SPECIFICATION FOR 316 STAINLESS STEEL SEAMLESS CLADDING TUBES

TRITIUM TARGET QUALIFICATION PROJECT

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Tritium Target Qualification Project

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SPECIFICATION FOR
316 STAINLESS STEEL SEAMLESS CLADDING TUBES

1.0 SCOPE

This specification establishes the minimum requirements that the tube stock material used in the fabrication of seamless cladding tubes for the tritium target rods must meet. The specification is in accordance with guidelines presented in ASTM Standard A 771-88, *Standard Specification for Austenitic Stainless Steel Tubing for Breeder Reactor Core Components*.

2.0 APPLICABLE DOCUMENTS

The following documents are referred to in this specification. In the event of a conflict between the documents referred and A771-88, the detail requirements of A771-88 shall be superseding.

A 771-88, *Standard Specification for Austenitic Stainless Steel Tubing for Breeder Reactor Core Components*.

A 370-95, *Test Methods and Definitions for Mechanical Testing of Steel Products*

E 3-95, *Methods of Preparation of Metallographic Specimens*

E 21-92, *Recommended Practice for Elevated Temperature Tension Tests of Metallic Materials*

E 29a-93, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications. AASHTO R11*

E 112-95, *Standard Test Methods for Determining Average Grain Size*

E 213-93. *Standard Practice for Ultrasonic Examination of Metal Pipe and Tubing*

E1065-95. *Standard Guide for Evaluating Characteristics of Ultrasonic Search Units*

RDT F 2-7T. *Acceptance Sampling Plans*

3.0 TECHNICAL REQUIREMENTS

The following requirements and conditions supplement ASTM standard specification A771-88; paragraph numbers correspond to paragraphs contained in that standard. Any omission of a paragraph number indicates that the requirement is believed adequately described in A771-88.

ASTM A 771-88

Paragraph	Requirement
4.1.1	Quantity shall be as specified in the purchase requisition.
4.1.2	Name of Material - Seamless Tubes.
4.1.3	Grade - TP 316.
4.1.4	Condition - Cold Worked.
4.1.5.1	Dimensions shall be as shown on drawing H-3-304430 "TTQP 316 Stainless Steel Seamless Cladding, Tubing for Order".
4.1.5.2	Ovality - 0.001 inch max. ovality shall be measured and recorded over the entire length.
4.1.4.3	Wall thickness and eccentricity tolerances shall be within the tube dimensions specified above.
4.1.5.4	Straightness - the tubes shall be straight within 0.010 inch/foot of distance between contact points with a maximum distance between contact points of one foot when lying unrestrained on a granite surface table and oriented to give maximum gaps between the table and tubes. Each finished tube length shall be inspected using feeler gages to measure maximum gaps between the table and tube Interface. Hand-straightening of the tubes is permitted if necessary to meet requirements of this Paragraph.

Paragraph	Requirement
4.1.6	Tube End Configuration - perpendicularity of each tube end shall not exceed 0.002 inch when referenced to the first 2 inches of the tube's outside surface adjacent to the end of the tube.
4.1.7	Percent of Cold Work - 20 ± 2%.
4.1.8	Number of Tension Tests - three randomly selected samples per lot. These sample tubes shall also be examined/tested for hardness, grain size, intergranular attack, and carbide precipitation.
4.1.9	Packaging - the tubes shall be suitably packaged in rigid containers or separated by corrugated spacers providing support every 12 inches to prevent shipping and handling damage.
4.1.10	Surface Roughness - finished tube surface roughness shall not exceed 20 μ inch.
4.1.11	Grain Size - the grain size of the tubes following the final anneal and prior to cold drawing shall be ASTM Grain Size 7-9. Three randomly selected tubes per lot shall be examined.

Paragraph	Requirement
4.1.12	Identification - each tube shall be marked in accordance with Paragraph 5.8 of A771-88 to show the following: (1) the vendors' initials, (2) lot code referenceable to seller's internal lot number, (3) the heat number and (4) a sequential tube number beginning with 001. The identification should be per tne following example: (1) (2) (3) (4) ABC-XX-XXXXXX-001 The code shall be limited to 2 inches in length and located 10.0 inches from the end of the tube. The character height shall be 0.12 ± 0.03 inches. The character depth shall not exceed 0.0005 inch.
4.1.13	Surface Condition - surface scratches, dents, and mars shall not exceed 0.001 inch in depth. Impressed particles shall be rejectable if any material is embedded in the tube surface and visible to 3X magnification. One hundred percent of the surface of each tube shall be examined while traversing the tube with a maximum 4 inch helical pattern. The tubes shall be examined against a white background and a light reading of no less than 200 foot-candles at the tube surface. In-process conditioning of tubes shall be permitted after review and approval of the proposed procedures.

Paragraph	Requirement
4.1.14	Sampling Levels - samples shall be selected randomly from each rational inspection lot. Acceptance sampling procedures for ovality, tube end configuration, cleanliness and surface roughness shall be in accordance with RDT F 2 - 7T. For these characteristics, the probability (β) of exceeding a lot tolerance percent defective (LTPD) of 5% percent shall not exceed 0.05. The criterion of acceptance for other characteristics wherein inspection or examination of selected samples is specified (i.e., grain size, intergranular attack, carbide precipitation, residual halides, and chemical composition) shall be lot qualification as specified in paragraph 10.1 of ASTM A771-88.
5.1	Material will be supplied by the purchaser.
5.4	The temperature of the final anneal shall be a minimum of 1900°F as demonstrated by thermocouple readings taken during furnace profile measurements.
6.1	Chemical composition certifications for starting material will be supplied by the purchaser and shall conform to the requirements shown in Table 1 of ASTM A771-88. One randomly selected finished tube per lot shall be analyzed by the supplier.
7.1	Room temperature tensile properties shall be determined using methods described in ASTM A370; 1000°F tensile properties shall be determined using methods described in ASTM E21. Gage lengths shall be consistent with recommendations in ASTM A370, Supplement II. The strain rate shall not exceed 0.05 inch/inch/min minimum up to the yield point. In determining the tensile strength, the rate of separation of the heads under load shall not exceed 0.5 inch/min/inch minimum of gage length.

Paragraph	Requirement
8.1	The inside and outside diameters of each tube shall be measured and recorded over the entire length of each finished tube using air gaging or other methods approved by the purchaser. The measurement shall be performed on a continuous helix with a pitch no greater than 1 inch.
8.2	Ovality shall be measured over the entire length using a two orifice air-ring gage or other methods approved by the purchaser. The measurement shall be performed on a continuous helix with a pitch no greater than 1 inch. Maximum and minimum diameters within each helical revolution shall be measured and recorded.
8.3	Wall thickness shall be measured and recorded over the entire length of each finished tube using an ultrasonic thickness gage operated on a continuous helix with a pitch no greater than 1 inch. The speed of rotation of the test piece and pulse rate of the gage shall be so adjusted that at least six thickness measurements shall be recorded per revolution.
9.1	Visual inspection shall be performed using a 3X magnifying lamp. Defects identified at 3X shall be examined at higher magnification, with a microscope and dial indicator capable of reading to 0.0001 inch, to determine exact type, size, and depth. Tubes shall be examined one at a time while supported in a V-trough, traversing the tube with a maximum 4-inch helical pattern, examining 100 percent of the surface of each tube. Tubes shall be examined against a white background and a light reading of no less than 200 foot-candles at the tube surface.
10.2	The grain size shall be determined in accordance with ASTM E112 using reference plate II on both transverse and longitudinal sections from each sample tube.

Paragraph	Requirement
10.3	Inclusion certification data for starting material will be furnished by the purchaser.
10.4	Intergranular attack shall be determined on a randomly selected sample of three tubes per lot by visual examination of transverse metallurgical srecimens prepared in accordance with ASTM Standard E 3.
10.5	Carbide precipitation shall be determined on a randomly selected sample of three tubes per lot.
10.6	The following tolerance limit interpretation applies to all limits as specified in ASTM A771-88.

Chemical Composition and Dimensional Requirements

For the purpose of determining conformance, an observed value or a calculated value shall be rounded off "to the nearest unit" in the last right-hand place of figures used in expressing the limiting value, in accordance with the rounding-off method of ASTM E 29. For carbon determination only, the check analysis of the finished tubing may exceed the specification requirement by 0.005% absolute (by weight).

Tensile Requirements

For the purpose of determining conformance, an observed value or calculated value shall be rounded off to the nearest 100 psi for tensile strength and to the nearest 0.1% elongation, in accordance with the rounding-off method of ASTM E 29.

Paragraph	Requirement
11.2 11.2.1 11.2.2	Attachment 1 provides supplementary requirements to Recommended Practice E 213. These requirements complement those specified in E 213 and correspond to paragraphs contained in E 213. Any omission of a paragraph number indicates that the requirement is adequately covered in E 213. In the event of a conflict between the supplementary requirements and E 213, the supplementary requirements shall be superseding.
11.2.3	The notch standard shall be provided by the seller to the purchaser with the tubes as part of the requisition.
12.1.1	Delete.
13.1	Cleanliness shall be evaluated by visual examination of white cloth cleaning patches drawn through the bore and rubbed over the outer surface of the tubes. This is a lot qualification test based upon one randomly selected tube per lot. Procedures to be used shall be approved by the purchaser. The bore patch shall be dampened with deionized water and fitted tightly. The patch used on the outer surface shall be similarly dampened and rubbed over the surface. Uniform gray discoloration of the patches is acceptable, but the presence on any patch of any lubricant, metallic flakes, carbon or other particles distinguishable at 10X magnification, shall be caused for rejection. Rejected lots may be recleaned and resubmitted for inspection, however, the sample shall consist of tubes not previously inspected. The amount of residual chloride and fluoride on the tubes prior to final annealing and on the as-delivered tubes shall each be less than 0.0005 mg/square-inch of tube surface.
15.1.4	NDE Test Procedures and evidence of Procedure Qualification and operator (examiner) qualification(s) for Ultrasonic Examination shall be submitted to the Purchaser for review and approval a minimum of three (3) weeks prior to intended use.

Paragraph	Requirement
15.1.6	A Nonconformance Report shall be submitted by the Seller to obtain the Purchaser's disposition on any discrepancies from the purchase requisition or specification requirements. The Seller shall obtain specific Purchaser disposition of such discrepancies prior to shipment.
15.1.8	Identification presented on the Purchaser's supplied material must be maintained and cross referenced on records of individual tubes produced. Traceability of Purchaser-supplied material must be maintained and a Material Utilization Certificate that Purchaser-supplied material was used, without replacement, for the items provided by the Seller under this requisition is to be furnished with the shipment.
16.1	Records of all tests and examinations and results thereof, including chart recordings, shall be supplied with the finished tubes.
17.1	Certified chemical and physical test reports are to be furnished with each shipment. These test reports must be legible and shall reference ASTM A771-88 and the Purchasers' purchase requisition and item number. Properly signed and completed NDE Test Reports shall be provided with each shipment.

Paragraph	Requirement

Purchasers Inspection

Prior to shipment, all items furnished under this requisition may be subject to verification and/or inspection at the seller's plant by the Purchaser's Quality Representative. Formal release by the Purchaser's Quality Representative is required prior to shipment.

Seller shall give the Purchaser ten day written advance notification of any inspections required under this requisition by the Purchaser's Quality Representative.

Seller shall afford the Purchaser's Quality Representative full access to his facilities, equipment, and Quality records for the purpose of inspection, audit or surveillance under the purchase requisition.

Attachment 1

SUPPLEMENTARY REQUIREMENTS TO RECOMMENDED PRACTICE E 213

ASTM-E213

1. SCOPE

The procedure is restricted to the detection of discontinuities by ultrasonic pulse echo shear waves or refracted longitudinal waves using immersing techniques.

2. CALIBRATION STANDARDS

Both axial and circumferential notch groups shall be introduced on the outer and inner surfaces of the calibration standard. A notch group shall consist of three notches of a particular type (ID or OD) and orientation (axial or circumferential), which are fabricated with nominal depths of 0.0005, 0.001, and 0.0015 inches deep for use in establishing the system calibration curves. The nominal length of the notch shall be 0.030, notch configuration shall be buttress (square bottom). The notches shall be located so that each notch may be ultrasonically evaluated without interference from any other notch. All upset metal and burrs adjacent to the notches shall be removed. Electrical discharge machining (EDM) is the preferred method for fabricating notches. Other methods require written approval by the purchaser.

The depth of the calibration notch shall be measured at a minimum of three locations along its length. The depth shall be measured near both ends and at the center of the notch. The measured notch depth shall be reported as the numerical average of these measurements. The notch depth shall be within ±0.0002 inch of the specified depth; the notch length shall be within ±0.005 inch of the specified length. A

description of the calibration standard shall be included in the specific procedure as follows:

1. Tube size (outside diameter and wall thickness).

2. Length of calibration standard.

3. Surface finish of the material.

4. Material type and heat number.

5. Sketch of the calibration standard showing location, orientation, and dimensions of notches.

6. Notch dimension measurements (length, width, and depth), and date of latest verification.

6. CALIBRATION OF APPARATUS

Calibration of the test system, including measurements taken for rejection limits determination, shall be performed under conditions identical to those to be used in the actual examination. These test conditions include scan path, scan speed within ±50 RPM, pulse repetition rate within ± 50 pulses/s, and equipment settings.

The rejection alarm shall be set such that the rejection of a 0.001 inch defect is assured at the 95% confidence level. The supplier shall establish a method and procedure to be employed for providing statistical control of the rejection level and control of the examination. The method of statistical control shall be included in the test procedure and submitted for approval by the purchaser.

7. PROCEDURE

During calibration and the production examination, either the cladding

to be examined or the search unit assembly shall be moved in a controlled rotary manner such that the entire surface of the test article is scanned at a specified constant scanning rate. Provision shall be made to ensure that scanning is accomplished using a known and controlled scan path. The means of achieving this known and controlled path shall be included in the test procedure. The characteristics of the ultrasonic unit(also known as transducer) shall be evaluated in accordance with ASTM E1065-92.

The scan path shall assure 100% coverage. Where the ultrasonic beam width, at the notch location within the material, is smaller than the longest dimension of the calibration notches, the distance between two adjacent scan paths shall be no larger than the calculated beam width (one-half power points). The distance between the scan paths shall be recorded in the specific procedure. The transducer element size, focal distance in the couplant fluid (if applicable), beam width, transducer type, frequency, couplant, material surface finish, and scanning pitch shall be included in the specific procedure.

After calibration, the response of the test system to each applicable reference notch group shall be measured at least twice immediately prior to the production examination, once every hour during production examinations, and twice immediately following the production examination or prior to any equipment shutdown.

All data from each of the system response checks described above shall be recorded and plotted as a function of measured notch size.

All material examined since the last valid response check shall be re-exam if the tester response is below the calibration tolerance band. If the tester response is higher than the calibration tolerance band, tubes that contained discontinuity signals may be re-examined.

8. INTERPRETATION OF RESULTS

All discontinuity indications with signal amplitudes equal to or greater than the calculated reject level shall be considered nonconforming.

9. REPORT

An examination report shall be submitted, including the following information as a minimum.

1. The purchase requisition number and lot number.
2. The name of the supplier.
3. The quantity and amplitude of recordable indications (as specified by the purchaser or his agent) traceable to each item.
4. The procedure designation.
5. Test calibration data and acceptance criteria used.
6. Identification of the standard used.
7. Name and certification level of the UT operator(s).
8. Final disposition (accept or reject) of the examined tubes.
9. Date the examination was performed.
10. Equipment identification.