

# Procedure

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# Visual Examination - ASME

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# REVISION INDEX

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## 1.0 SCOPE

- 1.1 This procedure describes the requirements to be implemented by Industrial Performance Services (IPS) personnel, or contract examination personnel performing inspection operations for IPS, for the performance of Visual Examinations (VT) of welds, equipment, and components.
- 1.2 This procedure is intended to be used for the examination of the in-process and/or final surface condition of welds and materials for detection of surface discontinuities, mechanical deterioration, distortion, deformation, and leaks, as applicable to client specifications, and/or applicable codes.
- 1.3 Certain codes, such as referenced documents below, list a wide range of additional VT and in-process examination attributes other than addressed by paragraphs 1.1 and 1.2 above. These additional attributes include, but are not limited to, verification of item/component material(s), verification of approved welding procedures and welder's certifications as well as the welder's adherence to the parameters of the welding procedure, etc. When these additional attributes are requested by either PO, contract, or customer to be included as part of the examination services to be provided by IPS, such as a CWI, are assigned to perform the verifications/examinations. When these attributes are requested, disposition of these attributes shall be included in the final report.
- 1.4 In the absence of specific Visual technique requirements provided in other codes, such as AWS D1.1, API Spec 2C, etc., the technique parameters herein may be utilized, and this procedure referenced for the performance of VT.
- 18 Technicians solely holding inspector certifications from organizations such as the American Petroleum Institute (API), American Welding Society (AWS), etc. are also required to conform to the vision acuity requirements of reference in 2.1 for NDT personnel.

## 2.0 REFERENCED DOCUMENTS

- 2.1 Industrial Performance Services Written Practice, IPS-WP-01, Procedure for Qualification and Certification of Personnel.
- 2.2 ASME Section V, Nondestructive Examination
- 2.3 ASME Section VIII, Pressure Vessels
- 2.4 ASME B31.1, Power Piping
- 2.5 ASME B31.3, Process Piping

## 3.0 RESPONSIBILITY

- 3.1 Technicians are responsible to comply with this procedure and to complete all required records/reports. At any time while performing work with this procedure, should it become evident that the requirements herein cannot be met, the technician is to immediately contact their supervisor or lead technician, as applicable, for resolution.
- 3.2 Technicians are to ensure that the item being inspected receives 100%

inspection of all accessible areas within the inspection zone. Accessible areas are defined as those where all test parameters can be applied in accordance with this procedure and the results properly viewed for interpretation/evaluation. In addition, inspection zone areas that are found to be inaccessible are to be recorded in the report.

#### **4.0 PERSONNEL QUALIFICATIONS**

- 4.1 Unless otherwise specified by contract, PO, customer specifications or codes other than ASME, personnel performing Visual examinations shall be qualified and certified in accordance with reference 2.1, which complies with SNT-TC-1A.
- 4.2 Personnel may also be qualified and certified to other certification schemes such as CP-189 or NAS-410, depending on customer requirements.
- 4.3 Personnel performing evaluations and/or reporting results in accordance with this procedure shall be certified Level II as a minimum.
- 4.4 Personnel utilizing this procedure for performing VT examinations to codes other than ASME shall be qualified and/or certified in accordance with the particular code. See paragraph 1.4.

#### **5.0 EQUIPMENT**

- 5.1 The inspector shall have access to any gauges, templates, scales, special tools, light sources, mirrors, magnifiers, or other devices to perform the required inspection.
- 5.2 As a minimum, the following devices shall be available:
  - 19 6" rule with 1/32" graduations
  - 20 Weld gauges/off-set gauges (for weldments)
  - 21 Mirrors
  - 22 Magnifying glass (5X min.)
  - 23 Flashlight
  - 24 Pit gauge
  - 25 File
  - 26 Ball peen hammer
  - 27 Putty knife or chisel
- 5.3 Other items such as comparative standards, borescopes, fiber optics, video imaging scopes, or other specialized equipment may be utilized when applicable.
- 5.4 The examiner shall be familiar with the operation of any tools that will be used. When using specialized devices or equipment, the inspector shall be familiar with the manufacturer's operating guides and recommendations.

#### **6.0 SURFACE PREPARATION**

- 6.1 Prior to Visual examination, the surface to be examined and all adjacent areas within at least one (1) inch shall be dry and free from any dirt, grease, paint, scale, welding flux, weld spatter, oil or other extraneous matter that

could interfere with the examination.

- 6.2 Visual examinations, which require clean surfaces for valid interpretations of results, shall be preceded by appropriate cleaning methods.
- 6.3 Surface preparation and cleaning methods, include, but are not limited to those provided in ASTM E 165 – Standard Practice for Liquid Penetrant Examination for General Industry, Annex 1. Cleaning of Parts and Materials. See Appendix 1 for a description of those methods, if needed beyond typical requirements.

**7.0 EXAMINATION**

Direct Examination

- 7.1 When performing direct examination, the examiner’s eyes shall be within 24” of the surface to be examined, and at an angle not less than 30 degrees to the surface of the area being inspected. Mirrors may be used to improve the angle of vision and aids, such as magnifying lens, may be used to assist examinations.
- 17 Flat mirrors are to be used. Mirrors shall be positioned in such a manner that the distance from the mirror to the test surface plus the distance from the mirror to the examiner’s eye is within 24”. When a measuring device such as a scale is required when using a mirror, the device shall be positioned on the actual test surface for the measurement.
- 7.2 Lighting shall be either natural or artificial. Lighting shall meet the minimum as specified herein in order to provide adequate illumination of the examination surface for the specific part, component or section being examined. The maximum lighting source used shall be such as to not produce any interfering glare ore reflections from the surface being examined. Adequate white or natural illumination of 100-foot candles (fc) (1076 lux) minimum at the examination surface is required to ensure no loss of sensitivity in the examination. The following light sources may be used to meet this requirement:

Light Source	Maximum Distance	Intensity
Sunlight (from 30 min. after sunrise to 30 min. before sunset)	Unlimited	>100 fc
300W Halogen Work Light	48”	>100 fc
Mag Instrument Mag-Light® (3C or D cell)	24”	>100 fc
Pelican Super Saberlight® (3C cell)	24”	>100 fc

- 7.3 When required, a calibrated white light meter shall be available to verify the required illumination. Light meters shall be calibrated every six (6) months. If meters have not been in use for six (6) months or more, they shall be calibrated before being used.

- 7.4 When Translucent Visual Examination is performed, the ambient lighting in the area shall be reduced to less than the light applied through the component being examined. The ambient lighting shall produce no glares or reflections from the examination surface. The light source used for translucent visual examination shall produce a lighting intensity that will illuminate and diffuse the light evenly through the area or region being examined. The lighting source shall have sufficient intensity to permit any “candling” translucent laminate thickness variations.

#### Remote Examination

- 7.5 When direct examination is not possible, remote examination may be performed; the examiner may use visual aids such as mirrors, telescopes, borescopes, remote video imaging scopes, or other suitable instruments. Such systems shall have a resolution capability and light intensity at least equivalent to that obtainable by direct visual examination.

#### Welds

- 7.6 Examination of welds may be performed prior to welding, during welding and after welding. Typical discontinuities found in welds are porosity, incomplete penetration, incomplete fusion, undercut, overlap, cracks, slag inclusions, excessive reinforcement, distortion, and arc burns.

#### Piping

- 7.7 Examination of piping may be performed for detection of corrosion, insulation damage, adequate support, misalignment, leaks, vibration, and mechanical deterioration.

#### Tanks

- 7.8 Examination of tanks may be performed for detection of surface conditions and flaws such as corrosion, blisters, pitting, mechanical deterioration, deformation, and leaks.

#### Vessels

- 7.9 Examination of vessels may be performed for detection of corrosion, distortion, cracks, leaks, blisters, bulges, and other signs of deterioration.

#### Dimensional Checks

- 7.10 Dimensional checks in fabrication to ensure parts meet engineering drawings by verifying lengths, widths, diameters, angles, and tolerances using tools like calipers, covering raw materials, in-process stages (fit-up, welding), and final products, all documented to guarantee safety, functionality, and compliance with standards.

## 8.0 STANDARDS OF ACCEPTANCE

- 8.1 All discontinuities or abnormal conditions detected by the examination shall be recorded and evaluated in accordance with this procedure. When no Code, Standard or Specification is referenced, all conditions detected shall be reported to the customer for disposition.

## 9.0 RECORDS

- 9.1 The information reported shall include, but not be limited to, the following:

- 18 Date examination performed
- 19 Procedure identification and revision used
- 20 Code, Standard, Specification referenced (if applicable)
- 21 Examination technique employed
- 22 Types of equipment used (as applicable)
- 23 Identification of the examiner (and qualification level, when required)
- 24 Identification of the part or component examined

Note 1: Additional details, such as drawings or sketches, may be provided to the customer's representative, along with the examination report.

Note 2: If dimensions and other data are recorded during the examination to aid in the evaluation process, documentation of each viewing or dimensional check is not required. The records shall include all observation and dimensional checks specified by the referencing Code, Standard, Specification, or Procedure.

## Appendix 1 ASME Section V, Article 24, SE-165

### A1. CLEANING OF PARTS AND MATERIALS

#### A1.1 Choice of Cleaning Method

A1.1.1 The choice of a suitable cleaning method is based on such factors as: (1) type of contaminant to be removed since no one method removes all contaminants equally well; (2) effect of the cleaning method on the parts; (3) practicality of the cleaning method for the part (for example, a large part cannot be put into a small degreaser or ultrasonic cleaner); and (4) specific cleaning requirements of the purchaser. The following cleaning methods are recommended:

A1.1.1.1 *Detergent Cleaning*—Detergent cleaners are non-flammable water-soluble compounds containing specially selected surfactants for wetting, penetrating, emulsifying, and saponifying various types of soils, such as grease and oily films, cutting and machining fluids, and unpigmented drawing compounds, etc. Detergent cleaners may be alkaline, neutral, or acidic in nature, but must be noncorrosive to the item being examined. The cleaning properties of detergent solutions facilitate complete removal of soils and contamination from the

surface and void areas, thus preparing them to absorb the penetrant. Cleaning time should be as recommended by the manufacturer of the cleaning compound.

A1.1.1.2 *Solvent Cleaning*—There are a variety of solvent cleaners that can be effectively utilized to dissolve such soils as grease and oily films, waxes and sealants, paints, and in general, organic matter. These solvents should be residue-free, especially when used as a hand-wipe solvent or as a dip-tank degreasing solvent. Solvent cleaners are not recommended for the removal of rust and scale, welding flux and spatter, and in general, inorganic soils. Some cleaning solvents are flammable and can be toxic. Observe all manufacturers' instructions and precautionary notes.

A1.1.1.3 *Vapor Degreasing*—Vapor degreasing is a preferred method of removing oil or grease-type soils from the surface of parts and from open discontinuities. It will not remove inorganic-type soils (dirt, corrosion, salts, etc.), and may not remove resinous soils (plastic coatings, varnish, paint,



etc.). Because of the short contact time, degreasing may not completely clean out deep discontinuities and a subsequent solvent soak is recommended.

**A1.1.1.4 Alkaline Cleaning:**

(a) Alkaline cleaners are nonflammable water solutions containing specially selected detergents for wetting, penetrating, emulsifying, and saponifying various types of soils. Hot alkaline solutions are also used for rust removal and descaling to remove oxide scale which can mask surface discontinuities. Alkaline cleaner compounds must be used in accordance with the manufacturers' recommendations. Parts cleaned by the alkaline cleaning process must be rinsed completely free of cleaner and thoroughly dried prior to the penetrant testing process (part temperature at the time of penetrant application shall not exceed 125 °F [52 °C]).

(b) Steam cleaning is a modification of the hot-tank alkaline cleaning method, which can be used for preparation of large, unwieldy parts. It will remove inorganic soils and many organic soils from the surface of parts, but may not reach to the bottom of deep discontinuities, and a subsequent solvent soak is recommended.

**A1.1.1.5 Ultrasonic Cleaning**—This method adds ultrasonic agitation to solvent or detergent cleaning to improve cleaning efficiency and decrease cleaning time. It should be used with water and detergent if the soil to be removed is inorganic (rust, dirt, salts, corrosion products, etc.), and with organic solvent if the soil to be removed is organic (grease and oily films, etc.). After ultrasonic cleaning, parts must be rinsed completely free of cleaner, thoroughly dried, and cooled to at least 125 °F [52 °C], before application of penetrant.

**A1.1.1.6 Paint Removal**—Paint films can be effectively removed by bond release solvent paint remover or disintegrating-type hot-tank alkaline paint strippers. In most cases, the paint film must be completely removed to expose the surface of the metal. Solvent-type paint removers can be of the high-viscosity thickened type for spray or brush application or can be of low viscosity two-layer type for dip-tank application. Both types of solvent paint removers are generally used at ambient temperatures, as received. Hot-tank alkaline strippers should be used in accordance with the manufacturer's instructions. After paint removal, the parts must be thoroughly rinsed to remove all contamination from the void openings, thoroughly dried, and cooled to at least 125 °F [52 °C] before application of penetrant.

**A1.1.1.7 Mechanical Cleaning and Surface Conditioning**—Metal-removing processes such as filing, buffing, scraping, mechanical milling, drilling, reaming, grinding, liquid honing,

sanding, lathe cutting, tumble or vibratory deburring, and abrasive blasting, including abrasives such as glass beads, sand, aluminum oxide, ligno-cellulose pellets, metallic shot, etc., are often used to remove such soils as carbon, rust and scale, and foundry adhering sands, as well as to deburr or produce a desired cosmetic effect on the part. *These processes may decrease the effectiveness of the penetrant testing by smearing or peening over metal surfaces and filling discontinuities open to the surface, especially for soft metals such as aluminum, titanium, magnesium, and beryllium alloy.*

**A1.1.1.8 Acid Etching**—Inhibited acid solutions (pickling solutions) are routinely used for descaling part surfaces. Descaling is necessary to remove oxide scale, which can mask surface discontinuities and prevent penetrant from entering. Acid solutions/etchants are also used routinely to remove smeared metal that peens over surface discontinuities. Such etchants should be used in accordance with the manufacturers' recommendations.

**NOTE A1.1**—Etched parts and materials should be rinsed completely free of etchants, the surface neutralized and thoroughly dried by heat prior to application of penetrants. Acids and chromates can adversely affect the fluorescence of fluorescent materials.

**NOTE A1.2**—Whenever there is a possibility of hydrogen embrittlement as a result of acid solution/etching, the part should be baked at a suitable temperature for an appropriate time to remove the hydrogen before further processing. After baking, the part shall be cooled to a temperature below 125 °F [52 °C] before applying penetrants.

**A1.1.1.9 Air Firing of Ceramics**—Heating of a ceramic part in a clean, oxidizing atmosphere is an effective way of removing moisture or light organic soil, or both. The maximum temperature that will not cause degradation of the properties of the ceramic should be used.

**A1.2 Post Cleaning**

**A1.2.1 Removal of Developer**—Dry powder developer can be effectively removed with an air blow-off (free of oil) or it can be removed with water rinsing. Wet developer coatings can be removed effectively by water rinsing or water rinsing with detergent either by hand or with a mechanical assist (scrub brushing, machine washing, etc.). The soluble developer coatings simply dissolve off of the part with a water rinse.

**A1.2.2 Residual penetrant** may be removed through solvent action. Solvent soaking (15 min minimum), and ultrasonic solvent cleaning (3 min minimum) techniques are recommended. In some cases, it is desirable to vapor degrease, then follow with a solvent soak. The actual time required in the vapor degreaser and solvent soak will depend on the nature of the part and should be determined experimentally.

Visual Examination  
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Examination Methods	Visual		Radiography	
	Visual	Radiography	Visual	Radiography
Branch Connection Weld [Note (2)]	Crack	✓	✓	✓
	Incomplete fusion	✓	✓	✓
Weld [Note (5)]	Incomplete penetration	✓	✓	✓
	Rounded Indications	...	✓	✓
Weld [Note (6)]	Linear indications	...	✓	✓
	Undercut [Note (6)]	✓	✓	✓
Weld [Note (7)]	Surface porosity or exposed slag inclusion [Note (7)]	✓	...	...
	Surface finish	✓	✓	✓
Weld [Note (8)]	Concave surface, concave root surface, or burn-through	✓	✓	✓
	Face reinforcement or root reinforcement	✓	✓	...

3, and M341.4, or by the engineering design. or this type of weld.

as. 341.5 and 341.5.3.

ce with a standard listed in Table A-1 (Table A-1C) or Table

e para. 341.4.2.

**Criterion Value Notes for Table 341.3.2-1**

Criterion	Measure	Acceptable Value Limits [Note (1)]
fusion	Zero (no evident imperfection)	
th of incomplete fusion and incomplete	Zero (no evident imperfection) ≤38 mm (≤1.5 in.) in any 150 mm (6 in.) weld length or 25% of total weld length, whichever is less. Incomplete fusion is not permitted on external surfaces.	
ation of rounded indications	See ASME BPVC, Section VIII, Division 1, Appendix 4 [Note (2)]	
ation of rounded indications	For $\bar{T}_w \leq 6$ mm ( $1/4$ in.), limit is same as D [Note (2)] For $\bar{T}_w > 6$ mm ( $1/4$ in.), limit is $1.5 \times D$ [Note (2)]	
as characterized as neither incomplete penetration nor		
sion		
th		$\leq \bar{T}_w/3$
h		$\leq 2.5$ mm ( $\leq 3/32$ in.) and $\leq \bar{T}_w/3$
gth		$\leq \bar{T}_w$ in any 12 $\bar{T}_w$ weld length [Note (2)]
as characterized as neither incomplete penetration nor		
sion		
th		$\leq 2\bar{T}_w$
h		$\leq 3$ mm ( $\leq 1/8$ in.) and $\leq \bar{T}_w/2$
th		$\leq 4\bar{T}_w$ in any 150 mm (6 in.) weld length or 8% of total weld length, whichever is less [Note (2)]
ut		$\leq 1$ mm ( $\leq 1/32$ in.) and $\leq \bar{T}_w/4$ [Note (3)]
th of internal and external undercut		$\leq 38$ mm ( $\leq 1.5$ in.) in any 150 mm (6 in.) weld length or 25% of total weld length, whichever is less
ut		$\leq 1.5$ mm ( $\leq 1/16$ in.) and $\leq [\bar{T}_w/4$ or 1 mm ( $1/32$ in.)] [Note (3)]
th of internal and external undercut		$\leq 38$ mm ( $\leq 1.5$ in.) in any 150 mm (6 in.) weld length or 25% of total weld length, whichever is less
ess		$\leq 12.5$ $\mu$ m ( $\leq 500$ $\mu$ in.) $R_a$ in accordance with ASME B46.1
e concavity, root surface concavity, or		Total joint thickness, including weld reinforcement, $\geq \bar{T}_w$ [Notes (4), (5)]
inforcement or root reinforcement [Note (6)] in		
ough the weld shall be within limits of		
height value in the tabulation at right,		
vided in Note (7). Weld metal shall merge		
the component surfaces.		
inforcement or root reinforcement [Note (6)]		
n L. Note (7) does not apply.		
		Height, mm (in.)
		$\leq 1.5$ ( $\leq 1/16$ )
		$\leq 3$ ( $\leq 1/8$ )
		$\leq 4$ ( $\leq 5/32$ )
		$\leq 5$ ( $\leq 3/16$ )

ated by "and," the lesser of the values determines acceptance. Where two sets of values are separated by "or," the larger value is acceptable.  $\bar{T}_w$  is the nominal o components joined by a butt weld.

### Criterion Value Notes for Table 341.3.2-1 (Cont'd)

NOTES: (Cont'd)

- (2) Porosity and inclusions such as slag or tungsten are defined as rounded indications where the maximum length is three times the width or less. These indications may be circular, elliptical, or irregular in shape; may have tails; and may vary in density. Indications where the length is greater than three times the width are defined as linear indications and may also be slag, porosity, or tungsten.
- (3) Depth of undercut shall be evaluation by visual examination only.
- (4) For circumferential groove welded joints in pipe, tube, and headers made entirely without the addition of filler metal, external concavity shall not exceed the lesser of 1 mm ( $1/32$  in.) or 10% of the joint nominal thickness. The contour of the concavity shall blend smoothly with the base metal. The total joint thickness, including any reinforcement, shall not be less than the minimum wall thickness,  $t_{nr}$ .
- (5) For radiography, acceptability may be determined by comparing the density of the image through the affected area to the density through the adjacent base metal ( $\bar{T}_a$ ). If digital radiography is used, brightness comparison may be utilized. A density or brightness darker than the adjacent base metal is cause for rejection.
- (6) For groove welds, height is the lesser of the measurements made from the surfaces of the adjacent components; both face reinforcement and root reinforcement are permitted in a weld. For fillet welds, height is measured from the theoretical throat, [Figure 328.5.2-1](#); root reinforcement does not apply.
- (7) For welds in aluminum alloy only, root reinforcement shall not exceed the following values:
- (a) 1.5 mm ( $1/16$  in.) for thickness  $\leq 2$  mm ( $\leq 5/64$  in.)
  - (b) 2.5 mm ( $1/8$  in.) for thickness  $> 2$  mm and  $\leq 6$  mm ( $\leq 1/4$  in.)
- For face reinforcement and for greater thicknesses, see the tabulation for symbol L.

## Appendix 3 Acceptance Criteria - B31.3 High Pressure Service

**Table K341.3.2-1  
Acceptance Criteria for Welds**

Imperfection	Examination Methods		Criteria (A to F) for Type of Welds [Note (1)]			
	Visual	Ultrasonics or Radiography	Girth Groove	Longitudinal Groove [Note (2)]	Fillet [Note (3)]	Branch Connection [Note (4)]
Crack	✓	✓	A	A	A	A
Incomplete fusion	✓	✓	A	A	A	A
Incomplete penetration	✓	✓	A	A	A	A
Rounded indications	...	✓	B	B	N/A	B
Linear indication	...	✓	C	C	N/A	C
Undercutting	✓	✓	A	A	A	A
Surface porosity or exposed slag inclusion	✓	...	A	A	A	A
Concave surface, concave root surface, or burn-through	✓	✓	D	D	N/A	D
Surface finish	✓	...	E	E	E	E
Face reinforcement or root reinforcement	✓	...	F	F	F	F

**GENERAL NOTES:**

- (a) Imperfections are evaluated by one or more of the examination methods given, as specified in [paras. K341.4.1](#) and [K341.4.2](#).
- (b) "N/A" indicates this Chapter does not establish acceptance criteria or does not require evaluation of this kind of imperfection for this type of weld.
- (c) Check (✓) indicates examination method generally used for evaluating this kind of imperfection.
- (d) Ellipsis (...) indicates examination method not generally used for evaluating this kind of imperfection.
- (e) Symbols A through F are explained in the table on the next page.

**NOTES:**

- (1) Criteria given are for required examination. More-stringent criteria may be specified in the engineering design.
- (2) Longitudinal welds include only those permitted in [paras. K302.3.4](#) and [K305](#). The criteria shall be met by all welds, including those made in accordance with a standard listed in [Table K326.1.1-1](#) or in [Appendix K](#).
- (3) Fillet welds include only those permitted in [para. K311.2.2](#).
- (4) Branch connection welds include only those permitted in [para. K328.5.4](#).

**Criterion Value Notes for Table K341.3.2-1**

Criterion		
Symbol	Measure	Acceptable Value Limits [Note (1)]
A	Extent of imperfection	Zero (no evident imperfection)
B	Size and distribution of rounded indications	See ASME BPVC, Section VIII, Division 1, Appendix 4 [Note (2)]
C	Linear indications characterized as neither incomplete penetration nor incomplete fusion. Linear indications are unacceptable if the amplitude exceeds the reference level, or linear indications have lengths that exceed  Individual length [Note (3)]  Cumulative length	6 mm ( <sup>1</sup> / <sub>4</sub> in.) for $\bar{T}_w \leq 19$ mm ( <sup>3</sup> / <sub>4</sub> in.) $\bar{T}_w/3$ for $19$ mm ( <sup>3</sup> / <sub>4</sub> in.) $< \bar{T}_w \leq 57$ mm ( $2\frac{1}{4}$ in.) 19 mm ( <sup>3</sup> / <sub>4</sub> in.) for $\bar{T}_w > 57$ mm ( $2\frac{1}{4}$ in.) $\leq \bar{T}_w$ in any 12 $\bar{T}_w$ weld length [Note (2)]
D	Depth of surface concavity, root surface concavity, or burn-through	$\bar{T}_w$ , mm (in.) ≤13 (≤ <sup>1</sup> / <sub>2</sub> ) >13 (> <sup>1</sup> / <sub>2</sub> ) and ≤51 (≤2.0) >51 (>2.0) Depth, mm (in.) ≤1.5 (≤ <sup>1</sup> / <sub>16</sub> ) ≤3 (≤ <sup>1</sup> / <sub>8</sub> ) ≤4 (≤ <sup>5</sup> / <sub>32</sub> ) and total joint thickness including weld reinforcement $\geq \bar{T}_w$
E	Surface roughness	≤12.5 μm (≤500 μin.) $R_a$ (see ASME B46.1 for definition of roughness average, $R_a$ )
F	Height of face reinforcement or root reinforcement [Note (4)] in any plane through the weld shall be within the limits of the applicable height value in the tabulation at the right. Weld metal shall be fused with and merge smoothly into the component surfaces.	$\bar{T}_w$ , mm (in.) ≤13 (≤ <sup>1</sup> / <sub>2</sub> ) >13 (> <sup>1</sup> / <sub>2</sub> ) and ≤51 (≤2.0) >51 (>2.0) Height, mm (in.) ≤1.5 (≤ <sup>1</sup> / <sub>16</sub> ) ≤3 (≤ <sup>1</sup> / <sub>8</sub> ) ≤4 (≤ <sup>5</sup> / <sub>32</sub> )

NOTES:

- (1) Where two limiting values are given, the lesser measured value governs acceptance.  $\bar{T}_w$  is the nominal wall thickness of the thinner of two components joined by a butt weld.
- (2) Porosity and inclusions such as slag or tungsten are defined as rounded indications where the maximum length is three times the width or less. These indications may be circular, elliptical, or irregular in shape; may have tails; and may vary in density. Indications where the length is greater than three times the width are defined as linear indications and may also be slag, porosity, or tungsten.
- (3) For ultrasonic examination, refer to para. K344.6.3 for acceptable value limits.
- (4) For groove welds, height is the lesser of the measurements made from the surfaces of the adjacent components. For fillet welds, height is measured from the theoretical throat; root reinforcement does not apply. Required thickness  $t_m$  shall not include face reinforcement or root reinforcement.

**Appendix 4 Acceptance Criteria - B31.1 Power Piping**

16 B31.1 Power Piping

16.0 Cracks are rejectable regardless of length

16.1 Undercut on the surface is greater than 1/32 in. (1.0 mm) deep or encroaches on the minimum required section thickness.

16.2 Undercut on the surface of longitudinal butt welds.

- 16.3 Weld reinforcement greater than specified in Table 127.4.2.
- 16.4 Lack of fusion that is surface breaking.
- 16.5 Incomplete Penetration that can be seen on the ID of the pipe.
- 16.6 Any other linear indications greater than 3/16 in. long.
- 16.7 Surface porosity with rounded indications having dimensions greater than 3/16 in. (5.0 mm) or four or more rounded indications separated by 1/16 in. (2.0 mm) or less edge to edge in any direction. Rounded indications are indications that are circular or elliptical with their length less than three times their width.

**Table 127.4.2-1  
Reinforcement of Girth and Longitudinal Butt Welds**

Thickness of Base Metal, in. (mm)	Maximum Thickness of Reinforcement for Design Temperature			
	>750°F (400°C)		≤750°F (400°C)	
	in.	mm	in.	mm
Up to 1/8 (3), incl.	1/16	1.5	3/32	2.5
Over 1/8 to 3/16 (3 to 5), incl.	1/16	1.5	1/8	3
Over 3/16 to 1/2 (5 to 13), incl.	1/16	1.5	5/32	4
Over 1/2 to 1 (13 to 25), incl.	3/32	2.5	3/16	5
Over 1 to 2 (25 to 50), incl.	1/8	3	1/4	6
Over 2 (50)	5/32	4	[Note (1)]	[Note (2)]

GENERAL NOTES:

- (a) For double-sided groove welds, the limitation on reinforcement given above shall apply separately to both inside and outside surfaces of the joint.
- (b) For single-sided groove welds with backing strips or bars that remain in place, the limitation on reinforcement given above shall apply to the outside surface. For single-sided groove welds without backing strips or bars that remain in place, the limits shall apply to the outside surface; they also apply to the inside surface when the inside surface is readily accessible.
- (c) The thickness of weld reinforcement shall be based on the thickness of the thinner of the materials being joined.
- (d) The weld reinforcement thicknesses shall be determined from the higher of the abutting surfaces involved.
- (e) Weld reinforcement may be removed if so desired.

NOTES:

- (1) The greater of 1/4 in. or 1/8 times the width of the weld in inches.
- (2) The greater of 6 mm or 1/8 times the width of the weld in millimeters.

**Appendix 5 Acceptance Criteria - ASME Section VIII - Division 1**

**15 ASME Section VIII - Division 1**

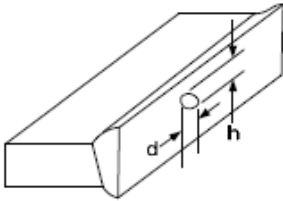
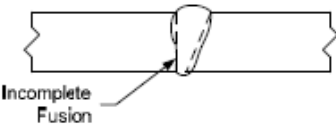
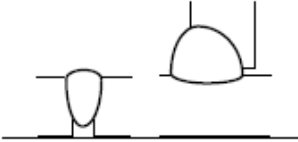
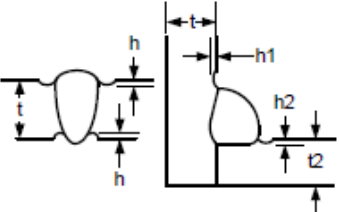
15.0 These Acceptance standards shall apply unless other more restrictive standards are specified for specific materials or applications by our Client.

15.1 All surfaces to be examined shall be free of:

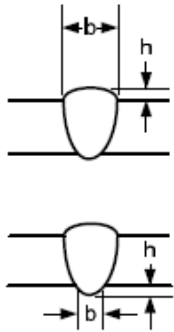
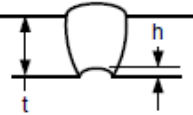
- 15.1.1 Relevant linear indications;
- 15.1.2 Relevant rounded indications greater than 3/16 in.;
- 15.1.3 Four or more relevant rounded indications in a line separated by 1/6 in. or less, edge to edge.

## **Appendix 6 Acceptance Criteria - ASME Section VIII - Division 2**

**Table 7.6 – Visual Examination Acceptance Criteria**

No.	Type Of Imperfection <sup>1</sup>	Acceptance Criteria
1	Cracks (all)	---
2	Gas cavity (all) Shrinkage cavity (all)	
3	Slag inclusions (all) Flux inclusions (all) Oxide inclusions (all) Metallic inclusions (all)	---
4	Incomplete fusion (all)	
5	Lack of penetration	
6	Undercut	

**Table 7.6 – Visual Examination Acceptance Criteria**

No.	Type Of Imperfection <sup>1</sup>	Acceptance Criteria	
7	Weld reinforcement		Acceptable weld reinforcement in butt welding joints shall be in accordance with paragraph 6.2.4.1.d. A smooth transition is required.
8	Joint offset	---	Refer to paragraph 6.1.6 for acceptable offset in butt welded joints.
9	Peaking	---	Refer to paragraph 6.1.6 for acceptable peaking in butt welding joints.
10	Stray flash or arc strike	---	Not permitted <sup>2</sup> .
11	Spatter	---	Spatter shall be minimized <sup>2</sup> .
12	Torn surface Grinding mark Chipping mark	---	Not permitted <sup>2</sup> .
13	Concavity		Refer to paragraph 6.2.4.1(d) for acceptable concavity
<p>Notes:</p> <p>1) The following symbols are used in this table.  a – nominal fillet weld throat thickness  b – width of weld reinforcement  d – diameter of pore  h – height of imperfections  t – wall or plate thickness</p> <p>2) These imperfections may be removed by blend grinding.</p>			

## Appendix 7 Sample Report