

**AWS C7.6/C7.6M:2017**  
**An American National Standard**



# **Process Specification and Operator Qualification for Laser Hybrid Welding**



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**An American National Standard**

**Approved by the**  
**American National Standards Institute**  
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**Process Specification and**  
**Operator Qualification for**  
**Laser Hybrid Welding**

**1st Edition**

Prepared by the  
American Welding Society (AWS) C7 Committee on High Energy Beam Welding and Cutting

Under the Direction of the  
AWS Technical Activities Committee

Approved by the  
AWS Board of Directors



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## Foreword

This foreword is not part of this standard but is included for informational purposes only.

Combining lasers with other welding techniques to achieve a *hybrid process* has been around almost as long as laser welding. While there are many advantages associated with the high power density properties of lasers, it was determined that gap, base material metallurgy, and weldment performance may be difficult to address with the laser beam alone. One approach was to utilize the advantages of the laser while addressing its shortcomings with the addition of a process that added material to the weld joint. While material could be added in a number of methods (blown powder, preplaced inserts, sacrificial features, etc.), one simple method was to combine the laser with techniques already used for conventional arc welding. This included combining the laser with a Gas Metal Arc Welding (GMAW) process or with a resistant heated wire as is used in Gas Tungsten Arc Welding (GTAW) to form a *Hybrid Process*.

The hybrid laser process has already been accepted for many applications. It has been utilized in the welding of ship structures, structural components, and automotive parts. While the materials processing applications of hybrid laser processing are diverse and may be required to meet other performance criteria, this document focuses on the process specification and operator qualification.

The data contained in this *Process Specification and Operator Qualification for Laser Hybrid Welding* has been compiled and reviewed by the C7D Laser Hybrid Welding Subcommittee of the American Welding Society, which includes representatives from manufacturers and users of laser beam welding and those involved in hybrid laser processes and equipment.



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# Process Specification and Operator Qualification for Laser Hybrid Welding

## 1. General Requirements

**1.1 Scope.** This specification covers processing and quality control requirements for Laser Hybrid Processing. Equipment includes any laser source (examples include, but are not exclusive to CO<sub>2</sub>, Nd: YAG, Diode, Ruby, Yb Fiber (Fibre), Yb Disk (Disc), Nd: Glass) in combination with an arc welding system (power supply, wire feeder, torch, etc.) as defined by AWS A3.0M/A3.0, *Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*.

Specifically, this specification covers both (1) Laser Hybrid Arc Welding that uses both a laser to create a keyhole and GMAW (Gas Metal Arc Welding) to add filler material (resulting in a weld bead that is deeper compared to a traditional arc weld and wider than an autogenous laser weld) and (2) Laser Hot Wire Processing that uses a laser to create a conduction mode or keyhole mode molten puddle and an auxiliary power supply that adds heat to the filler wire that enters the puddle (resulting in a lower heat input weldment that could be used to weld joints or to add a hardfacing overlay).

Tutorial information regarding techniques of welding or details of machine setup or operation of laser hybrid processing and laser hybrid processing systems is beyond the scope of this specification. For more information on this subject, refer to AWS C7.2. *Recommended Practices for Laser Welding, Cutting, and Related Processes*.

**1.1.1 Materials.** This specification covers all major engineering alloys including the following:

- (1) Ferrous Alloys (e.g., steels and stainless steels)
- (2) Non-Ferrous Alloys (e.g., Al alloys, Ni alloys, Ti alloys, Superalloys)
- (3) Heat-Resisting Alloys (e.g., Mo alloys, Ta alloys, W alloys)
- (4) Other Metals (e.g., Be and Cu alloys, precious metals)

**1.2 Units of Measurement.** This standard makes use of both U.S. Customary Units and the International System of Units (SI). The latter are shown within brackets [ ] or in appropriate columns in tables and figures. The measurements may not be exact equivalents; therefore, each system must be used independently.

**1.3 Safety.** Safety and health issues and concerns are beyond the scope of this standard; some safety and health information is provided, but such issues are not fully addressed herein.

Safety and health information is available in the following sources:

American Welding Society:

- (1) ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*
- (2) AWS Safety and Health Fact Sheets
- (3) Other safety and health information on the AWS website

Material or Equipment Manufacturers:

- (1) Safety Data Sheets supplied by materials manufacturers
- (2) Operating Manuals supplied by equipment manufacturers