

**Ministry of Defence  
Defence Procurement Agency, ADRP2  
Abbey Wood  
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BS34 8JH**

## **OBSOLESCENCE NOTICE**

All DTD specifications were declared obsolescent from 1<sup>st</sup> April 1999. All DTD 900 series approvals also lapsed at that time. The standards will no longer be updated but will be retained as obsolescent documents to provide for the servicing of existing equipment.

### **Further Guidance**

The aim in declaring the specifications obsolescent is to recognise that the documents are not being updated and thus should be used with care by both purchaser and supplier. For example, a specification could contain valid technical information but may also contain type approval clauses that contradict procurement policy and/or use materials that do not comply with environmental legislation. The obsolescent specification can still be used as a basis for a purchase provided that the supplier and purchaser agree suitable changes to the specification within the purchase order/contract.

For the DTD 900 system, each specification has provided an MoD approved material and process. For these items, the declaration of obsolescence will constitute the termination of both the extant MoD approval and the continuing MoD assessment that had underpinned those approvals. Again, the technical content of the document remains valid and can be used by both purchaser and supplier as a basis for a contract but an acceptable (to the parties) approval/assessment procedure would be required.

**Aerospace Material Specification**

**INSPECTION AND TESTING PROCEDURE FOR TITANIUM  
ALLOY RE-MELTING STOCK AND CASTINGS**

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*NOTE: This specification is one of a series issued by the Procurement Executive, Ministry of Defence to meet a requirement not covered by an existing British Standard for aerospace material.*

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**Foreword:** This specification covers the general inspection and, testing requirements for titanium and titanium alloy castings.

It is primarily for use in conjunction with related material specifications in the Procurement Executive, Ministry of Defence DTD series and Materials Department, Royal Aircraft Establishment, Farnborough approved specifications, but may also be used with other material specifications by agreement between the purchaser and the manufacturer. Additional special requirements may be agreed between the parties concerned.

This specification makes reference to the following specifications:

British Standard A4 - "Test pieces and test methods for metallic materials for aircraft". British Standard M34-"Method of preparation and use of radiographic techniques". Ministry of Defence Specification DTD 929 - "Penetrant methods of flaw detection."

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## 1. GENERAL REQUIREMENTS

*NOTE 1:* Where reference is made to other specifications the latest issue shall be used.

*NOTE 2:* In this specification, whenever agreement between the manufacturer or founder and the purchaser is required, the onus is on the purchaser to obtain the concurrence of the parent design firm to such agreement: if such concurrence is mandatory the word purchaser is marked with an asterisk (\*).

### 1.1 Foundry Approval

Special Foundry Approval may be required before titanium alloy castings to this specification can be supplied for military aerospace use. The purchaser\* is responsible for determining whether Special Foundry Approval is required in order to conform with current design requirements.

### 1.2 Definitions

For the purpose of this standard the following definitions apply:

1.2.1 Batch: Castings to the same pattern produced from the same melt and, if heat treated, heat treated together. Castings to left-hand and right-hand version of any pattern are considered as being to the same pattern.

1.2.2 Cast: The product of a single furnace charge used to produce remelting stock.

1.2.3 Designated Area: Highly stressed or otherwise important region of a casting, the location of which is determined by the purchaser and recorded on the drawing or associated documents.

1.2.4 Non-Designated Areas: All regions within a casting which have not been designated.

1.2.5 Manufacturer: The firm that is responsible for the production of the material in the form (remelting stock or castings) in which it is consigned to the purchaser.

1.2.6 Melt: The product of a single furnace or crucible charge used to produce castings.

1.2.7 Quality Assurance Authority: The authority stated in the contract or the accredited representative of the authority stated.

1.2.8 Vacuum Melting: The practice of melting and casting under vacuum.

### 1.3 Foundry Technique

1.3.1 For each new pattern, an agreed number of sample castings shall be submitted to the purchaser for approval.

1.3.2 The foundry technique for each accepted sample casting shall be recorded giving the position of runners and risers, chills and mould lines, the type of moulding material and the mould temperature. Details of the manufacturing process such as method of moulding and melting, metal casting temperatures, method of descaling and cleaning, weld repair technique, the sequence of manufacture and inspection, etc shall also be recorded

1.3.3 If required by the purchaser and stated in the order, drawing or material specification, the foundry technique shall be submitted to the purchaser for approval prior to the manufacture of production castings.

1.3.4 Each subsequent production casting shall be made by the same technique. If, for any reason the technique needs to be altered, production shall not proceed without the authority of the purchaser\* who may require sample castings made by the new technique.

### 1.4 Chemical Composition

1.4.1 The chemical composition of re-melt stock and castings shall comply with the requirements of the material specification. The values stipulated in the specification shall be applied in accordance with the instructions of the Quality Assurance Authority.

1.4.2 Elements not quoted in the material specification shall not be intentionally added to the alloy without the agreement of the purchaser\*.

1.4.3 Analytical samples shall be selected and prepared in accordance with the relevant sections of this specification.

1.4.4 No further additions shall be made to a cast or melt after the final analytical sample has been selected.

## 1.5 Heat Treatment

1.5.1 If a temperature with a tolerance is stated in a material specification, order or drawing, that temperature shall be mandatory. If a temperature range is stated, a temperature within that range shall be selected to give the required properties. The limits on the selected temperature shall be  $\pm 1\%$ , with a minimum of  $\pm 5^{\circ}\text{C}$  and a maximum of  $\pm 15^{\circ}\text{C}$ .

1.5.2 Unless otherwise agreed between the manufacturer and the purchaser\* no material shall be subjected to the specified heat treatment more than twice.

## 1.6 Selection and preparation of mechanical test samples

1.6.1 Test samples shall be selected in accordance with the requirements of the relevant section of this specification.

1.6.2 Test samples shall be machined in the finally heat treated condition to the dimensions of the appropriate largest size of proportional round test piece shown in British Standard A4 that can be prepared from the test samples.

## 1.7 Mechanical Tests

1.7.1 Test pieces selected and prepared in accordance with 1.6 shall be tested in accordance with the requirements of British Standard A4, except that in the room temperature tensile test the rate of strain in the plastic range up to the proof stress determination shall be within 0.001 to 0.005 per minute.

## 1.8 Freedom from defects

1.8.1 Remelting stock and castings shall be clean and free from harmful defects. Remelting stock shall be capable of producing vacuum melts free from dross or foreign matter on the melt surface.

1.8.2 All castings shall be suitably descaled and cleaned for surface inspection purposes. Unless otherwise stated on the drawing, order or material specification the sequence and methods of descaling and cleaning are at the option of the manufacturer.

1.8.3 The castings shall be free from any contaminated layer. A representative sample from each batch of castings shall be tested to ensure freedom from surface contamination, unless otherwise agreed between the founder and the purchaser.

The test samples shall be integrally cast or gated to the castings and tests shall be carried out after all manufacturing processes, including heat treatment and surface finishing, have been completed.

The method of testing shall be by metallographic section where the standard of acceptance is agreed between founder and purchaser, or by surface chemical analysis where the oxygen, nitrogen and carbon contents shall not exceed the composition limits of the material specification. Details of the test method selected by the founder shall be recorded on the Foundry Technique.

1.8.4 Each casting shall be visually inspected and shall be free from harmful defects. If a standard of surface finish is agreed between the manufacturer and the purchaser, this shall be stated on the order, drawing or associated documents.

1.8.5 After all heat treatment has been completed each casting shall be examined by a penetrant flaw detection method complying with the requirements of Ministry of Defence Process Specification DTD 929, or by a penetrant flaw detection method otherwise agreed between founder and purchaser.

1.8.6 Each casting shall be radiologically examined in accordance with British Standard M34 to a technique agreed between the founder and the purchaser\* subject to any general condition specified by the Quality Assurance Authority. Details of the required radiological technique shall be stated on the drawing, order or associated documents. Radiographs shall be supplied to the purchaser with each casting and shall be suitably identified with the castings they represent.

1.8.7 The standard of acceptance for defects shall be agreed between the founder and the purchaser\* and shall be stated on the order, drawing or associated documents.

1.8.8 Notwithstanding previous acceptance as complying with the requirements of this specification any re-melting stock or casting that is later found to contain harmful defects may be rejected.

## 1.9 Dimensional Tolerances

1.9.1 Re-melting Stock: Re-melting stock shall comply with the agreed dimensional and weight tolerances stated on the order, drawing or material specification.

1.9.2 Castings:

1.9.2.1 The casting tolerances shall be agreed between the purchaser and the founder and stated on the drawing.

1.9.2.2 Drawings shall indicate the datum points to be used for machining or jigging and, unless otherwise agreed between the purchaser and the founder, samples for pattern approval shall be supplied to the purchaser.

### **1.10 Identification**

Re-melting stock and castings shall be kept identifiable as to their melt and cast, and if appropriate, the heat treatment batch, to enable final identification marking to be made in accordance with the requirements of 1.11

### **1.11 Final Marking**

1.11.1 Re-melting Stock: Re-melting stock passed by the inspector, shall be individually marked with the mark of the manufacturer, the cast number, the specification and such other markings as will ensure full identification of the material.

#### **1.11.2 Castings**

1.11.2.1 Each casting 500g in weight and over shall bear the mark of the inspector and such other markings as shall ensure full identification of the casting. All such marking shall be located where it is least liable to be detrimental to the casting; the location and method of marking shall be shown on the casting drawing.

1.11.2.2 Castings under 500g in weight passed by the inspector shall be marked in accordance with the requirements of 1.11.2.1, or at the option of the founder, unless the order requires individual identification, shall be packed in bags or bundles each of which shall carry a durable label bearing the mark of the inspector and such other marking as shall ensure full identification of the castings.

## **2. RE-MELTING STOCK**

### **2.1 Manufacture**

2.1.1 Re-melting stock may be wrought or cast. The material shall be multiple melted and at least the final melting cycle shall be under vacuum. The first cast shall be made by either consumable or non-consumable electrode practice and the subsequent cast or casts shall be made using a consumable electrode process.

2.1.2 If required by the purchaser the method of control of manufacture shall be agreed with the re-melting stock manufacturer and shall not be modified except by prior agreement. Such a requirement shall be stated in the order, drawing or material specification.

### **2.2 Analytical Requirements**

2.2.1 An analytical sample shall be selected from each cast of re-melting stock and suitably marked to ensure identification. The residue of all samples for analysis shall be retained for a minimum period of three months after disposal of all the cast by the re-melting stock manufacturer.

2.2.2 Each sample selected in accordance with 2.2.1 shall be chemically analysed for each of the specified elements, with the exception of hydrogen which, where required by the purchaser, shall be determined on a sample of the re-melting stock in the condition in which it is supplied.

2.2.3 The results of analysis for each of the specified elements shall be supplied with each cast of re-melting stock.

## **3. CASTINGS**

### **3.1 Manufacture**

3.1.1 Castings and test samples shall be poured under vacuum from a melt of vacuum melted material without loss of vacuum between melting and pouring.

3.1.2. The melt shall be made-up from one cast of re-melting stock complying with the requirements of Section 2. At no time during re-melting shall material of any other composition or type be introduced into the melting chamber.

3.1.3 Scrap arising from the founder's own production shall be used only in the preparation of casts of re-melting stock and shall not be re-melted directly for the manufacture of castings. Such scrap may include runners, risers, rejected castings and heavy fettling scrap, but shall exclude all foreign matter and machined turnings.

## **3.2 Analytical Requirements**

3.2.1 From each melt an analytical sample shall be cast and suitably marked to ensure identification. The residue of all samples for analysis shall be retained for a minimum period of three months after disposal of all the product of the melt by the founder.

3.2.2 A sample from at least one melt produced from each cast of re-melting stock, selected in accordance with 3.2.1, shall be chemically analysed for the specified elements, with the exception of hydrogen which shall be determined on a sample from each batch of castings after all manufacturing processes, including heat treatment and pickling, have been completed by the manufacturer.

3.2.3 The results of chemical analysis for the specified elements shall be supplied to the purchaser.

## **3.3 Condition**

3.3.1 The castings shall be supplied in the condition required by the material specification, unless otherwise agreed between the manufacturer and the purchaser, and stated on the order or drawing.

## **3.4 Provision, selection and preparation of test samples**

3.4.1 Test samples shall be provided from each batch of castings by one or more of the following methods as agreed between founder and purchaser\* and stated on the order, drawing or material specification.

- (1) Test samples cut from castings.
- (2) Test samples cast integrally with, or gated to, castings.
- (3) Test samples cast under similar conditions to the castings they represent, but cast in a separate mould from the same melt.

3.4.2 Where test samples are selected in accordance with 3.4.1 (1), the purchaser\* shall specify the number of castings to be tested, and shall define on the drawing the location, size and form of test samples to be taken.

3.4.3 The test samples shall be heat treated with the castings they represent, and shall not be further heat treated before being tested.

## **3.5 Mechanical Properties**

At least one test per batch shall be made for each of the mechanical tests required by the material specification. Unless otherwise agreed between the founder and the purchaser, the mechanical properties obtained from the test pieces selected and prepared in accordance with 3.4 shall comply with the requirements of the material specification, or with the requirements otherwise agreed between the founder and the purchaser\* and stated on the order, drawing or associated documents.

## **3.6 Re-test Procedure**

### **3.6.1 Cut-up Test Samples**

If any test piece prepared in accordance with 3.4.1 (1) fails to comply with the specified properties, the test results shall be submitted to the purchaser and, if necessary, a re-test procedure shall be agreed.

### **3.6.2 Separately Cast and Integrally Cast Test Sample(s)**

3.6.2.1 If any test piece selected and prepared in accordance with 3.4.1 (2) or 3.4.1 (3) fails to comply with the specified properties the founder shall adopt one or more of the following procedures:

- (1) Select for test from the same batch of castings twice the number of test samples originally selected.
- (2) Allow heat treated castings to be re-heat treated in accordance with the requirements of the material specification and tested in accordance with 3.4 and 3.5
- (3) Subject one or more representative castings to a cut-up test procedure; the form, size and location of the test pieces and the minimum values to be obtained from them shall be agreed between the founder and the purchaser.

3.6.2.2 The castings shall be accepted if all the re-test samples of 3.6.2.1 (1) or (2) comply with the specified properties, or all the test pieces cut from the selected casting(s) in accordance with 3.6.2.1 (3) comply with the agreed mechanical test requirement.

## **3.7 Rectification of Defects in Castings**

### **3.7.1 Repair of Castings by Welding**

3.7.1.1 Repair of defects by welding shall be carried out only with the prior written consent of the purchaser\*, subject to conditions laid down by the Quality Assurance Authority.

3.7.1.2 The founder shall submit the proposed method of repair to the purchaser, with particular reference to any pre-heating to be used and to the treatment to be given after rectification. When required by the purchaser the agreed method of repair shall be stated on the order, drawing or material specification.

3.7.1.3 Castings subject to re-heat treatment shall be subsequently tested in accordance with the requirements of the material specification.

3.7.1.4 All repaired castings shall be radiographed to ensure that the repair has been executed in such a manner as to give satisfactory fusion and freedom from harmful defects. Radiographs shall be suitably identified with the castings they represent and supplied to the purchaser.

3.7.1.5 For each repaired casting the founder shall supply the purchaser with a sketch showing the location of weld repaired areas.

3.7.1.6 All repaired castings shall be subjected to penetrant flaw detection in accordance with 1.8.5.

3.7.1.7 Whenever repaired castings are delivered as part of a consignment the repaired castings shall be identified in a manner acceptable to the purchaser and the release documentation boldly over stamped "Repaired Castings".

### 3.7.2 Correction of Distortion

3.7.2.1 Correction of distortion may be carried out, subject to the agreement of the purchaser\* and any special conditions that he may impose. If re-heat treatment is required the castings shall be subsequently tested in accordance with the requirements of the material specification.

3.7.2.2 All castings subject to correction for distortion shall be subjected to penetrant flaw detection in accordance with 1.8.5.

### 3.7.3 Impregnation

Castings shall not be impregnated, chemically treated or coated to prevent leakage, unless written permission is given by the purchaser\*, specifying the method to be used.

### 3.7.4 Hot Isostatic Pressing (HIP)

3.7.4.1 Hot Isostatic Pressing of castings shall be carried out only with the prior written consent of the purchaser\*, subject to any special conditions that he may impose.

3.7.4.2 Test samples selected and prepared in accordance with 3.4 shall accompany the castings throughout the HIP operations. Castings subject to re-heat treatment, shall be heat treated together with the representative test bars, which shall subsequently be tested in accordance with the requirements of the material specification.

3.7.4.3 Castings which have been subjected to HIP operations shall subsequently be radiologically examined in accordance with 1.8.6 and submitted to penetrant flaw detection in accordance with 1.8.5

### 3.8 Certificate of Conformity

A certificate of conformity shall be supplied by the manufacturer to the purchaser in respect of all deliveries. The certificate shall state the following:

- (1) the purchaser's name and address;
- (2) the contract and/or order number;
- (3) description of supplies with drawing or part numbers;
- (4) quantity;
- (5) specification reference(s);
- (6) cast number of re-melting stock;
- (7) melt number of castings;
- (8) heat treatment batch (if heat treated);
- (9) moulding process;
- (10) condition of the castings as delivered;
- (11) authorised signature;
- (12) results of the tests or analysis carried out, or a reference to the test report applicable;
- (13) reference number of relevant radiographs;
- (14) details of weld repaired castings.

Approved for issue,

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