Date	Description Of Change	Signature	Rev. Level
12/27/2011	Initial Release	Jeremy Wilson	-
1/4/2012	Changed Para. 1.0,2.0,4.0,6.0,8.0,11.0 Changed from 600 tubes / 10,000 Lbs. to 300 tubes / 5,000 lbs. and added Table I also added general verbiage	Jeremy Wilson	A
3/21/2012	Changed the Name to SOP 100 from QP 10-05 and added Para. 2.2, 2.3, 2.4	Jeremy Wilson	B
9/7/2012	Added table II and revised Para. 3 and 4	Jeremy Wilson	C
8/14/2014	Added section 1, added Table VIII-821 from Section 8 article 5, section 2.10 was added, section 5 was added, section 6 was added, section 7 was added, and section 8 was added	Andres Kim	D
10/21/15	Added Reference to Article 26, Se-243 2011, Section 5	Gary Ravitsky	E
11/25/15	Modified Para 2.7 and added Attachment A	Gary Ravitsky	F
11/25/15	Reviewed and Approved for use	Level III	G

Reviewed: S.B Prasad (ASNT NDT Level III)

Procedure Approval: **Company Title:** **Date:**

1. Standard

1.1 Eddy current testing will be according to the standards from Article 26, SE-243 2011 (Electromagnetic (Eddy-Current) Examination of Copper and Copper-Alloy Tubes.

1.2 Eddy Current Standard shall be made in accordance with SE-243 unless otherwise defined by the client. The Eddy Current Standard shall be checked prior to use to ensure that it is free of visible nicks, dents and/or scratches.

1.3 Only personnel qualified to SOP-500 will perform Eddy Current Testing

2. Testing Setup

2.1. Select correct coil size for tube OD, and correct coil with magnets for ferrule tubes if they require saturation. Circumferential coil shall be in good condition with no Breaks, Cracks, or damaged wiring. Refer to Table I for coil chart.

Table I	
Tube Size (Inches)	Coil ID (Inches)
3/8”	1/2” Or 5/8”*
½”	5/8 or 3/4” *
5/8”	3/4”
¾”	7/8”
7/8”	1-1/8”*
1”	1-1/8”

*Requires increased sensitivity because of increased gap between tube OD and coil ID

2.2. Install coil in coil platform. Check to make sure pinch and drive rolls are in good condition and adjusted for a smooth center of the tube traveling through them. Tube should be centered and feeding with no binding, and no major wear on the rolls. **(Do not squeeze tube too tight with pinch rolls it will cause tube deformation on the ends).**

2.3. Power on Eddy Current Unit and allow it to boot into the Eddy Current screen.

2.4. Center the tube in the coil, with tube through coil and in all three (3) pinch rolls. On the centering unit adjust the bottom black knob (Meter current) to the center of the adjustment. The switch shall be set on small tube for 1”

(Inch) tube and below. Now adjust the top knob (Centering Meter) so the meter indicator will read approximately 30 on the scale. Loosen the lock nut for the up/down on the coil platform, and slowly adjust up and down while watching the scale indicator deflect to the peak position if the needle doesn't move enough to verify increase the meter current knob for more sensitivity and just opposite if the needle bounces to much decrease for less sensitivity. Lock the up/down adjustment. Loosen the in/out lock nut and slowly adjust in and out to peak the indicator on the centering unit, and when peak is determined, lock the in/out knob. Do a final check with a flash light to make sure the tube is centered in the coil and adjusted properly. Return the test/center switch to Test position.

2.5. Ensure your standard has no visual shape or surface defects such as dents, nicks or scratches. Preferred method is to have all flaws lined up on one (1) side for repeatability check.

2.6. Turn on the drive system, and set up the Eddy Current instrument on EC for 50% gate by adjusting the mV setting to 25 and turn on the recording by pressing F5. Feed the standard into the first pinch rolls and allow it to run all the way through the test coil. **Note: The A scope display for proper signals should be above the 50% gate line, and adjust the sensitivity as needed to get the flaw signals to just break between 65% and 75%.** Testing with too much flaw screen height over 80% will cause non-flawed tubes to indicate as flaws.

2.7. The frequency and sensitivity shall be adjusted to the lowest value required to detect the artificial discontinuities machined into reference standard as it is identified in the work order as per Attachment A. The manufacturer shall select equipment, reference standard as specified by the purchase order, and examination parameters consistent with the product, unless otherwise agreed upon between manufacturer and customer. If Purchase Order does not specify reference standard artificial discontinuity reference standard to be prepared in accordance with one of the options described by the Article 26, SE-243 2011 (Electromagnetic (Eddy-Current) Examination of Copper and Copper-Alloy Tubes or as selected by customer.

2.8. The filter setting should be set at half (1/2) the line speed, adjust the filter setting for best signal to noise ratio while running the standard repeatedly through the coil from start side to finish side.
Adjust the End suppression to keep the ends of the tube from showing flaws on the front and back of the tubes. The end suppression should be set 0" and 3.0", and make sure your proximity switch lights are red when a tube is present and switches off when the light beam is unbroken.

2.9. Perform final coil centering by running the standard through at 12, 6, 3, and 9 o'clock positions, making sure the flaw indications all have approximately the same screen height on the chart recording A scope presentation. The signal between 6 & 12 needs to be within 65-75% of each other. If this is exceeded, adjust toward the larger percentage in very small increments; i.e….. Up if 12 o'clock is higher than 6. Then lock up/down and re-run in 12, and 6 until they are approximately the same. Do the same for 3 o'clock and 9 with the in/out knob. Once

all four (4) flaw directions are set up just between 65% and 75%, save the Eddy Current Settings for the tube and wall size you are testing.

2.10. Make sure that a flash drive or other selected recoding devices are functional to record and backup all acquired eddy current signal data from all test frequencies. The recording system shall be capable of recording and playing back text information. The recording system shall have a minimum resolution of 12 bits per data point.

3. Evaluation

3.1. Means of Determining Indication Depth. For indication types that must be reported in terms of depth, a means of correlating the indication depth with the signal amplitude or phase shall be established. The means of correlating the signal amplitude or phase with the indication depth shall be based on the basiccalibration standard or other representative standards that have been qualified unless customer specify in the purchase order the standard to be used. This shall be accomplished by using curves, tables, or equations and aided by software.

3.2. Non relevant indications : Indications due to moisture, soil, small dents and chatter marks or roller marks can produce non relevant indication.

3.3. Non relevant indications are required to be individually examined to establish if they are relevant in accordance with this procedure. Otherwise, they will be considered relevant indications

3.4. Customer specific acceptance criteria may supersede the general requirements of this procedure if specified in a referencing documents

3.5. Any indication that is believed to be irrelevant dent or chatter mark shall be regarded as unacceptable, unless it is visually reviewed and determined to be of a smooth contour, having a depth not greater than ½ of the tube wall thickness and size is any direction not greater than ½ of the tube OD (unless otherwise specified by the governing tube specification) and the tube is subsequently hydrostatically or pneumatically tested per the applicable tube specification.

4. Inspection Procedure

4.1. Set up the new tube job on the batch screen for the recordings, begin recording with F5, and run the standard one time at 12, 6, 3, and 9 o'clock.

4.2. You are now ready to begin properly EC Testing production tubes. **Note: Standard verification must be conducted at the beginning of each production run, and re-run after every 4 hours of continuous operation or each new batch or heat. If at any time you change any settings on the Eddy Current Machine the standard must be re-run. Standard verification must be also re-run at the end of the production testing. If the standard fails, you must re-run all of the tubes sincethe last successful Standard verification.**

5. Reporting

5.1. The following will be a requirement from the criteria:

5.1.1. Location along the length of the tube and with respect to the support members, when the indication identification is relevant to a specific location (i.e., fretting @ baffle 2)

5.1.2. Depth. The maximum evaluated depth of flaws shall be reported in terms of percentage of tube wall loss. When the loss of tube wall is determined by the analyst to be less than 20%, the exact percentage of tube wall loss need not be recorded.

5.1.3. Non-conformance report will be written for non-quantifiable issues that cannot be characterized. The indication shall be considered a flaw until otherwise resolved after an internal non-conformance meeting.

5.2. The following will be Data Examination procedures:

5.2.1. The Owner or his agent shall prepare a report of the examinations performed. The report shall be prepared, filed, and maintained in accordance with the referencing Code Section. Procedures and equipment used shall be identified sufficiently to permit comparison of the examination results with new examination results run at a later date. This shall include initial calibration data for each eddy current examination system or part thereof.

5.2.2. The report shall include a record indicating the tubes examined (this may be marked on a tube sheet sketch or drawing), any scanning limitations, the location and depth of each reported flaw, and the identification and certification level of the operators and data evaluators that conducted each examination or part thereof.

5.2.3. Tubes that are to be repaired or removed from service, based on eddy current examination data, shall be identified.

6. Support Members

6.1. The location of support members used as reference points for the eddy current examination shall be verified by the use of a measurement technique.

7. Records

7.1. The recording media shall contain the following information within each unit of data storage:

(a) owner
(b) plant site and unit
(c) heat exchanger identification
(d) data storage unit number
(e) date of examination
(f) serial number of the calibration standard
(g) operator's identification and certification level
(h) examination frequency or frequencies
(i) mode of operation including instrument sample rate, drive voltage, and gain settings

(j) lengths of probe and probe extension cables
(k) size and type of probes
(I) probe manufacturer's name and manufacturer's part number or probe description and serial number
(m) eddy current instrument model and serial number
(n) probe scan direction during data acquisition
(0) application side - inlet or outlet
(p) slip ring serial number, as applicable
(q) procedure identification and revision

8. Record Retention

8.1 Records will be maintained for one year unless specified by the customer contract.

9. Inventory Jobs Management

9.1. Tubes that do not actuate the alarm signaling device of the eddy current tester shall be considered to conform to the requirements of the governing specification and require no cutting to length cut only residual points or only the first 3" (Inches) for material testing of wall thickness. If a tube 21' Feet and above signals a defect within the last 3 feet of the material remove the defect and accept the tube.

9.2. Tubes causing irrelevant signals because of moisture, soil, and like effects can be reconditioned and retested.

9.3. Tubes that cause relevant signals shall be bundled as nonconforming and identified as redraw material and moved to the nonconforming area.

10. Customer contract Job Management

10.1. Tubes that do not actuate the alarm signaling device of the eddy current tester shall be considered to conform to the requirements of the governing specification or customer requirements.

10.2. Tubes causing irrelevant signals because of moisture, soil, and like effects can be reconditioned and retested.

10.3. Tubes that cause relevant signals but can yield an acceptable tube to the customer's specifications, the acceptable tube to be cut out and the remaining shall be rejected. Rejected tube to be labeled and moved into redraw inventory, scrap all material that is under 5/8" diameter 8 feet long and under, anything over 5/8" diameter 5 feet and under scrap.

10.4. Once you run the final Standard Verification, end recording by pressing F5, and let management know the testing for the tubes are complete.

10.5. Some indications that cause signals may not be relevant to product quality, such as caused by minute dents or tool chatter marks. Any indication that is believed to be irrelevant dent or chatter mark shall be regarded as unacceptable, unless it is visually reviewed and determined to be of a smooth contour, having a depth not greater than ½ of the tube wall thickness and size is any direction not greater than ½ of the tube OD (unless otherwise specified by the governing tube specification) and the tube is subsequently hydrostatically or pneumatically tested per the applicable tube specification.

ATTACHEMENT A.

3702

HWO-15

EDDY-CURRENT TESTING

W.O. Date	
Customer Name	
PO#	
Issued By:	
Signed:	
Revision:	

REQUIRED PRINTING:

C71500 TAG# [####] PO# 2485-2222

		OD, In	Wall, In	Length, In	FREQUENCY, Khz	SENSITIVITY, Db	FILTER TYPE / FREQ, Khz	
Material	C71500							
Standard	SB-111	1	0.049	504	12	54	BP	150

Parameters to be verified using reference standard # Holtec 001

Work Instructions

1. Setup Eddy Current machine in accordance to SOP 100
2. Prepare the required reference standard according to Holtec Purchase Order 2485-2222,
3. Have certified NDT level II or III personnel verify & initial work order for proper machine setup.
4. Witnessed and Certified by NDT level II or III personal according to SOP 500.

DATE	OPERATOR INITIALS	TAG#	HEAT#	PIECES			VERIFIED BY	STANDARD #
				REC'D	FAILED	PASSED		

SAFETY FIRST

OPERATOR! YOU WERE ASSIGNED THIS WORK TO BE COMPLETED TO THE BEST OF YOUR ABILITY. BY ACCEPTING THIS WORK ASSIGNMENT YOU CONFIRM THAT YOU UNDERSTAND ALL THE REQUIREMENTS PROCEDURES AND SAFETY RULES.

WITNESSED AND CERTIFIED: _____NDT INSPECTOR LEVEL _____ DATE: _____