AWS C7.1M/C7.1:2013
An American National Standard

Recommended Practices for Electron Beam Welding and Allied Processes

American Welding Society®

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American National Standards Institute
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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 AWS C7.1M/C7.1:2013, *Recommended Practices for Electron Beam Welding and Allied Processes*, but is included for informational purposes only.

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.

It has been estimated that there are upwards of 3000 electron beam welders presently in operation throughout the world—of which approximately 35% are involved with automotive related tasks, 15% with both aircraft and aerospace related tasks, 10% with nuclear (either commercial or military) related tasks, 20% with a variety of job shop (contract welding) related tasks, and 20% with other industries (electronic, medical bimetal, Research and Development, etc.). It is also estimated that out of this total number of operating units, approximately 40% of those that were delivered during the ’60s and ’70s time frame (i.e., units having upwards of 35 years or more 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, thus attesting to the fact that equipment being supplied by the EBW manufactures 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.

AWS C7.1M/C7.1:2013, *Recommended Practices for Electron Beam Welding and Allied Processes*, is the third revision (4th edition) of the document issued initially in 1992. This edition adds three new practical examples and adaptations of the electron beam process, including electron beam braze welding (EBBW), electron beam cutting (EBC) and drilling, the deposition of supplementary weld metal (surfacing, cladding, and hard-facing), electron beam additive manufacturing (EBAM), surface texturing, and heat treating of components. Previous editions of the document are as follows:

AWS C7.1-92	*Recommended Practices for Electron Beam Welding*
AWS C7.1:1999	*Recommended Practices for Electron Beam Welding*
AWS C7.1M/C7.1:2004	*Recommended Practices for Electron Beam Welding*

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 Doral Blvd., Suite 130, Doral, 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. Information regarding the safe practice of electron beam welding and allied processes can be found in Clause 4 of this standard.

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.

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 shall 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. Some safety considerations are addressed in Clause 4.

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) Material Safety and 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.