THE CWB OFFICE OF PUBLIC SAFETY

CSA/CWB Certification Program – Steel and Aluminum Welded Bridge Fabrication

Engineering and Technical program staff
BC Ministry of Forest, Lands, Natural Resource Operations and Rural Development

February 14th, 2022

BRITISH COLUMBIA | Ministry of Forests, Lands, Natural Resource Operations and Rural Development

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Attention

- *The presentation has been provided to Brian Chow and will be made available to all interested parties.*
- *The power point has considerable content volume, speaking points will be high level of specific details.*
- *When questions come to mind, it is recommended to write them down and bring them up during the various Q&A sessions throughout the presentation. For questions unable to provide a response, take a screen shot of the CWB Contact listed on the various Q&A pages and send the inquiry to the listed contacts.*

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Preface

The Office of Public Safety is committed to provide vital knowledge to regulatory authorities, engineers, technical professions, and industry to ensure a better understanding of the correlation between governing codes and specifications, product design standards, construction standards, inspection standards and CWB's enforcement activities corresponding to welding, manufacturing and construction associated with the Canadian Welding Bureau's (CWB) certification program and how the effective implementation can assist industry become more competitive, improve quality and reduce risk, all while protecting the safety of the Public.

Agenda

- Objective
- Overview of CWB and The Office of Public Safety
- Certification Drivers
- Overview and interconnection of standards related to welding requirements for bridges
  - Q&A
  - Safety
  - AJH Code/Specification
  - Design
  - Q&A
  - Construction Fabrication Standards
  - Material
  - Electrodes & Consumables
  - Q&A
  - CSA Certification Programs
    - Fabricator Certification
    - Personnel Qualification
      - Welder
      - Supervisor
      - Engineer
    - Welding Procedures
  - Q&A
  - Inspectors and Inspection Organizations
- Complexity of welding
- Limitation of Visual Inspection
- Samples of poor welds / defects
- Additional Videos/Literature of interest (information purposes only)
- Courses of Interests (information purposes)
- FAQ (information purposes only)
- Open Q&A

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Objective

- *To provide stakeholders with an understanding of governing codes and specifications, product design standards, construction standards and inspection standards associated with the effective implementation of CWB's certification program to assist industry improve quality and for protecting the safety of the Public.*

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Overview of CWB

As we drive over bridges, walk in our local shopping center, or enjoy time with family in our homes, most of us take it for granted that the structures that we use every day will be safe. The primary reason for this assumption of safety by the general public has been the expanded use of standards and systems since the early part of the 20th century. Standards now exist for every aspect of welding including design, preparation, welder and procedure qualification, fabrication techniques and quality. Each of these critical elements working together ensures high quality welds and in turn ensures a safe structure.

- Created by CSA in 1947, *the CWB is the only Standards Council of Canada (SCC) accredited welding related certification body* that continues to provide, stability in an industry where local, regional and industry rules made the safe and constant use of welding difficult. Public Safety is a vital role of the organization
- *Under the Canadian Standards Association (CSA), the CWB administers CSA company certification and personnel qualification scheme across Canada as mandated by codes and specifications derived by the Authorities Having Jurisdiction (AJH)*

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- Early 1990’s The CWB was spun off as a private independent not-for-profit organization - now named “The CWB Group”
- The recognition and demand for welding certification has grown steadily in Canada and globally. As of January 2022, The CWB Group has certified 14,523 fabricators and inspection companies, with 7,096 currently active, 6,449 in Canada and 647 in various countries globally. In addition, 234 manufacturers globally certify filler metals through CWB

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The CWB Group

- Is Canada's largest welding related third-party company certification, personnel and procedure qualification and auditing service provider
- Is the administrator of CSA and other welding standards (AWS, ISO, etc.)
- Is funded solely by industry through service fees
- Ensures best practices among all welding establishments and educational institutions across Canada
- As of June 2018, conducted 2456 construction job site visits: 80 sites where non-compliant through the use of non-certified companies. Job site visits have been conducted for over 25 years.
- ❖ *Offers Welder Supervisor and Visual weld Inspector qualification training services*
- ❖ *Is the administrator of exams within the purview of the applicable CSA standards for Welding Supervisors, Visual Weld Inspectors and Welding Engineers.*
- ❖ *Provides non-destructive examination (NDE) training services*
- Delivers ISO and other quality systems registration/assessment services

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- Internationally, represents the International Institute of Welding (IIW) as the
  - Authorized National Body (ANB) in Canada
  - Authorized National Body for Company Certification (ANBCC) in Canada
- Has over 200 staff & contractors globally, of them 90 are field representatives in Canada
- Provides services in over 35 countries

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Service Overview of CWB Certification

Service Overview of CWB Certification									
	Recorded Since	Since Recorded	Active	In Canada	Other Countries	Applicants	QTY Countries	Staff All Entities	Canada Field Representatives
Certified Fabricators	1947	14245	**6613**	6005	608	428	**35**	**>200**	**90 FT = 62**
Qualified Engineers		3372	-	-	-	-			
Qualified Supervisors		37195	-	-	-	-			
Qualified Welders		>270000	-	-	-	-			
Certified Inspection Organizations	1973	309	**172**	166	6	9			
Certified Inspectors	1982	21590	**9127**	8874	253	2022			
Filler Metals Manufacturers	1993	332	**234**	42	192	3			
Construction Site Visit Reports	2018	**2456**	-	-	-	-	Canada		
Construction Visit Non-Compliance		**80**	-	-	-	-			

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Field Services

- ***Work undertaken by CWB field staff to help ensure the safety of the Canadian public includes***
  - *Certification audits of applicant fabrication and inspection companies*
  - *Bi-annual verification audits for companies maintaining certification*
  - *Ongoing testing and qualification of welding personnel, including 2-year renewals*
  - *Train, invigilate exams and qualify Welding Supervisors, Engineers, and Inspectors*
  - *Review and approve welding procedures*
  - *Testing & certification of welding electrodes and consumables*
  - *Qualification of welding studs*
  - *Random construction site visit to determine whether welding activities are conducted by certified companies to the applicable standards*

Office of Public Safety Overview

- The CWB Office of Public Safety was created in 2012 to educate and advocate for both public safety and the Canadian industry while ensuring the Canadian Welding Bureau's accreditations are maintained and executed to the highest standards

❖ *The CWB Office of Public Safety is also a resource for Building Officials, Owners, Specifiers, and Industry to better understand standards related to welding and construction and how effective implementation of these standards can assist the industry to become more competitive, improve quality, reduce risk, and maintain public safety*

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Services Associated with CWB's Certification Program

- *Education*
- ***Enforcement***
  - *Construction Site visits to determine the fabricators/Erectors certification status*
  - ***Complaint investigations***
    - ***Public safety concerns***
      - *Non-Compliance to codes and standards*
      - *Workmanship Quality*
      - *Structural Integrity*
    - ***False claims of certification***
- *Public Safety inquiries related to CWB as a Certification Body*

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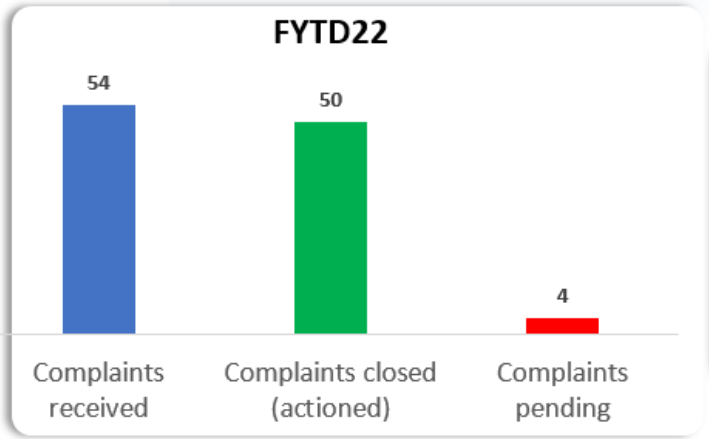
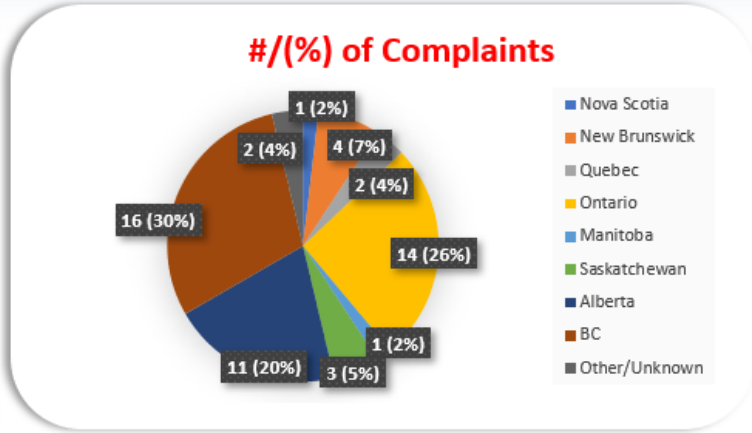
Complaints & Inquiries

Complaints Received

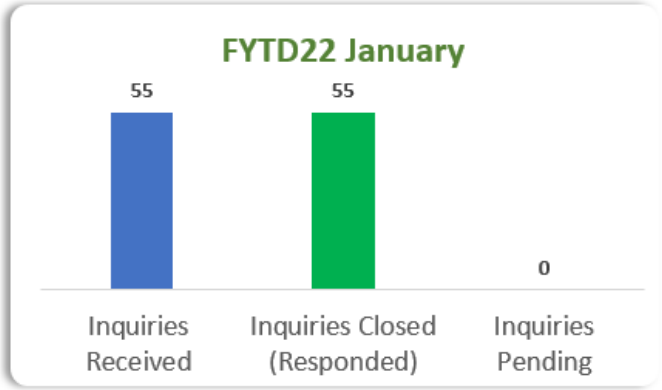


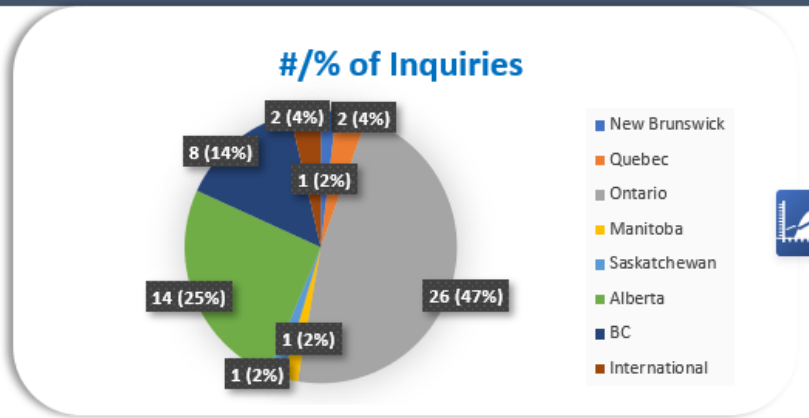


22
FYTD22 Average Days Opened

Inquiries Received

Note: Start date September 22nd, 2021





1.5
FYTD22 Average Response Time

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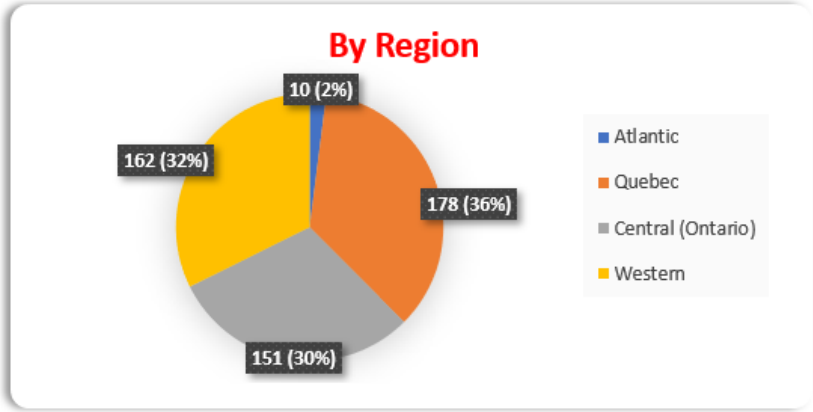
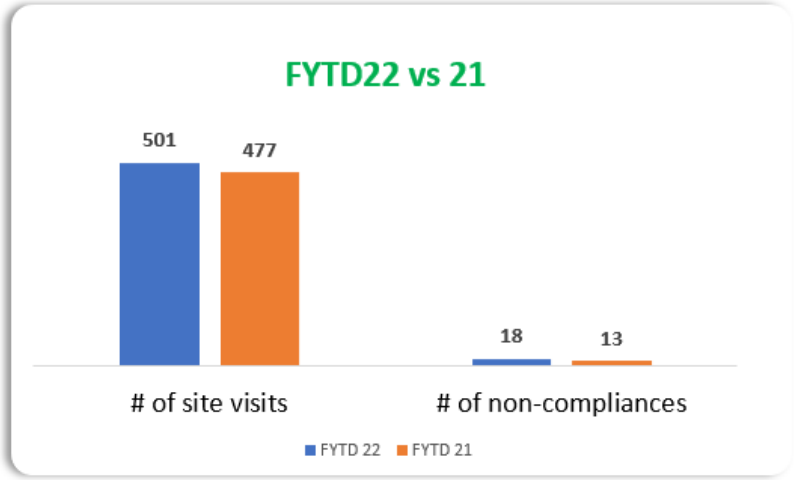
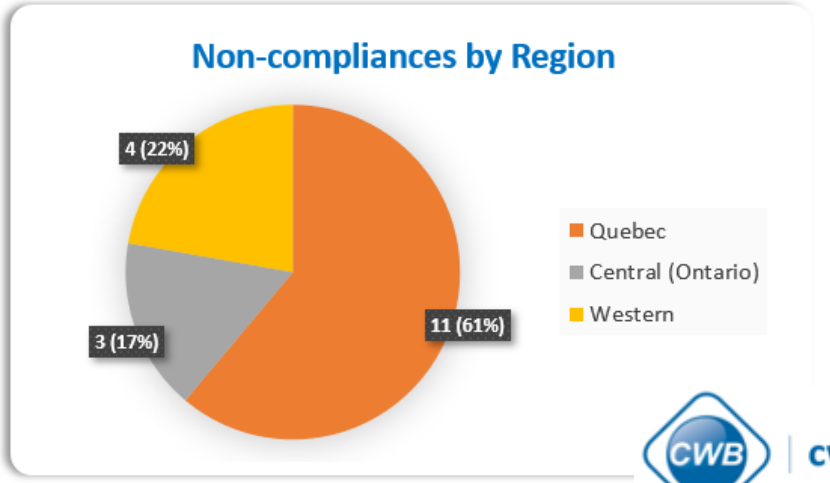
Construction Site Visits

Site Visits and Non-compliance







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Certification Drivers

- ***CSA certification programs are driven by***
  - *Codes & Specifications developed by the Authorities Having Jurisdiction*
  - *Mandatory requirements in design and product code/standards*
  - *Owner specifications*
  - *Voluntary weld quality program*
    - *An obligation to demonstrate due diligence / reduce risk*
    - *The aspiration to improve quality / lower rework*

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Welding Standards

Welded Construction
W59 Steel Construction
W59.2 Aluminum Construction

Safety
W117.2 Safety in Welding & Cutting

Material Designation
G40.20/21 Rolled or Welded Structural Steel
S136 Design of Cold-Formed Structural Steel
Other – ASTM, API, ABS, IACS, Lloyds

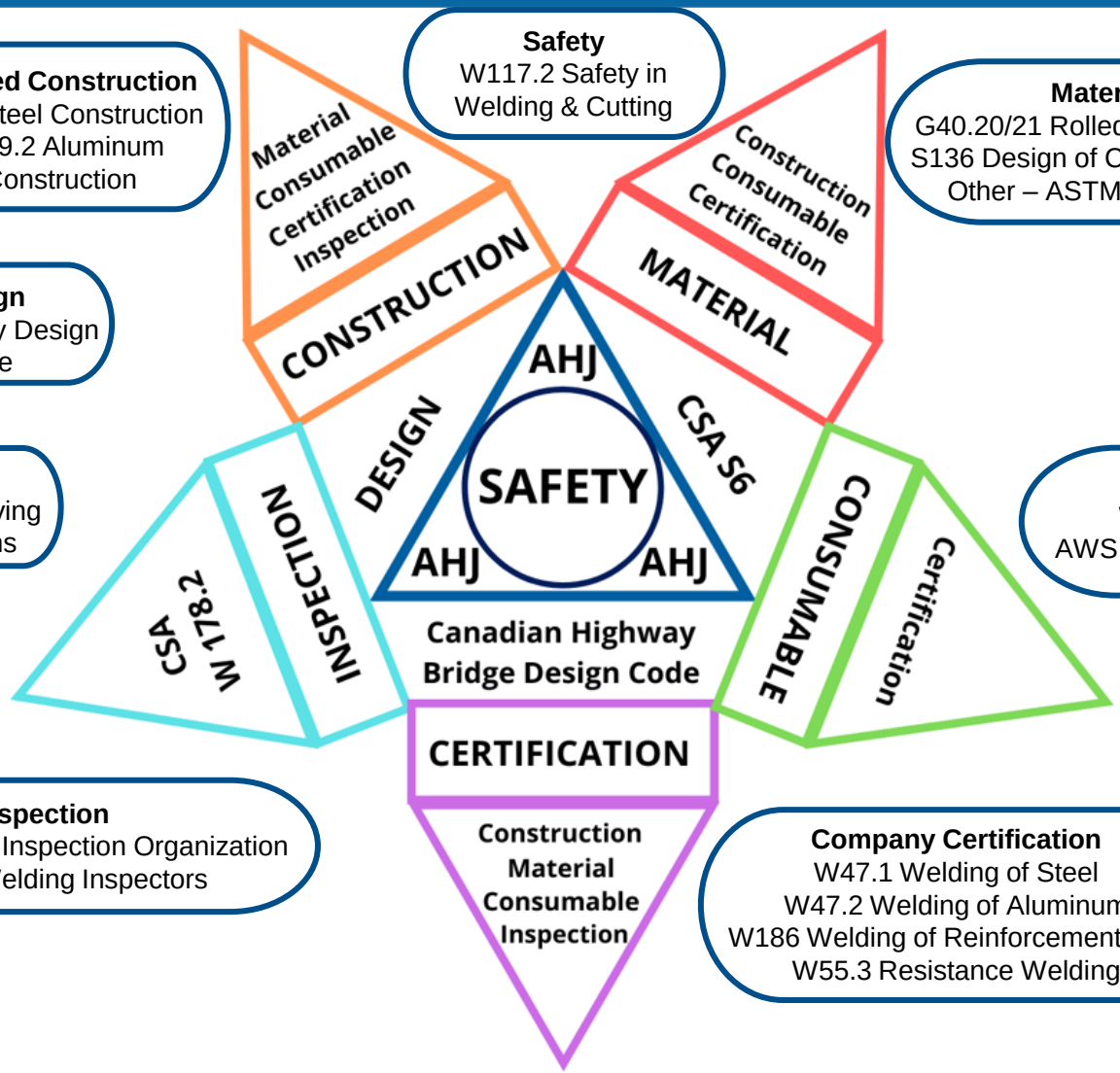
Design
S6 Highway Design Code

AJH
Authority Having Jurisdictions

Consumable Certification
W48 Filler Metal for Arc Welding
AWS A5 series for electrode Specifications

Inspection
W178.1 Welding Inspection Organization
W178.2 Welding Inspectors

Company Certification
W47.1 Welding of Steel
W47.2 Welding of Aluminum
W186 Welding of Reinforcement Bars
W55.3 Resistance Welding



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Welding Standards

- **The CSA has a full assortment of welding standards including the following related to bridge construction**
  - **Safety**
    - CSA W117.2 “Safety in welding, cutting, and allied processes”
  - **Design**
    - CSA S6 “Canadian highway bridge design code”
  - **Welded construction fabrication, techniques, and weld design**
    - CSA W59 “Welded steel construction”
    - CSA W59.2 “Welded aluminum construction”
  - **Material designations/specifications**
    - G40.20/G40.21 “General requirements for rolled or welded structural quality steel/Structural quality steel
    - S136 “North American specification for the design of cold-formed steel structural members”
    - other material standards such as ASTM, API, ABS, IACS, Lloyds standards

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- **Welding consumables**
  - CSA W48 “Filler metals and allied materials for metal arc welding”
- **Company certification and personnel & procedure qualification**
  - CSA W47.1 “Certification of Companies for the fusion welding of steel”
  - CSA W47.2 “Certification of Companies for the fusion welding of aluminum”
  - CSA W186 “Welding of reinforcing bars in reinforced concrete construction”
  - CSA W55.3 “Certification of companies for resistance welding of steel and aluminum”
- **Welding inspection**
  - CSA W178.1 “Certification of Welding Inspection Organizations”
  - CSA W178.2 “Certification of Welding Inspectors”

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Questions

ASK A QUESTION

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Welding Safety

- **CSA W117.2 "Safety in welding, cutting, and allied processes"**
  - *The Standard provides minimum requirements and recommendations to protect persons* who work in an environment affected by welding, cutting, and allied processes from illness and injury and to prevent damage to property arising from the installation, operation, and maintenance of equipment used in these processes
  - ***Hazards associated with welding & cutting activities***
    - *Electric shock*
    - *Radiation - i.e., welder's flash, painful sunburn & grit effect to the eye*
    - *Sparks/Burns*
    - *Fire/explosion*
    - *Fumes*
    - *Gases*
    - *Noise*
    - *Electromagnetic forces*

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AJH Specifications

- ***Ministry of Forests, Lands, Natural Resource Operations and Rural Development*** *has specifications focusing on welding standards, welding qualifications, fabrication standards, quality assurance and quality control associated with welding for forest and resource road bridges, that reference and are consistent with CSA standards and the CWB process. The specifications can be seen on the FLNR Bridge Guidelines, Standards and Specifications webpage.*

Select FLNRORD bridge guidelines, standards and specifications - Province of British Columbia (gov.bc.ca) for complete details located on the gov.bc.ca website.

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Welding Standards

- **Typically, Ministry bridge construction involves two types of welding**
  - Shop fabrication, including but not limited to: primary steel load bearing members, bracing, inserts for embedment into concrete; bearing components, and guardrails; and
  - Field welding required for erection, assembly, and installation of bridge components, including but not limited to: bearing components, steel substructure components, and welded connections for precast members. Field welding of steel girders is not permitted except as specifically pre-approved by the Ministry

Select Steel and welding standards for resource road bridges - Province of British Columbia (gov.bc.ca) for complete details located on the gov.bc.ca website.

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Welding Qualifications

- **Companies responsible for shop welded construction must**
  - Be certified, at the time of project tender and for the duration of fabrication, to Division 1 or Division 2 of CSA W47.1 Certification of Companies for Fusion Welding of Steel Structures; and
  - Have the equipment and capability to make web to flange welds continuously by machine or automatic welding using the submerged arc process
    - ❖ *Exception to the foregoing - fabrication of bridge railings, shear connectors for concrete slab bridges, and miscellaneous steelwork for all-timber portable superstructures may be undertaken by companies certified for Division 3 of CSA W47.1*

❖ *Companies responsible for field welded construction must be certified, at the time of project tender and for the duration of fabrication, to Division 3 or better of CSA W47.1 Certification of Companies for Fusion Welding of Steel Structures*

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- All welding, and inspection of welding, must conform to CSA W59 Welded Steel Construction (Metal Arc Welding)
- All welders, welding operators and welding procedures shall be qualified under the requirements of the applicable CSA company certification standards
- All CWB certified companies are required to have certified welders and approved welding procedures for each specific type of weld produced (Welding Procedure Data Sheets)
- Other requirements related to welding and steel fabrication for Ministry bridges are specified on the Ministry standard drawings, in CHBDC and elsewhere

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Fabrication Standards

- **General**
  - Use new materials and in accordance with Ministry, manufacturer's specifications, and relevant CSA standards
    - Unless otherwise approved by a Ministry engineer, all materials used for the construction of bridges must be new. The materials or material combinations must conform to applicable Ministry, CSA, ASTM, or other standards and must have the appropriate supporting identification
    - All material shall be used in accordance with the manufacturer’s specifications and relevant CSA standards, unless otherwise specified by Ministry standards or a Ministry engineer

- **Quality control and quality assurance**
  - **Fabricator's quality control (QC) program**
    - Quality control (QC) is generally defined as the ‘checking activities’ undertaken by a fabricator to ensure a product is provided that meets contract requirements, and that the causes of unsatisfactory production have been eliminated.

For example, QC for structural steel will normally require implementation of QC checklists for layup and welding of individual members, and other checking and verification processes aimed at identifying, rejecting, and correcting defects in the finished product.

- **Ministry quality assurance in-plant inspection**
  - Quality Assurance (QA) is a process, independent of the fabricator's QC, that encompasses the activities undertaken by the Ministry's QA inspection agency (by persons or companies independent of those doing the work) to verify that the final product satisfies contract requirements (generally meeting the requirements of the materials, drawings, and specifications). This includes verifying that quality control has been performed effectively by the fabricator, thereby providing confidence that the product satisfies the relevant quality standards

- **Steel fabrication quality control**
  - The fabricator shall carry out an ongoing quality control program as required by CSA Standard W47.1 Certification of Companies for Fusion Welding of Steel, and CSA Standard W59 Welded Steel Construction (Metal Arc Welding)

- **Non-destructive testing**
  - Non-destructive testing is the responsibility of the fabricator. If non-destructive testing of welded joints reveals imperfections, the fabricator shall correct the quality of welds to the Ministry's in-plant QA inspector's satisfaction at the fabricator's own expense

(Select Fabrication and materials - Province of British Columbia (gov.bc.ca) for complete details located on the gov.bc.ca website)

Design Standards

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CSA S6:19

Canadian Highway Bridge Design Code

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Design Standards

- **CSA S6 “Canadian Highway Bridge Design Code”**
  - **Definitions**
    - **Regulatory authority:** the appropriate federal, provincial, or territorial Minister having governmental jurisdiction and control, his or her nominee, or the local authority to whom this authority is delegated
      - It is the responsibility of the engineer to be knowledgeable of the applicable legislation and to understand who the appropriate regulatory authority is. The actual person having the authority to regulate any given issue will depend on the jurisdiction
    - ❖ ***Bridge:*** *a structure that provides a roadway or walkway for the passage of vehicles, pedestrians, or cyclists across an obstruction, gap, or facility, and is greater than 3m in span*
    - **Component:** a member of a structure requiring individual design consideration
    - **Design:** the process of planning, analyzing, proportioning, drawing, and writing specifications for the construction of a structure

- ***Highway:*** *a common and public thoroughfare, e.g., a road, street, avenue, parkway, driveway, square, place, bridge, culvert, viaduct, or trestle, designed and intended for, or used by the general public for, the passage of pedestrians, cyclists, animals, or vehicles*
  - **Pedestrian bridge**: a bridge that provides a walkway for the passage of pedestrians

- *Provides guidance for individuals and organizations involved in the design, evaluation, and structural rehabilitation design of fixed and movable highway bridges in Canada*

- *It also covers the design of pedestrian bridges, retaining walls, barriers, and highway accessory supports of a structural nature, e.g., lighting poles and sign support structures*

- *CSA has formed a new TC to develop a new standard for pedestrian bridges CSA S7. The standard will provide guidelines supplementing requirements of CSA S6 for the design, fabrication, inspection, and maintenance of pedestrian bridges. The new standard is forecasted to be published late 2022 or early 2023*

CSA S6 Construction Requirements for Structural Steel

- *Note: Annex A is a mandatory part of CSA S6*

- ***Quality Management System***
  - **A10.1.1.2 General:** *"Fabricators shall have a comprehensive*, documented *quality management system* (QMS). The quality standard shall be an industry recognized certification program specific to steel bridge fabrication acceptable to the regulatory authority. Note: *A quality management system certified by the Canadian Institute of Steel Construction, in the category of steel bridges, is an industry-recognized certification program*

- ***Material***
  - **8.4.2.1.1 Specification:** All reinforcing bars shall meet the requirements of CSA G30.18 Grade 400W or 500W
  - **10.4.2 Structural steel, 10.4.3 Cast Steel, and 10.4.4 Stainless Steel:** *"The clauses list the structural metal requirements"*

- ***Electrodes***
  - **10.4.6 Welding electrodes:** *"Welding electrodes shall meet the requirements of CSA W48 or the AWS A5 series*, as applicable. Except as permitted by Clause 10.23.5, welding electrodes, electrode/gas, or electrode/flux combinations shall include hydrogen designators (e.g., H16, H8, H4, H2) or shall be accepted as being low hydrogen in accordance with CSA W59"
    - **10.23.5.2 Welding consumables:** "Except as permitted in CSA W47.1, only welding consumables meeting the requirements of CSA W48 and CSA W48, Annex K, shall be used, or, in the absence of an applicable CSA W48 requirement, the applicable AWS A5 series of Standards shall be used. Welding consumables shall satisfy the requirements of applicable standard and demonstrate compliant Charpy V-notch toughness compliant"

- ***Procedures***
  - **A10.1.2.4 Welding procedures:** *"All welding procedures to be employed for both fabrication and erection activities shall be established in accordance to the requirements of CSA W47.1"*

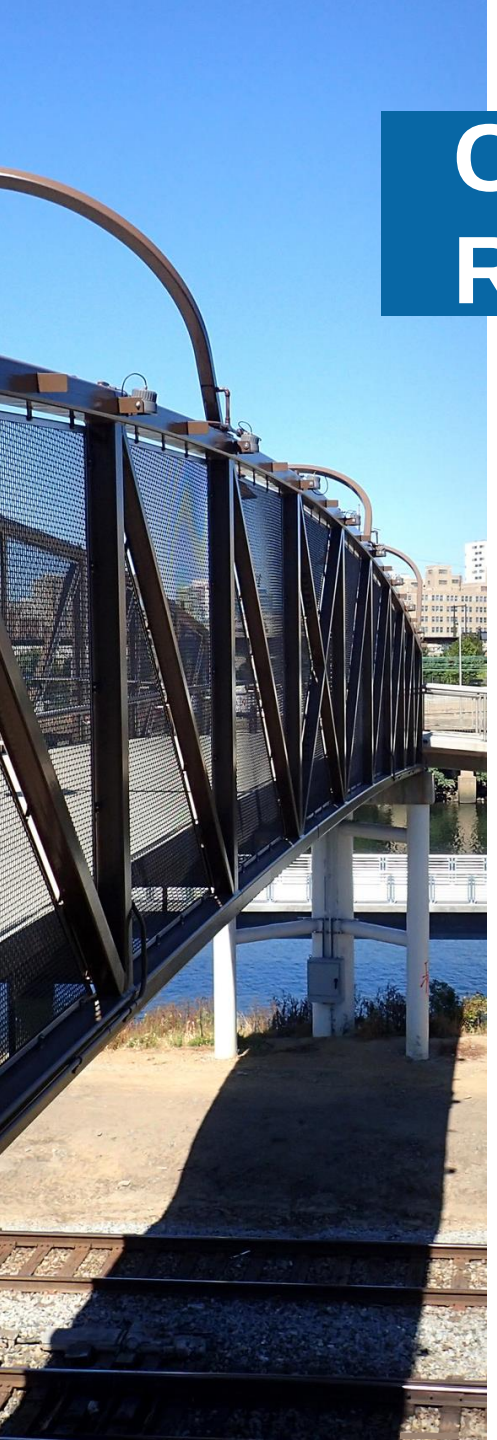
- ***Construction***
  - **A10.1.5.1 General welded construction**: *"All welding, including quality of work, techniques, repairs, and qualifications, shall comply with CSA W47.1 and CSA W59"*

- **8.4.2.1.2 Welding:** *Welding of reinforcement shall be in accordance with CSA W186.* Bars to be welded shall be Grade W. Tack welding of reinforcement shall not be allowed unless approved by the engineer

- ***Studs***
  - **10.4.7 Stud shear connectors:** "Stud shear connectors shall meet the requirements of ASTM A108 Grades G10100 to G10200. *All stud shear connectors shall meet the requirements of CSA W59, Annex H.* Only studs of Type B as defined by CSA W59, Annex H, shall be used"

- ***Fabricator Certification & Qualification***
  - **A10.1.5.5 Fabricator and erector qualification:** *"Fabricators and erectors responsible for welding structures fabricated or erected under this Code (including steel piles, railings and guards, or other welded attachments) shall meet the requirements of CSA W47.1 (Division 1 or Division 2)"*
    - **A10.1.10.8 Field welding:** "Any company undertaking field welding in accordance with this Section shall meet the requirements of Clause A10.1.5.5"

- ***Inspection and Certification***
  - **A10.1.8.1 Qualification of welding inspectors:** *"Visual welding inspectors shall comply with the requirements of CSA W178.2 level 2 minimum. Nondestructive testing personnel (other than visual) shall comply with CAN/CGSB-48.9712 level 2 minimum"*
    - **A10.1.8.2 Non-destructive testing of welds:** "The clause lists the minimum various non-destructive testing of welds that shall be performed"
  - **A10.1.8.3 Acceptance criteria for welds:** *"The acceptance criteria for welds shall be as defined for cyclically loaded structures specified in Clause 12 of CSA W59"*
    - **10.23.8 Inspection records:** "The constructor shall maintain documentation of all visual and non-destructive testing for review and confirmation by the engineer"

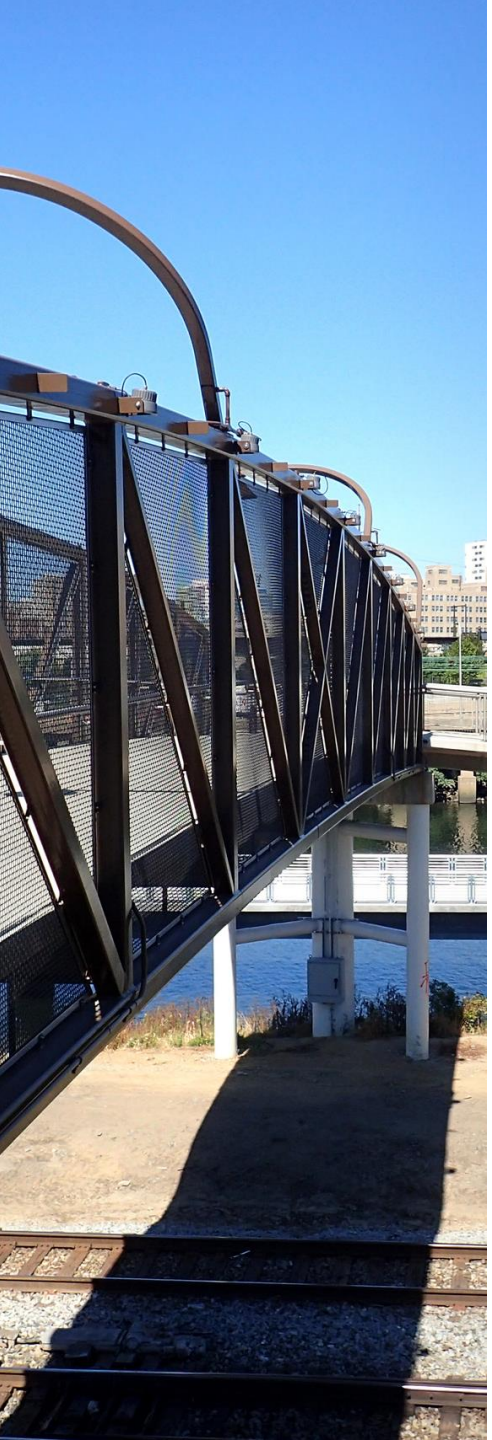


CSA S6 Construction Requirements for Aluminum Structures

- ***Material***
  - **17.4.1 General, 17.4.2 Wrought products, 17.4.3 Castings:** *"The clauses list the structural metal requirements"*

- ***Electrodes***
  - **17.4.5 Welding electrodes:** *"Filler metals, rods, and electrodes for welding shall meet the requirements of AWS A5.10 and shall be qualified in accordance with the requirements of CSA W59.2*, unless otherwise specified in this Code
    - **17.25.2.3 Electrodes:** "Filler metals, rods, and electrodes for welding shall be stored and selected in accordance with the requirements of CSA W59.2"

- ***Procedures***
  - **17.25.1.4 Welding procedures:** *"Welding procedures shall comply with CSA W47.2"*



- ***Construction***
  - **17.25.4.1 General Welded construction:** *"All welding shall comply with CSA W59.2. All welding shall be with an inert-gas-shielded arc process*, including gas tungsten arc welding (GTAW), *gas metal arc welding (GMAW),* or plasma arc welding (PAW), or a suitable solid state process such as friction stir welding (FSW)"

- ***Studs***
  - **17.4.6 Stud shear connectors:** "All stud shear connectors shall meet the requirements of CSA W59.2"
  - **17.25.4.3 Stud welds:** *"Stud welding shall meet the requirements of CSA W59.2"*

- ***Fabricator Certification & Qualification***
  - **17.25.4.5 Fabricator and erector qualification:** *"Fabricators and erectors responsible for welding structures fabricated or erected under this Standard (including railings and guards, or other welded attachments) shall meet the requirements of CSA W47.2 (Division 1 or Division 2)"*
  - **17.25.9.8 Field welding:** "Any company undertaking field welding in accordance with this Section shall meet the requirements of Clause 17.25.4.5. Field welding shall only occur with approval of the owner and with sufficient shelter provided in accordance with CSA W59.2"

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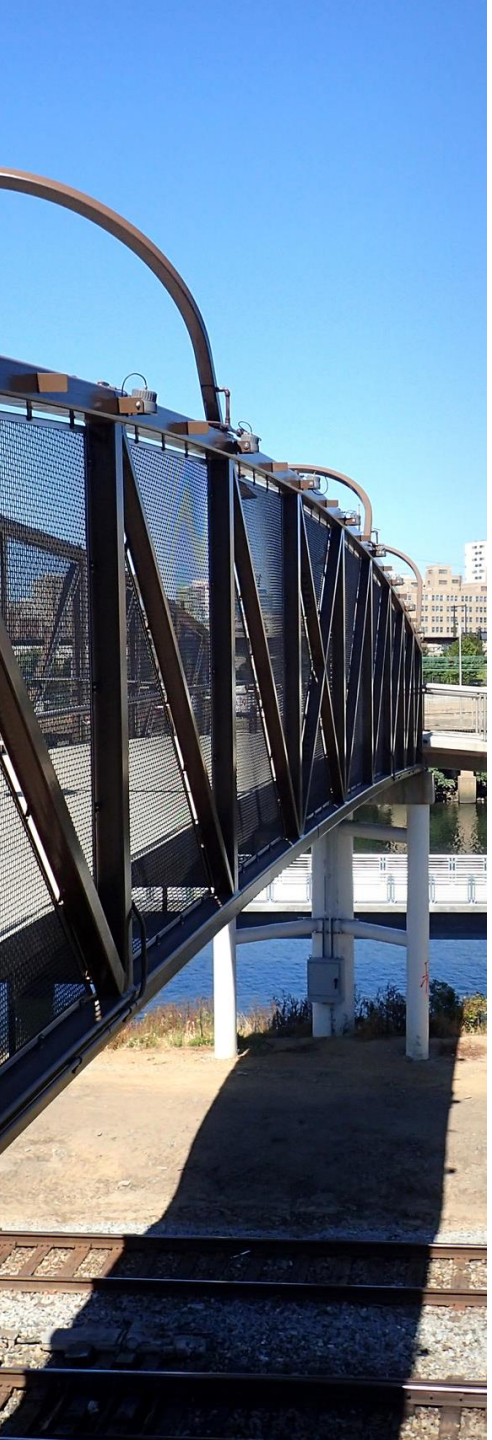

- ***Inspection and Certification***
  - **17.25.7.1 General quality control and welding inspection:** *"The fabricator or erector shall visually inspect all welds.* Non-destructive examination of welds (other than visual inspection) shall be completed by the fabricator or erector when specified by the owner"
  - **17.25.7.2 Non-destructive testing of welds:** "Non-destructive testing of welds shall be conducted in accordance with CSA W59.2"
  - **17.25.7.3 Extent of examination:** "The clause lists the minimum various non-destructive testing of welds that shall be performed"
  - **17.25.7.4 Acceptance criteria:** *"The fabricator or erector shall ensure that all welds under their responsibility comply with CSA W59.2* for cyclically loaded weldments

When third-party welding inspection is required by the owner, such verification shall be completed by the fabricator or erector prior to third-party inspection

Unless otherwise specified, *the acceptance criteria for all welds shall be in accordance with CSA W59.2* for cyclically loaded weldments"

- **17.25.7.5.1 General competency of inspection personnel:** *"The required competency of personnel performing visual weld inspection tasks shall be defined and documented by the fabricator or erector based on their processes. Records of personnel competency shall be maintained by the fabricator or erector"*

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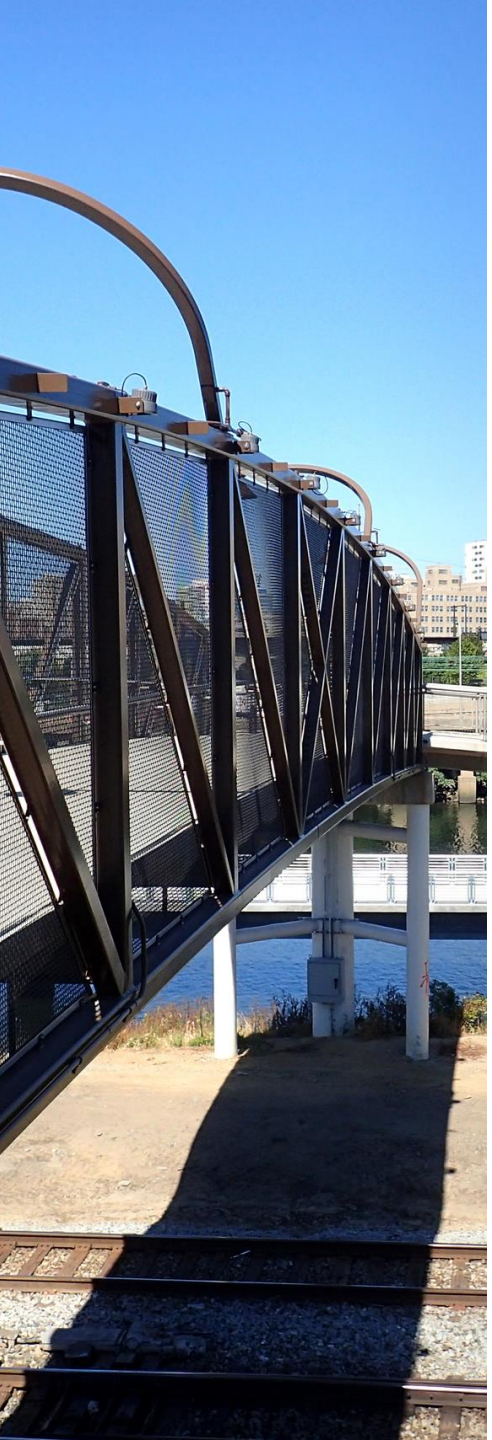

- **17.25.7.5.2 Competency of all personnel performing non-destructive testing (not including visual inspection):** *"Competency of all personnel performing non-destructive testing, other than visual, shall be in accordance with CAN/CGSB-48.9712/ISO 9712"*
- **17.25.7.5.3 Competency for third-party personnel performing non-destructive testing (visual inspection only):** *"The competency of third-party visual inspection personnel shall meet the requirements of CSA W178.2"*
- **17.25.7.5.5 Qualification of non-destructive testing personnel:** *"Non-destructive testing personnel referenced in Clauses 17.25.7.5.2 and 17.25.7.5.3 shall meet the requirements of Level 2 or 3 of CSA W178.2 with CSA W47.1/59.2 endorsement or CAN/CGSB-48.9712/ISO 9712 as applicable.*

  Level 1 personnel may only perform the applicable tasks under the direct supervision of Level 2 or 3 personnel"

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Questions

ASK A QUESTION

Contacts

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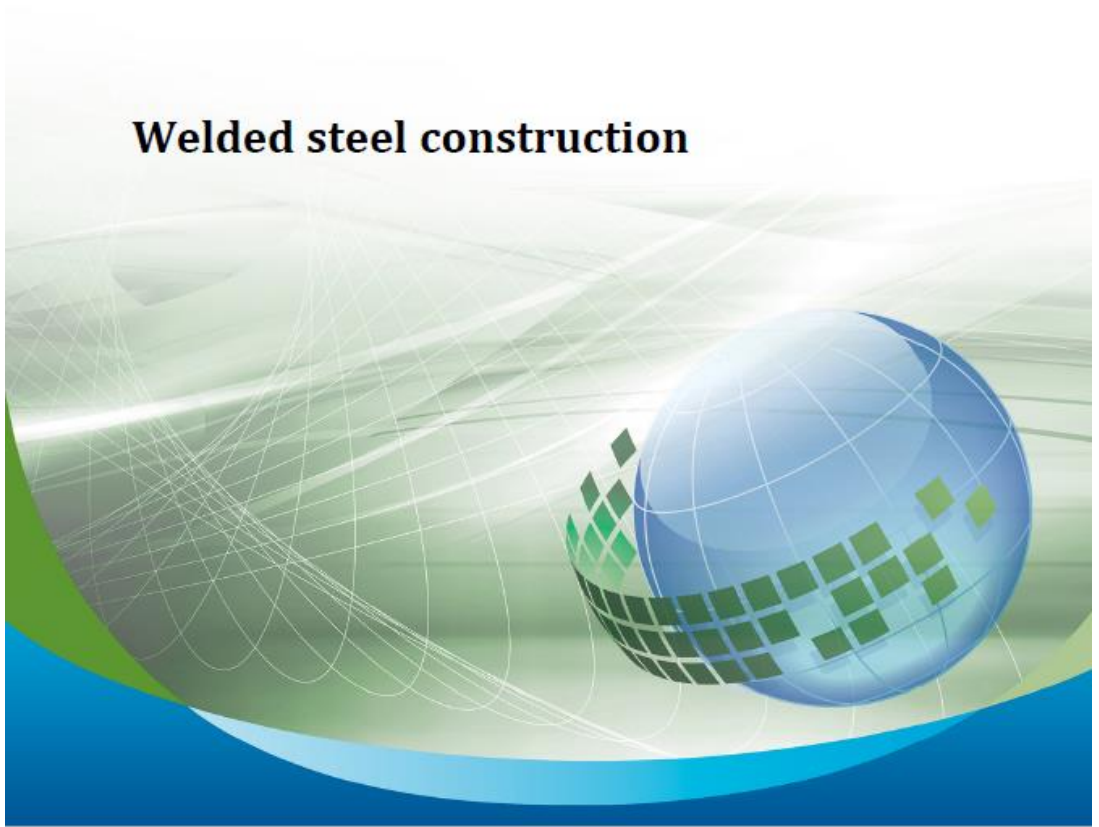
Construction Standards

CSA Group

W59-18

Welded steel construction



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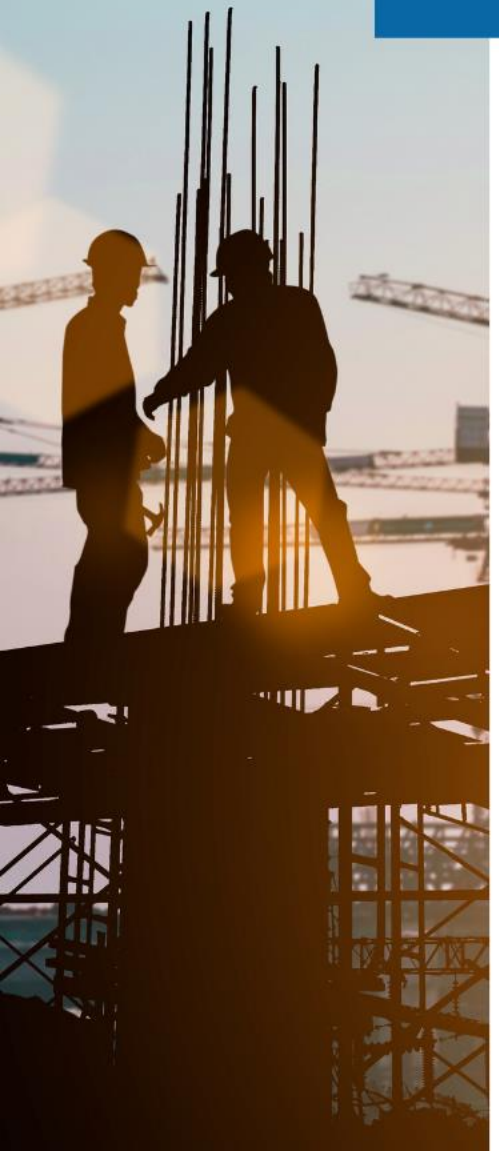

Construction Fabrication Standards

- ***The 3 primary fabrication standards with similar subject areas covered are***
  - *CSA W59 "Welded steel construction"*
  - *CSA W59.2 "Welded aluminum construction"*
  - *CSA W186 "Welding of Reinforcing bars for reinforced concrete constructions"*
- ***These cover all aspects of welding, ensuring that critical items are addressed such as***
  - *Weld capacities*
  - *Preheat*
  - *Crack prevention / hydrogen control*
  - *Treatment of electrodes / filler metals*
  - *Control of shrinkage / distortion*
  - *Weld repairs*
  - *Weld profiles*
  - *Weld quality criteria*
  - *Weld Procedures*
  - *Inspection technique and acceptance criteria*

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CSA W59 Electrodes, Workmanship, and Technique

- *The welder or welding operator, the work, and the welding consumables shall be adequately protected against the direct effect of wind, rain, and snow*

- *Welding shall not be done when the ambient temperature is lower than -18°C (0°F)*, except with the express consent of the Contractor's Engineer

  - The sizes and lengths of welds shall be not less than those specified by design requirements and detail documents, nor shall they be substantially in excess of those requirements without approval of the engineer. The location of welds shall not be changed without approval of the Engineer

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- ***Preparation of material***
  - *Surfaces and edges to be welded shall be smooth, uniform, and free from fins, cracks, and other defects that would adversely affect the quality or strength of the weld*
  - *Surfaces to be welded shall also be free, within 50 mm (2 in) of any weld locations, from loose or thick scale* (except for tightly adhering small islands of scale), *slag, loose rust, paint, grease, moisture, and other foreign material*

- Welding through a light coat of shop applied primer is not cause for rejection and does not require specific welding procedures, provided the conditions of the standard are met:
- Machining, air carbon arc or oxy-fuel gas gouging, chipping, or grinding may be used for joint preparation, for back-gouging, or for the removal of defective work or material, except that oxygen-fuel gouging shall not be used on quenched and tempered steels

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- The standard provides surface and edge roughness and notch limitations. *Notches exceeding the limitations may be welded to an approved procedure* with the contractor's engineer's approval

- The standard provides assembly workmanship tolerances for the various joint types

- **Tack Welds**
  - *Tack welds that are incorporated into the final weld shall be subject to the same quality requirements as the final welds*, condition to be approved by the Engineer.

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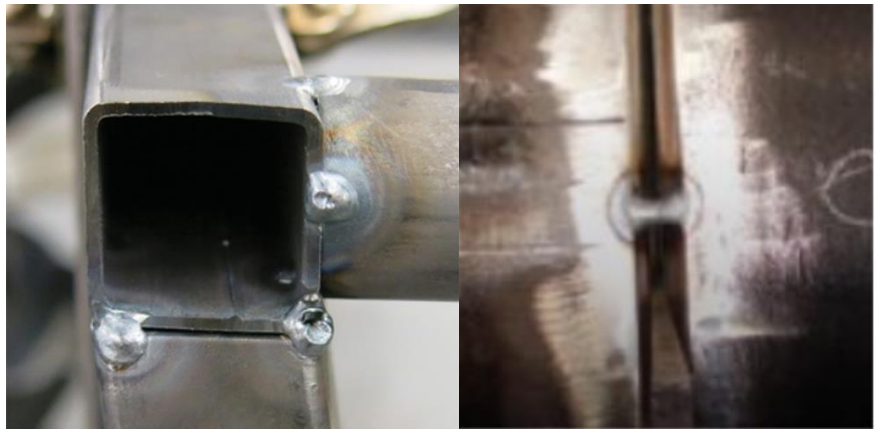
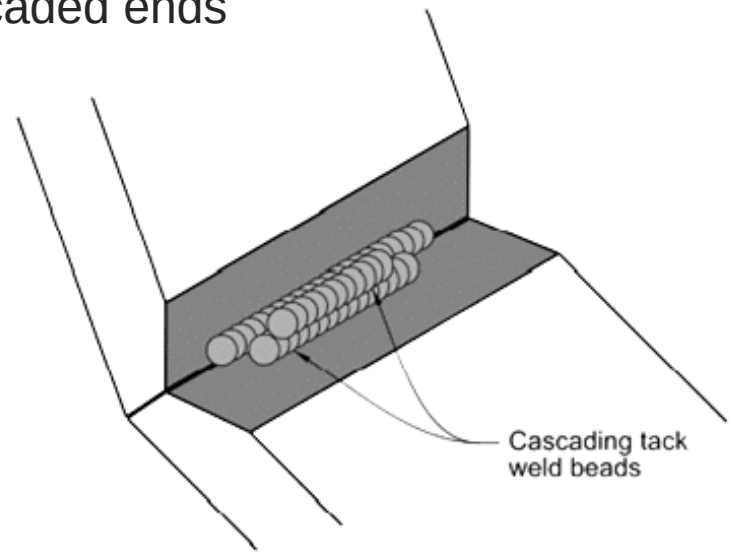
- *Tack welds not incorporated into the final weld shall be removed*, except that they need not be removed for statically loaded structures unless required by the Engineer
- Multiple-pass tack welds shall have cascaded ends





- *The **preheat and interpass** temperature shall be sufficient to prevent cracking. Preheat and interpass temperatures shall be as shown in Table 5.3*
  - The standard provides criterions for acceptable weld profiles
- ***Arc strikes** outside the area of permanent welds should be avoided on any material. When they occur in cyclically loaded structures, the surface of the arc strike should be lightly ground and checked for soundness using the magnetic particle inspection method.*
  - The standard provides requirements for stud welding.

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Preheat

Minimum preheat and interpass temperatures

Thickness of thickest part at point of welding, mm (in)		Welding process				
		SMAW, FCAW, MCAW, and SAW, using consumables with diffusible hydrogen designators of ≤ H 16, or without a diffusible hydrogen designator or any non-low hydrogen electrode	SMAW, FCAW, MCAW, and SAW, using consumables with diffusible hydrogen designators of ≤ H8 GMAW, GTAW		SMAW, FCAW, MCAW, and SAW, using consumables with diffusible hydrogen designators of ≤ H4 GMAW, GTAW
1		2	3	4	5	
		CSA G40.21 API 5L X42 260W (38W), 260WT (38WT) 300W (44W), 300WT (44WT)	CSA G40.21 API 5L X52 260W (38W), 260WT (38WT) 300W (44W), 300WT (44WT) 350W (50W), 350WT (50WT) 380W (55W), 380WT (55WT) 345WM (50WM), 345WMT (50MT), 350R (50R)	350A (50A) 350AT (50AT) 400A (60A) 400AT (60AT)	CSA G40.21 450W (65W) 450WT (65WT) 400W (60W), 400WT (60WT) 480W (70W), 480WT (70WT), 480A (70A), 480AT (70AT) 550W (80W) 550WT (80WT) 550A (80A) 550AT (80AT)	CSA G40.21 700Q (100Q), 700QT (100QT)
mm Up to 20 incl. Over 20 to 40 Over 40 to 60 Over 60	(in) Up to 3/4 incl. Over 3/4 to 1 1/2 Over 1 1/2 to 2 1/2 Over 2 1/2	None‡ 65 °C (150 °F) 110 °C (225 °F) 150 °C (300 °F)	None‡ 10 °C (50 °F) 65 °C (150 °F) 110 °C (225 °F)		10 °C (50 °F) 65 °C (150 °F) 110 °C (225 °F) 150 °C (300 °F)	10 °C (50 °F) 50 °C (125 °F) 80 °C (175 °F) 110 °C (225 °F)

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CSA W59 Welding Inspection

- ***The contractor*** *(fabricator/erector) shall be responsible for visual inspection of all welds* regardless of any additional inspection required in contract documents. Such inspection shall be carried out by the contractor's inspection personnel

  - *The **contractor's inspection personnel** may be*
    - *an individual(s) deemed competent by the contractor;*
    - *a certified welding inspector certified in accordance with CSA W178.2 or in conformance with the requirements of AWS QC1*

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CSA W59 Third Party Inspection

- *When required by contract,* ***third party visual welding inspection*** *shall be performed by either an individual welding inspector or a welding inspection organization*
  - *A* ***welding inspector*** *shall either be currently certified to CSA W178.2 or AWS QC1 or shall be suitably trained and experienced, to the satisfaction of the engineer*, to ensure that adequate competency exists for the inspection tasks to be performed
  - ***Welding inspection organizations*** *shall either be certified to CSA W178.1 or shall provide evidence to satisfy the engineer that they are capable of performing welding inspection*

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Material designation / specifications

- ***CSA G40.20/G40.21*** “General requirements for rolled or welded structural quality steel/Structural quality steel

- ***CSA S136*** “North American specification for the design of cold-formed steel structural members”

- *And other material standards such as* ***ASTM, API, ABS, IACS, Lloyds***

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Electrode & filler metal certification

- *The selection of electrodes / filler metals are critical components in depositing of sound welds*
- ***CSA W48 "Filler Metals and Allied Materials for Metal Arc Welding" provides the following requirements***
  - *Quality management system used in manufacturing*
  - *Chemical properties*
  - *Mechanical properties*
  - *Dimensional tolerances*
  - *Other property requirements (e.g., hydrogen control)*
  - *Testing criteria*
  - *Labeling requirements (includes statement of CWB certification)*
- The objectives are to ensure that electrodes/filler metals are:
  - Manufactured to defined properties
  - Manufactured consistently
  - Identifiable
- ***Manufactures must demonstrate ongoing compliance through***
  - *Retesting of product every 2 years*
  - *Independent audit of manufacturing processes every 2 years*

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❖ CSA W59 requirements for electrodes

Select (CWB Certified Consumables Search | CWB Group)

- ❖ *The electrode classifications used are in accordance with CSA W48 or AWS A5 series of standards*
- ❖ *After welding consumables have been removed from their original packages, they shall be protected or stored* so that their specified properties and welding characteristics are not adversely affected

- Table 5.1 provides requirements for selection of filler metal when welding exposed bare applications. E.g., CSA G40.21 350A, 350AT, 400A, 400AT (50A, 50AT, 60A, 60AT) and ASTM A242, A588 and A709 Gr. 50W steels

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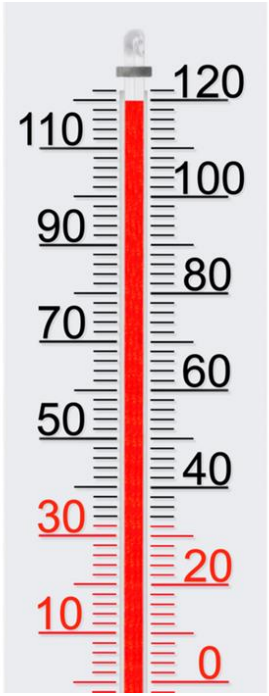
- *Table 5.3 provides requirements for the hydrogen designators for electrode selections used in accordance with the base material to be welded*
- *Table 5.3 provides the minimum preheat and interpass temperature for base material to be welded*
- All low-hydrogen electrodes shall be delivered in sealed containers or shall be reconditioned or discarded if exposed
  - *Immediately after opening sealed containers* or removal from baking ovens for reconditioning, *electrodes shall be stored in ovens held at a temperature of at least 120˚ C (250˚ F)*
  - *Low-hydrogen electrodes of the E49 classification that are not used within 4 hours after removal from ovens shall be reconditioned or discarded*



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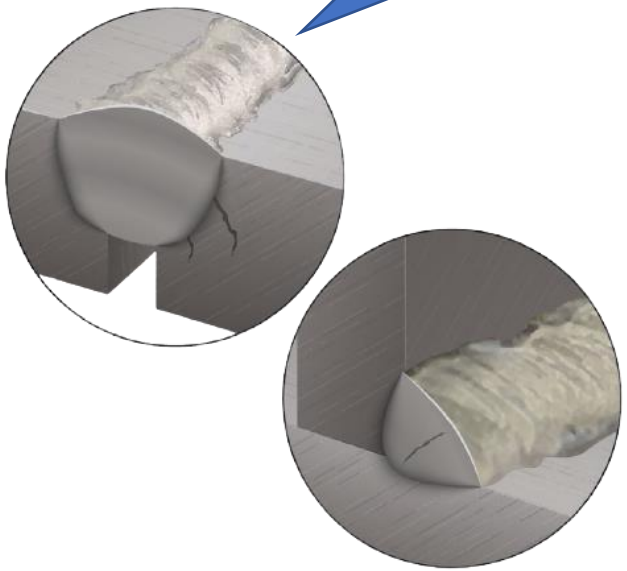
Storage of Arc Welding Electrodes

CSA W48 Filler material	Ambient air	Storage temperature (°C)	Rebaking temperature (°C)
Carbon steel covered electrodes			
EXX10; EXX11	20 to 70% relative humidity	Not required	Consult manufacturer
EXX12; EXX13 EXX14; EXX22 EXX24; EXX27	-10 to +30°C 50 % max. relative humidity	10-25 above ambient	1 hr. @ 135+/-15
EXX15; EXX16 EXX18; EXX28 EXX48	Not recommended	120 to 150	between 2 hr. @ 230 or 1 hr.@ 430 (consult manufacturer)
Cr and Cr-Ni Covered Electrodes			
EXXX-X5 EXXX-X6 EXXX-X7	Not recommended	120-150	225-300 for 1 hr. 300-400 for 1 hr. 340-440 for 1 hr.

Detrimental Action of Moisture and Hydrogen from Electrode Coatings”



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SMAW Classification

E 4 9 1 8 – X – H Z R

- **E** — Arc welding electrode
- **49** — Minimum tensile strength of deposited weld metal in megapascals (MPa)/10 (490 MPa)
- **1** — Welding positions of usability
- **8** — Electrode covering type and type of current
- **X** — Optional designator for improved notch toughness
- **HZ** — Diffusible hydrogen designator in ml/100g of deposited metal, could be 2,4,8 or 16 (i.e. H8 denotes 8 milliliters (ml) of diffusible hydrogen per 100 grams (g) of deposited metal)
- **R** — Optional designator for moisture resistant electrode

Position Abbreviations:
F = flat
H = horizontal
H-F = horizontal fillet
VU = vertical progression upwards AC (alternating current)
VD = vertical progression downwards DCEP (direct current, electrode positive) O = overhead DCEN (direct current, electrode negative)

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GMAW Classification

New GMAW Designators - what do all the numbers mean?

Wire electrodes and deposits for GMAW of non-alloy and fine grained steels under CSA W48-06 use the designations and classification requirements specified in CAN/CSA-ISO 14341.

B-G 49A 3 C1 S6

B - B system based on Tensile Strength and impact 27J (North America)
A - A System based on Yield Strength and impact 47J (Europe)

G - Deposit/gas shielded metal arc welding

Tensile Strength (TS)	
43 - TS = 430 to 600 MPa	YS=330 MPa, EL=20%
49 - TS = 490 to 670 MPa	YS=390 MPa, EL=18%
55 - TS = 550 to 740 MPa	YS=390 MPa, EL=18%
57 - TS = 570 to 770 MPa	YS=490 MPa, EL=17%

Tensile specimens condition
A - As weld condition
P - Post weld heat treated condition

Temperature used for impact energy of 27 J
Z - no requirements
Y - +20 deg C
0 - 0 deg C
2 - -20 deg C
3 - -30 deg C
up to 10
10 - -100 deg C

Optional symbol for impact energy of 47J U

Shielding gas
C1 - 100%CO_2
M20 - Ar + 6 @ 15%CO_2
M21 - Ar + 15@25 %CO_2

Chemical composition
S6 or S3 (or other as per table 3B of ISO14341
S6 similar to AWS A5.18 ERXXS-6
S3 similar to AWS A5.18 ERXXS-3

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FCAW / MCAW Classification

Flux and Metal Cored Wires

E X X T X – X X X – X – X H X

(1) (2) (3) (4) (5) (6) (7) (8) (9) (10)

(1) Designates an electrode.

(2) Tensile Strength Designator

For A5.36 one or two digits indicate the minimum tensile strength (when multiplied by 10,000 psi) of weld metal deposited with the electrode under the welding conditions specified in this specification. For A5.36M two digits are used to indicate the minimum tensile strength (when multiplied by 10 Megapascals (Mpa).

(3) Position Designator

This designator is either "0" or "1". The "0" is for flat and horizontal positions only. "1" is for all positions (flat, horizontal, vertical with upward or downward progression, and overhead.

(4) Usability Designator

This designator is the letter "T" followed by a number from 1 through 17, or the letter "G". The letter "T" identifies it as a flux cored or metal cored electrode. This designator refers to the usability of the electrode with requirements for polarity and general operating characteristics. The letter "G" indicates that the polarity and general operating characteristics are not specified but are as agreed upon between the purchaser and supplier. An "S" appears at the end of this designator when the electrode being classified is for single pass welding only.

(5) Shielding Gas Designator

Two or three digits are used to indicate the type of shielding gas, if any, used for classification. The letter "G" in this position indicates that the shielding gas is not specified but is agreed upon between the purchaser and supplier. When no designator appears in this position it indicates that the electrode is self-shielded and that no external shielding gas is used.

(6) Condition of Heat Treatment

This designator indicates the condition of heat treatment, if any, specified for the electrode classification. "A" is for as-welded and "P" is for postweld heat treated. The letter "G" indicates that the PWHT procedure is as agreed upon between the purchaser and supplier. This designator is omitted when the electrode being classified is for single pass only.

(7) Impact Designator

For A5.36 this designator indicates the temperature in °F at or above which the notch toughness of the weld metal meets or exceeds 20 ft•lbf. For A5.36M this designator indicates the temperature in °C at or above which the notch toughness of the weld deposit meets or exceeds 27 J. The impact designator may be either one or two digits. A "Z" in this position indicates there are no impact requirements for the classification. A "G" in this position indicates the impact requirements are not specified but are as agreed upon between the purchaser and supplier. This designator is omitted when the electrode being classified is for single pass only.

(8) Deposit Composition Designator

One, two or three characters are used to designate the composition of the deposited weld metal. The letter "G" indicates that the weld composition is not specified but is as agreed upon between the purchaser and supplier. No designator is used in this position when the electrode being classified is a single pass electrode. See A6 in Annex A for optional, supplemental designators used to indicate reduced maximum requirements for the Mn + Ni content of certain Cr-Mo alloy types.

(9) Optional, Supplemental Designators[b]

(10) Optional, Supplemental Diffusible Hydrogen Designator

"D" and "Q" Optional, Supplemental Designators

The letter "D" or "Q" when present in this position, indicates that the weld metal will meet supplemental mechanical property requirements with welding done using low heat input, fast cooling rate procedures and using high heat input, slow cooling rate procedures.

[a] *The combination of these designators constitutes the flux cored or metal cored electrode classification.*

[b] *These designators are optional and do not constitute a part of the flux cored or metal cored electrode classification.*

A5.36/A5.36M Open Classification System

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Questions

ASK A QUESTION

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Cristian Zanfir
Email: cristian.zanfir@cwbgroup.org
Phone #: 1-226-314-2323

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Certification Programs

- ***CSA certification programs are in place for***
  - *Fabricators*
  - *Inspection Organizations / Inspectors*
  - *Electrodes & Filler Metals*
- ***Common to all programs***
  - *Independent verification of compliance*
  - *Demonstration of competence and/or technical compliance*
  - *Continual monitoring of compliance*
- ***Key Benefits***
  - *Improved quality / Reduction of risk = Public Safety*
  - *Level playing field for industry*
  - *Independent oversight*

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Fabricator Certifications

Select (Certified Companies | CWB Group)

- Certification ensures that key elements are in place and working
- **There are 4 available programs for fabricators**
  - CSA W47.1 “Certification of Companies for the fusion welding of steel”
  - CSA W47.2 “Certification of Companies for the fusion welding of aluminum”
  - CSA W186 “Welding of reinforcing bars for reinforced concrete construction”
  - CSA W55.3 “Certification of companies for resistance welding of steel and aluminum”

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- ***There are 4 key elements to a fabricator certification program***
  - *Qualified welding personnel*
  - *Qualified welding supervisor personnel*
  - *Qualified welding engineer*
  - *Accepted welding procedure specification and data sheets*
- ***In practical terms, this means that a welding fabricator must have***
  - *Competent qualified people making the welds, who are…*
    - *Following proven qualified welding procedures "recipes", in a shop…*
    - *Overseen by competent qualified individuals*
- ***When all three are in place, high quality sound welds will result, equating to public safety***

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CSA W47.1 Steel & Stainless and CSA W47.2 Aluminum

- Only the company name at the location indicated on the CWB certificate is certified

- **Fabricators can be certified to 1 of 3 “Divisions”. W186 requires all fabricators to be certified in either Division 1 or Division 2**
  - Division 1 employs a welding engineer
  - Division 2 retains a welding engineer
  - Division 3 a welding engineer is not required. The company cannot fabricate any bridge components and cannot be responsible for the fabrication of any buildings and building service components

- **Fabricators must define the “Scope” of their certification**
  - Like all quality systems, the work that falls within the control of the system must be clear to the employees of the organization, the independent certification body, and the customers
  - The Scope of Certification is done through a statement on a Fabricator’s certificate and made available to the public. Examples
    - “Welding, fabrication, manufacturing for bridges”

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- “Field welding fabrication, repairs and maintenance for highways and bridges”
- “Welding and fabrication of steel buildings including miscellaneous work such as handrail, stairs and platforms”

❖ *The company shall **review the contractual requirements** related to welding and shall establish that all the information necessary to carry out the welding manufacturing operations is complete and available prior to the commencement of the work*

❖ *The company **shall affirm its capability** to meet all welding-related requirements and shall ensure adequate planning of all welding-related activities, and that the documentation is clear and unambiguous*

❖ *W47.2, companies shall produce and implement an **operational control procedure (OCP)*** and shall be used in connection with all projects completed in accordance with this Standard

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LETTER OF VALIDATION

The CWB acknowledges that

ABC Welding Company

123 Main St

Anytown, ON Canada

is certified to **CSA Standard W47.1**

Certification of Companies for Fusion Welding of Steel"

In DIVISION 2

for the period **April 04, 2021** to **May 03, 2022**

Company Code: ABCDE1

Scope:

Custom fabrication, structural steel fabrication and industrial maintenance. Custom fabrication at customer request.

Registrar

8260 Parkhill Drive, Milton, Ontario L9T 5V7
1-800-844-6790 | Int 905-542-1312 | Fax: 905-542-1318
Email: info@cwbgroup.org | Web: www.cwbgroup.org

Only the company name at the location indicated on the CWB certificate is certified

Certification Standard

Division 1 employs a welding engineer

Division 2 retains a welding engineer

Period of Certification

Like all quality systems, the work that falls within the control of the system must be clear to the employees of the organization, the independent certification body, and the customers

Division 3 a welding engineer is not required. The company cannot fabricate any bridge components and cannot be responsible for the fabrication of any buildings and building service components.

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Annex G (informative)
Example of operational control procedure document

Note: *This Annex is not a mandatory part of this Standard.*

ALUMINUM OPERATIONAL CONTROL PROCEDURE		
COMPANY NAME/LOGO:		
PROJECT DESCRIPTION/JOB #:		
CLIENT:		
REFERENCE DWGS/SPEC:		
BASE METAL:		
FILLER METAL:		
REFERENCE STANDARDS/SPECS/CODE:		
SPECIAL BASE AND FILLER METAL INSTRUCTIONS		
SPECIAL INSTRUCTIONS/TEST REQUIREMENTS		
WELD CHECKLIST		
Do all materials have mill test reports?	Yes	No
Have any essential variables changed? (see WPS/CSA W47.2)	Yes	No
Are the electrodes stored in a sealed/dry source and in good condition?	Yes	No
Are preheats required?	Yes	No
Temperature used (if required)		
Was the base metal prepared as per WPS/Code requirements?	Yes	No
Are all required WPDS and WPS available?	Yes	No
Does the joint geometry conform to the applicable WPS/WPDS/Code?	Yes	No
Is the welder properly qualified?	Yes	No
Is the general weld appearance in accord with project code requirements?	Yes	No
If any question was answered "no", explain mitigating action taken:		

Approved by:	Signature	Date

Figure G.1
Example of operational control procedure document

An operational control procedure shall be used in connection with all projects completed in accordance with the Standard

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Welding Personnel Qualification as part of the fabricator's certification

❖ ***Must pass a practical test witnessed by the CWB for joints, positions, processes, and material/electrode type used***
  - Fillets, grooves, backing/no backing, plate, tubular
  - Flat, horizontal, vertical, overhead
  - SMAW, FCAW/MCAW, GMAW, SAW, GTAW, …
  - Steel, stainless, aluminum

- **Issued a Welder Qualification Card**
  - Transferable between certified companies, regardless of the company name on the qualification card
  - Non-transferable/alternate are certified company procedure specific
- **Use of Card**
  - Valid only while employed by a CWB certified company
  - Typically, valid for only 2 years

❖ ***Welder tests are evaluated by either***
  - *Destructive tests*
    - *Bends, fracture, macro-etch*
  - *Non-destructive tests*
    - *Radiography*

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Attention
Transferable or Non-transferable for Welder, Tacker, Operator or Robotic Operator & Programmer
Welder Qualification
This card is valid only while employed by a CWB certified company
Transferable Welder
Validity
The Qualification card is still valid regardless of the certified company name or test center name
Name: JOE WELDER
Exp. Date: August 21, 2019
Employer: Weld It CWB Certified Company, City, Prov
Thickness Range: 3mm & above
Material: Carbon Steel
Common metals- Carbon Steel, Stainless Steel & Aluminum
Process: SMAW
Common processes SMAW, SAW, FCAW/MCAW, GMAW & GTAW
Manual, Semi-automatic, Mechanized, Automatic & Robotic
Mode: MANUAL
Standard: CSA W47.1
T, S, FW & WT
Classification: S
Electrode: F4
Flat, Horizontal, Vertical-up, Vertical-down & Overhead
Class: FLAT/HORIZONTAL/VERTICAL UP/OVERHEAD
See reverse
See reverse for conditions
Carbon steel electrode group designations - F1, F2, F3, F4
Common standards W47.1, W47.2, W186

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Conditions Of Use

1. This card remains the property of the CWB and may be recalled and/or cancelled at any time. Fraudulent use of this card can result in loss of qualifications of the individual and/or the certified company employing the individual.

2. This card must be available for inspection by any CWB representative or other designated officials at all times.

3. This qualification may be revoked by the CWB if the individual is not engaged in the process qualified for a period of three months or more.

For any questions regarding this qualification, please contact:
1-800-844-6790 | www.cwbgroup.org

Welding Supervision Qualification as part of the fabricator's certification

- *The fabricator **must employ a sufficient quantity of qualified Welding Supervisor's** to ensure full control of all welding activities. e.g., If a company fabricates in a shop and simultaneously is working on multiple construction sites, one welding supervisor may not have full control of all welding activities*

- ***Qualified welding supervisors must demonstrate***
  - ***Minimum education/knowledge***
    - *Drawings, welding symbols, knowledge of weld faults, quality control, inspection methods and the company's welding procedures & equipment*
    - *Welding codes and standards*
    - *Examinations related to the above topics are required*
  - ***Minimum experience***
    - *5 years of welding-related experience pertinent to the company's type of operations*

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❖ *Key roles*

- ❖ *To ensure that welders are correctly qualified*
- ❖ *To ensure that approved welding procedures are in place and in use*
- ❖ *To ensure visual weld quality requirement are met*

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cwbcertification

WELDING SUPERVISOR CERTIFICATE FOR CSA STANDARD W47.1

This certificate is the property of CWB Group. It must be returned on request.

Presented to

Joe Welder

For successfully meeting the qualification requirements of a Welding Supervisor, as stated in CSA Standard W47.1 Initial

Acceptance Date: May 23, 2001

Valid while employed with

Weld It College

Registrar & Director,Quality Assurance

This qualification only valid while employed by a CWB certified company.

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Welding Engineer Qualification as part of the fabricator's certification

Select *(Approved Engineers | CWB Group)*

- *Employ/Retain at least one Welding Engineer (Div. 1 or 2 only)*
- ***Must demonstrate***
  - ***Minimum education/knowledge***
    - *Steel / stainless / aluminum, welding fundamentals, welding metallurgy, and welding procedures and practice*
    - *Welding codes and standards*
    - *Examinations related to the above topics are required*
  - ***Minimum experience***
    - *5 years of welding-related experience*
- ***Key roles***
  - *Development of new and maintaining of existing welding specifications and procedures (Generally the welding engineer is not the engineer that performed the weld design for the product to the requirement of the applicable CSA construction standard)*
  - *Periodic reviews of overall welding operations*

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Approved Welding Procedures as part of the fabricator's certification

❖ *A document of welding details & parameters; in short a "recipe" for welding*

- **Covers items such as**
  - Process
  - Base material
  - Filler materials / electrodes, shielding mediums (The combination of filler metal and shielding medium must be CWB approved and is only approved for the point of manufacturing, i.e., plant)
  - Joint details: thickness, preparation, position, tolerances
  - Welding parameter ranges, pass/layer sequence
  - Preheat

❖ *Are independently reviewed and accepted by the CWB against the requirements of the applicable certification and governing standards*

❖ *In some cases, are deemed to be "pre-qualified" based on the details within the construction fabrication standards. i.e., procedure qualification testing is not required*

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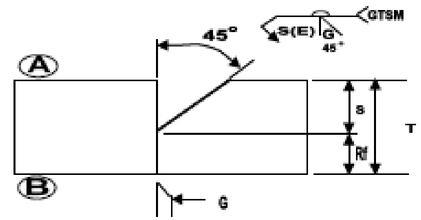
Welding Procedure

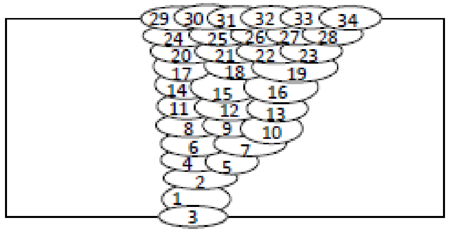
cwbconsulting	WELDING PROCEDURE DATA SHEET/ WELDING PROCEDURE SPECIFICATION	WPDS#	SM-BTC-4-1G
		Date:	Monday, February 7, 2022
Company Name:	ABC Company	Ref. Standards:	CSA W47.1 & W59
Address:	123 Main st	Ref. WPS:	SM-WPS-01
	Toronto / Ontario / M3J 1A6	Ref. PQR:	

Process:	SMAW	Pulsed?	No	Position:	Flat	Process Mode:	Manual	
Base Material:	Steel Groups 1, 2, 3 - Table 11-1 or 12-1 of CSA W59			Flux Type:		Shielding Gas 1:		
				Tungsten Type:		Shielding Gas 2:		
Filler Metal:	E4918-H8 or H4			Tungsten Dia.:	in	Flow Rate:		ft3/h
Cleaning:	Remove slag and wire brush between passes			PHT Temp:	Table 5.3 W59 °F	Interpass: Min:	PHT	°F
				PWHT Temp:	N/A °F	Interpass: Max:	500	°F

Typical Joint Preparation:



Typical Pass and Layer Sequence:



Joint Dimensions:		G =	0 - 1/8	Q (°) =	45	RFmin =	1/16	ETT(E)=	T	W=	
Joint Tolerances:		±				*Unless noted dimensions are in*				*inches.*	

Weld Type:	Groove Weld	Joint Type	Butt	✓	Electrical Stickout:		in
Type of Penetration:	Complete Joint Penetration		Tee	✓	Nozzle Dia:		in
Type of backing:	Gouged to Sound Metal		Corner	✓	Avg Deposition Rate:		lbs/h
			Lap	☐			
Material:	Thickness: (in)		Edge	☐			

Technique:

Material Thickness (T) (in)		Weld Size (in)	No. of Layers	No. of Passes	Electrode Size (in)	Current Polarity	Current (A)	Wire Feed Speed (in/min)	Voltage (V)	Travel Speed (in/min) Min	Travel Speed (in/min) Max	Heat Input (kJ/in) Min	Heat Input (kJ/in) Max
1/4		1/4	1 - 3	1 - 3	1/8	DCRP	120 - 150		23 - 27	9	11		
3/8		3/8	1 - 4	1 - 5	1/8	DCRP	120 - 150		23 - 27	9	11		
1/2		1/2	1 - 6	1 - 10			120 - 150		23 - 27	10	12		
3/4		3/4	1 - 8	1 - 16	5/32	DCRP	160 - 190		23 - 27	12	14		
1		1	1 - 9	1 - 19	3/16	DCRP	220 - 250		23 - 27	9	11		
1 1/4		1 1/4	1 - 10	1 - 23	3/16	DCRP	220 - 250		23 - 27	9	11		
1 3/8		1 3/8	1 - 11	1 - 28	3/16	DCRP	220 - 250		23 - 27	9	11		
1 1/2		1 1/2	1 - 12	1 - 34	3/16	DCRP	220 - 250		23 - 27	9	11		

Notes:

Revision Date:	Explanation:	CWB Approval:	Company's Authorization:

Prepared by CWB Consulting

This document may not be used for fabrication without bearing the CWB Acceptance Stamp used to show review & acceptance by the CWB in accordance with the referenced standards

Monday, February 7, 2022

Note :Welding procedures are not always laid-out the same. The essential details are required but may be placed differently on the page. Some use the CWB template and other make their own templates.

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Company details, Process, Materials, Consumables, Position & Temperatures

cwbconsulting	WELDING PROCEDURE DATA SHEET/							WPDS#	SM-BTC-4-1G		
	WELDING PROCEDURE SPECIFICATION							Date:	Monday, February 7, 2022		
Company Name:	ABC Company							Ref. Standards:	CSA W47.1 & W59		
Address:	123 Main st							Ref. WPS:	SM-WPS-01		
	Toronto	Ontario	M3J 1A6					Ref. PQR:			
Process:	SMAW	Pulsed?	No	Position:	Flat			Process Mode:	Manual		
Base Material:	Steel Groups 1, 2, 3 - Table 11-1 or 12-1 of CSA W59			Flux Type:				Shielding Gas 1:			
				Tungsten Type:				Shielding Gas 2:			
Filler Metal:	E4918-H8 or H4			Tungsten Dia.:		in		Flow Rate:			ft3/h
Cleaning:	Remove slag and wire brush between passes			PHT Temp:	Table 5.3 W59	°F		Interpass:	Min:	PHT	°F
				PWHT Temp:	N/A	°F			Max:	500	°F

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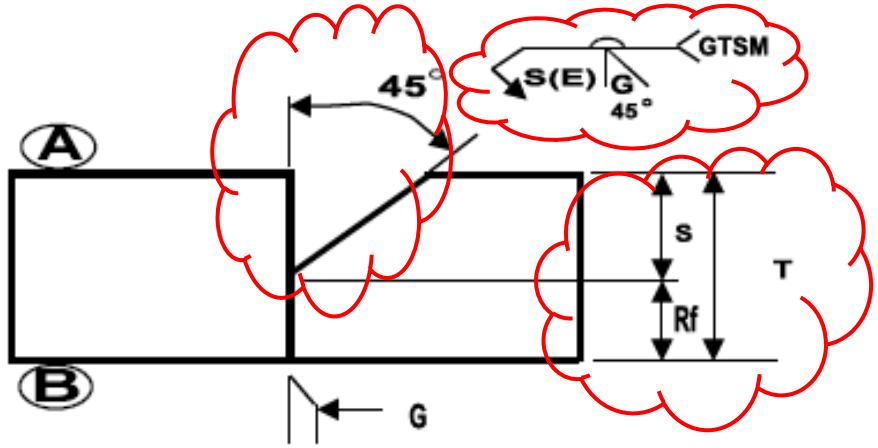
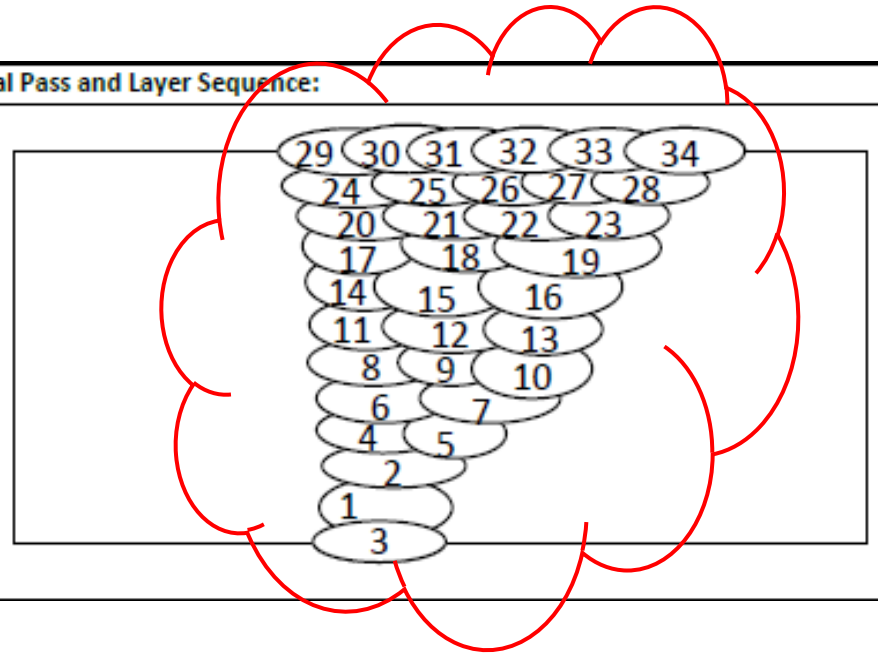
Joint Configuration & Weld Sequence

Typical Joint Preparation:	Typical Pass and Layer Sequence:
	

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Joint Details & Notes

Joint Dimensions:		G =	0 - 1/8	Q (°) =	45	RFmin =	1/16	ETT(E)=	T	W=	
Joint Tolerances:		±				*Unless noted dimensions are in*				*inches.*	
Weld Type:	Groove Weld	Joint Type	Butt	✓		Electrical Stickout:				in	
Type of Penetration:	Complete Joint Penetration		Tee	✓		Nozzle Dia:				in	
Type of backing:	Gouged to Sound Metal		Corner	✓		Avg Deposition Rate:				lbs/h	
			Lap								
Material:	Thickness: (in)		Edge								
Technique:											

Material Thickness (T) (in)	Weld Size (in)	No. of Layers	No. of Passes	Electrode Size (in)	Current Polarity	Current (A)	Wire Feed Speed (in/min)	Voltage (V)	Travel Speed (in/min) Min	Travel Speed (in/min) Max	Heat Input (kJ/in) Min	Heat Input (kJ/in) Max

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Sizes & Parameters

Material Thickness (T) (in)	Weld Size (in)	No. of Layers	No. of Passes	Electrode Size (in)	Current Polarity	Current (A)	Wire Feed Speed (in/min)	Voltage (V)	Travel Speed (in/min) Min	Travel Speed (in/min) Max	Heat Input (kJ/in) Min	Heat Input (kJ/in) Max
1/4	1/4	1 - 3	1 - 3	1/8	DCRP	120 - 150		23 - 27	9	11		
3/8	3/8	1 - 4	1 - 6	1/8	DCRP	120 - 150		23 - 27	9	11		
1/2	1/2	1 - 6	1 - 10			120 - 150		23 - 27	10	12		
3/4	3/4	1 - 8	1 - 16	5/32	DCRP	160 - 190		23 - 27	12	14		
1	1	1 - 9	1 - 19	3/16	DCRP	220 - 250		23 - 27	9	11		
1 1/4	1 1/4	1 - 10	1 - 23	3/16	DCRP	220 - 250		23 - 27	9	11		
1 3/8	1 3/8	1 - 11	1 - 28	3/16	DCRP	220 - 250		23 - 27	9	11		
1 1/2	1 1/2	1 - 12	1 - 34	3/16	DCRP	220 - 250		23 - 27	9	11		

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Notes & Approvals

Notes:			
Revision Date:	Explanation:	CWB Approval:	Company's Authorization:

Prepared by CWB Consulting

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Monday, February 7, 2022

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Maintaining Certification is an ongoing process

❖ ***To maintain certification, companies must***

- ❖ *Qualify new & check test existing welders every 2 years*
- ❖ *Submit new or revised welding procedures, as required*
- ❖ *Continually verify visual acceptance of welded products*
- ❖ *Ensure subcontracted welding activities within the company's scope of certification are awarded to certified companies*

❖ *Bi-annual CWB verification audits are conducted*

- Annual certification renewal base fee:
  - $1500 - $1900/ year

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Certification Verification

- *Verify company, inspector & consumable certification, and welding engineer qualification status on the CWB website*

  Select (Certified Directory Search | CWB Group)

- ***Ask fabricators/erectors for their valid Letter of Validation***
  - *Annual letter of validation issued to certified clients*
  - *Verify the date of certification validity*
  - *Verify the scope of certification relates to bridges (may not state the word bridge)*
- ***Call the CWB***
  - *1.800.844.6790*
- ***The following documents are part of the certification program, but none can be used on their own as proof of certification***
  - *Welder Tickets*
  - *Welding Procedures*
  - *Wall Certificates*
  - *Welding Supervisor Certificates*

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Validity of Qualifications

cwbcertification

NOTICE

(Please ensure to provide this letter to each recipient of qualification cards)

To: Individuals and non-CWB certified companies testing at CWB accredited Test Centres.

The CWB Office of Public Safety regularly receives questions concerning the validity and use of welder qualification cards by individuals and employees of non-CWB certified companies that have obtained these qualifications by attending a CWB witnessed welder test session at CWB Accredited Test Centres.

The front face of the qualification card has a statement noting, *"This card is only valid while employed by a CWB certified company"*.

The back of the card also has a statement noting, *"This card remains the property of CWB and may be recalled and/or cancelled at any time. Fraudulent use of this card can result in loss of qualifications of the individual and/or the certified company employing the individual"*.

Therefore, please be aware that the welder qualification cards issued through testing at CWB Accredited Test Centres are not valid unless the individual named on the card is employed by a CWB Certified company.

The use of the welder qualification card as proof of certification to the CSA Standard listed on the card (e.g. CSA W47.1, W47.2, etc.) is not permitted.

The CWB only grants permission to companies that have met all requirements of the CSA Standard to make a claim of CWB certification.

Individuals and non-CWB certified companies have not met the requirements and therefore have not been granted permission to advertise in any manner that they are CWB qualified/certified. The CWB will take action against individuals and companies making false claims of certification in accordance with the requirements of its federal government accreditations and provincial and federal legislation.

If you have any questions on the validity and use of welder qualification cards, please contact the CWB Office of Public Safety.

8260 Parkhill Drive, Milton ON L9T 5V7
www.cwbgroup.org
1.800.844.6790

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Non-Certified Companies risks Public Safety

- ***Generally non-certified companies do not have any type of established process***
  - *Quality assurance*
  - *Quality control*
  - *Material and consumable selection*
  - *Industry welding practices*
  - *Workmanship techniques*

- ***Welding Engineer***
  - *None in place, qualification only exist through the CSA certification standards*
  - ***Unqualified***
    - *Have not performed proven competency exams fully witnessed and evaluated by a third part certification body. (Exams on welding fundamentals, welding metallurgy, welding procedures and practice, applicable welding standards)*
  - *Not developing weld procedure*
  - *Not performing overall welding operation reviews*

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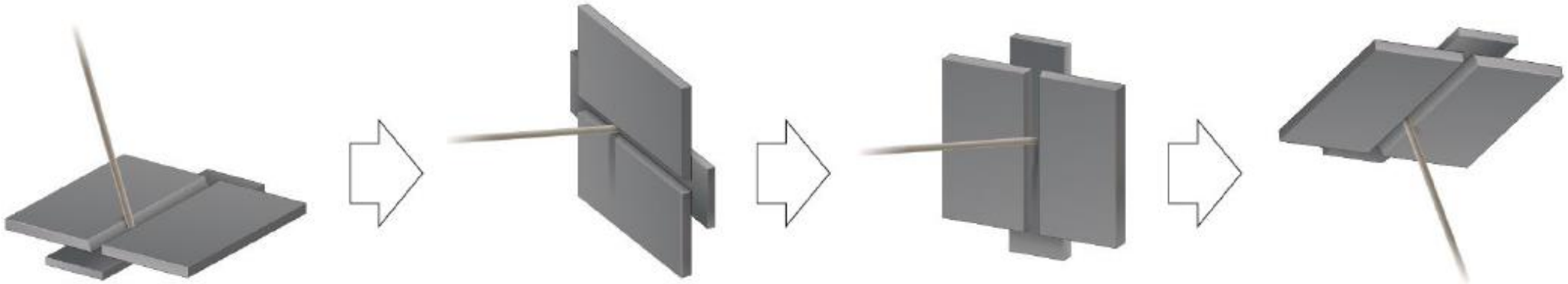
- ***Welding Supervision***
  - *None in place, qualification only exist through the CSA certification standards*

  - ***Unqualified***
    - *Have not performed proven competency exams fully witnessed and evaluated by a third part certification body. (Exams on weld symbols, weld faults, inspection and quality control, applicable welding standards)*
    - *Not ensuring welding personnel are following proven welding procedures*
    - *Not performing 100% visual weld inspection*

- ***Welding Personnel***
  - ***Unqualified***
    - *Have not performed a proven practical competency test fully witnessed and evaluated by a third part certification body*
    - *May not position the weldment in the best optimal position for best weld quality and soundness (welding in the flat position provides best ease of welding and weld quality results, out of position welding such as horizontal, vertical and overhead is more prone to quality concerns and requires welding personnel with enhanced skills)*

- ***Not following proven welding procedures***
  - *Randomly selecting welding parameters*
  - *Inconsistent use of welding parameters amongst welding personnel*
  - *Inadequate GTSM when required for full penetration joints*
  - ***Lack of knowledge of essential variables and tolerances***
    - *Filler metal selection*
    - *Shielding medium selection*
    - *Material grade and thickness selection*
    - *Removal of material contaminants*
    - *Parameter selection and tolerances*
    - *Joint preparation and tolerances*
    - *Weld size, quantity of passes and layers and tolerances*
    - *Minimum preheated and minimum/maximum interpass temperatures*
    - *Procedure specific instructions*



Position Qualification Progression

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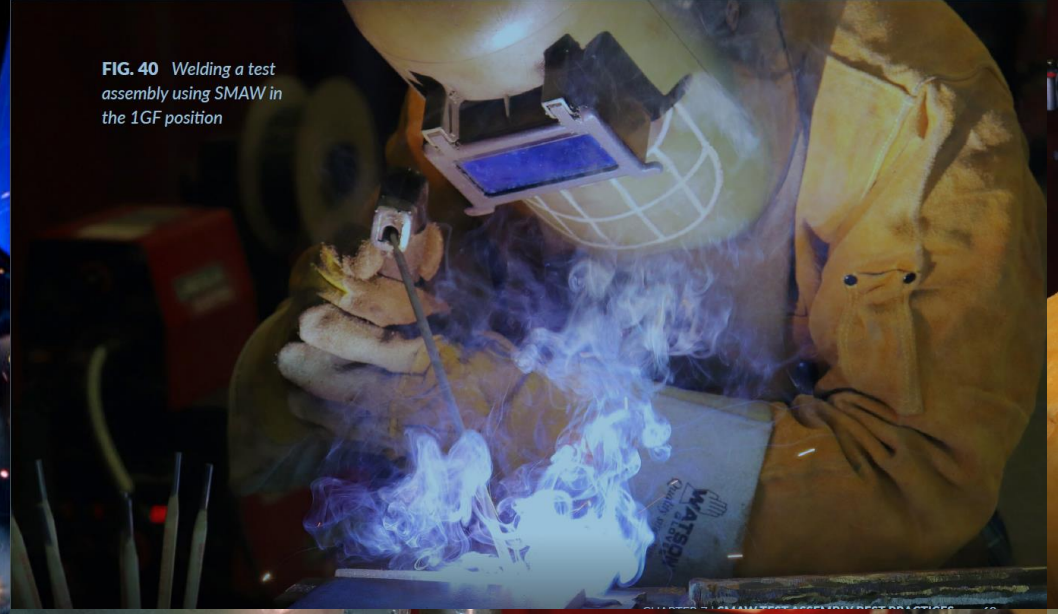

FIG. 40 *Welding a test assembly using SMAW in the 1GF position*

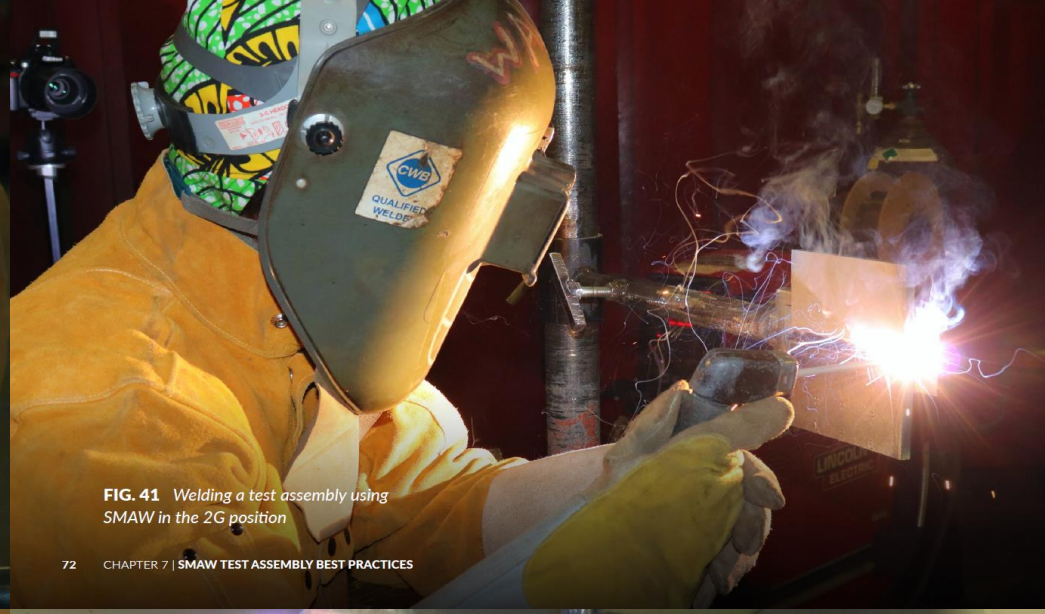

FIG. 41 *Welding a test assembly using SMAW in the 2G position*

72 CHAPTER 7 | **SMAW TEST ASSEMBLY BEST PRACTICES**

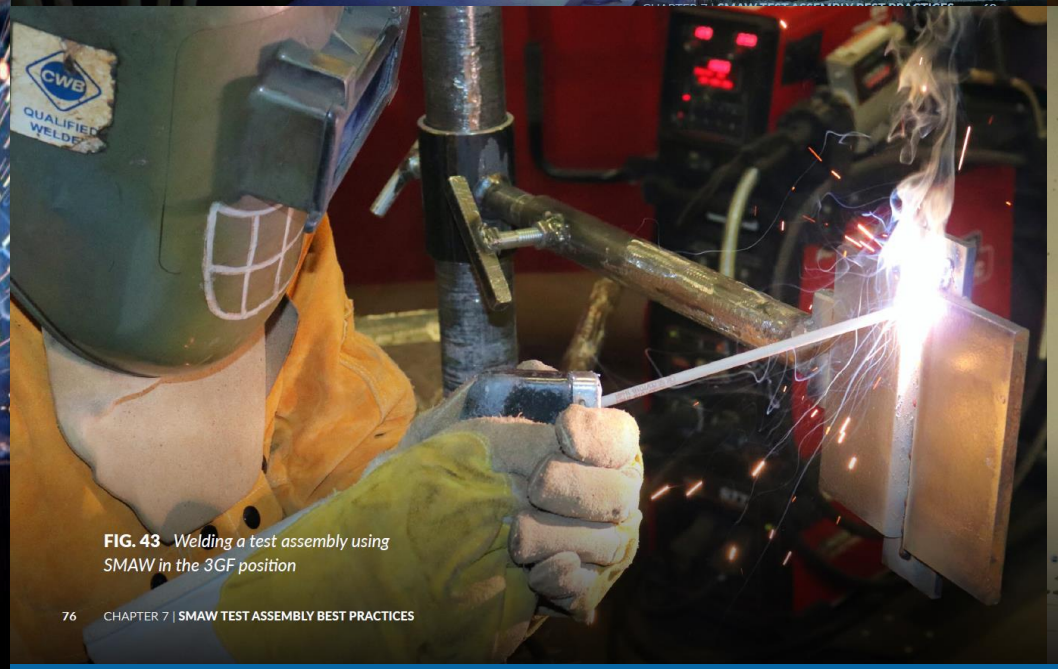

FIG. 43 *Welding a test assembly using SMAW in the 3GF position*

76 CHAPTER 7 | **SMAW TEST ASSEMBLY BEST PRACTICES**

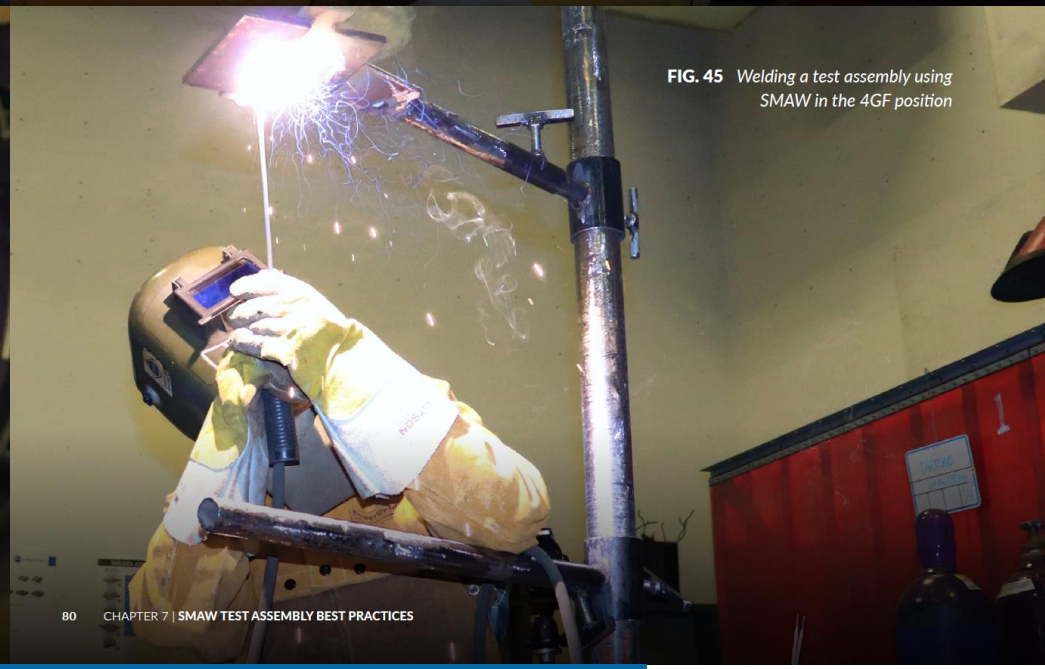

FIG. 45 *Welding a test assembly using SMAW in the 4GF position*

80 CHAPTER 7 | **SMAW TEST ASSEMBLY BEST PRACTICES**

CSA Welder Qualification Tests

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Poor Quality Welds

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Questions

ASK A QUESTION

Contacts

CWB Group
Email: info@cwbgroup.org
Phone #:1-800-844-6790

CWB Office of Public Safety:
Neil Martin
Email: neil.martin@cwbgroup.org
Phone #: 1-705-419-2649

Cristian Zanfir
Email: cristian.zanfir@cwbgroup.org
Phone #: 1-226-314-2323

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Inspection Certification

- **There are 2 available programs related to inspection**
  - CSA W178.1 “Certification of Welding Inspection Organizations”
  - CSA W178.2 “Certification of Welding Inspectors”

❖ **CSA W178.1 requirements**

Select *(*Certified Welding Inspection Companies | CWB Group)

- ❖ *Covers organizations that provide visual and non-destructive welding inspection services*
- ❖ *Only the company name at the location indicated on the CWB certificate is certified*
- ❖ *Must have a procedure to allow inspectors to inspect and report without bias and fear of reprisal*
- ❖ ***Inspection must be conducted by competent, certified individuals***
  - Visual welding inspectors
  - Non-destructive equipment operators (e.g., ultrasonic, radiography personnel)
  - ❖ *The inspection work performed by Level 1 welding inspectors shall be the responsibility of a Level 2 or Level 3 welding inspector.*

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- ***Inspection operations must be overseen by competent, qualified individual***
  - Inspections *Certified W178.2 Level 3 Inspection Supervisor*
  - *Shall review and sign all final written inspection reports*
- Must follow inspection procedures for each of the product categories included in the scope of operations.
- *Formal inspection reports must be documented*
- *Must demonstrate ongoing compliance through competence of staff, procedures, and equipment calibrations*
  - *Annual CWB verification audits are conducted*
- *Welding Inspection Organizations must define their scope of welding inspection activities through the*
  - ***Inspection methods used***
    - Visual (VT)
    - Mechanical
    - Metallographic
    - Liquid Penetrant (PT)
    - Magnetic Particle (MT)
    - Eddy Current (EC)
    - Ultrasonic (UT)
    - Radiographic (RT)

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❖ *Product categories inspected*

- Buildings, bridges, industrial structures, machinery, cranes, rail, and road vehicles
- Ships and floating marine structures
- Mobile drilling units and steel fixed offshore structures
- Industrial pipe
- Pipelines and piping
- Pressure vessels, boilers, and heat exchangers
- Storage tanks

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LETTER OF VALIDATION

Only the company name at the location indicated on the CWB certificate is certified

The CWB acknowledges that

ABC Welding Company

123 Main St

Anytown, ON Canada

Certification Standard

is certified to CSA Standard W178.1
"Certification of Welding Inspection Organizations"

for the period December 20, 2021 to January 19, 2023

Period of Certification

Company Code: ABCDE1

Scope:

Welding inspection of buildings, bridges, industrial structures, machinery, cranes, rail and road vehicles, industrial piping, pipelines and storage tanks using the following inspection methods: visual (VT), radiographic (RT), ultrasonic (UT), magnetic particle (MT) and liquid penetrant (PT).

Like all quality systems, the work that falls within the control of the system must be clear to the employees of the organization, the independent certification body, and the customers

Registrar

8260 Parkhill Drive, Milton, Ontario L9T 5V7
1-800-844-6790 | Int 905-542-1312 | Fax: 905-542-1318
Email: info@cwbgroup.org | Web: www.cwbgroup.org

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CSA W178.2 requirements

Select (CWB Certified Inspector Search | CWB Group)

- Covers individuals that conduct welding inspection, Individuals must:
- *Meet the minimum years of experience for the level of certification*

- ***Demonstrate***
  - ***Specific technical knowledge***
    - *Welding fundamentals, welding inspection, and welding metallurgy*
  - *Ongoing compliance*
  - *Continued involvement in welding inspection activities*
  - *Understanding of current product standard requirements*
  - *Practical evaluation techniques*
  - *Meet vision requirements*
- *Perform written and practical examinations*
- *Follow a code of ethics through personal integrity and professional competence*

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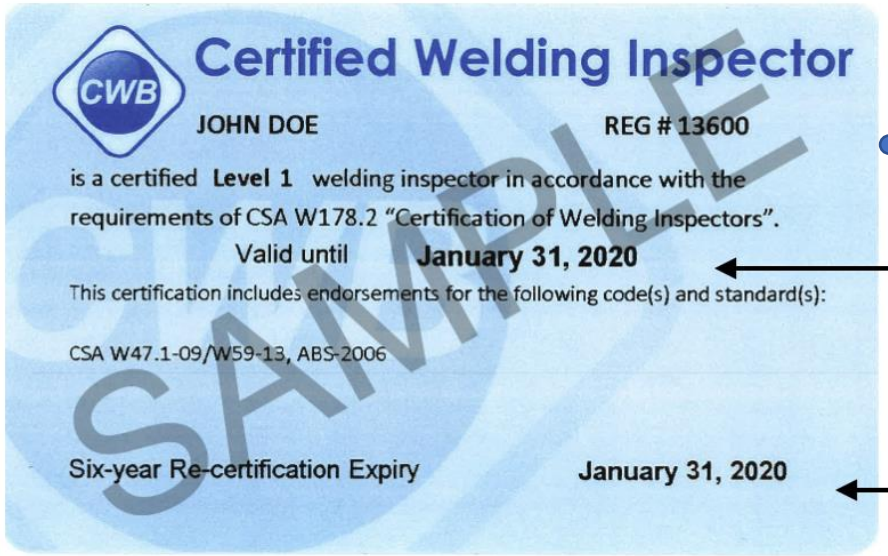
- **Certification is available in one of 3 levels**
  - Level 1 (must work under Level 2's or 3's)
  - Level 2
  - Level 3

Renewal of certification shall be required every 3 years and shall be recertified at six-year intervals



3-Year Renewal Date

6-Year Recertification Date

- *Renewal of certification shall be required every 3 years and shall be recertified at six-year intervals*

❖ *All levels can conduct inspections and document results*

❖ *Level 2 can independently conduct welding inspection activities*

❖ ***Level 3, additional capabilities***

- ❖ *Interpreting specifications and codes, preparing welding inspection procedures, and implementing quality assurance and control programs*
- ❖ *Reviewing contractor's inspection and test plans to ensure all welding-related quality requirements have been included and inspections have been performed as specified*

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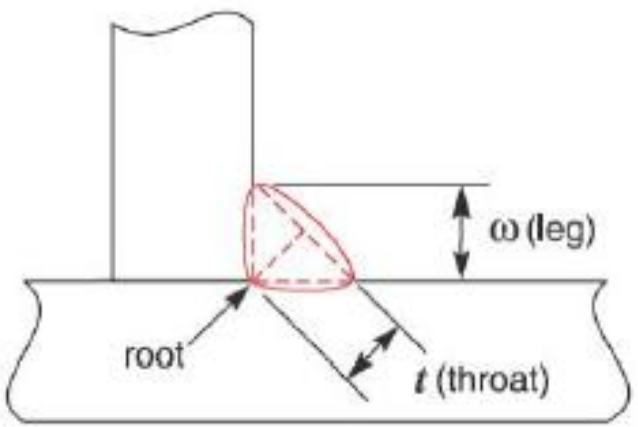
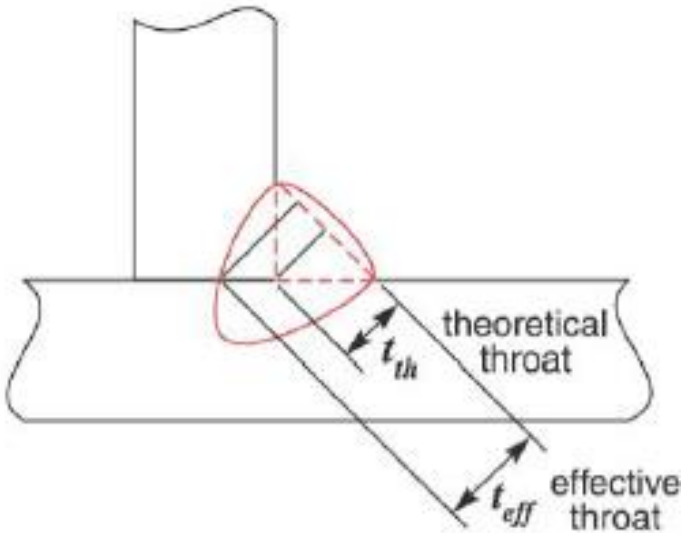
Complexity of Welding

- ***Welding Personnel competency***
  - *To be a competent welder much training is necessary. The CWB practical test does not indicate that the welder is skilled and competent for shop and field fabrication, it is only an indicator that they are competent to succeed on the practical test. The certified company's qualified welding supervisor must ensure that skilled and competent welding personnel are used for specific work taking place.*
- *Weld may visually look acceptable but may not be sound, hence limitation requirements noted in the applicable construction standards, approved procedures, personnel qualifications and monitoring of practices to ensure sound quality welds*

Theoretical vs Effective Throat





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Welding of Steel versus Aluminum

- **General**
  - ***Aluminum is more sensitive to***
    - *Contaminants*
    - *Parameter adjustments*
    - *Welding personnel manipulation during welding (less forgiving)*
    - *Wire feed problems*
  - *Aluminum has less welding processes in common use (GMAW, GTAW predominantly)*
  - *Similar to the mill scale on steel, aluminum has a surface oxide layer. Aluminum oxide is very hard and is use as an abrasive in grinding discs. It is strongly recommended to remove the aluminum oxide layer through use of chemical or mechanical means*

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❖ ***Aluminum is more prone to craters at weld terminations***

- One technique is for welding personnel to pause for a fraction of a second and then press the trigger for a fraction of a second to fill the crater.
- Another technique is reversing the direction of travel for a sufficient distance while maintaining the arc for a sufficient time to fill any resulting crater

❖ ***Example of witnessing procedure testing***

❖ *When requested by a certified company to witness procedure testing, often companies do not conduct internal testing prior to the visit by the CWB representative, they hope for the best during the official procedure tests.*

❖ *Welding personnel generally welding steel with the use of a wire feed process will initially have difficulties adapting to the travel speeds required for GMAW aluminum welding. A typical travel speed used to deposit a ¼" fillet weld for steel will produce a 3/8" fillet weld for aluminum. Most will believe that the larger 3/8" fillet weld is stronger, but large single pass fillet welds are prone to lack of fusion in the root at the faying intersection of the plates. Destructive weldment fusion and strength can be examined by conducting fracture tests. A ¼" fillet weld with satisfactory fusion at the faying intersection will be more difficult to fracture than a 3/8" weld with slight lack of fusion at the faying intersection*

CWB | cwbgroup

Field Welding

- ***Steel***
  - *Generally, SMAW and FCAW for steel*
  - *Portable oven is required for storage of basic SMAW electrodes shortly after being removed from sealed packages*
  - *Welding shall not be done when the ambient temperature is lower than -18° C (0° F)*
- ***Aluminum***
  - *Generally, GMAW and GTAW for aluminum*
  - *Welding shall not be done when the adjacent metal temperature within a distance not less than 75 mm (3 in) is lower than 10° C (50° F).*
- ***General***
  - *Control environment and knowledge/use of requirements for field welding activities are generally reduced*
  - *Requirement for enclosures/shelter during inclement weather*
  - *Frequent requirement for preheat and maintain interpass temperatures due to temperature fluctuations*

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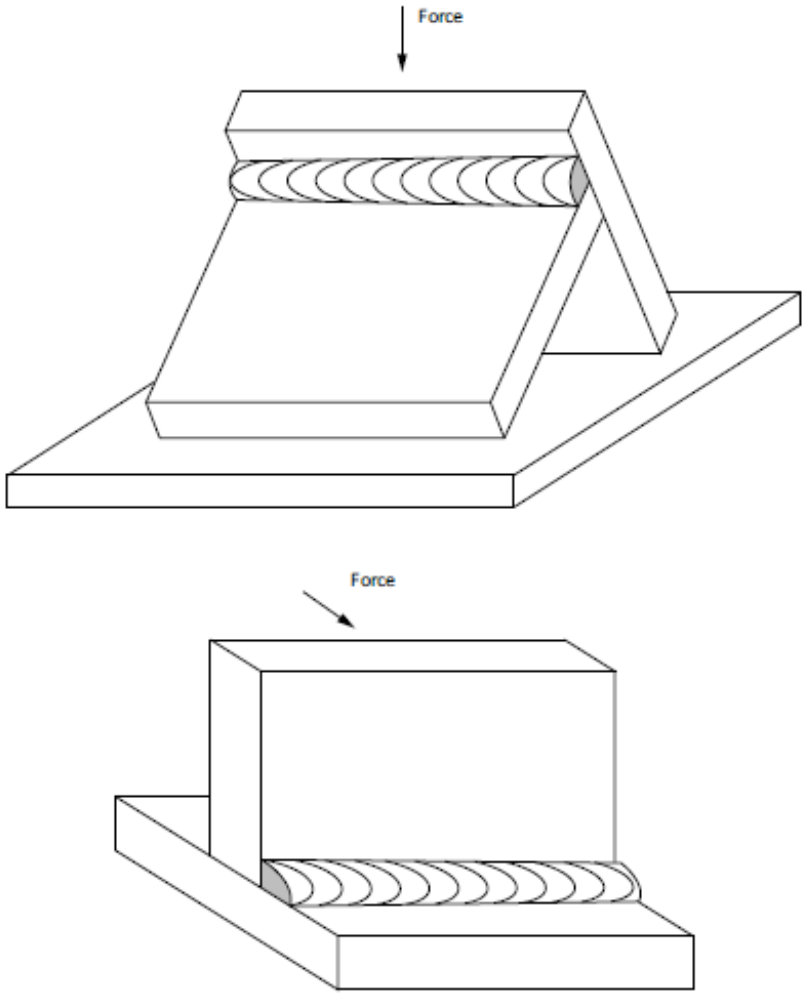
Fillet Weld Fracture Test

Method of rupturing test specimen — FW and WT classification



Limitations of visual inspection

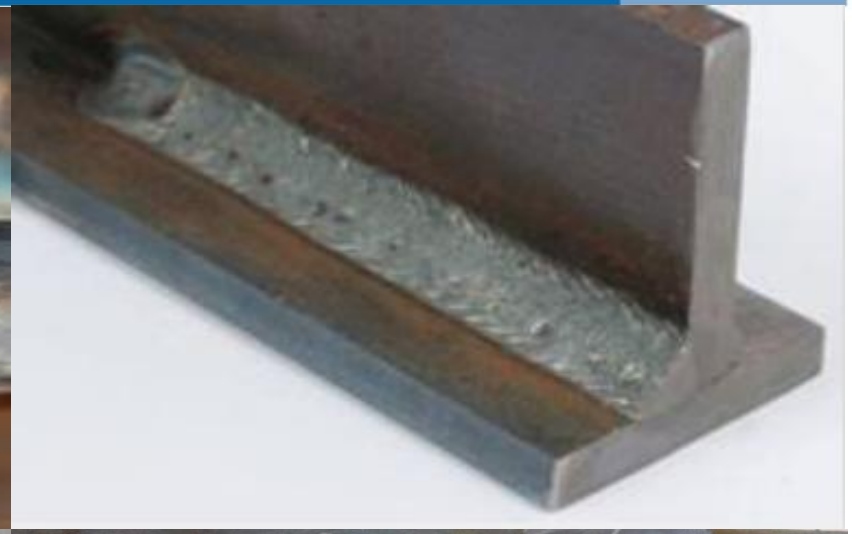
- *Each nondestructive examination method has inherent limitations in detecting flaws having specific locations and orientations. Users should become familiar with these limitations by consulting appropriate technical sources and/or certified welding inspection organizations*

- ***Visual Inspection***
  - *Only detect macroscopic surface discontinuities*
  - *Adequate lighting conditions are required*
  - *Vision strength, eye fatigue*
  - *All slag must be removed to avoid imperfections being obscured*
  - *Inadequate training and/or product knowledge, possible misinterpretation of flaws*
  - *Remote visual equipment may be required to access interior surfaces*
  - *Object's complex geometry may limit the inspection*
  - *Optical equipment needs to be placed at the adequate viewing angle*

Weld quality

- *Visually acceptable welds shall be **continuous and in line** where physically possible, and **free of defects** as per the applicable construction standard*
- *The **sizes and lengths** of welds shall be not less than those specified by design requirements and detail design documents, nor shall they be substantially in excess of those requirements.*
- ***Faces of fillet** welds may be slightly convex, flat, or slightly concave*
- *Deposited metal shall be **smooth and uniform** in cross section*
- *Ends of **butt welds** shall be of sound metal, finished smoothly and conforming to the cross section of the welded joint*
- *Weld beads shall **merge smoothly** with the base metal*
- *Some visual discontinuities are acceptable when the visual inspection evaluation determines that they are within the **acceptable tolerance** of the applicable construction standard. There are some differences for visual weld acceptance depending on the structure if Statically or Cyclically loaded*
- ***Incorrect weld profiles and surface appearance** - overlap, excessive convexity, excessive reinforcement, undercut, excessive concavity, misaligned beads*
- ***Fusion faults** - incomplete fusion (Lack of fusion) and incomplete penetration*

Acceptable Weld Quality



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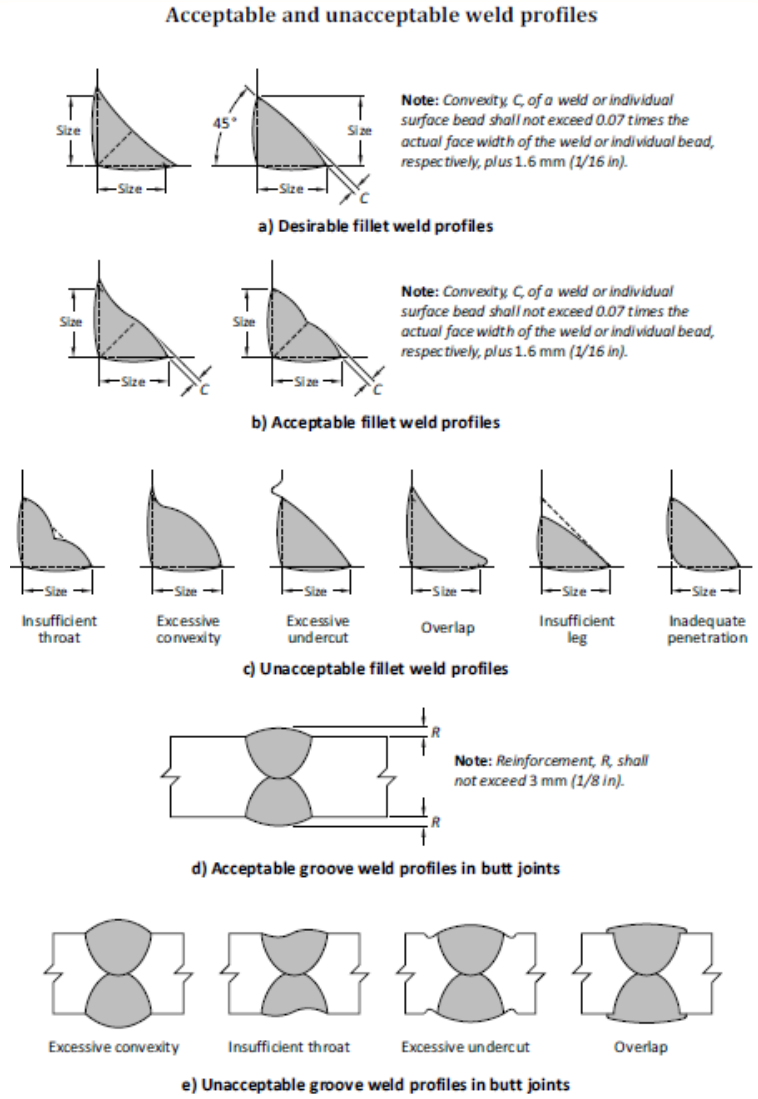
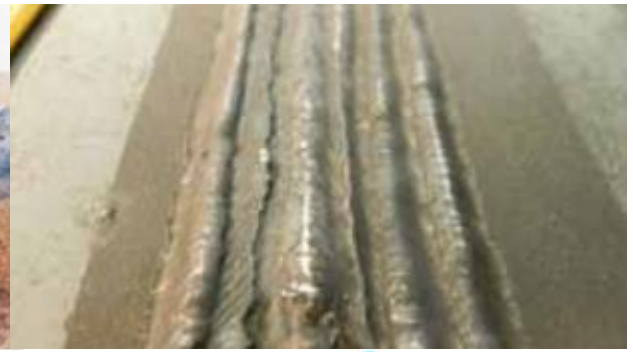
Incorrect Weld Profiles & Surface Appearance



- Cause: Improper welding technique, steep electrode angle, fast/slow travel speed, improper machine settings, faulty or wet electrodes and unsuitable base metal (e.g., high Sulphur) may cause similar defects
- Prevention: Proper welding technique
- Repair: Some can be removed and blend smoothly into the base metal



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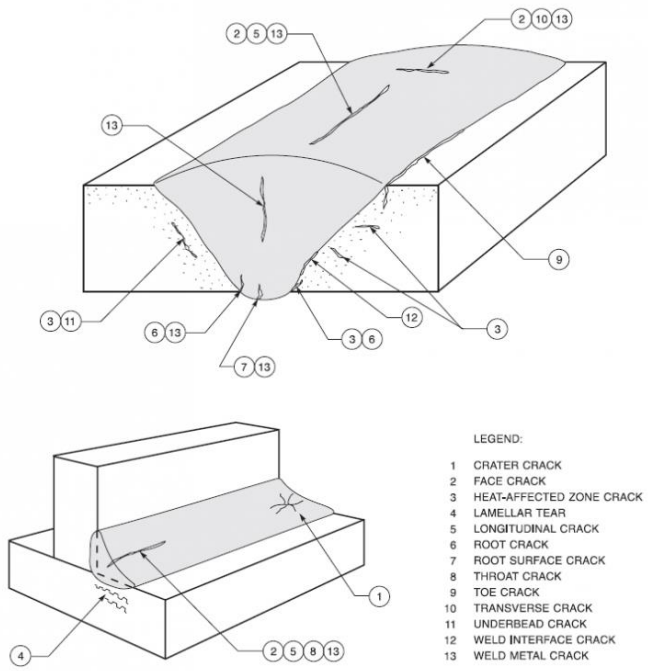
Cracks

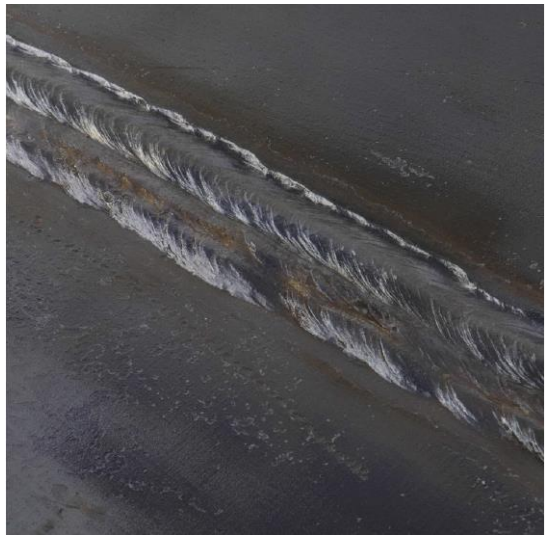
- *A tear, fracture or fissure in the weld or base metal appearing as a broken, jagged or straight line*

  - **Longitudinal Cracks**: Occurring along the weld direction
  - **Transverse cracks**: Occurring perpendicular to the weld direction
  - **Toe crack**: Occurring in the toe area of the weld
  - **Root Crack**: Appearing in the root area of the weld
  - **Crater Cracks**: Are shrinkage cracks that may occur in the crater of a weld bead. The improper filling of the crater causes this condition before raising the electrode away from the weld puddle, or by stopping the arc suddenly. This type of cracking occurs due to shrinkage of weld metal when solidified



Undercut

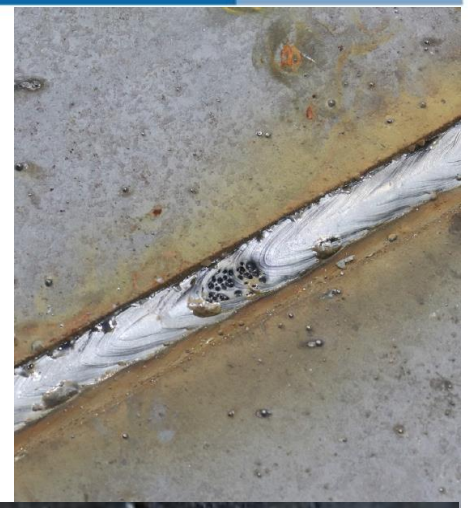
- *Term describes the melting away of the parent metal during the welding process*
- *Undercut will produce notches and result in stress risers which can be harmful under the load*
- *Limitations of undercut are specified in governing codes and standards (e.g., W59) and are based on the type of loading that the weld is subjected (static, dynamic/cyclic)*



- Cause: Incorrect electrode type or incorrect electrode size, incorrect voltage or amperage, incorrect electrode angle, long arc length, rust, incorrect joint preparation, joint accessibility and position - vertical up welding is more prone to undercut than welding in the flat position

- Repair: Weld with smaller electrode, sometimes must be low hydrogen with preheat

Surface Porosity



- *Gases dissolve into the molten metal causing voids within the solidified weld metal*

- Causes: Insufficient care in positioning the welding gun, long arc/incorrect restart technique, incorrect bead placement by the welder/operator, low amperage or short arc gap, contaminated filler metal, impurities in the base metal, incomplete or excessive shielding of the molten pool

- Prevention: Preheat will help eliminate. May need an electrode with more deoxidizers. Use run-on/ run—off tabs. Restart on top of previous weld and grind off lump

- Repair: Remove & reweld, being careful to completely remove the defective area

Arc Strikes

- Can arise from touching the welding area or outside of it with either the electrode holder or with the electrode

❖ *Creates a quenched and brittle condition on the base material that may create high static or normal fatigue stresses and may results in cracks*

- Repairs of arc strikes are specified in governing standards (e.g.W59) and are based on the type of loading that the weld is subjected (static, dynamic or cyclic)

Incomplete Fusion (Lack of fusion) and Incomplete Penetration

❖ *Lack of fusion is a discontinuity where the weld deposit has not melted into either of the base materials being joined or into previous weld passes. Fusion discontinuities can occur anywhere in the weld joint such as the root of the fillet weld or the side wall of the bevel groove*

- Cause: Improper electrode selection, insufficient amperage, steep electrode angle, fast travel speed, short arc length, gap, lack of preheat, electrode too small, contaminated base metal, arc off seam, poor joint preparation and fit-up, inadequate shielding

- Prevention: Eliminate the potential causes

- Repair: Remove & reweld, being careful to completely remove the defective area

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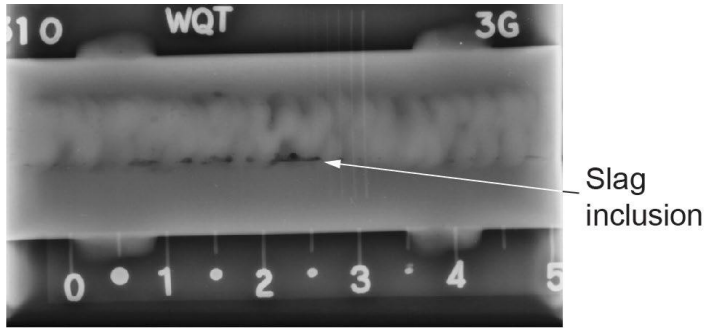
Slag Inclusion

- *Slag inclusions are oxides and other non-metallic solids that are sometimes found inside the weld. Slag inclusions are typically located at the edge of the underlying weld deposits*

- Cause: Low amperage, improper manipulation of the electrode, slow travel rate, improper interpass cleaning, undercut or other weld discontinuities from a previous weld pass

- Prevention: Increase amperage, increase travel rate
-
- Repair: Remove by grinding or other mechanical process



Underfill

- *Underfill is undersized welding making the total thickness of the weld less than the total thickness of the base material next to the weld*

- Cause: Improper welding techniques

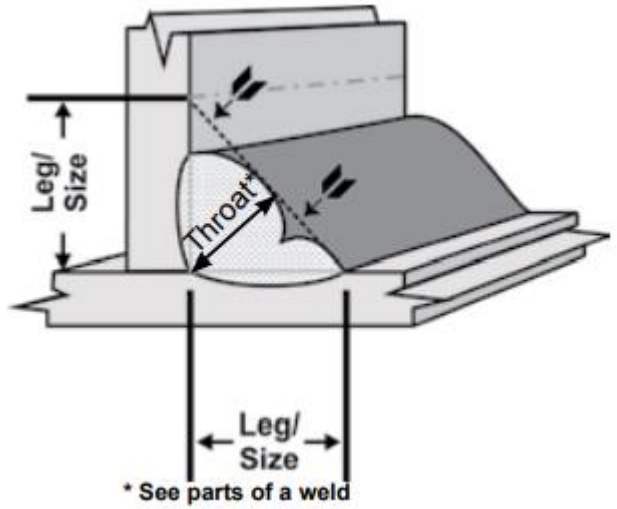
- Prevention: Apply proper welding techniques for the weld type & position. Use stripper beads before the cover pass

- Repair: Simply weld to fill. May require preparation by grinding

Undersized welds (Insufficient weld throat)

❖ *The cross section of the weld does not meet the requirement as defined by drawing and applicable standard*

- Cause: Improper welding techniques, electrode size or number of passes
- Prevention: Apply proper welding techniques for the weld type & position. Make sure the electrode size and number of required passes is correct
- Repair: Simply weld to gain proper size. May require preparation by grinding is correct



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Intermittent Stop-Starts

❖ *Are interruptions in continuous weld requirements*

- Cause: Cable hang up or lack of welder supervision
- Prevention: Keep work area clear, provide lots of cable slack and direct supervision of the welding machine
- Repair: Typically done by grinding or depositing additional weld metal and grinding flush

Excessive Spatter

- *Scattered droplets of molten metal produced during a welding process that spray or splash from the weld and arc onto the weldment*

- Cause: High arc power, magnetic arc blow, damp electrodes

- Prevention: Reduce arc power, reduce arc length, use dry electrodes

- Repair: Remove by mechanical means

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Additional Video/Literature of Interests

Certification

- CISC Certification Why is Certification Essential? Why Should it be Considered Mandatory? | CWB Group

Procedures

- WHAT ARE THE TOP FIVE CHALLENGES AND SOLUTIONS FOR REVIEWING WPSs? | CWB Group
- Why is Preheating Performed before Welding? | CWB Group
- Welding Procedure Fundamentals PowerPoint Presentation (cwbgroup.org)

Design

- Which Plate Thickness needs to be beveled for Welding? | CWB Group
- Designing and Calculating Weld Strength Capacity PowerPoint Presentation (cwbgroup.org)

Inspection/Quality Control

- Weld Magazine - Summer - 2018 - Independent Third-Party Welding Inspection A Canadian And Global Perspective
- A technical approach to assessment of weld faults Josh Brewster- Weld Ed Presentation (2019) (cwbgroup.org)
- so you want to be a welding inspector? (cwbgroup.org) & PowerPoint Presentation (cwbgroup.org)
- Structural Welding Inspection PowerPoint Presentation (cwbgroup.org)
- weldinginspectionprint.pdf (cwbgroup.org)
- Methods in Weld Quality Control Management Scurry: (cwbgroup.org) & PowerPoint Presentation (cwbgroup.org)
- Welding Inspection | CWB Group

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Weld Fundamentals

- What is the 'Heat Affected Zone' in welding and which types of Welding Processes produce less HAZ? | CWB Group
- Am I allowed to weld over paint? Or do I have to remove it? What about primers and paints that claim to be “weldable”? | CWB Group

Aluminum

- Lack of Fusion in Aluminum Welding gregdoria-aluminum-improvedfusionwadvancedwaveform.pdf (cwbgroup.org)
- Welding of Aluminum and Aluminum Alloys (cwbgroup.org)
- Working with Aluminum patrick_lapointe_walter_surface_technologies.pdf (cwbgroup.org) & Patrick Lapointe - Walter Surface Technologies (cwbgroup.org)
- StarGold Aluminum – Designed for high quality joining | CWB Group

Courses of Interests (Onsite custom courses may be available)

- Welding Fundamentals for Managers and Non-welding Personnel | CWB Group
- Intermediate Weld Discontinuities Methods - Aluminum | CWB Group
- Intermediate Weld Discontinuities Methods - Steel | CWB Group
- Introduction to Welding Processes | CWB Group

Welding Personnel Testing

Welder Testing Instructions

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FAQ

Inquiry:

Can Division 3 certified companies conduct welding activities on bridge and bridge services components?

Response:

As per CSA S6, only division 1 or 2 certified companies can conduct welding activities on bridge and bridge services components.

Specifications by the authority having jurisdiction and product standards supersede design codes and construction standards and may allow Division 3 certified companies to conduct welding activities on specific bridge service components. When multiple standards are referenced in the specification, if the superseding standard is lacking details, the AHJ may refer to the standard that includes the required details.

Inquiry:

Are other standards equivalent?

Response:

There are no domestic or international equivalents to CSA welding certification standards.

Other national systems, such as that of the American Welding Society (AWS), do not include key concepts of the CSA standards such as independent and on-going verification, witnessing of welders qualification, review, and acceptance of welding procedures, witnessing of procedure qualification testing, and qualification of welding supervisors and welding engineers.

The CWB strongly cautions specifiers and owners around accepting substitutions; doing so may contravene the intent of Canadian design and product standards and place public safety at risk.

Not sure? Call the CWB

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Inquiry:

What about Steel Fabricated outside of Canada?

Response:

Regardless of the country of manufacture, structural steel destined for Canada must comply to CSA Standards.

CWB certification is available to fabricators worldwide

Currently, 647 certified companies outside of Canada.

Inquiry:

The steel is erected and I just discovered the fabricator was not certified…

Response:

The design code for bridges, CSA S6, simply states that fabricators of welded components be certified to CSA W47.1.

It does not provide any specific guidance to rectify situations where this requirement is not followed.

Determination of the action required is up to the project owner and/or the authority having jurisdiction (e.g., MOTI , FLNRORD) based on their level of comfort with the risks related to non-compliance with the design code.

As the certification body for CSA W47.1, the CWB has no authority in this regard.

Some possible options include:

Remove and replace the structure with one fabricated by a company certified by the CWB to CSA W47.1

Require that CWB certification to CSA W47.1 be obtained by the fabricator of the welded component, prior to acceptance of the component.

This is not a solution CWB would recommend on its own, as this will not assess the prior competence of the fabricator (i.e., when the welding of the component took place).

Conduct visual and, if determined necessary, NDE inspection on the welded component.

Inquiry:

What should be the suggested wording for tenders and specifications?

Response:

There are many codes, standards and specifications with various design, certification, qualification, workmanship, and inspection requirements. Select Resource Library | CWB Group to view a list known to CWB for structural welding in Canada.

Various manufactured products from other countries for use in Canada must meet the requirements of the applicable CSA standards, but various CSA standards deliberately omit certain requirements details (I.e., the certification level and endorsement requirements of an inspector) or allow the use of non-CSA standards and qualifications. The intent is for the specifier (I.e., governing authorities, engineers, purchasers, …) to enhance the specification by including specific details to clarify the requirements applicable for the project.

Note: The requirements of a governing specification or specific product standards supersede the requirements of general design and construction standards.

Sample wording:

Design:

- Design fabrication and installation shall be in accordance with the governing specification and CSA S6 (latest edition) “Canadian highway bridge design code”.

Certification:

- Welding shall only be undertaken by a company Certified by the Canadian Welding Bureau (CWB) to the requirements of CSA Standard W47.1 (latest edition) “Certification of Companies for the Fusion Welding of Steel” in Division 1 or 2. Part of the work may be sublet to a Division 3 fabricator or erector; however, the Division 1 or 2 fabricator or erector shall retain responsibility for the sublet work.

Qualification:

- All welders employed by the certified company shall hold valid qualifications issued by the Canadian Welding Bureau for the material, process, and position in use.

Workmanship:

- All welding shall be done in accordance with and meet the quality requirements of CSA Standard W59 (latest edition) “Welded Steel Construction”.

Procedures:

- All welding shall be done in accordance with welding procedures approved by the Canadian Welding Bureau for the material, process, position, and joint configuration in use.

Contractor Inspection:

- The contractor (fabricator/manufacturer/erector) shall be responsible for visual inspection of all welds regardless of any additional inspection required in contract documents. Such inspection shall be carried out by the contractor’s inspection personnel.

- The contractor’s visual welding inspection personnel:
    - Shall be an individual deemed competent by the contractor. The required competency of personnel performing visual weld inspection tasks shall be defined and documented by the contractor based on their processes. Records of personnel competency shall be maintained by the contractor or
    - A Level 2 or 3 welding inspector certified in accordance with CSA W178.2, endorsed to W47.1/W59 or certified in conformance with the requirements of AWS QC1, endorsed to AWS D1.1 or D1.5. AWS inspectors shall have evidence of an eye exam showing 20/20 vision corrected or uncorrected within the last 2 years. Level 1 welding inspectors may independently perform welding inspection duties under appropriate qualified supervision as defined in W178.2.

Third Party Inspection:

- When required by contract, visual welding inspection shall be performed by either an individual welding inspector or a welding inspection organization.
    - Visual welding inspection personnel shall be performed by organizations certified to CSA W178.1 or
    - Except that visual welding inspection may also be performed by individuals certified to Level 2 or 3 of CSA W178.2, endorsed to W47.1/W59 or in conformance with the requirements of AWS QC1, Level 2 or 3, endorsed to AWS D1.1 or D1.5. AWS inspectors shall have evidence of an eye exam showing 20/20 vision corrected or uncorrected within the last 2 years. Level 1 welding inspectors may independently perform welding inspection duties under appropriate qualified supervision as defined in W178.2. or
    - Shall be suitably trained and experienced, to the satisfaction of the authority having jurisdiction or the engineer who acts as the designated representative of the regulatory authority.

Tenders:

Only tenders supplied with current copies of the CWB Letter of Validation will be accepted.

Warning:

Words strongly suggested not to use in place of certification and qualifications. These words implicate that CWB certification or qualification is not required, but the intent is the principal use of the standard.

- In compliance with
- In accordance with
- In agreement with
- Conforms with
- Adhere with
- Must follow
- Must meet
- Etc.

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The End Questions

ASK A QUESTION

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