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# DEPARTMENT OF DEFENSE HANDBOOK

## RADIOGRAPHIC INSPECTION FOR SOUNDNESS OF WELDS IN STEEL BY COMPARISON TO GRADED ASTM E390 REFERENCE RADIOGRAPHS



This handbook is for guidance only. Do not cite this document as a requirement.

AMSC N/A

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FOREWORD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense.
2. This handbook is for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.
3. MIL-HDBK-1264 contains tables from which acceptance/rejection criteria can be prescribed for radiographic inspection for soundness of welds in steel by comparison to selected severity levels of ASTM E390 reference radiographs.
4. All information and data contained in this handbook have been coordinated with industry and the U.S. Army, Navy, Air Force and DLA prior to publication.
5. Copies of this document and revisions thereto may be obtained from the Defense Automated Printing Service (DAPS), 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.
6. 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 Research Laboratory, Weapons and Materials Research Directorate, ATTN: AMSRL-WM-M, Aberdeen Proving Ground, MD 21005-5069, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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## 1. SCOPE

1.1 Scope. This handbook prescribes requirements for radiographic inspection for soundness of welds in steel by comparison to selective severity levels of ASTM E390, Volume II reference radiographs. The base material varies from greater than 0.25 to 3.0 in. (6.4 to 76 mm) inclusive in thickness. This handbook is not suitable for shipyard use. This handbook is for guidance only. This handbook cannot be cited as a requirement. If it is, the contractor does not have to comply.

## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are the ones that are needed in order to fully understand the information provided by this handbook.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the latest issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto.

## STANDARDS

## DEPARTMENT OF DEFENSE

MIL-STD-410 - Nondestructive Testing Personnel Qualification and Certification

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service (DAPS), 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the latest issue of the DoDISS, and supplement thereto.

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E390 - Standard Reference Radiographs for Steel Fusion Welds (DoD adopted)  
ASTM E1742 - Standard Practice for Radiographic Examination (DoD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

## AMERICAN PETROLEUM INSTITUTE (API)

API STD 1104 - Welding of Pipelines and Related Facilities (DoD adopted)

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(Application for copies should be addressed to the American Petroleum Institute, 1220 "L" Street, NW, Washington, DC 20005-4070.)

## AMERICAN WELDING SOCIETY (AWS)

- AWS B3.0 - Welding Procedure and Performance Qualification
- AWS D1.1 - Structural Welding Code - Steel (DoD adopted)

(Application for copies should be addressed to the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

## 3. DEFINITIONS

3.1 Radiographic grade I. This term is used to classify a weld that is subject to high stresses in critical applications.

3.2 Radiographic grade II. This term is used to classify a weld for critical applications with a small design safety factor.

3.3 Radiographic grade III. This term is used to classify a weld for general applications with an average design safety factor.

3.4 Radiographic grade IV. This term is used to classify a weld that is subject to low stresses.

## 4. GENERAL REQUIREMENTS

4.1 Qualification for inspection. Personnel performing radiographic inspection shall be qualified in accordance with MIL-STD-410. Radiographic inspection shall be conducted in accordance with ASTM E1742.

4.2 Inspection lot. Unless otherwise specified, a lot shall consist of all welds of a specific design and size produced at one facility by the same personnel and production technique, and submitted for inspection at one time.

4.3 Grade. Welds shall be designated grades I, II, III or IV as shown in table I. A grade I weld would contain the least and/or smallest discontinuities and a grade IV weld would contain the largest and/or most numerous discontinuities.

## 5. DETAILED REQUIREMENTS

5.1 Determination of grades. The design activity shall establish the least acceptable grade for each weld design and this grade shall be indicated on the applicable approved drawing. If grade is not provided on drawing or other contractual document, grade II shall apply.

5.2 Acceptance criteria. Welds graded I, II, III, or IV shall contain discontinuities no greater than the acceptance level indicated in table I. Acceptance or severity levels indicated refer to those contained in ASTM E390.

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Each of the graded discontinuity types has five severity levels, 1 through 5 in order of increasing severity. Arabic number one references a radiograph which indicates smaller, fewer or less severe discontinuities than Arabic number two. Arabic number two references a radiograph which indicates smaller, fewer or less severe discontinuities than Arabic number three and so on.

TABLE I. Severity level requirements for welds per ASTM E390, Volume II reference radiographs.

Discontinuities	WELD THICKNESS		GRADE I	GRADE II	GRADE III	GRADE IV
	MAXIMUM	INCHES INCLUSIVE				
		3/8	NONE	1	2	3
Fine Scattered Porosity		3/4	NONE	2	2	3
		2	1	2	3	4
		3/8	NONE	1	2	3
Coarse Scattered Porosity		3/4	NONE	2	2	3
		2	1	2	3	4
		3/8	NONE	1	2	3
Clustered Porosity		3/4	NONE	2	2	3
		2	1	2	3	4
		3/8	NONE	1	2	3
Linear Porosity or Globular Indications		3/4	NONE	2	2	3
		2	1	2	3	4
		3/8	NONE	1	2	3
Slag Inclusions		3/4	NONE	2	2	3
		2	1	2	3	4
		3/8	NONE	1	2	3
Tungsten Inclusions		3/4	NONE	2	2	3
		3/8	NONE	1	2	3
Incomplete Penetration		3/4	NONE	2	3	4
		2	1	2	3	4
		3/8	NONE	1	2	3
Lack of Fusion		3/4	NONE	2	2	3
		2	1	2	3	4
<u>Ungraded Discontinuities</u>	Up to 3/8 inclusive					
Crater crack	-----NOT ALLOWED-----					
Transverse Crack	-----NOT ALLOWED-----					
Longitudinal Crack	-----NOT ALLOWED-----					
Tungsten Inclusions	---NO-GREATER THAN UNGRADED RADIOGRAPH---					
<u>Ungraded Discontinuities</u>	3/8, 3/4, and 2					
Undercut	-----NOT ALLOWED-----					
Burn Through	-----NOT ALLOWED-----					
Icicles (Teardrops)	-----NOT ALLOWED-----					
Elongated (or Wormhole) Porosity	-----NOT ALLOWED-----					
Crater crack	-----NOT ALLOWED-----					
Transverse Crack	-----NOT ALLOWED-----					
Longitudinal Crack	-----NOT ALLOWED-----					
Tungsten Inclusions	---NO-GREATER THAN UNGRADED RADIOGRAPH---					

Note: The following notes are an integral part of table I.

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(1) When two or more types of defects are present to an extent equal to or not significantly better than the acceptance standards for respective defects, the part shall be rejected.

(2) When two or more types of defects are present and the predominating defect is not significantly better than the acceptance standard, the part shall be considered borderline, and requires further review.

(3) Borderline welds may be considered acceptable, upon review and written approval by competent welding NDE and engineering personnel.

(4) Gas holes or sand spots and inclusions allowed by this table shall be cause for rejection when closer than twice their maximum dimension to an edge or extremity of a weldment, in a highly stressed or critical area as determined by design engineering personnel.

5.2.1 Applicable thickness ranges. The applicable thickness ranges for the reference radiograph illustration plate thickness used to determine severity level requirements for welds in table I of this document are given in table I, Applicable Thickness Ranges, under Volume II, ASTM E390. A 0.375 in. (9.5 mm) illustration plate thickness is applicable for weld thickness over 0.25 in. (6.4 mm) to and including 0.50 in. (13 mm). A 0.75 in. (19 mm) illustration plate thickness is applicable for weld thickness over 0.50 in. (13 mm) to and including 1.50 in. (38 mm). A 2.0 in. (51 mm) illustration plate thickness is applicable for weld thickness over 1.50 in. (38 mm) to and including 3.0 in. (76 mm). The thickness limits for this document may be extended beyond the limits in table I, ASTM 390 with the approval of the procuring activity.

5.2.2 Further acceptance criteria. The design activity may choose additional acceptance criteria from AWS D1.1, section 10.17, AWS B3.0, and API STD 1104, section 6. These documents will only be applicable when they appear on the drawing or other contractual document.

### 5.3 Radiographic inspection.

5.3.1 Welds, general. Radiographic inspection shall be in accordance with ASTM E1742. Acceptance inspection shall be in accordance with table I and ASTM E390. The extent of radiographic inspection of all welds shall be accomplished as required by drawing or contract. If extent is not provided, radiographic inspection shall be 100% of weld joints.

### 5.4 Standards.

5.4.1 Radiographic standards. Radiographic standard grades shall be established for each weld design for which radiographic inspection is specified (see 4.3). Such grades shall be in terms of ASTM E390 for steel fusion welds. Maximum acceptable defects shall be in accordance with table I.

### 5.5 Examination of rejected lots.

5.5.1 Rejection. Unless prohibited by the drawing, specification or other contract document, weld joints rejected because of non-compliance to ASTM E390 and table I may be repaired using a repair procedure approved by the

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authorized government inspection. All repaired areas shall be re-inspected in accordance with paragraph 5.3.1.

5.5.2 Review. In performing the review of the rejected lot, a technique may be detailed for the subsection of welds to various destructive tests, including loading (as in service use) or by sectioning, as practicable. This consideration shall be predicated on the size of the rejected lot, the size of the welds and criticality of the weld application.

## 6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This handbook is to be used as a guide when comparing radiographic inspection for soundness of welds in steel to selected severity levels of reference radiographs provided in an ASTM standard.

6.2 Producibility warning. The grade assigned to the weld should represent a realistic value for safety and for functional requirement. Do not assign a grade I weld for a grade II function. Caution should be exercised in specifying the grade of maximum permissible radiographic discontinuity level to be met in a weld.

6.3 Subject term (key word) listing.

Crater crack  
Discontinuities  
Porosity  
Tungsten inclusions



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CONCLUDING MATERIAL

Custodians:

Army - MR  
Navy - AS  
Air Force - 11

Preparing activity:

Army - MR

(Project NDTI-0268)

Review activities:

Army - CR, PT  
Navy - NP  
Air Force - 10, 13  
DLA - DH(DCMC-OF, DLSC-LEQ)

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

### I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER  
MIL-HDBK-1264

2. DOCUMENT DATE (YYMMDD)  
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3. DOCUMENT TITLE **RADIOGRAPHIC INSPECTION FOR SOUNDNESS OF WELDS IN STEEL BY COMPARISON TO GRADED  
ASTM E390 REFERENCE RADIOGRAPHS**

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

### 5. REASON FOR RECOMMENDATION

### 6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*

b. ORGANIZATION

c. ADDRESS *(Include Zip Code)*

d. TELEPHONE *(Include Area Code)*  
(1) Commercial  
(2) AUTOVON  
*(if applicable)*

7. DATE SUBMITTED  
(YYMMDD)

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