



Plymouth Engineered Shapes

Plymouth Tube CO USA

201 Commerce Court
Hopkinsville, KY. 42240
Office: 270-886-6631
Fax: 270-885-7034, email: hquality@plymouth.com

PRINTED COPY CONTROLLED ONLY IF STAMPED

HV-3 Rev 15

Revision date: May 23, 2024

Approved by: Kendall Joiner PES Quality Manager
Phani Gudipati -PTC Director, Innovation & Engineering

TITANIUM ROUNDS FOR EXTRUSION STOCK

1.0 SCOPE

- 1.1. This specification covers titanium round bars purchased in long length or pre-cut billets to be used for extrusion of hollow and solid shapes.

2.0 BASIS OF PURCHASE

- 2.1. Purchase Orders for material under this specification shall include the following, as required to describe the desired material adequately:
 - 2.1.1. Size (outside diameter)
 - 2.1.2. Length
 - 2.1.3. Weight (pounds)
 - 2.1.4. Surface finish (finished turned, finished ground) (See paragraph 3.1)
 - 2.1.5. Grade (Table 1 Chemical Composition, or as specified on the Purchase Order)
 - 2.1.6. Specification(s)
 - 2.1.7. Condition
 - 2.1.8. Packaging
 - 2.1.9. Special Requirements

3.0 SURFACE CONDITION / FINISH

- 3.1. Titanium bars are to be furnished Forged and Turned.
 - 3.1.1. Polishing of the bar is allowed, provided "SURFACE FINISH" requirements (3.1) are maintained.
- 3.2. Surface finish will range Ra-40 min – Ra 125 max., measured by use of a profilometer.

4.0 CHEMICAL COMPOSITION

- 4.1. Suppliers may have options in supplying material to meet our chemistry requirements. The supplier may either provide material which conforms to the chemical composition requirements prescribed in Table 1, or, for **6-4 Titanium**, the supplier may provide material which meets requirements of AMS 4935 or AIMS03-18-011 based on application **and** has a minimum Oxygen Equivalent (OE) of 0.25 based on the formula (using the minimum certified value of weight percentage for each element or constituent):

4.1.1.1. Oxygen Equivalent = Oxygen + (3 X Nitrogen) + (1.8 X Carbon)

4.1.1.2. or as may be specified on our purchase order. Regardless of acceptance method used, the chemistry (per Table 1) is to be reported in a certified test report, referencing the acceptance method used (if OE is utilized, calculation must be included)

4.1.2. Target values of chemistry and Oxygen Equivalent, where provided, represent identified optimal ranges that are compatible with PES processing.

5.0 MELT PRACTICE

5.1. Alloy shall be multiple melted.

5.1.1. The first melt shall be made by vacuum consumable electrode, nonconsumable electrode, electron beam cold hearth, or plasma arc cold hearth melting practice.

5.1.2. The subsequent melt or melts shall be made using vacuum arc remelting (VAR) practice.

5.1.3. Scrap / Alloy additions are only allowed in the first melt.

6.0 ULTRASONIC INSPECTION

6.1. Material Test Report must list ultrasonic procedure/technique, scan plan, and their date of issue.

6.2. Ultrasonic inspection must certify to the following specifications as a minimum, plus any other ultrasonic specification referenced on our purchase order.

6.2.1. AMS-Std-2154.....Type 1 Class A for (5" Diameter - 9 1/2" Diameter)

6.2.2. AMS 2631..... Class A for (5" Diameter – 9 1/2" Diameter)

6.2.3. Note: Either of the above specifications meet the requirements of AITM-4003 when specified.

7.0 PERMISSIBLE VARIATIONS IN DIMENSIONS OF ROUNDS

7.1. Outer diameter readings required from the Front, Middle, and Back of each bar.

NOTE: Correlate the bar length/s with the diameter reading/s.

7.2. Bar lengths shall be written on outer diameter of one end of each bar.

7.3. Variations in outside diameter shall not exceed amounts prescribed in Table 5.

7.4. The outside diameter shall be uniform from one end of a bar to the other and shall not vary more than .005" in any 2 feet (an exception will be made for grind-out of defects).

8.0 CUT LENGTH TOLERANCE of PRE-CUT BILLETS

8.1. Tolerance of + / - 1/16" on length.

8.2. Ends of billet shall be cut square within 1/2°. Cupped ends are not acceptable.

9.0 LENGTH of BAR

9.1. Random length range is from 10 feet minimum to 30 feet maximum. (Max of 4,100 lbs. Per bar)

9.1.1. Shorts less than 10 feet subject to negotiation.

9.2. When multiple lengths are specified, a cutting allowance of plus 1/4-inch will be required.

9.3. Ends of bar shall be machined or abrasive cut. Cupped ends are not acceptable.

10.0 STRAIGHTNESS

10.1. The deviation from straightness shall not exceed amounts shown in Table 6.

11.0 PACKAGING for BAR

- 11.1. Unless otherwise specified, material will be shipped bare.
- 11.2. Bars shall be banded together not to exceed 2 bars per bundle or 6000 pounds per bundle.
- 11.3. Bundles and/or bars shall be placed on blocks to allow clearance underneath the ends for ropes to facilitate unloading.
- 11.4. Blocks shall be placed between each bundle to allow clearance on the sides for ropes to facilitate unloading.

12.0 IDENTIFICATION

- 12.1. Each bar shall be identified on one end minimum by metal stamping / engraving using 1/4", (6 mm), or larger characters as to grade and heat number.
- 12.2. Tag or stencil with producer's name or brand, and purchaser's order number shall identify each bundle or lift.

13.0 WORKMANSHIP

- 13.1. Bars shall have smooth ends free from burrs. Bars shall be free from injurious defects.

14.0 Reports

- 14.1. The material shall conform to the requirements of the material grade / specification of the purchase order as evidenced by a certified test report that includes as a minimum:
 - 14.1.1. Purchase Order Number
 - 14.1.2. Producer identity and address.
 - 14.1.3. Description
 - 14.1.3.1. Grade / Alloy
 - 14.1.3.2. Surface Condition (Cold finished turned, ground, hot finished, etc.)
 - 14.1.3.3. Size (diameter)
 - 14.1.3.4. Weight
 - 14.1.4. Heat Number / ID
 - 14.1.5. Chemical composition (Table 1)
 - 14.1.5.1. Where Oxygen Equivalent is used for acceptance (see 4.0), Oxygen Equivalent calculation is to be reported.
 - 14.1.6. Beta Transus
 - 14.1.7. Mechanical Properties (as applicable to specification)
 - 14.1.8. Bars must be free from Alpha Case.
 - 14.1.9. Applicable material and test specifications.
 - 14.1.10. Method of manufacture including melt practices (see section 5.0).
 - 14.1.11. Country where the metal was melted (final melt)
 - 14.1.12. Ultrasonic Inspection Results (see 6.0)
 - 14.1.13. Material to be certified MERCURY FREE.
 - 14.1.14. Where an end customer approved Manufacturing Route / Plan is applicable, the Test Report shall provide reference for that approval.

15.0 Revision History:

- 15.10. Changed numbering sequence from HV-3-08 to HV-3 Rev #. Also, added 5" billet to ranges in sections 5.2.1 and 5.2.3.
- 15.11. Changed section 7 and renumbered to add Cut Length Tolerance of Pre-Cut Billets
- 15.12. Changed the Header and 5.2.2/3 to Class A
- 15.13. Added 4.1.1 to reference Target Ranges added to Table 1 for C, Fe, N and O, and to SPEC-00010

provide guidance for monitoring. Corrected formatting in Table 1.

- 15.14. Clarified surface roughness requirements (3.1). Provided two ways to meet chemistry requirements for 6-4 Titanium (chemistry or Oxygen Equivalent – 4.1). Modified 4.1.1 to no longer include the “not a basis for rejection” clause: if targets are not met. Added 10.1.1 allowing polishing of the bar provided 3.1 is met. Redefined chemical requirements for 6-4 and 6-6-2 alloys. Added 7.875” billet diameter.
- 15.15. 3.0 Combined 3.0 / 11.0 Surface Finish / Condition. And removed “S 13 MICRO FINISH COMPARATOR” from requirements leaving min / max Ra values. 4.1 Added clarification for Element and OE calculation reporting. Moved 4.2, 4.3, and 4.4 to section 14.0 “Reports” 5.0 – New Section, Added Melt Practice requirements; 6.0 (was 5.0) – Revised UT requirements to 5” ~ 9 ½” dia. Only. 12.1 – added engraving. 15.0 – Added section for Minimum Test Report requirements.
- 15.15.1. Correction made to AMS2631 requirement. Changed from Class A1 to Class A.

TABLE #1
ALPHA-BETA TITANIUM ALLOY CHEMICAL REQUIREMENTS

<u>ELEMENT</u>	<u>6-4</u>	<u>6-6-2</u>	<u>6-4 (ELI)</u>
ALUMINUM	6.30 / 6.70	5.2 / 6.0	5.50 / 6.50
VANADIUM	3.75 / 4.25	5.0 / 6.0	3.50 / 4.50
TIN	-----	1.8 / 2.5	-----
COPPER	-----	0.60 / 1.00	-----
IRON	0.18 / 0.22	0.60 / 1.00	0.25 max
OXYGEN	0.17 / 0.20	0.17 / 0.20	0.13 max
CARBON	0.02 / 0.03	0.02 / 0.05	0.08 max
NITROGEN	0.015 / 0.025	0.020 / 0.04	0.05 max 500 ppm
HYDROGEN	0.0125 max 125 ppm	0.015 max 150 ppm	0.0125 max 125 ppm
YTTRIUM	0.005 max 50 ppm	0.005 max 50 ppm	-----
RESIDUAL ELEMENTS	0.10 max each	0.10 max each	0.05 max each
RESIDUAL ELEMENTS	0.40 max total	0.30 max total	0.30 max total
TITANIUM	balance	balance	balance

TABLE 5
PERMISSIBLE VARIATIONS IN DIMENSIONS

OUTSIDE DIAMETERS		
<u>OUTSIDE DIAMETER</u>	<u>TOLERANCE</u>	<u>OVALITY</u>
5.030" (127 mm)	Plus or Minus .030" (0.76 mm)	Not to exceed .058" (1.47 mm)
6.030" (153 mm)	Plus or Minus .030" (0.76 mm)	Not to exceed .062" (1.58 mm)
7.090" (180 mm)	Plus or Minus .030" (0.76 mm)	Not to exceed .062" (1.58 mm)
7.875" (200 mm)	Plus or Minus .030" (0.76 mm)	Not to exceed .062" (1.58 mm)
8.250" (210 mm)	Plus or Minus .030" (0.76 mm)	Not to exceed .062" (1.58 mm)
8.750" (222 mm)	Plus .060" (1.52 mm) Minus .00	Not to exceed .062" (1.58 mm)
9.250" (235 mm)	Plus .060" (1.52 mm) Minus .00	Not to exceed .062" (1.58 mm)

TABLE 6
STRAIGHTNESS TOLERANCE

1/8" in any 5 feet but not to exceed: $(1/8" \times \text{Number of feet in length}) / 5$
