



CPO (REFINERIES)

**TURNAROUND JOBS OF PROCESS UNITS IN VGO-HDS
AND NHT-CCR COMPLEX AT BPCL-KOCHI REFINERY**



**ADDENDUM NO:1 TO REQUEST FOR QUOTATION
CRFQ NO. 1000212483
(E-TENDER NO. 15560- VGO-HDS COMPLEX (PACKAGE -1))**

ADDENDUM NO:1 TO REQUEST FOR QUOTATION CRFQ -1000212483
E-Tender Sys No: 15560- VGO-HDS COMPLEX (PACKAGE –1)

1.0 INTRODUCTION

Addendum No:1 is issued against the tender for “TURNAROUND JOBS OF PROCESS UNITS IN VGO-HDS AND NHT-CCR COMPLEX AT BPCL-KOCHI REFINERY”.

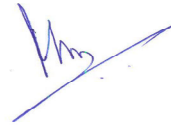
This Addendum is issued against E-Tender Sys No: 15560- VGO-HDS COMPLEX (PACKAGE –1). This addendum shall form the part of tender document pertaining to VGO-HDS COMPLEX (PACKAGE –1) and shall be signed and submitted along with the techno-commercial/unpriced bid documents for the subject package.

The description of the Addendum is given below;

Section No/Page No. of the document in the tender	Sub heading Ref	Present description	Addendum issued
SECTION 4, SPECIAL CONDITIONS OF THE CONTRACT, PAGE 91 OF THE TENDER	Scope of Supply/Materials/ Facilities provided by BPCL	Nil	To add: 3.1.21- Flameproof handlamps and transformers wherever required shall be supplied by BPCL. 3.1.22- Metallic blind tags shall be supplied by BPCL. 3.1.23-Level gauges of all vessels and columns shall be removed from the equipment and cleaned. However if the level gauge glasses need to be replaced, it will be done by BPCL for which the Contractor will have to shift the level gauges to BPCL workshop.
SECTION- 1,VGO-HDS COMPLEX (PACKAGE-1) TURNAROUND TENDER DOCUMENT INDEX, PAGE 65 OF THE TENDER	ANNEXURES	NIL	To add: ANNEXURE-21-Technical Specification for Non Destructive Testing of Static Equipment and piping BPKR/AS/INSP/SPEC/001 Rev.1 (The same is attached)
SECTION-12, SCOPE OF WORK- REPAIR OF EQUIPMENT/ PART- SPRING SUPPORTS OVERHAULING/SERVICING PAGE 182 OF THE TENDER		This scope of work is for overhauling/ servicing of 150 Nos spring supports specified in Annexure 18 & Annexure 19	This scope of work is for overhauling/ servicing of 151 Nos spring supports specified in Annexure 18 & Annexure 19

SECTION-12, SCOPE OF WORK- REPAIR OF EQUIPMENT/ PART- SPRING SUPPORTS OVERHAULING/SE RVICING PAGE 183 OF THE TENDER	—	The scope of work involves the following in the 119Nos of spring supports in VGO-HDS unit and 31Nos spring supports in NHT-CCR unit	To read as: The scope of work involves the following in the 119Nos of spring supports in VGO & 32Nos in VGO SRU.
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All other terms and conditions of the tender remain unaltered



(f) DGM (CPO-Refineries)

Place: Mumbai
Date: 29th July 2014



**TECHNICAL SPECIFICATION FOR NON DESTRUCTIVE TESTINGS OF
THE STATIC EQUIPMENTS AND PIPING'S AT BPCL-KOCHI REFINERY,
KOCHI.**

(BPKR/AS/INSP/SPEC/001 Rev.1)

**ADVISORY SERVICES DEPARTMENT
INSPECTION SECTION**

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1. General

This specification covers the general requirements for conducting non destructive examination (NDE) during Turn around (TA) in BPCL Kochi Refinery. The technical requirements specified in the document are the minimum requirements for each NDE and agencies selected for conducting NDE shall follow this specification. **The applicability and extent of a specific NDT for an equipment/job will be as mentioned in the Inspection work list/ Maint scope of work**

2. Scope

2.1 The document is applicable for the following NDE/Testing carried out (when specified in scope of work) in BPCL KR for its TA in process units.

2.1.1 Ultrasonic Thickness Measurement (UTM)

2.1.2 Radiography (RT)

2.1.3 Penetrant Testing (PT)

2.1.4 Magnetic Particle Testing (MT)

2.1.5 Hardness Testing

2.1.6 In-Situ Metallography by Replication Technique.

2.1.7 Remote Field Electromagnetic Technique (RFET) & Eddy current Testing (ECT) of Tubes.

2.1.8 Internal Rotary Inspection System (IRIS)

2.1.9 Positive Material Identification (PMI).

2.2 The document is applicable for the following static equipment

1. Pressure Vessel
2. Columns
3. Heat Exchanger
4. Tank
5. Heater
6. Filters
7. Pipelines & fittings
8. Boiler

3. Ultrasonic Thickness Measurement

3.1 **Ultrasonic thickness measurement will be taken by a separate agency appointed by BPCL-KR. All the facilitation required for thickness survey like scaffolding, insulation removal and cleaning to be done by the LSTK Contractor. General guideline on thickness measurement is given below, so that the LSTK Contractor is aware of the type of facilitation required.**

3.2 Facilitation for carrying out thickness survey of equipment has to be done as given below.

3.3 Columns:

- i. Shell plate: In 4 compass directions at every 3 to 4 tray levels Minimum two set of readings in each shell course
- ii. Dished ends: In 4 compass directions in crown and knuckle area each.
- iii. All connected nozzles in 4 directions. (If thickness survey is not possible from inside, necessary facilitation has to be done to conduct thickness survey from outside)
- iv. Skirt: In 4 compass directions.
- v. Internals: Trays (10% of trays, 4 locations on each tray) and distributors (100%, one set of readings {4 compass directions} at every one meter length).
- vi. Area opposite to feed nozzles.
- vii. Demister pad support plate location (Shell)

3.4 Vessels:

- i. Shell plate: In 4 compass directions for all shell courses. Minimum two set of readings in each shell course (near to circumferential weld joint)
- ii. Dished ends: In 4 compass directions at crown and knuckle area each
- iii. All connected nozzles in 4 directions. (If thickness survey is not possible from inside, necessary facilitation has to be done to conduct thickness survey from outside)
- iv. Skirt (for vertical vessels): In 4 compass directions.
- v. Internals: All Baffles (4 locations on each baffle) and distributors (100%, one set of readings {4 compass directions} at every one meter length).
- vi. Area opposite to feed nozzles.
- vii. Demister pad support plate location (Shell)

3.5 Heaters:

a) Radiation Section:

- i. Straight tubes: In 4 compass directions at 3 levels (1st level shall be approx. 1 mtr. from floor level).
- ii. Return bends: All bends, min. 3 readings on the outer radius of each bend.
- iii. All support locations.
- iv. All overheated/coke deposited area

b) Convection Section (Hydrocarbon Coils, BFW Coils, Steam Generating Coils and Super Heater Coils):

- i. Tubes (straight sections):- In 4 compass directions adjacent to each bend.
- ii. Return bends:- All bends, min. 3 readings on the outer radius of each bend.

iii. Bottom shock tubes:- In 3 compass directions at 3 locations.

c) Stack:

I. One set of readings on each shell course along the staircase.

d) Air Duct (Horizontal sections):

i. One set of 3 to 4 readings on plate (at all four sides) at every 6 meters length.

3.6 Exchangers:

- i. Shell & shell cover: In 4 compass directions for all shell courses (At min. 3 locations).
- ii. Dished ends: In 4 compass directions at crown and knuckle area each.
- iii. Tube sheet and floating head, partition plates, baffle plates
- iv. All connected nozzles in 4 directions. (If thickness survey is not possible from inside, necessary facilitation has to be done to conduct thickness survey from outside)
- v. Thickness by measuring ID&OD of tubes

3.7 Air fin coolers:

- i. Inlet and outlet Header boxes (all 4 plates at 3 locations) and partition plate.
- ii. All connected nozzles in 4 directions.

3.8 Pipelines

- i. All elbows, tees and reducers, caps
- ii. Minimum three readings shall be taken on the elbows of the piping network at the outer curvature. One reading shall be at the centre of the bend and two readings on the same line on either side of this reading.
- iii. Pipe: one set of readings in 4 compass directions or 3, 6, 9 and 12 o'clock positions at every 10m length. In case of small pipe sections i.e. less than 10m length, one set of readings in every section of straight pipe. Minimum one set of readings each on the straight pipes on upstream and downstream of the bend adjacent to welds of the bend to pipe.
- iv. All locations upstream and downstream of control valves, injection points, restricted orifices.

Note:-

In general thickness measurements are taken from inside the equipment where intrusive inspection is possible. If intrusive inspection is not possible like in piping, heater tubes, small vessels etc, thickness survey shall be carried out externally. In case of high corrosion/pitting, lamination of plates etc. the thickness survey should be conducted externally and the same shall be documented.

4. Radiography:

- 4.1 All radiography activities shall be carried out by BARC certified personnel only. Radiography film shall be evaluated by certified ASNT/ ISNT level II/level III personnel.
- 4.2 Additional requirements if any required for the completion of TA jobs shall be as per the instruction of the BPCL-KR Inspection Engineer In-charge.
- 4.3 All the films will be re-reviewed by BPCL Inspection and the decision from BPCL inspection is final. All the films are property of BPCL.
- 4.4 Applicable Codes & Standards
 - a) ASME Sec.V, Edn- 2010, Article -2- Non destructive Testing–Radiographic Examination
 - b) ANSI B 31.3,Ed-2008 (For acceptance Standard)-Code for Process Piping
 - c) ASME Sec.VIII,Div.I, Edn 2010, Para UW-51,UW-52 and Appendix 4.
 - d) ASNT Recommended practice: SNT-TC-1A-Personnel qualification and certification in Non destructive testing.
 - e) M/s. EIL standards 6-44-00016

5. Penetrant Testing (PT)

- 5.1 The requirement of Dye Penetrant Test shall conform to ASTM-E-165. Liquid Penetration Examination shall be carried out as per ASME Section V Article 6
- 5.2 Penetrant testing shall be carried out as per WPS/tender specification/as required during fabrication.
- 5.3 Only good quality consumable, such as P-Met from Baroda (India), Xylgo from Magnaflux Corporation (U.S.) or equivalent, shall be used.
- 5.4 Developers/Penetrant shall be applied through aerosol spraying cans.
- 5.5 When examining austenitic or duplex stainless steel and titanium, all penetrant materials shall be analyzed individually for halogens content in accordance with SE-165, Annex 4. The total halogens content shall not exceed 1% by weight
- 5.6 Locations and extent of Dye Penetrant Testing in the static equipments shall be decided by Engineer-in-charge at site
- 5.7 Any defect observed during the test shall be immediately communicated to Engineer-in-charge.
- 5.8 Observation/record sheet shall be submitted with proper sketches of the location and the area thus inspected/tested.
- 5.9 Applicable Codes & Standards
 - a) ASME Code for Pressure piping- B. 31.3

- b) ASME Boiler & Pressure Vessel Code, Sec VIII, Div I Rules for Construction of Pressure Vessels. Appendix-8
- c) ASME Boiler & Pressure Vessel Code, Sec V, Non destructive examination. Article-6 & SE 165 of Article 24

5.10 GENERAL

- 5.11 Penetrant Testing shall be applied to detect discontinuities that are open to the surface of nonporous and other materials. Typical defects which are detectable by this method are cracks, porosity, laminations, seams, laps etc.
- 5.12 Prior to examination, surface to be tested and adjacent area shall be cleaned, to allow the penetrant to enter the discontinuities.
- 5.13 Cleaner shall not be directly applied to surface. Surface temperature shall not be above 50 Deg C.

5.14 Personnel Qualifications

- 5.15 Individuals performing Penetrant examination shall be qualified ASNT/ISNT level-II/ level-III in accordance with SNT-TC-1A or equivalent.

6. Magnetic Particle Testing (MPT)

- 6.1 WMPT is required to be carried out to detect all types of surface and near surface crack or such other discontinuities mainly in welds and adjacent areas by using :
 - Articulated AC/HWDC Magnetic Yoke
 - Fluorescent iron powder suspended in water.
 - Ultraviolet Light.
- 6.2 WMPT method used shall meet the requirement of ASTM standard recommended practice for MPT, ASME Sec. V, Article 7/SE-709/BS-6072 including selection of equipment and magnetic power, calibration/testing of equipment and examination technique, Reliable equipment of Magnaflux or equivalent make shall be used for the job.
- 6.3 Weld joints subjected to WMPT shall be thoroughly cleaned by mechanical means.
- 6.4 Only experienced and ASNT/ISNT certified level-II holder shall be employed for the job.
- 6.5 At least 70 mm of parent metal on either side of the weld shall be covered in WMPT of welds.
- 6.6 WMPT shall be carried out location specified in WPS/tender/ as required during fabrication.
- 6.7 All the surfaces inspected shall be thoroughly cleaned after testing is over.
- 6.8 Report shall contain the details as above including the verification and signature of the operator.
- 6.9 Applicable Codes & Standards

- i. ASME Code for Pressure piping - B. 31.3
- ii. ASME Boiler & Pressure Vessel Code, Sec VIII, Div I Rules for Construction of Pressure Vessels.
- iii. ASME Boiler & Pressure Vessel Code, Sec V, Article-7 Non destructive examination.
- iv. ASNT Recommended practice: SNT-TC-A1

6.10 General

- 6.11 Magnetic Particle Testing shall be applied to detect surface & sub-surface discontinuities of ferrous material.
- 6.12 Before Magnetic Particle testing, surface to be tested shall be cleaned, to allow the magnetic particles movement according to flow and direction of magnetic flux.

6.13 Personal Qualifications

- i. Individuals performing Magnetic Particle Testing shall be trained and qualified ASNT ISNT level-II / level-III in accordance with SNT-TC-1A or equivalent.
- ii. Use battery operated equipment.

7. Hardness Measurement

- 7.1 Hardness is to be measured in the, HAZ and weld metal of weld joints. Hardness requirements for welds shall be as per the Welding Specification Chart/Non Destructive Examination Specification attached elsewhere in the contract.
- 7.2 M/s.EIL spec No.6-15-0091, Rev-1 shall be followed as standard specification for Hardness requirements. Providing hardness tester shall be the responsibility of NDT agency.
- 7.3 Hardness testing shall be carried out by Telebrinneller type hardness tester. Microdur, Equotip or equivalent make may be used with prior approval from BPCL. Hardness should be specified in terms of BHN. Hardness to be checked for all weld after PWHT but before hydrotest. Each longitudinal seam shall be checked both internally and externally near the centre and at one end. Each circumferential seam shall be checked at four locations 90° apart internally (if possible) and externally. Each nozzle weldment shall be checked at two locations 180° apart internally (if possible) and externally
- 7.4 Contractor shall produce documentary evidence/calibration certificate to the Owner's Inspector and obtain approval of the hardness testing equipment.

8. In-Situ Metallography by Replication Technique.

- 8.1 Replication technique shall be applied after preparing the surface at selected location of the component to reproduce accurately the metallographic features such as distribution, size and morphology of the carbide precipitation and microvoids

associated with early stage of creep damage, intergranular/transgranular cracks typical in stress corrosion and temper embrittlement cases.

- 8.2 The procedure of the job shall generally conform to ASTM SE-1351.
- 8.3 Unless stated otherwise, replicas shall contain weld metal, heat affected zone and base metal.
- 8.4 Superior quality of replication consumable shall be used.
- 8.5 The areas for replica shall be prepared by either mechanical or electrolytic polishing means followed by chemical/electrochemical etching of the spots before study/examination. Preparation of metallographic specimen shall be as per latest revision of ASTM E-0003. The replica shall be prepared as soon as possible after specimen preparation of the original surface is completed, to minimize transfer of post-preparation oxidation and contamination to the replicating film. A microscopic examination of each replica shall be made on site to verify that it is of adequate quality and to note signs of material damage (e.g. creep micro or macro cracking) which may require immediate attention. Standard method for micro etching of metals & alloys shall be as per latest revision of ASTM E-0407. If significant damage is found at a replica site during the onsite examination, the location shall be re-replicated after re-grinding/polishing
- 8.6 Prior to final evaluation of replicas, these shall be coated with a film of vapour deposited gold or gold-palladium. The coated replicas shall be examined, as a minimum, with a light optical microscope at magnification ranging from 50 X to 500 X. Arrangement then shall be made by the NDT agency to view the replicas under a Scanning Electron Microscope (SEM) at magnification ranging from 2000X to 5000X.
- 8.7 Each replica shall be given a unique identification designation. The report shall include a sketch of the component showing the location of each replica site as well as an overall photograph and close up photograph showing the replica location.
- 8.8 The report shall include a photomicrograph of the replica at each zone where creep image has occurred, taken at a suitable magnification to show the microstructure and significant findings. A photomicrograph shall be taken of a typical replica of each component.
- 8.9 The report shall include the damage classification associated with each zone of interest of each replica and the corresponding recommended re-examination interval.
- 8.10 In situ Metallography shall be carried out through BPCL-KR approved agencies only. The following are the present approved vendor list for in-situ metallography. (If any change is there, that will be intimated later. Contractor can carry out job as per the BPCL approved list effective during November 2014)
 - BHEL , Trichy
 - Materials Science & Technology Division

National Metallurgical Laboratory
Council of Scientific & Industrial Research
Jamshedpur-831007

- Central power Research Institute
(A Govt of India Society, Ministry of Power)
Thermal Research Centre, Koradi-441 111
Nagpur (M.S), Ph No 07109 262251, Mob-9423103379.
- TCR Engineering Services Pvt. Ltd.
Plot No. EL-182, MIDC-TTC, Electronic Zone,
Behind Nelco, Mhape, Navi Mumbai-400 710
Maharashtra, India, Tel: +91-22-67380900 to 999,
Tel: +91-22-27612324, 27610921

SUBMISSION OF REPORT

A preliminary report shall be submitted immediately after completion of field jobs for each equipment. A detailed report highlighting the material degradations if any and remaining operating life of the material examined to be submitted within 30 days from the date of completion of field jobs for each equipment. In the final report all microstructural features w.r.t to the corresponding replica shall be accurately rendered and photomicrographic documentation of microstructural features shall be provided over the range of magnifications normally used for replica evaluation. The Final Report shall consist of good quality images of adequate magnification indicating identification/characterization/ sizing of any defect in the tested component and also shall include SEM analysis details. This shall include micro structural changes, carbide distribution, degree of oxidation, level of creep and also loss of ductility by sigma phase precipitation etc. if any. All grain boundaries, grain boundary precipitates, any crack/ cavities, crack like voids, carburization, any such discontinuities indicating advanced stages of creep damage, micro cracks etc. shall be easily identifiable. Interpretations of microstructures and detailed recommendations including assessment on the condition of the tested component or the sample w.r.t. corresponding micrographs shall be included in the final report

Two copies (original in all respects) along with soft copy in CD of final report incorporating photomicrographs shall be submitted along with the entire set of replicas properly protected and secured inside glass slides. Replicas shall remain attached to their carrier slides, and shall be stored in dust-free biological slide cases, with proper indexing to permit retrieval where required for record.

9. Remote Field electromagnetic Technique (RFET) & Eddy current Testing (ECT)

- 9.1 ECT (Eddy Current Testing) shall be conducted on SS300 series, Cupro-Nickel, Al-Brass, Titanium and other non-ferrous metallurgy tubes in heat exchangers / coolers/ condensers in hydrocarbon or cooling water service and report the observations and recommendations in standard format.
- 9.2 RFET (Remote Field Electromagnetic Testing) has to be conducted on ferrous tubes in heat exchangers / coolers/ condensers in hydrocarbon or cooling water service and report the observations and recommendations in standard format.

- 9.3 NDT agency shall be responsible of fabrication and calibration of probes well in advance of the commencement of job. Tubes required for calibration shall be available with NDT agency.
- 9.4 The job shall be carried out by complying the requirements of Article 8 (for ECT) and Article 17 (for RFET) of ASME Sec-V and ASTM E243 (ECT) & ASTM E2096 (RFET).
- 9.5 The testing shall be performed by inserting probes energized with alternating currents of one or more frequencies. System sensitivity shall be verified by using eddy current system reference standard. System sensitivity and settings shall be checked and recorded at regular intervals during examination. Data and system settings shall be recorded in a manner that allows archiving and later recall of all data and system settings for each tube.
- 9.6 General requirements for these probes are as follows:
 - a. The probe shall be able to detect calibration standard discontinuities as mentioned in Article 8 (for ECT) and Article 17 (for RFET) of ASME Sec-V and ASTM E243 (ECT) & ASTM E2096 (RFET).
 - b. The probe shall have sufficient bandwidth for operating frequencies selected for flaw detection and sizing.
 - c. When selecting the test coil, the objective should be to obtain a coil fill factor as large as possible.
 - d. The probe should be bobbing type or encircling type and having frequency of operation as per the requirements.
- 9.7 Testing procedure, equipment, calibration standard procedure and probe shall conform to the requirements of Article 8 (for ECT) and article 17 (for RFET) of ASME Sec-V.
- 9.8 The tube bundles have to be cleaned by the contractor before carrying out RFET or ECT.
- 9.9 NDT agency shall arrange all the testing equipment necessary for performing ECT or RFET.
- 9.10 NDT agency shall ensure proper calibration of the equipment/probe to measure different sizes and metallurgy of tubes as indicated at no extra cost to BPCL.
- 9.11 Contractor shall submit a written procedures approved by ASNT-Level-III person. The procedure shall include all details as per Table II 821, Appendix II Article 8 of ASME section-V. Contractor to complete the calibration prior to work commencement and take prior approval of procedure before starting the testing work.

Data Acquisition:

- 9.12 Testing shall be done for each tube assigning it appropriate identification.
- 9.13 If any indications are observed exceeding the acceptance level, the tube shall be subjected to recheck and confirmation.
- 9.14 Data corresponding to all the tubes tested shall be saved.

Reporting:

- 9.15 Agency shall submit the spot/field assessment report for review by BPCL so that immediate repair action can be taken up. This should include all details regarding test results for repair/plugging purposes. A comprehensive final report with tube layout drawings, tabulated tube data, sample wave forms of tubes etc. to be submitted in two

hard copy reports and soft copy on a CD within 2 weeks time after completion of field jobs.

- 9.16 Contractor to provide on-site individual data analysis for each tube by qualified Technician indicating wall loss in excess of 20% or as per BPCL-Inspection, as applicable. The test results may be verified by BPCL inspection by pulling out the tubes as and when required.
- 9.17 BPCL may cut the selected tube sections for verification of findings. If the cut sections do not match the reported findings/defects, then BPCL reserves the right to suspend further testing. In such case BPCL will not pay for the tubes which have been tested till that time in that particular tube bundle.
- 9.18 All examination conducted in accordance with this general procedure shall be reported in the following format-
 - 1) Summary sheet
 - 2) Summary of practice
 - 3) Procedure
 - 4) Eddy current abstract
 - 5) Calibration details
 - 6) Tube orientation diagram
 - 7) Test results (tube wise)
 - 8) Conclusion and remarks
 - 9) Calibration and defect signals strip charts (as per customer requirement if any)
 - 10) Personnel qualification certificate
 - 11) Equipment calibration certificates
 - 12) Acquired data in waveforms of all the tested tubes / pipes recorded on CD/DVD
 - 13) Print outs of waveforms of tubes showings defects.

10. Internal Rotary Inspection System (IRIS)

- 10.1 IRIS has to be conducted on exchanger tubes. The purpose of the test is to assess the condition of each exchanger tubes for localized/general corrosion/pitting and to measure wall thickness.
- 10.2 Any observation that requires immediate attention shall be communicated at the earliest. NDT agency shall submit daily report on observation.
- 10.3 The tube bundles have to be cleaned by the contractor before carrying out IRIS.
- 10.4 The technicians carrying out the IRIS inspection at site shall be holding valid ASNT Level III or Level II in Ultrasonic examination and shall have received training in operation of IRIS equipment. The technician should preferably have special training & certification in Ultrasonic inspection and or IRIS technique from reputed process licensor / equipment manufacturer. In absence of the special certification, operator should possess credentials of performing examination on exchangers in oil refineries of reputed companies. All the credentials shall be submitted to BPCL Inspection for review and approval. Mobilisation and work shall be commenced only after the approval.
- 10.5 NDT agency shall be required to provide all necessary equipment, testing instruments, power cables, sockets, hoses, hose fittings etc. as well as necessary consumables to carry out the testing job.
- 10.6 **Data Acquisition:**

Testing shall be done for each tube assigning it appropriate identification.

If any indications are observed exceeding the acceptance level, the tube shall be subjected to recheck and confirmation.

Data corresponding to all the tubes tested shall be saved.

10.7 Reporting:

Agency shall submit the spot/field assessment report for review by BPCL so that immediate repair action can be taken up. This should include all details regarding test results for repair/plugging purposes. A comprehensive final report with tube layout drawings, tabulated tube data, sample wave forms of tubes etc. to be submitted in two hard copy reports and soft copy on a CD within 2 weeks time after completion of field jobs.

Contractor to provide on-site individual data analysis for each tube by qualified Technician indicating wall loss, as applicable. The test results may be verified by BPCL inspection by pulling out the tubes as and when required.

BPCL may cut the selected tube sections for verification of findings. If the cut sections do not match the reported findings/defects, then BPCL reserves the right to suspend further testing. In such case BPCL will not pay for the tubes which have been tested till that time in that particular tube bundle.

Final Report shall contain

- Summary of measurement results
- Tube location plot
- Stipulating the defect class assigned to each tube and whether the recorded defect is on the external or internal side of the tube.
- List of tubes with defect indications including size, location, shape, identity (tube nos and rows), % of thinning and overall condition.
- Rejection criteria specifying which tubes to be plugged
- All aspects regarding immediate reports (This shall be intimated after completion of test at site)

11. Phased Array (PA) Inspection

11.1 The PA equipment, probes and the software proposed to be deployed at BPCL site shall be of a reputed make. The equipment shall be capable of evaluating the welds / base metal condition exactly (detection of cracks etc.) and of well established one.

11.2 PA Inspection shall be as per ASME Section VIII Div.1, ASME Section V Article 4.

11.3 The equipment to be used shall have a calibration certificate and the same shall be furnished to BPCL inspection before execution of the job.

11.4 The Capability of PA equipment and probes shall be demonstrated with suitable calibration specimen of same metallurgy before starting the job at site.

- 11.5 The person deputed for PA job shall have adequate prior experience in carrying out similar type of jobs.
- 11.6 The person performing the job shall have a Level-II certificate in Ultrasonic testing and the report shall also be interpreted by a Level-II / Level III personnel and certified by a Level-III personnel.
- 11.7 The PA inspection shall focus on accurate health assessment of the reactor weld joint. The comprehensive inspection shall aim at detecting minimum following likely service damage mechanisms and their characterization;
- a. High temperature Hydrogen Attack (HTHA) damages
 - b. Surface and internal decarburization
 - c. Micro-fissuring / cracks across the reactor wall thickness
 - d. Weld overlay disbonding
 - e. Hydrogen embrittlement
 - f. Creep cracking and any other defects in weld & HAZ
 - g. General observations / comments, if any
- 11.8 The examination shall not be limited to detecting the above defect mechanisms alone. Any other defects on the scanned areas, which may require immediate repair / monitoring in future or may impede upon safety of the reactor for continued service shall be highlighted and recommend action to be taken.
- 11.9 The area of examination shall be weld seams and Heat Affected Zones (HAZ).
- 11.10 Hard copy of the as-built drawing and requisite documents shall be made available to the agency at site for reference only.
- 11.11 The agency shall inform about any abnormality found in the reactors (if any) during inspection to BPCL inspection Engineer. BPCL Inspection representative reserves the rights to cross check the findings.
- 11.12 Document to be submitted for approving the NDT agency
1. Prior Experience in conducting PA (Purchase order, Client certificate(if available))
 2. Detailed procedures of the NDT techniques to be used to detect & characterize any service related degradation mechanisms as per Section 11.6 above and fitness for service assessment,
 3. PA equipment proposed to be deployed,
 4. Details of the calibration block.
 5. Details of NDT personnel by whom the PA would be carried out. Number of specialists/technicians to be deployed with details (If Technicians are from outside India, Passport and business visa details has to be provided in advance as permission from Govt of India is required)
- 11.13 **Reporting**
- The agency shall ensure the following reporting system;
- a. All reporting formats shall be approved by BPCL-KR Inspection department before start of the work.
 - b. Submission of daily site inspection reports at the end of each shift. Daily interim as well as the final reports shall contain complete details of the examination carried out and recorded defect including but not limited to the type, size, location, shape, identity, criticality etc. Daily / interim reports should cover all aspects / details regarding immediate repairs / actions.

- c. Any observation of concern during the process of the inspection shall be brought to the notice of EIC outright.
- d. The reactor shall be put back into service immediately after the inspection and repair (if any). Therefore, the report must be complete in all respect, covering all such critical issues necessitating immediate repair or replacement before putting the reactor into service. And, the agency shall be fully equipped, and the deployed site personnel shall include qualified technical & NDT instrument experts to provide answer to technical queries at site itself.
- e. The final report shall minimum address the following;
 - i. Fitness for continued service at the TOFD location
 - ii. Non-destructive / destructive examination required in future
 - iii. Short term as well as long term inspection / repair requirements
 - iv. Any other relevant recommendations.
- f. All the reports of field inspection and Final report shall be submitted to EIC. In both cases viz. Field report and the final report, the bidder shall submit properly bound 2 (two) hard copies and 1 (one) soft copy in CD-Rom.
- g. The medium of reporting shall be in English, legible, of highest standard and color graphics of relevance shall be incorporated.

12. Positive Material Identification (PMI)

- 12.1 Positive Material identification refers to determination/verification of alloy types or its composition using portable alloy analyser.
- 12.2 Requirements of PMI shall be as per M/s.EIL spec No6-82-0002 and as per the instruction of the BPCL-KR Inspection Engineer In-charge for the completion of TA jobs.
- 12.3 Calibration chart & Details of portable alloy analyser shall be provided to BPCL-Inspection Section for approval before using the equipment
- 12.4 Portable X-ray fluorescence (XRF) type analysers such as Metorex X-Met 2000 Metal Master or Niton II Alloy analyser or similar analyser shall be used for carrying out PMI.

12.5 Personal Qualifications

The person(s) performing the PMI test should be knowledgeable about all aspects of operation of PMI test equipment and the PMI test method used. Qualification of the person performing the PMI test, including training and experience, should be documented and submitted for review and approval t. Personnel shall be trained, to:

- Safely use the PMI analyzers(s) (i.e., electrical arcing, X-Ray emission or chemical testing methods).
- Properly apply material specification such as ASTM and ASME.
- Fully understand the PMI requirements, including the verification method to be used, the period during fabrication when verification will be conducted, and the method of marking and color coding verified material and segregation and reporting non-compliant material.

13. General Instructions for the Contractor/NDT Agency.

- 13.1 Contractor is advised in his own interest to visit the site before making any offer.
- 13.2 Only qualified NDT technicians having valid certificate of at least ASNT/ISNT level II or level III should be employed for all the NDT jobs as mentioned in the foregoing paras. One copy of the relevant certificates must be submitted to the BPCL Inspection section before starting of work.
- 13.3 NDT agency shall depute a supervisor/leader of teams at no extra cost to BPCL-KR for the supervision, work planning and also for progress reporting at the end of the day.
- 13.4 Minimum two persons or more as may be required should be considered for a team.
- 13.5 In order to avoid idle time and to complete the work expeditiously composition of the NDT team should be such that each technician is able to perform more than one NDT technique. Any specific team not able to meet the above requirement should be indicated in the proposal.
- 13.6 Daily progress report giving quantum of work done with equipment/plant shall be submitted to the Inspection Engineer-in-Charge at the end of the day.
- 13.7 After completion of all NDT applications, the contractor shall submit proper documents showing the NDTs carried out, and records of regular calibration of the NDT equipment and test results. Records/documents and reports shall be given in neatly typed, bound and in professionally prepared volumes. All the inspection documents / reports / sketches shall be submitted to BPCL-KR Inspection Engineer in-charge in both soft and hard copy after duly reviewed by an Level-II/Level-III as the case may be.
- 13.8 All personnel working in the plant in connection with NDT shall strictly follow the safety regulations of BPCL-KR.
- 13.9 A written procedure duly reviewed and approved by a Level-III certified person for each type of NDT shall be submitted to BPCL-KR Inspection Engineer in charge for review and approval before commencement of the NDT activities.**



CPO (REFINERIES)

TURNAROUND JOBS OF PROCESS UNITS IN VGO-HDS AND NHT-CCR COMPLEX AT BPCL-KOCHI REFINERY



**ADDENDUM NO:1 TO REQUEST FOR QUOTATION
CRFQ NO. 1000212483
(E-TENDER NO. 15561- NHT-CCR COMPLEX (PACKAGE – 2))**

ADDENDUM NO:1 TO REQUEST FOR QUOTATION CRFQ -1000212483
E-Tender Sys No: 15561- NHT-CCR COMPLEX (PACKAGE – 2)

1.0 INTRODUCTION

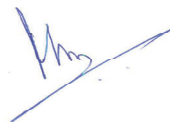
Addendum No:1 is issued against the tender for “TURNAROUND JOBS OF PROCESS UNITS IN VGO-HDS AND NHT-CCR COMPLEX AT BPCL-KOCHI REFINERY”.

This Addendum is issued against E-Tender Sys No: 15561- NHT-CCR COMPLEX (PACKAGE – 2). This addendum shall form the part of tender document pertaining to NHT-CCR COMPLEX (PACKAGE – 2) and shall be signed and submitted along with the techno-commercial/unpriced bid documents for the subject package.

The description of the Addendum is given below;

Section No/Page No. of the document in the tender	Sub heading Ref	Present description	Addendum issued
SECTION 4, SPECIAL CONDITIONS OF THE CONTRACT, PAGE 88/89 OF THE TENDER	Scope of Supply/Materials/Facilities provided by BPCL	Nil	To add: 3.1.21- Flameproof handlamps and transformers wherever required shall be supplied by BPCL. 3.1.22- Metallic blind tags shall be supplied by BPCL. 3.1.23-Level gauges of all vessels and columns shall be removed from the equipment and cleaned. However if the level gauge glasses need to be replaced, it will be done by BPCL for which the Contractor will have to shift the level gauges to BPCL workshop.
SECTION- 1_NHT-CCR COMPLEX (PACKAGE-2) TURNAROUND TENDER DOCUMENT INDEX, PAGE 65 OF THE TENDER	ANNEXURES	NIL	To add: ANNEXURE-20- Technical Specification for Non Destructive Testing of Static Equipment and piping BPKR/AS/INSP/SPEC/001 Rev.1 (The same is attached)

All other terms and conditions of the tender remain unaltered



(f) DGM (CPO-Refineries)

Place: Mumbai
Date: 29th July 2014



**TECHNICAL SPECIFICATION FOR NON DESTRUCTIVE TESTINGS OF
THE STATIC EQUIPMENTS AND PIPING'S AT BPCL-KOCHI REFINERY,
KOCHI.**

(BPKR/AS/INSP/SPEC/001 Rev.1)

**ADVISORY SERVICES DEPARTMENT
INSPECTION SECTION**

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1. General

This specification covers the general requirements for conducting non destructive examination (NDE) during Turn around (TA) in BPCL Kochi Refinery. The technical requirements specified in the document are the minimum requirements for each NDE and agencies selected for conducting NDE shall follow this specification. **The applicability and extent of a specific NDT for an equipment/job will be as mentioned in the Inspection work list/ Maint scope of work**

2. Scope

2.1 The document is applicable for the following NDE/Testing carried out (when specified in scope of work) in BPCL KR for its TA in process units.

2.1.1 Ultrasonic Thickness Measurement (UTM)

2.1.2 Radiography (RT)

2.1.3 Penetrant Testing (PT)

2.1.4 Magnetic Particle Testing (MT)

2.1.5 Hardness Testing

2.1.6 In-Situ Metallography by Replication Technique.

2.1.7 Remote Field Electromagnetic Technique (RFET) & Eddy current Testing (ECT) of Tubes.

2.1.8 Internal Rotary Inspection System (IRIS)

2.1.9 Positive Material Identification (PMI).

2.2 The document is applicable for the following static equipment

1. Pressure Vessel

2. Columns

3. Heat Exchanger

4. Tank

5. Heater

6. Filters

7. Pipelines & fittings

8. Boiler

3. Ultrasonic Thickness Measurement

3.1 **Ultrasonic thickness measurement will be taken by a separate agency appointed by BPCL-KR. All the facilitation required for thickness survey like scaffolding, insulation removal and cleaning to be done by the LSTK Contractor. General guideline on thickness measurement is given below, so that the LSTK Contractor is aware of the type of facilitation required.**

3.2 Facilitation for carrying out thickness survey of equipment has to be done as given below.

3.3 Columns:

- i. Shell plate: In 4 compass directions at every 3 to 4 tray levels Minimum two set of readings in each shell course
- ii. Dished ends: In 4 compass directions in crown and knuckle area each.
- iii. All connected nozzles in 4 directions. (If thickness survey is not possible from inside, necessary facilitation has to be done to conduct thickness survey from outside)
- iv. Skirt: In 4 compass directions.
- v. Internals: Trays (10% of trays, 4 locations on each tray) and distributors (100%, one set of readings {4 compass directions} at every one meter length).
- vi. Area opposite to feed nozzles.
- vii. Demister pad support plate location (Shell)

3.4 Vessels:

- i. Shell plate: In 4 compass directions for all shell courses. Minimum two set of readings in each shell course (near to circumferential weld joint)
- ii. Dished ends: In 4 compass directions at crown and knuckle area each
- iii. All connected nozzles in 4 directions. (If thickness survey is not possible from inside, necessary facilitation has to be done to conduct thickness survey from outside)
- iv. Skirt (for vertical vessels): In 4 compass directions.
- v. Internals: All Baffles (4 locations on each baffle) and distributors (100%, one set of readings {4 compass directions} at every one meter length).
- vi. Area opposite to feed nozzles.
- vii. Demister pad support plate location (Shell)

3.5 Heaters:

a) Radiation Section:

- i. Straight tubes: In 4 compass directions at 3 levels (1st level shall be approx. 1 mtr. from floor level).
- ii. Return bends: All bends, min. 3 readings on the outer radius of each bend.
- iii. All support locations.
- iv. All overheated/coke deposited area

b) Convection Section (Hydrocarbon Coils, BFW Coils, Steam Generating Coils and Super Heater Coils):

- i. Tubes (straight sections):- In 4 compass directions adjacent to each bend.
- ii. Return bends:- All bends, min. 3 readings on the outer radius of each bend.

iii. Bottom shock tubes:- In 3 compass directions at 3 locations.

c) Stack:

I. One set of readings on each shell course along the staircase.

d) Air Duct (Horizontal sections):

i. One set of 3 to 4 readings on plate (at all four sides) at every 6 meters length.

3.6 Exchangers:

- i. Shell & shell cover: In 4 compass directions for all shell courses (At min. 3 locations).
- ii. Dished ends: In 4 compass directions at crown and knuckle area each.
- iii. Tube sheet and floating head, partition plates, baffle plates
- iv. All connected nozzles in 4 directions. (If thickness survey is not possible from inside, necessary facilitation has to be done to conduct thickness survey from outside)
- v. Thickness by measuring ID&OD of tubes

3.7 Air fin coolers:

- i. Inlet and outlet Header boxes (all 4 plates at 3 locations) and partition plate.
- ii. All connected nozzles in 4 directions.

3.8 Pipelines

- i. All elbows, tees and reducers, caps
- ii. Minimum three readings shall be taken on the elbows of the piping network at the outer curvature. One reading shall be at the centre of the bend and two readings on the same line on either side of this reading.
- iii. Pipe: one set of readings in 4 compass directions or 3, 6, 9 and 12 o'clock positions at every 10m length. In case of small pipe sections i.e. less than 10m length, one set of readings in every section of straight pipe. Minimum one set of readings each on the straight pipes on upstream and downstream of the bend adjacent to welds of the bend to pipe.
- iv. All locations upstream and downstream of control valves, injection points, restricted orifices.

Note:-

In general thickness measurements are taken from inside the equipment where intrusive inspection is possible. If intrusive inspection is not possible like in piping, heater tubes, small vessels etc, thickness survey shall be carried out externally. In case of high corrosion/pitting, lamination of plates etc. the thickness survey should be conducted externally and the same shall be documented.

4. Radiography:

- 4.1 All radiography activities shall be carried out by BARC certified personnel only. Radiography film shall be evaluated by certified ASNT/ ISNT level II/level III personnel.
- 4.2 Additional requirements if any required for the completion of TA jobs shall be as per the instruction of the BPCL-KR Inspection Engineer In-charge.
- 4.3 All the films will be re-reviewed by BPCL Inspection and the decision from BPCL inspection is final. All the films are property of BPCL.
- 4.4 Applicable Codes & Standards
 - a) ASME Sec.V, Edn- 2010, Article -2- Non destructive Testing–Radiographic Examination
 - b) ANSI B 31.3,Ed-2008 (For acceptance Standard)-Code for Process Piping
 - c) ASME Sec.VIII,Div.I, Edn 2010, Para UW-51,UW-52 and Appendix 4.
 - d) ASNT Recommended practice: SNT-TC-1A-Personnel qualification and certification in Non destructive testing.
 - e) M/s. EIL standards 6-44-00016

5. Penetrant Testing (PT)

- 5.1 The requirement of Dye Penetrant Test shall conform to ASTM-E-165. Liquid Penetration Examination shall be carried out as per ASME Section V Article 6
- 5.2 Penetrant testing shall be carried out as per WPS/tender specification/as required during fabrication.
- 5.3 Only good quality consumable, such as P-Met from Baroda (India), Xylgo from Magnaflux Corporation (U.S.) or equivalent, shall be used.
- 5.4 Developers/Penetrant shall be applied through aerosol spraying cans.
- 5.5 When examining austenitic or duplex stainless steel and titanium, all penetrant materials shall be analyzed individually for halogens content in accordance with SE-165, Annex 4. The total halogens content shall not exceed 1% by weight
- 5.6 Locations and extent of Dye Penetrant Testing in the static equipments shall be decided by Engineer-in-charge at site
- 5.7 Any defect observed during the test shall be immediately communicated to Engineer-in-charge.
- 5.8 Observation/record sheet shall be submitted with proper sketches of the location and the area thus inspected/tested.
- 5.9 Applicable Codes & Standards
 - a) ASME Code for Pressure piping- B. 31.3

- b) ASME Boiler & Pressure Vessel Code, Sec VIII, Div I Rules for Construction of Pressure Vessels. Appendix-8
- c) ASME Boiler & Pressure Vessel Code, Sec V, Non destructive examination. Article-6 & SE 165 of Article 24

5.10 GENERAL

- 5.11 Penetrant Testing shall be applied to detect discontinuities that are open to the surface of nonporous and other materials. Typical defects which are detectable by this method are cracks, porosity, laminations, seams, laps etc.
- 5.12 Prior to examination, surface to be tested and adjacent area shall be cleaned, to allow the penetrant to enter the discontinuities.
- 5.13 Cleaner shall not be directly applied to surface. Surface temperature shall not be above 50 Deg C.

5.14 Personnel Qualifications

- 5.15 Individuals performing Penetrant examination shall be qualified ASNT/ISNT level-II/ level-III in accordance with SNT-TC-1A or equivalent.

6. Magnetic Particle Testing (MPT)

- 6.1 WMPT is required to be carried out to detect all types of surface and near surface crack or such other discontinuities mainly in welds and adjacent areas by using :
 - Articulated AC/HWDC Magnetic Yoke
 - Fluorescent iron power suspended in water.
 - Ultraviolet Light.
- 6.2 WMPT method used shall meet the requirement of ASTM standard recommended practice for MPT, ASME Sec. V, Article 7/SE-709/BS-6072 including selection of equipment and magnetic power, calibration/testing of equipment and examination technique, Reliable equipment of Magnaflux or equivalent make shall be used for the job.
- 6.3 Weld joints subjected to WMPT shall be thoroughly cleaned by mechanical means.
- 6.4 Only experienced and ASNT/ISNT certified level-II holder shall be employed for the job.
- 6.5 At least 70 mm of parent metal on either side of the weld shall be covered in WMPT of welds.
- 6.6 WMPT shall be carried out location specified in WPS/tender/ as required during fabrication.
- 6.7 All the surfaces inspected shall be thoroughly cleaned after testing is over.
- 6.8 Report shall contain the details as above including the verification and signature of the operator.
- 6.9 Applicable Codes & Standards

- i. ASME Code for Pressure piping - B. 31.3
- ii. ASME Boiler & Pressure Vessel Code, Sec VIII, Div I Rules for Construction of Pressure Vessels.
- iii. ASME Boiler & Pressure Vessel Code, Sec V, Article-7 Non destructive examination.
- iv. ASNT Recommended practice: SNT-TC-A1

6.10 General

- 6.11 Magnetic Particle Testing shall be applied to detect surface & sub-surface discontinuities of ferrous material.
- 6.12 Before Magnetic Particle testing, surface to be tested shall be cleaned, to allow the magnetic particles movement according to flow and direction of magnetic flux.

6.13 Personal Qualifications

- i. Individuals performing Magnetic Particle Testing shall be trained and qualified ASNT ISNT level-II / level-III in accordance with SNT-TC-1A or equivalent.
- ii. Use battery operated equipment.

7. Hardness Measurement

- 7.1 Hardness is to be measured in the, HAZ and weld metal of weld joints. Hardness requirements for welds shall be as per the Welding Specification Chart/Non Destructive Examination Specification attached elsewhere in the contract.
- 7.2 M/s.EIL spec No.6-15-0091, Rev-1 shall be followed as standard specification for Hardness requirements. Providing hardness tester shall be the responsibility of NDT agency.
- 7.3 Hardness testing shall be carried out by Telebrinneller type hardness tester. Microdur, Equotip or equivalent make may be used with prior approval from BPCL. Hardness should be specified in terms of BHN. Hardness to be checked for all weld after PWHT but before hydrotest. Each longitudinal seam shall be checked both internally and externally near the centre and at one end. Each circumferential seam shall be checked at four locations 90° apart internally (if possible) and externally. Each nozzle weldment shall be checked at two locations 180° apart internally (if possible) and externally
- 7.4 Contractor shall produce documentary evidence/calibration certificate to the Owner's Inspector and obtain approval of the hardness testing equipment.

8. In-Situ Metallography by Replication Technique.

- 8.1 Replication technique shall be applied after preparing the surface at selected location of the component to reproduce accurately the metallographic features such as distribution, size and morphology of the carbide precipitation and microvoids

associated with early stage of creep damage, intergranular/transgranular cracks typical in stress corrosion and temper embrittlement cases.

- 8.2 The procedure of the job shall generally conform to ASTM SE-1351.
- 8.3 Unless stated otherwise, replicas shall contain weld metal, heat affected zone and base metal.
- 8.4 Superior quality of replication consumable shall be used.
- 8.5 The areas for replica shall be prepared by either mechanical or electrolytic polishing means followed by chemical/electrochemical etching of the spots before study/examination. Preparation of metallographic specimen shall be as per latest revision of ASTM E-0003. The replica shall be prepared as soon as possible after specimen preparation of the original surface is completed, to minimize transfer of post-preparation oxidation and contamination to the replicating film. A microscopic examination of each replica shall be made on site to verify that it is of adequate quality and to note signs of material damage (e.g. creep micro or macro cracking) which may require immediate attention. Standard method for micro etching of metals & alloys shall be as per latest revision of ASTM E-0407. If significant damage is found at a replica site during the onsite examination, the location shall be re-replicated after re-grinding/polishing
- 8.6 Prior to final evaluation of replicas, these shall be coated with a film of vapour deposited gold or gold-palladium. The coated replicas shall be examined, as a minimum, with a light optical microscope at magnification ranging from 50 X to 500 X. Arrangement then shall be made by the NDT agency to view the replicas under a Scanning Electron Microscope (SEM) at magnification ranging from 2000X to 5000X.
- 8.7 Each replica shall be given a unique identification designation. The report shall include a sketch of the component showing the location of each replica site as well as on overall photograph and close up photograph showing the replica location.
- 8.8 The report shall include a photomicrograph of the replica at each zone where creep image has occurred, taken at a suitable magnification to show the microstructure and significant findings. A photomicrograph shall be taken of a typical replica of each component.
- 8.9 The report shall include the damage classification associated with each zone of interest of each replica and the corresponding recommended re-examination interval.
- 8.10 In situ Metallography shall be carried out through BPCL-KR approved agencies only. The following are the present approved vendor list for in-situ metallography. (If any change is there, that will be intimated later. Contractor can carry out job as per the BPCL approved list effective during November 2014)
 - BHEL , Trichy
 - Materials Science & Technology Division

National Metallurgical Laboratory
Council of Scientific & Industrial Research
Jamshedpur-831007

- Central power Research Institute
(A Govt of India Society, Ministry of Power)
Thermal Research Centre, Koradi-441 111
Nagpur (M.S), Ph No 07109 262251, Mob-9423103379.
- TCR Engineering Services Pvt. Ltd.
Plot No. EL-182, MIDC-TTC, Electronic Zone,
Behind Nelco, Mhape, Navi Mumbai-400 710
Maharashtra, India, Tel: +91-22-67380900 to 999,
Tel: +91-22-27612324, 27610921

SUBMISSION OF REPORT

A preliminary report shall be submitted immediately after completion of field jobs for each equipment. A detailed report highlighting the material degradations if any and remaining operating life of the material examined to be submitted within 30 days from the date of completion of field jobs for each equipment. In the final report all microstructural features w.r.t to the corresponding replica shall be accurately rendered and photomicrographic documentation of microstructural features shall be provided over the range of magnifications normally used for replica evaluation. The Final Report shall consist of good quality images of adequate magnification indicating identification/characterization/ sizing of any defect in the tested component and also shall include SEM analysis details. This shall include micro structural changes, carbide distribution, degree of oxidation, level of creep and also loss of ductility by sigma phase precipitation etc. if any. All grain boundaries, grain boundary precipitates, any crack/ cavities, crack like voids, carburization, any such discontinuities indicating advanced stages of creep damage, micro cracks etc. shall be easily identifiable. Interpretations of microstructures and detailed recommendations including assessment on the condition of the tested component or the sample w.r.t. corresponding micrographs shall be included in the final report

Two copies (original in all respects) along with soft copy in CD of final report incorporating photomicrographs shall be submitted along with the entire set of replicas properly protected and secured inside glass slides. Replicas shall remain attached to their carrier slides, and shall be stored in dust-free biological slide cases, with proper indexing to permit retrieval where required for record.

9. Remote Field electromagnetic Technique (RFET) & Eddy current Testing (ECT)

- 9.1 ECT (Eddy Current Testing) shall be conducted on SS300 series, Cupro-Nickel, Al-Brass, Titanium and other non-ferrous metallurgy tubes in heat exchangers / coolers/ condensers in hydrocarbon or cooling water service and report the observations and recommendations in standard format.
- 9.2 RFET (Remote Field Electromagnetic Testing) has to be conducted on ferrous tubes in heat exchangers / coolers/ condensers in hydrocarbon or cooling water service and report the observations and recommendations in standard format.

- 9.3 NDT agency shall be responsible of fabrication and calibration of probes well in advance of the commencement of job. Tubes required for calibration shall be available with NDT agency.
- 9.4 The job shall be carried out by complying the requirements of Article 8 (for ECT) and Article 17 (for RFET) of ASME Sec-V and ASTM E243 (ECT) & ASTM E2096 (RFET).
- 9.5 The testing shall be performed by inserting probes energized with alternating currents of one or more frequencies. System sensitivity shall be verified by using eddy current system reference standard. System sensitivity and settings shall be checked and recorded at regular intervals during examination. Data and system settings shall be recorded in a manner that allows archiving and later recall of all data and system settings for each tube.
- 9.6 General requirements for these probes are as follows:
 - a. The probe shall be able to detect calibration standard discontinuities as mentioned in Article 8 (for ECT) and Article 17 (for RFET) of ASME Sec-V and ASTM E243 (ECT) & ASTM E2096 (RFET).
 - b. The probe shall have sufficient bandwidth for operating frequencies selected for flaw detection and sizing.
 - c. When selecting the test coil, the objective should be to obtain a coil fill factor as large as possible.
 - d. The probe should be bobbing type or encircling type and having frequency of operation as per the requirements.
- 9.7 Testing procedure, equipment, calibration standard procedure and probe shall conform to the requirements of Article 8 (for ECT) and article 17 (for RFET) of ASME Sec-V.
- 9.8 The tube bundles have to be cleaned by the contractor before carrying out RFET or ECT.
- 9.9 NDT agency shall arrange all the testing equipment necessary for performing ECT or RFET.
- 9.10 NDT agency shall ensure proper calibration of the equipment/probe to measure different sizes and metallurgy of tubes as indicated at no extra cost to BPCL.
- 9.11 Contractor shall submit a written procedures approved by ASNT-Level-III person. The procedure shall include all details as per Table II 821, Appendix II Article 8 of ASME section-V. Contractor to complete the calibration prior to work commencement and take prior approval of procedure before starting the testing work.

Data Acquisition:

- 9.12 Testing shall be done for each tube assigning it appropriate identification.
- 9.13 If any indications are observed exceeding the acceptance level, the tube shall be subjected to recheck and confirmation.
- 9.14 Data corresponding to all the tubes tested shall be saved.

Reporting:

- 9.15 Agency shall submit the spot/field assessment report for review by BPCL so that immediate repair action can be taken up. This should include all details regarding test results for repair/plugging purposes. A comprehensive final report with tube layout drawings, tabulated tube data, sample wave forms of tubes etc. to be submitted in two

hard copy reports and soft copy on a CD within 2 weeks time after completion of field jobs.

- 9.16 Contractor to provide on-site individual data analysis for each tube by qualified Technician indicating wall loss in excess of 20% or as per BPCL-Inspection, as applicable. The test results may be verified by BPCL inspection by pulling out the tubes as and when required.
- 9.17 BPCL may cut the selected tube sections for verification of findings. If the cut sections do not match the reported findings/defects, then BPCL reserves the right to suspend further testing. In such case BPCL will not pay for the tubes which have been tested till that time in that particular tube bundle.
- 9.18 All examination conducted in accordance with this general procedure shall be reported in the following format-
 - 1) Summary sheet
 - 2) Summary of practice
 - 3) Procedure
 - 4) Eddy current abstract
 - 5) Calibration details
 - 6) Tube orientation diagram
 - 7) Test results (tube wise)
 - 8) Conclusion and remarks
 - 9) Calibration and defect signals strip charts (as per customer requirement if any)
 - 10) Personnel qualification certificate
 - 11) Equipment calibration certificates
 - 12) Acquired data in waveforms of all the tested tubes / pipes recorded on CD/DVD
 - 13) Print outs of waveforms of tubes showings defects.

10. Internal Rotary Inspection System (IRIS)

- 10.1 IRIS has to be conducted on exchanger tubes. The purpose of the test is to assess the condition of each exchanger tubes for localized/general corrosion/pitting and to measure wall thickness.
- 10.2 Any observation that requires immediate attention shall be communicated at the earliest. NDT agency shall submit daily report on observation.
- 10.3 The tube bundles have to be cleaned by the contractor before carrying out IRIS.
- 10.4 The technicians carrying out the IRIS inspection at site shall be holding valid ASNT Level III or Level II in Ultrasonic examination and shall have received training in operation of IRIS equipment. The technician should preferably have special training & certification in Ultrasonic inspection and or IRIS technique from reputed process licensor / equipment manufacturer. In absence of the special certification, operator should possess credentials of performing examination on exchangers in oil refineries of reputed companies. All the credentials shall be submitted to BPCL Inspection for review and approval. Mobilisation and work shall be commenced only after the approval.
- 10.5 NDT agency shall be required to provide all necessary equipment, testing instruments, power cables, sockets, hoses, hose fittings etc. as well as necessary consumables to carry out the testing job.
- 10.6 **Data Acquisition:**

Testing shall be done for each tube assigning it appropriate identification.
If any indications are observed exceeding the acceptance level, the tube shall be subjected to recheck and confirmation.
Data corresponding to all the tubes tested shall be saved.

10.7 Reporting:

Agency shall submit the spot/field assessment report for review by BPCL so that immediate repair action can be taken up. This should include all details regarding test results for repair/plugging purposes. A comprehensive final report with tube layout drawings, tabulated tube data, sample wave forms of tubes etc. to be submitted in two hard copy reports and soft copy on a CD within 2 weeks time after completion of field jobs.

Contractor to provide on-site individual data analysis for each tube by qualified Technician indicating wall loss, as applicable. The test results may be verified by BPCL inspection by pulling out the tubes as and when required.

BPCL may cut the selected tube sections for verification of findings. If the cut sections do not match the reported findings/defects, then BPCL reserves the right to suspend further testing. In such case BPCL will not pay for the tubes which have been tested till that time in that particular tube bundle.

Final Report shall contain

- Summary of measurement results
- Tube location plot
- Stipulating the defect class assigned to each tube and whether the recorded defect is on the external or internal side of the tube.
- List of tubes with defect indications including size, location, shape, identity (tube nos and rows), % of thinning and overall condition.
- Rejection criteria specifying which tubes to be plugged
- All aspects regarding immediate reports (This shall be intimated after completion of test at site)

11. Phased Array (PA) Inspection

11.1 The PA equipment, probes and the software proposed to be deployed at BPCL site shall be of a reputed make. The equipment shall be capable of evaluating the welds / base metal condition exactly (detection of cracks etc.) and of well established one.

11.2 PA Inspection shall be as per ASME Section VIII Div.1, ASME Section V Article 4.

11.3 The equipment to be used shall have a calibration certificate and the same shall be furnished to BPCL inspection before execution of the job.

11.4 The Capability of PA equipment and probes shall be demonstrated with suitable calibration specimen of same metallurgy before starting the job at site.

- 11.5 The person deputed for PA job shall have adequate prior experience in carrying out similar type of jobs.
- 11.6 The person performing the job shall have a Level-II certificate in Ultrasonic testing and the report shall also be interpreted by a Level-II / Level III personnel and certified by a Level-III personnel.
- 11.7 The PA inspection shall focus on accurate health assessment of the reactor weld joint. The comprehensive inspection shall aim at detecting minimum following likely service damage mechanisms and their characterization;
- a. High temperature Hydrogen Attack (HTHA) damages
 - b. Surface and internal decarburization
 - c. Micro-fissuring / cracks across the reactor wall thickness
 - d. Weld overlay disbonding
 - e. Hydrogen embrittlement
 - f. Creep cracking and any other defects in weld & HAZ
 - g. General observations / comments, if any
- 11.8 The examination shall not be limited to detecting the above defect mechanisms alone. Any other defects on the scanned areas, which may require immediate repair / monitoring in future or may impede upon safety of the reactor for continued service shall be highlighted and recommend action to be taken.
- 11.9 The area of examination shall be weld seams and Heat Affected Zones (HAZ).
- 11.10 Hard copy of the as-built drawing and requisite documents shall be made available to the agency at site for reference only.
- 11.11 The agency shall inform about any abnormality found in the reactors (if any) during inspection to BPCL inspection Engineer. BPCL Inspection representative reserves the rights to cross check the findings.
- 11.12 Document to be submitted for approving the NDT agency
1. Prior Experience in conducting PA (Purchase order, Client certificate(if available))
 2. Detailed procedures of the NDT techniques to be used to detect & characterize any service related degradation mechanisms as per Section 11.6 above and fitness for service assessment,
 3. PA equipment proposed to be deployed,
 4. Details of the calibration block.
 5. Details of NDT personnel by whom the PA would be carried out. Number of specialists/technicians to be deployed with details (If Technicians are from outside India, Passport and business visa details has to be provided in advance as permission from Govt of India is required)

11.13 **Reporting**

The agency shall ensure the following reporting system;

- a. All reporting formats shall be approved by BPCL-KR Inspection department before start of the work.
- b. Submission of daily site inspection reports at the end of each shift. Daily interim as well as the final reports shall contain complete details of the examination carried out and recorded defect including but not limited to the type, size, location, shape, identity, criticality etc. Daily / interim reports should cover all aspects / details regarding immediate repairs / actions.

- c. Any observation of concern during the process of the inspection shall be brought to the notice of EIC outright.
- d. The reactor shall be put back into service immediately after the inspection and repair (if any). Therefore, the report must be complete in all respect, covering all such critical issues necessitating immediate repair or replacement before putting the reactor into service. And, the agency shall be fully equipped, and the deployed site personnel shall include qualified technical & NDT instrument experts to provide answer to technical queries at site itself.
- e. The final report shall minimum address the following;
 - i. Fitness for continued service at the TOFD location
 - ii. Non-destructive / destructive examination required in future
 - iii. Short term as well as long term inspection / repair requirements
 - iv. Any other relevant recommendations.
- f. All the reports of field inspection and Final report shall be submitted to EIC. In both cases viz. Field report and the final report, the bidder shall submit properly bound 2 (two) hard copies and 1 (one) soft copy in CD-Rom.
- g. The medium of reporting shall be in English, legible, of highest standard and color graphics of relevance shall be incorporated.

12. Positive Material Identification (PMI)

- 12.1 Positive Material identification refers to determination/verification of alloy types or its composition using portable alloy analyser.
- 12.2 Requirements of PMI shall be as per M/s.EIL spec No6-82-0002 and as per the instruction of the BPCL-KR Inspection Engineer In-charge for the completion of TA jobs.
- 12.3 Calibration chart & Details of portable alloy analyser shall be provided to BPCL-Inspection Section for approval before using the equipment
- 12.4 Portable X-ray fluorescence (XRF) type analysers such as Metorex X-Met 2000 Metal Master or Niton II Alloy analyser or similar analyser shall be used for carrying out PMI.

12.5 Personal Qualifications

The person(s) performing the PMI test should be knowledgeable about all aspects of operation of PMI test equipment and the PMI test method used. Qualification of the person performing the PMI test, including training and experience, should be documented and submitted for review and approval t. Personnel shall be trained, to:

- Safely use the PMI analyzers(s) (i.e., electrical arcing, X-Ray emission or chemical testing methods).
- Properly apply material specification such as ASTM and ASME.
- Fully understand the PMI requirements, including the verification method to be used, the period during fabrication when verification will be conducted, and the method of marking and color coding verified material and segregation and reporting non-compliant material.

13. General Instructions for the Contractor/NDT Agency.

- 13.1 Contractor is advised in his own interest to visit the site before making any offer.
- 13.2 Only qualified NDT technicians having valid certificate of at least ASNT/ISNT level II or level III should be employed for all the NDT jobs as mentioned in the foregoing paras. One copy of the relevant certificates must be submitted to the BPCL Inspection section before starting of work.
- 13.3 NDT agency shall depute a supervisor/leader of teams at no extra cost to BPCL-KR for the supervision, work planning and also for progress reporting at the end of the day.
- 13.4 Minimum two persons or more as may be required should be considered for a team.
- 13.5 In order to avoid idle time and to complete the work expeditiously composition of the NDT team should be such that each technician is able to perform more than one NDT technique. Any specific team not able to meet the above requirement should be indicated in the proposal.
- 13.6 Daily progress report giving quantum of work done with equipment/plant shall be submitted to the Inspection Engineer-in-Charge at the end of the day.
- 13.7 After completion of all NDT applications, the contractor shall submit proper documents showing the NDTs carried out, and records of regular calibration of the NDT equipment and test results. Records/documents and reports shall be given in neatly typed, bound and in professionally prepared volumes. All the inspection documents / reports / sketches shall be submitted to BPCL-KR Inspection Engineer in-charge in both soft and hard copy after duly reviewed by an Level-II/Level-III as the case may be.
- 13.8 All personnel working in the plant in connection with NDT shall strictly follow the safety regulations of BPCL-KR.
- 13.9 A written procedure duly reviewed and approved by a Level-III certified person for each type of NDT shall be submitted to BPCL-KR Inspection Engineer in charge for review and approval before commencement of the NDT activities.**