

TUBING, SUPERAUSTENITIC STEEL, CORROSION RESISTANT, UNS N08367 AND UNS S31254, BRIGHT ANNEALED, PASSIVATED, SPECIFICATION FOR

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ASTM	American Society for Testing and Materials
C	Celsius
F	Fahrenheit
ft	foot
in	inch
KSC	John F. Kennedy Space Center
μ	micro
NASA	National Aeronautics and Space Administration
SAE	Society of Automotive Engineers
UNS	Unified Numbering System

1. SCOPE

This specification defines the requirements for pressure tubing suitable for use with standard, 37-degree, flared tube fittings and buttwelding tube fittings in ground support equipment fluid systems at the John F. Kennedy Space Center (KSC), NASA.

Tubing system design and application details for the use of this tubing in Ground Systems shall be in accordance with KSC-DE-512-SM.

2. APPLICABLE DOCUMENTS

The following documents form a part of this document to the extent specified herein. When this document is used for procurement, including solicitations, or is added to an existing contract, the specific revision levels, amendments, and approval dates of said documents should be specified in an attachment to the Solicitation/Statement of Work/Contract.

The applicable documents are accessible via the NASA Standards and Technical Assistance Resource Tool at <http://standards.nasa.gov> or may be obtained directly from the standards developing organizations or other document distributors.

Citations of applicable documents are hyperlinked to their appearance in 2.1.

2.1 Governmental

Government Handbooks

GSA-FSS H 4-1 Federal Supply Code for Manufacturers

(Copies of the above documents are available from the NASA Technical Standards website (<https://standards.nasa.gov>), any NASA installation library or documentation repository, or from the procuring activity as directed by the Contracting Officer.)

2.2 Non-Governmental

American Society for Testing and Materials (ASTM)

ASTM A213	Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes
ASTM A249	Standard Specification for Welded Austenitic Steel Boiler, Superheater, Heat-Exchanger, and Condenser Tubes
ASTM A269	Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
ASTM A380	Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

ASTM A700	Standard Practices for Packaging, Marking, and Loading Methods for Steel Products and Shipment
ASTM A967	Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
ASTM A1016	Standard Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes
ASTM DS561	Metals and Alloys in the Unified Numbering System
ASTM E426	Standard Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products, Austenitic Stainless Steels, and Similar Alloys
ASTM G48	Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferritic Chloride Solution

(Application for copies should be addressed to the *American Society for Testing and Materials*; ASTM, 5916 Race Street, Philadelphia, PA 19103-1187.)

AL-6XN	AL-6XN is a registered trade name of Allegheny Ludlum Corporation
254 SMO	254 SMO is a registered trade name of Outokumpu

2.3 Order of Precedence

This specification does not supersede or waive established Agency requirements found in other documentation. Conflicts between this specification and applicable documents cited herein will be resolved by the responsible Technical Authorities. The following is the order of precedence:

1. Federal, state, and local laws and regulations
2. Agency and Center Directives
3. Agency mandatory standards

3. REQUIREMENTS

The tubing covered by this specification shall comply with the mechanical and physical properties specified in [ASTM A1016](#) and the additional requirements specified herein.

3.1 Alloy Types and Chemical Composition

Tubing material shall be types UNS N08367 (AL-6XN) or UNS S31254 (254 SMO) superaustenitic stainless steel in accordance with [ASTM A249](#). Chemical composition of both types, N08367 and S31254, shall be in accordance with [ASTM A249](#), Table 1.

3.2 Method of Manufacturing

Tubing shall be manufactured in accordance with [ASTM A249](#) welded (WLD) tubes from flatrolled steel by an automatic welding process with no addition of filler metal. Subsequent to welding and prior to final heat treatment, the tubes shall be cold worked either in both the weld and base metal or in the weld metal only. Cold work shall be sufficient to blend both the wall and weld on both the Outside Diameter and the Inside Diameter such that the wall thickness variation between the weld and base metal is less than half the wall tolerance allowance.

3.3 Characteristics

3.3.1 Pitting and Crevice Corrosion

Testing will be performed in accordance with [ASTM G48](#) as follows:

Method A - Ferric Chloride Pitting Test: Perform test on two (2) tubing samples selected from each heat lot except test temperature shall be $60 \pm 2^{\circ}\text{C}$ ($140 \pm 3.6^{\circ}\text{F}$). No evidence of pitting allowed at specified test temperature.

Method B - Ferric Chloride Crevice Corrosion Test: Perform test at $35 \pm 2^{\circ}\text{C}$ ($95 \pm 3.6^{\circ}\text{F}$) on each heat lot of strip coil to qualify the coil strip for tube fabrication. No evidence of crevice corrosion allowed at specified test temperature.

3.3.2 Physical Characteristics

3.3.2.1 Dimensions and Tolerances

- (1) Sizes – Tubing shall be furnished with the diameters and wall thickness specified in the contract or purchase order.
- (2) Wall Thickness – The wall thickness tolerances shall be in accordance with [ASTM A249](#).
- (3) Outside Diameter – The finished tolerance shall be in accordance with Table 1.

Table 1. OD Tolerances

Outside Diameter (in.)	Tolerance (in.)
.25	+0.004, -0.000
.375	+0.004, -0.000
.5	+0.004, -0.000

.75	+0.005, -0.000
1.0	+0.006, -0.000
1.25	+0.006, -0.000
1.5	+0.007, -0.000
2.0	+0.010, -0.000

- (4) Ovality – The allowable ovality of the finished tubing shall be in accordance with [ASTM A1016](#).
- (5) Length – The tube length shall be specified in the purchase order. If not stated on the purchase order the tubes shall be delivered in 20 ft. lengths. The tolerance of each tube length shall be specified in [ASTM A1016](#).

3.3.2.2 Tube Straightness and Finish

Tube straightness and finish shall be in accordance with [ASTM A1016](#). The finished tube shall have a maximum surface roughness of 32 μm on the inside surface and 63 μm on the outside surface, as defined by ASME B46.1.

3.3.2.3 Heat Treatment

The tubing shall be full furnace bright annealed, after weld fabrication and any subsequent cold drawing, above the minimum temperature specified in [ASTM A249](#) for each alloy.

Note: An unacceptable green coating can be produced on the surface of the tube if the tubing is not completely dry prior to the bright annealing process. Tubing delivered in this condition shall be rejected and the manufacturer notified in accordance with ASTM A1016.

3.3.2.4 Passivation

All fabricated tubing, after full furnace bright annealing has been completed, shall be passivated per the appropriate practice outlined in [ASTM A380](#) or, if the vendor prefers, the guidelines in [ASTM A967](#). The supplier shall select the proper practice/treatment/passivation effectiveness test in these specifications for the passivation of N08367 and/or S31254 alloys.

3.3.2.5 Repair by Welding

Not permitted.

3.3.2.6 Reheat Treatment

Reheat treatment shall be in accordance with [ASTM A1016](#).

3.3.3 Name Plates and Product Marking

Tube marking shall follow the basic guidelines of [ASTM A1016](#) with the exception of tube size. All tube sizes 1/4 in and larger shall be marked on the tube length. In addition to the requirements of ASTM the following shall be included:

1. UNS Number
2. Diameter and Wall Thickness
3. Heat Number
4. Shop Order Number
5. "KSC-SPEC-P-0027"
6. Mark "(XN)" every 8 inches along the entire length of tube for AL6XN tube and "(SM)" for 254SMO tube to help differentiate from other stainless steel tubing.

3.3.4 Workmanship

All workmanship shall conform to the standards of [ASTM A1016](#). Any deviations shall be listed on the purchase order.

3.3.5 Interchangeability

Material type shall not be substituted by any other product unless agreed upon by purchaser and manufacturer and adjustments to the purchase order are made.

3.4 Documentation

Certification and test reports shall be provided per [ASTM A1016](#).

3.5 Precedence

In the event of differences between this specification or its accompanying drawings and the referenced document, this specification shall govern to the extent of such differences.

3.6 Qualification

Tubing shall be subject to all testing and qualification requirements as stated in [ASTM A1016](#). Any elimination or addition of those requirements listed in [ASTM A1016](#) shall be stated in the purchase order.

3.7 Samples

Unless stated in the Statement of Work/Purchase Order, all samples shall be a part of the Verification/Qualification process during manufacturing.

3.7.1 Sampling Amount

Test samples shall be taken from 1 tube per 60 tube lengths (20 feet is standard tube length) processed with a minimum of two tests taken for each size (outside diameter x nominal wall thickness) manufactured. If more than 60 tube lengths are purchased another sample is required for every 60 tube lengths. For example, if 75 tube lengths are provided two samples shall be taken.

3.7.2 Sample Reaction

Final samples listed under the "Mechanical Tests" and "Pitting and Crevice Corrosion" sections shall be maintained for inspection/review by the government appointed Source Inspector. Upon the Source Inspector signing off on the Certificate of Compliance, the samples can be scrapped.

4. VERIFICATION

The government appointed Source Inspector shall ensure all testing requirements have been met satisfactorily and all required paperwork is in order in accordance with ASTM A1016.

The following documentation shall be supplied with each tubing shipment:

- Certified Material Test Report
- Certificate of Compliance
- Packing Tally

4.1 Mechanical Tests

Mechanical tests shall be conducted in accordance with the methods and guidelines found within [ASTM A1016](#).

4.2 Nondestructive Evaluation

Each tube fabricated shall be examined by the following methods:

- Eddy Current Examination – This test will be performed in accordance with [ASTM E426](#).
- Air Underwater Pressure Test – This test shall be in accordance with [ASTM A1016](#).

4.3 Responsibility for Inspection

Per [ASTM A1016](#), the manufacturer shall allow the government appointed inspector (or designee) all reasonable access to facilities necessary to satisfy that the product is being produced and furnished in accordance with the purchase order. Inspectors shall not interfere with manufacturer's operations.

Unless otherwise specified in the contract or order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may use his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.4 Rejections

Each length of tubing may be inspected by purchaser, and if it does not meet the requirement of the ordered product specification based on the inspection and test method(s) outlined in the purchase order specification(s), the length shall be rejected and the manufacturer notified in accordance with [ASTM A1016](#). Disposition of the rejected material shall be a matter of agreement between the manufacturer and the purchaser.

4.5 Verification Inspections

Shipping and Receiving shall perform visual and physical tests/inspections upon delivery of all tubing to ensure the quantity and quality of the product is per the purchase order: These examinations and tests shall include the following:

- a) Inspection delivery to ensure all paperwork is attached to shipment accounting for all material delivered.
- b) Measure tubing outside diameter and wall thickness to verify quantities are matched to that of the purchase order and delivery paperwork.
- c) Visual inspection of tubing interior, looking for greenish tint/coloring signifying undesirable moisture during the bright annealing process.
- d) Classification of characteristics as critical, major, or minor (ISO 9000-2000).

5. PREPARATION FOR DELIVERY

The product shall be packaged, marked, and loaded in accordance with [ASTM A700](#), or in accordance with the specification on the purchase order.

5.1 Marking for Shipment

The product marking guidelines of [ASTM A1016](#). Deviations or alterations to this specification shall be between the manufacturer and purchaser.

6. NOTES

6.1 Intended Use

AL-6XN and 254 SMO tubing should be used for all pneumatic ground support systems that are susceptible to high chloride atmospheres associated with ocean air exposure and/or solid rocket motor exhaust.

6.2 Ordering Data

Procurement documents for N08367 and S31254 superaustenitic stainless steel tubing shall specify the following:

- a) Title, number, and date of this specification
- b) Nominal outside diameter and minimum wall, thickness required
- c) Material Type required
- d) Quantity required
- e) Lengths required

7. REQUIREMENTS FOR SEAMLESS TUBING

In lieu of the requirements specified in sections 3 through 6, seamless tubing shall comply with the requirements of this section.

7.1 Material

- a) Seamless AL6XN (UNS N08367) superaustenitic stainless steel tubing shall be in the cold-formed condition in accordance with [ASTM A213](#) or shall be in accordance with [ASTM A269](#).
- b) Seamless 254SMO (UNS S31254) superaustenitic stainless steel tubing shall be in the cold-formed condition in accordance with [ASTM A213](#) or shall be in accordance with [ASTM A269](#).

7.2 Tensile Testing

Superaustenitic stainless steel tubing tensile properties shall be verified in accordance with [ASTM A213](#).

7.3 Annealing

After fabrication, superaustenitic stainless steel tubing shall be bright annealed.

7.4 Marking

Superaustenitic stainless steel tubing shall be marked with “KSC-SPEC-P-0027 Rev. A” and the specific alloy (“AL6XN” or “254SMO”) or UNS number (“N08367” or “S31254”).

NOTICE: The Government drawings, specifications, and/or data are prepared for the official use by, or on behalf of, the United States Government. The Government neither warrants these Government drawings, specifications, or other data, nor assumes any responsibility or obligation, for their use for purposes other than the Government project for which they were prepared and/or provided by the Government may have been formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded, by implication or otherwise, as licensing in any manner the holder or any other person or corporation nor conveying the right or permission, to manufacture, use, or sell any patented invention that may relate thereto.

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