Eskom	Technical Specification	Technology

Title: **Duvha Main oil cooler replacement works information**

Unique Identifier:	**382-170387**
Alternative Reference Number:	**N/A**
Area of Applicability:	**Engineering**
Documentation Type:	**SP**
Revision:	**0**
Total Pages:	**15**
Next Review Date:	**N/A**
Disclosure Classification:	**CONTROLLED DISCLOSURE**

Compiled by	Functional Responsibility	Authorised by
[redacted]	[redacted]	[redacted]
Turbine Engineering System Engineer	**Turbine Engineering Manager**	**Engineering Manager**
Date: 2024/01/10	Date: 2024/01/11	Date: 2024-01-17

CONTENTS

1. INTRODUCTION

This document provides the technical specifications for the Duvha main oil cooler replacement.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document covers the applicable work to be done, as well as the requirements and specifications regarding the work.

2.1.1 Purpose

The purpose of this document is to provide the *Contractor* with all the relevant details required to perform the work as defined in the scope.

2.1.2 Applicability

This document applies to Group Technology and all other relevant stakeholders that have an affiliation to this specific project including Duvha Power Station.

2.2 NORMATIVE/INFORMATIVE REFERENCES

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

2.2.1 Normative

[1] Pressure Equipment Regulations as defined in OHS Act (PER)

[2] SANS 347 Categorization and conformity assessment criteria for all pressure

[3] 240-106628253 Standard for welding Requirements on Eskom Plant

[4] 240-83539994 Standard for Non Destructive Testing (NDT) on Eskom Plant

[5] 240-86973501 Engineering Drawing Standard

[6] 240-145581571 Standard for the identification of contents of pipes and vessels

[7] ASTM B171 Standard Specification for Copper-Alloy Plate Sheet for Pressure Vessels, Condensers, and Heat Exchangers.

[8] ASTM B111 Standard Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock

[9] TEMA – Standards of the tubular exchanger manufacturers association

[10] PD 5500 Specification for Unfired Fusion Welded Pressure Vessels

[11] ISO 3834 Quality Requirements for Fusion Welding of Metallic Material

[12] 0.57-64377 Duvha Main oil cooler arrangement drawing

[13] ASME VII Div 1 - Rules for Construction of Pressure Vessels

[14] BS EN 13445 – Unfired Pressure Vessels

2.2.2 Informative

N/A

3. SCOPE OF WORK

3.1 GENERAL REQUIREMENTS

1. This specification is for the manufacturing and delivery complete replacement main turbine lube oil coolers for Duvha Power station. The exact quantity required will be provided by the commercial department.
2. The *Contractor* is responsible for the supply, manufacture and transport, delivery and offloading to Duvha Power Station of all items in the following sections of this document (hereafter referred to as “the works”) according to the applicable codes and standards and the requirements in this document.
3. The replacement cooler will be a like for like replacement cooler. The *contractor* is however still responsible to verify the design in accordance with the selected design code and adjust if required within the parameters given in point 4 below.
4. After contract award the successful *Contractor* is responsible to confirm all measurements of the cooler to ensure that the new dimensions are exactly the same as those on site including the connecting flange locations and bolt hole orientation. These measurements are to be done before any material is ordered or manufacturing commence. One cooler will be made available for the *Contractor* for measurements. All dimensions given in this specification and on drawings [12] are for tendering purposes only.
5. The Coolers shall be manufactured and assembled in South Africa.
6. Each vessel shall be fitted with a permanent corrosion resistant name plate containing the nameplate information as required in Regulation 9 of the PER

3.2 DESIGN CONDITIONS AND REQUIREMENTS

1. The coolers are of a two pass design on water side (water inside the tubes) while oil flow is directed over the external surfaces of the tubes.
2. One side has a fixed tubesheet and the other a floating tubesheet.
3. See table below for cooler mechanical design data:

Table 1: Oil cooler design

	Tube Side	Shell Side
Medium	Water	Oil (Castrol THZ 32)
Max Working Pressure	4.14 bar(g)	9.31 bar(g)
Max Working Temperature	40ºC	65ºC
Test Pressure	6.3 bar(g)	13.79 bar(g)
Capacity	1.2 m³	1.7 m³
SANS 347 Hazard Category	SEP	SEP

4. Although the vessel is SEP in accordance with SANS 347, it must be designed and manufactured in accordance with an acceptable design code as given in the PER and SANS 347. For the coolers one of the following will be preferred:
    - PD 5500 Category 2
    - ASME VIII Div 1
    - BS EN 13445
5. Formally the design code will be stated as: “Generally in accordance with *insert selected code here*”.
6. Full mechanical design calculations as well as general arrangement drawings that includes bill of materials are required for the cooler.
7. Drawing [12] provides the layout and tube bundle details of the cooler. This includes all nozzles, flanges, supports, lifting equipment and overall footprint. The drawing can be used for tender purposes, but the exact dimensions must be verified on site prior to manufacture.
8. No process design is required. The tube size (OD and thickness), tube length and number of tubes must be exactly the same as existing coolers.
9. Details w.r.t the floating tubesheet and the tubesheet to shell connection shall be determined the *contractor*.

3.3 TUBE PLATES

1. The tube plate material shall be a suitable copper based material from ASME SB-171. *Contractor* to determine the exact grade. This is subject to Eskom Engineering approval.
2. Tube plate can be of clamped or bolted design.
3. The tube plate diameter and hole distribution shall be as per drawing [12], but confirmed with site measurements.
4. Tube plate thickness shall be calculated in accordance with the selected design code for the selected material mentioned above. It is acceptable to change the tube sheets from the original design if found not to be acceptable.
5. *Contractor* shall ensure that tube sheet is of sufficed strength to prevent any deformation during expansion process.
6. Tube plate calculations will form part of the design package.
7. The nominal tube plate hole diameter shall be as per TEMA requirements for a nominal tube outside diameter of 14 mm. If required, the relevant tables to be interpolated.
8. The tube plate hole diameter tolerance shall be in accordance to TEMA Standard Fit Tolerances.
9. Permissible tube plate ligament variation as per relevant TEMA table.
10. Tube plate hole inside edges shall be free of burrs. Internal hole finishes shall be given a smooth workmanlike finish. A practical test is that cotton wool shall not attach to the surface if wiped over it. *Contractor* can propose a different finish for Eskom approval if required.

3.4 BAFFLE PLATES

1. The baffle plate material shall be a suitable copper containing material and can be determined by the *contractor*.

2. The number of holes, spacing and orientation of holes shall be as per drawing [12].
3. The baffle plate thickness shall be 5 mm as a minimum and shall be as per TEMA requirements.
4. The Number of baffle plates shall be 13 as per drawing [12]. Take note that there are two different types of baffles. There are 7 of the one type and 6 of the other. The size of both types of the baffles is provided on drawing [12].
5. All tubes shall be straddled by each baffle plate, i.e. No tubes in the centre of the tube plate corresponding to the doughnut type baffle cut.
6. The nominal baffle plate hole diameter shall be as per TEMA requirements.
7. Tube baffle plate inside edges shall be free of burrs. Internal hole finishes shall be given a smooth workmanlike finish. The outside edges shall be rounded to a 1 mm radius.
8. The number of tie rods shall be used to connect the 19 baffles and secure these in position shall comply with the TEMA requirements. All material to copper based.

3.5 TUBES

1. Tube material shall be admiralty brass as per ASTM B111M: C44300 or ASME SB111M: C44300.
2. Cooler tubes shall be procured in accordance to section 3.11.
3. The number of tubes per cooler is provided on drawing [12]. Tubes to be used are 1424 tubes of 14 mm OD and 1 mm wall thickness.
4. The minimum number of spare tubes to be procured per cooler is 2% additional tubes.
5. Length of tubes to be ordered shall be determined by the *Contractor*.
6. Provision shall be made in the construction of the tube bundle to allow for the bundle to be easily removed and replaced without contact with the shell.
7. The *Contractor* to ensure the tubes is manufactured with acceptable tolerances on the OD of the tubes considering the tube plate tolerances (as per standard fit criteria).

3.6 TUBE EXPANSION

3.6.1 Tube Expansion Requirements

1. Tubes shall be left with a 2-3 mm stick-out on both tube plates to facilitate tube plate coating at a later stage if required.
2. Each tube stick out shall be flared slightly, about 15 degrees total.
3. The tubes shall be attached to the tube plates by mechanical roller expansion using 3-pin rollers.
4. The *Contractor* shall provide a marked up tube plate drawing indicating the tubes that will be used as calibration tube plate holes to verify and test the wall thinning during expansion process and these will represent no less than 2% tube plate holes. Under no circumstances will more than 50 tubes l be expanded without a reference tube. These holes will be clearly marked on the tube plate, recorded on a tube plate drawing, and measured with a 3 pin bore gauge before loading of tubes into tube plate. These measurements are to be recorded on an electronic spread sheet.

5. In addition to the tube hole measurement requirements, the *Contractor* shall test 100% of tube holes on each tube plate with a no-go gauge. No holes shall be larger than the maximum hole tolerance as per TEMA standard.
6. All joints at the fixed end tube plate shall be made before any joints at the expansion end tube plate are attempted. The expanding procedure at the fixed end tube plate shall be as follows:
    - The tube will then be positioned with a 2-3 mm stick-out from the inlet/outlet face of the tube plate.
    - The *Contractor* shall propose an expansion map or sequence to minimise any distortion of tube plate.
    - The tube will then be expanded according to the requirements of this Works Information and values achieved in the mock-up tests.
    - Full expansion terminating 3 - 5 mm from oil side (shell side) of tube plate.
7. When all expanded joints at the fixed end tube plate have been completed, the joints at the floating tube plate can be made. The expanding procedure at the expansion end tube plate shall be as follows:
    - The initial expansions shall be in approximately 10 clusters of approximately 10 tubes each, with the clusters spread out uniformly across the tube plate. The purpose of this initial set of expansions is to prevent distortion of the tube plate which can otherwise occur due to forces imposed by the expansion process.
    - Once the clusters are complete the remaining tubes can be expanded.
    - After expansion all tube ends are to be trimmed back so that the maximum protrusion from the tube plate face is 2-3 mm.
    - If tubes are faced this to be done after expansion of both sides and all trimming waste is to be removed from the tube plate area. Tubes will be cleaned by blasting plugs (with compressed air or similar) trough to remove shavings and debris that is formed during this process.
8. The *Contractor* shall monitor and control the expanding process at all times in order to ensure that satisfactory tube-to-tube plate joints are created for every tube. As a minimum the following checks and controls shall be implemented:
    - Roller expanders will be cleaned at least after every 25 tubes, and will be lubricated for each tube.
    - During each expansion of a hole identified for calibration as defined above, the following shall be done:
        - Clean expander.
        - Rotate manually and inspect rollers and verify free movement and inspect mandrill shaft for defects (score, abrasion & pitting).
        - Verify torque setting on expander torque scale to be correct and ensure that locking mechanism is securely tightened.
        - Inspections shall also be made in the event of torque fluctuations or evidence of damage to the tube inside surface.
        - For each tube that enters the tube plate on the calibration holes, the average tube OD has to be recorded (value “D” as detailed below). Also the *Contractor* shall measure the average tube ID before the tube is expanded (Value “d” as detailed below). Alternatively the average tube wall formula can also be used provided at least 3 measurements are done

9. Re-expansion of joints shall be avoided where possible. The *Contractor* shall employ a system of marking, recording and controlling the expansion process which avoids accidental re-expansion.

3.6.2 Tube Expansion Measurements

1. At least 30 percent of all tubes, selected in a "Z" with reference to the tube sheet, shall have back up documentation stating the expansion levels achieved. Measurements that will be recorded will be:
    - Tube sheet hole ID before tube is inserted.
    - Tube OD before tube is inserted.
    - Wall thickness of tube before tube is inserted and measured at the mid point of the expansion depth/length. Should average wall thickness be used, a cross comparison between wall thickness / ID and OD will be supplied
    - Tube ID after expansion measured at the depth/length of expansion.
    - Results shall be in spreadsheet format, and backed with a full trace-able tube sheet map indicating all measured tubes exactly.
2. The expansion records must be based on actual wall thickness and not average wall thickness. Wall thickness must be determined from (OD-ID)/2.
3. The following formula will be used for wall thinning and mock up testing:

$$T_w = \frac{(T - t) - (D - d)}{(d - t) * 100}$$

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

T_w = % wall thinning

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

Description	Symbol	Result
Tubesheet hole size	D	
Tube outside diameter	d	
Tube inside diameter before expansion	t	
Tube inside diameter after rolling	T	
% Expansion	Tw	

3.6.3 Requirements for Tube-to-Tubesheet Mock-up tests

1. Mock up test and pull out test must be completed before expanding any tubes in the cooler. Only one set of mock up tests are required in case of multiple coolers provided the same tube expander drives are used on the different units.

2. Two sample expansion mock up blocks shall be supplied to the *Employer* by the *Contractor* for testing and analysis.
3. The torque value on the expander to be adjusted until a pull out force value obtained during these tests for a nominal hole diameter as per TEMA requirements for wall thinning exceeding 4%. Maximum wall thinning for brass not to exceed 6% (12% expansion).
4. Before pull out test the measurements for wall thinning to be taken and calculate wall thinning as formula above.
5. The *Employer*'s representative shall witness the generation of the mock-up blocks.
6. Each of the "mock up" blocks must contain a minimum of 6 tubes. Blocks will ensure the complete range of tube hole ID's as per TEMA allowances. At least 2 holes on smallest ID, two holes on largest ID, and two holes on average ID are required. Rest of the holes can be anywhere in range,

3.6.4 Requirements for pull out test

1. The *Contractor* is responsible for concluding the datum point pull-out and push-test.
2. The following should be determined from pull out tests and the following conclusions should be derived:
    - The corresponding force (torque value used for the mechanical expansion) for the greatest load bearing joint
    - Documentation of the test results for subsequent use on the tubesheets.
    - Tube or pull out tests for various tube hole diameters: The *Contractor* is responsible to ensure all the specified pull-out tests are conducted to assess the load-bearing capabilities of the expanded joints at various tube hole diameters.

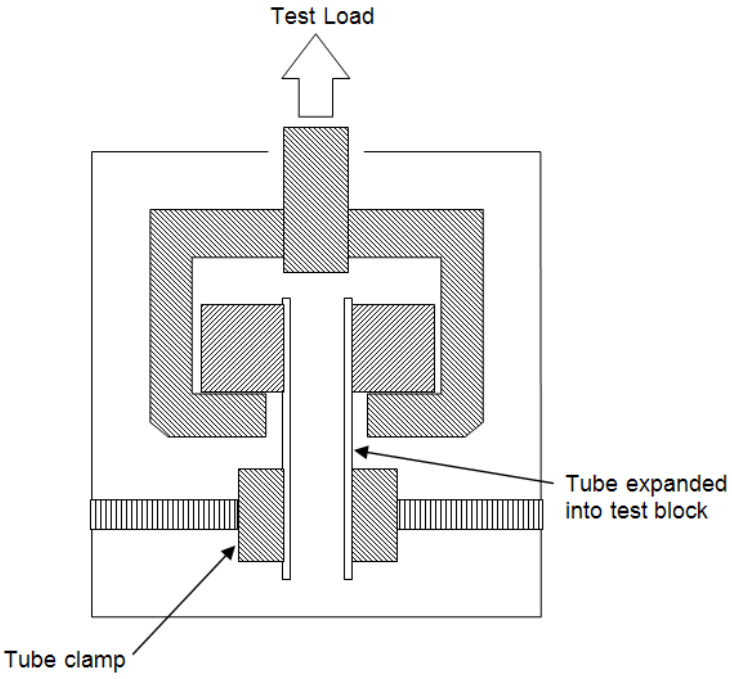

Figure 1: Pull-Out and Push-Out Test Apparatus

3.7 WATER BOX

1. Water box on both ends to be as per drawing [12].
2. Water box to manufacture from a suitable grade of stainless steel. *Contractor* can select exact grade of material. Selected material to be approved by Eskom engineering.
3. *Contractor* to ensure that material choice takes the PV difference of the material and the tube / tube plates into consideration to minimize effects of dissimilar material or galvanic corrosion.
4. Drain configuration must allow complete drainage of the water box and tube sheet.
5. The pass partition must have a minimum thickness of 12 mm.
6. The pass partition shall be constructed from pressure vessel quality steel and shall be of the same general material (Material group) as the water box.
7. Attachment welds between the pass partition and the water box shall be continuous full penetration welds and shall be subjected to a surface test as a minimum.

3.8 SHELL

1. Shells shall be of an all-welded construction.
2. Shell and nozzle arrangement shall be as per drawing [12]. Exact measurement to be confirmed on site to ensure cooler fit in existing position.
3. The new coolers must fit in the exact same position as the existing coolers. Above drawing is for tender purposes, final dimensions must be confirmed on site.
4. The *Contractor* must propose shell material with justification for selected material and the material shall be accepted by the *Employer*. Pressure vessel quality plate is required. Structural steel shall not be allowed.
5. The edges of shell plates shall be checked by surface testing for laminations or any defects prior to weld fit up.
6. Care shall be taken to exclude all foreign matter from the shell interior and tube bundle before bundle insertion.

3.9 FLANGES

1. All flanges (Inlet, outlet, vent and drain) shall be of the same spec, details, position and orientation as per original cooler.
2. Blanks shall be fitted on all flanges before delivery to site.
3. All flanges on the cooling water will be supplied with a galvanic corrosion resistant gasket.

3.10 GENERAL MATERIAL REQUIREMENTS

1. The *Contractor* is responsible for supply of all materials. This includes, but is not limited to the tubes, tube plates, baffles, water boxes, shell and any structural steel that is used. Any consumables required like gaskets, bolts and nuts shall also be supplied by *contractor*.
2. All material that forms part of the pressure envelope including tube sheets, waterbox and shell shall be provided with 3.1 material certification in accordance with BS EN 10204:2004.

3.11 TUBES MATERIAL REQUIREMENTS

1. *Contractor* to compile a procurement specification of the tubes. Procurement specification to be reviewed and agreed to by employer.
2. Tube material shall be admiralty brass as per ASTM B111M: C44300 or ASME SB111M: C44300.
3. Tubes to be supplied with a 3.1 material certification in accordance with BS EN 10204:2004.
4. *Contractor* is responsible to specify the required tube tolerances.
5. Chemical composition shall comply to ASTM or ASME specification.
6. The finished tubes shall be clean and free of foreign material, shall have smooth ends free of burrs, and shall be free of injurious external and internal imperfections from burrs and defects as per paragraph 15 of ASME B111M but without any superficial film.
7. The external and internal surfaces shall be clean, smooth and free from any drawing scratches that would affect the integrity of the future tube expansion process. No residual drawing lubricant is permitted.
8. All tubes shall be free from surface oxides/carbon film and supplied in the bright annealed condition with no pickling or passivation.
9. Each tube manufactured in accordance with this Specification shall be legibly marked by stencilling the ASTM UNS designation, the temper and heat number or batch number or batch number, outside diameter, thickness, length, name of supplier and the lot number.
10. The finished tubes shall comply with the mechanical requirements as per the ASTM or ASME specification.
11. All testing in accordance to the ASTM or ASME standard to be done.

3.12 WELDING AND NDE REQUIREMENTS

3.12.1 Welding Requirements

1. *Contractor* responsible for the welding shall be ISO 3834-2 certified. The provided ISO 3834-2 certificate shall include the scope of accreditation that includes the design code to be used.
2. All welders for manual welding shall be coded to BS EN ISO 9606.
3. All welding procedures shall be qualified to the latest version of BS EN 15614-1.
4. Geometry specific Weld Procedure Specification (WPS's) are required, supported by the relevant PQR.
5. All welding documentation including weld maps will be subject to approval by an Eskom welding Engineer, to current Eskom standards.
6. The following Eskom standard is applicable and must be complied with for all welding activities: *240-106628253 Standard for Welding Requirements on Eskom Plant.*

3.12.2 NDE Requirements

1. All required NDE shall be provide by the *Contractor*.
2. All NDE done shall comply with the following Eskom standards: *240-83539994 Standard for Non-Destructive Testing (NDT) on Eskom Plant.*

3.13 QUALITY REQUIREMENTS

1. No work will be done without a QCP that is approved by the *Employer*.
2. A QCP and dimensional drawings must be submitted to the *Employer* for the works 7 days before that part of the work is to commence.
3. QCP's and related documentation shall be subject to comment and approval by the *Employer*'s Quality Control personnel as well as Engineering. QCP's will make provision for signatures for interventions by at least the *Contractor*'s QC Representative and the *Employer*'s QC Representative and the *employer*`s engineer.
4. Each QCP will have a page for proof signatures, so that any signature can be traced to the individual who has endorsed any activity on QCP.
5. Intervention points will be signed as the work progresses and no back-dating will be allowed.
6. Notification for hold and witness points shall be in writing and shall be done at least 72 hours in advance.
7. All drawings to be "A approved" before pressure test.
8. The following minimum hold points must be included for the *Employer*'s Quality Control Department:
    - Approval of QCP
    - Review of expansion mock up tests results before actual expansion commence on the cooler.
    - Review material certificates
    - Final Visual Inspection
    - Witness of Pressure Tests
    - Final Sign off and Acceptance
    - Final Data book Review

3.14 DRAWING REQUIREMENTS

1. The *Contractor* shall provide a drawing of the complete cooler with all relevant dimensions and full material list. Details of the tube bundle shall also be provided.
2. All Drawings to be provided shall be in accordance with the Engineering Drawing Standard – Common Requirement (240-86973501).
3. Drawings issued to Eskom may not be "Right Protected" or encrypted.

3.15 DOCUMENTATION REQUIREMENTS

1. All documents supplied by the *Contractor* shall be subject to Eskom's approval. Documents such as QCP's, Method Statements and other documents impacting the work must be approved by the *Employer* at least 7 working days prior to commencement of the Works.
2. Each revision of a document or drawing shall be accompanied with a list of the comments made by the *Employer* on the previous revision if applicable and the response/corrective action taken by the *Contractor*. Changes will be recorded in a revision table contained on/in each drawing/document. Any changes by *Employer* or *contractor* will be captured in this revision table. On approval of the new revision all old revisions will be removed from production floor.
3. Documents and drawings shall indicate the *Employer*'s drawing number as allocated by the *Employer*. The *Contractor* may have his own document or drawing number on the document or drawing, but where reference is made among documents or drawings, the *Employer*'s number shall be used.
4. The *Contractor* shall compile a complete data book for all work done containing the following as a minimum if applicable:
    - Scope of work
    - Approved QCP / ITP
    - Inspection reports and Procedures
    - As built drawings including tube maps.
    - Mechanical design calculations.
    - Full traceable material certificates in accordance with EN 10204 3.1 and be traceable to the actual bill of materials, drawings and designs. Note this is only applicable to material where 3.1 certification are required.
    - Pressure test certificates, a photo copy of the nameplate including calibration certificates of pressure gauge.
    - Pressure test reports
    - All NCR/CAR's and corrective actions
5. All data books to be delivered within 1 month after cooler delivery.

3.16 PRESSURE TEST REQUIREMENTS

1. The pressure test shall be done according to the pressure required by the design code based on design pressure.
2. The shell side pressure test shall be done first, with the waterbox blank flanges removed to inspect for leaking tubes. After that the water box pressure test shall be done.
3. Pressure test to be executed using normal tap water as test medium at ambient temperature.
4. Any leaking tube-tube plate joints found during the test will be re-expanded once. This will be indicated on a tube plate map. If the tube is still leaking after a second expansion the *Employer* will be consulted. In this case leaking tubes shall be replaced.
5. For the vessel to succeed the pressure need to be sustained for at least 30 minutes. No cyclic testing is required

3.17 CONFIGURATION MANAGEMENT AND DOCUMENT MANAGEMENT

1. Transmittal letters shall be provided with each document submittal. The transmittal letter shall include the *Contractor*'s drawing/document number, revision number, and title for each drawing or document attached.
2. Each drawing title shall be unique and shall be descriptive of the specific drawing content.

3.18 COATING REQUIREMENTS

1. The surface can be mechanically prepared (wire brush or sandblasting) before coating.
2. Rust protection external primer like or similar to red oxide is required.
3. Coolers to be painted golden brown as per typical oil piping and vessels and Eskom standard 240-145581571.

3.19 DRYING AND PRESERVATION

1. The *Contractor* shall submit the complete drying out and preservation procedures for the coolers. These procedures shall be approved by the *Employer* and the *Employer*'s quality representative prior to pressure testing
2. After completion of all hydrostatic testing, the coolers shall be drained and dried out. *Contractor* to prove that the cooler is completely dry on shell side and tube side
3. The drying out of the coolers will be monitored by the *Employer* and final blanking off shall not be carried out without the approval of the *Employer* and the Inspection Agency.
4. For storage periods of longer than a week coolers shall be stored indoors or under a fixed roof to avoid exposure to direct sunlight and high ambient temperatures.

4. TENDER RETURNABLES

4.1 MANDATORY TENDER 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. *Contractor* shall provide proof of ISO 3834-2 certification (all pages) for the company/manufacturer that owns and runs the workshop where the heaters will be built. The scope of accreditation of the ISO 3834-2 certificate shall include the design code to be used for this project.
2. A letter signed by tenderer and intended tube mill to be used for tubes stating compliance to ASTM B111M.
3. Verifiable reference list of industrial (power or petrochemical industry) shell and tube heat exchangers manufactured by the manufacturer during the last 5 years. A minimum number of 10 shell and tube heat exchangers are required.

4.2 QUALITATIVE TENDER RETURNABLES FOR EVALUATION PURPOSES

1. A completed Quality Control Plan or Inspection and Test Plan of a similar heat exchanger built by the *Contractor* in the past.
2. Exclusions or qualifications to the above Works Information. If there are no exclusions or qualifications then a specific statement to that effect is required.
3. An example of a method statement, from the Manufacturer, for tube expansion used for a similar vessel manufactured previously.
4. Tools List: Table 2 below shall be included in the tender with columns 2 and 4 completed.

Table 2: Tool List to be completed

Minimum required quantity	Quantity available at *Contractor*s workshop	Tool / Equipment Description	Description, Type or Make where applicable
2		Tube expander drive	
4		3 Pin roller expanders	
N/A		Lubricant for expansion	
2		Tube facing tools	
5		Tube facing tool replacement blades	
1		Calibrated 3-Prong internal micrometer, min accuracy 0.01 mm	
1		Calibrated external tube vernier, min accuracy 0.01 mm	
1		Calibrated Torque analyser	

5. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
[redacted]	Corporate Consultant – PEI
[redacted]	Snr Consultant - PEI
[redacted]	Senior Technologist – Duvha
[redacted]	Senior Engineer - Duvha
[redacted]	Engineer - Duvha

6. REVISIONS

Date	Rev.	Compiler	Remarks
Jan 2024	1	[redacted]	First Issue

7. DEVELOPMENT TEAM

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

- [redacted]
- [redacted]

8. ACKNOWLEDGEMENTS

- N/A