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MASTER

LARGE RADIOISOTOPE HEAT SOURCE
CAPSULE PROGRAM
Topical Report No. 1
Capsule Materials Specifications

AEC Research and Development Report

ATOMICS INTERNATIONAL

A DIVISION OF NORTH AMERICAN AVIATION, INC.

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LARGE RADIOISOTOPE HEAT SOURCE
CAPSULE PROGRAM
Topical Report No. 1
Capsule Materials Specifications

By
Large Radioisotope Heat Source
Capsule Program Staff

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ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.

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ABSTRACT

The Large Radioisotope Heat Source Capsule (LRHSC) Program is developing technology for high temperature (2000°F), long life heat sources (5 years or longer) which can be used in the space environment. The LRHSC program is specifically concerned with the development of a tantalum alloy fuel capsule. Data are to be obtained under conditions of biaxial creep, impact and burial and include strain, compatibility and thermal maps. This topical report presents the material specifications which were prepared for all capsule materials. Because of the necessity for full characterization of materials and hardware these specifications were prepared to reflect both program needs and vendor capabilities. Material has in fact been obtained which meet these specifications.

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I. INTRODUCTION

The Large Radioisotope Heat Source Capsule (LRHSC) Program is a heat source technology effort directed toward gathering basic engineering data on refractory metal fuel capsules under the various environments of operation (vacuum, internal pressure, impact, burial, etc.). The capsule design shown in Figure 1 is basically a test device from which long term creep, impact and burial data can be obtained. However, it is representative of a usable 2000°F, 5 year life refractory metal capsule.

This topical report contains the principal material specifications prepared and utilized to procure raw and semi-stock materials for the program. These specifications as presented reflect both user constraints and requirements and supplier capabilities.

It is intended that the included specifications be available for use or extraction by all organizations participating in the AEC radioisotope systems program.

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II. PROGRAM MATERIALS SPECIFICATIONS

The Large Radioisotope Heat Source Capsule (LRHSC) is a prototype multi-layered pressure vessel designed to provide structural containment of the radioisotope fuel through environments which could be encountered during a space mission. It is basically a test device. A section view of the capsule is shown in Figure 1. The fuel volume is an annulus between the inner and outer liners of Ta-10W alloy. This fuel liner subassembly is contained within a structural shell of T-111, a high creep strength tantalum alloy.

The tantalum alloys were selected for the liners and structural shell because of their high mechanical strengths at elevated temperatures. However, these alloys are easily oxidized above 600°F and can be contaminated by minute amounts of oxygen, nitrogen, hydrogen, halogens, carbon monoxide and dioxide and hydrocarbons from the surrounding atmosphere. To protect the structural member from destructive oxidation and significant changes in its mechanical properties, a Pt-10Rh alloy oxidation cladding is used.

To improve the emittance and thus, the heat transfer from the capsule, an iron titanate coating is applied to the Pt-10Rh oxidation cladding.

Platinum and tantalum alloys are known to interdiffuse at the times and temperatures of interest to the LRHSC Program. Therefore, an alumina diffusion barrier is needed between the structural shell and the environmental protection cladding.

The materials and test environments used in the LRHSC Program must be carefully identified and controlled so that meaningful, reproducible data can be obtained from the test program. To achieve the required control, detailed materials specifications have been written for all the alloys used in the LRHS capsule, the emittance coating and the helium gas used as an inert atmosphere during capsule fabrication and biaxial creep testing. A material specification has not been written for the alumina coating since this is deposited by a chemical vapor deposition process. However, process control specifications are being used for such processes.

Figure 1. Section View of the Capsule

The specifications that have been written not only include the controls required by the LRHSC Program but also are practical, i. e., vendors are able to supply material to these specifications. Special requirements, vendor exceptions and material certifications are discussed below.

A. PLATINUM-10 RHODIUM ALLOY SPECIFICATIONS

Most applications of Pt-Rh alloys at high temperatures have been concerned with chemical composition, electrical resistivity or thermoelectric stability. In the LRHSC application, both inertness to chemical environment and creep strength are important. Since creep testing is not practical for acceptance of a material, the mechanical properties selected are room temperature tensile strength and hardness. The microhardness test specified was selected for convenience and to conserve material. As long as the tests are conducted consistently, the specific method is not considered critical. The suppliers requested a Rockwell hardness test for their convenience.

The various suppliers also expressed concern over the range specified for ultimate tensile strength. They requested that the range be increased to 45 to 55 ksi compared to the 35 to 50 ksi originally specified. Atomics International concurred with the selected alloy supplier that this requirement would be evaluated when the material was tested. The supplier's results indicate that the range should indeed be increased by the suggested amount. Results of tests on samples of sheet indicate a range of 45 to 55 ksi ultimate strength. The enclosed specifications reflect this change.

Defects in the alloy are specified by microstructure and surface imperfection requirements. Because most of the material will be in thin and short sections, the parts are not amenable to ultrasonic or eddy current testing. Gross inclusions, particulate contamination from fabrication, and tears will be indicated by the surface imperfection requirements. Grain size and laminations will be detected by metallographic examination.

One supplier requested that the requirement for seamless tubing be changed to allow welded and drawn material. The tubing would, of course, meet the grain size variation requirements. This request was based on ease of fabricability, not technology limits. The exception was allowed.

Several suppliers also requested that the fabrication History section be changed to protect production procedures considered proprietary. Only in the event that the buyer requires this information to resolve a specific problem, will it be made available. However, the data must be gathered and documented by the supplier.

The supplier's test reports indicate that material has been fabricated to the specifications. The only discrepancy was that previously noted on the ultimate strength. Future buys will utilize the 45 to 55 ksi ultimate strength range.

PREPARED BY S. Block/A. Carnazzola	CODE IDENT. NO.: 09974	NUMBER ST0170NB0058
APPROVALS Engineering Supervisor J. R. M. 4/15/67 Engineering B. R. Stung Specification Supervisor	ATOMICS INTERNATIONAL A Division of North American Aviation, Inc.	TYPE Material
	SPECIFICATION	DATE November 20, 1967
		SUPERSEDES SPEC. DATED: June 12, 1967
		REV. LTR. A
		PAGE 1 of 9

TITLE

Total Pgs. 11

PLATINUM-10 RHODIUM ALLOY, SHEET AND STRIP

THIS SPECIFICATION IS A BASELINE DOCUMENT

<u>REVISION</u>	<u>DATE</u>	<u>REVISION BY</u>	<u>REMARKS</u>
A	11-20-67	P. J. Fessia	Refer to Summary of Changes

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SUMMARY OF CHANGESFor Specification ST0170NB0058Approvals

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W. V. Botts
 W. V. Botts, Program Manager
 Large Radioisotope Heat Source Capsule

This Summary of Changes delineates the changes which constitute Revision A to the June 12, 1967 issue of this specification (refer to BCR No. 2056).

The outside margins of this specification have been marked to indicate where changes, deletions, or additions from the previous issue have been made. This has been done as a convenience only and AI assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the marginal notations, the Summary of Changes, and relationship to the last previous issue.

<u>Page</u>	<u>Paragraph</u>	<u>Title - Description of Change</u>
2	2.1	<u>Applicable Documents</u> "ASTM E18" was "ASTM E92."
3	3.3.1	<u>Tensile Properties</u> "45,000 to 55,000" was "35,000 to 50,000."
3	3.3.2	<u>Hardness</u> "Rockwell B55" was "Vickers 100 or equivalent."
3	3.5	<u>Microstructure</u> Revised the first sentence - it did read: "The grain size in the material shall be an ASTM Micro-Grain Size No. 6 to 8 as specified in ASTM E112."
5	4.3.4	<u>Hardness Tests</u> "ASTM E18" was "ASTM E92."
6	6.2	<u>Fabrication History</u> Revised the paragraph - it did read: "A report pertinent to the fabrication history of the material shall be submitted. This shall include the manufacturing history related to the percent of cold reduction prior to any heat treatment and the conditions of the final heat treatment."

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SPECIFICATIONS FOR
PLATINUM-10 RHODIUM ALLOY, SHEET AND STRIP

1. SCOPE This specification establishes the requirements for platinum-10 percent rhodium alloy sheet and strip.
2. APPLICABLE DOCUMENTS The following documents, of the latest issue, are applicable to this specification to the extent specified. Where the requirements of this specification differ from the requirements of the applicable documents, this specification shall have precedence.

Specifications

NA0115-001 Penetrant Inspection

Standards

ASTM E45 Recommended Practice for Determining the Inclusion Content of Steel

ASTM E18 Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials

ASTM E112 Methods for Estimating the Average Grain Size of Metals

3. REQUIREMENTS

- 3.1 Chemical Composition The composition of the finished product shall conform to the following.

<u>Element*</u>	<u>Percent by Weight</u>	
	<u>Minimum</u>	<u>Maximum</u>
Rhodium	9.9	10.1
Platinum	Remainder	

*Total impurity content, including gases, shall not exceed 0.100 percent and no one impurity shall exceed 0.020 percent.

- 3.2 Condition The product shall be in the fully annealed condition.

3.3 Mechanical Properties

- 3.3.1 Tensile Properties The tensile properties of the finished material shall be as follows in the transverse direction.

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3.3.1 Tensile Properties (Continued)

	<u>Minimum</u>	<u>Maximum</u>
Ultimate Tensile Strength, psi	45,000	55,000
Elongation, in 4W, where W is the width of the test specimen	30 percent	

3.3.2 Hardness The hardness of the material shall not exceed Rockwell B55.

3.4 Surface Imperfections All material shall be free of surface defects such as slivers, cracks, pits, laps, seams and blisters. Local surface defects may be removed by buffing, provided that such conditioning does not violate the minimum gage tolerance. Such removal shall be accomplished prior to final heat treatment and shall not be performed on material thinner than .062 inch.

3.5 Microstructure The minimum grain size number in the material shall be an ASTM Micro-Grain Size Number 5 with an allowable variation not to exceed two grain size numbers as specified in ASTM E112. The inclusion count in the longitudinal and transverse plane shall not exceed No. 0.5 Thin, all Types, as specified in ASTM E45.

3.6 Tolerances

3.6.1 Thickness Tolerances on thickness shall conform to the following:

<u>Thickness, inch</u>	<u>Tolerance, inch ($\pm$)</u>
.002 - .005	.0003
.006 - .010	.0005
.011 - .015	.0007
.016 - .020	.0010
.021 - .025	.0015
.026 - .030	.0020

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3.6.2 Width Tolerances on width shall conform to the following:

<u>Width, Inches</u>	<u>Tolerance, Inch (+)</u>
Under 2	.005
2 - 8	.008

3.6.3 Length Tolerances on length shall conform to the following:

<u>Length, Ft</u>	<u>Tolerance, Inch (+)</u>
Under 1	1/16
1 - 6	1/8

4. QUALITY ASSURANCE

4.1 Performance of Inspection and Tests The Supplier shall be responsible for the performance of all inspections and tests.

4.2 Lot A lot shall be that quantity of material of the same form and size, produced from the same heat or melt under the same conditions of fabrication and treatment, and submitted for inspection at one time.

4.3 Tests

4.3.1 Examination of Product The product shall be carefully examined to determine compliance with workmanship and marking requirements.

4.3.2 Chemical Analysis A chemical analysis shall be performed on 2 samples from each lot of material to determine conformance with the requirement of 3.1.

4.3.3 Tensile Tests Tensile tests shall be performed on 3 specimens selected from each lot of material to determine conformance with the requirements of 3.3.1. The tests shall be performed at a rate of strain of 0.002 inch per inch per minute through the yield strength and at a rate of 0.02 inch per inch per minute above the yield strength. The tensile specimens shall be prepared in accordance with figure 1. In addition, the yield strength (0.2 percent offset) shall be measured and the results recorded and retained for historical purposes.

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4.3.4 Hardness Tests Hardness tests shall be performed in accordance with ASTM E18 to determine conformance with the requirements of 3.3.2. Two measurements shall be made on each end of each tensile test specimen.

4.3.5 Penetrant Inspection The surface of each item shall be inspected in accordance with NA0115-001, Type I, Class 2, or Type II, Class 4 to determine conformance with 3.4.

4.3.6 Micrographic Examination Micrographic examinations shall be performed on 2 specimens selected from each lot of material to determine conformance with the requirements of 3.5. The grain size shall be determined in accordance with ASTM E112 and the inclusion content shall be determined in accordance with ASTM E45, Method C.

4.3.7 Rejections Material not conforming to the requirements of this specification shall be subject to rejection.

5. PREPARATION FOR DELIVERY

5.1 Identification Each sheet and strip shall be marked in accordance with 5.1.1, 5.1.2, or 5.1.3 as applicable with at least the following information.

AI Specification ST0170NB0058
Heat or Lot Number
Manufacturer's Identification
Nominal Thickness in Inches

The characters shall be not less than 3/8 inches in height, shall be applied using a suitable marking fluid, and shall be capable of being removed in solvent cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance. The characters shall withstand normal handling.

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5.1.1 Flat Sheet. Flat Strip Over 6 Inches in Width Flat sheet, flat strip over 6 inches in width shall be marked in lengthwise rows of characters recurring at intervals not greater than 2 feet, the rows being spaced nor more than 1-1/2 inches apart and alternately staggered. Heat or lot number shall occur at least 3 times across the width of the product and at intervals not greater than 2 feet along the length.

5.1.2 Flat Strip Under 6 Inches in Width Flat strip under 6 inches in width shall be marked near one end.

5.1.3 Coiled Strip Coiled strip shall be marked near the outside end of the coil.

5.2 Packaging The material shall be packed in substantial exterior containers to assure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

5.3 Marking The exterior container shall be marked with at least the following information.

Manufacturer's Name and Address
Point of Delivery (Name and Address)
AI Specification ST0170NB0058
Purchase Order Number

6. NOTES AND DATA Data submittal shall be in accordance with the requirements of Table I.

6.1 Tests Results A certified test and inspection report covering the data taken during acceptance testing shall be submitted. The test report shall include the results from each test specified in Section 4, the purchase order number, the lot or heat number, and AI specification number ST0170NB0058.

6.2 Fabrication History Retrievable records containing the following information shall be maintained by the Supplier for a period of 5 years from the date of shipment of the material:

Feed material consolidation procedure.

Melting practice.

Ingot fabrication schedule (including working temperatures, reduction processes and procedures, heat treatments and conditioning).

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6.2 Fabrication History (Continued)

Semi-finished material fabrication schedule.

Finished material fabrication schedule.

Copies of a report describing the non-proprietary areas of the fabrication sequence shall be prepared for submittal to Atomics International.

TABLE I
DATA SUBMITTAL REQUIREMENTS

Item Number	Specification Paragraph Number	Title of Data	Type and Quantity	Delivery Date
1	6.1	Test Results	3 copies and one reproducible	At the time of shipment
2	6.2	Fabrication History	3 copies	At the time of shipment

Deliver Data to: Atomics International, Division
North American Aviation, Inc.
Post Office Box 309
Canoga Park, California 91304

Attention: Quality Assurance
Department 754

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Actual Size

Figure 1
Tensile Specimen

NOTE: Dimensions are in inches.

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PREPARED BY S. Block/P.J. Fessia	CODE IDENT. NO.: 09974	NUMBER ST0170NB0059
APPROVALS Engineering Supervisor <i>[Signature]</i> 6/15/67 Engineering <i>[Signature]</i> 6/15/67 Specification Supervisor <i>[Signature]</i>	ATOMICS INTERNATIONAL A Division of North American Aviation, Inc.	TYPE Material
	SPECIFICATION	DATE November 20, 1967
		SUPERSEDES SPEC. DATED: June 7, 1967
		REV. LTR. A
		PAGE 1 of 8

TITLE

Total Pgs. 10

PLATINUM-10 RHODIUM ALLOY, SEAMLESS TUBING

THIS SPECIFICATION IS A BASELINE DOCUMENT

<u>REVISION</u>	<u>DATE</u>	<u>REVISION BY</u>	<u>REMARKS</u>
A	11-20-67	P. J. Fessia	Refer to Summary of Changes

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CODE IDENT. NO. 09974

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SUMMARY OF CHANGESFor Specification ST0170NB0059Approvals

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 Large Radioisotope Heat Source Capsule

This Summary of Changes delineates the changes which constitute Revision A to the June 7, 1967 issue of this specification (refer to BCR No. 2056).

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3	3.4.2	<u>Hardness</u> "Rockwell B55" was "Vickers 100 or equivalent."
3	3.5	<u>Surface Imperfections</u> Added the next to last sentence.
3	3.6	<u>Microstructure</u> Revised the first sentence - it did read: "The grain size in the material shall be an ASTM Micro-Grain Size No. 6 to 8 as specified in ASTM E112."
5	4.3.4	<u>Hardness Tests</u> "ASTM E18" was "ASTM E92."
6	6.2	<u>Fabrication History</u> Revised the paragraph - it did read: "A report pertinent to the fabrication history of the material shall be submitted. This shall include the manufacturing history related to the percent of cold reduction prior to any heat treatment and the conditions of the final heat treatment."

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SPECIFICATION FOR
PLATINUM-10 RHODIUM ALLOY, SEAMLESS TUBING

1. SCOPE This specification establishes the requirements for platinum-10 percent rhodium alloy seamless tubing.
2. APPLICABLE DOCUMENTS The following documents, of the latest issue, are applicable to this specification to the extent specified. Where the requirements of this specification differ from the requirements of the applicable documents, this specification shall have precedence.

Specifications

NA0115-001	Penetrant Inspection
NA0115-012	Helium Leak Detection

Standards

ASTM E45	Recommended Practice for Determining the Inclusion Content of Steel
ASTM E18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E112	Methods for Estimating the Average Grain Size of Metals

3. REQUIREMENTS

- 3.1 Chemical Composition The composition of the finished product shall conform to the following.

<u>Element*</u>	<u>Percent by Weight</u>	
	<u>Minimum</u>	<u>Maximum</u>
Rhodium	9.9	10.1
Platinum	Remainder	

*Total impurity content, including gases, shall not exceed 0.100 percent and no one impurity shall exceed 0.020 percent.

- 3.2 Condition The product shall be in the fully annealed condition.

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3.3 Form The tubing shall be seamless.

3.4 Mechanical Properties

3.4.1 Tensile Properties The tensile properties of the material shall be as follows:

	<u>Minimum</u>	<u>Maximum</u>
Ultimate Tensile Strength, psi	45,000	55,000
Elongation, in 0.5 inch, percent	30	

NOTE: These properties apply only to tubing with 0.010 inch wall and over.

3.4.2 Hardness The hardness of the material shall not exceed Rockwell B55.

3.5 Surface Imperfections All material shall be free of surface defects such as slivers, cracks, pits, laps, seams, and blisters. Local surface defects may be removed by buffing, provided that such conditioning does not violate the minimum gage tolerance. Material having defects that are not removable within the minimum gage tolerance shall be cut out. Such removal shall be accomplished prior to final heat treatment.

3.6 Microstructure The minimum grain size number in the material shall be an ASTM Micro-Grain Size Number 5 with an allowable variation not to exceed two grain size numbers as specified in ASTM E112. The inclusion count in the longitudinal and transverse plane shall not exceed a No. 0.5 Thin, all Types, as specified in ASTM E45.

3.7 Tolerances

3.7.1 Outside Diameter and Wall Thickness The tolerances on the outside diameter and the wall thickness shall be as follows:

<u>O.D., inch</u>	<u>Tolerance, inch (+)</u>
0.500 and under	0.002
over 0.500 through 0.740	0.0025
over 0.740 through 1.000	0.003
over 1.000 through 1.250	0.0035
over 1.250 through 2.000	0.004

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3.7.1 Outside Diameter and Wall Thickness (Continued)

<u>Wall Thickness, inch</u>	<u>Tolerance, inch (+)</u>
0.002 through 0.007	0.0005
over 0.007 through 0.015	0.0007
over 0.015 through 0.025	0.001
over 0.025 through 0.040	0.0015
over 0.040	0.002

3.7.2 Length The tolerance on length shall be $\pm 1/16$ inch on lengths up to 15 feet.

3.7.3 Straightness Camber in the tubing shall not exceed 0.062 inch per foot.

4. QUALITY ASSURANCE

4.1 Performance of Inspections and Tests The Supplier shall be responsible for the performance of all inspections and tests.

4.2 Lot A lot shall be that quantity of material of the same form and size, produced from the same heat or melt under the same conditions of fabrication and treatment, and submitted for inspection at one time.

4.3 Tests

4.3.1 Examination of Product The product shall be carefully examined to determine compliance with workmanship and marking requirements.

4.3.2 Chemical Analysis A chemical analysis shall be performed on 2 samples from each lot of material to determine conformance with the requirement of 3.1.

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4.3.3 Tensile Tests Tensile tests shall be performed on 3 specimens selected from each lot of material to determine conformance with the requirements of 3.4.1. The tests shall be performed at a rate of strain of 0.002 inch per inch per minute through the yield strength and at a rate of 0.02 inch per inch per minute above the yield strength. The tensile specimens shall be prepared in accordance with figure 1. In addition, the yield strength (0.2 percent offset) shall be measured and the results recorded and retained for historical purposes.

4.3.4 Hardness Tests Hardness tests shall be performed in accordance with ASTM E18 to determine conformance with the requirements of 3.4.2. Two measurements shall be made on each end of each tensile test specimen.

4.3.5 Penetrant Inspection The surface of each item shall be inspected in accordance with NAO115-001, Type I, Class 2, or Type II, Class 4 to determine conformance with 3.5.

4.3.6 Micrographic Examination Micrographic examinations shall be performed on 2 specimens selected from each lot of material to determine conformance with the requirements of 3.6. The grain size shall be determined in accordance with ASTM E112 and the inclusion content shall be determined in accordance with ASTM E45, Method C.

4.3.7 Helium Leak Detection Helium leak detection shall be performed on all tubes in accordance with NAO115-012, Rate II.

4.3.8 Rejections Material not conforming to the requirements of this specification shall be subject to rejection.

5. PREPARATION FOR DELIVERY

5.1 Identification Individual tubes or tube bundles shall have attached a metal or plastic tag embossed with at least the following information.

Purchase Order Number
AI Specification ST0170NB0059
Manufacturer's Identification
Heat or Lot Number

In addition, tubes 2 inches and larger in diameter shall be marked in lengthwise rows of characters near both ends with the same information. The characters shall not be less than 3/8 inch in height, shall be applied using a suitable marking fluid, and shall be capable of being removed in solvent cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance.

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5.2 Packaging The material shall be packed in substantial exterior containers to assure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

5.3 Marking The exterior container shall be marked with at least the following information.

Manufacturer's Name and Address
Point of Delivery (Name and Address)
AI Specification ST0170NB0059
Purchase Order Number

6. NOTES AND DATA Data submittal shall be in accordance with the requirements of Table I.

6.1 Test Results A certified test and inspection report covering the data taken during acceptance testing shall be submitted. The test report shall include the results from each test specified in Section 4, the purchase order number, the lot or heat number, and AI specification number ST0170NB0059.

6.2 Fabrication History Retrievable records containing the following information shall be maintained by the Supplier for a period of 5 years from the date of shipment of the material:

Feed material consolidation procedure.

Melting practice.

Ingot fabrication schedule (including working temperatures, reduction processes and procedures, heat treatments and conditioning).

Semi-finished material fabrication schedule.

Finished material fabrication schedule.

Copies of a report describing the non-proprietary areas of the fabrication sequence shall be prepared for submittal to Atomics International.

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TABLE I
DATA SUBMITTAL REQUIREMENTS

Item Number	Specification Paragraph Number	Title of Data	Type and Quantity	Delivery Date
1	6.1	Test Results	3 copies and one reproducible	At the time of shipment
2	6.2	Fabrication History	3 copies	At the time of shipment

Deliver Data to: Atomics International, Division
North American Aviation, Inc.
Post Office Box 309
Canoga Park, California 91304

Attention: Quality Assurance
Department 754

NUMBER

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- NOTES:**
1. Dimensions are in inches.
 2. This specimen shall be taken only from tubes with a 1.000 inch OD and over. Specimens to be used for tubing under 1.000 inch OD shall require AI approval prior to test.

Actual Size

Figure 1
Tensile Specimen

B. TANTALUM ALLOYS

The tantalum base alloy material specifications were prepared with the intent that the materials procured should be representative of those commercially available today and in the foreseeable future and also be representative of tantalum base alloys being tested at other sites. The specifications were reviewed by four major suppliers of tantalum base alloys. Those comments which were consistent between suppliers and which did not change the intent of the specifications were incorporated as revision A to the specifications.

Except for the method of consolidation, the specifications do not establish processing techniques. Processing is controlled by specifying the end product in detail.

A recent change to the specifications was to revise the geometry of the tensile specimen from that specified in ASTM E-8. Because tantalum alloys are expensive, a smaller specimen is specified consistent with the material form and good testing practices.

Shipments of both Ta-10W and T-111 alloys procured to the enclosed specifications have been received from the selected supplier.

All of the above revisions have been incorporated into the enclosed specifications.

BLANK

PREPARED BY <i>P. J. Fessia</i> <i>6/13</i> N. Block / P. J. Fessia	CODE IDENT. NO.: 09974	NUMBER ST0170NB0048
APPROVALS Engineering Supervisor <i>6/15/67</i> Specification Supervisor <i>6/15/67</i>	ATOMICS INTERNATIONAL A Division of North American Aviation, Inc.	TYPE Material
	SPECIFICATION	DATE November 21, 1967
		SUPERSEDES SPEC. DATED: August 2, 1967
		REV. LTR. B
		PAGE 1 of 11

TITLE TANTALUM-10 TUNGSTEN ALLOY, BAR AND ROD	Total Pgs 13
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THIS SPECIFICATION IS A BASELINE DOCUMENT

REVISION	DATE	REVISION BY	REMARKS
A	8-2-67	P. J. Fessia	Refer to Summary of Changes
B	11-21-67	P. J. Fessia	Refer to Summary of Changes

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SUMMARY OF CHANGESFor Specification ST0170NB0048Approvals

P. B. Ferry, Process Development
Large Radioisotope Heat Source Capsule
Development Unit

P. J. Fessia, Specifications
Large Radioisotope Heat Source Capsule
Development Unit

J. R. Miller, Supervisor
Large Radioisotope Heat Source Capsule
Development Unit

B. A. Stringham, Supervisor
Specification and Manuals

W. V. Botts, Program Manager
Large Radioisotope Heat Source Capsule

This Summary of Changes delineates the changes which constitute Revision B to the August 2, 1967 issue of this specification (refer to BCR No. 2057).

The outside margins of this specification have been marked to indicate where changes, deletions, or additions from the previous issue have been made. This has been done as a convenience only and AI assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the marginal notations, the Summary of Changes, and relationship to the last previous issue.

<u>Page</u>	<u>Paragraph</u>	<u>Title - Description of Change</u>
3	3.4.1	<u>Tensile Properties</u> The elongation gage length was "2 inches".
5	4.3.3	<u>Tensile Tests</u> Added "in accordance with ASTM E8" to the second sentence. In the last sentence, "figures 1, 2 or 3, as applicable" was "ASTM E8."
9,10 & 11	Figures 1, 2 & 3	<u>Tensile Specimens</u> Added the figures.

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SPECIFICATION FORTANTALUM-10 TUNGSTEN ALLOY, BAR AND ROD

1. SCOPE This specification establishes the requirements for tantalum-10 percent tungsten alloy, bar and rod.
2. APPLICABLE DOCUMENTS The following documents, of the latest issue, are applicable to this specification to the extent specified. Where the requirements of this specification differ from the requirements of the applicable documents, this specification shall have precedence.

Specifications

AMS 2241 Tolerances, Corrosion and Heat Resistant
Steel Bars and Wire

NA0115-001 Penetrant Inspection

Standards

ASTM E8 Tentative Methods of Tension Testing of
Metallic Materials

ASTM E45 Recommended Practice for Determining the
Inclusion Content of Steel

ASTM E112 Methods for Estimating the Average Grain
Size of Metals

ASTM E92 Standard Method of Test for Vickers Hardness
of Metallic Materials

ASTM E214 Tentative Recommended Practice for Immersed
Ultrasonic Testing by the Reflection Method
Using Pulsed Longitudinal Waves

FED STD 151 Metal, Test Methods

3. REQUIREMENTS

3.1 Method of Consolidation The ingot from which the product is produced shall be consolidated by double vacuum melting using the electron beam or consumable electrode arc melting techniques.

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3.2 Chemical Composition The composition of the finished product shall conform to the following:

Element*	Minimum	Maximum
Tungsten	9.0	11.0 percent by weight
Columbium	---	1000 ppm
Molybdenum	---	200 ppm
Nickel	---	50 ppm
Iron	---	50 ppm
Oxygen**	---	100 ppm
Carbon	---	50 ppm
Nitrogen**	---	50 ppm
Hydrogen	---	10 ppm
Tantalum	Remainder	

*Any other one impurity shall be less than 100 parts per million (ppm).
The total of other impurities shall not exceed 300 ppm.

**For products with a minimum diameter or thickness of 0.150 inch or less, the maximum content of oxygen and nitrogen may be increased to 150 ppm and 75 ppm, respectively. The balance of the composition shall remain as specified in the table.

3.3 Condition The product shall be in the recrystallized condition.

3.4 Mechanical Properties

3.4.1 Tensile Properties The tensile properties of the material shall be as follows for the longitudinal direction:

Diameter or Thickness to 0.080 inch:	
Ultimate Tensile Strength, psi	75,000 to 105,000
Yield Strength, 0.2 percent offset, psi	65,000 to 95,000
Elongation, in 0.5 inch, percent	15 minimum

Diameter or Thickness Greater than 0.080 inch:	
Ultimate Tensile Strength, psi	65,000 to 100,000
Yield Strength, 0.2 percent offset, psi	55,000 to 90,000
Elongation, in 0.5 or 1 inch (depending on the tensile specimen used), percent	25 minimum

3.4.2 Hardness The hardness of the material shall not be higher than Vickers 260 or equivalent. A hardness traverse shall not show a hardness increase of more than Vickers 50 from the center to the edge of a cross sectional sample of the final product.

3.5 Surface Imperfections All material shall be free of surface flaws such as slivers, cracks, pits, laps, seams and blisters. Local surface defects may be removed by buffing or spot grinding, provided that such conditioning does not violate the minimum gage tolerance. Such removal shall be accomplished prior to final heat treatment and shall be limited to materials over 0.062 inch in diameter.

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3.6 Internal Defects There shall be no internal defects in bar and rod (over 1/4 inch in diameter) having indicated areas greater than 0.0031 square inch.

3.7 Microstructure The inclusion count in the longitudinal and transverse plane shall not exceed a No. 0.5 Thin, all Types, as specified in ASTM E45. The grain size in the material shall conform to the following ASTM E112 Micro-Grain Size Numbers:

Material Thickness or Diameter, Inch	Minimum Allowable Grain Size No.	Allowable Spread in Grain Size No. In Any One Item
0.010 up to 0.187	6	2
0.187 up to 0.500	4	2
0.500 up to 1.000	3	2
1.000 and greater	3	3

3.8 Tolerances

3.8.1 Diameter Tolerances on diameter shall conform to the following:

Diameter, Inch*	Tolerance, Inch ($\pm$)
0.125	0.0015
0.187	0.0015
0.250	0.002
0.312	0.003
0.375	0.003
0.500	0.005
0.625	0.005
0.750	0.007
1.000	0.015
1.250	0.015
1.500	0.015

*The tolerance on intermediate diameters shall be as specified for the next listed larger size.

3.8.2 Length Tolerances on length shall conform to the requirements of AMS 2241.

3.8.3 Straightness Camber in bar and rod shall not exceed 0.050 inch per foot.

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4. QUALITY ASSURANCE

4.1 Performance of Inspections and Tests The Supplier shall be responsible for the performance of all inspections and tests.

4.2 Lot A lot shall be that quantity of material of the same diameter, produced from the same heat or melt under the same conditions of fabrication and treatment, and submitted for inspection at one time.

4.3 Tests

4.3.1 Examination of Product The product shall be carefully examined to determine compliance with surface imperfection and marking requirements.

4.3.2 Chemical Analysis A chemical analysis shall be performed on 2 samples from each lot of material in accordance with FED STD 151. The chemical composition shall conform with 3.2.

4.3.3 Tensile Tests Tensile tests shall be performed on 3 specimens selected from each lot of material to determine conformance with the requirements of 3.4.1. The tests shall be performed in accordance with ASTM E8 at a rate of strain of 0.002 inch per inch per minute through the yield strength and at a rate of 0.02 inch per inch per minute above the yield strength. The tensile specimens shall be prepared in accordance with Figures 1, 2 or 3, as applicable.

4.3.4 Hardness Tests Hardness tests shall be performed in accordance with ASTM E92 to determine conformance with the requirements of 3.4.2. Two measurements shall be made on each end of each tensile test specimen.

4.3.5 Liquid Penetrant Inspection The surface of each item shall be inspected in accordance with NA0115-001, Type I, Class 2 or Type II, Class 4 to determine conformance with 3.5.

NOTE: The material shall be pickled prior to penetrant inspection. The pickling process shall require AI approval prior to use.

4.3.6 Ultrasonic Inspection Each item shall be inspected in accordance with ASTM E214 to determine conformance with 3.6. Techniques of inspection shall be subject to AI approval.

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4.3.7 Micrographic Examination Micrographic examinations shall be performed on 2 specimens selected from each lot of material to determine conformance with the requirements of 3.7. The grain size shall be determined in accordance with ASTM E112 and the inclusion content shall be determined in accordance with ASTM E45, Method C.

4.3.8 Rejections Nonconformance to 4.3.2, 4.3.3, 4.3.4, or 4.3.7 shall be cause for retesting 3 additional samples for each test in question. Failure of any one of the 3 samples shall be cause for rejecting the lot of material the sample represents. Items of material not conforming to 4.3.5 or 4.3.6 shall be cause for rejection of those items.

5. PREPARATION FOR DELIVERY

5.1 Identification Each bar or rod shall be marked with at least the following information.

AI Specification ST0170NB0048
Heat and Lot Number
Manufacturer's Identification
Nominal Diameter in Inches

The characters shall be not less than 3/8 inch in height, shall be applied using a suitable marking fluid, and shall be capable of being removed in solvent cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance. The characters shall withstand normal handling.

NOTE: Bar and rod that is too small to be marked in this manner shall be individually tagged with the identification information.

5.2 Packaging The material shall be packed in substantial exterior containers to assure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

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5.3 Marking The exterior container shall be marked with at least the following information:

Manufacturer's Name and Address
Point of Delivery (Name and Address)
AI Specification ST0170NB0048
Purchase Order Number

6. NOTES AND DATA Data submittal shall be in accordance with the requirements of Table I.

6.1 Test Results A certified test and inspection report covering the data taken during acceptance testing shall be submitted. The test report shall include the results from each test specified in Section 4, the purchase order number, the lot and heat number, and AI specification number ST0170NB0048.

6.2 Fabrication History Retrievable records containing the following information shall be maintained by the Supplier for a period of 5 years from the date of shipment of the material:

Powder fabrication procedure.

Electrode or feed material consolidation.

Melting practice.

Ingot fabrication schedule (including working temperatures, reduction processes and procedure, heat treatments and conditioning).

Semi finished material fabrication schedule.

Finished material fabrication schedule.

Copies of a report describing the non-proprietary areas of the fabrication sequence shall be prepared for submittal to AI.

TABLE I
DATA SUBMITTAL REQUIREMENTS

Item Number	Specification Paragraph Number	Title of Data	Type and Quantity	Delivery Date
1	6.1	Test Results	3 copies and one reproducible	At the time of shipment
2	6.2	Fabrication History	3 copies	At the time of shipment

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Delivery Data to: Atomics International, Division
North American Aviation, Inc.
Post Office Box 309
Canoga Park, California 91304

Attention: Quality Assurance
Department 754

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CODE IDENT. NO. 09974

NORTH AMERICAN AVIATION, INC.

NUMBER
ST0170NB0048

B

REVISION LETTER

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- NOTES: 1. Dimensions are in inches (Scale: None).
 (1) 2. Diameters to be concentric within .001 inch.
 (2) 3. 16 $\sqrt{\text{ }}$ finish within this dimension.

TENSILE SPECIMEN

For bar and rod whose section thickness is .125 to (but not including) .250 inch.

Figure 1

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- NOTES:
1. Dimensions are in inches (Scale: None).
 2. Diameters to be concentric within $.001$ inch.
 3. $16 \sqrt{\text{finish}}$ within this dimension.

TENSILE SPECIMEN

For bar and rod whose section thickness is $.250$ to $(\text{but not including}) .375$ inch.

Figure 2

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- NOTES:
1. Dimensions are in inches (Scale: None).
 2. Diameters to be concentric within .001 inch.
 3. $16 \sqrt{\quad}$ finish within this dimension.

TENSILE SPECIMEN

For any form of material whose section thickness is .375 inch or greater.

Figure 3

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CODE IDENT. NO. 0974

NORTH AMERICAN AVIATION, INC.

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PREPARED BY <i>290</i> S. Block/A. Carnazzola	CODE IDENT. NO.: 09974	NUMBER ST0170NB0049
APPROVALS Engineering Supervisor <i>[Signature]</i> 8/15/67	ATOMICS INTERNATIONAL <i>A Division of North American Aviation, Inc.</i> SPECIFICATION	TYPE Material
Engineering <i>[Signature]</i> 6/15/67		DATE November 21, 1967
Specification Supervisor <i>[Signature]</i>		SUPERSEDES SPEC. DATED: August 2, 1967
		REV. LTR. B

PAGE 1 of 9

TITLE

Total Pgs. 11

TANTALUM-10 TUNGSTEN ALLOY, SEAMLESS TUBING

THIS SPECIFICATION IS A BASELINE DOCUMENT

REVISION	DATE	REVISION BY	REMARKS
A	8-2-67	P. J. Fessia	Refer to Summary of Changes
B	11-21-67	P. J. Fessia	Refer to Summary of Changes

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SUMMARY OF CHANGESFor Specification ST0170NB0049Approvals

P. B. Ferry
P. B. Ferry, Process Development
Large Radioisotope Heat Source Capsule
Development Unit

P. J. Fessia
P. J. Fessia, Specifications
Large Radioisotope Heat Source Capsule
Development Unit

J. R. Miller
J. R. Miller, Supervisor
Large Radioisotope Heat Source Capsule
Development Unit

B. A. Stringham
B. A. Stringham, Supervisor
Specifications and Manuals

W. V. Botts
W. V. Botts, Program Manager
Large Radioisotope Heat Source Capsule

This Summary of Changes delineates the changes which constitute Revision B to the August 2, 1967 issue of this specification (refer to BCR No. 2057).

The outside margins of this specification have been marked to indicate where changes, deletions, or additions from the previous issue have been made. This has been done as a convenience only and AI assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the marginal notations, the Summary of Changes, and relationship to the last previous issue.

<u>Page</u>	<u>Paragraph</u>	<u>Title - Description of Change</u>
3	3.5.1	<u>Tensile Properties</u> The elongation gage length was "2 inches."
5	4.3.3	<u>Tensile Tests</u> Added "in accordance with ASTM E8" to the second sentence. Revised the next to last sentence--it did read: "The tensile specimens shall be prepared in accordance with ASTM E8." Added the last sentence.
9	Figure 1	<u>Tensile Specimen</u> Added the figure.

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SPECIFICATION FOR
TANTALUM-10 TUNGSTEN ALLOY, SEAMLESS TUBING

1. SCOPE This specification establishes the requirements for tantalum-10 percent tungsten alloy seamless tubing.
2. APPLICABLE DOCUMENTS The following documents, of the latest issue, are applicable to this specification to the extent specified. Where the requirements of this specification differ from the requirements of the applicable documents, this specification shall have precedence.

Specifications

NA0115-001	Penetrant Inspection
NA0115-012	Helium Leak Detection
AMS 2243	Tolerances, Corrosion and Heat Resistant Steel Tubing

Standards

ASTM E8	Tentative Methods of Tension Testing of Metallic Materials
ASTM E45	Recommended Practice for Determining the Inclusion Content of Steel
ASTM E112	Methods for Estimating the Average Grain Size of Metals
ASTM E92	Standard Method of Test for Vickers Hardness of Metallic Materials
ASTM E214	Tentative Recommended Practice for Immersed Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves
FED STD 151	Metal, Test Methods

3. REQUIREMENTS

3.1 Method of Consolidation The ingot from which the tubing is produced shall be consolidated by double vacuum melting using the electron beam or consumable electrode arc melting techniques.

3.2 Form The tubing shall be seamless.

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3.3 Chemical Composition The composition of the finished tubing shall conform to the following:

<u>Element*</u>	<u>Minimum</u>	<u>Maximum</u>
Tungsten	9.0	11.0 percent by weight
Columbium	---	1000 ppm
Molybdenum	---	200 ppm
Nickel	---	50 ppm
Iron	---	50 ppm
Oxygen**	---	100 ppm
Carbon	---	50 ppm
Nitrogen**	---	50 ppm
Hydrogen	---	10 ppm
Tantalum	Remainder	

*Any other one impurity shall be less than 100 ppm. The total of other impurities shall not exceed 300 ppm.

**For tubing with a minimum wall thickness of 0.150 inch or less, the maximum content of oxygen and nitrogen may be increased to 150 ppm and 75 ppm, respectively. The balance of the composition shall remain as specified in the table.

3.4 Condition The tubing shall be in the recrystallized condition.

3.5 Mechanical Properties

3.5.1 Tensile Properties The tensile properties of the finished tubing shall be as follows:

Wall Thickness to 0.080 Inch:

Ultimate Tensile Strength, psi	75,000 to 105,000
Yield Strength, 0.2 percent offset, psi	65,000 to 95,000
Elongation in 1 inch, percent	15 minimum

Wall Thickness Greater than 0.080 Inch:

Ultimate Tensile Strength, psi	65,000 to 100,000
Yield Strength, 0.2 percent offset, psi	55,000 to 90,000
Elongation, in 1 inch, percent	25 minimum

3.5.2 Hardness The hardness of the tubing shall not be higher than Vickers 260 or equivalent. A hardness traverse shall not show a hardness increase of more than Vickers 50 from the center to the edge of a cross sectional sample of the final product.

3.6 Surface Imperfections Tubing shall be free of surface defects such as slivers, cracks, pits, laps, seams and blisters. Local surface defects may be removed by buffing, provided that such conditioning does not violate the minimum gage tolerance. Such removal shall be accomplished prior to final heat treatment.

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3.7 Internal Defects There shall be no internal defects in tubing (with wall thicknesses 0.020 inch and over) having indicated areas greater than 0.0031 square inch.

3.8 Microstructure The inclusion count in the longitudinal and transverse plane shall not exceed a No. 0.5 Thin, all Types, as specified in ASTM E45. The grain size in the material shall conform to the following ASTM E112 Micro-Grain Size Numbers:

<u>Wall Thickness, Inch</u>	<u>Minimum Allowable Grain Size No.</u>	<u>Allowable Spread in Grain Size No. In Any One Item</u>
0.010 up to 0.187	6	2
0.187 and over	4	2

3.9 Tolerances

3.9.1 Diameter The tolerances for outside diameter shall conform to the following:

<u>O.D., Inch</u>	<u>O.D. Tolerance, Inch</u>
Up to but not including 3/32	+0.002 -0.000
3/32 and up to but not including 3/16	+0.003 -0.000
3/16 and up to but not including 1/2	+0.004 -0.000
1/2 and up to but not including 1-1/2	+0.005 -0.000
1-1/2 and up to but not including 2	+0.006 -0.000

3.9.2 Wall Thickness The tolerance on wall thickness shall be within + 10 percent of the thickness specified on the Procurement Document.

3.9.3 Length Length tolerances shall conform to the requirements of AMS 2243.

3.9.4 Straightness Camber in the tubing shall not exceed 0.050 inch per foot.

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4. QUALITY ASSURANCE

4.1 Performance of Inspections and Tests The Supplier shall be responsible for the performance of all inspections and tests.

4.2 Lot A lot shall be that quantity of tubing of the same size and wall thickness, produced from the same heat or melt under the same conditions of fabrication and treatment, and submitted for inspection at one time.

4.3 Tests

4.3.1 Examination of Product The tubing shall be carefully examined to determine compliance with surface imperfections and marking requirements.

4.3.2 Chemical Analysis Chemical analysis shall be performed on 2 samples from each finished lot of tubing to determine conformance with the requirements of 3.3. Chemical analysis shall be performed in accordance with FED STD 151.

4.3.3 Tensile Tests Tensile tests shall be performed on 3 tensile specimens selected at random from the finished tubing in each lot to determine conformance with the requirements of 3.5.1. The tests shall be performed in accordance with ASTM E8, at a rate of strain of 0.002 inch per inch per minute through the yield strength and at a rate of 0.02 inch per inch per minute above the yield strength. The tensile specimens for tubing with an O.D. of 1 inch or over shall be prepared in accordance with Figure 1. The tensile specimens for tubing with an O.D. less than 1 inch shall be full cylindrical sections of tubing whose lengths are $3.12 \pm .03$ inches.

4.3.4 Hardness Tests Hardness tests shall be performed in accordance with ASTM E92 to determine conformance with the requirements of 3.5.2. Two measurements shall be made on each end of each tensile test specimen.

4.3.5 Penetrant Inspection The O.D. surface of each tube and the I.D. surface, where geometry considerations permit, of each tube shall be inspected in accordance with NA0115-001, Type I, Class 2, or Type II, Class 4 to determine conformance with the requirements of 3.6.

NOTE: The material shall be pickled prior to penetrant inspection. The pickling process shall require AI approval prior to use.

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4.3.6 Ultrasonic Inspection Each tube shall be ultrasonically inspected in accordance with ASTM E214 to determine conformance with 3.7. Techniques of inspection shall be subject to AI approval.

4.3.7 Micrographic Examination Micrographic examinations shall be performed on 2 specimens selected from each lot of material to determine conformance with the requirements of 3.8. The grain size shall be determined in accordance with ASTM E112 and the inclusion content shall be determined in accordance with ASTM E45, Method C.

4.3.8 Helium Leak Detection Helium leak detection shall be performed on all tubes in accordance with NA0115-012, Rate II.

4.3.9 Rejections Nonconformance to 4.3.2, 4.3.3, 4.3.4, or 4.3.7 shall be cause for retesting 3 additional samples for each test in question. Failure of any one of the 3 samples shall be cause for rejecting the lot of material the sample represents. Items of material not conforming to 4.3.5, 4.3.6 or 4.3.8 shall be cause for rejection of those items.

5. PREPARATION FOR DELIVERY

5.1 Identification Individual tubes or tube bundles shall have attached a metal or plastic tag embossed with at least the following information.

Purchase Order Number
AI Specification ST0170NB0049
Manufacturer's Identification
Heat and Lot Number

In addition, tubes 2 inches and larger in diameter shall be marked in lengthwise rows of characters near both ends with the same information. The characters shall not be less than 3/8 inch in height, shall be applied using a suitable marking fluid, and shall be capable of being removed in solvent cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance.

5.2 Packaging The material shall be packed in substantial exterior containers to assure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

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5.3 Marking The exterior container shall be marked with at least the following information:

Manufacturer's Name and Address
 Point of Delivery (Name and Address)
 AI Specification ST0170NB0049
 Purchase Order Number

6. NOTES AND DATA Data submittal shall be in accordance with the requirements of Table I.

6.1 Test Results A certified test and inspection report covering the data taken during acceptance testing shall be submitted. The test report shall include the results from each test specified in Section 4, the purchase order number, the lot and heat number, and AI specification number ST0170NB0049.

6.2 Fabrication History Retrievable records containing the following information shall be maintained by the Supplier for a period of 5 years from the date of shipment of the material:

Powder fabrication procedure.

Electrode or feed material consolidation.

Melting practice.

Ingot fabrication schedule (including working temperatures, reduction processes and procedure, heat treatments and conditioning).

Semi finished material fabrication schedule.

Finished material fabrication schedule.

Copies of a report describing the non-proprietary areas of the fabrication sequence shall be prepared for submittal to AI.

TABLE I
DATA SUBMITTAL REQUIREMENTS

Item Number	Specification Paragraph Number	Title of Data	Type and Quantity	Delivery Date
1	6.1	Test Results	3 copies and one reproducible	At the time of shipment
2	6.2	Fabrication History	3 copies	At the time of shipment

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Deliver Data to: Atomics International, Division
North American Aviation, Inc.
Post Office Box 309
Canoga Park, California 91304

Attention: Quality Assurance
Department 754

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- NOTES: 1. Dimensions are in inches (Scale: None).
 2. 16 $\sqrt{\text{finish}}$ within this dimension.

TENSILE SPECIMEN

For tubing with an O.D. of 1 inch or over.

Figure 1

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PREPARED BY S. Block/A. Carnazzola	CODE IDENT. NO.: 09974	NUMBER ST0170NB0050
APPROVALS Engineering Supervisor <i>[Signature]</i> 6/15/67 Engineering <i>[Signature]</i> 6/15/67 Specification Supervisor <i>[Signature]</i>	ATOMICS INTERNATIONAL A Division of North American Aviation, Inc.	TYPE Material
	SPECIFICATION	DATE November 21, 1967
		SUPERSEDES SPEC. DATED: August 2, 1967
		REV. LTR. B
		PAGE 1 of 10

TITLE

TANTALUM-10 TUNGSTEN ALLOY, PLATE, SHEET, STRIP AND FOIL

Total Pgs. 12

THIS SPECIFICATION IS A BASELINE DOCUMENT

REVISION	DATE	REVISION BY	REMARKS
A	8-2-67	P. J. Fessia	Refer to Summary of Changes
B	11-21-67	P. J. Fessia	Refer to Summary of Changes

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SUMMARY OF CHANGESFor Specification ST0170NB0050Approvals

P. B. Ferry
P. B. Ferry, Process Development
Large Radioisotope Heat Source Capsule
Development Unit

P. J. Fessia
P. J. Fessia, Specifications
Large Radioisotope Heat Source Capsule
Development Unit

J. R. Miller
J. R. Miller, Supervisor
Large Radioisotope Heat Source Capsule
Development Unit

B. A. Stringham
B. A. Stringham, Supervisor
Specifications and Manuals

W. V. Botts
W. V. Botts, Program Manager
Large Radioisotope Heat Source Capsule

This Summary of Changes delineates the changes which constitute Revision B to the August 2, 1967 issue of this specification (refer to BCR No. 2057).

The outside margins of this specification have been marked to indicate where changes, deletions, or additions from the previous issue have been made. This has been done as a convenience only and AI assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the marginal notations, the Summary of Changes, and relationship to the last previous issue.

<u>Page</u>	<u>Paragraph</u>	<u>Title - Description of Change</u>
3	3.4.1	<u>Tensile Properties</u> The elongation gage length was "2 inches."
5	4.3.3	<u>Tensile Tests</u> Added "in accordance with ASTM E8" to the second sentence. In the last sentence, "figure 1 or figure 2, as applicable" was "ASTM E8."
9 & 10	Figures 1 and 2	<u>Tensile Specimens</u> Added the figures.

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SPECIFICATION FOR
TANTALUM-10 TUNGSTEN ALLOY, PLATE, SHEET, STRIP AND FOIL

1. **SCOPE** This specification establishes the requirements for tantalum-10 percent tungsten alloy, plate, sheet, strip and foil.
2. **APPLICABLE DOCUMENTS** The following documents, of the latest issue, are applicable to this specification to the extent specified. Where the requirements of this specification differ from the requirements of the applicable documents, this specification shall have precedence.

Specification

AMS 2242	Tolerances, Corrosion and Heat Resistant Sheet, Strip, and Plate
NA0115-001	Penetrant Inspection

Standards

ASTM E8	Tentative Methods of Tension Testing of Metallic Materials
ASTM E45	Recommended Practice for Determining the Inclusion Content of Steel
ASTM E92	Standard Method of Test for Vickers Hardness of Metallic Materials
ASTM E112	Methods for Estimating the Average Grain Size of Metals
ASTM E214	Tentative Recommended Practice for Immersed Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves
FED STD 151	Metal, Test Methods

3. **REQUIREMENTS**

3.1 **Method of Consolidation** The ingot from which the product is produced shall be consolidated by double vacuum melting using the electron beam or consumable electrode arc melting techniques.

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3.2 Chemical Composition The composition of the finished product shall conform to the following:

Element*	Minimum	Maximum
Tungsten	9.0	11.0 percent by weight
Columbium	---	1000 ppm
Molybdenum	---	200 ppm
Nickel	---	50 ppm
Iron	---	50 ppm
Oxygen**	---	100 ppm
Carbon	---	50 ppm
Nitrogen**	---	50 ppm
Hydrogen	---	10 ppm
Tantalum	Remainder	

*Any other one impurity shall be less than 100 parts per million (ppm). The total of other impurities shall not exceed 300 ppm.

**For products with a minimum thickness of 0.150 inch or less, the maximum content of oxygen and nitrogen may be increased to 150 ppm and 75 ppm, respectively. The balance of the composition shall remain as specified in the table.

3.3 Condition The product shall be in the recrystallized condition.

3.4 Mechanical Properties

3.4.1 Tensile Properties The tensile properties of the material shall be as follows in the longitudinal and transverse directions.

Thicknesses 0.010 to 0.080 Inch:		
Ultimate Tensile Strength, psi		75,000 to 105,000
Yield Strength, 0.2 percent offset, psi		65,000 to 95,000
Elongation, in 1 inch, percent		15 minimum
Thicknesses Greater than 0.080 Inch:		
Ultimate Tensile Strength, psi		65,000 to 100,000
Yield Strength, 0.2 percent offset, psi		55,000 to 90,000
Elongation, in 1 inch, percent		25 minimum

3.4.2 Hardness The hardness of the material shall not be higher than Vickers 260 or equivalent. A hardness traverse shall not show a hardness increase of more than Vickers 50 from the center to the edge of a cross sectional sample of the final product.

3.4.3 Bending Sheet and strip 0.187 inch and under in thickness shall withstand, without cracking, bending at minus 320F through an angle of 105 degrees around a diameter equal to three times the nominal thickness of the material.

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3.5 Surface Imperfections All material shall be free of surface flaws such as slivers, cracks, pits, laps, seams and blisters. Local surface defects may be removed by buffing, provided that such conditioning does not violate the minimum gage tolerance. Such removal shall be accomplished prior to final heat treatment

3.6 Internal Defects There shall be no internal defects in the material (over 1/16 inch thick) having indicated areas greater than 0.0031 square inch.

3.7 Microstructure The inclusion count in the longitudinal and transverse plane shall not exceed a No. 0.5 Thin, all Types, as specified in ASTM E45. The grain size in the material shall conform to the following ASTM E112 Micro-Grain Size Numbers:

Thickness, Inch	Minimum Allowable Grain Size No.	Allowable Spread In Grain Size No. In Any One Item
0.010 up to 0.187	6	2
0.187 and over	4	2

3.8 Tolerances

3.8.1 Thickness Tolerances on thickness shall conform to the following:

Thickness, Inch	Tolerance, Inch(+)
0.001	0.0001
0.002	0.0002
0.003	0.0003
0.004	0.0004
0.005	0.0005
0.006	0.0006
0.007	0.0006
0.008	0.0007
0.009	0.0008
0.010	0.0008
0.013	0.0010
0.015	0.0010
0.018	0.0015
0.020	0.0015
0.025	0.0020
0.030	0.0025
0.035	0.0030
0.040	0.0030
0.050	0.0035
0.060	0.0040
0.070	0.0045
0.080	0.0045
0.090	0.0045
0.100	0.0060
0.125	0.0060
0.187	0.0060
0.250	0.0070
0.375	0.015
0.500	0.015

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3.8.2 Width and Length Tolerances on width and length shall conform to the requirements of AMS 2242.

3.8.3 Flatness Deviation from flatness of plate and sheet shall not exceed 6 percent as determined by the following formula:

$$\frac{H}{L} \times 100 = \text{percent of flatness deviation}$$

where: H = maximum distance from a flat surface to the high point of the plate or sheet.

L = distance from H to where the plate or sheet contacts the flat surface.

4. QUALITY ASSURANCE

4.1 Performance of Inspections and Tests The Supplier shall be responsible for the performance of all inspections and tests.

4.2 Lot A lot shall be that quantity of material of the same thickness, produced from the same heat or melt under the same conditions of fabrication and treatment, and submitted for inspection at one time.

4.3 Tests

4.3.1 Examination of Product The product shall be carefully examined to determine compliance with surface imperfection and marking requirements.

4.3.2 Chemical Analysis A chemical analysis shall be performed on 2 samples from each lot of material in accordance with FED STD 151. The chemical composition shall conform with 3.2.

4.3.3 Tensile Tests Tensile tests shall be performed on 3 specimens selected from each lot of material to determine conformance with the requirements of 3.4.1. The tests shall be performed in accordance with ASTM E8, at a rate of strain of 0.002 inch per inch per minute through the yield strength and at a rate of 0.02 inch per inch per minute above the yield strength. For widths 8 inches and over, the specimens shall be taken with the axis perpendicular to the direction of rolling. For widths less than 8 inches, the specimens shall be taken with the axis parallel to the direction of rolling. The tensile specimens shall be prepared in accordance with Figure 1 or Figure 2, as applicable.

4.3.4 Hardness Tests Hardness tests shall be performed in accordance with ASTM E92 to determine conformance with the requirements of 3.4.2. Two measurements shall be made on each end of each tensile test specimen.

4.3.5 Bend Tests Two bend tests, one with the axis of bending parallel to the direction of rolling and one with the axis of bending perpendicular to the direction of rolling, shall be performed on each lot of material to determine conformance with the requirements of 3.4.3. The test specimens shall be deburred 0.5 inch wide and not less than 2 inches in length. A ram speed of not less than 1 inch per minute shall be used.

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4.3.6 Liquid Penetrant Inspection The surface of each item shall be inspected in accordance with NA0115-001, Type I, Class 2, or Type II, Class 4 to determine conformance with 3.5.

NOTE: The material shall be pickled prior to penetrant inspection. The pickling process shall require AI approval prior to use.

4.3.7 Ultrasonic Inspection Each item shall be ultrasonically inspected in accordance with ASTM E214 to determine conformance with 3.6. Techniques of inspection shall be subject to AI approval.

4.3.8 Micrographic Examination Micrographic examinations shall be performed on 2 specimens selected from each lot of material to determine conformance with the requirements of 3.7. The grain size shall be determined in accordance with ASTM E112 and the inclusion content shall be determined in accordance with ASTM E45, Method C.

4.3.9 Rejections Nonconformance to 4.3.2, 4.3.3, 4.3.4, 4.3.5 or 4.3.8 shall be cause for retesting 3 additional samples for each test in question. Failure of any one of the 3 samples shall be cause for rejecting the lot of material the samples represents. Items of material not conforming to 4.3.6 or 4.3.7 shall be cause for rejection of those items.

5. PREPARATION FOR DELIVERY

5.1 Identification Each sheet, strip, and plate shall be marked in accordance with 5.1.1, 5.1.2, or 5.1.3 as applicable with at least the following information.

AI Specification ST0170NB0050
Heat and lot number
Manufacturer's identification
Nominal thickness in inches

The characters shall be not less than 3/8 inch in height, shall be applied using a suitable marking fluid, and shall be capable of being removed in solvent cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance. The characters shall withstand normal handling.

5.1.1 Flat Sheet, Flat Strip Over 6 Inches in Width, and Plate Flat sheet, flat strip over 6 inches in width, and plate shall be marked in lengthwise rows of characters recurring at intervals not greater than 2 feet, the rows being spaced not more than 1-1/2 inches apart and alternately staggered. Heat or batch number shall occur at least 3 times across the width of the product and at intervals not greater than 2 feet along the length.

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5.1.2 Flat Strip Under 6 Inches in Width Flat strip under 6 inches in width shall be marked near one end.

5.1.3 Coiled Strip Coiled strip shall be marked near the outside end of the coil.

5.2 Packaging The material shall be packed in substantial exterior containers to assure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

5.3 Marking The exterior container shall be marked with at least the following information:

Manufacturer's Name and Address
 Point of Delivery (Name and Address)
 AI Specification ST0170NB0050
 Purchase Order Number

6. NOTES AND DATA Data submittal shall be in accordance with the requirements of Table I.

6.1 Test Results A certified test and inspection report covering the data taken during acceptance testing shall be submitted. The test report shall include the results from each test specified in Section 4, the purchase order number, the lot and heat number, and AI specification number ST0170NB0050.

6.2 Fabrication History Retrievable records containing the following information shall be maintained by the Supplier for a period of 5 years from the date of shipment of the material:

Powder fabrication procedure.

Electrode or feed material consolidation.

Melting practice.

Ingot fabrication schedule (including working temperatures, reduction processes and procedure, heat treatments and conditioning).

Semi finished material fabrication schedule.

Finished material fabrication schedule.

Copies of a report describing the non-proprietary areas of the fabrication sequence shall be prepared for submittal to AI.

TABLE I
DATA SUBMITTAL REQUIREMENTS

Item Number	Specification Paragraph Number	Title of Data	Type and Quantity	Delivery Date
1	6.1	Test Results	3 copies and one reproducible	At the time of shipment
2	6.2	Fabrication History	3 copies	At the time of shipment

Deliver Data to: Atomics International, Division
North American Aviation, Inc.
Post Office Box 309
Canoga Park, California 91304

Attention: Quality Assurance
Department 754

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NOTES: 1. Dimensions are in inches (Scale: None).

① 2. $\sqrt{16}$ finish within this dimension.

TENSILE SPECIMEN

For plate, sheet, strip and foil whose section thickness is less than $.375$ inch.

Figure 1

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- NOTES:
1. Dimensions are in inches (Scale: None).
 2. Diameters to be concentric within $.001$ inch.
 3. $16 \sqrt{\text{finish}}$ within this dimension.

TENSILE SPECIMEN

For bar and rod whose section thickness is $.250$ to (but not including) $.375$ inch.

Figure 2

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PREPARED BY S. Block/A. Carnazzola	CODE IDENT. NO.: 09974	NUMBER ST0170NB0051
APPROVALS Engineering Supervisor <i>[Signature]</i> 11/24/67	ATOMICS INTERNATIONAL <i>A Division of North American Aviation, Inc.</i> SPECIFICATION	TYPE Material
Engineering <i>[Signature]</i> 6/5/67		DATE November 21, 1967
Specification Supervisor <i>[Signature]</i>		SUPERSEDES SPEC. DATED: August 2, 1967
		REV. LTR. B

TITLE ^{Ta W HP} TANTALUM-8 TUNGSTEN-2 HAFNIUM ALLOY, PLATE, SHEET, STRIP AND ROD Total Pgs 17

THIS SPECIFICATION IS A BASELINE DOCUMENT			
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B	11-21-67	P. J. Fessia	Refer to Summary of Changes

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SUMMARY OF CHANGESFor Specification ST0170NB0051Approvals

 P. B. Ferry, Process Development
 Large Radioisotope Heat Source Capsule
 Development Unit

 P. J. Fessia, Specifications
 Large Radioisotope Heat Source Capsule
 Development Unit

 J. R. Miller, Supervisor
 Large Radioisotope Heat Source Capsule
 Development Unit

 B. A. Stringham, Supervisor
 Specifications and Manuals

 W. V. Botts, Program Manager
 Large Radioisotope Heat Source Capsule

This Summary of Changes delineates the changes which constitute Revision B to the August 2, 1967 issue of this specification (refer to BCR No. 2055).

The outside margins of this specification have been marked to indicate where changes, deletions, or additions from the previous issue have been made. This has been done as a convenience only and AI assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the marginal notations, the Summary of Changes, and relationship to the last previous issue.

Page	Paragraph	Title - Description of Change
3	3.4.1	<u>Tensile Properties</u> The elongation gage length was "2 inches."
7	4.3.3	<u>Tensile Tests</u> Added "in accordance with ASTM E8" to the second sentence. In the last sentence, "figures 1, 2, 3 or 4, as applicable" was "ASTM E8."
11,12,13 and 14	Figures 1, 2, 3 & 4	<u>Tensile Specimens</u> Added the figures.

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SPECIFICATION FORTANTALUM-8 TUNGSTEN-2 HAFNIUM ALLOY PLATE, SHEET, STRIP AND ROD

1. SCOPE This specification establishes the requirements for tantalum-8 percent tungsten-2 percent hafnium alloy plate, sheet, strip and rod.
2. APPLICABLE DOCUMENTS The following documents, of the latest issue, are applicable to this specification to the extent specified. Where the requirements of this specification differ from the requirements of the applicable documents, this specification shall have precedence.

Specifications

AMS 2241	Tolerances, Corrosion and Heat Resistant Steel Bars and Wire
AMS 2242	Tolerances, Corrosion and Heat Resistant Sheet, Strip and Plate
NA0115-001	Penetrant Inspection

Standards

ASTM E8	Tentative Methods of Tension Testing of Metallic Materials
ASTM E45	Recommended Practice for Determining the Inclusion Content of Steel
ASTM E92	Standard Method of Test for Vickers Hardness of Metallic Materials
ASTM E112	Methods for Estimating the Average Grain Size of Metals
ASTM E214	Tentative Recommended Practice for Immersed Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves
FED STD 151	Metal, Test Methods

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3. REQUIREMENTS

3.1 Method of Consolidation The ingot from which the product is produced shall be consolidated by double vacuum melting using the electron beam or consumable electrode arc melting techniques.

3.2 Chemical Composition The composition of the finished product shall conform to the following.

Element*	Minimum	Maximum
Tungsten	7.0	9.0 percent by weight
Hafnium	1.7	2.3 percent by weight
Columbium	---	1000 nppm
Molybdenum	---	200 nppm
Nickel	---	50 nppm
Iron	---	50 ppm
Oxygen**	---	50 ppm
Carbon**	---	30 ppm
Nitrogen**	---	50 nppm
Hydrogen	---	10 nppm
Zirconium	---	1000 ppm
Tantalum	Remainder	

*Any other one impurity shall be less than 100 parts per million (ppm). The total of other impurities shall not exceed 300 ppm.

**For products with a minimum diameter or thickness of 0.150 inch or less, the maximum content of oxygen, carbon and nitrogen may be increased to 150 ppm, 50 ppm, and 75 ppm, respectively. The balance of the composition shall remain as specified in the table.

3.3 Condition The product shall be in the recrystallized condition.

3.4 Mechanical Properties

3.4.1 Tensile Properties The tensile properties of the material shall be as follows (these properties apply in the longitudinal and transverse directions for flat stock).

Ultimate Tensile Strength, psi	80,000 to 110,000
Yield Strength, 0.2 percent offset, psi	65,000 to 85,000
Elongation, in 0.5 or 1 inch (depending on the tensile specimen used), percent	20 minimum

These properties apply to flat stock 0.010 inch and over and rod 1/8 inch and over in diameter.

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3.4.2 Hardness The hardness of the material shall not be higher than Vickers 280 or equivalent. A hardness traverse shall not show a hardness increase of more than Vickers 50 from the center to the edge of a cross sectional sample of the final product.

3.4.3 Bending Sheet and strip 0.187 inch and under shall withstand, without cracking, bending at minus 320F through an angle of 105 degrees around a diameter equal to three times the nominal thickness of the material.

3.5 Surface Imperfections All material shall be free of surface flaws such as slivers, cracks, pits, laps, seams and blisters. Local surface defects may be removed by buffing provided that such conditioning does not violate the minimum gage tolerance. Such removal shall be accomplished prior to final heat treatment.

3.6 Internal Defects There shall be no internal defects in the material (flat stock over 0.062 inch thick and rod over 1/4 inch diameter) having indicated areas greater than 0.0031 square inch.

3.7 Microstructure The inclusion count in the longitudinal and transverse plane shall not exceed a No. 0.5 Thin, all Types, as specified in ASTM E45. The grain size in the material shall conform to the following ASTM E112 Micro-Grain Size Numbers:

<u>Material Thickness or Diameter, Inch</u>	<u>Minimum Allowable Grain Size No.</u>	<u>Allowable Spread In Grain Size No. In Any One Item</u>
0.010 up to 0.187	6	2
0.187 up to 0.500	4	2
0.500 up to 1.000	3	2
1.000 and greater	3	3

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3.8 Tolerance3.8.1 Plate, Sheet and Strip3.8.1.1 Thickness Tolerances on thickness shall conform to the following:

<u>Thickness, inch</u>	<u>Tolerance, inch (+)</u>
0.005	0.0008
0.006	0.0008
0.007	0.0008
0.008	0.0008
0.010	0.0015
0.012	0.0015
0.015	0.0015
0.020	0.0025
0.025	0.0025
0.030	0.0030
0.035	0.0035
0.040	0.0035
0.050	0.0035
0.060	0.0040
0.070	0.0040
0.080	0.0040
0.100	0.0060
0.125	0.0060
0.187	5 percent
0.250	5 percent

3.8.1.2 Width and Length: Tolerances on width and length shall conform to the requirements of AMS 2242.3.8.2 Rod3.8.2.1 Diameter and Roundness Tolerances on diameter shall conform to the following:

<u>Diameter or Thickness, inch</u>	<u>Tolerance, inch (+)</u>	
	<u>Diameter or Thickness</u>	<u>Roundness</u>
0.125	0.0015	0.001
.156	"	"
.187	"	"
.250	.002	"
.312	.003	.0015
.357	"	"
.437	"	"

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3.8.2.1 Diameter and Roundness (Continued)

Diameter or Thickness, Inch	Tolerance, Inch (+)	
	Diameter or Thickness	Roundness
.500	.005	.0025
.562	"	"
.625	"	"
.687	"	"
.750	.007	.0035
.812	"	"
.875	"	"
.937	"	"
1.000	.015	.0075
1.250	"	"
1.375	"	"
1.437	"	"
1.500	"	"
1.750	.020	.010
2.000	"	"
2.500	"	"

3.8.2.2 Length Length tolerances shall conform to the requirements of ASM 2241.

3.8.2.3 Straightness Camber in bar and rod shall not exceed 0.050 inch per foot.

3.8.2.4 Flatness Deviation from flatness of plate and sheet shall not exceed 6 percent as determined by the following formula:

$$\frac{H}{L} \times 100 = \text{percent of flatness deviation}$$

where:

H = maximum distance from a flat surface to the high point of the plate or sheet

L = distance from H to where the plate or sheet contacts the flat surface

4. QUALITY ASSURANCE

4.1 Performance of Inspections and Tests The Supplier shall be responsible for the performance of all inspections and tests.

4.2 Lot A lot shall be that quantity of material of the same form, size and thickness or diameter, produced from the same heat or melt under the same conditions of fabrication and treatment, and submitted for inspection at one time.

4.3 Tests

4.3.1 Examination of Product The product shall be carefully examined to determine compliance with surface imperfection and marking requirements.

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4.3.2 Chemical Analysis A chemical analysis shall be performed on 2 samples from each lot of material in accordance with FED STD 151. The chemical composition shall conform with 3.2.

4.3.3 Tensile Tests Tensile tests shall be performed on 3 specimens selected from each lot of material to determine conformance with the requirements of 3.4.1. The tests shall be performed in accordance with ASTM E8 at a rate of strain of 0.002 inch per inch per minute through the yield strength and at a rate of 0.02 inch per inch per minute above the yield strength. For widths 8 inches and over, the specimens shall be taken with the axis perpendicular to the direction of rolling. For widths less than 8 inches, the specimens shall be taken with the axis parallel to the direction of rolling. The tensile specimens shall be prepared in accordance with Figures 1, 2, 3 or 4, as applicable.

4.3.4 Hardness Tests Hardness tests shall be performed in accordance with ASTM E92 to determine conformance with the requirements of 3.4.2. Two measurements shall be made on each end of each tensile test specimen.

4.3.5 Bend Tests Bend tests, one with the axis of bending parallel to the direction of rolling and one with the axis of bending perpendicular to the direction of rolling, shall be performed on each lot of material to determine conformance with the requirements of 3.4.3. The test specimens shall be deburred 0.5 inch wide and not less than 2 inches in length. A ram speed of not less than 1 inch per minute shall be used.

4.3.6 Penetrant Inspection The surface of each item shall be inspected in accordance with NA0115-001, Type I, Class 2, or Type II, Class 4 to determine conformance with 3.5.

NOTE: The material shall be pickled prior to penetrant inspection. The pickling process shall require AI approval prior to use.

4.3.7 Ultrasonic Inspection Each item shall be inspected in accordance with ASTM E214 to determine conformance with 3.6. Techniques of inspection shall be subject to AI approval.

4.3.8 Micrographic Examination Micrographic examinations shall be performed on 2 specimens selected from each lot of material to determine conformance with the requirements of 3.7. The grain size shall be determined in accordance with ASTM E112 and the inclusion content shall be determined in accordance with ASTM E45, Method C.

4.3.9 Rejections Nonconformance to 4.3.2, 4.3.3, 4.3.4, 4.3.5 or 4.3.8 shall be cause for retesting 3 additional samples for each test in question. Failure of any of the 3 samples shall be cause for rejecting the lot of material the sample represents. Items of material not conforming to 4.3.6 or 4.3.7 shall be cause for rejection of those items.

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5. PREPARATION FOR DELIVERY

5.1 Identification Sheet, strip, plate and rod shall be marked in accordance with 5.1.1, 5.1.2, 5.1.3, or 5.1.4, as applicable, with at least the following information.

AI Specification ST0170NB0051
Heat and Lot Number
Manufacturer's Identification
Nominal Thickness in Inches

The characters shall be not less than 3/8 inch in height, shall be applied using a suitable marking fluid, and shall be capable of being removed in solvent cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance. The characters shall be sufficiently stable to withstand normal handling.

5.1.1 Flat Sheet, Flat Strip Over 6 Inches in Width and Plate Flat sheet, flat strip over 6 inches in width and plate shall be marked in lengthwise rows of characters recurring at intervals not greater than 2 feet, the rows being spaced not more than 1-1/2 inches apart and alternately staggered. Heat or batch number shall occur at least 3 times across the width of the product and at intervals not greater than 2 feet along the length.

5.1.2 Flat Strip Under 6 Inches in Width Flat strip under 6 inches in width shall be marked near one end.

5.1.3 Coiled Strip Coiled strip shall be marked near the outside end of the coil.

5.1.4 Rod Rods shall be individually identified by tagging.

5.2 Packaging The material shall be packed in substantial exterior containers to assure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

5.3 Marking The exterior container shall be marked with at least the following information:

Manufacturer's Name and Address
Point of Delivery (Name and Address)
AI Specification ST0170NB0051
Purchase Order Number

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6. NOTES AND DATA Data submittal shall be in accordance with the requirements of Table I.

6.1 Test Results A certified test and inspection report covering the data taken during acceptance testing shall be submitted. The test report shall include the results from each test specified in Section 4, the purchase order number, the lot and heat number, and AI specification number ST0170NB0051.

6.2 Fabrication History Retrievable records containing the following information shall be maintained by the Supplier for a period of 5 years from the date of shipment of the material:

- Powder fabrication procedure.

- Electrode or feed material consolidation.

- Melting practice.

- Ingot fabrication schedule (including working temperatures, reduction processes and procedure, heat treatments and conditioning).

- Semi finished material fabrication schedule.

- Finished material fabrication schedule.

Copies of a report describing the non-proprietary areas of the fabrication sequence shall be prepared for submittal to AI.

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TABLE I
DATA SUBMITTAL REQUIREMENTS

Item Number	Specification Paragraph Number	Title of Data	Type and Quantity	Delivery Date
1	6.1	Test Results	3 copies and one reproducible	At the time of shipment
2	6.2	Fabrication History	3 copies	At the time of shipment

Deliver Data to: Atomics International, Division
North American Aviation, Inc.
Post Office Box 309
Canoga Park, California 91304

Attention: Quality Assurance
Department 754

- NOTES: 1. Dimensions are in inches (Scale: None).
 2. 16 $\sqrt{}$ finish within this dimension.

TENSILE SPECIMEN

For plate, sheet, strip and foil whose section thickness is less than .375 inch.

Figure 1

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- NOTES: 1. Dimensions are in inches (Scale: None).
 (1) 2. Diameters to be concentric within .001 inch.
 (2) 3. 16 $\checkmark$ finish within this dimension.

TENSILE SPECIMEN

For bar and rod whose section thickness is .125 to (but not including) .250 inch.

Figure 2

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- NOTES:
1. Dimensions are in inches (Scale: None).
 2. Diameters to be concentric within .001 inch.
 3. 16 $\sqrt{}$ finish within this dimension.

TENSILE SPECIMEN

For bar and rod whose section thickness is .250 to (but not including) .375 inch.

Figure 3

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- NOTES:
1. Dimensions are in inches (Scale: None).
 2. Diameters to be concentric within .001 inch.
 3. $16 \sqrt{\text{finish}}$ finish within this dimension.

TENSILE SPECIMEN

For any form of material whose section thickness is .375 inch or greater.

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PREPARED BY	CODE IDENT. NO.: 09974	NUMBER ST0170NB0054
P.B.Ferry/P.J.Fessia	ATOMICS INTERNATIONAL <i>A Division of North American Aviation, Inc.</i>	TYPE Material
APPROVALS		DATE November 21, 1967
Engineering Supervisor		SUPERSEDES SPEC. DATED: August 2, 1967
Specification Supervisor		REV. LTR. B
		PAGE 1 of 9

SPECIFICATION

TITLE

TANTALUM-8 TUNGSTEN-2 HAFNIUM ALLOY, SEAMLESS TUBING

Total Pgs. 11

THIS SPECIFICATION IS A BASELINE DOCUMENT

REVISION	DATE	REVISION BY	REMARKS
A	8-2-67	P. J. Fessia	Refer to Summary of Changes
B	11-21-67	P. J. Fessia	Refer to Summary of Changes

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SUMMARY OF CHANGESFor Specification ST0170NB0054Approvals

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<u>Page</u>	<u>Paragraph</u>	<u>Title - Description of Change</u>
3	3.5.1	<u>Tensile Properties</u> The elongation gage length was "2 inches."
5	4.3.3	<u>Tensile Tests</u> Added "in accordance with ASTM E8" to the second sentence. Revised the next to last sentence - it did read: "The tensile specimens shall be prepared in accordance with ASTM E8." Added the last sentence.
9	Figure 1	<u>Tensile Specimen</u> Added the figure.

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SPECIFICATION FORTANTALUM-8 TUNGSTEN-2 HAFNIUM ALLOY, SEAMLESS TUBING

1. SCOPE This specification establishes the requirements for tantalum-8 percent tungsten-2 percent hafnium alloy, seamless tubing.
2. APPLICABLE DOCUMENTS The following documents, of the latest issue, are applicable to this specification to the extent specified. Where the requirements of this specification differ from the requirements of the applicable documents, this specification shall have precedence.

Specifications

NA0115-001	Penetrant Inspection
NA0115-012	Helium Leak Detection
AMS 2243	Tolerances, Corrosion and Heat Resistant Steel Tubing

Standards

ASTM E8	Tentative Methods of Tension Testing of Metallic Materials
ASTM E45	Recommended Practice for Determining the Inclusion Content of Steel
ASTM E92	Standard Method of Test for Vickers Hardness of Metallic Materials
ASTM E112	Methods for Estimating the Average Grain Size of Metals
ASTM E214	Tentative Recommended Practice for Immersed Ultrasonic Testing by the Reflection Method Using Pulsed Longitudinal Waves
FED STD 151	Metal, Test Methods

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3. REQUIREMENTS

3.1 Method of Consolidation The ingot from which the product is produced shall be consolidated by double vacuum melting using the electron beam or consumable electrode arc melting techniques.

3.2 Form The tubing shall be seamless.

3.3 Chemical Composition The composition of the finished product shall conform to the following.

<u>Element*</u>	<u>Minimum</u>	<u>Maximum</u>
Tungsten	7.0	9.0 percent by weight
Hafnium	1.7	2.3 percent by weight
Columbium	---	1000 ppm
Molybdenum	---	200 ppm
Nickel	---	50 ppm
Iron	---	50 ppm
Oxygen**	---	50 ppm
Carbon**	---	30 ppm
Nitrogen**	---	50 ppm
Hydrogen	---	10 ppm
Zirconium	---	1000 ppm
Tantalum	Remainder	

*Any other one impurity shall be less than 100 parts per million (ppm).
The total of other impurities shall not exceed 300 ppm.

**For tubing with a minimum wall thickness of 0.150 inch or less, the maximum content of oxygen, carbon and nitrogen may be increased to 150 ppm, 50 ppm, and 75 ppm, respectively. The balance of the composition shall remain as specified in the table.

3.4 Condition The tubing shall be in the recrystallized condition. Heat treatment in the 2400 to 3000F range shall not be allowed.

3.5 Mechanical Properties

3.5.1 Tensile Properties The tensile properties of the finished tubing shall be as follows:

Ultimate Tensile Strength, psi	80,000 to 110,000
Yield Strength, 0.2 percent offset, psi	65,000 to 85,000
Elongation, in 1 inch, percent	20 minimum

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3.5.2 Hardness The hardness of the tubing shall not be higher than Vickers 280 or equivalent. A hardness traverse shall not show a hardness increase of more than Vickers 50 from the center to the edge of a cross sectional sample of the final product.

3.6 Surface Imperfections Tubing shall be free of surface defects such as slivers, cracks, pits, laps, seams and blisters. Local surface defects may be removed by buffing provided that such conditioning does not violate the minimum gage tolerance. Such removal shall be accomplished prior to final heat treatment.

3.7 Internal Defects There shall be no internal defects in tubing (with wall thicknesses 0.020 inch and over) having indicated areas greater than 0.0031 square inch.

3.8 Microstructure The inclusion count in the longitudinal and transverse plane shall not exceed a No. 0.5 Thin, all Types, as specified in ASTM E45. The grain size in the material shall conform to the following ASTM E112 Micro-Grain Size Numbers:

Wall Thickness, Inch	Minimum Allowable Grain Size No.	Allowable Spread in Grain Size N In Any One Item
0.010 up to 0.187	6	2
0.187 and over	4	2

3.9 Tolerances

3.9.1 Diameter The tolerances for outside diameter shall conform to the following:

O.D., Inch	O.D. Tolerance, Inch
Up to but not including 3/32	+0.002 -0.000
3/32 and up to but not including 3/16	+0.003 -0.000
3/16 and up to but not including 1/2	+0.004 -0.000
1/2 and up to but not including 1-1/2	+0.005 -0.000
1-1/2 and up to but not including 2	+0.006 -0.000
2 and above	As specified on the Procurement Document.

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3.9.2 Wall Thickness The tolerance on wall thickness shall be within ± 10 percent of the thickness specified on the Procurement Document.

3.9.3 Length Length tolerances shall conform to the requirements of AMS 2243.

3.9.4 Straightness Camber in the tubing shall not exceed 0.050 inch per foot.

4. QUALITY ASSURANCE

4.1 Performance of Inspections and Tests The Supplier shall be responsible for the performance of all inspections and tests.

4.2 Lot A lot shall be that quantity of tubing of the same size and wall thickness, produced from the same heat or melt under the same conditions of fabrication and treatment, and submitted for inspection at one time.

4.3 Tests

4.3.1 Examination of Product The tubing shall be carefully examined to determine compliance with surface imperfections and marking requirements.

4.3.2 Chemical Analysis Chemical analysis shall be performed on 2 samples from each finished lot of tubing to determine conformance with the requirements of 3.3. Chemical analysis shall be in accordance with FED STD 151.

4.3.3 Tensile Tests Tensile tests shall be performed on 3 tensile specimens selected at random from the finished tubing in each lot to determine conformance with the requirements of 3.5.1. The tests shall be performed in accordance with ASTM E8 at a rate of strain of 0.002 inch per inch per minute through the yield strength and at a rate of 0.02 inch per inch per minute above the yield strength. The tensile specimens for tubing with an O.D. of 1 inch or over shall be prepared in accordance with Figure 1. The tensile specimens for tubing with an O.D. less than 1 inch shall be full cylindrical sections of tubing whose lengths are $3.12 \pm .03$ inches.

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4.3.4 Hardness Tests Hardness tests shall be performed in accordance with ASTM E92 to determine conformance with the requirements of 3.5.2. Two measurements shall be made on each end of each tensile test specimen.

4.3.5 Penetrant Inspection The O.D. surface of each tube and the I.D. surface, where geometry considerations permit, of each tube shall be inspected in accordance with NA0115-001, Type I, Class 2, or Type II, Class 4 to determine conformance with the requirements of 3.6.

NOTE: The material shall be pickled prior to penetrant inspection. The pickling process shall be subject to A.I. review prior to use.

4.3.6 Ultrasonic Inspection Each tube shall be ultrasonically inspected in accordance with ASTM E214 to determine conformance with 3.7. Techniques of inspection shall be subject to A.I. review.

4.3.7 Micrographic Examination Micrographic examinations shall be performed on 2 specimens selected from each lot of material to determine conformance with the requirements of 3.8. The grain size shall be determined in accordance with ASTM E112 and the inclusion content shall be determined in accordance with ASTM E45, Method C.

4.3.8 Helium Leak Detection Helium leak detection shall be performed on all tubes in accordance with NA0115-012, Rate II.

4.3.9 Rejections Nonconformance to 4.3.2, 4.3.3, 4.3.4, or 4.3.7 shall be cause for retesting 3 additional samples for each test in question. Failure of any one of the 3 samples shall be cause for rejecting the lot of material the sample represents. Items of material not conforming to 4.3.5, 4.3.6 or 4.3.8 shall be cause for rejection of those items.

5. PREPARATION FOR DELIVERY

5.1 Identification Individual tubes or tube bundles shall have attached a metal or plastic tag embossed with at least the following information.

Purchase Order Number
A.I. Specification ST0170NB0054
Manufacturer's Identification
Heat and Lot Number

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In addition, tubes 2 inches and larger in diameter shall be marked in lengthwise rows of characters near both ends with the same information. The characters shall not be less than 3/8 inch in height, shall be applied using a suitable marking fluid, and shall be capable of being removed in solvent cleaning solution without rubbing. The markings shall have no deleterious effect on the material or its performance.

5.2 Packaging The material shall be packed in substantial exterior containers to assure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

5.3 Marking The exterior container shall be marked with at least the following information:

Manufacturer's Name and Address
Point of Delivery (Name and Address)
A.I. Specification ST0170NB0054
Purchase Order Number

6.0 NOTES AND DATA Data submittal shall be in accordance with the requirements of Table I.

6.1 Test Results A certified test and inspection report covering the data taken during acceptance testing shall be submitted. The test report shall include the results from each test specified in Section 4, the purchase order number, the lot and heat number, and A.I. specification number ST0170NB0054.

6.2 Fabrication History Retrievable records containing the following information shall be maintained by the Supplier for a period of 5 years from the date of shipment of the material:

Powder fabrication procedure.

Electrode or feed material consolidation.

Melting practice.

Ingot fabrication schedule (including working temperatures, reduction processes and procedure, heat treatments and conditioning).

Semi finished material fabrication schedule.

Finished material fabrication schedule.

Copies of a report describing the non-proprietary areas of the fabrication sequence shall be prepared for submittal to AI.

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TABLE I
DATA SUBMITTAL REQUIREMENTS

Item Number	Specification Paragraph Number	Title of Data	Type and Quantity	Delivery Date
1	6.1	Test Results	3 copies and one reproducible	At the time of shipment
2	6.2	Fabrication History	3 copies	At the time of shipment

Deliver Data to: Atomics International, Division
North American Aviation, Inc.
Post Office Box 309
Canoga Park, California 91304

Attention: Quality Assurance
Department 754

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- NOTES: 1. Dimensions are in inches (Scale: None).
 2. $\sqrt{16}$ finish within this dimension.

TENSILE SPECIMEN

For tubing with an O.D. of 1 inch or over.

Figure 1

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NORTH AMERICAN AVIATION, INC.
 CODE IDENT. NO. 09974

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C. ULTRA HIGH PURITY HELIUM GAS

The ultra high purity helium specification applies to all LRHSC fabrication and testing operations where an inert gas atmosphere is required. These operations include the TIG welding of refractory metals, all operations after the simulated fueling, and the subsequent biaxial creep testing of these metals at a temperature of 2000°F.

The interesting, if not unusual, feature of the specification is the extreme high purity requirement which specifies that the total active impurities in the gas (hydrogen, oxygen, nitrogen, halogens, carbon dioxide, carbon monoxide and hydrocarbons) shall not exceed 1 ppm.

The need for a high purity helium gas is based on the following technical criterion:

1. To protect tantalum base alloys, especially at high temperatures, from the effects of interstitial pickup. Interstitial pickup changes the mechanical behavior of these alloys.
2. To simulate the purity of helium gas generated by α -decay of a radio-isotope during the LRHSC life cycle.

The minimum helium gas pressure required for creep testing is 6,000 psi. The maximum pressure at which 99.9999 percent pure helium is supplied is 2,200 psi. A gas producer was found who could supply helium gas at a pressure of 6,000 psi with a minimum certified purity of 99.9997 percent. The 3 ppm of impurities in this gas is comprised of 2 ppm active and 1 ppm inactive materials. It is expected, and has been verified by various gas producers, that during the process of boosting the pressure of the 99.9999 purity gas from 2,200 psi to 6,000 psi, there would be an active impurity pickup in excess of 1 ppm. Therefore, exception was made to the specification and the high pressure 99.9997 pure helium gas was selected and purchased for use in conjunction with the LRHSC program. A copy of the suppliers material certification is shown in Figure 2.

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THE LA FLEUR CORPORATION

CERTIFICATE OF COMPLIANCE

THE LA FLEUR CORPORATION, 2001 WEST ARTESIA BOULEVARD, TORRANCE,

CALIFORNIA, CERTIFIES THAT: Helium Gas - Grade 5.5 6000 PSI +

SUPPLIED IN ACCORDANCE WITH Atomics International

PURCHASE ORDER NUMBER: N-7270220 IS EQUAL TO OR

SURPASSES A PURITY OF: 99.9997%

IN ACCORDANCE WITH: P.O. # N-7270220

BY:

(SIGNATURE & TITLE)

DATE: October 13, 1967

Figure 2

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INDUSTRIAL GAS DIVISION
2001 W. ARTESIA BLVD.
TORRANCE, CALIFORNIA, 90504

PHONE : 770-0175

GAS ANALYSIS REPORT

CUSTOMER'S ADDRESS :

DATE : October 13, 1967

North American Aviation/Rockwell Corporation P.O. NO: N-7270220
Atomics International Division
8900 De Soto Street
Canoga Park, California
GAS SAMPLE TO BE ANALYZED : 6000 PSI Plus Helium - Grade 5.5

CONTAINER - CUSTOMER OWNED : _____ SERIAL NO: _____
LA FLEUR OWNED : X SERIAL NO: 1180

ANALYSIS REQUESTED: TOTAL IMPURITIES

DATE CYL. RECEIVED AT LAB: 10-2-67 DATE ANALYZED: 10-2-67

RESULTS : Hydrogen 0.1
Neon 0.7
Oxygen 0.25
Nitrogen 0.26
Moisture 1.3
Hydrocarbon 0.04
ALL OTHER NIL

ACCOUNTING DEPT. COPY :

FIELD TECHNICIAN'S TIME : _____ HOURS : _____ MIN : _____

MILEAGE : _____

MISC. EXPENSES CHARGEABLE TO CUSTOMER : _____

Figure 2

W. T. ...
LABORATORY TECHNICIAN

NAA-SR-12635

PREPARED BY C. Benn E. Benn/P. J. Fessia	CODE IDENT. NO.: 09974	NUMBER ST0110NB0027
APPROVALS J. R. Miller 8/18/67 Engineering Supervisor B. A. [Signature] Specification Supervisor	ATOMICS INTERNATIONAL A Division of North American Aviation, Inc.	TYPE Material
	SPECIFICATION	DATE August 14, 1967
		SUPERSEDES SPEC. DATED:
		REV. LTR.
		PAGE 1 of 3

TITLE

Total Pgs 4

HELIUM GAS, ULTRA HIGH PURITY (99.9999 PERCENT)

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NORTH AMERICAN AVIATION, INC.

CODE IDENT. NO. 09974

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HELIUM GAS, ULTRA HIGH PURITY (99.9999 PERCENT)

1. SCOPE This specification establishes the requirements for ultra high purity helium gas.

2. APPLICABLE DOCUMENTS The following documents are applicable to this specification to the extent specified:

Interstate Commerce Commission Regulations

3. REQUIREMENTS

3.1 Purity The minimum purity of the helium gas shall be 99.9999 percent by volume. Total active impurities shall not exceed 1 ppm. Active impurities include hydrogen, oxygen, nitrogen, halogens, carbon dioxide, carbon monoxide and hydrocarbons.

3.2 Dew Point The dew point of the helium gas shall be at least a minus 110F.

3.3 Pressure The pressure of the gas in the cylinder shall be a minimum of 2,000 psig at 70F.

4. QUALITY ASSURANCE

4.1 Analysis The Supplier shall perform an analysis on the helium gas in each cylinder of gas offered for acceptance to determine conformance with the requirements of 3.1 and 3.2.

5. PREPARATION FOR DELIVERY

5.1 Packaging The helium gas shall be packaged in cylinders conforming to applicable ICC regulations.

5.2 Marking The cylinders shall be marked or tagged with at least the following information:

Purchase Order Number
Manufacturer's Name and Address
Point of Delivery (Name and Address)
AI Specification Number STOLLONB0027
Helium Gas, 99.9999 Percent Pure

6. NOTES AND DATA

6.1 Test Report The Supplier shall submit a certified test report on the results of the tests performed in accordance with 4.1. The report shall include the method of determining the impurity content, the limits of detectability for the various impurities, the equipment used in the overall analysis, and a certificate of calibration (NBS or other) for the analytical equipment used.

6.2 Data Submittal Data submittal shall be in accordance with Table I.

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TABLE I
DATA SUBMITTAL REQUIREMENTS

Item Number	Specification Paragraph Number	Title of Data	Type and Quantity	Delivery Date
1	6.1	Test Results	3 copies and one reproducible	At the time of shipment.
NAA-SR-12635 112				

Deliver Data to: Atomics International Division
North American Aviation, Inc.
Post Office Box 309
Canoga Park, California 91304

Attention: Quality Assurance
Dept. 754

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