the material from a predominately carbon steel design to a more FAC resistant material than contain >1.25% Chrome material.

This modification is to be applied to LPH 3 Emergency Drain Line RN51G070 and HPH 5A/5B Emergency Drain Line RP11G003 and RP21G048 respectively. The drain baffles for both the HP heater 5 emergency drains are a free issue and will only require installation.

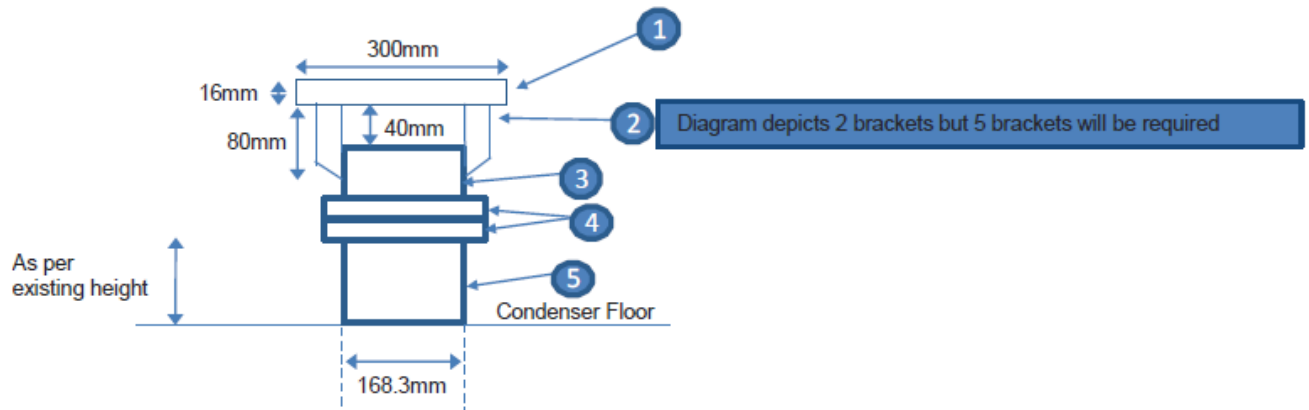
The modification for each of the 5 emergency drain inlet nozzle comprise of cutting the distillate inlet stub in the condenser steam space, then fitting a flange to the remaining stub. A matching disperser nozzle with a deflector plate is then fitted to this flange. As an example please see Figure 10: Proposed Arrangement in Condenser below that indicates typically the installation on LP heater 3 line.

Using LPH 3 as an example, a standard flange will be welded onto RN51G070 (item 4 and 5). The section above this flange can be manufactured in a workshop and installed onto the pipework (item 5). The heights depicted in Figure 3 may remain consistent for the HPH emergency drains. Heater specific diagrams can be found in the design calculations in Appendix B. The table below lists the schedule of material.

### CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

All Welding activities must be done by the contractor or a sub-contractor that is ISO 3834 Part 2 certified. The *Contractor* shall ensure that minimum welding happens inside the condenser especially when tubes are already installed.



**Figure 10: Proposed Arrangement in Condenser**

**Table 6: Condenser Modification Schedule of Materials**

AKZ	Description	Component Description	Material Description	NB	SCH	THK (mm)	App. Quantity
RN51G070	LPH 3 emergency distillate drain to Main Condenser	Item 1: Diffuser (Plate)	SA-240 Grade 316L	-	-	16	1
		Item 2: Support Bracket (Plate)	SA-240 Grade 316L	-	-	16	5
		Item 3: Straight Pipe	SA-312 Grade 316L	150	40	-	0.5m
		Item 4: Flange	SA-240 Grade 316L	EN1092-1, Type 01 (Slip-on), Flat Face, DN150, PN16			2
		Item 5: Nozzle and Spool Piece	EN 10216-2 10CrMo9-10 or ASTM A335 P22	150	40	-	1m

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

AKZ	Description	Component Description	Material Description	NB	SCH	THK (mm)	App. Quantity
RP11G003	HPH 5A emergency distillate drain to Main Condenser	Item 1: Diffuser (Plate)	SA-240 Grade 316L	-	-	16	1
		Item 2: Support Bracket (Plate)	SA-240 Grade 316L	-	-	16	5
		Item 3: Straight Pipe	SA-312 Grade 316L	250	40	-	0.5m
		Item 4: Flange	SA-240 Grade 316L	EN1092-1, Type 01 (Slip-on), Flat Face, DN250, PN16			2
		Item 5: Nozzle and Spool Piece	EN 10216-2 10CrMo9-10 or ASTM A335 P22	250	40	-	1m
RP21G047	HPH 5B emergency distillate drain to Main Condenser	Item 1: Diffuser (Plate)	SA-240 Grade 316L	-	-	16	1
		Item 2: Support Bracket (Plate)	SA-240 Grade 316L	-	-	16	5
		Item 3: Straight Pipe	SA-312 Grade 316L	250	40	-	0.5m
		Item 4: Flange	SA-240 Grade 316L	EN1092-1, Type 01 (Slip-on), Flat Face, DN250, PN16			2
		Item 5: Nozzle and Spool Piece	EN 10216-2 10CrMo9-10 or ASTM A335 P22	250	40	-	1m

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

## 8. COMPLETION TESTING, COMMISSIONING AND CORRECTION OF DEFECTS

### 8.1 Shell Flood Test and Waterbox Leak Test

It is the *Contractor's* responsibility to check the tube side water box gasket joints, manways and openings, CW pipe connections and water box integrity. The *Contractor* shall perform an on line test with the CW flowing at normal operating pressure. The *Contractor's* scope of work includes but is not limited to the following:

- Reinstall water boxes using an approved procedure and bolting sequence
- Remove all blanks including covers on CW valves.
- Secure any CW connections that may have been dismantled during the outage.
- The condensate suction strainers to the condensate pumps pipe must be disconnected and be cleaned of any debris before the shell side flood test is performed.
- Fill shell side with demin water ensuring all the tubes are covered and the water is a minimum 1000 mm above the top row of tubes. (Site to ensure witness point to prevent overfilling). Note that no fluorescene should be used during the test.
- During filling of steam side any leaking expansion joints shall be repaired and mark up on a register (QCP verify point).
- Leave steam side full of water for a minimum period of 12 hours after last joint was repaired and re-inspect tube to tubesheet joints and all plugged tubesheet holes for leaks.
- Fluorescene dye test might be required by the station, it must only be done after final soak test when last visually leaking tube has been sealed. The fluorescene shall be supplied by the *Employer*
- On completion of the steam side the CW side can be filled and monitored on the waterbox side if any leaks are evident.
- Inspect 100% of shell construction for any leaks. In the event of shell side construction leaks, these can be repaired after the flood test and tested by surface NDT. (PT or MPI).
- Inspect all shell side manways and openings for any leaks.
- Drain condenser and verify operation of all hotwell drains.
- Close and seal all waterbox manholes and other openings.
- Open CW isolation valves and circulate CW at the operating pressure for a minimum 2 hour period.
- Under no circumstances will double rubber gasket be used – meaning if the manhole is rubber lined and seal cannot be achieved, the face to be inspected, and repaired.

### CONTROLLED DISCLOSURE



In the event of any gasket joint leaks the bolting can be lightly tighten to affect a seal. However excessive tightening and extrusion of gasket joints is not permitted.

In the event that the gasket joints cannot be sealed the water box covers have to be removed, inspected, rectified, reinstalled and re-tested, all bolts to be tightened again to specified torque.

Silicone sealant shall not be applied to any part of the water box to tubesheet joint.

## **8.2 Final Inspection**

The *Contractor's* scope of work includes but is not limited to the following:

- Check to ensure all relevant QA documents are completed, NCR's are closed out and filed in a condensers refurbishment databook.
- Verify that all temporary working platforms are removed and permanent access fixtures are re-instated.
- The Employer does a visual inspection on the cleaning system (Taprogge System) and does all repairs required to restore the system to its original design.

## **8.3 Commissioning**

The *Contractor* will be present during commissioning of the re-tubed condensers.

## **8.4 Access Given by the Employer for Correction of Defects**

The *Project Manager* will make arrangements for the *Contractor* to have access to the *works* including *works* which have been taken over, for the purpose of correction of Defects by the *Contractor*.

Special arrangements will have to be made for the correction of Defects after the *works* have been put into operation.

## **8.5 Performance Tests after Completion**

No thermal performance tests will be carried out.

## **8.6 Training and Technology Transfer**

The *Employer* intends to second maintenance, engineering or operating staff part-time or full-time, to the *Contractor's* team during the installation and commissioning stages of the contract, without affecting the Contract Prices. The aim is that the *Employer's* personnel receive 'on-the-job' training in order to become familiar with the requirements and processes of the *works*.

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

## **8.7 Operational Maintenance after Completion**

Standard station maintenance procedures will be used. These will be modified if necessary if changes are proposed by the *Contractor* and accepted by the *Project Manager*.

## **9. Tests, Test Certificates and Inspection**

### **9.1 NDT**

All NDT mentioned in this scope of work will form part of the contract and the Contractor will include this in the pricing.

The Contractor to make allowance for:

- 5 m<sup>2</sup> PT
- 5 m<sup>2</sup> MPI
- 30 Wall thickness measurements

### **9.2 Non Conformances**

Where Non-Conformance Report (NCR) notifications are issued, the Contractor acknowledges receipt within the period of reply and proposes corrective and preventive actions to the Supervisor. The corrective and preventive actions will include the implementation and completion dates. Progress on all NCR's notifications issued to the Contractor must be reported to the Supervisor on weekly basis.

- The Contractor's Quality Manager maintains a register of all NCR's issued, and provide dates for close out of NCR's.
- Records of NCR's notifications and close out reports are kept and form part of the data book records.
- During the contract execution phase, the Contractor will be monitored by the *Employer's* Supervisor for performance on quality related aspects. The monitoring will be in the form of audits and assessments.

### **9.3 Quality Control Plan**

The Contractor submits to the Project Manager within 30 days of Contract Date for review and acceptance prior to the commencement of work. A QCP which will detail the Contractor's organisation, quality assurance and quality control procedures within that organisation specific to this project will be supplied.

The QCP shall be subject to the Employer's approval and shall indicate all inspection and test points, method statement and procedures to be used as well as acceptance criteria to be applied. Following review by the Employer, agreed quality surveillance requirements such as witness points and hold points shall be indicated on the QCP for the Employer's interventions.

## **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

The Contract Quality Plan (CQP) will make reference to the Contractor's QMS documents to be used in this Contract:

- The Contractor's QMS compliance with the requirements of ISO 9001
- Contractor's quality manual
- Contractor's quality procedures
- Contractor's quality forms and work instructions
- Contractor's quality system documents referenced in this Works Information
- Employers Works Information, drawings, specifications, standards and codes, etc.

### **9.3.1 Inspections and Tests**

All Plant and Materials is comprehensively tested in accordance with the agreed ITP/ QCPs prior to delivery. The Employer reserves the right to appoint others to inspect all parts during manufacturing, erection and commissioning to be present at any of the tests specified. The witnessing of tests by the Supervisor or Others, and if the Supervisor chooses to waive the witnessing of any tests, it does not relieve the Contractor of his responsibilities.

The Supervisor inspects parts of the Plant at his discretion during manufacturing stages and before shipment as per the agreed ITP/QCP;

- The Contractor is responsible for the inspection of all the work that is performed, and the Supervisor only verifies that the work is conducted as per the Works Information and interventions as per QCP.
- The Contractor conducts all inspections in accordance with the accepted ITP/QCP.
- The Contractor provides suitably qualified personnel to conduct on-site inspections
- The Contractor ensures that all are inspected and approved before the Supervisor is invited for verification.
- The Contractor provides a minimum of 24 hours for local on-site inspection. The notice contains copies of the Contractor's inspection reports.

### **9.3.2 Quality Responsibility**

The Contractor responsibilities include but are not limited to the following:

- The Contractor is accountable for the quality of the output and liable for any failures.
- Implementation of their QMS on site.
- Administration of their QA/QC systems on site.

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- Verification of approval status of Subcontractor's Quality programmes, that is, CQP's, QCPs, NCR's, Defects, operational procedures and works instructions for on- site inspections.
- Weekly progress reporting on quality performance.
- The Contractor is responsible for defining the level of intervention of QA/QC or inspections in line with the Employers requirements.
- The Contractor is responsible for defining the level of intervention of QA/QC or inspections to be imposed on his Sub-contractor, suppliers and must ensure that these are in line with the Employer's requirements.

The Supervisor will be responsible for the following:

- Reviews of the quality either inspections or document submissions.
- Verification of the Contractor's intervention points.
- Reviews the Contractor's ITP/QCP documents (procedures, test results).

## **10. Mandatory Returnables**

The submission of the returnables stated in this section is mandatory. Failure to submit any of these returnables will result in disqualification of the tender.

1. Verifiable experience of the Contractor or sub-Contractor or joint venture partner regarding fully re-tubed main steam condenser for a turbine size greater than 100 MW in the last 5 years.
2. Verifiable references are to be provided for condenser stakes supplied. At least 5 previous condenser retube projects within the previous 5 years, where due to the design, condenser stakes are a requirement. The stake design shall adhere to the requirements as detailed elsewhere in this document. The reference list shall contain contact details of the plant owners and the date when the retube (which involved stakes) was done as well as the condenser tube material used for the respective retube projects

## **11. RETURNABLES USED FOR TECHNICAL EVALUATION**

### **11.1 General:**

1. All welding activities on distillate pipework as per section 7.11 will only be performed by an ISO 3834 Part 2, contractor or sub-contractor. A valid copy of the ISO 3834 certificate must be supplied with tender.
2. Adherence to the above *Works Information*. If the contractor adhere fully to the scope of work a letter stating this shall be supplied. Any technical deviations shall be clearly indicated.

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

3. An example of the *Contractor's* procedures (mock-up and pull out test, tube removal, installation and expansion procedure)
4. An example of the *Contractor's* QCP for a typical condenser retube project
5. The tool list (Table 7: Tools list) shall be included in the tender with columns 2 and 4 completed. These tools need to be on site for the total duration of the specific condenser under refurbishment, these tools will not be removed from site to assist any other condenser refurbishments project, which runs concurrent with the unit that is contracted.

## 11.2 Stakes Supply and Installation

6. Overall dimensional drawing of a proposed stakes including material selection.

## 11.3 Coating of Waterboxes

7. The coating of condenser waterboxes shall only be performed by contractors who can produce verifiable references of similar corrosion protection on CW systems, chemical tanks and associated piping & ducts, done during the last 5 years.
8. Supply of the latest revisions of the specified Material Product Data Sheets and Material Safety Data Sheets.
9. Detailed QCP for similar work done, as per coating specification RTD/MAT/19/199 (Appendix B)

**Table 7: Tools list**

Minimum quantity	Quantity available per Duvha Turbine Generating unit condenser	Tool / Equipment Description	Description, Type or Make where applicable
8		Tube stub puller or spear	
2		Automatic puller	
8		Internal tube cutter mandrel	
30*		Tube cutter replacement blades sets	
12		Tube expander drive	
24*		5 Pin roller expanders	

### CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

20*		Sets of spare rollers including taper pin	
		Lubricant for expansion	
10		Tube facing tools	
100*		Tube facing tool replacement blades	
2		Torque analyser (Independent device to verify expander drive torque)	
3		Adjustable reamers from 19.0 – 21.0mm	
10*		Set of replacement reamer blades	
2		Calibrated 3-Prong internal micrometer, min accuracy 0.01 mm	
2		Calibrated external tube vernier, min accuracy 0.01 mm	
300*		19.35 ±0.05 mm outside diameter spherical carbide ball burrs	
800*		Cylindrical flapper disc / Wire brush for cleaning tubesheet holes. Diameter ± 19mm. Grit size 80 or finer	

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

4		Pneumatic Flaring tool mandrels	
2		Industrial vacuum cleaner	
2		High pressure water washer (minimum 150 Bar) to clean support plates before loading tubes	
4		Go-No-Go gauge with at least 7 intervals from 19.1 mm up to 19.7mm in 0.1 mm steps	
16		Pneumatic ball burr or brush driver	
30*		Stainless steel wire cup brushes	
1		At least a 2 metre long straight edge	
One sets		Water spray piping and nozzles	
100		Expandable rubber plugs catering for ranges from 17 to 20 ID of tube	
		Slings and rigging equipment for removal of waterboxes and CW duct with valid test certificates as per OHS Act	
20		95% fill factor based on internal area bullet test for blowing through tubes	

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

		after installation. The outer diameter of the plugs shall be 95% fill factor.	
--	--	---	--

Consumables: The above quantities are required for 100% hot condenser Duvha turbine-generator unit

## 12. AUTHORISATION

Name & Surname	Designation
K Nzimande	Turbine Engineering Manager
F du Preez	Corporate Consultant
F Mlangeni	System Engineer

## 13. REVISIONS

Date	Rev.	Compiler	Remarks
May 2020	0.1	W Huyser	First Draft issued for comments
June 2020	1	W Huyser	First Issue

## 14. DEVELOPMENT TEAM

Herman van Niekerk

### CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



## **APPENDIX A: STAKE SPECIFICATION**

### **Minimum stake design requirements**

1. One set of hot condenser stakes shall be supplied (free issue) to the contractor for installation. The *Contractor* shall supply and install stakes on the cold condenser.
2. The stake Manufacturer shall have a Quality Management System that meets or exceeds the requirements of ISO 9001. Relevant Certification shall be submitted.
3. Only metallic stakes with a minimum Chromium content of 15% are acceptable. Non-metallic stakes is not acceptable.
4. Minimum stake width is 25 mm.
5. The stakes shall be proven not to migrate along the length of the tube towards the support plates, (along the length of the tube), shall not fall out the bundle when installed at the bottom or move deeper into the bundle, (perpendicular to the tube direction), when installed at the top or sides of the bundle at an angle of 30° with respect to the vertical.
6. Only stake designs which have been used in the past during condenser retube projects where brass tubes were replaced will be considered.
7. The stake lengths are detailed in Figure 11 up to Figure 14. The manufacturer must supply a final stake design clearly indicating the overall stake length to satisfy the tube support length as specified.
8. The thickness of the stake is part of the contractors design.
9. The tubesheet drill pattern for the Hot and Cold condenser is shown in Figure 15.
10. Identical stakes, i.e. same length, shall be bundled together before packaging for ease of identification.
11. If any special tools are required for the installation of the stakes, this must be specified in the tender returnables. The minimum amount of these tools will be quantified and clearly defined and included in the tender price. The contractor to provide a method statement how these special tools are to be used.
12. The stake pattern is provided in attached drawings no. D-02-4830 for left hand side and right hand side below.

### **Stakes information**

#### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

PT#	STAKE LENGTH	# REQ'D PER BUNDLE	# REQ'D PER CONDENSER	SPARES	TOTAL STAKES
5	6-1/16"	35	280	9	289
7	8-1/16"	16	128	4	132
9	10-1/16"	16	128	4	132
10	11-1/16"	25	200	6	206
11	12-1/16"	14	112	4	116
12	13-1/16"	34	272	8	280
TOTALS		140	1120	35	1155

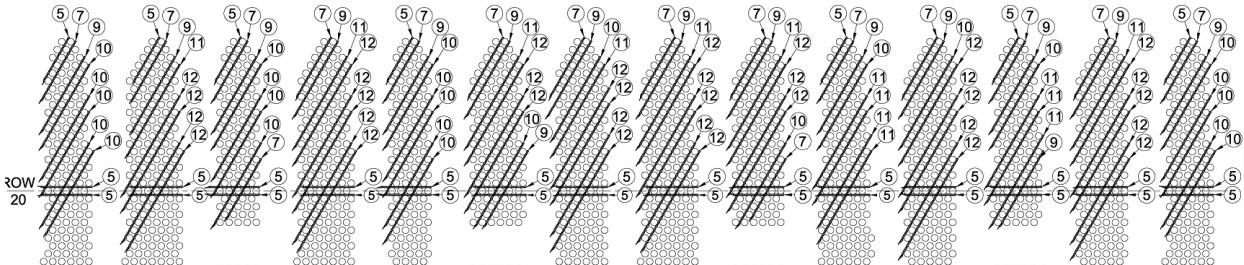


Figure 11: Cold Condenser Left Hand Side

PT#	STAKE LENGTH	# REQ'D PER BUNDLE	# REQ'D PER CONDENSER	SPARES	TOTAL STAKES
5	6-1/16"	35	280	9	289
7	8-1/16"	16	128	4	132
9	10-1/16"	16	128	4	132
10	11-1/16"	25	200	6	206
11	12-1/16"	14	112	4	116
12	13-1/16"	34	272	8	280
TOTALS		140	1120	35	1155

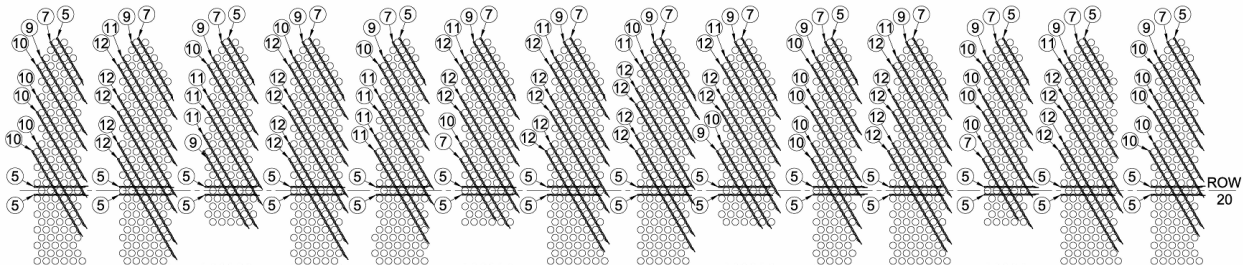


Figure 12: Cold Condenser Right Hand Side

PT#	STAKE LENGTH	# REQ'D PER BUNDLE	# REQ'D PER CONDENSER	SPARES	TOTAL STAKES
5	6-1/16"	26	234	7	241
7	8-1/16"	12	108	4	112
9	10-1/16"	18	162	5	167
10	11-1/16"	7	63	3	66
11	12-1/16"	12	108	4	112
12	13-1/16"	39	351	9	360
14	15-1/16"	18	162	5	167
15	16-1/16"	5	72	3	75
TOTALS		140	1260	40	1300

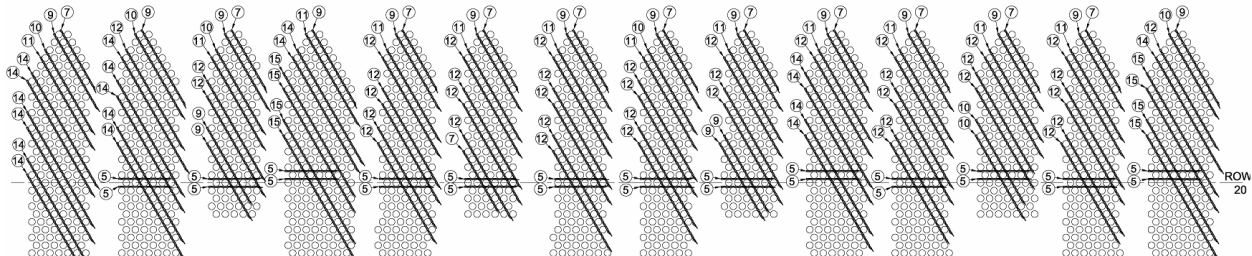


Figure 13: Hot Condenser Right Hand Side

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

PT#	STAKE LENGTH	# REQD PER BUNDLE	# REQD PER CONDENSER	SPARES	TOTAL STAKES
5	6-1/16"	26	234	7	241
7	8-1/16"	12	108	4	112
9	10-1/16"	18	162	5	167
10	11-1/16"	7	63	3	66
11	12-1/16"	12	108	4	112
12	13-1/16"	39	351	9	360
14	15-1/16"	18	162	5	167
15	16-1/16"	8	72	3	75
TOTALS		140	1260	40	1300

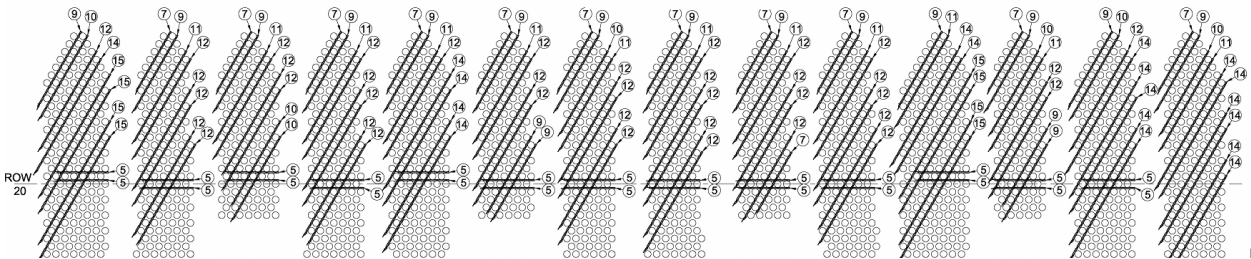


Figure 14: Hot Condenser Left Hand Side

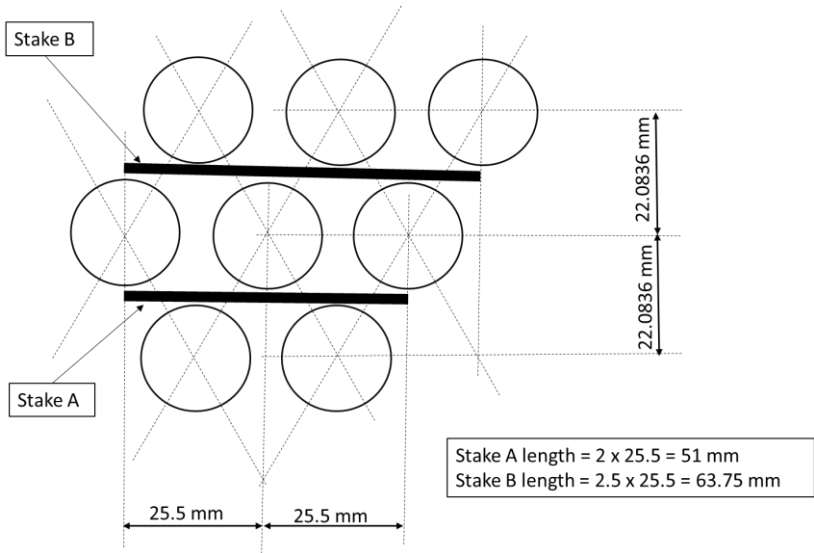


Figure 15: Stake length clarification and tubesheet drill pattern

CONTROLLED DISCLOSURE

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

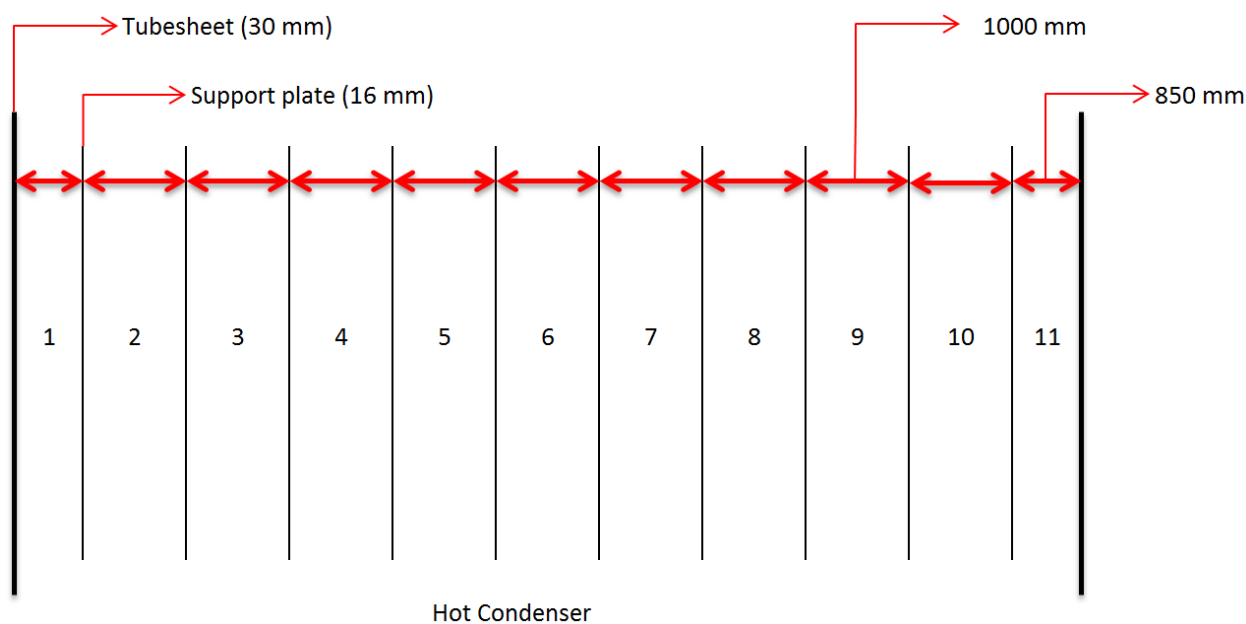


Figure 16: Hot condenser support plate span length.

- Stakes to be installed in the bays 2 to 10

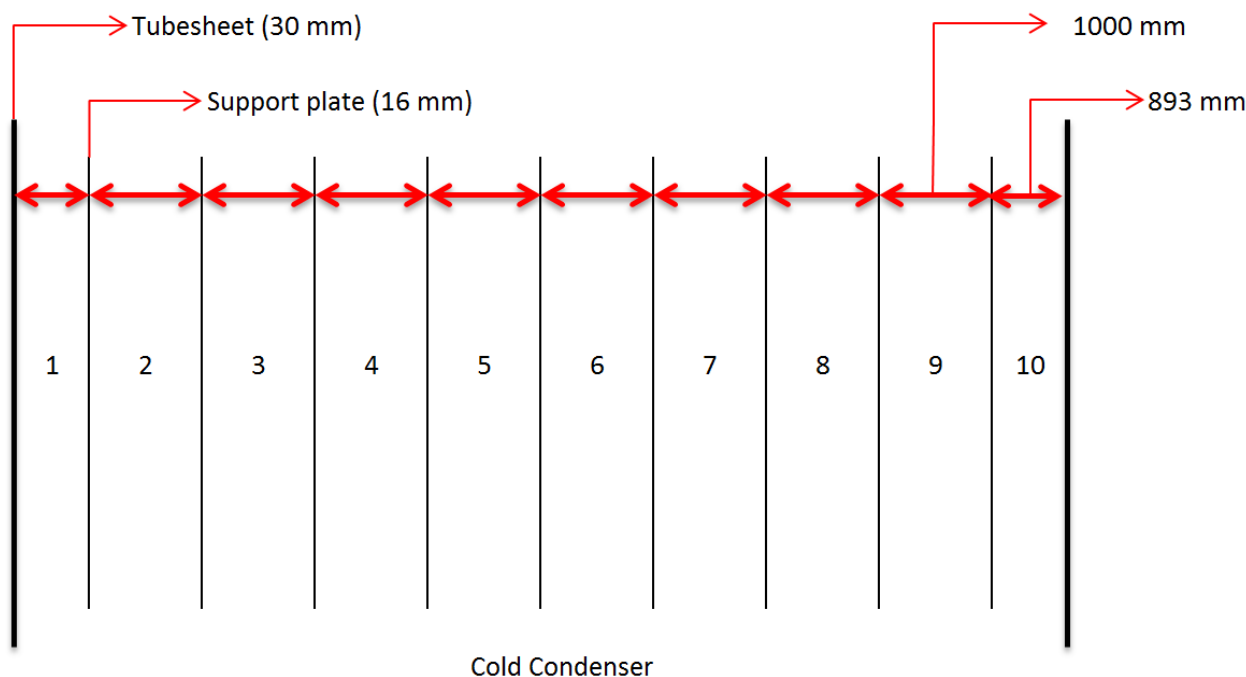


Figure 17: Cold condenser support plate span length

- Stakes to be installed in bays 2 to 9

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

**APPENDIX B: RTD/MAT/19/199****Corrosion Protection Specification – Duvha Power Station Unit 5 Condenser Waterbox Coating**

<b>To be considered as Annexure D of 240-101712128: “Specification for the Internal Corrosion Protection of Water Systems, Chemical Tanks and Vessels and Associated Piping with Linings”. All other aspects of 240-101712128 section 4.4 – 4.15 shall apply unless specified separately in this specification sheet.</b>	
Vessels	Main Condenser Waterboxes
Environment	Immersed cooling water, pH 8,1 to 8,6 temperature range 25°C to 45°C, flow rates of up to 2,0 m/s
Application	Maintenance coating/lining of the internal surfaces of Main Turbine Condenser Waterboxes.
Material	Carbon steel BS1501-151 grade 23 either rubber lined or coated
Surface Preparation	Abrasive blast clean to Grade Sa 3  Surface profile as specified by the coating manufacturer
Generic System	(Optional) primer specifically designed for enhancing adhesion of the system as specified by coating manufacturer  2 coats of a two component solvent free amine cured epoxy coating @ minimum Dry Film Thickness (DFT) 300 micron per coat.  In the case where a primer is not part of the coating system then;  3 coats of a two component solvent free amine cured epoxy coating @ minimum Dry Film Thickness (DFT) 300 micron per coat.  Total dry film thickness of the coating system: 675 to 850 micron (with the use of a primer).

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

	<p>Total dry film thickness of the coating system: 900 to 1200 micron (without the use of a primer).</p> <p>The coating DFTs shall be as per the requirements of this specification sheet and the manufacturer's recommendation in the latest Product System Data Sheet. The selection of the coating product/system shall therefore be matched to the requirements of this specification sheet.</p>
--	--

**This specification is applicable to Duvha Power Station Main Condenser Waterboxes Coating Scope of Work**

As part of re-tubing scope of work (SOW) rubber lining on the condenser the waterboxes are to be replaced with a coating/lining system. On some waterboxes rubber lining was previously replaced with a coating/lining system, therefore the Contractor shall note that the waterboxes are either coated or rubber lined.

The coating SOW on this condenser includes:

- Intermediate waterboxes A and B – Visual inspection of previous coating and coating repairs (including staybars).
- Hot & Cold Condenser A and B – Inspection and/or recoat or replacement of rubber with coating.

**1. Special Notes**

- 1.1 The intermediate waterboxes/covers shall not be removed from the condenser. All maintenance activities shall be performed on the waterboxes in-situ.
- 1.2 The condenser waterboxes (Inlet and outlet) will be removed for the retubing and any further corrosion protection activities shall be performed away from the condenser in a designated laydown area.
- 1.3 In the case of any existing rubber lining then the lining shall be completely stripped and removed in preparation for coating
- 1.4 In the case of any existing coating system then a thorough inspection shall be performed by the Eskom engineer. Based on the inspection Eskom will decide whether to completely recoat the waterbox OR perform patch repairs. Patch repairs shall be performed as identified and instructed and with the systems as specified above. Specific requirements for patch repairing a coating system are defined in section 4.8.6 of 240-101712128.
- 1.5 Depending on the scenario or possible outcome described above the failed coating shall be removed by appropriate mechanical means followed by abrasive blast cleaning to ISO8501 Grade Sa 3. The Contractor is required to describe dust mitigation or management steps and define preventative

**CONTROLLED DISCLOSURE**



steps of unwanted blasting of the tubesheet and grit ingress in the tube entrances in the Method Statement.

## **2. Special Requirements**

- 2.1 All requirements of Eskom standard 240-101712128 shall apply unless specifically defined in this specification sheet.
- 2.2 After surface preparation and prior to coating application the prepared surfaces shall be tested for soluble salts as specified in section 4.7.6 of 240-101712128. The acceptable levels of salts shall be as specified by the coating manufacturer. If the level of salt contamination is in excess of the coating supplier specification the surfaces shall be washed with potable water and then re-blasted. This step will need to be repeated until the level of salt contamination is within acceptable limits.
- 2.3 The applicator shall take cognisance of the fact that after initial surface preparation as above Eskom will require access for mechanical inspections and possible repairs. Thereafter surface preparation and coating application work can proceed.
- 2.4 Special care shall be taken to ensure adequate protection of any parts of the condenser not requiring blast cleaning and coating and every effort shall be taken to avoid deformation or damage to the tubesheet and other surrounding condenser components. Surrounding areas shall be protected from over-spray and coating contamination.
- 2.5 All compressed air for blasting activities shall be free from entrained moisture and oil. All traps shall be in a functional condition. The compressed air shall be tested at regular intervals using clean white clothes to assess cleanliness and dryness.
- 2.6 No coating application shall be performed on surfaces containing traces of grit, grease, oil, loose rust, mill scale and traces of previous rubber lining. The requirement for surface preparation is strictly Grade Sa 3 (ISO 8501-1).
- 2.7 After preparation, all dust, grit blasting media or any other deleterious matter shall be removed by means of vacuuming. The process shall be repeated until the required level of dust and debris removal is achieved. Freedom from dust and debris shall be less than 'dust quantity rating' 1 when tested in accordance with ISO 8502-3.
- 2.8 A detailed visual inspection shall be carried out to identify all areas where pitting is evident or any other damage on the steel surface. Unfortunately, this inspection can only be carried out once the surfaces have been blast cleaned in preparation for coating. The depth and morphology of the pits need to be considered. Where applicable, the following procedure can be applied to all areas of extensive deep pitting.
  - All pits less than 2mm in depth and all edges and weld seams shall be stripe coated after application of the primer/first coat.

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

- All pits in excess of 2mm and up to 5 mm in depth shall be filled using a compatible two component solvent free epoxy filler. The filler to be used shall be supplied by the same supplier as the rest of the coating system and confirmed to be compatible to the specified coating system.
- All crevices and pits in excess of 5 mm in depth shall be filled by welding (repair procedure shall be submitted to Eskom for approval).

- 2.9 In order to avoid recontamination and flash rusting of the surfaces, the first coat shall be applied within 8 hours after final surface preparation of the steel surfaces. Under no circumstances shall the blast be permitted to stand overnight.
- 2.10 The method of application, i.e. brush, roller or spray, shall be agreed between the applicator and coating manufacturer and will depend upon access constraints and the substrate condition after abrasive blast cleaning. The primer coat must be brush/roller applied. In the case where the primer is not part of the specified coating system then the first coat shall be applied with brush/roller more especially on the pitted areas. The lining material shall be applied in such a manner as to thoroughly wet out the whole surface and all surfaces of pitting.
- 2.11 Multiple coats shall be applied as per the table above in this document. Single coat systems are not permissible.
- 2.12 In the event of surface blooming of the first coat then this shall be removed as per the surface preparation procedures as recommended by the manufacturer.
- 2.13 Application of subsequent coats shall be in accordance with the specified system. The required over-coating intervals as mentioned in the latest Product Data Sheet must be observed and adhered to.
- 2.14 All edges and weld seams shall be stripe coated.
- 2.15 The number of coats and thickness per coat required to achieve the total film thickness shall be agreed between the applicator and coating manufacturer and will be dependent upon the method of application chosen.
- 2.16 The coating shall be evenly applied to form a smooth, continuous, unbroken layer free from misses, sags, runs, tears and other defects that could affect the integrity of the coating.
- 2.17 Unless otherwise instructed by the Eskom Engineer for flange surfaces at least one coat of the lining system shall be brought around onto a third of the surface area of the flange face. In the case of flange face (gramophone surface finish) with compressed fibre gaskets blasting and coating is not permitted.
- 2.18 The contractor shall perform pinhole detection using either "Wet sponge testing" or appropriate "spark" testing equipment at a voltage setting as per the coating manufacturer's requirements.

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.



- 2.19 Defects shall be recorded and the defects repaired as per 4.8.6 of 240-101712128. All surfaces shall then be retested to ensure the lining is pinhole free and if required additional repairs performed as above
- 2.20 After completion of the coating activities sufficient curing time of the coating system shall be given prior to immersion as per the requirements of the Product Data Sheet.
- 2.21 Accelerated curing is not permitted. All coated surfaces shall be adequately ventilated until full cure has been achieved.
- 2.22 At the end of the curing period the full cure of the applied coating shall be verified by the applicator and/or coating manufacturer.
- 2.23 No work shall be performed until the Quality Control Plan is approved by the Eskom Engineer.

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.

**APPENDIX C: RUBBER GASKET MATERIAL DATA SHEET****John Moffat Prolock (Pty) Ltd**Reg. No. 1999/021887/07  
VAT Reg. No. 4780103018

ES 3586 Johannesburg 2000 • 18 Kinton Road Robertsham • ☎ 433 1870 Fax: 433 1453 E-mail: sales@jmp.co.za

**Technical Data Sheet****GP 45****General properties and application**

GP 45 has very good abrasion and rebound properties. It is not recommended for use in areas with hydrocarbons and oils. It does not have a high operating temperature but has good mechanical properties and is a very resilient material.

<b>Basis</b>	Natural Rubber Blend	
Temperature	Recommended maximum	70°C
Pressure	Recommended maximum	1 000 kPa

**Typical Properties**

Tensile Strength	10 Mpa
Compression set	40%
Hardness (A)	45 ± 5
Elongation at break	500%
Specific Gravity	1.2
Tear Strength	25 kg/cm
Ozone resistance	Poor

Available in rolls 1.2 metres wide and approximately 10 metres long.

Thickness range 1.5mm, 3mm, 4.5mm, 6mm, 10mm, 12.5mm, 15mm, 20mm and 25mm

This information represents typical values, which can vary according to the application. These values do not constitute a performance guarantee. Users should determine, prior to use, the suitability of this material for their particular application.

**CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.