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USACE / NAVFAC / AFCEA UFGS-05090A (December 2003)  
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Preparing Activity: USACE Superseding  
UFGS-05090A (September 1998)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags

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### SECTION 05090A

WELDING, STRUCTURAL  
12/03

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NOTE: This guide specification covers the requirements for welding of structural steel for buildings bridges and other structures.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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## PART 1 GENERAL

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NOTE: This specification can be used for bridges and other structures with similar types of live loads by implementing the requirements of AWS D1.1/D1.1M, Section 9 or 10, as applicable, in the design of the weldments, and deleting the references to AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

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### 1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of

SpecsIntact automated reference checking is  
recommended for projects based on older guide  
specifications.

\*\*\*\*\*

The publications listed below form a part of this specification to the  
extent referenced. The publications are referred to within the text by the  
basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 335 (1989) Structural Steel Buildings  
Allowable Stress Design and Plastic Design

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT RP SNT-TC-1A (2001) Recommended Practice

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4 (1998) Standard Symbols for Welding,  
Brazing and Nondestructive Examination

AWS A3.0 (2001) Standard Welding Terms and  
Definitions

AWS D1.1/D1.1M (2002) Structural Welding Code - Steel

AWS Z49.1 (1999) Safety in Welding, Cutting and  
Allied Processes

1.2 DEFINITIONS

Definitions of welding terms shall be in accordance with AWS A3.0.

1.3 GENERAL REQUIREMENTS

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NOTE: The drawings should be checked to ensure that  
any supplementary information required by the  
paragraph has been shown and that there is no  
conflict between the drawings and the  
specifications. Complete information about  
location, type, size, and extent of all welds and  
nondestructive testing, where required, shall be  
clearly shown on the drawings. When welding is to  
be covered by more than one section in the contract  
specifications, this section will cover all  
structural welding; the other sections will cover  
the utilities or special equipment required inside  
the structure. Welding of utilities or special  
equipment to structural members should be done  
carefully so that the overall structure is not  
weakened. The extent of welding required must be  
clearly shown on drawings or covered by the contract  
specification. Revise this paragraph to clearly  
define the welding that is covered. Drawings or  
other section of the specifications must specify the  
strength of the base material.

Drawings or the text of the contract specifications must specify the weld requirements: tensile strength, elongation, shear strength, size, length, type, and location.

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The design of welded connections shall conform to AISC 335 unless otherwise indicated or specified. Material with welds will not be accepted unless the welding is specified or indicated on the drawings or otherwise approved. Welding shall be as specified in this section, except where additional requirements are shown on the drawings or are specified in other sections. Welding shall not be started until welding procedures, inspectors, nondestructive testing personnel, welders, welding operators, and tackers have been qualified and the submittals approved by the Contracting Officer. Qualification testing shall be performed at or near the work site. Each Contractor performing welding shall maintain records of the test results obtained in welding procedure, welder, welding operator, and tacker performance qualifications.

#### 1.3.1 Pre-erection Conference

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NOTE: ASTM A 992 steel must be used for all buildings which have groove welds in their lateral force resisting systems, and are either in Seismic Design Categories D, E and F or in Category C and are Seismic Use Group III; this and the following paragraph will be retained for this type of buildings.

Government personnel attending the pre-erection conference should include all field QA inspectors, the building designer, the EOR (if different from the designer) and the PM.

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A pre-erection conference shall be held, prior to the start of the field welding, to bring all affected parties together and to gain a naturally clear understanding of the project and the Welding Procedure Specifications (WPS) (which the Contractor shall develop and submit for all welding, including welding done using prequalified procedures). Attendees shall include all Contractor's welding production and inspection personnel and appropriate Government personnel. Items for discussion could include: responsibilities of various parties; welding procedures and processes to be followed; welding sequence (both within a joint and joint sequence within the building); inspection requirements and procedures, both visual and ultrasonic; welding schedule; fabrication of mock-up model; and other items deemed necessary by the attendees.

#### 1.3.2 Mock-up Model

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NOTE: Building designer will designate, on the drawings, a joint to be used as a mock-up model. This model should be a critical, but typical, field welded groove joint connection located at or near where a properly sequenced erection pattern starts.

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The field-welded connection designated as the mock-up model on the drawings shall be the first connection made. All welders qualified and designated to perform field-welded groove joints shall be present during the welding of the mock-up model connections and each one shall perform a part of the welding. The mock-up test shall simulate the physical and environmental conditions that will be encountered during the welding of all groove joints. All inspection procedures required for groove welded joints, including NDE tests, shall be performed on the mock-up model. All Contractor inspection and testing personnel that will perform QC of groove welded joints shall be present during the welding of the mock-up model and each one shall perform the inspection procedures to be performed on production welding of these joints. This mock-up model connection shall be the standard of performance, both for the welding and inspection procedures used and the results to be achieved in the production welding for these groove welded joints.

#### 1.4 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with

Section 01330 SUBMITTAL PROCEDURES:

SD-03 Product Data

Welding Procedure Qualifications[; G][; G, [\_\_\_\_]]  
Welder, Welding Operator, and Tacker Qualification  
Inspector Qualification  
Previous Qualifications  
Prequalified Procedures

Copies of the welding procedure specifications; the procedure qualification test records; and the welder, welding operator, or tacker qualification test records.

SD-06 Test Reports

Quality Control

A quality assurance plan and records of tests and inspections.

1.5 WELDING PROCEDURE QUALIFICATIONS

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NOTE: Drawings or the text of the contract specifications must specify the weld requirements: tensile strength, elongation, shear strength, size, length, type, and location.

When the proposed shielded metal-arc welding procedures are reviewed, the voltage and travel speed should be within the limits shown in the following table:

| Electrode | Voltage Limits | Travel Speed Limits                         |
|-----------|----------------|---|
| E6010     | 28 - 32        | 125 - 380 mm/minute<br>(5 - 15 inch/minute) |
| E6011     | 28 - 32        | 150 - 300 mm/minute<br>(6 - 12 inch/minute) |
| E6013     | 22 - 26        | 200 - 360 mm/minute<br>(8 - 14 inch/minute) |
| E7018     | 25 - 28        | 150 - 510 mm/minute<br>(6 - 20 inch/minute) |
| E7024     | 26 - 32        | 200 - 410 mm/minute<br>(8 - 16 inch/minute) |
| E8018     | 22 - 28        | 200 - 510 mm/minute<br>(8 - 20 inch/minute) |
| E11018    | 25 - 30        | 150 - 410 mm/minute<br>(6 - 16 inch/minute) |

These limits are for 3.0 mm (1/8 inch) diameter electrodes and the voltage will vary a small amount

(plus or minus 2 volts) with different diameters. The travel speed limits will remain constant. The current limits, which are based on coating types and core wire diameter, should be as designated in AWS A5.1. The heat input, measured in Joules per mm (Joules per inch),

$$(\text{Voltage} \times \text{Current} \times 60) / (\text{Travel speed inch/minute})$$

This should not exceed 2,165 Joules per mm (55,000 Joules per inch) for A36 steel. With higher heat inputs, the weld metal strengths fall below the specification limits. For gas metal-arc welding, the maximum heat input should be 1,969 Joules per mm (50,000 Joules per inch).

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Except for prequalified (per AWS D1.1/D1.1M) and previously qualified procedures, each Contractor performing welding shall record in detail and shall qualify the welding procedure specification for any welding procedure followed in the fabrication of weldments. Qualification of welding procedures shall conform to AWS D1.1/D1.1M and to the specifications in this section. Copies of the welding procedure specification and the results of the procedure qualification test for each type of welding which requires procedure qualification shall be submitted for approval. Approval of any procedure, however, will not relieve the Contractor of the sole responsibility for producing a finished structure meeting all the requirements of these specifications. This information shall be submitted on the forms in Appendix E of AWS D1.1/D1.1M. Welding procedure specifications shall be individually identified and shall be referenced on the detail drawings and erection drawings, or shall be suitably keyed to the contract drawings. In case of conflict between this specification and AWS D1.1/D1.1M, this specification governs.

#### 1.5.1 Previous Qualifications

Welding procedures previously qualified by test may be accepted for this contract without requalification if the following conditions are met:

- a. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.
- b. The qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.
- c. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

#### 1.5.2 Prequalified Procedures

Welding procedures which are considered prequalified as specified in AWS D1.1/D1.1M will be accepted without further qualification. The Contractor shall submit for approval a listing or an annotated drawing to indicate the joints not prequalified. Procedure qualification shall be required for these joints.



### 1.5.3 Retests

If welding procedure fails to meet the requirements of AWS D1.1/D1.1M, the procedure specification shall be revised and requalified, or at the Contractor's option, welding procedure may be retested in accordance with AWS D1.1/D1.1M. If the welding procedure is qualified through retesting, all test results, including those of test welds that failed to meet the requirements, shall be submitted with the welding procedure.

### 1.6 WELDER, WELDING OPERATOR, AND TACKER QUALIFICATION

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**NOTE: Additional requirements may be inserted if  
necessary. The methods of nondestructive testing  
required will be determined and specified.**  
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Each welder, welding operator, and tacker assigned to work on this contract shall be qualified in accordance with the applicable requirements of AWS D1.1/D1.1M and as specified in this section. Welders, welding operators, and tackers who make acceptable procedure qualification test welds will be considered qualified for the welding procedure used.

#### 1.6.1 Previous Personnel Qualifications

At the discretion of the Contracting Officer, welders, welding operators, and tackers qualified by test within the previous 6 months may be accepted for this contract without requalification if all the following conditions are met:

- a. Copies of the welding procedure specifications, the procedure qualification test records, and the welder, welding operator, and tacker qualification test records are submitted and approved in accordance with the specified requirements for detail drawings.
- b. Testing was performed by an approved testing laboratory, technical consultant, or the Contractor's approved quality control organization.
- c. The previously qualified welding procedure conforms to the requirements of this specification and is applicable to welding conditions encountered under this contract.
- d. The welder, welding operator, and tacker qualification tests conform to the requirements of this specification and are applicable to welding conditions encountered under this contract.

#### 1.6.2 Certificates

Before assigning any welder, welding operator, or tacker to work under this contract, the Contractor shall submit the names of the welders, welding operators, and tackers to be employed, and certification that each individual is qualified as specified. The certification shall state the type of welding and positions for which the welder, welding operator, or tacker is qualified, the code and procedure under which the individual is qualified, the date qualified, and the name of the firm and person certifying the qualification tests. The certification shall be kept on file, and 3 copies shall be furnished. The certification shall be kept current for the duration of the contract.

### 1.6.3 Renewal of Qualification

Requalification of a welder or welding operator shall be required under any of the following conditions:

- a. It has been more than 6 months since the welder or welding operator has used the specific welding process for which he is qualified.
- b. There is specific reason to question the welder or welding operator's ability to make welds that meet the requirements of these specifications.
- c. The welder or welding operator was qualified by an employer other than those firms performing work under this contract, and a qualification test has not been taken within the past 12 months. Records showing periods of employment, name of employer where welder, or welding operator, was last employed, and the process for which qualified shall be submitted as evidence of conformance.
- d. A tacker who passes the qualification test shall be considered eligible to perform tack welding indefinitely in the positions and with the processes for which he is qualified, unless there is some specific reason to question the tacker's ability. In such a case, the tacker shall be required to pass the prescribed tack welding test.

### 1.7 INSPECTOR QUALIFICATION

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**NOTE: Additional requirements may be inserted if necessary. The methods of nondestructive testing required will be determined and specified. If quality control inspection is to be the responsibility of the Government, delete this paragraph.**  
\*\*\*\*\*

Inspector qualifications shall be in accordance with AWS D1.1/D1.1M. Nondestructive testing personnel shall be qualified in accordance with the requirements of ASNT RP SNT-TC-1A for Levels I or II in the applicable nondestructive testing method. The inspector may be supported by assistant welding inspectors who are not qualified to ASNT RP SNT-TC-1A, and assistant inspectors may perform specific inspection functions under the supervision of the qualified inspector.

### 1.8 SYMBOLS

Symbols shall be in accordance with AWS A2.4, unless otherwise indicated.

### 1.9 SAFETY

Safety precautions during welding shall conform to AWS Z49.1.

## PART 2 PRODUCTS

### 2.1 WELDING EQUIPMENT AND MATERIALS

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**NOTE: Normally, the Contractor (fabricator) selects the specific electrode material for weldments. In**

all cases, a class of electrode should be called out based on the table of matching filler metals in AWS D1.1/D1.1M. If in special cases the selection of the proper electrode is critical to the design, the designer may specify the electrode to be used in this or other sections. In special cases, it may also be necessary to specify the welding process.

\*\*\*\*\*

All welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator performing qualified welding procedures. All welding equipment and materials shall comply with the applicable requirements of AWS D1.1/D1.1M.

### PART 3 EXECUTION

#### 3.1 WELDING OPERATIONS

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NOTE: When the proposed shielded metal-arc welding procedures are reviewed, the voltage and travel speed should be within the limits shown in the following table:

| Electrode | Voltage Limits | Travel Speed Limits                         |
|-----------|----------------|---|
| E6010     | 28 - 32        | 125 - 380 mm/minute<br>(5 - 15 inch/minute) |
| E6011     | 28 - 32        | 150 - 300 mm/minute<br>(6 - 12 inch/minute) |
| E6013     | 22 - 26        | 200 - 360 mm/minute<br>(8 - 14 inch/minute) |
| E7018     | 25 - 28        | 150 - 510 mm/minute<br>(6 - 20 inch/minute) |
| E7024     | 26 - 32        | 200 - 410 mm/minute<br>(8 - 16 inch/minute) |
| E8018     | 22 - 28        | 200 - 510 mm/minute<br>(8 - 20 inch/minute) |
| E11018    | 25 - 30        | 150 - 410 mm/minute<br>(6 - 16 inch/minute) |

These limits are for 3.0 mm (1/8 inch) diameter electrodes and the voltage will vary a small amount (plus or minus 2 volts) with different diameters. The travel speed limits will remain constant. The current limits, which are based on coating types and core wire diameter, should be as designated in AWS A5.1. The heat input, measured in Joules per mm (Joules per inch),

$(\text{Voltage} \times \text{Current} \times 60) / (\text{Travel speed inch/minute})$ .

This should not exceed 2,165 Joules per mm (55,000 Joules per inch) for A36 steel. With higher heat inputs, the weld metal strengths fall below the specification limits. For gas metal-arc welding, the maximum heat input should be 1,969 Joules per mm (50,000 Joules per inch).

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#### 3.1.1 Requirements

Workmanship and techniques for welded construction shall conform to the requirements of AWS D1.1/D1.1M and AISC 335. When AWS D1.1/D1.1M and the AISC 335 specification conflict, the requirements of AWS D1.1/D1.1M shall govern.

#### 3.1.2 Identification

Welds shall be identified in one of the following ways:

- a. Written records shall be submitted to indicate the location of welds made by each welder, welding operator, or tacker.
- b. Each welder, welding operator, or tacker shall be assigned a number, letter, or symbol to identify welds made by that individual. The Contracting Officer may require welders, welding operators, and tackers to apply their symbol next to the weld by means of rubber stamp, felt-tipped marker with waterproof ink, or other methods that do not cause an indentation in the metal. For seam welds, the identification mark shall be adjacent to the weld at 1 meter 3 foot intervals. Identification with die stamps or electric etchers shall not be allowed.

#### 3.2 QUALITY CONTROL

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NOTE: The methods of nondestructive testing required will be determined and specified. The specification writer (designer) must decide what weld defects can be tolerated under service conditions. Next, the type of nondestructive examination (NDE) system to be used must be determined, considering joint design, material thickness, and accessibility to the joint. Every weld joint will not require 100 percent NDE. Joints critical to the structure should be determined. These should be inspected more closely than noncritical joints. Remember, visual inspection is as important to the final quality of the weld as the other methods. The specifications or drawings must clearly indicate which joints require 100 percent NDE, which joints require random inspection, and which method(s) are to be used for each joint. For random inspection, the drawings must indicate the location, number of joints, and minimum increment length of weld which will be inspected, but must not disclose the exact spot to be examined. Joints not inspected by radiographic, magnetic particle, liquid penetrant, or ultrasonic methods shall be subject to

visual inspections only. If quality control is to be primarily the Contractor's responsibility and the inspection and tests are adequately called out, then acceptance by the Government can rely on the Contractor's work and records -- with some spot checking to verify the results. On projects with only a small amount of welding that needs just visual inspection, acceptance inspection by the Government may be the only quality control required.

Additional requirements may be inserted if necessary. The methods of nondestructive testing required will be determined and specified. If quality control inspection is to be the responsibility of the Government, delete this paragraph.

If the Contractor must do radiographic or nondestructive inspection other than visual, or inspection other than that covered by Section 6 of AWS D1.1/D1.1M, these requirements must be added to this paragraph. The extent of inspection must be clearly shown either on the drawings or by this or other sections of the specifications. The bracketed portion of the paragraph must be edited to define the extent of nondestructive testing required.

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Testing shall be done by an approved inspection or testing laboratory or technical consultant; or if approved, the Contractor's inspection and testing personnel may be used instead of the commercial inspection or testing laboratory or technical consultant. The Contractor shall perform visual [and] [radiographic,] [ultrasonic,] [magnetic particle,] [and] [dye penetrant] inspection to determine conformance with paragraph STANDARDS OF ACCEPTANCE. Procedures and techniques for inspection shall be in accordance with applicable requirements of AWS D1.1/D1.1M, except that in radiographic inspection only film types designated as "fine grain," or "extra fine," shall be employed.

### 3.3 STANDARDS OF ACCEPTANCE

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**NOTE: Drawings or the text of the contract specifications must specify the weld requirements: tensile strength, elongation, shear strength, size, length, type, and location.**

\*\*\*\*\*

Dimensional tolerances for welded construction, details of welds, and quality of welds shall be in accordance with the applicable requirements of AWS D1.1/D1.1M and the contract drawings. Nondestructive testing shall be by visual inspection [and radiographic,] [ultrasonic,] [magnetic particle,] [or] [dye penetrant] methods. The minimum extent of nondestructive testing shall be random [\_\_\_\_\_] percent of welds or joints, as indicated on the drawings.

#### 3.3.1 Nondestructive Examination

The welding shall be subject to inspection and tests in the mill, shop, and

field. Inspection and tests in the mill or shop will not relieve the Contractor of the responsibility to furnish weldments of satisfactory quality. When materials or workmanship do not conform to the specification requirements, the Government reserves the right to reject material or workmanship or both at any time before final acceptance of the structure containing the weldment.

### 3.3.2 Destructive Tests

When metallographic specimens are removed from any part of a structure, the Contractor shall make repairs. The Contractor shall employ qualified welders or welding operators, and shall use the proper joints and welding procedures, including peening or heat treatment if required, to develop the full strength of the members and joints cut and to relieve residual stress.

### 3.4 GOVERNMENT INSPECTION AND TESTING

In addition to the inspection and tests performed by the Contractor for quality control, the Government will perform inspection and testing for acceptance to the extent determined by the Contracting Officer. The costs of such inspection and testing will be borne by the Contractor if unsatisfactory welds are discovered, or by the Government if the welds are satisfactory. The work may be performed by the Government's own forces or under a separate contract for inspection and testing. The Government reserves the right to perform supplemental nondestructive and destructive tests to determine compliance with paragraph STANDARDS OF ACCEPTANCE.

### 3.5 CORRECTIONS AND REPAIRS

When inspection or testing indicates defects in the weld joints, the welds shall be repaired using a qualified welder or welding operator as applicable. Corrections shall be in accordance with the requirements of AWS D1.1/D1.1M and the specifications. Defects shall be repaired in accordance with the approved procedures. Defects discovered between passes shall be repaired before additional weld material is deposited. Wherever a defect is removed and repair by welding is not required, the affected area shall be blended into the surrounding surface to eliminate sharp notches, crevices, or corners. After a defect is thought to have been removed, and before rewelding, the area shall be examined by suitable methods to ensure that the defect has been eliminated. Repair welds shall meet the inspection requirements for the original welds. Any indication of a defect shall be regarded as a defect, unless reevaluation by nondestructive methods or by surface conditioning shows that no unacceptable defect is present.

-- End of Section --