



Transmittal of Billet Defect Data on Premium Quality Titanium

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This specification is in addition to and in no way limiting, superseding, or abrogating any contractual obligation as required by the applicable procurement document.

1 PURPOSE

- 1.1 This specification will establish procedures for the transmittal of maps showing the location of ultrasonic indications or other abnormalities in billet to the Purchaser. These maps are required to assess the proper inspection of forgings to assure that only sound, void free, non-segregated material is used in critical applications.

2 SCOPE

- 2.1 This specification shall apply to premium quality titanium alloys, which are converted from ingot to billet.
- 2.2 This specification will apply only when referenced on the Purchase Order.
- 2.3 This specification is in addition to and in no way limits, supersedes, or abrogates any contractual obligations as required by Purchase Order, drawings or applicable specifications.
- 2.4 This specification will become a contractual agreement, effective upon acceptance by the supplier of a Purchase Order document, which incorporates it.
- 2.5 The Purchaser reserves the right to revise this specification. Such revisions shall be binding upon the Sellers acceptance of them after notification through Purchase Order or a supplement there to.

3 DEFINITIONS

- 3.1 Billet - Converted material having a cross section greater than 16 square inches (103 cm²), and a width less than five times the thickness.

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- 3.2 Billet Map - Pictorial indication of abnormalities in a forging billet. This map is constructed by the conversion source following inspection of the billet.
 - 3.3 Cut-Out - Portion of billet removed due to abnormalities identified by billet inspection which are not contained in the standard crops made by the conversion source.
 - 3.4 Heat - The ingot and ingot product of the final VAR of a single consumable electrode.
 - 3.5 High Density Inclusion – A region with a concentration of elements, usually tungsten, niobium or molybdenum, having a higher density than the matrix.
 - 3.6 Macroetch - Etching of a metal surface for accentuation of gross structural details, segregation and defects to be examined at 1x magnification.
 - 3.7 Premium Quality Material - Material purchased, manufactured, and inspected per the appropriate P1TFXX specification.
 - 3.8 Purchaser - The procuring activity of GE Aviation that issued the procurement document invoking this specification.
 - 3.9 Segregation – Regions in the alloy product containing an out of specification content of alloying elements which result in an out of specification microstructure. These segregated regions appear as zones of microstructural variation where the morphology or volume fractions of the alpha and beta phases are discernibly different from the matrix.
 - 3.10 Standard Crop - Standard stock removal for top and bottom ingot effects and billet end effects. The conversion source and the purchaser shall agree upon the size of the standard crop.
 - 3.11 Type I (Hard Alpha Inclusion)- An interstitially stabilized alpha-rich region of significantly higher hardness than the surrounding matrix. It arises from a high and out of specification concentration of one or more of the elements: nitrogen, oxygen, or carbon, which is not explained by partitioning. Also known as a High Interstitial Defect (HID) or a Low Density Inclusion (LDI).
 - 3.12 Type II (Aluminum Stabilized) Alpha Segregation - An aluminum rich alpha stabilized region containing an abnormally large amount of aluminum which may extend across a large number of beta grains. Also known as High Aluminum Defects (HAD).
- 4 PROCEDURE
- 4.1 Billets will be ultrasonically inspected per the appropriate plan. Rejectable ultrasonic indications will be removed and evaluated per the purchaser-approved plan. Removed indications will be indicated on the billet map. Sufficient inspection shall be performed to assure all defects revealed by ultrasonic inspection have been completely removed.



- 4.2 Macroetch slices or the faces of the billet adjacent to the cropped areas shall be given a suitable finish, etched and examined for voids, cracks, inclusions, Type I or Type II segregation, beta flecks and other defects. The general macrostructure shall also be examined. The purchaser shall approve Macroetching procedures and standards. Surfaces shall be free of defects.
- 4.3 Cropping will continue until the billet ends are free from indications as determined by macroetch inspection. Excessive cropping shall be reported to the Purchaser per the requirements of the applicable process specification (P1TFXX).
- 4.4 A billet map will be constructed by the conversion source in accordance with [Appendix I](#). This map will be filed and made available to GE Aviation personnel on request.
- 4.5 Material disposition will be made to the provisions of the appropriate specifications. All cutouts will be evaluated in accordance with the appropriate specification requirements and/or the Quality Agreement and indicated for size and cause on the Billet map.

5 RESPONSIBILITIES

- 5.1 The forging supplier will be responsible for:
 - 5.1.1 Obtaining billet maps from their suppliers or making such maps if the ingot is converted in-house.
 - 5.1.2 Checking each map to assure the quality level is adequate for application to the appropriate P1TFxx material specification. Evaluate melting records for cause determination on heats deemed questionable.
- 5.2 The conversion source will be responsible for:
 - 5.2.1 Generating billet maps for all premium quality billet converted from ingot.
 - 5.2.2 Maintain billet inspection records for all premium quality billets.
 - 5.2.3 Making billet maps and inspection records available for GE Aviation audits.



APPENDIX I

BILLET MAP PREPARATION

All billet maps for premium quality material will be constructed to include the information identified below. The actual format of the billet map will be left to the discretion of the conversion source. Billet maps shall include the following:

MELT SOURCE(S)	INGOT SIZE (DIA.)
CONVERSION SOURCE(S)	BILLET SIZE (DIA.)
MATERIAL NAME	U/T DATA INCLUDING:
MATERIAL SPEC.(S)	TYPE OF U/T -IMMERSION OR
HEAT NO.(S)	CONTACT
INGOT NO.(S)	TRANSDUCER DIAMETER
BILLET NO.(S)	TRANSDUCER FREQUENCY
FINAL MELT DATE	REJECT LIMIT SIZE -I.E. #FBH
ULTRASONIC INSPECTION SOURCE	
ULTRASONIC SPECIFICATION(S)	

In addition, the billet maps shall include the following information for each billet.

- 1.) Billet Location - Billet location is defined as the location of the billet with respect to the remelted ingot from which it was made.
- 2.) Section removed for a reason to be identified as listed below:
 - a. Diversion of billet product to a non-premium quality (non-P1TFXX) application.
 - b. Diversion of billet product to another customer.
 - c. Ultrasonic indication by cause, such as clean porosity, Type II segregation (aluminum stabilized), Type I segregation (oxygen/nitrogen stabilized), high-density inclusions, cracks, microstructural variations, or no defects found.
 - d. Macroetch discrepancies such as Type I segregation, Type II segregation, grain size variations, cracks, porosity and other deleterious inclusions or segregation.
 - e. Visual defects such as end enfoliation or cracks.
 - f. Dimensional variations in the billet. This includes variations in diameter size or short billet sections.
- 3.) The location of the removed sections along the length of the billet shall be shown as distances in inches from a zero location at the bottom of the billet (See [Figure 1](#)).



FIGURE 1

- 1 Billet Location per Appendix I [Paragraph 1](#)
- 2 SECTION REMOVED - IDENTIFIED PER Appendix I [PARAGRAPH 2](#)
- 3 DISTANCE ALONG BILLET PER Appendix I [PARAGRAPH 3](#)

