MIL-STD-370(MR)
26 MAY 1988

MILITARY STANDARD

VISUAL ACCEPTANCE CRITERIA FOR INSPECTION OF ALUMINUM ALLOY WELDS

AMSC N/A

AREA NDTI

DEPARTMENT OF DEFENSE
WASHINGTON, DC 20402

Visual Acceptance Criteria For Inspection of Aluminum Alloy Welds

1. This standard is approved for use within the Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, U.S. Army Materials Technology Laboratory, ATTN: SLCMT-MEE, Watertown, Massachusetts 02172-0001, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

This standard covers the requirements for establishing the visual acceptance criteria of welded aluminum alloys made by fusion welding processes. Included in this standard, are illustrations depicting the various weld discontinuities. The standard is intended to be used in conjunction with MIL-W-45205 and MIL-STD-1946. The weld discontinuity sizes tested herein are the maximum allowable size for the designated category. In case of a conflict between this document and any other document, this document takes precedence.

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1. SCOPE

1.1 Scope. This standard provides visual acceptance criteria for fusion welding of aluminum alloys made by any of the following processes: Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW), Electron Beam Welding (EBW), Plasma Arc Welding (PAW), and Shielded Metal Arc Welding (SMAW).

1.2 Classification. For visual inspection purposes, weldments shall be classified as follows:

1.2.1 Grade A - critical applications. Weldment is critical where a failure of any portion would cause loss of system, loss of ballistic integrity, loss of major component, or loss of personnel.

1.2.2 Grade B - semi-critical applications. A weldment, non-ballistic and structural, is semi-critical when failure could reduce overall efficiency of the system but loss of system would not be experienced and possible injury to personnel could result.

1.2.3 Grade C - non-critical applications. A weldment is non-critical when failure would not affect the efficiency of the system or endanger personnel.

1.2.4 Grade A(SP) - special applications. Special applications such as a pressure vessel or a vacuum system which requires special consideration.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-W-45205 - Welding, Gas Metal Arc & Gas Tungsten-arc, Aluminum Alloys, Readily Weldable for Structures, Excluding Armor

STANDARDS

MILITARY

MIL-STD-1946 Welding of Aluminum Alloy Armor

(Copies of specifications, standards, handbooks, drawings, publications, and other Government documents required by contractors in connection wih specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following document(s) form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the non-government documents which is current on the date of the solicitation.

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4 - Symbols for Welding and Nondestructive Testing.
AWS A3.0 - Welding Terms and Definititions

(Applications for copies should be addressed to the American Welding Society, Inc. 2501 NW 7th, Miami, FL 33125.

(Industry association specifiections and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this standard shall take precedence. Nothing in this standard, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 For the terms and definitions used in this standard refer to AWS A2.4 and AWS A3.0.

3.2 Visual inspection. Visual inspection, for the purpose of this standard, is the examination with aided or unaided eye to determine the presence of discontinuities.

3.3 Footcandle. The measure of illumination. One footcandle equals one candle illumination at a distance of one foot.

3.4 Appurtenance. A part that is attached to an assembly or subassembly.

3.5 Defect. A discontinuity which is detrimental to the useful service of the part in which it occurs.

3.6 Discontinuity. An interruption in the normal physical structure or configuration of a part. A discontinuity is termed a defect whenever any of its dimensions exceed the maximum as specified within this document.

3.7 Indication. That which denotes the presence of a discontinuity.

4. GENERAL REQUIREMENTS

N/A

5. DETAILED REQUIREMENTS.

5.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

5.2 Weld preparation criteria.

5.2.1 Grade A. Grade A weldments shall be prepared in accordance with MIL-STD-1946.

5.2.2 Grade B. Grade B weldments shall be prepared in accordance with Class A specified in MIL-W-45205.

5.2.3 Grade C. Grace C weldments shall be prepared in accordance with Class B specified in MIL-W-45205. Appurtenance weldments to armor shall be prepared in accordance with MIL-STD-1946.

5.2.4 Grade A(SP). Grade A(SP) weldment shall be prepared in accordance with drawings specified in the contract.

5.3 Visual inspection. Visual inspection of weld shall be performed in a well lit area, having a minimum of 100 ft. candle light. All welds shall be visually inspected in accordance with this standard.

5.4 Workmanship. Workmanship shall be as established by the approved workmanship specimens as required by MIL-STD-1946 and MIL-W-45205 as applicable and in conjunction with table 1 of this standard.

5.5 Allowable discontinuities. The amount of allowable discontinuities in a weld shall be as specified in table I of this standard.

5.6 Complete fusion. For the purpose of illustration complete weld fusion is shown on figure 1.

5.7 Incomplete fusion. For the purpose of illustration incomplete fusion of welds is shown on figure 2.

5.8 Weld flaws. For the purpose of illustration weld flaws are shown on figures 3a and 3b.

5.9 Weld cracks. For the purpose of illustration weld cracks are shown on figure 4.

5.10 Unacceptable welds. Welds found to be of unacceptable quality shall be repaired per an approved weld repair procedure as required by the applicable welding document.

6. NOTES

6.1 Intended use. This visual acceptance criteria does not replace the normal radiographic, dye penetrant, or other NDT requirement as specified in the contract, drawings, or welding procedure documents that are part of the procurement package. This standard is to augment the other NDT requirements and provide an inexpensive, quick method of checking the fabrication acceptability of weldments.

6.2 Subject term (key word) listing.

Visual inspection
Aluminum welds
Critical applications
Semi-critical applications
Non-critical applications

Custodian:
Army - MR

Review activity
Army - AT

Preparing activity:
Army - MR

(Project NDTI - A051)

(WP# ID 0344B/DISC-0134A. FOR MTL USE ONLY

TABLE I. Allowable discontinuity limits for each grade of weldment.

Discontinuity	GRADE OF WELDING A-SP	A	B	C
1. Cracks	None	None	None	None
2. Crater Cracks	None	Retained within crater only	Retained within crater only	Retained within crater only
3. Mismatch	10% T or 0.06 in 1/	10% T or 0.12 in 1/	10% T or 0.18 in 1/	10% T or 0.18 in 1/
4. Porosity open to surface	None	2 per in 1/16" max dia 2/	4 per in, 1/4 in min spacing 2/	[4 per in, 1/4 in] 1/4 in min spacing 2/
5. Undercut	None	20% T or 0.03 in 1T max length 1T 1/	20% T or 0.05 in 3T max length 1/	20% T or 0.06 in 5T max length 1/
6. Incomplete fusion	None	10% T or 0.03 in depth 1T max length 1/	10% T or 0.05 depth 1/ 2T max length	20% T or 0.06 in depth 1/ 4T max length
7. Overlap 3/	None	1T or 0.1 in 1/ max length	1T max length	2T max length
8. Concavity	None	20% T or 0.03 in depth 1/ 1T max length	20% T or 0.05 in depth 1/ 1T max length	20% T or 0.06 in depth 1/ 1T max length
9. Craters	None	20% T or 0.03 in depth 1/ 1T max length	20% T or 0.05 in depth 1/ 1T max length	20% T or 0.06 in depth 1/ 2T max length
10. Underbead drop through	1/8 in max for T 0.05 in	Requirement only for clearance of mating parts		
11. Corner Melt	Not applicable	10% T or .03 in 1T or .25 in 1/	10% T or .05 in 3T or .38 in max length 1/	20% T or .06 in 3T or .38 in max max length 1/
12. Accumulation	Not applicable	10T minimum between any 2 defects	6T minimum between any 2 defects	4T minimum between any 2 defects

Notes:

1/ Whichever is the lesser

2/ Maximum size 30 percent of T or 0.10 in, whichever is the lesser; T is plate thickness.

3/ If the defects exhibit sharp radii, sharp terminations or are crack-like, they shall be removed. If depression is not larger than permitted, they need not be rewelded.

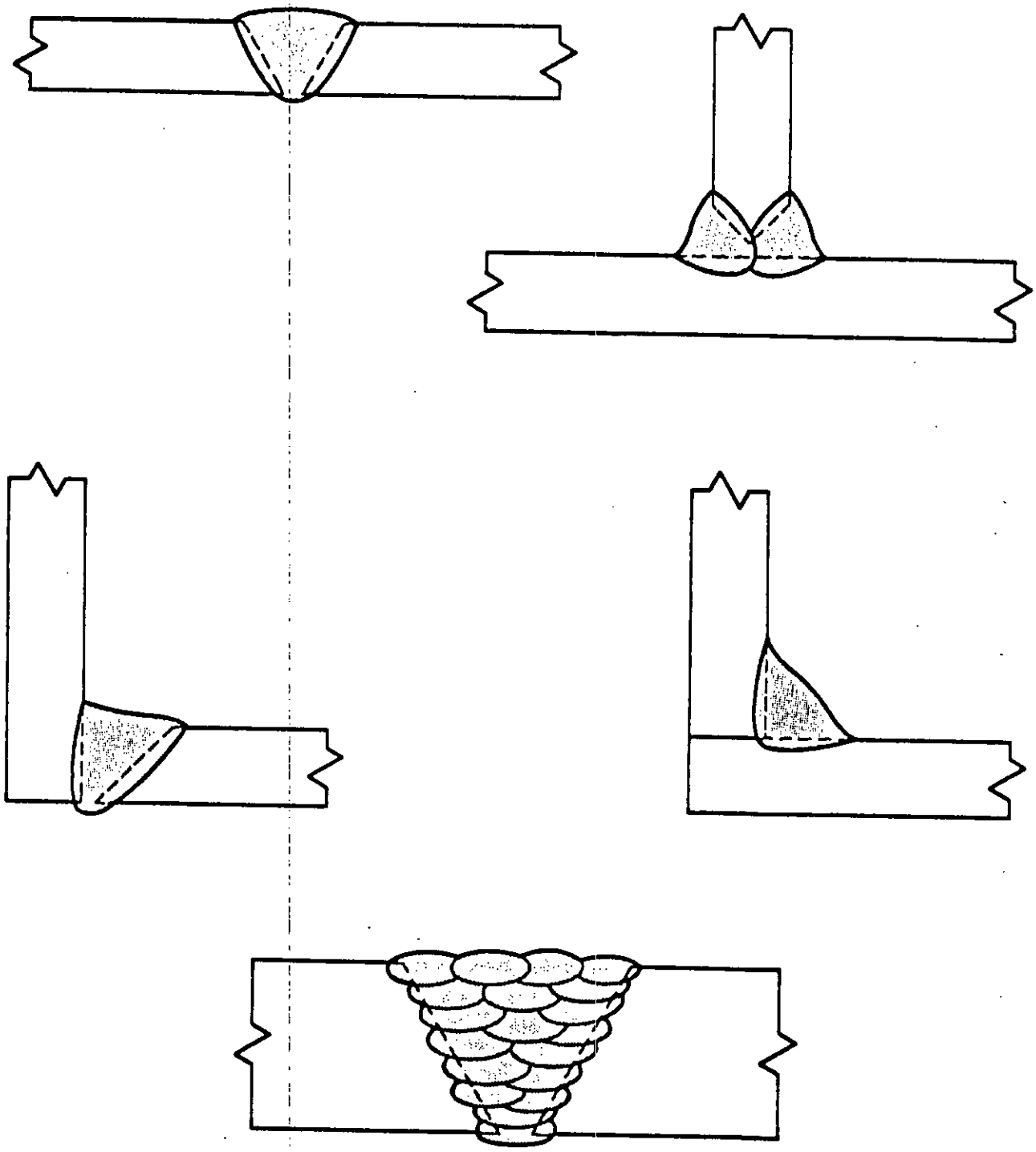


FIGURE 1. Complete fusion.
(Courtesy of the American Welding Society)

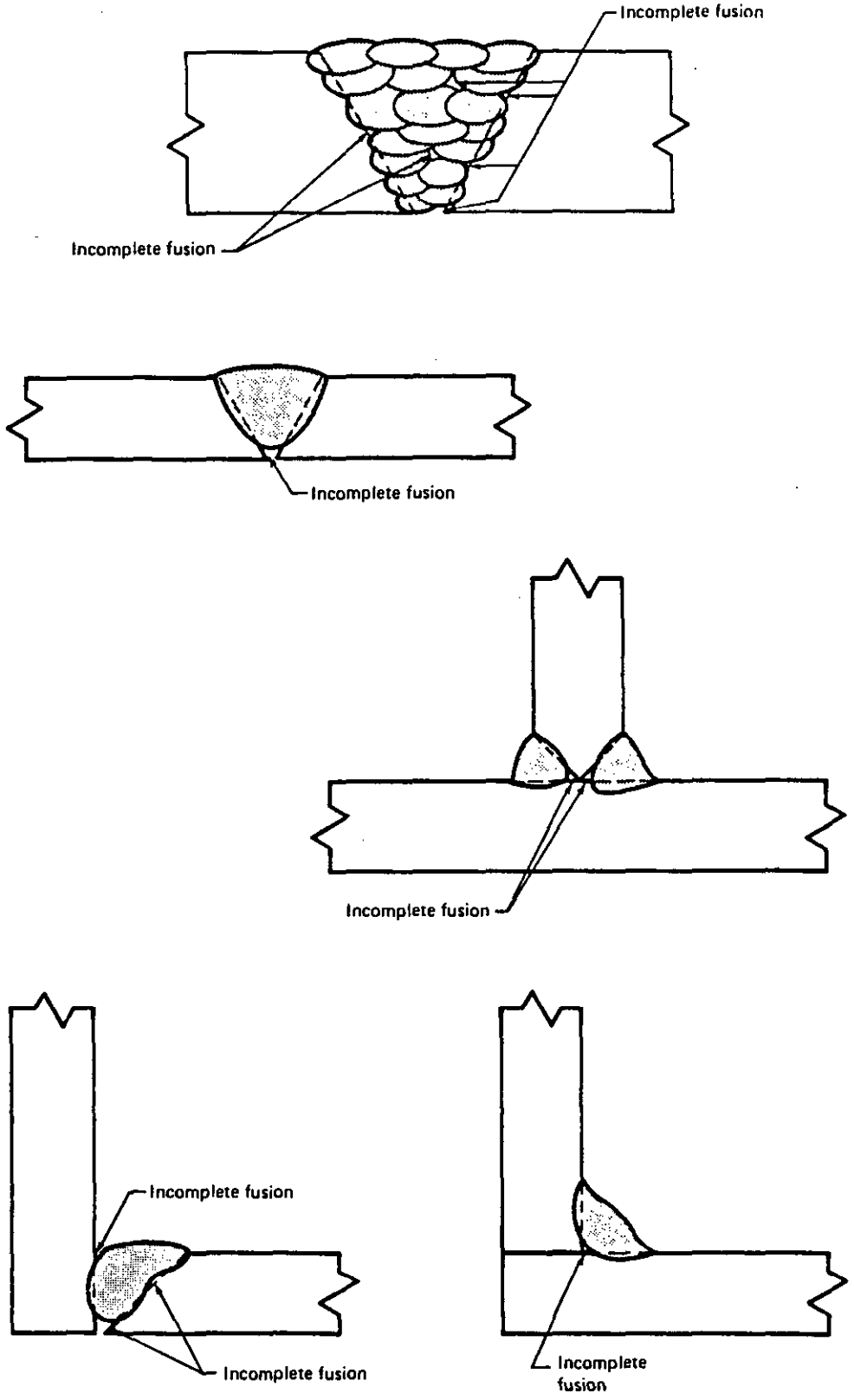


FIGURE 2. Incomplete fusion.
(Courtesy of the American Welding Society)

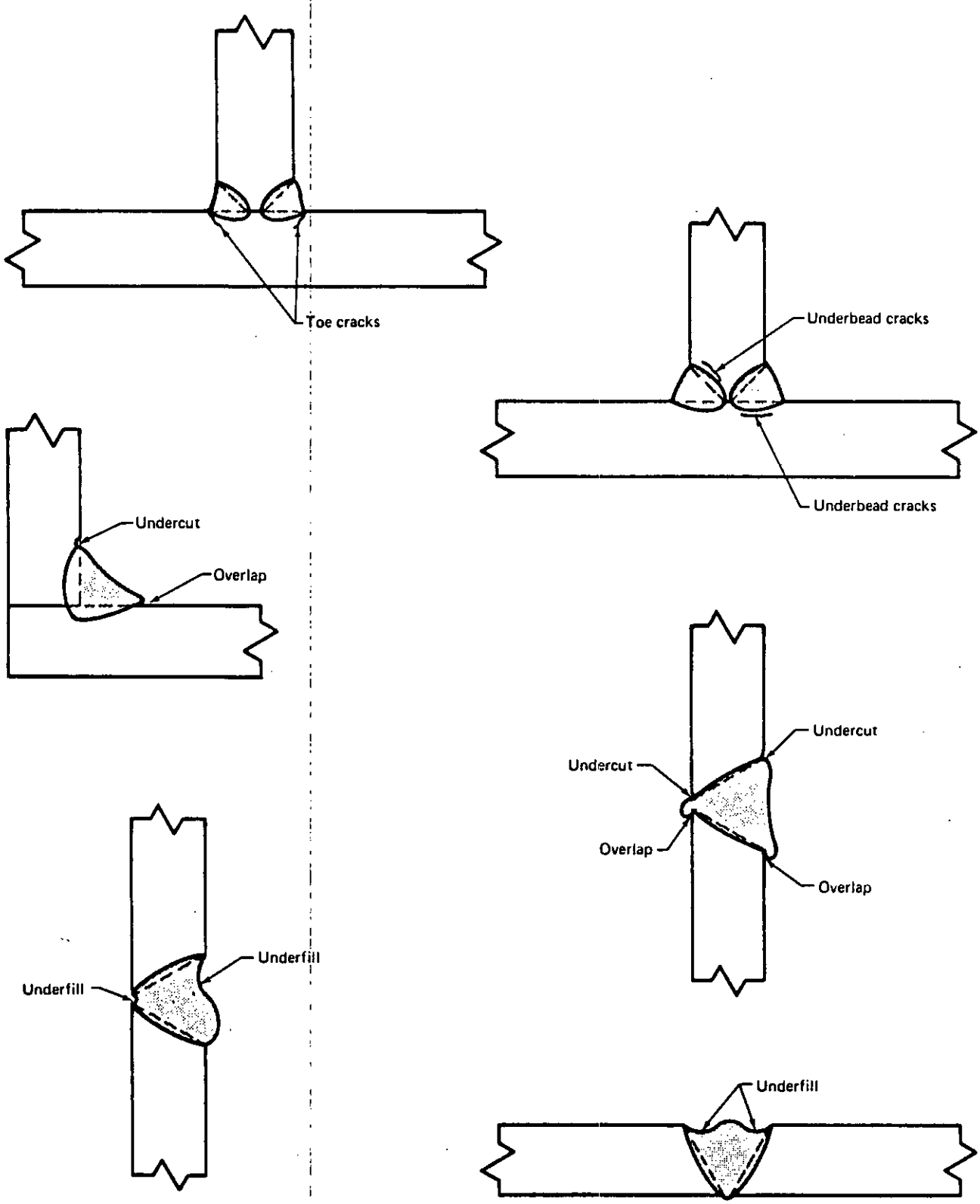
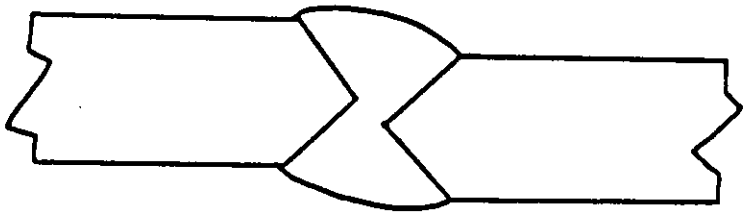
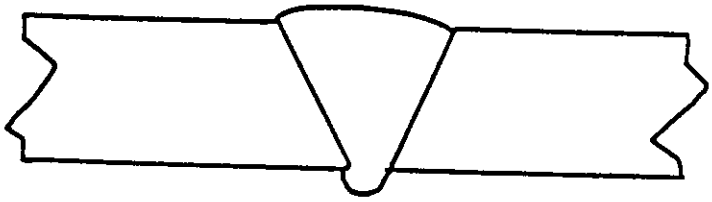


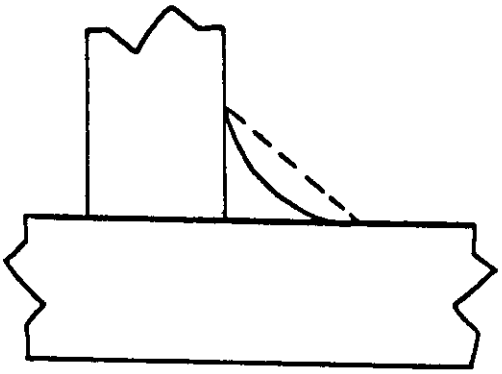
FIGURE 3a. Weld flaws.
(Courtesy of the American Welding Society)



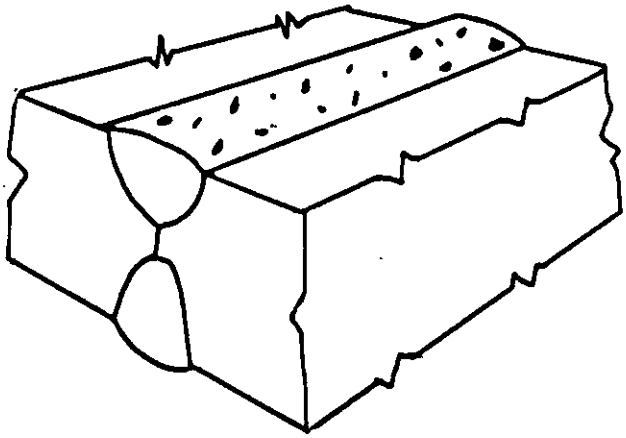
MISMATCH



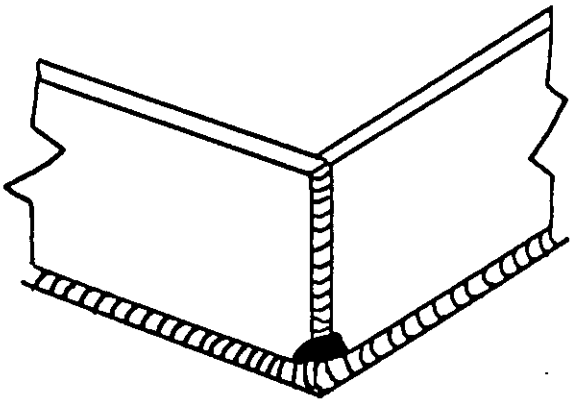
UNDERBEAD DROP THROUGH
(MELT THROUGH)



CONCAVITY

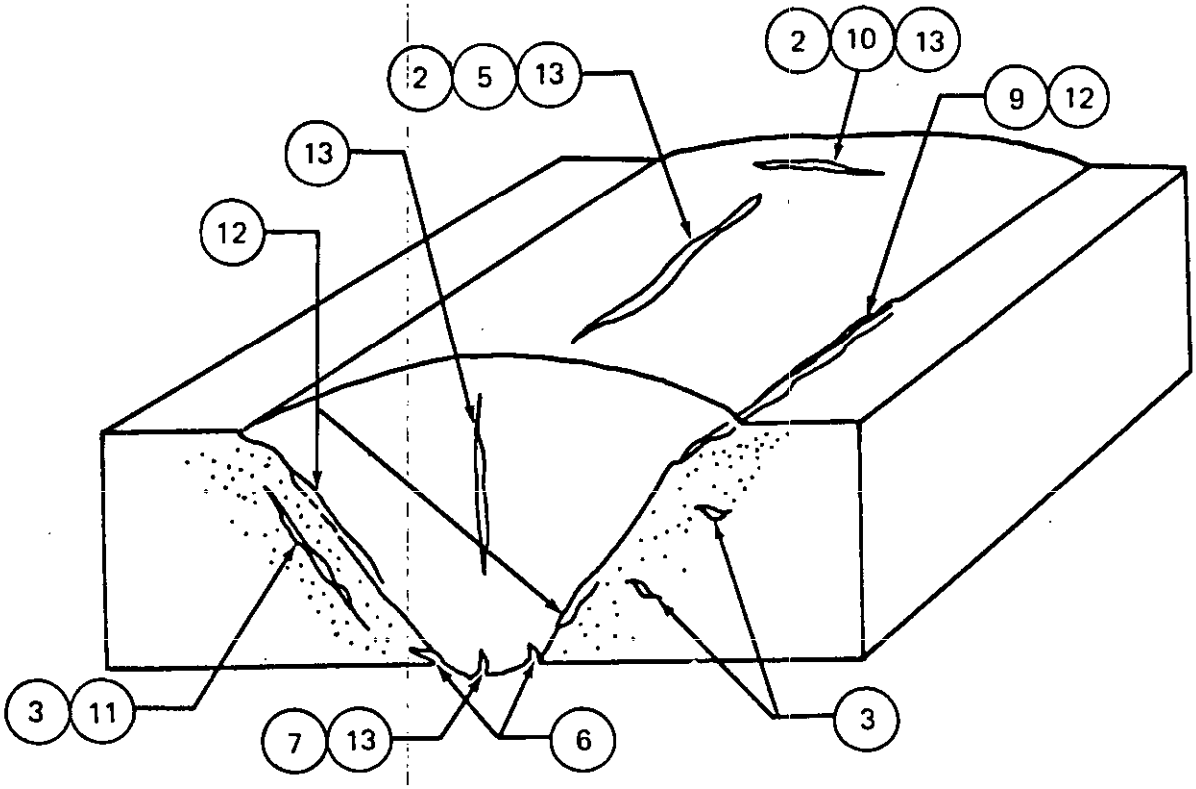


SURFACE POROSITY



CORNER MELT

FIGURE 3b. Weld flaws.



LEGEND

1 Crater crack
2 Face crack
3 Heat-affected zone crack
4 Lamellar tear
5 Longitudinal crack
6 Root crack
7 Root surface crack
8 Throat crack
9 Toe crack
10 Transverse crack
11 Underbead crack
12 Weld interface crack
13 Weld metal crack

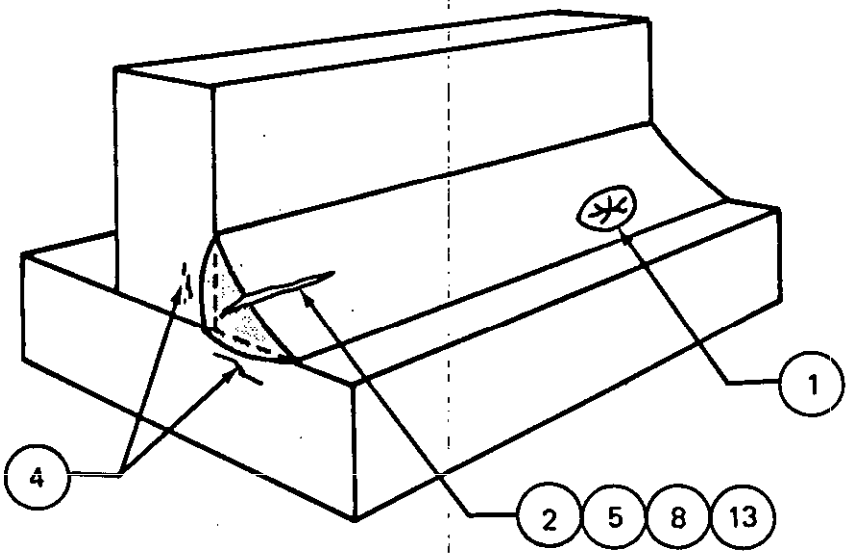


FIGURE 4. Crack types.
(Courtesy of the American Welding Society)