

# Weldment Visual Inspection Requirements

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# Weldment Visual Inspection Requirements

## 1.0 Purpose / Scope / Timing

### 1.1 Purpose / Scope

The purpose of this specification is to establish minimum requirements for Weld visual inspection for product acceptance of GE Grid Solutions (GS) components to detect surface defects on welds, base metal defects caused by weld, or defects in base metal that is repaired by welding. Weld visual inspection for product acceptance is conducted after all processing is complete and is a part of the final product acceptance process prior to release to the external customer.

### 1.2 Compliance Date

- Full compliance from all organizations within scope is expected at the time of issuance of this document. This document replaces and simplifies the former GE Grid Solutions specification P29B-AL-0001 Rev -, Visual Inspection Requirements for Weldments.
- Any system or specification exceptions to references in this document must be approved by the appropriate GS representative and documented accordingly.

## 2.0 Procedure / Quality Record Requirements

### 2.1 General Requirements

Weld visual inspection procedure shall be in accordance with the requirements of QME-10, latest revision.

#### 2.1.1 Welded Fabrications Receipt Audit

- a. Welded fabrications purchased by GS may be subject to audit inspection upon receipt. The audit inspection may be performed over a coating. If the audit inspection reveals suspect conditions, the coat shall be removed prior to disposition.

#### 2.1.2 Personnel

- a. Weld visual inspection shall be performed by personnel trained through an established program that reflects the intent of the recommended guidelines provided in ASNT-TC-1A, EN473, AWS B1.11, CAN/CGSB-48.972-2000, or EN 970.
- b. Personnel conducting weld visual inspection for final product acceptance shall annually pass an examination where their vision, with or without correction, meets the Jaeger J2 (Per AWS QC 1; and SNT-TC1A, or CAN/CGSB-48.972-2000) near vision test at a distance of not less than 12 inches as well as a color perception test. Visual examination records shall be maintained for the current year and must be available for review.
- c. Qualified personnel who are independent of the welding operation shall perform all visual inspections for final product acceptance.

#### 2.1.3 Documentation



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- a. Visual weld inspections shall be performed in accordance with a written procedure or method applicable to the parts or groups of parts under inspection. This procedure or method shall be reference in the Manufacturing Process Plan (MPP) under which the parts or groups of parts was qualified.
- b. The written procedure or method shall include, at a minimum, the following elements, either directly or by reference to applicable document(s):
  - Procedure identification number and date written or revision number
  - Complete inspection requirements, including lighting requirements and method of marking defects for rework or repair
  - Identification of components or areas within a component requiring inspection in accordance with the procedure
  - Acceptance requirements for evaluation indications and disposition of parts after evaluations

### 2.1.4 Inspection Criteria

- a. Surfaces to be welded or thermally cut shall be cleaned of all foreign material such as grease, oil, dirt, scale, slag, and paint that would be detrimental to either the weld or base material. Weld preparations shall be machined (1000 RMS maximum surface roughness), grit blasted (near white blast), wire brushed, or ground to bright metal prior to welding.
- b. Groove weld dimensions shall be verified by measuring the groove dimensions prior to welding. All weld preps shall meet drawing specified dimensions (whether provided via dimensions on the drawing or in a welding specification). If no dimensions are provided as part of the drawing or ordering documents, the dimensions shall meet dimensions specified by approved welding procedures (WPS). Tolerances specified in the welding specification or approved WPS shall apply. Measurement will be conducted with instruments suitable for the applied tolerances.
- c. All completed weld surfaces shall be visually inspection for the entire weld length, unless an audit frequency is permitted by the applicable welding or quality specification. The inspected surfaces shall be inspected in accordance with the requirements of this procedure and evaluated to the applicable acceptance criteria, unless alternate inspection attributes or criteria are specified in the ordering documents communicated to the supplier or in the internal GS processing documents. A minimum light intensity at the inspection site of 100 foot-candles (1000 Lux) is required.
- d. Welds shall be dimensionally inspected for compliance to drawing tolerance a minimum of one (1) place per weld in every three (3) feet of weld. The weld location selected for examination shall be the least favorable as determined by visual examination.
- e. The inspection area shall include the weld and the accessible adjacent base material for a distance of 1.2 inch from the toes of the weld of edge of the base metal, whichever is



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less.

- f. Material thickness shall be the nominal or actual thickness as specified on the engineering drawing or material specification. The material thickness used for the acceptance criteria for welds shall be based on the thickness of the thinner member joined except as follows:
  - For upgrade or repair welds, the material thickness of the area of the base metal being welded is considered to be the material thickness.
  - For weld deposited cladding, buttering, hard surfacing, wear surfacing, etc., the material thickness is the thickness of the weld deposit specified on the engineering drawing.
- g. Fillet welds shall be examined for size using standard weld profile gages or customer profile gages for sizes not covered by standard gages. Maximum fillet dimensions may be exceeded to meet minimum throat dimensions.
- h. The weld inspection surface shall be in the final heat treated condition and be free of all coatings and other surface conditions such as paint, plating, corrosion, etc. When blending or contouring is not required, welds shall be inspected in the as-welded condition. When surface blending or contouring is required for other non-destructive tests, weld visual inspection shall be performed after surface conditioning.
- i. Weld contour and size attributes may be verified prior to stress relief treatments. All other attributes shall be verified after post weld heat treatments.
- j. For welds that will be subsequently machined, the weld size shall be verified prior to machining and the machined surface shall be visually inspected relative to all of the other attributes contained herein.

### 2.1.5 Inspection Timing Requirements

- a. In-process inspection shall be performed as required by drawing.
- b. Final product acceptance inspection shall be performed after the completion of all operations that could cause or reveal surface connected discontinuities or operations that could expose discontinuities not previously open to the surface. These operations include, but are not limited to, heat treating, welding, grinding, straightening, rolling, bending, or machining
- c. Sections of welds may be covered over or become inaccessible during the fabrication. For these welds, the final visual inspection for product acceptance may be performed prior to the stress relieving heat treatment only if the welds will be inaccessible after stress relieving. This practice shall be included in the approved process instruction or MPP.
- d. Final product acceptance inspection shall capture first yield defect data from the welding operation. The intent of this requirement is to capture the actual defect rate



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that occurs in the fabrication process.

- e. Final GS witness or product or process audit visual inspections may be conducted over coatings or other surface conditions such as paint, plating, corrosion, etc., at the discretion of the GS Sourcing Quality Engineer (SQE) or manufacturing personnel, who may request additional rework or cleaning at that time.

### 2.1.6 Defect Findings, Rework, and Repair

- a. All defect findings shall be documents in the inspection report and appropriately marked on the part for rework or repair.
- b. Welders shall perform all rework or repair using an approved rework or repair procedure prepared by a welding supervisor, welding technician, or welding engineer.

### 2.1.7 Inspection Records

- a. The inspector shall make a record of the inspection which shall include, as a minimum, the following information:
  - Unique part identifier (serial number, shop order, or batch number)
  - Drawing number and revision
  - Procedure and applicable acceptance criteria
  - Inspector identity and date of inspection
  - Record of defect findings, including size and location
- b. Final product acceptance inspection shall be indicated by permanent stamping or marking adjacent to the weld or must be unambiguously identified in the inspection report.

### 2.1.8 Audits

GS reserves the right to periodically audit the supplier's facilities and practices. Such audits shall not relieve the supplier from the responsibility of producing the material in a suitable condition.

## 2.2 Acceptance Criteria

The following acceptance criteria apply if not otherwise specified on the drawing or part specification.

- 2.2.1 Examples of acceptable and unacceptable weld profiles are found in Appendix A.
- 2.2.2 All welds shall be free from the defects listed in Table 1. The presence of any defect(s) listed in Table 1 shall be cause of automatic rejection of the weld.

## 2.3 Applicable Documents



## Weldment Visual Inspection Requirements

The following documents shall form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue shall apply.

### 2.3.1 General Electric Company

QME-10 Supplier Quality Requirements

### 2.3.2 American Society for Testing and Materials

SNT-TC-1A Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

### 2.3.3 American Welding Society

ANSI/AWS A2.4 Standard Symbols for Welding, Brazing, and Nondestructive Evaluation

ANSI/AWS A3.0 Standard Welding Terms and Definitions

ANSI/AWS B1.11 Guide for the Visual Examination of Welds

ANSI/AWS D1.1/D1.1M Structural Welding Code – Steel

AWS QC 1 Standard for AWS Certification of Welding Inspectors

### 2.3.4 Canadian Standard Association

CAN/CGSB-48.972-2000 (Canadian General Standards Board) Non-Destructive Testing – Qualification and Certification of Personnel

### 2.3.5 European Standard

EN 473 Non-Destructive Testing – Qualification And Certification of NDT Personnel – General Principles

EN ISO 287-1 Qualification of Test Welders – Fusion Welding – Part 1: Steels

EN 970 Non-Destructive Examination of Fusion Welds

## 2.4 Quality Records

### 2.4.1 Documentation

Quality and product records may include, but are not limited to:

- Product quality or inspection and test plans and results
- Weld process schedules (WPS)
- Process quality requirements (PQR)
- Qualification documentation
- Other specific component record requirements specified in POs or contracts

### 2.4.2 Record Retention



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- a. The supplier shall have a written procedure for the documentation and retention of quality and product records for products supplied to EC.
- b. Records shall be maintained for a minimum of ten (10) years unless otherwise specified by EC.
- c. It is the responsibility of the supplier to determine the appropriate storage means to meet the retention requirement and allow for timely retrieval of records.

## 3.0 Definitions, Acronyms and References

For standard terminology used in nondestructive testing and weld defects definitions, refer to ANSI/AWS A2.4 and A3.0 respectively, unless specifically defined elsewhere in this specification.

## 4.0 Document Revisions and Approvals

The following chart lists the revisions made to this document tracked by version. Use this to describe the changes and additions each time this document is re-published. The description should include as many details of the changes as possible.

Records of Reviewers and Approvers may be found within the DMS (Document Management System).

Version	Section Modified and Revision Description	Date	Author
1.1	Corrected typographical errors	11/11/2013	Tiffany Shomo
1.2	Corrected footer error	01/08/2014	Arianto Lawardi
2.0	Replacement Energy Management with Energy Connections	07/08/2016	Arianto Lawardi
3.0	Update Energy Connections to Grid Solutions	01/31/2020	Charles Danner
4.0	Revision Update	01/31/2022	Charles Danner
5.0	Updated EC-SRC-0002 Reference to QME-10 Supplier Quality Requirements.	04/11/2022	Charles Danner

Title: Weldment Visual Inspection Requirements  
 Reference: EC-SRC-0004  
 Revision: 5.0  
 Application Date: 01/31/2022  
 Expiration Date: 01/30/2025



# Weldment Visual Inspection Requirements



Uncontrolled when Printed  
or  
Transmitted Electronically



# Weldment Visual Inspection Requirements

**TABLE 1 WELD DEFECTS, DEFINITION / VISUAL APPEARANCE AND TYPICAL CAUSE(S)**

Defect	Definition / Visual Appearance	Typical Cause(s)
ARC STRIKE	A localized heat affected zone caused by an arc or heat generated when passing current through the work piece. Arc strikes are generally recognized by evidence of melting or overheating of the material and are often caused by weld rod or wire striking the part or by MT prods arcing to the part surface.	<ul style="list-style-type: none"> <li>Arc or heat generated when passing current through the work piece.</li> </ul>
BURN THROUGH	An open void or through-wall hole extending into a backing ring, backing strip, fused root or base material.	<ul style="list-style-type: none"> <li>Current too high.</li> <li>Travel speed too low.</li> <li>Combination of high current and low travel speed.</li> </ul>
CRACK or TEAR	A linear rupture of material under stress having a length at least 3 times its width.	<ul style="list-style-type: none"> <li>Improper weld bead aspect ratio.</li> <li>Improper filler selection.</li> <li>Insufficient preheat.</li> <li>Excessive interpass temperature.</li> </ul>
CRATER CRACK	A star like rupture coming out of a weld stop crater.	<ul style="list-style-type: none"> <li>Improper electrode manipulation.</li> <li>Improper parameter tapering at the weld stop.</li> </ul>
DAMAGED BASE METAL SURFACE AFTER WELDING	Base material shall be free from excessive localized discontinuities such as gouges, handling marks and excessive surface roughness or melt through of areas not intended to be penetrated by welding.	<ul style="list-style-type: none"> <li>Improper material handling</li> </ul>
INCOMPLETE CONSUMABLE INSERT MELTING	Incomplete melting of the consumable insert either with or without fusion and bonding to the base metal along one or both sides of the consumable insert.	<ul style="list-style-type: none"> <li>Improper weld joint preparation.</li> <li>Improper electrode manipulation.</li> <li>Current too low.</li> <li>Travel speed too high.</li> </ul>
INCOMPLETE FUSION	Failure of the weld metal to fuse completely at some portion of the weld zone or adjacent base metal. This includes incomplete fusion of consumable inserts.	<ul style="list-style-type: none"> <li>Improper weld joint preparation.</li> <li>Improper electrode manipulation.</li> <li>Current too low.</li> <li>Travel speed too high.</li> </ul>
INCOMPLETE JOINT PENETRATION	A joint root condition in a groove weld in which weld metal does not extend through the joint thickness.	<ul style="list-style-type: none"> <li>Improper weld joint preparation.</li> <li>Improper electrode manipulation.</li> <li>Current too low.</li> <li>Voltage too high</li> <li>Travel speed too high.</li> </ul>
IRREGULAR BEAD PROFILE	Under fill, valleys, or depressions in multipass welds greater than 2 times the undercut allowance or any depth that goes below the base metal cross section.	<ul style="list-style-type: none"> <li>Poor weld bead spacing.</li> <li>Poor wettability due to incorrect weld parameters, such as low voltage or high travel speed.</li> </ul>
OVERLAP (ROLL-OVER)	The protrusion of weld metal beyond the weld toe or weld root.	<ul style="list-style-type: none"> <li>Travel speed too slow.</li> <li>Welding electrode too large for the parameters or position.</li> </ul>
SLAG INCLUSION	A discontinuity consisting of slag entrapped in weld metal or at the weld interface.  Weld surfaces shall be free of slag.	<ul style="list-style-type: none"> <li>Welds in joints with too narrow a joint angle or initial joint gap.</li> <li>In multipass welds, improper bead spacing can result in a valley, between beads with too narrow a gap or side walls with too narrow a joint angle.</li> </ul>



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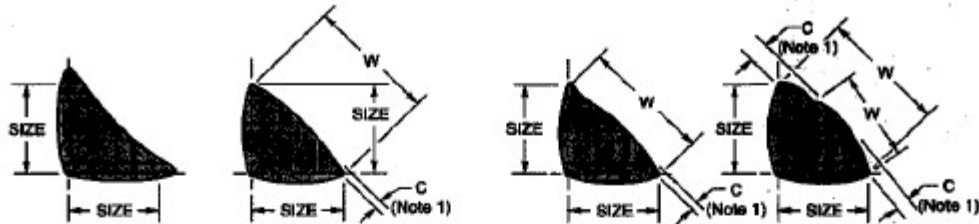
**TABLE 1 WELD DEFECTS, DEFINITION / VISUAL APPEARANCE AND TYPICAL CAUSE(S)**

Defect	Definition / Visual Appearance	Typical Cause(s)
SURFACE POROSITY	Gas bubbles frozen in the solidified weld metal. None allowed unless allowed up to certain limits specified on the engineering criteria referenced on the drawing or specification.	<ul style="list-style-type: none"> <li>Typically caused by contamination on the base metal or filler material.</li> <li>Too high a weld travel speed, loss of shielding, arc length too long.</li> </ul>
UNDERCUT	If not specified on the drawing or specification, localized under fill at the edge of toe of the weld shall be 1/32 inch [0.8mm] max. May be higher or lower value if specified in the engineering criteria referenced on the drawing or specification	<ul style="list-style-type: none"> <li>Current too high.</li> <li>Voltage too high.</li> <li>Travel speed too high.</li> <li>Combination of these variables.</li> </ul>
UNDERFILL	A depression in the crown of the weld extending below the surface of the adjacent base material in groove welds. Under fill may be allowed up to certain limits if specified in the engineering criteria referenced on the drawing or specification.	<ul style="list-style-type: none"> <li>Travel speed too high.</li> <li>Poor electrode manipulation.</li> <li>Drop through.</li> <li>Current too low.</li> </ul>
WELD SPATTER	Globular drops of weld metal that are deposited on the weld or base material during welding, which do not form part of the weld. Tightly adherent weld spatter may be allowed if specified in the engineering criteria referenced on the drawing or specification.	<ul style="list-style-type: none"> <li>Arc blow.</li> <li>Incorrect parameters such as current too high, voltage too high or both.</li> </ul> <p>Note: Some processes such as Globular transfer GMAW tend to result in spatter at normal parameter ranges.</p>



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## APPENDIX A Acceptable and Unacceptable Weld Profiles

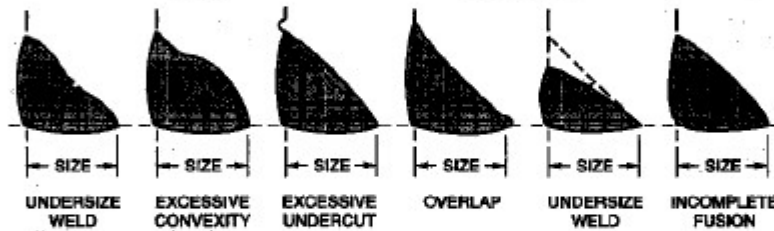


(A) DESIRABLE FILLET WELD PROFILES

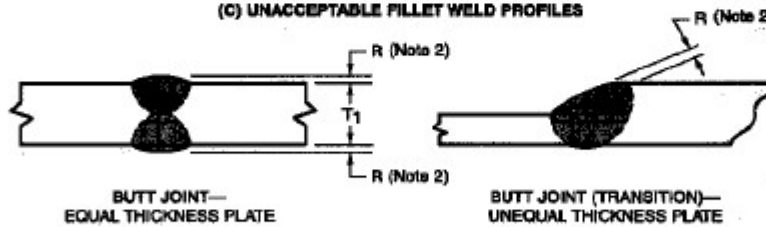
(B) ACCEPTABLE FILLET WELD PROFILES

Note 1. Convexity, C, of a weld or individual surface bead with dimension W shall not exceed the value of the following table:

WIDTH OF WELD FACE OR INDIVIDUAL SURFACE BEAD, W	MAX CONVEXITY, C
$W \leq 5/16$ in. [8 mm]	1/16 in. [2 mm]
$W > 5/16$ in. [8 mm] TO $W < 1$ in. [25 mm]	1/8 in. [3 mm]
$W \geq 1$ in. [25 mm]	3/16 in. [5 mm]

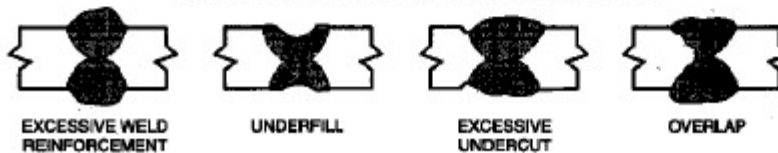


(C) UNACCEPTABLE FILLET WELD PROFILES



Note 2. Reinforcement R shall not exceed 1/8 in. [3 mm] (see 5.24.4).

(D) ACCEPTABLE GROOVE WELD PROFILE IN BUTT JOINT



(E) UNACCEPTABLE GROOVE WELD PROFILES IN BUTT JOINTS

D1.1/D1.1M:2004

Figure 5.4 reproduced with permission from The American Welding Society (AWS) Miami, FL

