

AWS C7.1M/C7.1:2026
An American National Standard

Recommended Practices for Electron Beam Welding and Allied Processes



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Recommended Practices for Electron Beam Welding and Allied Processes

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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

Abstract

This document presents recommended practices for electron beam welding and allied processes. It is intended to cover common applications of the process. Processes definitions, safe practices, general process requirements, and inspection criteria are provided.



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Foreword

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

Background: Electron beam processing was initiated in the early 1900s, when an electron beam was used to produce tantalum metal by melting tantalum sponge. Since then, electron beam technology for materials processing has steadily advanced and is now commonly used. While electron beam processing encompasses a wide range of metal processing activities, this document focuses on welding and joining. The commercial application of electron beam welding (EBW) was first introduced in the late 1950s and subsequently gained rapid and widespread acceptance by the industrial community because of its ability to produce high aspect ratio (depth-to-width) welds and join dissimilar and difficult-to-weld materials. Welding speeds on the order of 760 mm/s [1800 in/min] and single-pass autogenous welds in metals of greater than 150 mm [6 in] thickness have been achieved.

There are significant numbers of electron beam welders presently in operation throughout the world utilized in automotive, aircraft and aerospace, nuclear, job shop, and other industrial applications. Units having over 35 years of operational time are still being used on a regular basis—if not by the original purchaser, then by the 2nd or 3rd owner of the unit. This shows that the equipment being supplied by the EBW manufacturers has a demonstrated history of performing durably and reliably.

The information contained in the Recommended Practices was compiled by the American Welding Society's C7B Subcommittee on Electron Beam Welding and Cutting and has been carefully reviewed by a number of experts in the field, and should provide a helpful guide for use in applying the electron beam welding process. It must be noted that the operating parameters specified in these recommended practices will not be the only possible parameter combinations that can be employed for successfully processing the materials and thicknesses shown. Changes in material composition, dimensional tolerances, and machine calibration will cause changes in the resulting welds. Therefore, the procedures contained herein are offered simply as a guide and are intended only for use in aiding the application of electron beam technology and increasing process consistency.

The first edition of C7.1M/C7.1 was published in 1992 as *Recommended Practices for Electron Beam Welding*. This code was revised in 1999, 2004, and again in 2013. This is the fifth edition AWS C7.1M/C7.1, *Recommended Practices for Electron Beam Welding and Allied Processes*.

This revision has undergone significant editorial and technical revisions from the previous edition; for readability and formatting purposes changes from the previous edition have not been underlined. This edition has undergone significant revisions including, but not limited to, the list below:

Summary of Changes	
Clause/Annex	Modification
Clause 4	Equipment description has been moved to Clause 4 previously listed in Clause 6. Defined EBW System Upgrades and Options. Added process modes to Vacuum Chamber Configurations of Electron Beam Welding.
Clause 7	A new section has been added to describe Electron Beam Directed Energy Deposition (EB-DED) and Electron Beam Powder Bed Fusion (EB-PBF) processes.
Clause 9	The allied processes are defined in their own section under Electron Beam Transformation Hardening and Allied Processes
Annex C	Practical examples are no longer a part of the body of the specification, they have been moved to Annex C.

Normative Annexes. These annexes address specific subjects in the code and their requirements are mandatory requirements that supplement the code provisions.

Informative Annexes. These annexes are not code requirements but are provided to clarify code provisions by showing examples, providing information, or suggesting alternative good practices.

Errata. All errata to a standard shall be published in the *Welding Journal* and posted on the AWS website <www.aws.org/standards/page/errata>.

Suggestions. Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS C7 Committee on High Energy Beam Welding and Cutting, American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166.

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Recommended Practices for Electron Beam Welding and Allied Processes

1. General Requirements

1.1 Scope. These recommended practices present descriptions of electron beam welding equipment and procedures for welding a wide range of metals and thicknesses; allied processes, to include electron beam braze welding (EBBW), cutting, drilling, surfacing, additive manufacturing, surface texturing, and heat treating, are also discussed. The appropriate terms, definitions, and safety considerations are presented. Information is included on designing for electron beam welding (EBW), welding dissimilar metals and thicknesses, fixturing, specifications, and operator training and qualification.

Highly technical and detailed descriptions of metallurgy and the physics of the EBW process, though important to the engineer and scientist, were considered beyond the scope of this publication.

Although this recommended practice is not written with mandatory requirements, mandatory language, such as the use of “shall”, will be found in those portions of the document where failure to follow the instructions or procedures could produce inferior, misleading, or unsafe results.

1.2 Units of Measurement. This standard makes use of both the International System of Units (SI) and U.S. Customary Units. 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 issues and concerns are addressed in this standard, although health issues and concerns are beyond the scope of this standard.

Safety and health information is available from 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

Applicable Regulatory Agencies

Work performed in accordance with this standard may involve the use of materials that have been deemed hazardous, and may involve operations or equipment that may cause injury or death. This standard does not purport to address all safety and health risks that may be encountered. The user of this standard should establish an appropriate safety program to address such risks as well as to meet applicable regulatory requirements. ANSI Z49.1 should be considered when developing the safety program.

2. Normative References

The documents listed below are referenced within this publication and are mandatory to the extent specified herein. For undated references, the latest edition of the referenced standard shall apply. For dated references, subsequent amendments or revisions of the publications may not apply since the relevant requirements may have changed.