

AWS B1.11M/B1.11:2015
An American National Standard

Guide for the Visual Examination of Welds



American Welding Society®



**AWS B1.11M/B1.11:2015
An American National Standard**

**Approved by the
American National Standards Institute
September 8, 2014**

Guide for the Visual Examination of Welds

3rd Edition

Supersedes AWS B1.11:2000

Prepared by the
American Welding Society (AWS) B1 Committee on Methods of Inspection

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This guide contains information to assist in the visual examination of welds. Included are sections on fundamentals, surface conditions, and equipment. Sketches and full-color photographs illustrate weld discontinuities commonly found in welds.



American Welding Society®

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 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 is entrusted to appropriately qualified and competent personnel.

This standard may be superseded by new editions. This standard may also be corrected through publication of amendments or errata, or supplemented by publication of addenda. Information on the latest editions of AWS standards including amendments, errata, and addenda is posted on the AWS web page (www.aws.org). Users should ensure that they have the latest edition, amendments, errata, and addenda.

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.

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

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, 8669 NW 36 St, # 130, Miami, FL 33166 (see Annex B). 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 B1 Committee on Methods of Inspection. 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 B1 Committee on Methods of Inspection 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 B1 Committee on Methods of Inspection 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, 8669 NW 36 St, # 130, Miami, FL 33166.

Personnel

AWS B1 Committee on Methods of Inspection

W. Komlos, Chair	<i>Arc Tech LLC</i>
R. Cook, 1st Vice Chair	<i>SME Steel Contractors</i>
A. Moore, 2nd Vice Chair	<i>Marion Testing & Inspection</i>
E. Abrams, Secretary	<i>American Welding Society</i>
J. Armstrong	<i>LeTourneau Technologies, Incorporated</i>
U. Aschemeier	<i>Subsea Global Solutions LLC</i>
B. Baker	<i>Bechtel National, Incorporated</i>
K. Baucher	<i>Technicon Engineering Services, Incorporated</i>
R. Campbell	<i>Banker Steel Company</i>
R. Clarke	<i>TEAM Industrial Services</i>
B. Craft	<i>Trinity Industries, Incorporated</i>
D. Crowe	<i>Massachusetts Highway Department (Retired)</i>
C. Eure	<i>AMEC E&I</i>
G. Gratti	<i>Arcos Industries</i>
B. Hill	<i>Cameron Process Systems Canada</i>
R. Holdren	<i>ARC Specialties/Welding Consultants LLC</i>
A. Johnson	<i>Johnson Inspection</i>
E. Levert	<i>Lockheed Martin Missiles & Fire Control</i>
E. Lichtfusz	<i>Roush Industries</i>
C. Mankenberg	<i>Shell International Exploration & Production</i>
R. McCabe	<i>Consultant</i>
J. Mehta	<i>Alta Vista Solutions</i>
T. Studebaker	<i>St. Louis Testing</i>
H. Thompson	<i>UL LLC</i>

Advisors to the AWS B1 Committee on Methods of Inspection

D. Wright	<i>Wright Welding Technologies</i>
C. Hellier	<i>The Summit Group</i>
K. Nicholson	<i>MACTEC Engineering & Consulting, Incorporated</i>
C. Phelps	<i>Joseph Oat Corporation</i>

AWS B1B Subcommittee on Visual Examination of Welds

A. Moore, Chair	<i>Marion Testing & Inspection</i>
R. Campbell	<i>Banker Steel Company</i>
R. Clarke	<i>TEAM Industrial Services</i>
R. Cook	<i>SME Steel Contractors</i>
B. Craft	<i>Trinity Industries</i>
R. Holdren	<i>Arc Specialties</i>
A. Johnson	<i>Johnson Inspection</i>
W. Komlos	<i>Arc Tech LLC</i>
E. Lichtfusz	<i>Roush Industries</i>
M. Plumley	<i>Cenergy LLC</i>
C. Mankenberg	<i>Shell International Exploration & Production</i>

Foreword

This foreword is not part of AWS B1.11M/B1.11:2015, *Guide for the Visual Examination of Welds*, but is included for informational purposes only.

Visual examination (VT), as used in this guide, is a nondestructive method whereby a weldment, the related base metal, and particular phases of welding may be evaluated in accordance with applicable requirements. All visual examination methods require the use of eyesight to evaluate the conditions which are present; hence, the term *visual* examination.

The use of gauges and other tools is supplemental to the main method, and these are treated only as adjuncts to visual examination of weldments.

The *Guide for the Visual Examination of Welds* has been prepared by the AWS B1 Committee on Methods of Inspection to serve as a simple tutorial source of basic information concerning visual examination of welds. It is not the intent of this document to present the *only* approved methods for conducting visual examination. Some typical standards are listed in this document. It is intended that the material presented be useful to engineers, designers, educators, inspectors, and other welding personnel who need knowledge about basic visual examination attributes, which would be essential, or desirable, for a particular process. Included in this guide are fundamental prerequisites for performing visual examination, steps in performing visual examination at various stages of welding, and also typical examples of visual examination, discontinuities and conditions, equipment supplements and aids, records, and other reference sources which may be helpful. Terminology used throughout this guide has been established in AWS A3.0M/A3.0, *Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*.

This guide is intended as an instructive reference. The codes or specifications applicable to any particular weldment always take precedence over the generalized material contained herein, should any conflict arise between the two. The text has been written in general terms and does not include all the conditions applicable to a specific instance. Examples given are general and are used only for the purpose of illustration.

This material can be used as a training text for inspectors. Although the information generally relates to the arc welding processes, most of it applies to weldments fabricated by other fusion welding processes, for which these methods may be required.

For the examination of resistance welded assemblies, refer to AWS C1.1M/C1.1, *Recommended Practices for Resistance Welding*, AWS C1.3, *Recommended Practices for Resistance Welding Coated Low Carbon Steels*, and AWS D8.7, *Recommended Practices for Automotive Weld Quality—Resistance Spot Welding*, published by the American Welding Society.

For the examination of brazed assemblies, refer to the *Brazing Handbook*, also published by the American Welding Society.

For those who need more detailed information than this guide provides, bibliographies or complete books on the subjects covered in each chapter may be found in good technical libraries. The many specifications and codes that are listed, and have been used as illustrative examples, may also be consulted for more detailed information.

Basic information on other nondestructive examination methods is contained in AWS B1.10M/B1.10, *Guide for Nondestructive Examination of Welds*, and in the *Welding Inspection Handbook*.

All revisions to the 2000 edition are identified by a vertical line in the margin next to the text.

Comments and inquiries concerning this standard are welcome. They should be sent to the Secretary, AWS B1 Committee on Methods of Inspection, American Welding Society, 8669 NW 36 St, # 130 Miami, FL 33166.

Table of Contents

	Page No.
<i>Personnel</i>	v
<i>Foreword</i>	vii
<i>List of Tables</i>	xi
<i>List of Figures</i>	xi
1. General	1
1.1 Application	1
1.2 Scope	1
1.3 Safety and Health	1
2. Normative References	2
3. Qualification of Examination Personnel	2
3.1 General	2
3.2 Visual Acuity	2
3.3 Equipment	2
3.4 Experience and Training	2
3.5 Procedures	3
3.6 Certification Programs	3
4. Fundamentals of Visual Examination	3
4.1 General	3
4.2 Prior to Welding	3
4.3 During Welding	5
4.4 After Welding	6
5. Weld Surface Conditions	7
5.1 General	7
5.2 Porosity	7
5.3 Incomplete Fusion	11
5.4 Incomplete Joint Penetration	11
5.5 Undercut	17
5.6 Underfill	17
5.7 Overlap	17
5.8 Lamination	17
5.9 Seams and Laps	18
5.10 Cracks	19
5.11 Slag Inclusions	26
5.12 Weld Reinforcement	26
5.13 Concavity and Convexity	27
5.14 Arc Strikes	27
5.15 Spatter	27
5.16 Melt-Through	28
5.17 Weld Size	28
5.18 Surface Oxidation	30

6. Examination Equipment	30
6.1 Introduction.....	30
6.2 Calibration and Handling of Examination Equipment	30
6.3 Linear Measuring Devices	31
6.4 Temperature Measuring Devices	31
6.5 Weld Gauges	32
6.6 Fiberscopes and Borescopes	35
6.7 Ferrite Gauges.....	35
6.8 Light Source.....	35
6.9 Electrical Meters.....	35
7. Records	38
Annex A—List of Standards Commonly Used in the Welding Industry	41
Annex B—Guidelines for the Preparation of Technical Inquiries	43
Annex C—Sample Forms.....	45
Annex D—Informative References	47
List of AWS Documents on Welding Inspection.....	49