

**AWS B2.1-5A-224:1999 (R2009)**  
**An American National Standard**

**Standard Welding Procedure  
Specification (SWPS) for**

**Gas Tungsten Arc  
Welding followed  
by Shielded Metal Arc  
Welding of Chromium-  
Molybdenum Steel  
(M-5A/P-5A), 1/8 through  
1/2 in. Thick, As-Welded  
Condition; 1/8 through  
1-1/2 in. Thick, PWHT  
Condition, ER90S-B3  
and E9018-B3, Primarily  
Pipe Applications**

**Site License**



**American Welding Society**



**AWS B2.1-5A-224:1999 (R2009)  
An American National Standard**

**Approved by the  
American National Standards Institute  
December 8, 1999  
Reaffirmed: May 29, 2009**

**Standard Welding Procedure Specification (SWPS) for  
Gas Tungsten Arc Welding followed by  
Shielded Metal Arc Welding of  
Chromium-Molybdenum Steel (M-5A/P-5A),  
1/8 through 1/2 in. Thick, As-Welded Condition;  
1/8 through 1-1/2 in. Thick, PWHT Condition,  
ER90S-B3 and E9018-B3, Primarily Pipe Applications**

**1st Edition**

Prepared by the  
American Welding Society (AWS) B2 Committee on Procedure and Performance Qualification

Under the Direction of the  
AWS Technical Activities Committee

Approved by the  
AWS Board of Directors

## **Abstract**

This standard contains the essential welding variables for chromium-molybdenum steel in the thickness range of 1/8 through 1/2 in. in the as-welded condition; or 1/8 through 1-1/2 in. in the postweld heat treated (PWHT) condition, using manual gas tungsten arc welding followed by manual shielded arc welding. It cites the base metals and operating conditions necessary to make the weldment, the filler metal specifications, and the allowable joint designs for groove welds. This standard welding procedure specification (SWPS) was developed primarily for pipe applications.



**American Welding Society**

550 N.W. LeJeune Road, Miami, FL 33126

International Standard Book Number: 0-87171-603-8  
American Welding Society  
550 N.W. LeJeune Road, Miami, FL 33126  
© 2000 by American Welding Society  
All rights reserved  
Printed in the United States of America  
Reaffirmed: May 29, 2009

## Statement on the Use of American Welding Society Standards

All standards (codes, specifications, recommended practices, methods, classifications, and guides) of the American Welding Society (AWS) are voluntary consensus standards that have been developed in accordance with the rules of the American National Standards Institute (ANSI). When AWS American National Standards are either incorporated in, or made part of, documents that are included in federal or state laws and regulations, or the regulations of other governmental bodies, their provisions carry the full legal authority of the statute. In such cases, any changes in those AWS standards must be approved by the governmental body having statutory jurisdiction before they can become a part of those laws and regulations. In all cases, these standards carry the full legal authority of the contract or other document that invokes the AWS standards. Where this contractual relationship exists, changes in or deviations from requirements of an AWS standard must be by agreement between the contracting parties.

AWS American National Standards are developed through a consensus standards development process that brings together volunteers representing varied viewpoints and interests to achieve consensus. While the AWS administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its standards.

AWS disclaims liability for any injury to persons or to property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this standard. AWS also makes no guarantee or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this standard available, AWS is neither undertaking to render professional or other services for or on behalf of any person or entity, nor is AWS undertaking to perform any duty owed by any person or entity to someone else. Anyone using these documents should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. It is assumed that the use of this standard and its provisions are entrusted to appropriately qualified and competent personnel.

This standard may be superseded by the issuance of new editions. Users should ensure that they have the latest edition.

Publication of this standard does not authorize infringement of any patent or trade name. Users of this standard accept any and all liabilities for infringement of any patent or trade name items. AWS disclaims liability for the infringement of any patent or product trade name resulting from the use of this standard.

Finally, the AWS does not monitor, police, or enforce compliance with this standard, nor does it have the power to do so.

On occasion, text, tables, or figures are printed incorrectly, constituting errata. Such errata, when discovered, are posted on the AWS web page ([www.aws.org](http://www.aws.org)).

Official interpretations of any of the technical requirements of this standard may only be obtained by sending a request, in writing, to the appropriate technical committee. Such requests should be addressed to the American Welding Society, Attention: Managing Director, Technical Services Division, 550 N.W. LeJeune Road, Miami, FL 33126 (see Annex A). With regard to technical inquiries made concerning AWS standards, oral opinions on AWS standards may be rendered. These opinions are offered solely as a convenience to users of this standard, and they do not constitute professional advice. Such opinions represent only the personal opinions of the particular individuals giving them. These individuals do not speak on behalf of AWS, nor do these oral opinions constitute official or unofficial opinions or interpretations of AWS. In addition, oral opinions are informal and should not be used as a substitute for an official interpretation.

This standard is subject to revision at any time by the AWS B2 Committee on Procedure and Performance Qualification. It must be reviewed every five years, and if not revised, it must be either reaffirmed or withdrawn. Comments (recommendations, additions, or deletions) and any pertinent data that may be of use in improving this standard are required and should be addressed to AWS Headquarters. Such comments will receive careful consideration by the AWS B2 Committee on Procedure and Performance Qualification and the author of the comments will be informed of the Committee's response to the comments. Guests are invited to attend all meetings of the AWS B2 Committee on Procedure and Performance Qualification to express their comments verbally. Procedures for appeal of an adverse decision concerning all such comments are provided in the Rules of Operation of the Technical Activities Committee. A copy of these Rules can be obtained from the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

## Personnel (Reaffirmation)

### AWS B2 Committee on Procedure and Performance Qualification

J. J. Fluckiger, Chair	<i>Idaho National Laboratory</i>
J. L. Cooley, Vice Chair	<i>J. C. and Associates, Incorporated</i>
E. W. Beckman, 2nd Vice Chair	<i>International Training Institute</i>
S. Morales, Secretary	<i>American Welding Society</i>
L. P. Connor	<i>Consultant</i>
W. D. Doty	<i>Doty and Associates, Incorporated</i>
E. H. Gray	<i>U.S. Nuclear Regulatory Commission</i>
B. J. Hable	<i>Ford Motor Company</i>
M. Herrle	<i>Arise, Incorporated</i>
R. A. LaFave	<i>Elliott Company, Incorporated</i>
K. Y. Lee	<i>The Lincoln Electric Company</i>
K. M. McTague	<i>Factory Mutual</i>
A. S. Olivares	<i>HSB Global Standards</i>
J. F. Pike	<i>NASA Langley Research Center</i>
W. M. Ruof	<i>Bechtel Plant Machinery, Incorporated</i>
J. J. Sekely	<i>Welding Services, Incorporated</i>
M. R. Stone	<i>Canadian Welding Bureau</i>
G. M. Wisbrock	<i>Lockheed Martin Missiles and Fire Control (Retired)</i>
R. K. Wiswesser	<i>Welder Training and Testing Institute</i>

### Advisors to the AWS B2 Committee on Procedure and Performance Qualification

W. L. Ballis	<i>Consultant</i>
J. D. Duncan	<i>Consultant</i>
N. K. Kanaya	<i>BEAR Testing Laboratory</i>
B. B. MacDonald	<i>Consultant</i>
A. W. Sindel	<i>Alstom Power, Incorporated</i>
C. E. Speader, Jr.	<i>Aristech Chemical Corporation</i>
W. J. Sperko	<i>Sperko Engineering Services</i>
R. F. Waite	<i>Consultant</i>

### AWS B2D Subcommittee on Standard Welding Procedure Specifications

J. J. Sekely, Chair	<i>Welding Services, Incorporated</i>
S. Morales, Secretary	<i>American Welding Society</i>
L. P. Connor	<i>Consultant</i>
W. D. Doty	<i>Doty and Associates, Incorporated</i>
J. J. Fluckiger	<i>Idaho National Laboratory</i>
K. M. McTague	<i>Factory Mutual</i>
W. M. Ruof	<i>Bechtel Plant Machinery, Incorporated</i>

### Advisor to the AWS B2D Subcommittee on Standard Welding Procedure Specifications

G. M. Wisbrock	<i>Lockheed Martin Missiles and Fire Control (Retired)</i>
----------------	------------------------------------------------------------

## Personnel (Original)

### AWS B2 Committee on Procedure and Performance Qualification

J. J. Sekely, Chair	<i>Eichleay Corporation</i>
G. M. Wisbrock, 1st Vice Chair	<i>Lockheed Martin Missiles and Fire Control</i>
J. J. Fluckiger, 2nd Vice Chair	<i>Bechtel Babcock &amp; Wilcox Idaho</i>
P. B. Dickerson, 3rd Vice Chair	<i>Consultant</i>
L. P. Connor, Secretary	<i>American Welding Society</i>
T. J. Anderson	<i>Bechtel Group</i>
*W. L. Ballis	<i>Consultant</i>
*H. B. Cary	<i>Consultant</i>
J. L. Cooley	<i>JC and Associates, Incorporated</i>
W. D. Doty	<i>Doty and Associates</i>
E. A. Gallagher	<i>Non Destructive Testing Group</i>
E. H. Gray	<i>US NRC Region 1</i>
M. Herrle	<i>ABS Group, Incorporated</i>
*J. E. Hinkel	<i>The Lincoln Electric Company</i>
*M. J. Houle	<i>Welding Engineering Services</i>
R. W. Jackson	<i>Consultant</i>
A. W. Johnson	<i>A. W. Johnson and Associates</i>
N. Kanaya	<i>BEAR Testing Laboratory</i>
R. A. LaFave	<i>Elliott Company</i>
*B. B. MacDonald	<i>United Association</i>
J. W. McGrew	<i>Consultant</i>
K. M. McTague	<i>NEOC</i>
A. S. Olivares	<i>Hartford Steam Boiler, Inspection and Insurance Company</i>
*G. W. Oyler	<i>Consultant</i>
S. Panezic	<i>Canadian Welding Bureau</i>
J. F. Pike	<i>NASA Langley Research Center</i>
B. J. Rampolla	<i>J. J. McMuller Association</i>
W. M. Ruof	<i>Westinghouse</i>
*J. B. Shore	<i>Brooks Automation</i>
A. W. Sindel	<i>Sindel &amp; Associates</i>
*C. E. Spaeder, Jr.	<i>Aristech Chemical Corporation</i>
*W. J. Sperko	<i>Sperko Engineering Services</i>
*R. F. Waite	<i>Consultant</i>
R. K. Wiswesser	<i>Welder Training and Testing Institute</i>

### AWS B2E Subcommittee on Standard Welding Procedure Specifications

R. W. Jackson, Chair	<i>Consultant</i>
L. P. Connor, Secretary	<i>American Welding Society</i>
W. D. Doty	<i>Doty and Associates</i>
*M. J. Houle	<i>Welding Engineering Services</i>
K. M. McTague	<i>NEOC</i>
B. J. Rampolla	<i>J. J. McMuller Associates</i>
J. J. Sekely	<i>Eichleay Corporation</i>

\*Advisor

## Foreword

This foreword is not part of AWS B2.1-5A-224:1999 (R2009), *Standard Welding Procedure Specification (SWPS) for Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-5A/P-5A), 1/8 through 1/2 in. Thick, As-Welded Condition; 1/8 through 1-1/2 in. Thick, PWHT Condition, ER90S-B3 and E9018-B3, Primarily Pipe Applications*, but is included for informational purposes only.

The American Welding Society and the Welding Research Council have joined in a cooperative effort to generate standard welding procedures for industry. The need for pretested welding procedures that are supported by adequate test data and that satisfy the technical requirements for the commonly used construction codes and specifications has been expressed by many individuals and organizations. The purpose of a welding procedure qualification is to provide test data for assessing the properties of a weld joint.

This Welding Procedure Specification is an outgrowth of the coordinated work of the Welding Procedures Committee of the Welding Research Council and the AWS B2 Committee on Welding Procedure and Performance Qualification. The Welding Procedures Committee has provided the test data documented by a Summary of Procedure Qualification Records.

The welding terms used in this specification shall be interpreted in accordance with the definitions given in the latest edition of AWS A3.0, *Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*.

The AWS Committee on Welding Procedure and Performance Qualification was formed in 1979 to provide welding standards concerning the subject of qualification. The primary document developed by this committee is AWS B2.1, *Specification for Welding Procedure and Performance Qualification*. This document established the foundation and framework for Standard Welding Procedure Specifications.

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS B2 Committee on Welding Procedure and Performance Qualification, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

# Standard Welding Procedure Specification (SWPS)

---

## Gas Tungsten Arc Welding followed by Shielded Metal Arc Welding of Chromium-Molybdenum Steel (M-5A/P-5A), 1/8 through 1/2 in. Thick, As-Welded Condition; 1/8 through 1-1/2 in. Thick, PWHT Condition, ER90S-B3 and E9018-B3, Primarily Pipe Applications

Welding Research Council—Supporting PQR Numbers: 200704, 200705, 200706, 200716, 200717, 200718, 200719, 200740, 200741, 200742, 200743, 200744, 200745, 200797, 200827, 200836, 200838

### Requirements for Application of SWPSs

**Scope.** The data to support this Standard Welding Procedure Specification (SWPS) were derived from the above-listed Procedure Qualification Records (PQRs) which were reviewed and validated under the auspices of the Welding Research Council. This SWPS is not valid using conditions and variables outside the ranges listed. The American Welding Society considers that this SWPS presents information for producing an acceptable weld using the conditions and variables listed. The user needs a significant knowledge of welding and accepts full responsibility for the performance of the weld and for providing the engineering capability, qualified personnel, and proper equipment to implement this SWPS.

**Application.** This SWPS is to be used only as permitted by the applicable fabrication document(s); such as code, specification, or contract document(s). The fabrication document(s) should specify the engineering requirements such as design, need for heat treatment, fabricating tolerances, quality control, and examination and tests applicable to the end product.

**User's Responsibility.** An SWPS does not replace or substitute for fabrication codes, specifications, contract requirements, or capability and judgment

on the part of the user. An SWPS is to be used only as permitted by the applicable fabrication code, specification, or contract document.

The ability to produce production welds having properties suitable for the application depends upon supplementing the SWPS with appropriate performance qualification tests and sound engineering judgment. The user is responsible for the quality and performance of the final product in accordance with the provisions of the fabrication document(s).

**Supplementary Instructions.** To adapt this SWPS to a specific application, a user may issue supplementary instructions. Such instructions may consist of tighter fit-up tolerances, higher minimum preheat temperature or any other instructions necessary to produce a weldment that meets the requirements of the fabrication document(s). These instructions shall not be less restrictive than provided in the SWPS.

**Safety.** Safety precautions shall conform to the latest edition of ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, published by the American Welding Society.

This specification may involve hazardous materials, operations, and equipment. The specification does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices. The user should determine the applicability of any regulatory limitations prior to use.