AWS C3.12M/C3.12:2024
An American National Standard

Specification for Furnace Soldering

American Welding Society®

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An American National Standard

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Specification for Furnace Soldering

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Prepared by the
American Welding Society (AWS) C3 Committee on Brazing and Soldering

Under the Direction of the
AWS Technical Activities Committee

Approved by
AWS Board of Directors

Abstract

This specification provides the minimum requirements for equipment, materials, processing procedures as well as inspection for metal and ceramic base materials that can be furnace soldered. This specification provides criteria for classifying furnace soldered joints based on loading and the consequences of failure. It also provides quality assurance criteria that define the limits of acceptability in each class. This specification describes acceptable furnace soldering equipment, materials, and procedures, as well as the required inspection for each class of solder joint so produced.

American Welding Society®

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Foreword

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

This document responds to the need of the soldering community for specifications that address the making of soldering filler metal joints using furnace equipment. To date, there has been only one other voluntary consensus standard issued in soldering, AWS C3.11M/C3.11, *Specification for Torch Soldering*, published in 2011.

It is the objective of the AWS C3 Committee on Brazing and Soldering to continue the development of other specifications for the soldering community. While the respective brazing specifications have provided the templates for AWS C3.11M/C3.11 as well as this document, those documents have been tailored or further amended to reflect details that are particular to soldering technology.

This is the second edition of this specification. This second edition reflects both editorial corrections as well as substantive changes to clarify several technical points.

All errata to a standard shall be published in the *Welding Journal* and posted on the AWS website.

Underlined text or a vertical line in the margin indicates a change from the previous edition.

Comments and suggestions for the improvement of this specification are welcome. They should be sent to the Secretary, C3 Committee on Brazing and Soldering, American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166.

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Specification for Furnace Soldering

1. General Requirements

1.1 Scope. This specification presents the minimum fabrication and quality requirements for the furnace soldering of materials, including elemental metals, metal alloys, and ceramic base materials, having geometries suitable for the process.

The purpose of this specification is to standardize furnace soldering process requirements to assure the solder joints attain the quality level designated by the application. This specification presents the minimum requirements of a furnace soldering process that results in solder joints which meet necessary product performance and reliability. The Organization Having Quality Responsibility (OHQR) is solely responsible for establishing the applicability of this specification and to document any modification of its requirements deemed necessary to assure that quality requirements are met of the soldered assembly.

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 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 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 the 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.

See 5.6 for supplemental safety and health information.

1.4 Ordering Information. The purchaser shall provide the following information to the fabricator:

(1) Part number and quantity of parts

(2) Base material and condition

(3) Soldering Filler Metal Composition and Form

The following information is optional or has default requirements in this document; therefore, the purchaser may specify alternate requirements:

(1) Solder joint classification (Clause 4)

(2) Cosmetic criteria

(3) Fillet size

(4) Areas to be free of excess filler metal

(5) Heating or cooling rates

(6) Postsolder heat treatment

(7) Pre- or postsolder cleaning methods

(8) Method of nondestructive examination

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.

American Welding Society (AWS) standards:

AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*

AWS A3.0M/A3.0, *Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*

AWS B2.3/B2.3M*, Specification for Soldering Procedure and Performance Qualification*

AWS C3.3, *Recommended Practices for the Design, Manufacture, and Examination of Critical Brazed Components*

AWS C3.8M/C3.8, *Specification for the Ultrasonic Pulse-Echo Examination of Brazed Joints*

ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*

American Society for Quality (ASQ) standard:

ASQ Z1.4, *Sampling Procedures and Tables for Inspection by Attributes*

SAE International/Aerospace Materials Division standard:

AMS 2750*, Pyrometry*

ASTM International standards:

ASTM B32, *Standard Specification for Solder Metal*

ASTM B813*, Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube*

ASTM B907, *Standard Specification for Zinc, Tin and Cadmium Base Alloys Used as Solders*

ASTM E230/E230M, *Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

ASTM E1417/E1417M, *Standard Practice for Liquid Penetrant Testing*

ASTM E1742/E1742M, *Standard Practice for Radiographic Examination*

International Organization for Standardization (ISO) standards:

ISO 12224-1, *Solder wire, solid and flux cored — Specification and test methods — Part 1: Classification and performance requirements*

ISO/IEC 17025*, Testing and calibration laboratories*

Institute of Printed Circuits (IPC)/Electronics Industry Alliance (EIA) standards:

IPC/EIA J-STD-004, *Requirements for Soldering Fluxes*

IPC/EIA J-STD-005, *Requirements for Soldering Pastes*

IPC/EIA J-STD-006*, Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Solder Applications*

3. Terms and Definitions

AWS A3.0M/A3.0, *Standard Welding Terms and Definitions*, provides the basis for terms and definitions used herein. However, the following terms and definitions are included below to accommodate usage specific to this document.

joint width. The smallest dimension of the faying surface area.

Organization Having Quality Responsibility (OHQR). The organization responsible for the soldered assembly—solder joint and base materials—to meet all quality requirements. This organization may exist in the company performing the soldering process; the manufacturer of the product; or the end user of the product. Although the manufacturer may subcontract the soldering process to another company, the latter has responsibility for the quality of the soldered assembly and not that of the product.

protective finish. A coating layer deposited either on the base material or on a solderable finish to protect its solderability.

resoldering. The correction of a defect in the solder joint through the application of additional solder after assembly but prior to leaving the manufacturing cycle.

solderability. The capacity of the soldering filler metal to spontaneously wet and spread over the solder joint surfaces.

solder joint. The total area, as shown by the engineering drawing, of the faying surfaces to be joined by soldering, including the exposed fillets.

(solder) spreading. The spontaneous coverage of the base material surfaces by the molten solder. Spreading also includes capillary flow of molten solder within a hole or joint clearance.

solderable finish. A coating layer deposited on top of the base material, to which the soldering filler metal will wet and form a metallurgical bond.

surface finish. A metal layer, which is deposited by hot solder dipping, plating (electroless or autocatalytic plating, electroplating, or displacement or immersion plating), physical vapor deposition, or chemical vapor deposition.

void. Any area of the solder joint that is not completely filled with soldering filler metal.

4. Classification of Solder Joints

4.1 Method of Classification. Furnace soldered joints are classified in this specification based on two criteria: the design requirements and the consequences of their failure. It is the responsibility of the OHQR to understand and implement the process and procedure requirements related to the specified joint classification. This classification provides a guideline for selecting inspection methods and acceptance criteria.

4.2 Class A Joints. Class A is specified when joints are subjected to high stresses, cyclic stresses, or both, the failure of which could result in a high risk of personal injury, property damage, or loss of operational capability.

4.3 Class B Joints. Class B is specified when joints are subjected to medium stresses, cyclic stresses, or both, the failure of which could result in a medium risk of personal injury, property damage, or loss of operational capability.

4.4 Class C Joints. Class C is specified when joints are subjected to low stresses, cyclic stresses, or both, the failure of which could result in a low risk of personal injury, property damage, or loss of operational capability.