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**Welding procedure qualification tests for titanium, zirconium  
and their alloys**

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## 1 Scope

This Document specifies the test methods and requirements for welding procedure evaluation for titanium, zirconium and their alloys.

This Document applies to welding procedure evaluation for arc welding of titanium, zirconium and their alloys (metal inert-gas welding, tungsten inert gas welding, and plasma arc welding).

## 2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest

version (including all the amendments) is applicable to this Document.

GB/T 2651 Tensile Test Method on Welded Joints (GB/T 2651-2008, ISO 4136:2001, IDT)

GB/T 2653 Bend Test Methods on Welded Joints (GB/T 2653-2008, ISO 5173:2000, IDT)

GB/T 3323.1 Non-Destructive Testing of Welds - Radiographic Testing - Part 1: X- and Gamma- Ray Techniques with Film (GB/T 3323.1-2019, ISO 17636-1:2013, MOD)

GB/T 3323.2 Non-Destructive Testing of Welds - Radiographic Testing - Part 2: X- and Gamma- Ray Techniques with Digital Detectors (GB/T 3323.2-2019, ISO 17636-2:2013, MOD)

GB/T 16672 Welds-Working Positions-Definitions of Angles of Slope and Rotation (GB/T 16672-1996, ISO 6947:1990, IDT)

GB/T 18851.1 Non-Destructive Testing - Penetrant Testing - Part 1: General Principles (GB/T 18851.1-2012, ISO 3452-1:2008, IDT)

GB/T 19805 Qualification Test of Welding Operators (GB/T 19805-2005, ISO 14732:1998, IDT)

GB/T 19866 Specification and Qualification of Welding Procedures for Metallic Materials - General Rules (GB/T 19866-2005, ISO 15607:2003, IDT)

GB/T 19867.1 Welding Procedure Specification for Arc Welding (GB/T 19867.1-2005, ISO 15609-1:2004, IDT)

GB/T 19868.4 Welding Procedure Qualification Based on Pre-Production Welding Test (GB/T 19868.4-2005, ISO 15613:2004, IDT)

GB/T 26955 Destructive Tests on Welds in Metallic Materials - Macroscopic and Microscopic Examination of Welds (GB/T 26955-2011, ISO 17639:2003, MOD)

GB/T 32259 Non-Destructive Testing of Welds - Visual Testing of Fusion-Welded Joints (GB/T 32259-2015, ISO 17637:2003, MOD)

GB/T 36234 Qualification Testing of Welders for Fusion Welding on Titanium and Titanium Alloys, Zirconium and Zirconium Alloys (GB/T 36234-2018, ISO 9606-5:2000, MOD)

GB/T 39255 Gases and Gas Mixtures for Welding and Cutting Processes (GB/T 39255-2020, ISO 14175:2008, MOD)

### **3 Terms and Definitions**

For the purposes of this Document, the terms and definitions given in GB/T 19866 apply.

### **4 Pre-Welding Procedure Specification (pWPS)**

The pre-welding procedure specification shall be formulated according to GB/T 19867.1.

## 5 Evaluation Test of Welding Process

Welding and testing of test pieces shall comply with the provisions of Clauses 6 and 7 of this Document.

On the premise that the relevant test requirements are met, the welder or welding operator who has passed the welding procedure qualification test in accordance with this Document shall obtain the qualification for the corresponding scope of GB/T 36234 or GB/T 19805.

### 6.1 General

The test piece shall be a standard test piece; and its processing shall comply with the relevant provisions of 6.2. The welding process used in the preparation of the test piece shall be consistent with the pre-welding process specification and be representative of actual production.

When the standard test piece is not applicable, the pre-production welding test piece shall be For pipes with an outer diameter greater than 50mm, the reinforcement on the inner and outer surfaces of the pipe shall be removed so that the thickness of the specimen is the same as that of the pipe wall.

For pipes with an outer diameter less than or equal to 50mm, when taking the overall sampling by a small pipe, the reinforcement on the inner surface of the pipe may be retained.

Unless otherwise specified, the tensile strength of the specimen shall be no lower than the lower limit of the relevant mother metal.

The tensile strength of dissimilar material joints shall be no lower than the lower limit of the lower mother metal.

### 7.4.3 Bending test

Bending specimens and tests of butt joints shall comply with the provisions of GB/T 2653.

When the thickness is less than 12mm, two normal bend and root bend specimens shall be made, respectively. When the thickness is greater than or equal to 12 mm, it is recommended to make

4 side bending specimens instead of the normal bend and root bend specimens.

For butt joints of dissimilar metals or dissimilar materials, two longitudinal bend specimens (one normal bend and root bend) may be used instead of four transverse bend specimens.

Except for Group 51 materials, which shall adopt be 4t, the bend diameter (or drum diameter)