PROCEDURE FOR EDDY CURRENT TESTING OF NON-FERROMAGNETIC TUBES.

	PREPARED	REVIEWED	APPROVED
NAME			
POSITION			
SIGNATURE			
DATE			

REVISION HISTORY

ISSUE	REVISION	DATE	REMARKS
01	00	07.08.2010	New Procedure

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1.0 SCOPE

This Procedure specifies the minimum requirements for the Eddy Current Testing (ECT) of Non Ferromagnetic Cooler tubing.

This procedure is suitable for tube material ASTM B111 C71640, having tube OD 25.4mm and wall thickness 2.41mm.

2.0 REFERENCE DOCUMENTS:

2.1	ASME Section V 2007 Edition	Non Destructive Examination
2.2	ASNT SNT TC –1A 2006 Edition	Guidelines for Personnel Qualification & Certification
2.3	STI/WP/QOP/11/2009	Written procedure for Training and Certification of Personnel
2.4	STI-HSEM-01-10	HSE Manual & General Safety Procedures

3.0 PERSONNEL QUALIFICATION:

The interpretation and recording of the test results shall be carried out by the NDT Level II as per written procedure. The Technician shall be used as an assistant to the NDT Level II. All the personnel used to operate ECT equipment shall have minimum 1 year of experience and shall be well versed with the operation of relevant Equipment and safety standards.

4.0 PROCEDURE QUALIFICATION:

Procedure qualification test shall be performed to the satisfaction of the company before starting of the work. All qualification tests shall be witnessed by company

5.0 SAFETY:

All Personnel shall have responsibility to themselves and other persons with regard to safety and shall ensure that site facilities are adequate with regard to lighting, scaffolding and the like, prior to commencement of Operations.

6.0 EQUIPMENT:

The ECT Equipment used as per this procedure shall be MS 5800 of RD Tech, Canada make.

7.0 PROBES:

Probes used shall be dual coil internal bobbin type and shall be capable of simultaneous differential and absolute operation.
Bobbin Coils shall be able to detect calibration standard discontinuities
Bobbin Coils shall have sufficient bandwidth for operating frequencies selected for flaw detection and sizing

8.0 CALIBRATION STANDARD:

Calibration standards shall be manufactured from a tubing of the same material specification, same heat treatment, and same nominal size.

Calibration tube standards for Eddy Current examination shall comply with the requirements of **ASME section 5 Article 8.**

9.0 PROCEDURE

9.1 BASIC INFORMATION REQUIREMENTS

The following minimum information is required prior to conducting an inspection:

- Tube dimensions:
  (Outside diameter, wall thickness, length)
- Tube materials:
- Tube characteristics:
  (Finned, 'U' bends, swaged etc.)
- Scope of inspection:
  (Number of tubes, inspection pattern)
- Service:
  (E.g., tube side – water / shell side steam)
- Types of wastage taking place:
  (If known)
- Review of previous inspection reports
  (If any)
- Drawing, diagrams, maps or any other relevant information.

9.2 WORK INSTRUCTIONS

Inspection shall be performed in accordance with written Work Instructions or Technique Sheets. Each shall include the following information:

- Tube material, diameter, wall thickness and length
- Size and type of probes
- Mode of operation
- Inspection frequencies

- Inspection and recording equipment
- Probe traverse speed
- Calibration tube standards
- Calibration procedure

Work instruction and Technique sheet shall be prepared by a Level 2 technician and approved prior to application.

9.3 PRE-INSPECTION REQUIREMENTS

Prior to conducting the inspection the technician shall conduct a visual inspection and attempt to verify the following:

- Unit identification
- Location of the tube bundle
  (Top, bottom, north, south, east, west, left side, right side)
- Number of passes
- Inspection conducted from which end
- Thickness of tube sheet
- Number of support plates (material, thickness)
- Position of shell-side nozzles (inlet, outlet)
- Condition of tube sheet (corroded, painted)
- Condition of tubes externally (baffle wear, fretting, dents)
- Cleanliness of tubes internally

9.4 TUBESHEET PREPARATION

Tube sheet drawings shall be marked up in such a way as to identify individual zones (if required) and rows. The tube sheet of each heat exchanger shall be clearly marked in the same manner to ensure traceability of each tube.

9.5 TUBE CLEANLINESS

The surfaces of the tube material to be examined shall be free of any irregularities such as scale, dirt, or any other foreign material.

Scale and other deposits will reduce the sensitivity of the inspection technique and thereby adversely affect test results.

10.0 FREQUENCY SELECTION

The basic differential frequency shall be chosen to suit the Tube material such that it shall provide good sensitivity to both internal and external defects.

The frequency used shall normally be based on the following formula,

$$f90 = \frac{3P}{t^2}$$

Where f90 = test frequency (kHz)
P = resistivity of tube material, micro ohms / centimeter
t^2 =tube wall thickness in mm.

11.0 SYSTEM CALIBRATION

The Calibration Standard tube shall be used for equipment calibration as per following steps

Differential Mode F1:- The through hole to be set at 40 deg and 10% OD groove shall be set to 120 deg .

Set the sensitivity of the equipment at 1V using 100% through hole.

Pull the calibration tube and record the phase values for 20%,40%,60%,80%, 100% through hole and support plate to make the calibration curve (depth curve).

- Absolute Mode F1:- The OD gradual wall loss (20%, 40% and 60%) signal shall be set to 45 deg in third quadrant.

- Differential Mode F2:- The F2 frequency shall be set to Double of F1 frequency.

Match the angle of 100% through hole and amplitude equal to 100% hole angle in differential F1

Any change in probe, extension cable, test instrument or any other part of the examination system hardware shall be cause for re – calibration.

The test equipment response shall be checked and verified by use of the calibration tube standard as follows:

- At least once every two hours
- At each change of operator
- At any time that malfunctioning is suspected

If during any check, it is determined that the test equipment is out of calibration (as defined by the work instruction) the equipment shall be re – calibrated and a new data file opened. The data analyst shall determine which tubes, if any are to be re – examined.

It is the responsibility of the data capture technician to ensure that the data is of the quality required by the relevant procedure and/or as defined by the data analyst.

11.1 PROBE TRAVERSE SPEED

The maximum probe traverse speed is limited by the frequency response of the electronic system

Traverse speed shall not exceed 1000mm per second and driven manually

12.0 EXAMINATION TECHNIQUE

In all techniques measurement are taken whilst withdrawing the probe. The pushing and withdrawing shall be done manually

The technician shall ensure that an even speed is maintained.

13.0 DATA RECORDING

For the purposes of this procedure all test results will be recorded on suitable data acquisition system.
Four channels shall be displayed and shall include the basic frequency (horizontal and vertical component), second frequency, absolute mode and mix.

Each data storage unit shall contain the following information:

- Positive identification of the item under test.
- Data storage unit number.
- A reference to the contents.
- Date
- Probe identification.

Each trace shall be identified according to zone/row/tube number as applicable.

14.0 DATA ANALYSIS

Data analysis systems shall conform to the requirements of ASME Section 5 Article 8

Analysis of all data shall be conducted by NDT Level II qualified in data analysis.

All indications shall be evaluated. Indication types that must be reported shall be characterized using the frequencies which were qualified. Signal amplitude and phase shall be taken into account whenever defect indications are evaluated using the absolute or differential modes.

Indication depth classification
The depth of indications shall be determined by the analyst.
All indications must be evaluated and defects classified into a category of wall loss as follows.

- 0% - 20% wall thickness loss
- 21% - 40% wall thickness loss
- 41% - 50% wall thickness loss
- >50% wall thickness loss

Reporting of indications shall be in accordance with ASME section 5 Article 8 and shall be recorded on the report format.

15.0 REPORTING

The following minimum information shall become part of the permanent record of the inspection:

- Client
- Plant site
- Cooler identification
- Test equipment serial number
- Calibration standard serial number
- Size and type of probes
- Examination frequencies
- Operators and analysts identification and certification level.

REPORT FORMAT

Final Report contains the following details:

1) **Main Inspection Report**
2) **Tube sheet Layout**
3) **Remaining wall loss report.**

ECT REPORT	
Client : **Site :** **Date. Insp :** **Total tubes :**	**Exchanger :** **Tube material :** **Tube Dimension :** **Tube Inspected :**
Equipment : MS 5800	**Probe Details:**

SUMMARY

WALL LOSS PERCENTAGE	NO OF TUBES	PERCENTAGE (%)
NO DEFECTS DETECTED		
1% - 10% WALL LOSS		
11% - 20% WALL LOSS		
21% - 30% WALL LOSS		
31% - 40% WALL LOSS		
41% - 60% WALL LOSS		
61% - 100% WALL LOSS		
PLUGGED		
RESTRICTED		