ASME BOILER AND PRESSURE VESSEL CODE

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RULES FOR CONSTRUCTION OF NUCLEAR POWER PLANT COMPONENTS

Division 2

Code for Concrete Reactor Vessels and Containments

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ASME BOILER AND PRESSURE VESSEL COMMITTEE
SUBCOMMITTEE ON NUCLEAR POWER
ACI-ASME JOINT TECHNICAL COMMITTEE

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
NEW YORK, NEW YORK

CC-4333 Mechanical Splices

CC-4333.1 Qualifications, Records, and Identifying Stamps

CC-4333.1.1 Required Qualifications. Each Constructor or Fabricator is responsible for the splicing made by his organization and he shall conduct the tests required by this Subarticle in order to qualify the splicing procedure and the splicers.

CC-4333.1.2 Maintenance and Certification of Records. The Constructor or Fabricator shall maintain a record of the splicing procedure and the splicers qualified and employed by him, showing the date and results of tests, and the identification mark or marks assigned to each splicer. These records shall be reviewed, verified, and signed by an authorized individual assigned by the Constructor. The records shall be accessible to the Owner and to the Authorized Inspector.

CC-4333.1.3 Splicing Prior to Qualification. No splicing shall be undertaken until a splicer has been qualified. Only splicers who are qualified in accordance with CC-4333.4 shall be used.

CC-4333.2 Splice System Qualification Requirements

CC-4333.2.1 General Requirements. Each splice system Manufacturer shall conduct a series of performance tests in order to qualify his splice system for use.

CC-4333.2.2 Materials to Be Used for Performance Tests. The types of materials to be used for the performance test splices shall be the same as those intended for use in production splices. The actual materials used and the necessary dimensions of all test specimens shall be documented.

CC-4333.2.3 Type and Number of Performance Tests

(a) Static Tensile Tests. Six splice specimens for each bar size and splice type to be used in construction shall be tensile tested to failure using the loading rate set forth in SA-370. For swaged or sleeve with cementitious grout splices, three different deformation patterns shall be used for each bar size tested. The static tensile tests shall be repeated for each bar grade to be used in construction for taper threaded splices and threaded splices in thread deformed reinforcing bars. For taper threaded splices, one of the six specimens shall be tested at 20°F (–7°C) or less. A tensile test on an unspliced specimen from the same bar used for the spliced specimens shall be performed to establish actual tensile strength. The average tensile strength of the splices shall not be less than 90% of the actual tensile strength of the reinforcing bar being tested, nor less than 100% of the specified minimum tensile strength. The tensile strength of an individual splice system shall not be less than 125% of the specified minimum yield strength of the spliced bar. Each individual test report on both the spliced and unspliced specimens shall include at least the following information:

(1) tensile strength;

(2) total elongation;

(3) load–extension curve to a minimum of 2% strain.

The gage length for each pair of spliced and unspliced specimens shall be the same, and equal to the length of splice sleeve, plus not less than 1 bar diameter nor more than 3 bar diameters at each end. For taper threaded splices, one of the splice specimens shall be cold soaked for a minimum of 24 hr prior to testing at a temperature equal to or less than the temperature required for this test. The test temperature at the root of the critical thread shall be 20°F (–7°C) or less and maintained until the specimen reaches yield level load.

(b) Cyclic Tensile Tests. Three specimens of the bar-to-bar splice for each reinforcing bar size (and grade for taper threaded splices and threaded splices in thread deformed reinforcing bar) and splice type to be used in construction shall be subjected to a low cycle tensile test. Each specimen shall withstand 100 cycles of stress variation from 5% to 90% of the specified minimum yield strength of the reinforcing bar. One cycle is defined as an increase from the lower load to the higher load and return.

CC-4333.2.4 Essential Variables. The performance tests must be completely reconducted when any of the applicable changes listed below are made. Changes other than those listed may be made without the necessity for repeating the performance tests.

(a) for all splice systems:

(1) a change in splice sleeve material or grade

(2) a reduction in the cross-sectional area of the splice sleeve

(3) a reduction in the bar engagement length

(4) an increase in reinforcing bar grade

(b) for sleeve with ferrous filler metal splices, a change in the filler metal;

(c) for taper threaded splices:

(1) a change in thread geometry

(2) a change in torque

(d) for swaged splices:

(1) a change in swaging pressure

(2) a change in die geometry

(3) a change in stud material

(4) a change in outside or inside diameter

(5) for heated splices, a change in the required minimum temperature of the sleeve at the time of swaging and maximum time and temperature that sleeves may be held in the heating oven

(e) for threaded splices in thread deformed bar:

(1) a change in thread geometry

(2) a change in torque

(f) for sleeve with cementitious grout splices:

(1) a change in the cementitious grout formulation

(2) a change in the deformation pattern inside the sleeve

(3) a change in the reinforcing steel deformation pattern

(4) a change in temperature limits for the splice system (bar, sleeve, grout) during placement and curing of grout.

CC-4333.3 Requirements for Production Splicing Procedures. All production splicing shall be performed in accordance with a written procedure which shall include, as a minimum, the procedures used for the performance tests in CC-4333.2.3, with the following additional information:

(a) for sleeve with ferrous filler metal splices:

(1) bar end preparation

(2) cleanliness requirements

(3) bar end location tolerances

(4) permissible gap between reinforcing bar ends

(5) allowable voidage in the filler metal

(b) for taper threaded splices:

(1) type of equipment and methods used to verify bar thread acceptability

(2) cleanliness requirements

(3) type of equipment and methods used for torquing

(4) required force and method of measurement

(5) method of mechanically locking the position splices

(6) method used to verify the final alignment and engagement of the splice on both bars

(c) for swaged splices:

(1) cleanliness requirements

(2) type of equipment and methods used for swaging

(3) required swaging pressure, method of measurement, pressure tolerance, and frequency of calibration of the hydraulic system

(4) method used to verify final alignment and engagement of the splice on both bars

(5) bar end preparation

(6) minimum and maximum number of swaging operations per sleeve

(7) method used to ensure sleeve is swaged along full length

(8) limits of die wear and frequency of checking

(9) for heated sleeves, limits and methods used to measure duration and temperature of heating cycle and temperature of sleeve at time of swaging

(10) method used to ensure that stud is locked to swaged sleeve

(d) for threaded splices in thread deformed bar:

(1) type of equipment and methods used to verify bar thread acceptability

(2) cleanliness requirements

(3) type of equipment and methods used for torquing

(4) required torque, tolerance on required torque, and method of measurement

(5) method used to verify the final alignment and engagement of the splice coupler on both bars

(6) method used to lock the coupling in position to prevent loosening of the splice

(e) for sleeve with cementitious grout splices:

(1) bar end preparation

(2) cleanliness requirements

(3) bar end location tolerances

(4) bar and sleeve centering tolerances

(5) permissible gap between reinforcing bar ends

(6) allowable voidage in the grout

(7) procedures for storing, mixing, placing, and curing the grout

(8) maximum and minimum temperature of the splice system during placement and curing of grout

(9) restriction to prevent relative bar movement during setting and strength development of the grout

CC-4333.4 Initial Qualification Tests. Each splicer shall prepare two qualification splices on the largest bar size to be used. In addition, for ferrous filler metal splices, cementitious grouted splices, and swaged splices only, each of the splice positions to be used (e.g., horizontal, vertical, diagonal) shall be qualified. The qualification splices shall be made using reinforcing bar identical to that to be used in the structure. The completed qualification splices shall be tensile tested using the loading rates set forth in SA-370 and the tensile results shall meet those specified in Table CC-4334-1.

CC-4333.5 Continuing Splice Performance Tests

CC-4333.5.1 Introduction. A continuing series of tests shall be made to ensure that production splices meet the tensile requirements. Nondestructive examination requirements are specified in CC-5320.

CC-4333.5.2 Splice Samples. Splice samples may be production splices (cut directly from in-place reinforcement) or straight sister splices (removable splices made in place next to production splices and under the same conditions), in accordance with the schedule established in CC-4333.5.3.

CC-4333.5.3 Testing Frequency. Splice samples shall be tensile tested in accordance with the following schedule for the appropriate splice system.

(a) Separate test cycles shall be established for sleeve with ferrous filler metal splices, sleeve with cementitious grout splices, and swaged splices in horizontal, vertical, and diagonal bars. Straight sister splices may be substituted for production test samples on radius bent bars and for splicing sleeves arc welded to structural steel elements or the liner.

(1) For sleeve with ferrous filler metal splices, ne splice shall be tested for each unit of 100 production plices.

(2) For swaged splices and sleeve with cementitious grout splices, test cycles shall be established as follows.

(a) If only production splices are tested, the sample frequency shall be as follows:

(1) 1 of the first 10 production splices;

(2) 1 of the next 90 production splices;

(3) 2 of the next units and each subsequent unit of 100 production splices.

(b) If production and sister splices are tested, the sample frequency shall be as follows:

(1) 1 production splice of the first 10 production splices;

(2) 1 production and 3 sister splices for the next 90 production splices;

(3) 3 splices, either production or sister splices, for the next and each subsequent unit of 100 oduction splices. At least one-fourth of the total umber of splices tested shall be production splices.

(b) Taper threaded splices and threaded splices in thread deformed reinforcing bar. Separate test cycles shall be established for each bar size and grade, using straight sister splices as follows:

(1) 1 of the first 10 splices;

(2) 1 of the next 90 splices;

(3) 2 of the next and subsequent units of 100 splices.

In addition, for taper threaded splices, a minimum of three tests shall be made for each bar heat.

CC-4333.5.4 Tensile Testing Requirements. Splice samples shall be tensile tested using the loading rates set forth in SA-370. All taper threaded sample splices shall be tensile tested at 20°F (–7°C) or less. The following shall constitute the acceptance standards.

(a) The tensile strength of each sample shall equal or exceed 125% of the specified yield strength as shown in Table CC-4334-1.

(b) The average tensile strength of each group of 15 consecutive samples shall equal or exceed the specified minimum tensile strength as shown in Table CC-4334-1.

If any sample tested fails to meet the provisions of (a) or (b) above, the requirements of CC-4333.5.5 shall be followed.

CC-4333.5.5 Substandard Tensile Test Results

(a) If any splice used for testing fails to meet the strength requirement of Table CC-4333-1 and failure occurs in the bar, the cause of the bar break shall be investigated by the Constructor or Fabricator. Any necessary corrective action affecting splice samples shall be implemented prior to continuing the testing frequency of CC-4333.5.3.

(b) If any splice used for testing fails to meet the strength requirement of Table CC-4333-1 and failure does not occur in the bar, two additional splices shall be tested. If either of these retests fails to meet the strength requirement of Table CC-4333-1, splicing shall be halted. Splicing shall not be resumed until the cause of failures has been corrected and resolved.

(c) If the running average tensile strength of 15 consecutive samples fails to meet the tensile requirement of Table CC-4333-1, splicing shall be halted. The Constructor or Fabricator shall investigate the cause and make the necessary corrective action.

(d) When splicing is resumed, the testing frequency shall be started anew.

CC-4333.6 Recording of Tensile Test Results. The results of all tensile tests obtained from the tests prescribed by CC-4333.4 and CC-4333.5, along with all other pertinent data, shall be recorded.

CC-4333.7 Welding. Welding of splice sleeves to parts shall be performed using welding procedures and welders qualified in accordance with AWS D1.1 or Section IX.

CC-4333.8 Impact Requirements. When reinforcing bar or mechanical splices are to be welded to material that requires impact testing, the following shall apply.

(a) The weld filler metal shall be impact tested in accordance with the requirements of the material that the reinforcing bar is attached to.

(b) The acceptance criteria of the material requiring impact testing shall be met.

TABLE CC-4333-1
TENSILE REQUIREMENTS FOR MECHANICAL REINFORCING BAR SPLICES AND WELDED JOINTS

	Reinforcing Bar Properties			Splice or Joint Strength Requirements	
Specification	Bar Grade	Minimum Yield Strength, psi	Minimum Tensile Strength, psi	Minimum Average Mechanical Splice or Welded Joint Tensile Strength, psi [Note (1)]	Minimum Single Mechanical Splice or Welded Joint Tensile Strength, psi [Note (2)]
ASTM A 615	Grade 40	40,000	70,000	70,000	50,000
ASTM A 615	Grade 60	60,000	90,000	90,000	75,000
ASTM A 706		60,000	80,000	80,000	75,000

NOTES:
(1) See CC-4333 and Appendix XI.
(2) These values are equivalent to 125% of the yield strength of each bar grade.

CC-4334 Arc Welded Joints

Refer to Appendix XI for qualification requirements.

CC-4340 PLACING REINFORCEMENT

CC-4341 General

The placement of reinforcing steel shall comply with the Design and Construction Drawings and the placing tolerances specified in the Construction Specification.

CC-4342 Supports

Reinforcement shall be accurately placed and adequately supported before concrete is placed and shall be secured against displacement beyond permitted tolerances. Welding of crossing bars shall not be permitted.

CC-4343 Tolerances

The tolerances for the placement of reinforcement shall be specified in the Construction Specification.

CC-4350 SPACING OF REINFORCEMENT

CC-4351 Layers

The clear distance between parallel bars in a layer and the clear distance between parallel layers of reinforcement shall not be less than that required by the Construction Specification to properly place and consolidate concrete.

CC-4352 Splices

The clear distance limitation between bars shall also apply to the clear distance between a contact (lap) splice and adjacent splices or bars.

CC-4360 SURFACE CONDITION

(a) Reinforcing bars at the time concrete is placed shall be free from mud, oil, ice, snow, or other coatings that adversely affect bonding.

(b) Reinforcing bars with rust, mill scale, or a combination of both shall be considered satisfactory provided the minimum dimensions, including height of deformations and weight of a hand wire brushed test specimen, are not less than ASTM A 615 requirements.

CC-4400 FABRICATION AND INSTALLATION OF PRESTRESSING SYSTEMS

CC-4410 GENERAL

This Subarticle covers the requirements for the fabrication, installation, tensioning, and protection of prestressing tendons.

CC-4420 RECEIVING, STORING, AND HANDLING OF MATERIAL

The construction procedures shall specify the manner in which material is to be received, stored, and handled in the Fabricator's plant and at the construction site.

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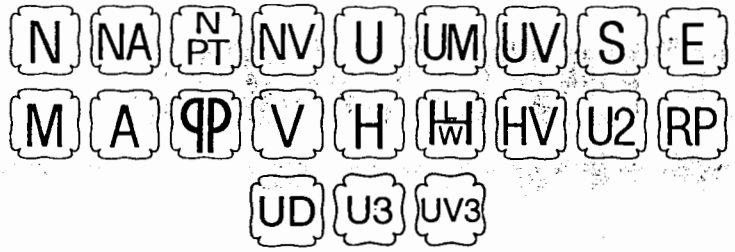

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The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990