



TITANIUM
 SALES, CONVERSION
 FORGING, ROLLING

CERTIFICATION

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| GRADE | SIZE / QUANTITY | MELT SOURCE / HEAT NUMBER |
|---------------|--|---------------------------|
| Ti 6Al-4V ELI | Dim:(ST)7.500" x (LT)7.500" 4.479 Lbs | RTI-Niles 8G56530 |

SPECIFICATIONS

AMS-6932B

COMPLIANCE STATEMENTS

No weld repair. Mercury free during processing.
 No exposure to radioactive materials.
 Material Safety Data Sheets (MSDS) available upon request
 Melt source - RTI International. Melt method: 2X VAR.
 Chemistry performed by RTI International
 Final product testing performed by Product Evaluation Systems, Inc.
 Bar product was produced from purchased raw material at TSI Titanium by open die forging. Descaled and grit blasted surface finish to tolerances of +0.375", - 0.00" for the ST and LT dimensions
 Product conforms to the technical requirements of the specification(s) and the requirements of the purchase order.
 Melted and manufactured in the United States. Product complies with DFARS 252.225-7008, 252.225-7009, and 252.225-7014, Alt 1
 TSI Titanium has complied with all producer requirements of AS6279A (4.1.3)

HEAT TREAT CONDITION

Annealed per AMS-H-81200D: 1300F, 2.00 hours at temperature. Air-Cooled.

TSI Titanium is Nadcap accredited for Heat Treating and can be found on the Nadcap Qualified Manufacturers List.

METALLOGRAPHY

Macro and micro acceptable per applicable specifications.
Alpha case free.

Cross section is outside the scope of the mechanical and metallographic requirements for the listed specification.
All reported results are informational and not cause for rejection.

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NON-DESTRUCTIVE TESTING

Immersion ultrasonic acceptable per:

AMS-2631E CL. A

AMS-STD 2154C Type 1. CL. A

MIL-STD-2154 Type 1 CL. A

NAS 824 Rev. 1 Gr. A

Inspection performed by West Penn NDT.

Reported rejected areas have been removed. These were primarily the as-forged ends.

HEAT NO.: 8G56530

CHEMICAL ANALYSIS - WGT%

| | C | Mn | P | S | Si | Cr | Ni | Cu | Mo | W | Fe |
|---|-------|------|------|------|-------|----|----|---------|------|--------|---------|
| T | 0.007 | | | | | | | | | | 0.177 |
| B | 0.006 | | | | | | | | | | 0.151 |
| | Co | Ti | Al | V | N | Zr | Sn | B | O | H | Y |
| T | Bal. | Bal. | 5.93 | 3.84 | 0.004 | | | <0.0010 | 0.11 | 0.0004 | <0.0010 |
| B | Bal. | Bal. | 5.95 | 3.84 | 0.004 | | | <0.0010 | 0.11 | 0.0010 | <0.0010 |

Beta Transus: T- 1793 B-1793

PHYSICAL ANALYSIS

| ID | UTS | .2%YS | % ELONG | | %RA | Hardness | Hyd Final - % |
|-------|---------|---------|-----------|-----------|------|----------|---------------|
| | PSI | PSI | Elong 4 D | Elong 5 D | | | |
| B1x3L | 122,900 | 111,500 | 18.6 | 16.2 | 32.8 | 30 HRC | 0.0017 |
| B1x3T | 126,100 | 113,700 | 11.6 | 11.4 | 26.4 | | |
| T2x3L | 123,700 | 110,400 | 15.1 | 12.5 | 29.9 | | 0.0042 |

BY: *Mark P. Sobota* 7/31/2018

Mark P. Sobota - Executive Vice-President, QA



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1010 Industrial Blvd.
 New Kensington, PA 15068
 Ph 724-334-1900
 Fax 724-334-9785
 info@westpenntesting.com

Ultrasonic Inspection Report

PO: 128210
 Size: 7.5 x 7.5
 Material: Ti 6-4 ELI
 Order #: 180706
 Heat #: 8G56530



Net Weight: 8501

Type of Test: UT Immersion
 Specifications: AMS 2631 Rev E Class A, MIL-STD-2154 N/C Type 1 Class A, AMS-STD-2154 Rev C Type 1 Class A, NAS 824 Rev 2 Grade A
 Procedure: WP-UT-12 Rev 9
 Acceptance: WP-UT-12 Rev 9 Class A

| Total Pieces Inspected | Pieces Accepted | Pieces Rejected | Reason for Rejection |
|------------------------|-----------------|-----------------|----------------------|
| 8 | 0 | 8 | See Maps |

The recording of false, fictitious or fraudulent statements or entries on this document may be punishable as a felony under Federal Statutes including Federal Law, Title 18, Chapter 47.
 During the test and inspections, the products furnished against this order have not come in direct contact with asbestos, mercury, or any of its compounds nor with any mercury-containing devices employing a single boundary of containment.
 Testing complies with the specifications listed. Inspection records and special process records are on file and available for review.

Inspector: JSchultheis UT Level 2
 Inspection Date(s): 7/24/2018, 7/25/2018, 7/26/2018, 7/27/2018

Respectfully submitted,

Gregg Pompe NDT Level 3
 WEST PENN TESTING GROUP, INC.
 Please send your comments and concerns to us at feedback@westpenntesting.com



RMI Titanium Company, LLC d/b/a RTI Niles
 A subsidiary of Arconic, Inc.
 Arconic Titanium and Engineered Products
 1000 Warren Ave.
 Niles, OH 44448

30253296 8G56530-01-00

Test Report

ORDER DETAILS

MATERIAL DETAILS

SHIPPING DETAILS

Packing List: 80611369
 Size: 12.500in/317.5 mm
 No. of Pieces: 4
 Piece ID's: B1, T2, T1, B2
 Weight (lbs): 17522 lbs/7,948 kg
 Test Piece: No
 Test Piece Qty: 0
 Customer Test Piece Size: N/A
 Test Piece ID: N/A

Alloy: TI 6-4 ELI
 Melt Method: 2x VAR
 Final Melt Location: Niles, OH, USA
 Final Melt Date: 4/6/2018
 Heat-Lot-SR: 8G56530-01-00
 Material: Forged, Conditioned Ti Bloom
 Ingot Diameter: 36in dia./914.4 mm dia.
 Sponge Source: Osaka



SPECIFICATIONS:

AMS 4930H Chemistry Only, AMS 6932C Chem Only, AMS-T-9047 May 2003 Ti-6Al-4V Chemistry Only, ASTM B348-13 Grade 23 Chemistry Only, ASTM F136-13 Chemistry Only, MIL-T-9047G Am 2 Not. 1 2/8/93 Ti-6Al-4V ELI Chemistry Only, ZES 2A-81R Chemistry Only, PWA 300BP, PWA F-17C 7/1/15, S-1000 5/23/17, S-400 6/3/16

Exceptions: None

FPA'S: N/A

MELTING ONLY FPA'S: N/A

CONCESSIONS/ APPROVALS:

None

Ingot Chemistry

| Element | Top | Center | Bottom | Method | Limits |
|------------------------------|-------|--------|--------|---------------|--------------------|
| O (%) | 0.11 | 0.12 | 0.11 | ASTM E1409-13 | 0.13 max |
| N (%) | 0.004 | 0.004 | 0.004 | ASTM E1409-13 | 0.03 max |
| C (%) | 0.007 | 0.006 | 0.006 | ASTM E1941-10 | 0.08 max |
| Fe (%) | 0.177 | 0.151 | 0.151 | ASTM E2994-16 | 0.25 max |
| Al (%) | 5.93 | 5.96 | 5.95 | ASTM E2994-16 | 5.50 min, 6.50 max |
| V (%) | 3.94 | 3.75 | 3.84 | ASTM E2994-16 | 3.50 min, 4.50 max |
| B (ppm) | <10 | <10 | <10 | ASTM E2994-16 | 50 max |
| Y (ppm) | <10 | <10 | <10 | ASTM E2994-16 | 50 max |
| Residual Elements, Each (%) | <0.05 | <0.05 | <0.05 | ASTM E2994-16 | 0.10 max |
| Residual Elements, Total (%) | <0.30 | <0.30 | <0.30 | ASTM E2994-16 | 0.30 max |
| Ti | BAL. | BAL. | BAL. | ASTM E2994-16 | - |

Product Chemistry

| Element | T1 MR | B1 MR | Method | Limits |
|---------|-------|-------|---------------|---------|
| H (ppm) | 4 | 10 | ASTM E1447-09 | 120 max |

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ARCONIC

RMI Titanium Company, LLC d/b/a RTI Niles
A subsidiary of Arconic, Inc.
Arconic Titanium and Engineered Products
1000 Warren Ave.
Niles, OH 44446

30253298 8G56530-01-00

Test Report

Beta Transus - DTA +/- 10 F (+/- 6 C)

| Property | T1 | B1 | Limits |
|------------------|--------|--------|--------|
| Beta Transus (F) | 1793 F | 1793 F | - |
| Beta Transus (C) | 978 C | 978 C | - |

Certification Statements

Material has no weld repair.
 Material is free of mercury, radium, luminous or alpha source materials.
 Unless stated otherwise, all testing performed at RTI Niles, Niles, OH, USA
 Material/Parts controlled to P&W reqs. for LCS per P&W-MCL section F-17
 Tested at an approved GE source satisfying the requirements of S400
 Testing performed in accordance with MCL manual section F-23

Bill Colletta

Bill Colletta

Certifications Specialist

Date: 6/27/2018



PRODUCT EVALUATION SYSTEMS, INC.

637 Donohoe Road, P.O. Box 722, Latrobe, PA 15650

www.PES-Testing.com

PHONE 724-834-8848 FAX 724-834-9151

July 19, 2018



Subject: Microstructural and Macrostructural Evaluation of Titanium Samples

Identification: Techspec, Inc. PO# 128211

PES ID# 93585-560-P259 thru P263

Sample Identification: Material: 6-4 ELI, Heat#: 8G56530, WO# 180706, Size: 7.500" Sq.,
Condition: Annealed

PES Sample ID#: P261 (Disc B1x3), P262 (Disc B1x3), & P263 (Disc B1x3x)

Date Sample Rec'd: 7/16/2018

Dear Mark,

As per above subject and identification, the sample was sectioned, mounted, polished, etched and evaluated per identified specifications for microstructure, alpha case, and macrostructure.

Microstructure Examination:

Typical photomicrographs of Disc B1x3 taken at mid-radius illustrating a microstructure of equiaxed and elongated primary alpha (white areas) in a transformed beta matrix (dark areas) with no continuous network of alpha at prior beta grain boundaries. The specimen is considered to be in conformance with AMS 6932B. PES Etch: ET1 (Krolls)

Alpha Case Examination:

Photomicrographs of Disc B1x3 taken near surface in transverse direction. No evidence of alpha case or other surface contaminations was observed. The sample is in conformance with AMS 6932B. The sample was prepared in accordance with ASTM E3-11 (17) and is considered acceptable. PES Etch: ET1

Macrostructure Examination:

Macrophotographs of Disc B1x3 and Disc B1x3x cross sections taken in transverse direction. The samples were etched in a solution of 300ml of H₂O, 42g HNO₃, and 18g of HF at room temperature for a period of 5 minutes. The procedure was done in accordance with AMS 2643E and is in conformance with AMS 6932B.

If you have any questions, please call me (724-834-8848).

Sincerely,

Tara Matson
Lab Technician



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CHEMICAL ANALYSIS TEST REPORT

PES ID.: 93585-560-P259 thru P263

PO #: 128211

TEST: Chemical Analysis

Methods(s): ASTM E1447-09(16); PES-C012



DATE REC'D: 7/16/2018

DATE: 7/17/2018

Notes: Specs per AMS 6932B Standards utilized for analysis: AR 649, LECO 502-135

Work Performed By: _____

Erin St. Mars, Chemist

Results as reported: Conforming Non-Conforming

Material: 6-4 BLI 7.500" Sq.

| LAB ID: 93585 P259 | ANALYSIS | RESULT | METHOD | SPEC | DATE | TIME | TECH |
|---|----------|--------|----------------|-------|----------|-------|------|
| Customer Sample ID: | Hydrogen | 17 | PPM E1447 LECO | ≤ 125 | 07/17/18 | 10:41 | ES |
| Sample ID: Bar B1x3 Heat#: 8G56530 WO#: 180706 Condition: Annealed | | | | | | | |

MECHANICAL, METALLOGRAPHIC, NONDESTRUCTIVE, CHEMICAL TESTING, AND CONSULTANT SERVICES



ISO 17025



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637 Donohoe Road, P.O. Box 722, Latrobe, PA 15650

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PHONE 724-834-8848 FAX 724-834-9151

CHEMICAL ANALYSIS TEST REPORT

PES ID.: 93585-560-P259 thru P263

PO #: 128211

TEST: Chemical Analysis

Methods(s): ASTM E1447-09(16); PES-C012



DATE REC'D: 7/16/2018

DATE: 7/17/2018

Notes: Specs per AMS 6932B Standards utilized for analysis: AR 649, LECO 502-135

Work Performed By: *Eric St. Mars*

Eric St. Mars, Chemist

Results as reported: Conforming Non-Conforming

Material: 6-4 ELI 7.500" Sq.

| LAB ID: 93585 P260 | ANALYSIS | RESULT | METHOD | SPEC | DATE | TIME | TECH |
|---|----------|--------|----------------|-------|----------|-------|------|
| Customer Sample ID: | Titanium | 42 | PPM E1447 LECO | ≤ 125 | 07/17/18 | 10:55 | ES |
| Sample ID: Bar T2x3 Heat#: 8G56530 WO#: 180706 Condition: Annealed | | | | | | | |

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M E C H A N I C A L T E S T R E P O R T

PES ID.: 93585-560-P259 thru P263

PO #: 128211

TEST: Mechanical Properties

TESTING SPEC.: ASTM E8-16a, E18-17e1

TEST EQUIPMENT: U12, E25, H01

MAT'L/SPEC.: 6-4 ELI

DIMENSION: 7.500" Sq.

NOTES: AMS-6932B (Reference)

DATE RECD: 7/16/2018

DATE: 7/18/2018

TESTED BY:

Matthias Maruschok
Mat Maruschok, Lab Technician



CONFORMANCE/NONCONFORMANCE/AS REPORTED: As Reported

| CUSTOMER BAR ID: | Bar B1x3 | Bar T2x3 | Disc B1x3 |
|-------------------------------------|--------------|--------------|------------|
| CUSTOMER HEAT NO.: | 8G56530 | 8G56530 | 8G56530 |
| CONDITION: | Annealed | Annealed | Annealed |
| TSI WORK ORDER: | 180706 | 180706 | 180706 |
| SPECIMEN ORIENTATION: | Longitudinal | Longitudinal | Transverse |
| PES SPECIMEN ID: | P259 | P260 | P261-1 |
| Original Specimen Diameter (inches) | 0.349 | 0.350 | 0.352 |
| Ultimate Tensile Strength (ksi) | 122.9 | 123.7 | 126.1 |
| 0.2% Offset Yield Strength (ksi) | 111.5 | 110.4 | 113.7 |
| Upper Yield Strength (ksi) | | | |
| Original Gage Length 4D (inches) | 1.400 | 1.400 | 1.400 |
| Elongation Increase 4D (%) | 18.6 | 15.1 | 11.6 |
| Original Gage Length 5D (inches) | 1.750 | 1.750 | 1.750 |
| Elongation Increase 5D (%) | 16.2 | 12.5 | 11.4 |
| Reduction of Area (%) | 32.8 | 29.9 | 26.4 |
| Test Comment Code(s) | N | N | N |
| CUSTOMER BAR ID: | Disc B1x3 | | |
| PES SPECIMEN ID: | P261-2 | | |
| Hardness (mid-radius) | 30 HRC | | |
| Test Comment Code(s) | N | | |

N = No comment(s).

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