CAN/CSA-N287.4-04 – Construction, fabrication, and installation requirements for concrete containment structures for CANDU nuclear power plants

This document provides an overview of the requirements of *Welding Requirements CSA-N287.4 – Construction, fabrication, and installation requirements for concrete containment structures for CANDU nuclear power plants* with respect to welding. It is designed to provide guidance for individuals and organizations involved in the construction, fabrication, and installation requirements that apply to concrete containment structures of a containment system designated as class containment components, parts, and appurtenances for CANDU nuclear power plants.

This document is only for general guidance purposes; reference to the full text of CSA N287.4 should be made. For further information, please contact the CWB at 1-800-844-6790 or info@cwbgroup.org.

Introduction

Welding is a key joining method used in the fabrication of steel structures and concrete containment structures. To ensure welds of the highest quality and the safety of both the users of CANDU power plants and the general public, CSA Standard N287.4 provides specific requirements around the construction, fabrication, and installation of concrete containment structures, with awareness that the CANDU nuclear plants are used by people.

Welded Fabrication

CSA N287.4 provides the following requirements:

6.6 Welding of reinforcing bars
6.6.2 *Welding of reinforcing bars shall conform to the requirements of CSA W186, except as otherwise required by this Standard.*

6.5 Quality of welds
The welding process and quality of welds shall be in accordance with CSA W186. In addition, care shall be taken to
(a) prevent damage to the pre-stress tendons from arc spraying and stray electrical currents when reinforcing bars are being welded in close proximity to pre-stressing systems; and
(b) limit the concrete interface temperature that can result from preheat, interpass, or post-heat treatment to 260°C when reinforcing bars are to be welded to partially embedded reinforcing bars, structural members, or metallic parts.

6.6.6 Welding procedures
Welding procedures shall be qualified in accordance with CSA W186, except for direct butt-spliced joints, which shall produce sufficient ultimate strength in a tension test to be equal to or greater than the minimum specified tensile strength of the base metal, based on the nominal bar area.

6.6.1 Welder qualification
6.6.1.1 *Welders shall be qualified in accordance with the requirements of CSA W186, except that*
(a) for direct butt-spliced joints, the tension specimen shall produce sufficient ultimate strength in a tension test equal to or greater than the minimum specified ultimate tensile strength of the base metal, based on the nominal bar area;
(b) for direct butt-spliced joints and joints connecting reinforcing bars to structural members, the macro-etch specimen shall show complete fusion and shall be free of imperfections that do not meet the quality requirements of CSA W186; and
(c) for joints connecting reinforcing bars to structural members, two macro-etch specimens shall be prepared from two transverse surfaces 90° from each other.

6.6.1.2 *Fabricators shall qualify each welder in accordance with the applicable qualified welding procedure specification(s). Welder qualification identification cards shall not be transferred.*

CSA standard W186 provides requirements for the qualification of welders and welding operators, welding procedures and welding supervisory and engineering personnel. A company certified to CSA W186 Division 1 requires having full time engineer(s) and a company certified to Division 2 requires having retained part time engineer(s).

CSA standard W186 provides guidance on weld design, fabrication techniques, inspection and other key considerations around welding for steel and aluminum respectively.

An organization meeting the requirements of CSA Standard W186 will have qualified welders, accepted welding procedures and accepted supervisory/engineering personnel. All elements of the welding operation will be independently verified by the Canadian Welding Bureau on an on-going basis.

9.2 Welding
9.2.1.1 *Companies performing fusion welding for fabrication and/or erection shall be certified to Division 1 or 2 in accordance with CSA W47.1.*
9.2.1.2 *Welding of carbon steel shall conform to the requirements of CSA W59 and the requirements specified in this Standard.*
9.2.1.4 *Welding of austenitic steels to austenitic steels and to carbon steels shall comply with the requirements of CSA W47.1 and AWS DI.6/DI.6M.*

9.2.2 Impact tests
Impact tests shall be performed in accordance with Annex E of CSA W47.1, in order to qualify welding procedures and welding processes for all welded joints when impact test requirements have been specified for the base metals and weld materials.

9.3 Additional requirements for embedded parts
9.3.2.1 *All welding procedures, except stud welding procedures, shall be qualified by each manufacturer or contractor by*
(a) the welding of test coupons;
(b) the testing of specimens as required in CSA W47.1; and
(c) the recording of the welding data and the test results in the welding procedure qualification test report.
Prequalified procedures shall not be used.

9.3.2.2 *Procedure qualification tests shall be conducted for any change in the essential variables as specified in Clause 11.4 of CSA W47.1 and in accordance with the following:*
(a) The maximum thickness qualified by any pipe or plate test sample shall be two times the thickness of the sample.
(b) If impact testing is required for a base material that requires post-weld heat-treatment, the welded test coupon shall be heat-treated at the specified temperature and for a holding time of at least 80% of the maximum time to be applied to the weld metal in the production application.

9.3.2.4 *Welder and welding operator qualification tests shall be carried out in accordance with Clause 9 of CSA W4 7.1 and as follows:*
(a) When a welder or welding operator is to be qualified on metals other than the steel groups listed in Clause 9.2.2 of CSA N287.2, the base and filler metals and the applicable essential variables of the welding procedure shall be used in production welding.
(b) When a welder or welding operator is to be qualified on the gas metal arc process, the operator shall be requalified where a change from spray arc, globular arc, or pulsing arc to short-circuiting arc or vice versa occurs.

9.3.2.5 *Only welders who are qualified in the "T" or "s" classification, as applicable, in accordance with CSA W47.1, shall carry out production welding.*

9.3.2.7.1 *Preheat and interpass temperature control shall comply with the requirements of CSA W59. In addition, a minimum preheat temperature of 95°C shall be applied for materials greater than*
(a) 32 mm in thickness when the reported carbon content is less than 0.30%; and
(b) 19 mm in thickness when the reported carbon content for both materials to be joined is equal to or greater than 0.30%.

9.3.2.7.2 *For conditions not specified in CSA W59, the preheat and interpass temperature shall be in accordance with proper metallurgical practices and shall be documented and approved by the designer prior to the start of the treatment.*

9.4 Stud welding
9.4.1 *Stud welding shall comply with the requirements of CSA W59 and the requirements specified in this Standard.*

9.7 Metallic liners
9.7.3 Qualification of welding procedure data sheets
Welding procedure data sheets shall be qualified in accordance with CSA W47.1 and shall be based on assemblies prepared under the same conditions as the production welds.

9.7.4 Qualification of welders and operators
9.7.4.1 *Welders shall be qualified in accordance with the requirements of CSA W47.1.*

An organization meeting the requirements of CSA Standard W47.1 will have qualified welders, accepted welding procedures and accepted supervisory/engineering personnel. All elements of the welding operation will be independently verified by the Canadian Welding Bureau on an on-going basis.

CSA Standard W59 requires that contractors performing work under this standard be certified under the requirements of CSA Standard W47.1 unless the Engineer of record approves the contractor for the work to be undertaken. CSA Standard W47.1 provides requirements for the qualification of welders and welding operators, welding procedures and welding supervisory and engineering personnel.

Please note that there are no domestic or international equivalents to CSA Standard W47.1 and / or CSA Standard W186. Other national systems, such as that of the American Welding Society (AWS) do not include key concepts such as independent and on-going verification and welding supervisors/engineers. The CWB strongly cautions the reader around accepting substitutions; doing so may place public safety at risk.

For a listing of all organizations that currently meet the requirements of CSA Standard W186 and / or CSA Standard W47.1 please see *www.cwbgroup.org*.

Welding Inspection

CSA Standard W186 and CSA Standard W59 require that all welds be visually inspected. In addition, when required by contract weld inspection must be completed by certified welding inspectors or a welding inspection organization following the requirements of CSA Standard W178.2 or CSA Standard W178.1 respectively. It also requires that CSA Standard W186 and CSA Standard W59 be followed for the acceptance criteria for all welds. It should be noted that CSA Standard W178.2 has individual "product categories" that inspectors may qualify to, including one for CSA Standard W59.

For a listing of all organizations and individuals who currently meet the requirements of CSA Standard W178.1 and CSA Standard W178.2, please see *www.cwbgroup.org* .