1.0 Purpose

The purpose of this specification is to define the NRG requirements for purchasing individual boiler tubes in accordance with the ASME Boiler & Pressure Vessel Code, Section I.

2.0 Scope

This specification shall apply to the purchase of all stock and non-stock boiler tubing in accordance with the ASME codes and specifications listed in Section 4.0.

3.0 Definitions

3.1 ASME – American Society of Mechanical Engineers

3.2 B&PV Code – ASME Boiler and Pressure Vessel Code

3.3 NRG – NRG Energy Inc.

3.4 ISO – International Organization for Standardization

3.5 Manufacturer – The organization (mill) making the tubing

3.6 Supplier – The organization providing the boiler tubing

4.0 References

4.1 ASME Boiler & Pressure Vessel Code Section II, Part A, “Ferrous Material Specifications”

4.2 ASME Boiler & Pressure Vessel Code Section II, Part B, “Nonferrous Material Specifications”

4.3 ASME Boiler & Pressure Vessel Code Section V, “Nondestructive Testing”

4.4 ASME Boiler & Pressure Vessel Code Section IX, “Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators”

4.5 ASME SA-450/SA-450M, “Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes”

4.6 ASME SB-829, “Specification for General Requirements for Nickel and Nickel Alloys Seamless Pipe and Tube”

The latest edition of the above codes and specifications shall apply. In the event of conflicts between this specification and the references cited above, the Supplier shall notify NRG, who will make the final judgment and interpretation.

5.0 Responsibility

5.1 The Supplier shall be responsible for fulfilling the requirements as set forth in this specification. Exceptions to and deviations from this specification shall be clearly delineated in the Supplier’s bid for disposition by NRG.

5.2 The Supplier shall provide certified material test reports (CMTRs) for all boiler tubing in accordance with the requirements of the applicable ASME B&PV Code, Section II material specifications. All CMTRs shall report chemical and mechanical test data as required. CMTRs shall be in English units or if in another language with conversions to English units.

5.3 The Manufacturer shall have a Quality Program in compliance with and certified to ISO 9001.

5.4 If the Supplier is not the Manufacturer, the Supplier must have a formal program for qualifying their manufacturers and must have evidence of periodically monitoring their performance.

5.5 NRG Supply Chain Department shall specify the following in the purchase order:

5.5.1 Description of the product
5.5.2 ASME material specification number and grade or type
5.5.3 Requirement that material be “SA” or “SB” grade
5.5.4 OD and minimum wall thickness
5.5.5 Requirement that Supplier provide CMTRs

5.5.6 Supplementary requirements (when applicable)

6.0 Material

6.1 All tubing shall be ASME SA or SB grade made to the requirements of ASME SA-450/SA-450M or ASME SB-829, respectively.

6.2 Supplier to furnish either cold-finished or hot-finished tubing. If hot-finished tubing is furnished, the Manufacturer shall meet the applicable ASME SA-450/SA-450M or ASME SB-829 tolerances for cold-finished tubing.

6.3 Tubing shall be seamless unless otherwise specified.

6.4 All materials of construction shall be new.

6.5 Butt welds and weld repairs are prohibited unless otherwise specified or approved by NRG.

6.6 For purchase of tube sections containing dissimilar metal welds, the following requirements apply:

6.6.1 The Supplier's welding procedures, welders and welding operators shall be qualified per the Supplier's Quality Program and the ASME B&PV Code, Section IX.

6.6.2 The Supplier shall submit or make available all weld procedure specifications (WPS), supporting procedure qualification records (PQR), and copies of all welding operator and welder performance qualifications, along with applicable welder continuity data, to NRG for review and approval.

6.6.3 The weld filler metal shall be nickel based (Inconel). The filler metals shall be ERNiCr-3 for the root pass and ENiCrFe-2 for the cover passes. An inert gas is required.

6.6.4 If required, the stainless steel tubing shall be worked (swaged or upset) to match the internal diameter of the ferritic tubing. The ferritic tubing shall not be counterbored.

6.6.5 For tubing with a wall thickness greater than 0.250", the joint preparation on the ferritic material shall consist of a compound bevel as shown in Figure 1 below.

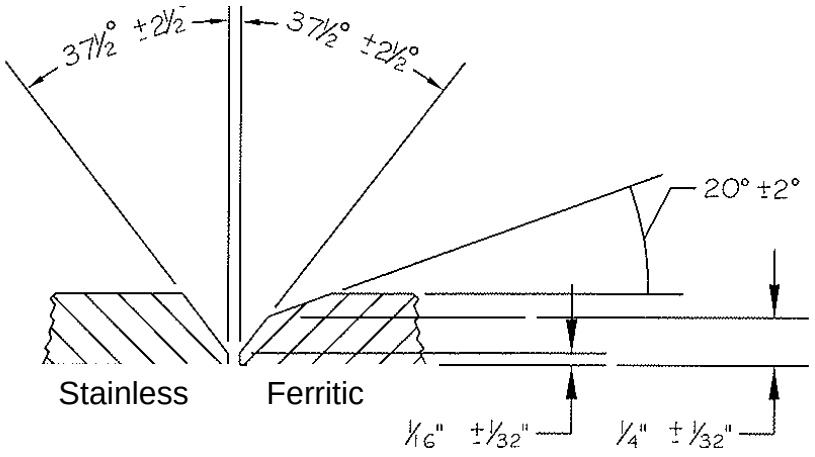


Figure 1

7.0 Heat Treatment

7.1 Austenitic stainless steels shall be solution annealed in accordance with the ASME B&PV Code, Section II, SA-213 after forming (i.e., bending, swaging, upsetting, or flaring). Material hardness after heat treatment shall not exceed 90 HRB.

7.2 Ferritic materials covered by the ASME B&PV Code, Section II, SA-213 shall be heat treated after bending, swaging, upsetting, or flaring. Heat treatment and material hardness requirements after heat treatment shall comply with the ASME B&PV Code, Section II, SA-213.

7.3 Tube sections containing dissimilar metal welds shall not be post-weld heat treated unless NRG approves the Supplier's Weld Procedure Specification that requires post-weld heat treatment.

8.0 Inspection and Testing

8.1 Visual inspection shall be performed on all tubing to assure proper surface finish and the absence of any harmful defects, gouges, tears and cracks along the entire length of the tubing, the presence of which shall be cause for rejection.

8.2 Heat and/or product analysis shall be performed as required by the applicable ASME B&PV Code, Section II material specification. The elemental composition shall meet the requirements of the applicable ASME material specified.

8.3 Mechanical tests shall be performed as required by the applicable ASME B&PV Code, Section II material specification. The mechanical test results shall meet the requirements of the ASME material specified.

8.4 Tube wall thickness shall be measured prior to fabrication on a sampling of tubes to confirm the tubing meets the minimum wall thickness as described in the purchase order. Sample size is determined by Table 1 below.

8.4.1 Wall thickness measurements shall be made using the Ultrasonic Pulse-Echo Contact Method in accordance with ASME B&PV Code, Section V, Subsection B, Article 23, SE-797.

8.4.2 In lieu of the ultrasonic method described in Paragraph 8.4.1, micrometer measurements taken at each tube end may be taken.

8.4.3 Readings are to be taken at the 0, 90, 180 and 270 degree positions at each end of the tube.

8.4.4 Any tube in the sample group found with readings below minimum wall thickness shall cause the entire lot to be rejected. Disposition of the rejected lot shall be discussed and approved by NRG.

Table 1

Lot Size (# of tubes)	Sample Size
1 to 8	Entire Lot
9 to 90	8
Greater than 90	5%

Notes:1) Lot size is the entire number of tubes being provided with the Purchase Order.
2) Each heat of steel provided by the tubing manufacturer is to be considered as a separate lot.

8.5 Eddy current examination shall be performed on a sampling of tubes to confirm the absence of abrupt imperfections. Sample size determined by Table 1 above.

8.5.1 Eddy current testing shall be conducted in accordance with Paragraph 24 of ASME SA-450 for carbon, ferritic, and

austenitic stainless tubes and Paragraph 5.3 of ASME SB-829 for nickel alloy tubes.

8.5.2 Any tube in the sample group found with readings below minimum wall shall cause the entire lot to be rejected. Disposition of the rejected lot to be discussed and approved by NRG.

8.5.3 If eddy current testing was conducted by the tube Manufacturer and satisfactory results are documented on the tube material CMTR, this sampling eddy current examination is not required.

8.6 For tube bends, wall thickness and ovality measurements shall be obtained from a 20% sample of each unique type of bend. Ultrasonic testing shall be per the ASME B&PV Code, Section V, Article 23, SE-797. The following are the acceptance criteria for tube bends:

8.6.1 Maximum allowable wall thinning shall be ten percent (10%) of the specified minimum wall thickness.

8.6.2 Maximum ovality, as defined by the following equation, shall be ten percent (10%):

$$\text{Ovality} = \frac{(\text{Major OD} - \text{Minor OD}) \times 100}{\text{Nominal Tube OD}}$$

8.6.3 Necking or OD reduction of the tube at a bend shall not exceed 10% of the specified tube OD.

8.7 For tube sections with butt welds specified or approved by NRG, one hundred percent (100%) of all butt welds shall be inspected by radiography.

8.8 The radiographic examination shall be performed using the single shot elliptical technique in accordance with the ASME B&PV Code, Section V.

8.9 Acceptance criteria for radiography shall conform to the ASME B&PV Code, Section I, PW-51. The radiograph film, copies thereof, or an electronic copy of digital radiographs shall be provided to NRG for review. The film will be returned after review.

9.0 Marking and Shipping

9.1 Material identification markings shall be stenciled on the tubing once every three to four feet.

9.2 Markings shall include the following as a minimum:

- 9.2.1 ASME material specification number and grade or type
- 9.2.2 OD and minimum wall thickness
- 9.2.3 Heat Number
- 9.2.4 Manufacturer's Name

9.3 All tubing shall be internally clean and free of dirt, rust, oil or other foreign matter.

9.4 All tubing up to and including 3.0" OD shall be suitably capped at both ends.

9.5 All ferrous tubing shall be supplied with a protective external coating (e.g., varnish, dry powder coating) to prevent corrosion. Oil dripped tubing is not acceptable.

10.0 Documentation

The Supplier's final documentation package shall include the following:

10.1 CMTRs
10.2 Manufacturer's ISO certificate
10.3 Visual inspection report
10.4 Tube wall thickness report
10.5 Eddy current test report (when applicable)