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## UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

Latest change indicated by CHG tags

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### SECTION 03201

#### STEEL BARS AND WELDED WIRE FABRIC FOR CONCRETE REINFORCEMENT FOR CIVIL WORKS 10/01

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NOTE: This guide specification covers the requirements for furnishing all equipment, materials and labor for providing and placing steel bars, steel welded wire fabric and accessories for concrete reinforcement.

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

##### 1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the

reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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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.

ACI INTERNATIONAL (ACI)

ACI 318/318R	(2002) Building Code Requirements for Structural Concrete and Commentary
ACI 318M/318RM	(2002) Metric Building Code Requirements for Structural Concrete and Commentary
ACI SP-66	(2004) ACI Detailing Manual

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4	(1998) Structural Welding Code - Reinforcing Steel
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ASTM INTERNATIONAL (ASTM)

ASTM A 184/A 184M	(2001) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 185	(2002) Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A 370	(2003a) Mechanical Testing of Steel Products
ASTM A 497/A 497M	(2002) Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A 615/A 615M	(2004b) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 706/A 706M	(2004b) Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 767/A 767M	(2000b) Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A 775/A 775M	(2001) Epoxy-Coated Reinforcing Steel Bars
ASTM A 996/A 996M	(2004) Rail-Steel and Axle-Steel Deformed Bars or Concrete Reinforcement
ASTM E 94	(2004) Radiographic Examination

## 1.2 UNIT PRICES

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NOTE: If Section 01270 MEASUREMENT AND PAYMENT is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01270.  
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### 1.2.1 Deformed Steel Bars for Concrete Reinforcement

#### 1.2.1.1 Payment

Payment will be made for costs associated with furnishing and placing deformed steel bars for concrete reinforcement. Payment for steel in laps will be made as indicated or required. No payment will be made for additional steel in laps wherein the additional steel lap was made for the convenience of the Contractor.

#### 1.2.1.2 Measurement

Deformed Steel Bars for Concrete Reinforcement will be measured for payment based upon the quantity of kilograms pounds in place. The measured lengths will be converted to weights for the size of bars listed by the use of the nominal weights per linear meter foot specified in ASTM A 615/A 615M.

#### 1.2.1.3 Unit of Measure

Unit of measure: per kilogram pound.

### 1.2.2 Fabricated Deformed Steel Bar Mats for Concrete Reinforcement

#### 1.2.2.1 Payment

Payment will be made for costs associated with furnishing and placing fabricated deformed steel bar mats for concrete reinforcement. Payment for steel in laps will be made as indicated or required. No payment will be made for additional steel in laps wherein the additional steel lap was made for the convenience of the Contractor.

#### 1.2.2.2 Measurement

Fabricated Deformed Steel Bar Mats for Concrete Reinforcement will be measured for payment based upon the quantity of kilograms pounds in place. The weights shall be determined by weighing or by manufacturer's or catalog weights when weighing is not practicable.

#### 1.2.2.3 Unit of Measure

Unit of measure: per kilogram pound.

### 1.2.3 Butt-Splices in Deformed Steel Bars for Concrete Reinforcement

#### 1.2.3.1 Payment

Payment will be made for costs associated with making butt-splices in deformed steel bars for concrete reinforcement. No separate payment will

be made for test splices, tension testing, or radiographic examination of butt-splices since these costs are included in the contract unit price for Butt-Splices in Deformed Steel Bars for Concrete Reinforcement.

#### 1.2.3.2 Measurement

Butt-Splices in Deformed Steel Bars for Concrete Reinforcement will be measured for payment based upon each butt-splice in place.

#### 1.2.3.3 Unit of Measure

Unit of measure: each.

#### 1.2.4 Steel Welded Wire Fabric for Concrete Reinforcement

##### 1.2.4.1 Payment

Payment will be made for costs associated with furnishing and placing steel welded wire fabric for concrete reinforcement. Payment for steel in laps will be made as indicated or required. No payment will be made for additional steel in laps wherein the additional steel lap was made for the convenience of the Contractor.

##### 1.2.4.2 Measurement

Steel Welded Wire Fabric for Concrete Reinforcement will be measured for payment based upon the quantity of kilograms pounds in place. The weights shall be determined by weighing or by manufacturer's or catalog weights when weighing is not practicable.

##### 1.2.4.3 Unit of Measure

Unit of measure: per kilogram pound.

#### 1.2.5 Resplicing Bars

##### 1.2.5.1 Payment

Payment will be made for costs associated with resplicing bars selected for supplemental examinations and tests for those splices found to be acceptable. No payment will be made for costs associated with resplicing bars selected for supplemental examinations and tests for those splices found to be defective. No payment will be made for costs associated with the supplemental examinations and tests performed by the Government.

##### 1.2.5.2 Measurement

Resplicing Bars, selected for examinations and tests and found to be acceptable, will be measured for payment based upon 150 percent of the applicable contract unit price for pay item Butt-Splices in Deformed Steel Bars for Concrete Reinforcement. Resplicing Bars, selected for examinations and tests and found to be defective, will not be measured for payment.

##### 1.2.5.3 Unit of Measure

Unit of measure: each.

#### 1.2.6 Accessories

No payment will be made for costs associated with furnishing and placing accessories incidental to and included in the payment for other items of work.

#### 1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

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, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army 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-02 Shop Drawings

Fabrication and Placement [; G] [; G, [\_\_\_\_\_]]

The Contractor shall submit shop drawings which include: reinforcement steel placement drawings; reinforcement steel schedules showing quantity, size, shape, dimensions, weight per meter foot, total weights and bending details; and details of bar supports showing types, sizes, spacing and sequence.

#### SD-03 Product Data

Butt-Splices[; G][; G, [\_\_\_\_\_]]

The Contractor shall submit the proposed procedure for butt-splicing steel bars prior to making the test butt-splices for qualification of the procedure. Properties and analyses of steel bars and splicing materials shall be included in the submitted procedure. Physical properties of splicing sleeves shall include length, inside and outside diameters, and inside surface details.

Materials[; G][; G, [\_\_\_\_\_]]

A system of identification which shows the disposition of specific lots of approved materials in the work shall be established and submitted before completion of the contract.

#### SD-04 Samples

[Epoxy-Coated Bars

Sample of coating material and 700 g 1.5 pounds of patching material shall be submitted with the delivery of the bars.]

#### SD-06 Test Reports

Material[; G][; G, [\_\_\_\_\_]]

Tests, Inspections, and Verifications[; G][; G, [\_\_\_\_\_]]

Certified tests reports of reinforcement steel showing that the steel complies with the applicable specifications shall be furnished for each steel shipment and identified with specific lots prior to placement. Three copies of the heat analyses shall be provided for each lot of steel furnished and the Contractor shall certify that the steel conforms to the heat analyses.

#### SD-07 Certificates

[Epoxy-Coated Steel Bars

Written certification for coating material and coated bars shall be submitted with the delivery of the bars.]

Qualification of Steel Bar Butt-Splicers

Certificates on the Qualifications of Steel Bar Butt-Splicers shall be submitted prior to commencing butt-splicing.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

Materials shall conform to the following requirements.

##### 2.1.1 Steel Bars

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**NOTE 1: The grade of steel bars used in the design must be indicated. ASTM A 615/A 615M, Grade 300(40)**



bars are manufactured only in sizes 10 through 20 (3 through 6). ASTM A 996/A 996M, Grade 350 (50) bars are furnished only in sizes 10 through 35 (3 through 11). Bar sizes 10 through 35 (3 through 11) shall be Grade 300, 350, 400 (40, 50, or 60). Bar sizes 45 and 55 (14 and 18) shall be Grade 400 (60). Due to the frequent unavailability of Grade 300 (40) bars, designers may choose to not use Grade 300 (40) bars. However, if Grade 300 (40) bars are used, include the sentence below enclosed with brackets in these specifications.

NOTE 2: Zinc-coated or epoxy-coated bars shall be used in bridge decks and other applications where bars would be subjected to corrosive action.

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Steel bars shall comply with the requirements of [ASTM A 615/A 615M] [ASTM A 996/A 996M including Supplementary Requirements], or [ASTM A 706/A 706M], deformed, of the grades, sizes and lengths shown. [If the Grade 300 40 bars shown are unavailable the Contractor may substitute Grade 350 50 or Grade 400 60 bars of the same size and spacing as indicated for Grade 300 40 bars when authorized.]

#### 2.1.1.1 [Zinc-Coated (Galvanized) Bars

Zinc-coated (galvanized) bars shall comply with the requirements of ASTM A 767/A 767M, Class [\_\_\_\_\_] coating, galvanized after fabrication.]

#### 2.1.1.2 [Epoxy-Coated Bars

Epoxy-coated steel bars shall comply with the requirements of ASTM A 775/A 775M, including written certifications for coating material and coated bars, sample of coating material, and 700 g 0.5 pounds of patching material.]

#### 2.1.1.3 Fabricated Bar Mats

Fabricated bar mats shall comply with the requirements of ASTM A 184/A 184M, clipped or welded mats, bar sizes and spacings as shown.

#### 2.1.2 Steel Welded Wire Fabric

Steel welded wire fabric shall comply with the requirements of [ASTM A 185], [ASTM A 497/A 497M] wire sizes and spacings as shown. For wire with a specified yield strength (fy) exceeding 400 MPa 60,000 psi, fy shall be the stress corresponding to a strain of 0.35 percent.

#### 2.1.3 Accessories

##### 2.1.3.1 Bar Supports

Bar supports shall comply with the requirements of ACI SP-66. Supports for bars in concrete with formed surfaces exposed to view or to be painted shall be plastic-coated wire, stainless steel or precast concrete supports.

Precast concrete supports shall be wedged-shaped, not larger than 90 by 90 mm 3-1/2 by 3-1/2 inches, of thickness equal to that indicated for concrete cover and have an embedded hooked tie-wire for anchorage. Bar supports used in precast concrete with formed surfaces exposed to view

shall be the same quality, texture and color as the finish surfaces.

#### 2.1.3.2 Wire Ties

Wire ties shall be 16 gage or heavier black annealed wire. Ties for epoxy-coated bars shall be vinyl-coated or epoxy-coated. Ties for zinc-coated bars shall be zinc-coated.

### 2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

The Contractor shall have material tests required by applicable standards and specified performed by an approved laboratory and certified to demonstrate that the materials are in conformance with the specifications. Tests, inspections, and verifications shall be performed and certified at the Contractor's expense.

#### 2.2.1 Reinforcement Steel Tests

Mechanical testing of steel shall be in accordance with ASTM A 370 except as otherwise specified or required by the material specifications. Tension tests shall be performed on full cross-section specimens using a gage length that spans the extremities of specimens with welds or sleeves included. Chemical analyses of steel heats shall show the percentages of carbon, phosphorous, manganese, sulphur and silicon present in the steel.

#### 2.2.2 Qualification of Steel Bar Butt-Splacers

Qualification of steel bar butt-splacers shall be certified to have satisfactorily completed a course of instruction in the proposed method of butt-splicing or have satisfactorily performed such work within the preceding year.

#### 2.2.3 Qualification of Butt-Splicing Procedure

As a condition of approval of the butt-splicing procedure, the Contractor, in the presence of the Contracting Officer, shall make three test butt-splices of steel bars of each size to be spliced using the proposed butt-splicing method. These test butt-splices and unspliced bars of the same size shall be tension tested to destruction with stress-strain curves plotted for each test. Test results must show that the butt-splices meet the specified strength and deformation requirements in order for the splicing procedure to be approved.

#### 2.2.4 Radiographic Examination of Welds

Radiographic examination of welds shall be in accordance with ASTM E 94 and shall be performed and evaluated by an approved testing agency adequately equipped to perform such services. Radiographs of welds and evaluations of the radiographs submitted for approval shall become the property of the Government.

## PART 3 EXECUTION

### 3.1 FABRICATION AND PLACEMENT

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**NOTE: Details of reinforcement which are not in accordance with ACI SP-66 or ACI 318M/318RM and ACI 318/318R must be indicated.**

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Reinforcement steel and accessories shall be fabricated and placed as specified and shown and approved shop drawings. Fabrication and placement details of steel and accessories not specified or shown shall be in accordance with ACI SP-66 and ACI 318M/318RM ACI 318/318R or as directed. Steel shall be fabricated to shapes and dimensions shown, placed where indicated within specified tolerances and adequately supported during concrete placement. At the time of concrete placement all steel shall be free from loose, flaky rust, scale (except tight mill scale), mud, oil, grease or any other coating that might reduce the bond with the concrete.

#### 3.1.1 Hooks and Bends

Steel bars, except for zinc-coated or epoxy-coated, shall be mill or field-bent. Zinc-Coated and epoxy-coated bars shall be mill-bent prior to coating. All steel shall be bent cold unless authorized. No steel bars shall be bent after being partially embedded in concrete unless indicated or authorized.

#### 3.1.2 Welding

Welding of steel bars will be permitted only where indicated or authorized.

Welding shall be performed in accordance with AWS D1.4 except where otherwise specified or indicated.

#### 3.1.3 Placing Tolerances

##### 3.1.3.1 Spacing

The spacing between adjacent bars and the distance between layers of bars may not vary from the indicated position by more than one bar diameter nor more than 25 mm 1 inch.

##### 3.1.3.2 Concrete Cover

The minimum concrete cover of main reinforcement steel bars shall be as shown. The allowable variation for minimum cover shall be as follows:

MINIMUM COVER	VARIATION
150 mm	plus 13 mm
100 mm	plus 10 mm
75 mm	plus 10 mm
50 mm	plus 6 mm
38 mm	plus 6 mm
25 mm	plus 3 mm
19 mm	plus 3 mm

MINIMUM COVER	VARIATION
6 inch	plus 1/2 inch
4 inch	plus 3/8 inch
3 inch	plus 3/8 inch
2 inch	plus 1/4 inch
1-1/2 inch	plus 1/4 inch
1 inch	plus 1/8 inch
3/4 inch	plus 1/8 inch

#### 3.1.4 Splicing

Splices in steel bars shall be made only as required. Bars may be spliced at alternate or additional locations at no additional cost to the Government subject to approval.

##### 3.1.4.1 Lap Splices

Lap splices shall be used only for bars smaller than size 45 14 and welded wire fabric. Lapped bars may be placed in contact and securely tied or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than 1/5 the required length of lap or 150 mm 6 inches.

##### 3.1.4.2 Butt-Splices

Butt-splices shall be used only for splicing size 45 and 55 14 and 18 bars and for splicing #11 bars to larger bars except where otherwise shown or authorized. Butt-splices shall be made by a method which develops splices suitable for tension, compression and stress reversal applications. Welded butt-splices shall be full penetration butt welds. Butt-splices shall develop 90 percent of the specified minimum ultimate tensile strength of the smallest bar of each splice. Bars shall be cleaned of all oil, grease, dirt, rust, scale and other foreign substances and shall be flame dried before splicing. Adequate jigs and clamps or other devices shall be provided to support, align and hold the longitudinal centerline of the bars to be butt-spliced in a straight line. Butt-splices shall be as follows:

a. Thermit Welded Butt Splices - Bars to be thermit welded shall be restricted to steel shown by heat analysis to have a sulfur content not exceeding 0.05 percent. The ends of bars to be thermit welded shall be cut square and smooth. Flame cutting will be permitted provided grinding is employed to remove the resulting scale and to square and smooth the cut ends to a condition equivalent to a saw cut. No shearing will be permitted. Bars shall be cleaned and flame dried before splicing. The joint shall be properly aligned in the mold with a gap opening in accordance with the manufacturer's recommendations. Charging and firing shall conform to the manufacturer's recommendations. The end of bars and the welded mold shall be preheated before welding to a temperature of not less than 40 degrees C 100 degrees F and the mold shall be left in place for at least 15 minutes after ignition. Risers shall be broken or burned off after removing the mold. Tension splices shall be staggered longitudinally a minimum of 1500 mm 5 feet so that no more than half of the bars are spliced at any one section or as otherwise indicated.

b. Mechanical Butt-Splices - Mechanical butt-splices shall be an approved exothermic, threaded coupling, swaged sleeve or other positive connecting type. Bars to be spliced by a mechanical butt-splicing process may be sawed, sheared or flame cut provided the ends of sheared bars are reshaped after shearing and all slag is removed from the ends of flame cut bars by chipping and wire brushing prior to splicing. Surfaces to be enclosed within a splice sleeve or coupling shall be cleaned by wire brushing or other approved method prior to splicing. Splices shall be made using manufacturer's standard jigs, clamps, ignition devices and other required accessories. In addition to the strength requirements specified paragraph BUTT-SPLICES the additional deformation of number 45 14 and smaller bars due to slippage or other movement within the splice sleeve shall not exceed 0.38 mm (unit strain

0.0015 mm/mm) 0.015 inches (unit strain 0.0015 inches/inch) beyond the elongation of an unspliced bar based upon a 250 mm 10 inch gage length spanning the extremities of the sleeve at a stress of 200 MPa 30,000 psi.

The additional deformation of number 55 18 bars shall not exceed 0.75 mm (unit strain 0.003 mm/mm) 0.03 inches (unit strain 0.003 inches/inch)

beyond the elongation of an unspliced bar based upon a 250 mm 10 inch gage length spanning the extremities of the sleeve at a stress of 200 MPa 30,000 psi. The amount of the additional deformation shall be determined from the stress-strain curves of the unspliced and spliced bars tested as required paragraph QUALIFICATION OF BUTT-SPLICING PROCEDURE for qualification of the butt-splicing procedure. Tension splices of number 45 14 or smaller bar shall be staggered longitudinally a minimum of 1500 mm 5 feet or as otherwise indicated so that no more than half of the bars are spliced at any one section. Tension splices of number 55 18 bars shall be staggered longitudinally a minimum of 1500 mm 5 feet so that no more than 1/3 of the bars are spliced at any one section.

### 3.2 FIELD TESTS AND INSPECTIONS

#### 3.2.1 Butt-Splices

##### 3.2.1.1 Identification of Splices

The Contractor shall establish and maintain an approved method of identification of all field splices which will indicate the splicer and the number assigned each splice made by the splicer.

##### 3.2.1.2 Examining, Testing, and Correcting

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**NOTE: If the total number of butt-splices exceed 5,000, the number of tension tests may be decrease to one test specimen for every 50 splices in excess of the first 5,000 splices provided that no splices are rejected in the last 500 splices made and the splicing operation will not be interrupted for more than 3 months.**  
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The Contractor shall perform the following during the butt-splicing operations as specified and as directed:

a. Visual Examination - All welded splices shall be visually examined for the presence of cracks, undercuts, inadequate size and other visible defects. Respliced connections resulting from correction of visual defects may be radiographically examined at the option of the Contracting Officer as specified in paragraph SUPPLEMENTAL EXAMINATION.

Exothermic mechanical butt-splices shall be visually examined to determine if the filler metal is clearly visible at the tap holes and completely fills the sleeves at both ends except for spaces of not more than 10 mm 3/8 inch occupied by packing.

b. Tension Tests - Tensions tests to 90 percent of the minimum specified ultimate tensile strength of the spliced bars or to destruction shall be performed on one test specimen made in the field for every 25 splices made. Test specimens shall be made by the splicers engaged in the work, using the approved splicing procedure and the same size bars placed in the same relative position, and under the

same conditions as those in the groups represented by the specimens. Stress-strain curves shall be furnished for each butt-splice tested.

c. Radiographic Examination - Not less than one of each 25 welded splices selected at random by the Contracting Officer shall be examined radiographically and evaluated for defects. The greatest dimension of any porosity (gas pocket or similar void) or fusion-type defect (slag inclusion, incomplete fusion or similar generally elongated defect in weld fusion) shall not exceed 6 mm 1/4 inch. The minimum clearance between edges of porosity or fusion-type defects shall not be less than 25 mm 1 inch.

d. Correction of Deficiencies - No splice shall be embedded in concrete until satisfactory results of visual examination and the required tests or examinations have been obtained. All splices having visible defects or represented by test specimens which do not satisfy the tests or examinations shall be removed. If any of the tension test specimens fail to meet the strength requirements or deformation limitations two production splices from the same lot represented by the test specimens which failed shall be cut out and tension tested by the Contractor. If both of the retests pass the strength requirements and deformation limitations all of the splices in the lot will be accepted.

If one or both of the retests fail to meet the strength requirements or deformation limitations all of the splices in the lot will be rejected. All costs of removal, testing and resplicing of the additional production splices shall be borne by the Contractor. The bars of rejected splices shall be cut off outside the splice zone of weld metal, filler metal contact, coupling or sleeve. The cut ends shall be finished as specified and the joints shall be respliced and reinspected at no additional cost.

e. Supplemental Examination - The Contracting Officer may require additional or supplemental radiographic examination and/or tension test of any completed splice. For costs of such examinations and tests see paragraph UNIT PRICES.

-- End of Section --