



Subject: Langley Research Center Standard for the Evaluation of Socket and Branch Connection Welds

Responsible Office: Safety and Mission Assurance Office

TABLE OF CONTENTS

PREFACE	3
P.1 PURPOSE	3
P.2 APPLICABILITY	3
P.3 AUTHORITY	3
P.4 APPLICABLE DOCUMENTS	3
P.5 MEASUREMENT/VERIFICATION	4
P.6 CANCELLATION	4
CHAPTER 1: INTRODUCTION	5
1.1 GENERAL	5
CHAPTER 2: INSPECTION TECHNIQUES	6
2.1 INSPECTION TECHNIQUES	6
CHAPTER 3: VISUAL EXAMINATION (VT)	7
3.1 METHOD OF INSPECTION	7
3.2 AREA OF INSPECTION	7
3.3 INSPECTION PERSONNEL QUALIFICATIONS	7
3.4 ACCEPTANCE CRITERIA FOR VISUAL EXAMINATION OF SOCKET AND BRANCH CONNECTION WELDS	7
3.5 INSPECTION REPORT	7
CHAPTER 4: RADIOGRAPHIC INSPECTIONS	9
4.1 METHOD OF INSPECTION	9
4.2 PERSONNEL QUALIFICATIONS	9
4.3 SAFETY	9
4.4 SURFACE PREPARATION	9
4.5 DIRECTION OF RADIATION	9
4.6 SHIM BLOCK THICKNESS, SIZE, AND MATERIAL	10
4.7 PENETRAMETER SELECTION AND ESSENTIAL HOLES	11
4.8 IDENTIFICATION MARKERS	11
4.9 SHIM BLOCK/PENETRAMETER PLACEMENT	12
4.10 RADIOGRAPHIC DENSITY	12
4.11 SOURCE STRENGTH	12
4.12 SCATTERED RADIATION	12
4.13 QUALITY OF RADIOGRAPHS	12
4.14 GEOMETRIC UNSHARPNESS/SOURCE-TO-FILM DISTANCE	12

4.15 ACCEPTANCE CRITERIA FOR RADIOGRAPHIC EXAMINATION OF SOCKET AND BRANCH CONNECTION WELDS	12
4.16 RADIOGRAPHIC TECHNICAL LOG AND INTERPRETATION REPORT	14
CHAPTER 5: MAGNETIC PARTICLE/DYE PENETRANT INSPECTIONS	15
5.1 GENERAL	15
5.2 INSPECTION TECHNIQUES	15
5.3 ACCEPTANCE CRITERIA FOR MAGNETIC PARTICLE AND DYE PENETRANT EXAMINATION OF SOCKET AND BRANCH CONNECTION WELDS	15
5.4 INSPECTION REPORT	16
APPENDIX A. ACRONYMS	17
APPENDIX B. FIGURES	18
B-1. SOCKET-WELD FITTING JOINT NOMENCLATURE	18
B-2. UNACCEPTABLE SOCKET-WELD LEG SIZE	18
B-3. SURFACE CRACKING	19
B-4. SURFACE INCOMPLETE FUSION.....	20
B-5. UNDERCUT.....	20
B-6. SURFACE SLAG AND POROSITY	21
B-7. RADIOGRAPHIC EXPOSURE TECHNIQUE FOR SOCKET WELDING FITTINGS	21
B-8. INTERNAL CRACKS	23
B-9. INCOMPLETE PENETRATION.....	24
B-10. INCOMPLETE FUSION	25
B-11. UNACCEPTABLE PIPE-TO-SOCKET GAP.....	26
B-12. POROSITY AND ROUNDED INDICATIONS.....	27
B-13. SLAG INCLUSIONS	28
B-14. MELT THROUGH	29
B-15. NOMENCLATURE FOR BRANCH-CONNECTION WELDS.....	30
B-16. RADIOGRAPHIC EXPOSURE TECHNIQUE FOR BRANCH CONNECTION FITTINGS	31
B-17. INCOMPLETE PENETRATION IN BRANCH CONNECTION FITTINGS...	32

PREFACE

P.1 PURPOSE

- a. This document sets forth the minimum safety procedural requirements for evaluating socket and branch connection welds within the framework of Langley Research Center (LaRC) pressure system work.
- b. It provides professional designers and craftsmen a basis for safety and uniformity in the design, fabrication, and inspection of welded piping systems.

P.2 APPLICABILITY

- a. This Langley Procedural Requirement (LPR) is applicable to all NASA LaRC organizations and all federal civil service personnel on Center.
- b. This LPR is applicable to contractors, grant recipients, or parties to agreements only to the extent specified or referenced in the appropriate contracts, agreements, or grants.
- c. Noncompliance with the requirements of this LPR may result in appropriate disciplinary action against civil service personnel or sanctions against contractors in accordance with the terms of their contracts.
- d. In this directive, all mandatory actions (i.e., requirements) are denoted by statements containing the term “shall.” The terms “may” denotes a discretionary privilege or permission, “can” denotes statements of possibility or capability, “should” denotes a good practice and is recommended, but not required, “will” denotes expected outcome, and “are/is” denotes descriptive material.
- e. In this directive, all document citations are assumed to be the latest version unless otherwise noted.

P.3 AUTHORITY

- a. NASA-STD-8719.17, NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems (PV/S).

P.4 APPLICABLE DOCUMENTS

- a. LPR 1710.5, Ionizing Radiation.
- b. LPR 1710.40, Langley Research Center Pressure Systems Handbook.
- c. LPR 1710.42, Safety Program for the Recertification and Maintenance of Ground-Based Pressure Vessels and Piping Systems (PVS).
- d. ASME Boiler and Pressure Vessel Code (B&PVC).
- e. ASME B16.11, Forged Fittings, Socket-Welding and Threaded.
- f. ASME B16.34, Valves – Flanged, Threaded, and Welding End.

- g. ASME B31.1, Power Piping.
- h. ASME B31.3, Process Piping.
- i. ASNT SNT-TC-1A, Personnel Qualification and Certifications in Nondestructive Testing.
- j. Manufacturers Standardization Society (MSS)-SP-97, Integrally Reinforced Forged Branch Outlet Fittings – Socket Welding, Threaded, and Buttwelding Ends.

P.5 MEASUREMENT/VERIFICATION

None

P.6 CANCELLATION

1710.41 I, Langley Research Center Standard for the Evaluation of Socket and Branch Connection Welds, dated January 4, 2017.

David F. Young December 16, 2021

Title

Date

Distribution:

Approved for public release via the Langley Management System; distribution is unlimited.

CHAPTER 1: INTRODUCTION

1.1 GENERAL

1.1.1 This procedural requirement shall be used for the nondestructive evaluation of socket and branch connection welds at LaRC, in conjunction with LPR 1710.40, “Langley Research Center Pressure Systems Handbook,” and LPR 1710.42, “Safety Program for the Recertification and Maintenance of Ground-Based Pressure Vessels and Piping Systems (PVS).”

1.1.2 Socket fittings include, but are not limited to, all common pipe fittings (e.g., tees, elbows, couplings, caps, flanges, unions, and valves meeting the requirements of ASME B16.11 “Forged Fittings, Socket Welding and Threaded,” and ASME B16.34, “Valves – Flanged, Threaded, and Welding End”).

1.1.3 Branch connections are defined as Weld-O-Let, Sock-O-Let, Thread-O-Let, or other similar commercial fittings made in accordance with MSS-SP-97, “Integrally Reinforced Forged Branch Outlet Fittings, Socket Welding, Threaded, and Butt Welding,” and include modified components such as couplings.

1.1.4 The exterior weld of slip-on flanges may be inspected using this standard.

1.1.5 Reference documents include those published by:

- a. American Society of Mechanical Engineers (ASME)
- b. American Society for Nondestructive Testing (ASNT)

CHAPTER 2: INSPECTION TECHNIQUES

2.1 INSPECTION TECHNIQUES

2.1.1 Four nondestructive evaluation techniques are available to be used exclusively or in combination to inspect socket type and branch connection welds. These techniques are:

- a. Visual examination (VT),
- b. Radiographic examination (RT),
- c. Magnetic particle examination (MT), and
- d. Dye penetrant examination (PT).

2.1.2 Under special circumstances, other techniques (e.g., eddy current examination or ultrasonic examination) may be required. Their application shall be guided by the appropriate sections of the ASME “Boiler and Pressure Vessel Code” (B&PVC).

CHAPTER 3: VISUAL EXAMINATION (VT)

3.1 METHOD OF INSPECTION

3.1.1 Socket and branch connection welds shall be inspected for surface defects using visual inspection techniques.

3.2 AREA OF INSPECTION

3.2.1 Visual inspections within the scope of this procedural requirement shall be the weld contour and adjacent pipe and fitting surfaces.

3.2.2 Inspections shall be conducted in accordance with the most current editions of the ASME Code B31.3, B31.1 and the ASME B&PVC, Section V, Article 9, with the following modifications:

- a. Unless otherwise specified, all welds shall be contour ground and free of rust, scale, slag, or other conditions that would obscure the surface condition.
- b. The pressure retaining wall thickness shall not be reduced below the Code allowable limits.

3.3 INSPECTION PERSONNEL QUALIFICATIONS

- a. Inspection personnel shall be currently certified under a plan based on the American Society for Nondestructive Testing (ASNT) recommended practice SNT-TC-1A "Recommended Practice for Nondestructive Testing Personnel Qualification and Certification" to a minimum qualification of Level II.
- b. Inspectors shall successfully pass a corrected eye examination in accordance with the requirements of ASNT SNT-TC-1A.

3.4 ACCEPTANCE CRITERIA FOR VISUAL EXAMINATION OF SOCKET AND BRANCH CONNECTION WELDS

3.4.1 Weld fillets shall comply with the requirements of the current edition of ASME B31.3. In lieu of a specified pressure design thickness t , the nominal pipe wall thickness T_w shall be substituted. (See Appendix B, Figures B-1 and B-2.)

3.4.2 The weld surface and adjacent base metal shall be free of cracks, incomplete fusion (IF), arc strikes, weld spatter, gouges, porosity, underfill, overlap, slag inclusion, convexity, concavity, mishandling marks, and other sharp surface irregularities and meet all requirements in ASME B31.3 for severe cyclic conditions.

3.4.3 The weld fillet shall blend uniformly into the pipe wall and fitting rim.

3.4.3.1 The undercut shall not exceed the lesser of 1/32 inch or $T_w/4$ (T_w = nominal pipe wall thickness).

3.4.4 Surface porosity and/or slag shall not be permitted. (See Appendix B, Figures B-3 through B-6 for examples of these irregularities.)

3.4.5 Unless otherwise specified, axial misalignment between the pipe and fitting shall not exceed 5°.

3.5 INSPECTION REPORT

3.5.1 Upon completion of visual inspections, the inspecting organization shall furnish a report containing, as a minimum, the following information:

- a. System identification,
- b. Drawing number,
- c. Location,
- d. Sketch or description of each component/weld,
- e. Material type,
- f. Surface condition,
- g. Discrepancies noted,
- h. Inspector's name,
- i. Inspection data, and
- j. Contract number.

CHAPTER 4: RADIOGRAPHIC INSPECTIONS

4.1 METHOD OF INSPECTION

4.1.1 Socket and branch connection weld joints shall be inspected for defects using radiographic techniques.

4.1.2 These radiographic inspections shall be conducted in accordance with the most current edition of the ASME B&PVC, Section V, Article 2, as modified by the following paragraphs.

4.1.3 Any item not specifically addressed herein will revert to the provisions of ASME B&PVC, Section V.

4.2 PERSONNEL QUALIFICATIONS

4.2.1 All inspection personnel shall be qualified in accordance with ASNT SNT-TC-1A Personnel qualified to Level I shall be used only under the field supervision of Level II or Level III inspectors.

4.2.2 Radiographic film interpreters shall be qualified per ASNT SNT-TC-1A, Level II or Level III, or shall be qualified as a certified Radiograph Interpreter per the American Welding Society (AWS).

4.2.3 Final interpretation and acceptance of radiographs of pressure-retaining items shall be by the LaRC Radiograph Interpreter.

4.2.4 In addition to the above requirement, radiographic interpreters shall have demonstrated near-distance acuity as specified under Chapter 3, Section 3.3 of this LPR and shall be familiar with weld fabrication techniques.

4.3 SAFETY

4.3.1 All radiographic inspection operations conducted at LARC shall be in accordance with LPR 1710.5.

4.4 SURFACE PREPARATION

4.4.1 Unless otherwise specified, all welds shall be contour ground and free of surface irregularities that could mask or be confused with discontinuities.

4.5 DIRECTION OF RADIATION

4.5.1 Each socket weld exposure setup shall be aligned so as to pass the radiation central ray parallel to, and in line with, the socket rim. (See Appendix B, Figure B-7.)

4.5.2 Each branch connection weld exposure setup shall be aligned so as to pass the radiation central ray in a tangent to the run pipe external surface.

4.5.2.1 Two views shall be imaged as follows (see Appendix B, Figure B-16):

- a. View 0 – with the central ray perpendicular to the run pipe axis.
- b. View 1 – with the central ray offset 25-35° from View 0.

NOTE

Branch connections over 6 inches in outside diameter (O.D.) shall require additional exposures or alternate techniques at the discretion of the NASA-NDE Radiograph Interpreter.

4.5.3 The requirements defined within this section (i.e., Section 4.5) may, at the discretion of the NASA Non-Destructive Evaluation (NDE) Radiograph Interpreter, be relaxed to allow the simultaneous exposure of closely spaced weld joints.

4.5.3.1 Three views of each weld joint taken at 60° to each other is the minimum acceptable coverage for pipe having a nominal size greater than 1 inch.

4.5.3.2 For pipe having a nominal size of 1 inch or less, two views of each weld joint taken at 90° to each other is the minimum acceptable coverage. (See Appendix B, Figure B-7.)

4.6 SHIM BLOCK THICKNESS, SIZE, AND MATERIAL

4.6.1 The shim block thickness shall be established for each joint by using the following formulas:

- a. For socket: $2T_W + R$
- b. For branch: $2T_f + R$

where:

- (1) T_f = the nominal fitting single wall thickness
- (2) T_W = the nominal pipe single wall thickness
- (3) R = the component of weld reinforcement measured perpendicular to the pipe axis at the fitting edge rim. (See Appendix B, Figure B-1 for socket welds and Figure B-15 for branch connection welds.)

4.6.2 The shim block shall be of sufficient size to allow placement of a penetrameter and identification markers.

4.6.3 Shim material shall be radiographically similar to the subject weld/pipe material.

4.7 PENETRAMETER SELECTION AND ESSENTIAL HOLES

4.7.1 The penetrameter selection shall be based on the calculated shim thickness as follows:

Table A. Table of Dimensions of Image Quality Indicator (IQI) (inches)

SHIM THICKNESS ($2T_w + R$) OR ($2T_f + R$)	<u>PENETRAMETER</u>	<u>ESSENTIAL HOLE</u>
a. 0 thru 0.375	10	4t
b. Over 0.375 thru 0.625	12	4t
c. Over 0.625 thru 0.875	15	4t
d. Over 0.875 thru 1.00	17	4t
e. Over 1.00 thru 1.50	25	2t
f. Over 1.50 thru 2.00	30	2t
g. Over 2.00 thru 2.50	35	2t

4.8 IDENTIFICATION MARKERS

4.8.1 An ID plate is necessary for all high-pressure piping and when random or partial radiographic inspection is instituted.

4.8.2 The ID plate shall be a flexible type plate stamped with the required information and bonded to the required location on the pipe or marked with permanent sharpie

4.8.3 An isometric weld map shall accompany all RT inspections of piping to facilitate location of welds.

4.8.3.1 If the radiographic view depicts more than one weld joint, identification numbers shall be included in the image to positively identify each weld.

4.8.4 No low-stress stamping or electric etcher or vibratory etching of any piping shall be allowed due to the fact that materials in operation under long-term creep or creep fatigue may experience a failure.

4.8.4.1 If marking on a pipe is required, utilize a flexible ID plate as noted in Section 4.8.2.

4.8.5 Film printer identification techniques are prohibited.

4.8.6 Each radiograph shall, as a minimum, have the following information permanently included in its image:

- a. Weld number,
- b. View number,
- c. NASA Quality Assurance (QA) or contract number,
- d. Radiographic contractor identification,
- e. Date of exposure,
- f. NASA drawing number, and

g. Welder ID.

4.9 SHIM BLOCK/PENETRAMEETER PLACEMENT

4.9.1 The shim block with identification numbers and penetrometer shall be aligned parallel to the subject pipe axis with the penetrometer center adjacent to the socket rim. (See Appendix B, Figure B-7 for socket welds and Figure B-16 for branch connection welds.)

4.10 RADIOGRAPHIC DENSITY

4.10.1 The calculated shim thickness stated in Section 4.6 shall be used to determine exposure values.

4.10.2 Film image density shall be measured through the shim block/penetrometer combination and shall equal 3.0 ± 0.5 . (See Appendix B, Figure B-7.)

4.11 SOURCE STRENGTH

4.11.1 Unless otherwise specified, the radiation source energy shall be equal to or greater than 35 curies from IR 192 and 150 KEV for x-ray machines.

4.12 SCATTERED RADIATION

4.12.1 To minimize the effect of backscatter radiation, all film cassettes shall be backed with a minimum of 1/16 inch-thick lead sheeting.

4.12.1.1 This sheeting shall be a sufficient size to completely cover the cassette and shall be covered with tape to prevent lead smearing. (See Appendix B, Figure B-7 for socket welds and Figure B-16 for branch connection welds.)

4.13 QUALITY OF RADIOGRAPHS

4.13.1 All radiographs shall be free of mechanical, chemical, or other blemishes that could mask the image of any discontinuity within the area of interest.

4.13.1.1 Such blemishes include, but are not limited to:

- a. Fogging;
- b. Processing defects such as streaks, water marks, or chemical stains;
- c. Scratches, finger marks, crimps, dirt, static marks, smudges, or tears;
- d. Loss of detail due to poor screen-to-film contact; and
- e. False indications due to defective screens or cassette faults.

4.14 GEOMETRIC UNSHARPNESS/SOURCE-TO-FILM DISTANCE

4.14.1 Geometric unsharpness of the radiographic image shall not exceed 0.020 inch.

4.14.2 The radiation source-to-film distance, unless otherwise specified by the NASA NDE Radiograph Interpreter, shall be not less than 14 inches.

4.15 ACCEPTANCE CRITERIA FOR RADIOGRAPHIC EXAMINATION OF SOCKET AND BRANCH CONNECTION WELDS

4.15.1 The following acceptance criteria apply:

- a. Cracks of any nature or extent are not acceptable. (See Appendix B, Figure B-8.)
- b. Incomplete penetration (IP) as follows is not acceptable:
 - (1) Socket: The failure of weld material to extend completely into and become integral with the intersection of socket rim inner diameter and cylindrical pipe wall. (See Appendix B, Figure B-9.)
 - (2) Branch: The failure of the weld material to:
 - (a) Extend completely to the inner surface of the fitting, and
 - (b) Become integral with both the pipe and the fitting. (See Appendix B, Figure B-17.)
- c. Incomplete Fusion (IF)—an isolated, discontinuous or continuous area of no weld material fusion at the weld-socket, weld-pipe interface, or between consecutive weld passes—is not acceptable. (See Appendix B, Figure B-10.)
- d. For socket welds only, a gap of $1/16$ inch \pm $1/32$ inch shall be maintained between pipe end and socket bottom before welding. (See Appendix B, Figures B-1 and B-11.)
- e. An individual porosity defect or rounded indication shall not exceed the lesser of $T_W/3$ or $1/8$ inch in its greater dimensions.
 - (1) Adjacent indications shall be separated by a minimum $T_W/2$ of sound weld.
 - (2) The summation of diameters for aligned rounded indications shall not exceed T_W in length for any $6T_W$ of weld. (See Appendix B, Figure B-12.)
- f. Slag inclusions/elongated defects requirements are as follows:
 - (1) The developed length of any single slag inclusion or elongated defect shall not exceed $T_W/3$.
 - (2) Adjacent slag inclusions shall be separated by a minimum $T_W/2$ sound weld.
 - (3) The total cumulative developed length of slag inclusions and/or elongated defects shall not exceed T_W in any $6T_W$ of weld.
 - (4) The width of a slag inclusion shall not exceed the lesser of $3/32$ inch or $T_W/3$.
 - (5) Slag inclusions or elongated defects that infringe upon the root area are not acceptable to any extent. (See Appendix B, Figure B-13.)
- g. Melt through, a localized area of pipe metal melting and resolidification usually located on the pipe inner diameter, shall be reviewed on an individual case basis and shall not:
 - (1) Reduce the nominal pipe wall thickness greater than 12.5 percent.
 - (2) Present unacceptable internal flow restrictions as determined by the Standard Practice Engineer.
 - (3) Include icicle type areas, which could become dislodged. (See Appendix B, Figure B-14.)

- h. Burn through or suck up shall not reduce the nominal pipe wall thickness greater than 12.5 percent.

4.16 RADIOGRAPHIC TECHNICAL LOG AND INTERPRETATION REPORT

4.16.1 The radiographer shall furnish, in addition to the radiographic film, a technical log and interpretation report relative to each inspected weld.

4.16.1.1 The log/report shall contain, as a minimum, the following data:

- a. System identification;
- b. Drawing number;
- c. Location;
- d. Sketch or description of each component/weld;
- e. Material type;
- f. Pipe nominal wall thickness T_W and fitting nominal wall thickness T_f ;
- g. Weld thickness R ;
- h. Shim block thickness - $2T_W + R$ or $2T_f + R$;
- i. Penetrameter size/essential hole;
- j. Isotope or x-ray machine with size, type, and energy;
- k. Film type and manufacturer;
- l. Screen type, thickness, and placement;
- m. Source-to-film distance;
- n. Exposure time/milliamp-minutes (MAM);
- o. Radiographer's name and level;
- p. Inspection date;
- q. Discrepancies noted;
- r. Interpreter's name and level;
- s. Interpretation date; and
- t. Job/purchase order number.

CHAPTER 5: MAGNETIC PARTICLE/DYE PENETRANT INSPECTIONS

5.1 GENERAL

5.1.1 Socket and branch connection weld joints shall be inspected for surface defects utilizing magnetic particle or dye penetrant techniques, as applicable.

5.1.1.1 This work shall be conducted in accordance with the ASME B&PVC, Section V, Article 7 for magnetic particle and Article 6 for dye penetrant, with the following modifications:

- a. Inspection personnel shall be qualified in accordance with ASNT-SNT-TC-IA. Personnel qualified to Level I shall be used only under the field supervision of Level II or Level III inspectors.
- b. Weld joint surfaces and adjacent areas (within a minimum of 1 inch on each side of weld) shall be free of any irregularities that could mask indications. All welds having received post weld heat treatment (PWHT) shall subsequently be MT or PT inspected per this LPR and the applicable welding code.
- c. Prior to inspection, these areas shall be dry and free of all paint, dirt, grease, lint, scale, welding flux and splatter, oil, and other extraneous matter that could interfere with the examination.

5.2 INSPECTION TECHNIQUES

5.2.1 The following are the two weld joint inspection techniques:

- a. Magnetic particle technique:
 - (1) The inspector has the option of using a coil encirclement or yoke magnetization technique.
 - (2) Magnetizing field adequacy shall be verified using a magnetic particle field indicator as illustrated in ASME B&PVC, Section V, Article 7. This verification shall be conducted at the beginning of each period of work or shift change and as a minimum every 4 hours during the work period.
 - (3) All surface areas of: (a) the weld and (b) the adjacent pipe and fitting material (for a minimum of 1 inch on each side of the weld) shall be 100 percent inspected.
- b. Dye penetrant technique:
 - (1) Unless otherwise specified, dwell time shall be not less than 10 minutes.
 - (2) When the surface temperature of the area to be inspected is outside of the 60°F to 125°F range, the testing procedure shall be qualified as per the requirements of ASME B&PVC, Section V, Article 6.

5.3 ACCEPTANCE CRITERIA FOR MAGNETIC PARTICLE AND DYE PENETRANT EXAMINATION OF SOCKET AND BRANCH CONNECTION WELDS

5.3.1 The following weld defects shall constitute rejectable conditions:

- a. Cracks,

- b. Incomplete fusion (IF), and
- c. Surface open slag or porosity.

5.4 INSPECTION REPORT

5.4.1 Upon completion of magnetic particle and/or dye penetrant inspections, the inspector shall furnish a report containing, as a minimum, the following information:

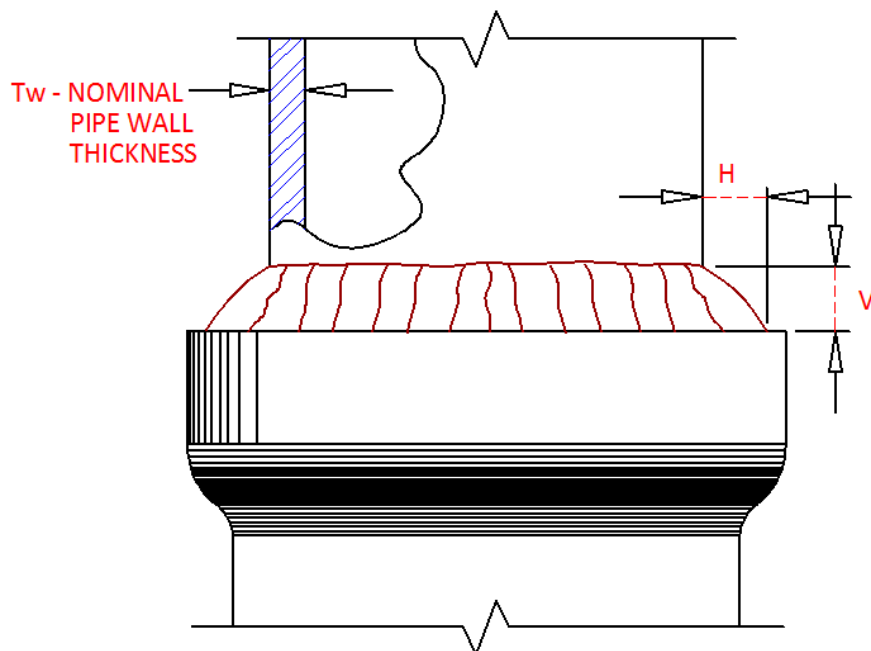
- a. System identification;
- b. Drawing number;
- c. Location;
- d. Description (e.g., sketch, photographs, weld map, description of inspected item);
- e. Discrepancies noted;
- f. Inspector's name, printed and certified by signature;
- g. Date of inspection; and
- h. Job/purchase order number.
- i. If using dye penetrant technique, the report shall also include:
 - (1) Penetrant type/manufacture,
 - (2) Part temperature,
 - (3) Dwell time,
 - (4) Cleaning method, and
 - (5) Development method.
- j. If using magnetic particle technique, the report shall also include:
 - (1) Magnetization method,
 - (2) Equipment manufacturer,
 - (3) Magnetization current (AC or DC),
 - (4) Magnetization current strength (amps), and
 - (5) Power type/manufacture.

APPENDIX A. ACRONYMS

ANSI	American National Standard Institute
ASME	American Society of Mechanical Engineer
ASNT	American Society for Nondestructive Testing
AWS	American Welding Society
B&PVC	Boiler and Pressure Vessel Code
IF	Incomplete Fusion
IP	Incomplete Penetration
IQI	Image Quality Indicator
LaRC	Langley Research Center
LPR	Langley Procedural Requirement
MAM	Milliamp-minutes
MSS	Manufacturers Standardization Society
MT	Magnetic Particle Examination
NDE	Non-Destructive Evaluation
NRC	Nuclear Regulatory Commission
PT	Dye Penetrant Examination
PWHT	Post Weld Heat Treatment
QA	Quality Assurance
RT	Radiographic Examination
VT	Visual External Examination

APPENDIX B. FIGURES

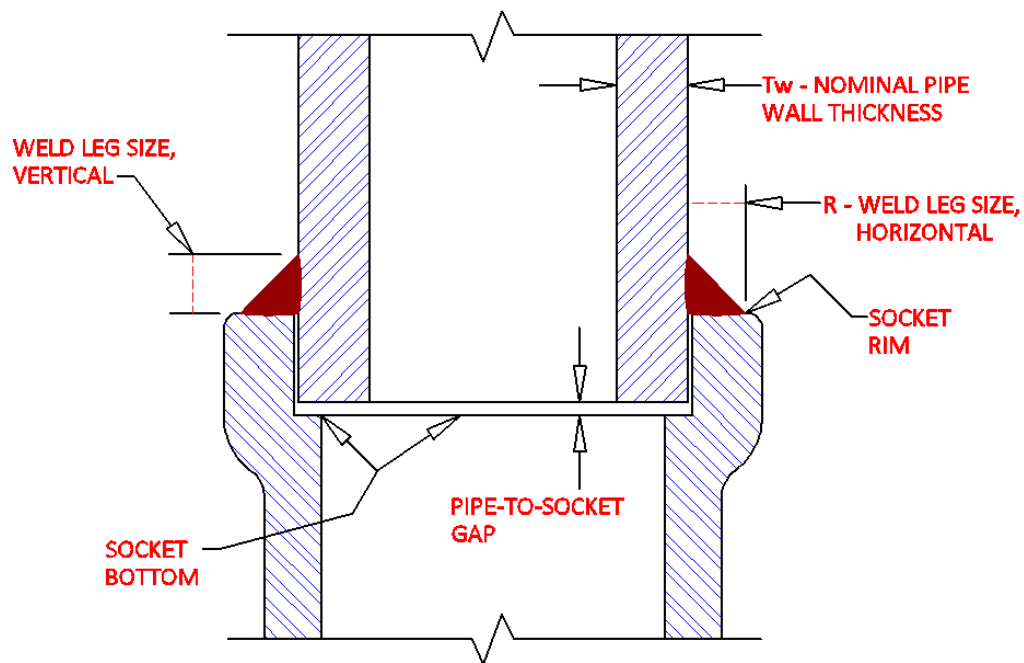
B-1. SOCKET-WELD FITTING JOINT NOMENCLATURE



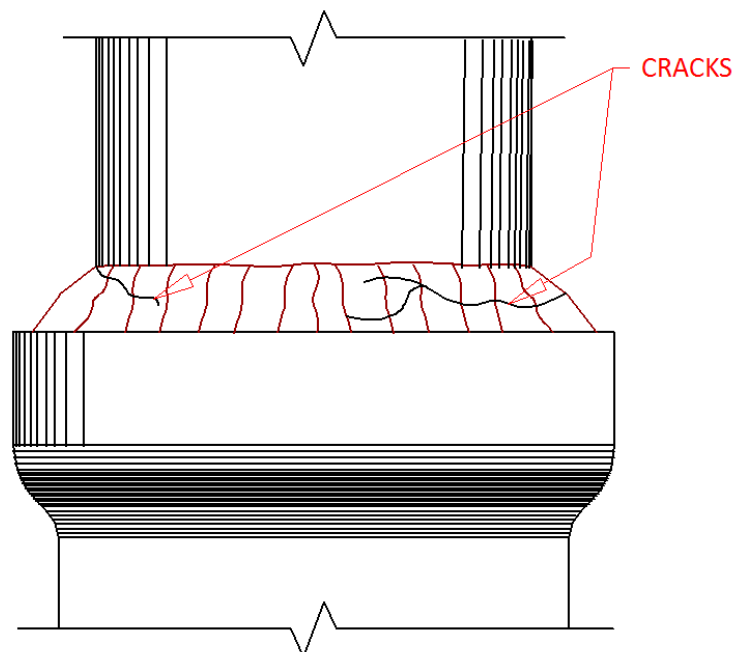
(excluding socket welds in pipe flanges)

B-2. UNACCEPTABLE SOCKET-WELD LEG SIZE

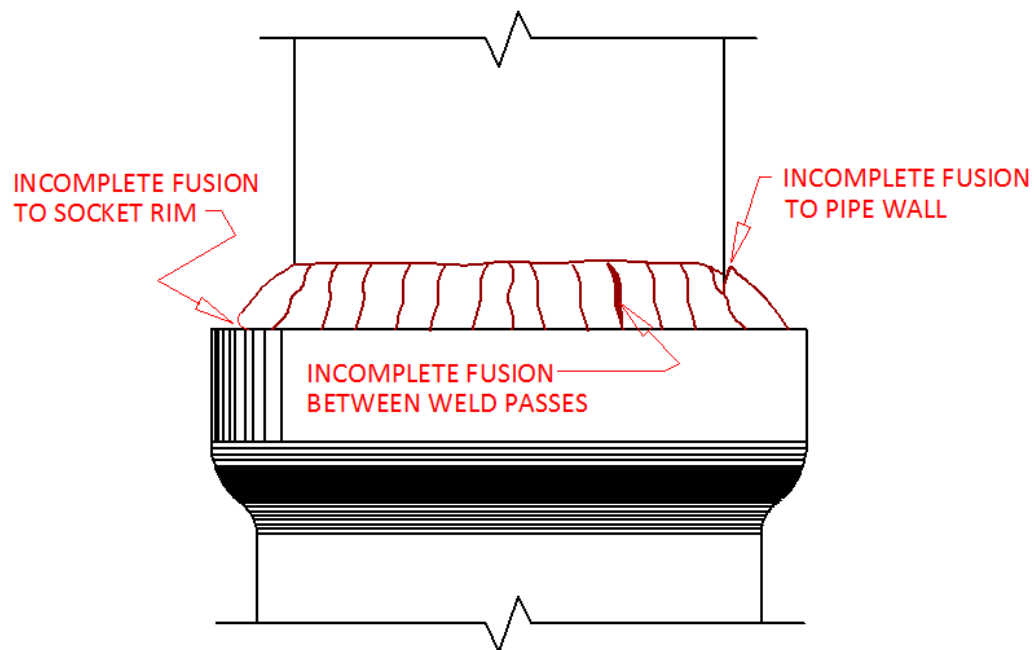
Weld leg size (H or V) less than the greater of $1.25 T_w$ or $1/8$ inch is rejectable.



B-3. SURFACE CRACKING



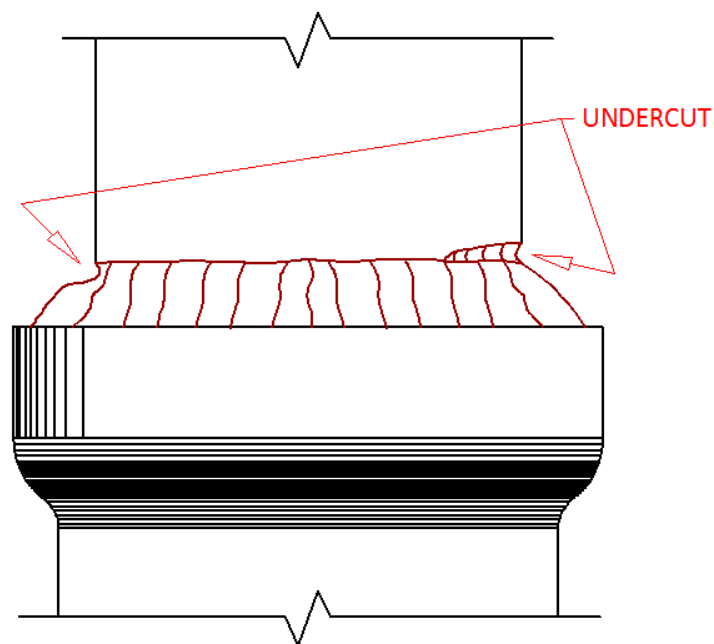
All indications of cracks open to the surface are unacceptable.

B-4. SURFACE INCOMPLETE FUSION

Incomplete fusion to socket rim is unacceptable.

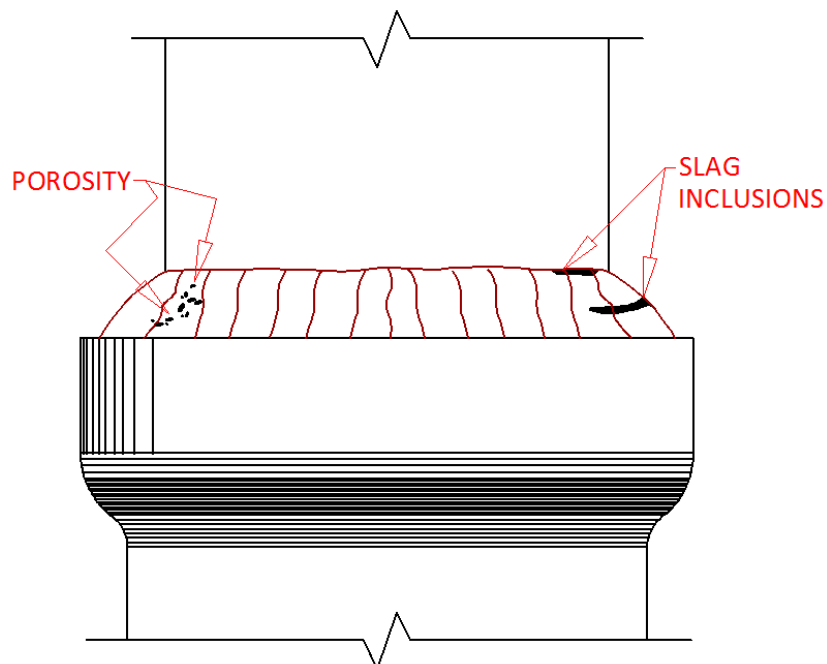
Incomplete fusion to pipe wall is unacceptable.

Incomplete fusion between weld passes is unacceptable.

B-5. UNDERCUT

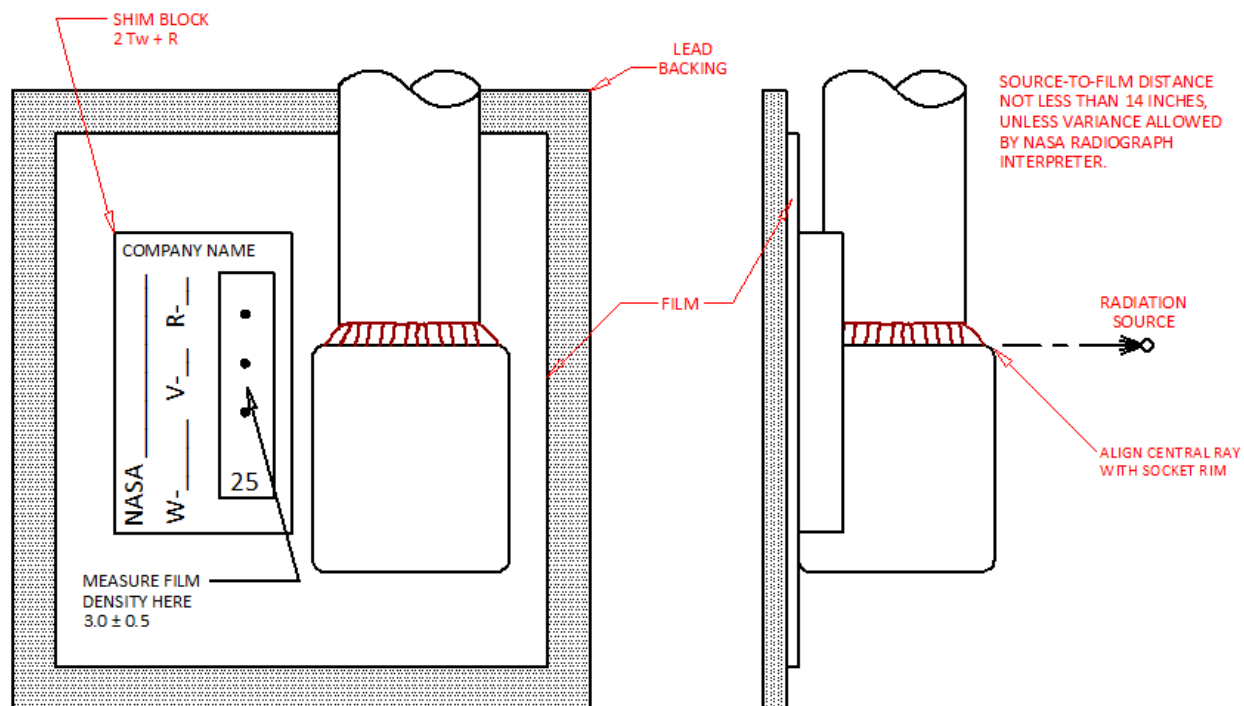
Undercut larger than the smaller of $0.25 T_w$ or $1/32$ inch is unacceptable.

B-6. SURFACE SLAG AND POROSITY



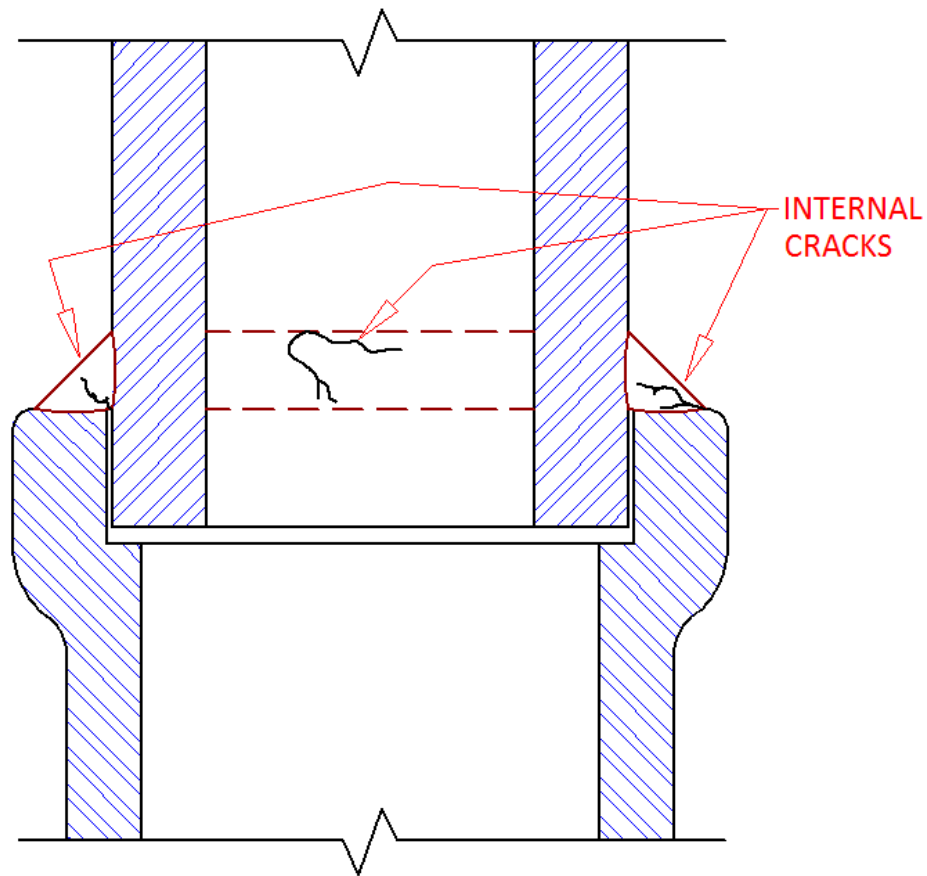
All indications of surface slag and surface porosity are unacceptable.

B-7. RADIOGRAPHIC EXPOSURE TECHNIQUE FOR SOCKET WELDING FITTINGS

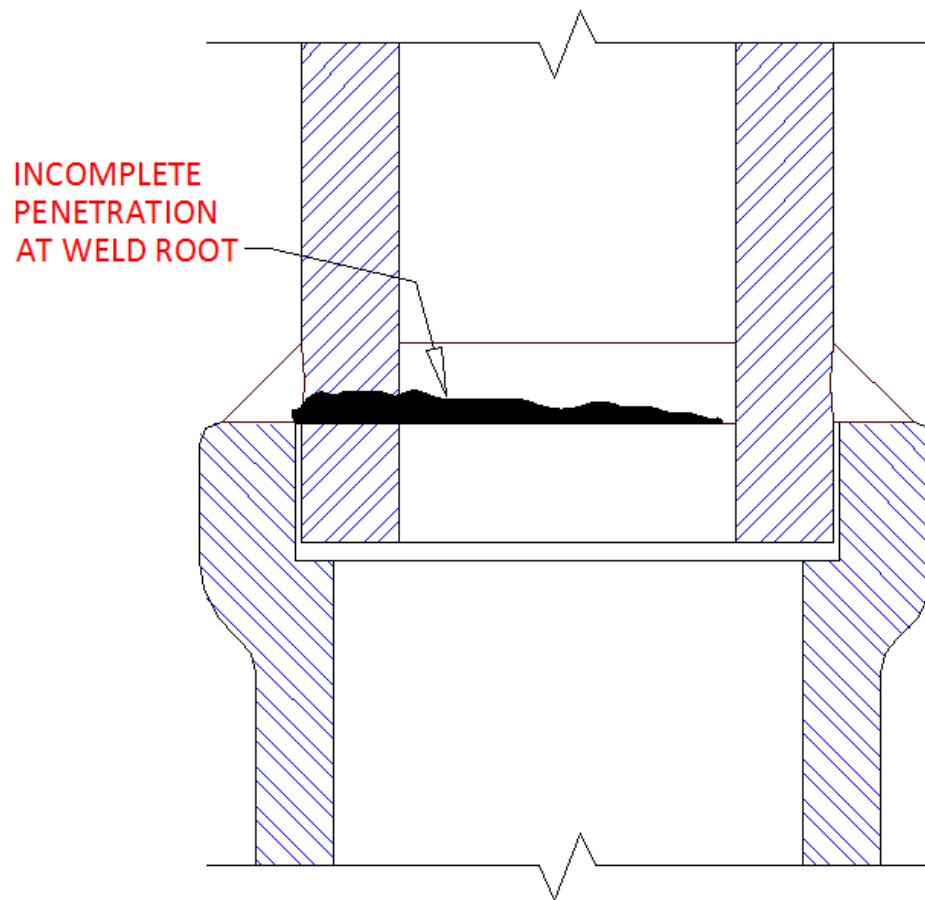


Notes:

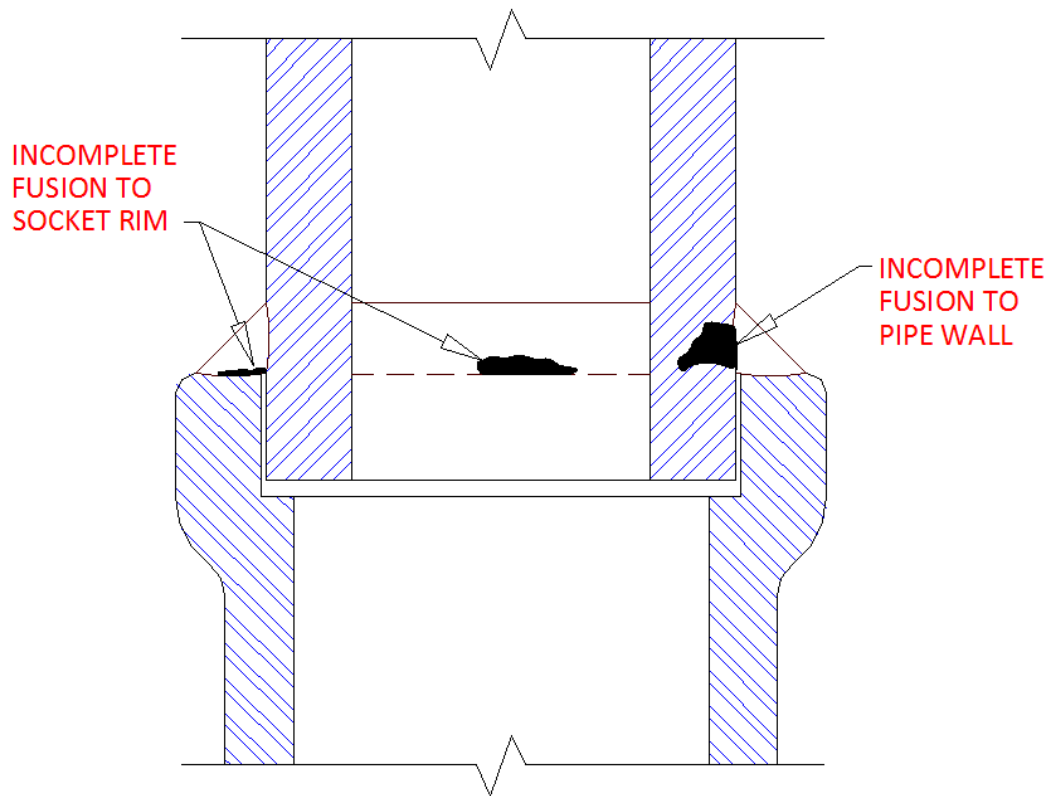
1. Three (3) views required at 60° radial separation for pipe sizes greater than 1 inch.
2. Two (2) views required at 90° radial separation for pipe sizes 1 inch or less.
3. The following information shall be included in the radiographic image:
 - a. Company Name or Contractor ID,
 - b. NASA Contract Number or Task Number,
 - c. Drawing Number,
 - d. NASA Weld Number,
 - e. View Identification Numbers,
 - f. Repair Cycle Number (Rxx),
 - g. Date of Inspection, and
 - h. Welder ID.

B-8. INTERNAL CRACKS

All crack indications are unacceptable.

B-9. INCOMPLETE PENETRATION

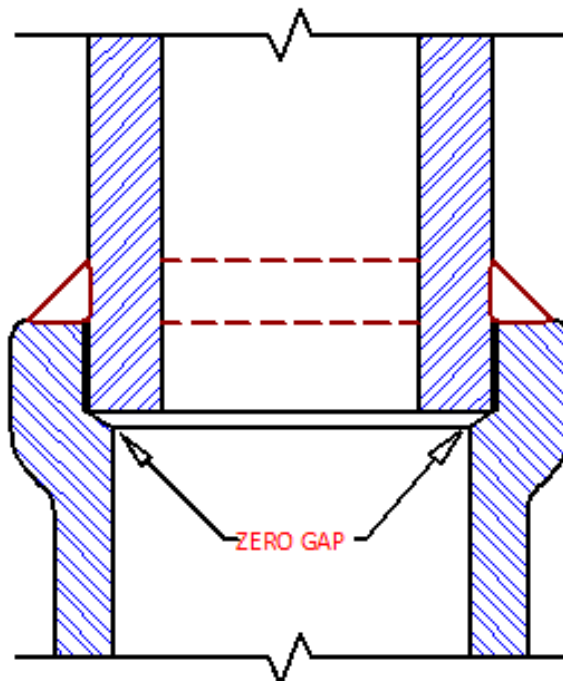
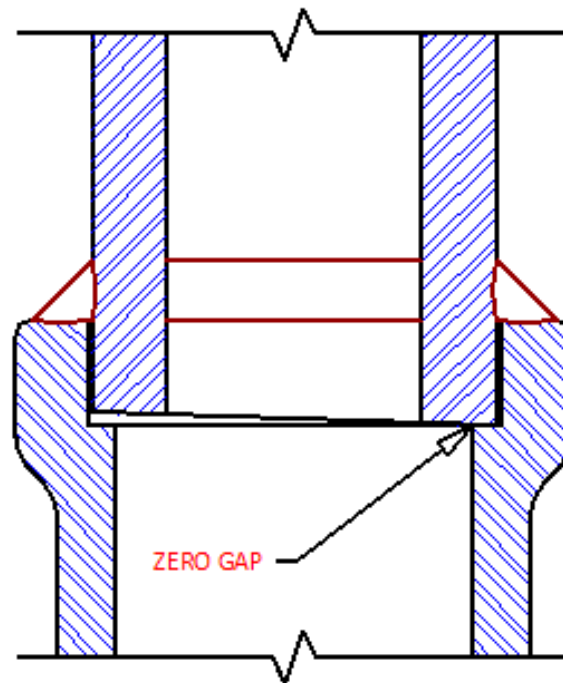
All indications of incomplete weld penetration are unacceptable.

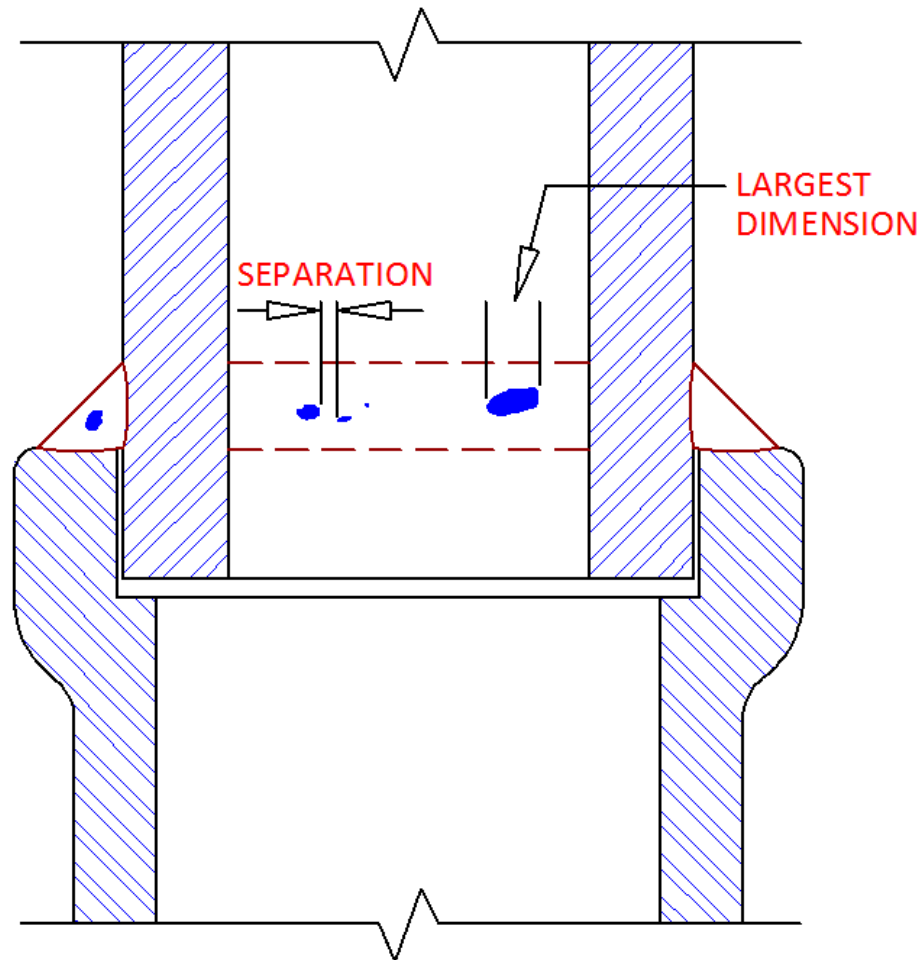
B-10. INCOMPLETE FUSION

Note: Incomplete fusion between weld passes is not illustrated above.

All indications of incomplete fusion are unacceptable.

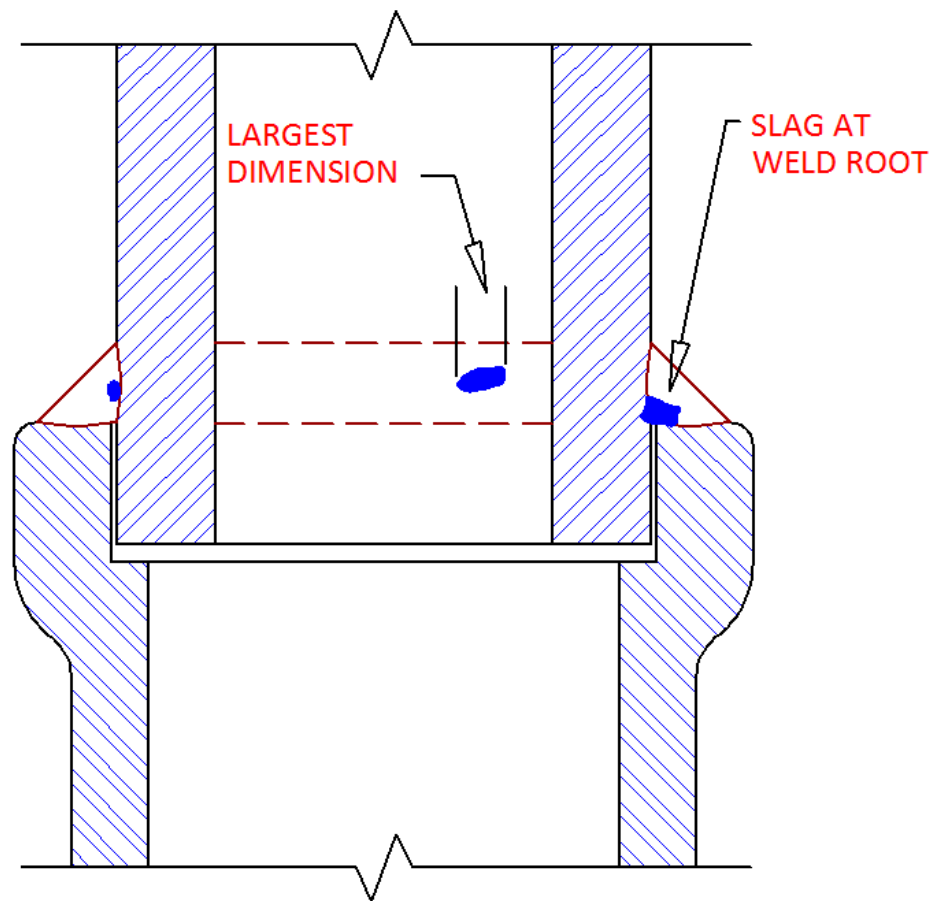
B-11. UNACCEPTABLE PIPE-TO-SOCKET GAP



B-12. POROSITY AND ROUNDED INDICATIONS

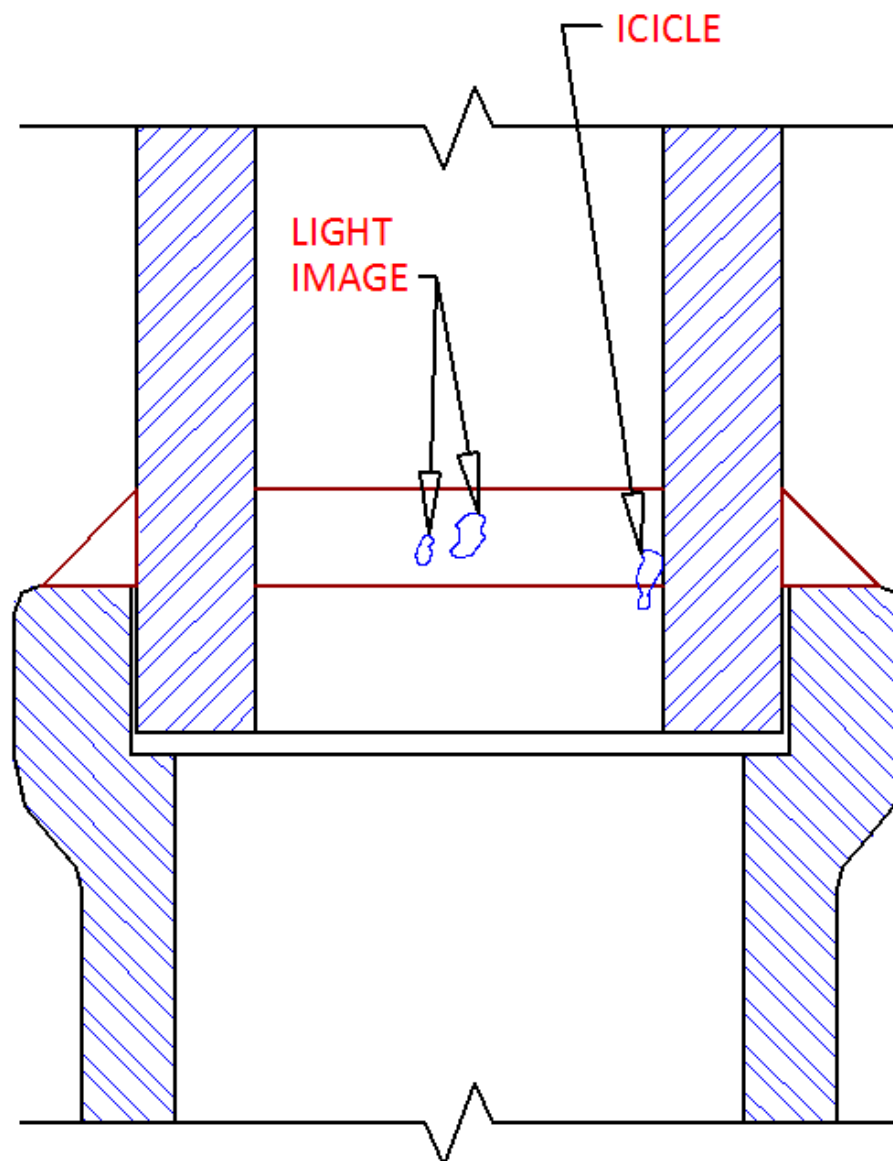
Not less than $0.5T_w$ separation.

Greatest dimension of rounded indications and porosity shall not exceed $0.3T_w$.

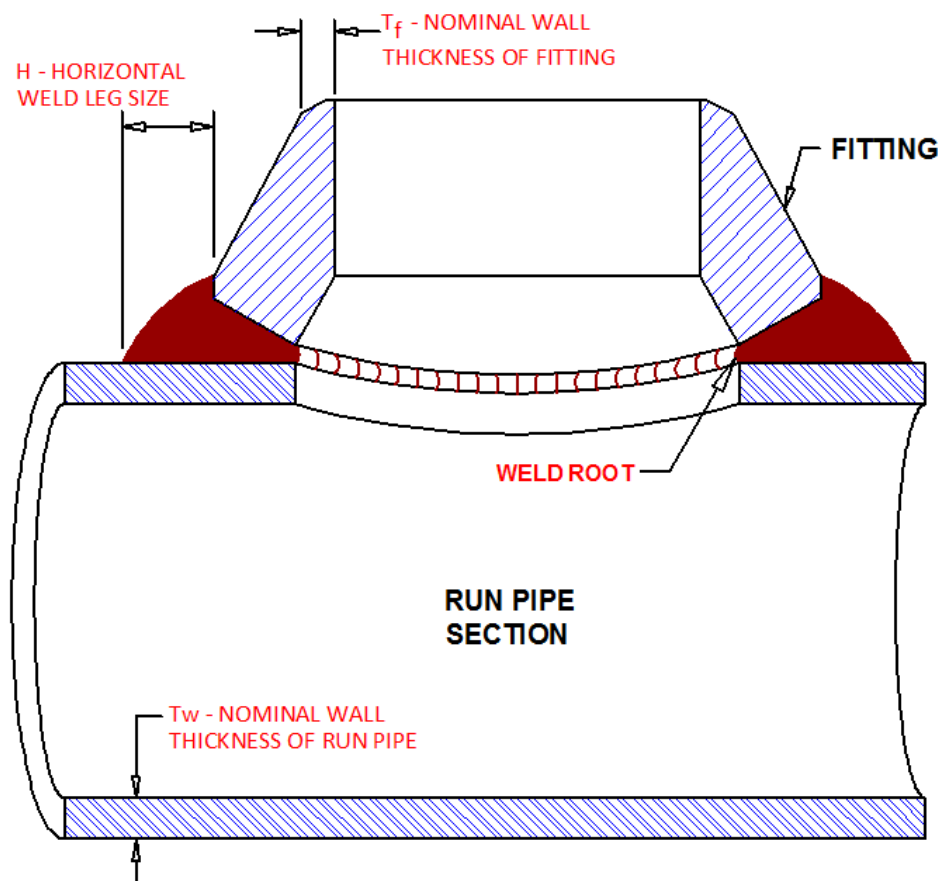
B-13. SLAG INCLUSIONS

Largest dimension of largest slag inclusion shall not exceed $0.3T_w$.

Slag inclusions at the root of the socket weld are unacceptable.

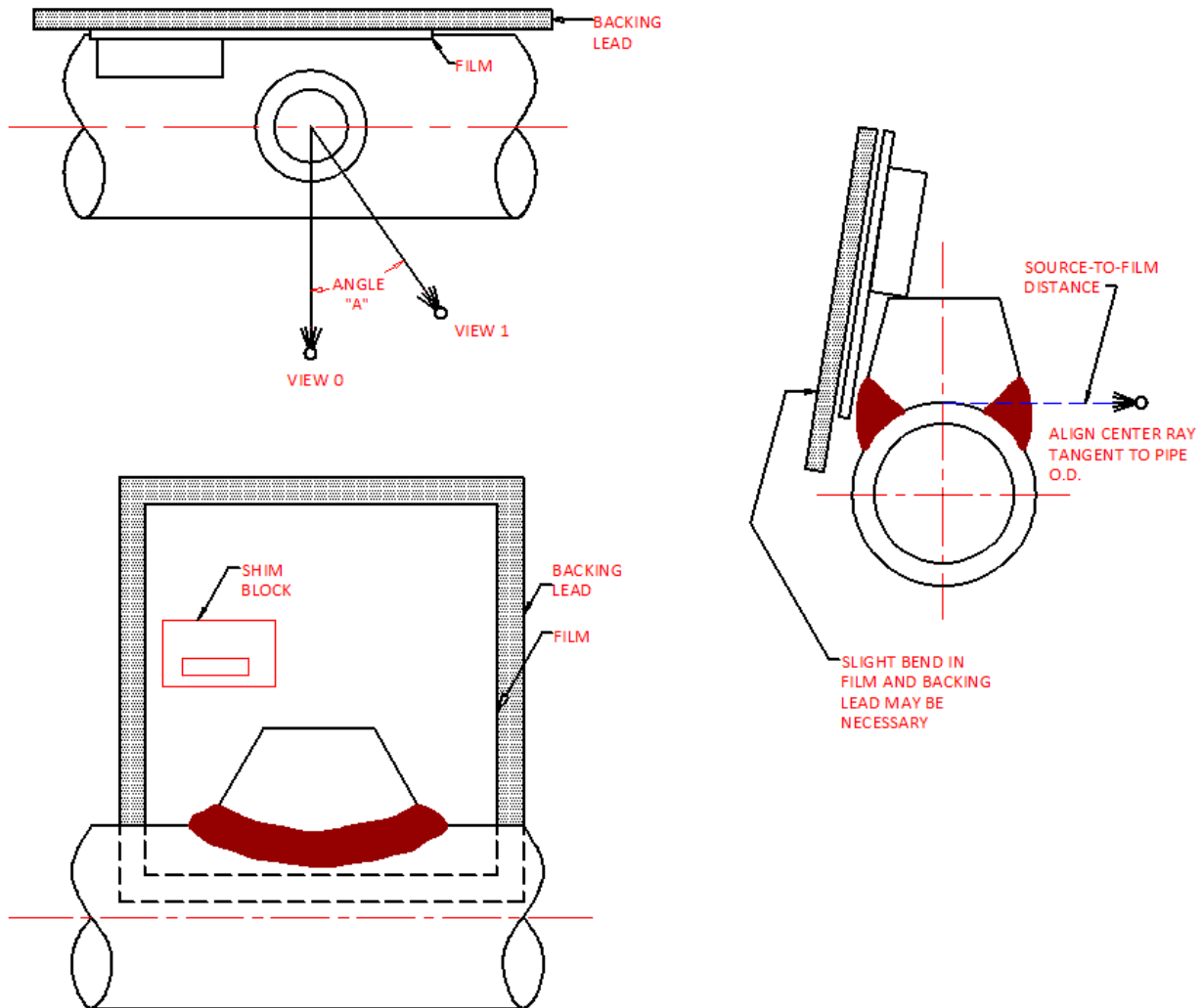
B-14. MELT THROUGH

Icicles are unacceptable.

B-15. NOMENCLATURE FOR BRANCH-CONNECTION WELDS

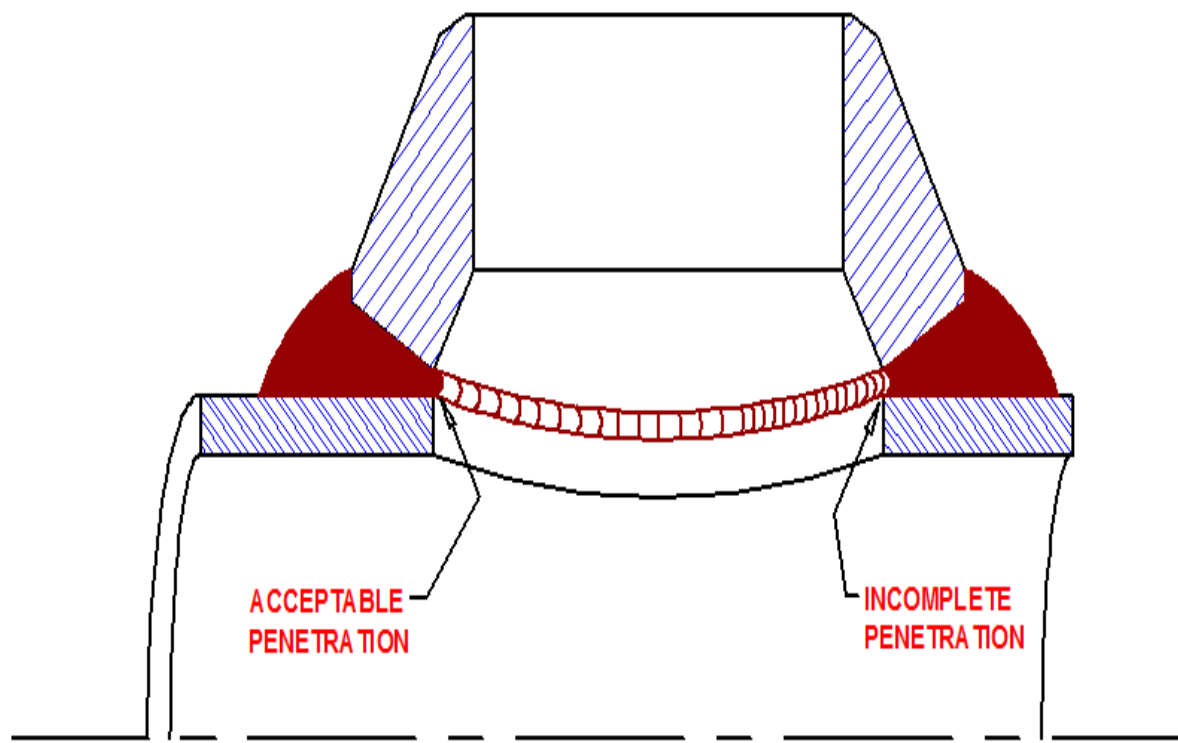
Internal grinding of the weld root area beyond the original fitting contour or beyond the original pipe opening contour is not allowed.

B-16. RADIOGRAPHIC EXPOSURE TECHNIQUE FOR BRANCH CONNECTION FITTINGS



Notes:

1. Angle "A" shall be between 25° and 35°. Counterclockwise is the preferred direction for views.
2. Shim block thickness shall be $2T_f + H$
3. Two (2) views required for branch connection fittings up to 6 inches in size. Branch connection fittings over 6 inches in size may require additional exposures or alternate techniques at the discretion of the NASA Radiograph Interpreter
4. Minimum source-to-film distance shall be 14 inches unless variation approved by NASA Radiograph Interpreter

B-17. INCOMPLETE PENETRATION IN BRANCH CONNECTION FITTINGS

All incomplete penetration is unacceptable.