

# THE OFFICE OF PUBLIC SAFETY

## CSA Welding Standards

BC Ministry of Forests, Lands and Natural Resource  
Operations – Engineering Branch  
February 2014

THE CWB GROUP - CANADIAN WELDING BUREAU





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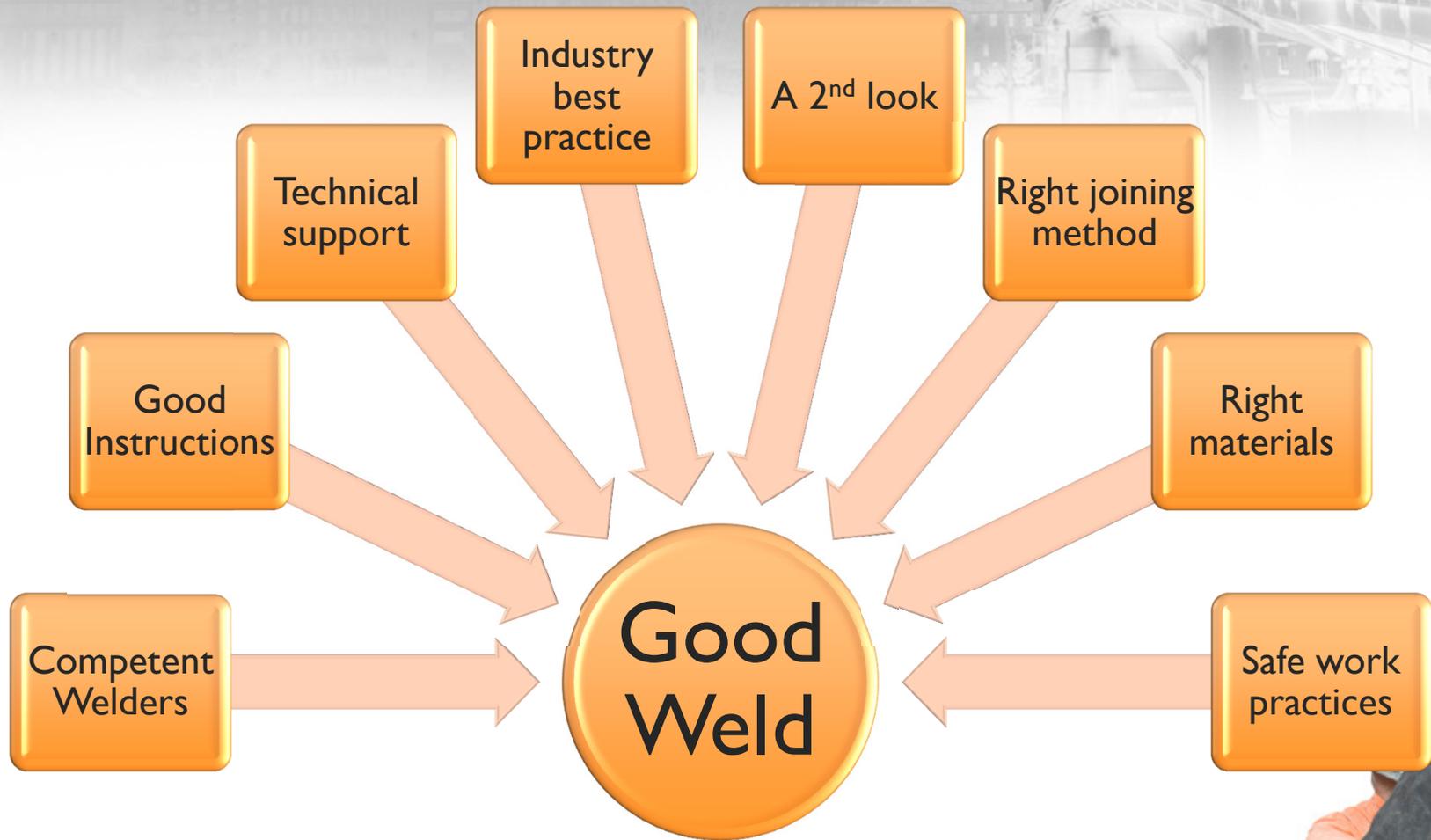
# Agenda

- An overview of Welding Standards
- What is the CWB and OPS?
- CSA Certification Programs
  - Companies, Type of Divisions
  - Inspectors and Inspection Organizations
  - Electrodes & Consumables
- CSA Fabrication Standards
- CSA Standard for Bridges and its connection to welding certification
- Electrodes, workmanship and technique
- Example of poor welds / defects
- Q&A



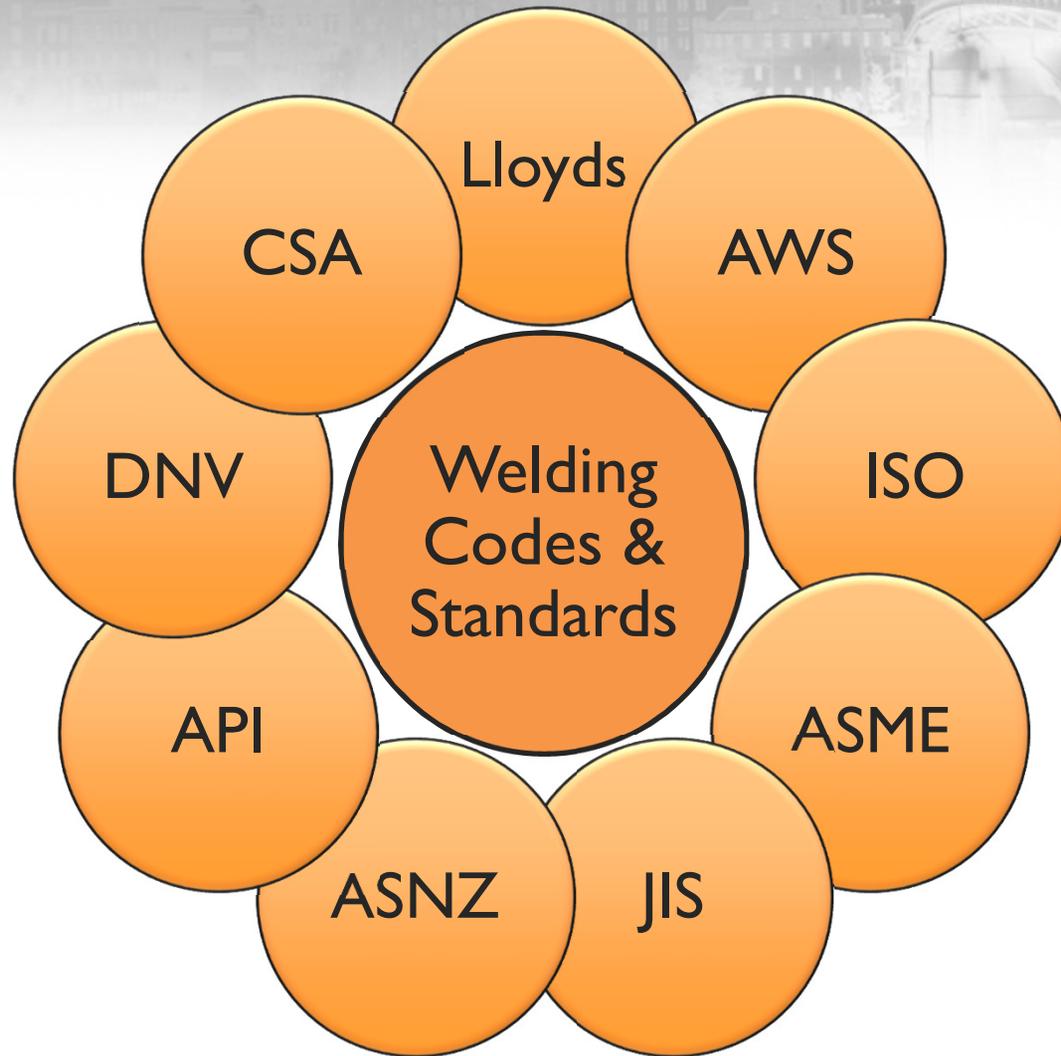


# What Makes a “Good” Weld?





# Welding Standards





# CSA Welding Standards

- The Canadian Standards Association (CSA) has a full suite of standards related to welding.
- These include standards for:
  - Qualifying welders & procedures
  - Welded fabrication & techniques
  - Weld design
  - Welding consumables
  - Welding inspection
  - Welding safety
- In addition, CSA has several standards that complement the welding standards:
  - Steel & aluminum design
  - Material designations / specifications





# CSA Welding Standards

- Qualifying welders & procedures
  - 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”
  - CSA W55.3 “Certification of companies for resistance welding of steel and aluminum”
- Welded fabrication & techniques / Weld Design
  - CSA W59 “Welded steel construction”
  - CSA W59.2 “Welded aluminum construction”





# CSA Welding Standards

- **Welding consumables**
  - CSA W48 “Filler Metals and Allied Materials for Metal Arc Welding”
- **Welding inspection**
  - CSA W178.1 “Certification of Welding Inspection Organizations”
  - CSA W187.2 “Certification of Welding Inspectors”
- **Welding safety**
  - CSA W117.2 “Safety in welding, cutting, and allied processes”





# CWB: History

- Created by CSA in 1947, the CWB provided, and continues to provide, stability in an industry where local, regional and industry rules made the safe and constant use of welding difficult.
- Under the Canadian Standards Association, the CWB administered the CSA company certification and welder qualification scheme across Canada as part of the National Building Code.
- In the early 1990's The CWB was spun off as a not-for-profit company -The CWB Group.
- Since that time the recognition and demand for welding certification in Canada has grown steadily

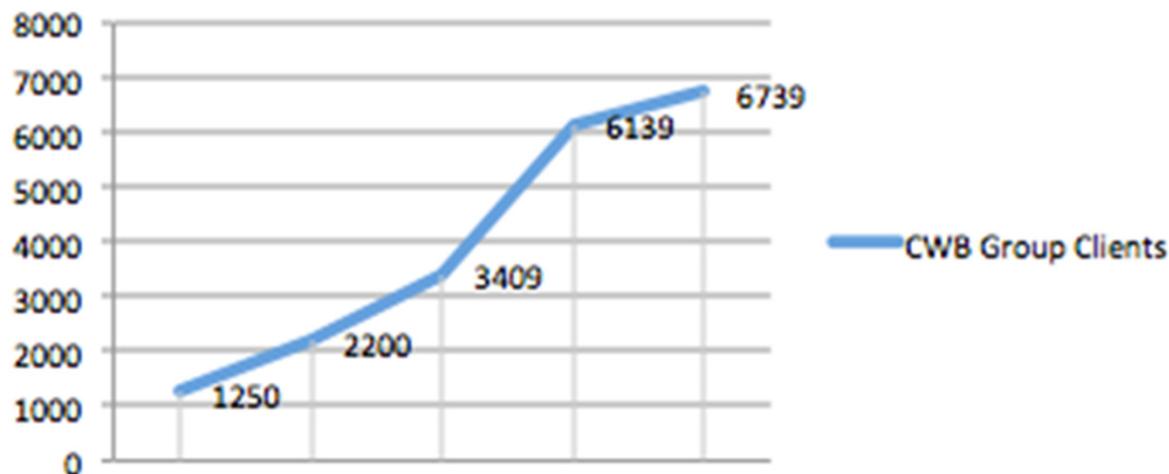
**The key role :The protection of public safety**





# CWB: An Overview

- Administrator of CSA and other standards
- A third party certification and auditing service provider
- A Standards Council of Canada (SCC) accredited certification body
- A private independent not-for-profit corporation
- Funded solely by industry from fees charged





# CWB: An Overview

- CWB Group – Canada’s largest welding services provider
  - Welding certification & services to over 7000 companies world-wide
  - Conduct over 11,000 field site audits annually
  - Witness approx. 90,000 on-site welder qualification test plates annually
  - Approve over 33,000 welding procedures annually
  - Responsible for the creation and administration of exams for all Welding Supervisors, Visual Inspectors and Welding Engineers within Canada
  - Provide Welder Supervisor and Visual Inspector training services
  - Provide non-destructive examination (NDE) training services
  - Deliver ISO and other quality systems registration/assessment services
  - Represent over 40,000 members through our membership association





# CWB: An Overview

- Internationally, the CWB represents the International Institute of Welding (IIW) as the:
  - Authorized National Body (ANB) in Canada
  - Authorized National Body for Company Certification (ANBCC) in Canada
- **We are Welding!**
  - 160+ staff in Canada and the world
    - 70% of staff are technical – most welding inspectors, welding technologists or welding engineers
  - Provides services in over 35 countries





# CWB Office of Public Safety: An Overview

- The Office of Public Safety was created 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

[www.weldquality.org](http://www.weldquality.org)





# CSA 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
  - Level playing field for industry
  - Independent oversight





# CSA Certification: Drivers

- CSA certification programs are driven by:
  - Mandatory requirements in design and product standards
  - Owner specifications
  - The need demonstrate due diligence / reduce risk
  - The desire to improve quality / lower rework





# CSA Certification: Fabricators

- 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”





# CSA Certification: Fabricators

- There are 4 key elements to a fabricator certification program:
  1. Qualified welders
  2. Qualified welding supervisor (s)
  3. Qualified welding engineer(s)
  4. Accepted welding procedures
- In practical terms, this means that a welding fabricator must have:
  - Competent people making the welds, who are...
    - Following proven and documented “recipes”, in a shop...
    - Overseen by competent “bosses”
- When all three are in place, high quality welds will result
  - Certification ensures these key elements are in place and working





# CSA W47.1: Steel Fabricators

## CSA W47.2: Aluminum Fabricators

- Fabricators can be certified to 1 of 3 “divisions”.

	Division 3	Division 2	Division 1
Qualified Welders	Yes	Yes	Yes
Qualified Welding Supervisor(s)	Yes	Yes	Yes
Qualified Welding Engineer(s)	No	Yes – Retained	Yes - Employed
Accepted Welding Procedures	Yes	Yes	Yes

- Unlike W47.1 and W47.2, W186 requires all fabricators to be certified in either Division 1 or Division 2.





# CSA W47.1 & CSA W47.2

- Fabricators must define the “scope” of their certification
  - Like any quality system, the work that falls within the control of the system must be clear to both the employees of the organization, the independent certification body and the customers
- This is done through a statement on a Fabricator’s certificate and made available to the public
- Examples:
  - *“Welding, fabrication, manufacturing for bridges.”*
  - *“Field welding fabrication, repairs and maintenance for the highways and bridges.”*
  - *“Welding and fabrication of steel buildings including miscellaneous work like handrail, stairs and platforms”*





# Requirement #1: Qualified Welders

- **Must pass a practical test**
  - For joint, positions and processes used
  - Witnessed by the CWB
- **Issued a Welder Card, or “Ticket”**
  - Valid for the certified company named on the ticket
  - Tickets transferable between certified companies
- **Use of Ticket**
  - Valid only while employed by a CWB certified company
  - Normally, valid only for 2 years

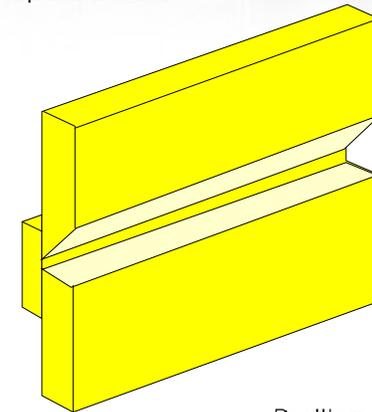




# Requirement #1: Qualified Welders

- Welders are tested for specific:
  - Welding processes
    - SMAW, FCAW, GMAW
  - Electrode type
    - Steel, stainless, aluminum
  - Welding position
    - Flat, horizontal, vertical, overhead
  - Welding joints / types
    - Fillets, grooves, backing/no backing, plate, tubular

Prepared Plate



Plates  
Vertical  
Axis of  
Weld  
Horizontal

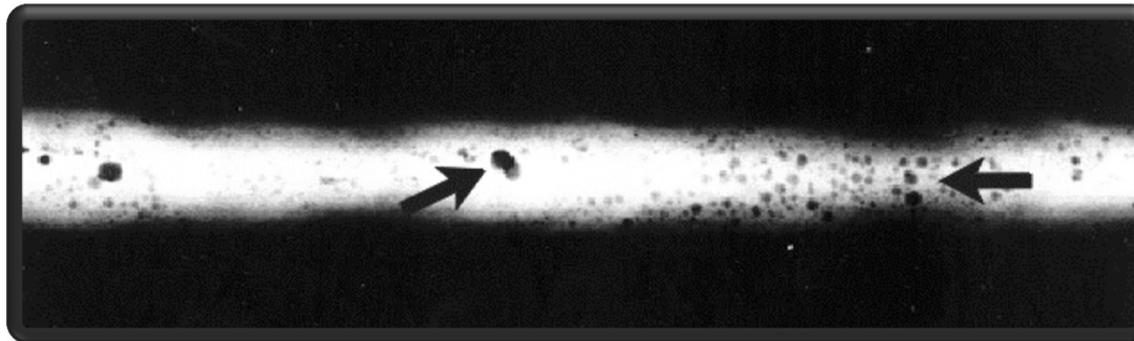
Position 2G





# Requirement #1: Qualified Welders

- Welders test are evaluated by either:
  1. Destructive tests
    - Bends, fracture, macro-etch
  2. Non-destructive tests
    - Radiography





# Requirement #1: Qualified Welders

**Welder Qualification**  
This card is valid only while employed by a CWB certified company

**Transferable Welder**

Name: **JOHN DOE** Exp. Date: **Oct 17, 2015**  
 Employer: **Kidd Operations, Timmins, ON**  
 Standard: **CSA W47.2-2011**  
 Process: **GMAW** Mode: **SEMI-AUTO**  
 Power Source: **Conventional & Pulsed**  
 Filler Alloy Group: **2**  
 Classification: **S**  
 Class: **FLAT**  
 Thickness Range: **1.5mm & above**

See Reverse for Conditions

**Welder Qualification**  
This card is valid only while employed by a CWB certified company

**Transferable Welder**

Name: **JOHN DOE** Exp. Date: **Oct 17, 2015**  
 Employer: **Rassaun Steel, Simcoe, ON**  
 Thickness Range: **3mm & above** Material: **Carbon Steel**  
 Process: **FCAW/MCAW**  
 Mode: **SEMI-AUTO** Standard: **CSA W47.1**  
**Single Electrode Mechanized** Classifier: **FW**  
**Single Electrode Automatic**  
 Class: **FLAT/HORIZONTAL**

See Reverse for Conditions

**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](http://www.cwbgroup.org)





## Requirement #2: Qualified Welding Supervisor(s)

- Employ at least one Welding Supervisor
- 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 are required
  - Minimum experience
    - 5 years of welding-related experience pertinent to the company's type of operations
- Key roles:
  - To ensure that welders are qualified
  - To ensure that welding procedures
  - To ensure visual weld quality requirements





# Requirement #3: Qualified Welding Engineer(s)

- Employ/Retain at least one Welding Engineer (Div. 1 or 2 only)
- Must demonstrate:
  - Minimum education/knowledge
    - Steel / aluminum, welding fundamentals, welding metallurgy, and welding procedures and practice.
    - Welding codes and standards
    - Examinations are required
  - Minimum experience
    - 5 years of welding-related experience
- Key roles:
  - Development of new welding procedures
  - Documentation related to welding procedures
  - Periodic review of overall welding operations





## Requirement #4: Qualified Welding Procedures

- A document of welding details & parameters; a “recipe” for welding
- Covers items such as:
  - base material
  - filler materials / electrodes
  - joint details: thickness, preparation, position
  - welding parameters, pass/layer sequence
  - preheat
- Are independently reviewed and accepted by the CWB against the requirements of the certification standard and governing standards
- In some cases are deemed to be “pre-qualified”, i.e. no qualification testing is required

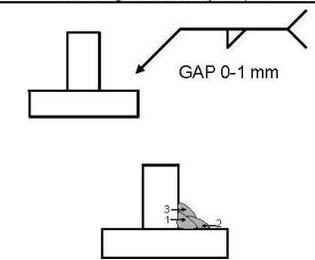




# Requirement #4: Qualified Welding Procedures

WELDING PROCEDURE DATA SHEET		WPDS NO.: GMAW-2F											
Company Name: Canadian Welding Bureau		DATE: 5/27/2008 Rev.: 0											
Address: 7250 West Credit Avenue, Mississauga, ON L5N 5N1		Ref. Standards: CSA W47.1/W59											
		Ref. WPS: GMAW-1											
Welding Processes: 1 GMAW Pulsed: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	2 Pulsed: <input type="checkbox"/> Yes <input type="checkbox"/> No												
Shielding Gas Type: 90%Ar/ 10% CO2													
Positions: Horizontal													
Process Mode: <input type="checkbox"/> Manual <input checked="" type="checkbox"/> Semi-Auto <input type="checkbox"/> Machine <input type="checkbox"/> Auto													
Joint Type: <input type="checkbox"/> Butt <input checked="" type="checkbox"/> Tee <input type="checkbox"/> Corner <input type="checkbox"/> Lap <input type="checkbox"/> Edge													
Penetration: <input type="checkbox"/> Complete <input type="checkbox"/> Partial ETT= <input type="checkbox"/> Fillet													
Backing: Material: N/A Thickness: <input type="text"/>													
Backgouging: <input type="checkbox"/> Yes Method: <input type="text"/> <input checked="" type="checkbox"/> No Depth: <input type="text"/>													
Electrode Extension: 20 mm													
Nozzle Diameter(s): 16 mm													
Flux Classification: N/A													
Tungsten Electrode: Type: N/A Dia.: <input type="text"/>													
Cleaning Procedures: Wire brush, clean between passes													
CSA W186 Rebar Splice Type: <input type="checkbox"/> Direct Splice <input type="checkbox"/> Indirect Splice <input type="checkbox"/> Lap Splice <input type="checkbox"/> Rebar to Structural Member Only													
Identification of Base Material (for CSA W186 indicate carbon equivalent, max. phosphorus & sulphur content)													
Part	Specification & Grade	Thickness or Dia. Special Requirements											
I	ASTM A36, A516 Gr. 70 G40.21Gr. 300W, 350 W	6-10 mm N/A											
II	ASTM A36, A516 Gr. 70 G40.21Gr. 300W, 350 W	6-10 mm N/A											
Identification of Filler Material													
Process	Trade Name	Classification Group Filler Treatment											
GMAW	N/A	E6.4.3 A 3 C G6 (ER49S-6) N/A Cl. 5.2.4.5, CSA W59											
Welding Parameters													
Thickness (mm)	Weld Size/ ETT	Layer	Pass Number	Welding Process	Welding Speed (mm/min)	Wire Feed Speed (mm/min)	Current A	Volt V	Current Polarity	Welding Speed (mm/min)	Burn-Off Rate (mm/min)	Gas Flow Rate (l/min)	Heat Input (kJ/in)
6		1	1	GMAW	1.2	10.0	260	28	DC+	400-500		20	
8		1	1	GMAW	1.2	10.0	260	28	DC+	300-400		20	
10		1	1	GMAW	1.2	10.0	260	28	DC+	400-500		20	
		2	2-3	GMAW	1.2	10.0	260	28	DC+	400-500		20	
Heat treatment:			CWB Acceptance			Company Authorization							
Preheat min.: 10° C Interpasstemp. max.: 250° C						To be signed by the engineer or supervisor before submission to the CWB							
Interpasstemp. min.: 10° C													
In accordance with Table 5-3, CSA Standard W59						Date: 5/27/2008							

SAMPLE





# Maintaining CWB Certification

- 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 product(s)
    - Ensure any CWB “scope” work subcontracted to a CWB certified company
- The CWB audits each company every 6 months
- Costs:
  - \$1500 - \$1900/ year





# How can I verify CWB Certification?

- Verify company status on CWB website
  - [www.cwbweb.org](http://www.cwbweb.org)
- Ask fabricator for current **Letter of Validation**
  - Annual letter given to certified clients
  - Verify dates
  - Verify scope of operations.
- Call the CWB
  - 1-800-844-6790





# How can I verify CWB Certification?



The CWB acknowledges that

**ABC Welding Company**

123 Main Street, Anytown, ON L7G 4C1

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

**"Certification of Companies for Fusion Welding of Steel"**

in **DIVISION 2**

for the period **April 14, 2011** to **May 21, 2012**

**Company Code: ABCDE1**

Scope: The welding and fabrication of structural steel and its components.

Registrar



8260 Parkhill Drive, Milton, Ontario L9T 5V7  
1-800-844-6790 | Int: 905-542-1312 | Fax: 905-542-1318  
Email: [info@cwbgroupp.org](mailto:info@cwbgroupp.org) | Web: [www.cwbgroupp.org](http://www.cwbgroupp.org)





# CSA Certification: Welding Inspection

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





# CSA Certification: Welding Inspection

- CSA WI78.1 “Certification of Welding Inspection Organizations”
  - Covers organizations that provide welding inspection services
- Key requirements:
  - Inspection must be conducted by competent, certified individuals
    - Both visual welding inspectors and NDE (e.g. ultrasonic, radiography personnel)
  - Inspection operations must be overseen by competent, qualified individual(s) (*known as the Welding Inspector Supervisor*)
  - Inspection must follow inspection procedures for each of the product categories included in the scope of operations.
    - independently reviewed and approved by the CWB
  - Formal inspection reports must be documented
  - Must demonstrate ongoing compliance
    - annual audit by the CWB.





# CSA Certification: Welding Inspection

- Welding Inspection Organizations must define their scope of work by defining:

## 1. The inspection methods that they use

Visual (VT)

Radiographic (RT)

Ultrasonic (UT)

Magnetic Particle (MPI)

Liquid Penetrant (LPI)

Eddy Current (EC)

Mechanical

Metallographic

## 2. The product categories which they inspect

Buildings & Bridges

Pipelines

Storage Tanks

Industrial Pipe

Mobile Drilling Units

Steel Fixed Offshore Structures

Industrial Structures,  
Machinery, Cranes

Pressure Vessels, Heat  
Exchangers, Boilers

Ships & Floating Marine Structures

- The competence of their staff (i.e. inspectors) and their procedures are assessed against this scope





# CSA Certification: Welding Inspection

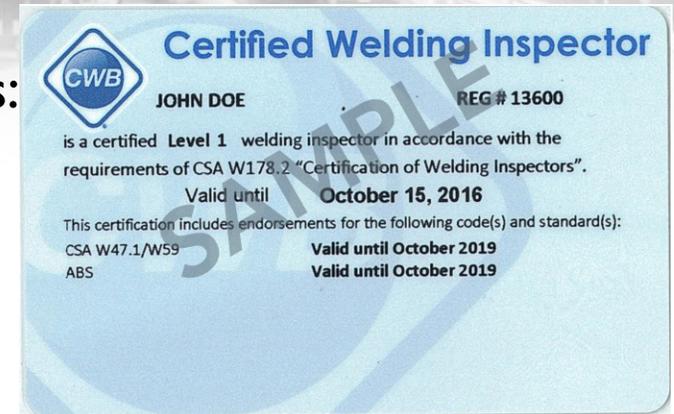
- CSA W178.2 “Certification of Welding Inspectors”
  - Covers individuals that conduct welding inspection
- Key requirements:
  - Individuals must meet a minimum number of years of experience
  - Individuals must demonstrate specific technical knowledge:
    - welding fundamentals, welding inspection, and welding metallurgy
    - practical evaluation techniques
    - written and practical examinations
  - Individuals must meet minimum vision requirements
  - Must demonstrate ongoing compliance
    - involvement in welding inspection activities
    - understanding of current product standard requirements
    - ability to meet vision requirements





# CSA Certification: Welding Inspection

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



- All levels can conduct inspection and document results
- Level 2 is considered the first level where fully independent work can be done
- At Level 3, additional duties are typically added such as:
  - interpreting specifications and codes, preparing welding inspection procedures, and implementing quality assurance and control programs
  - reviewing contractors' inspection and test plans





# CSA Certification: Electrodes & Filler Metals

- Electrodes / filler metals are critical components in making a weld
- 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





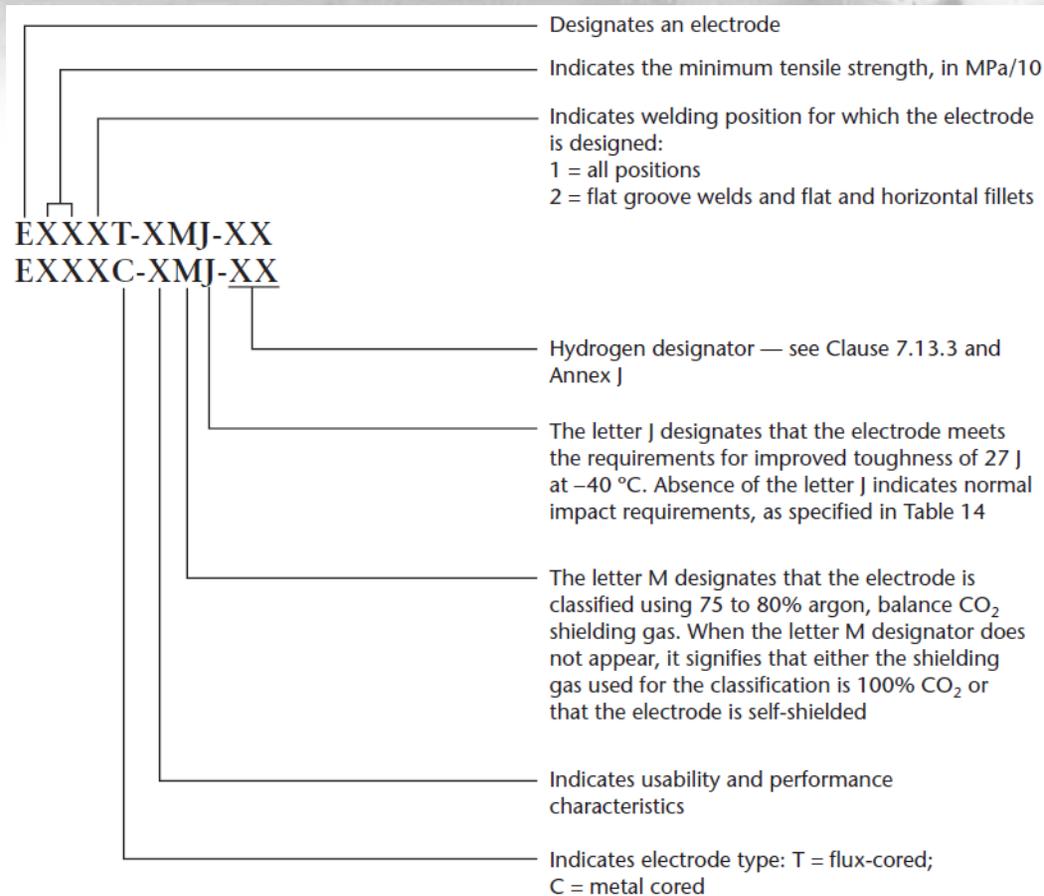
# CSA Certification: Electrodes & Filler Metals

- The objectives are to ensure that electrodes/filler metals are:
  - Manufactured with defined properties
  - Manufactured consistently
  - Be easily identifiable
- Manufactures must demonstrated ongoing compliance through:
  - Retesting of product every 2 years
  - Independent audit of manufacturing processes every 2 years





# CSA Certification: Electrodes & Filler Metals



**Figure C.1**  
**Method of classification for carbon steel electrodes for flux- and metal-cored arc welding**





# CSA Fabrication Standards

- The CSA “certification” type standards are only half of the complete picture.
- CSA “fabrication” standards are also critical in the overall welding operation.

<b>Certification</b>	<b>Fabrication</b>
Welders	Base materials
Welding procedures	Weld design
Welding supervisors	Welding processes
Welding engineers	Material preparation
Welding inspectors	Joint fit up
Welding electrodes	Preheat
Welding fabricators	Weld quality
	Inspection levels





# CSA Fabrication Standards

- The 3 primary fabrication standards are:
  - CSA W59 “Welded steel construction”
  - CSA W59.2 “Welded aluminum construction”
  - CSA W186 “Welding of Reinforcing bars for reinforced concrete constructions”
- All three are similar in the subject areas covered.
- These cover all the “science” 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 levels
  - Inspection technique and acceptance criteria





# CSA Standard S6 “Canadian Highway Bridge Design Code”

- 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 Standard S6 “Canadian Highway Bridge Design Code”

- **10.24.5.5 Certification of fabrication companies:** “Any company undertaking welded fabrication in accordance with this Section shall be certified to Division 1 or 2 of CSA Standard W47.1.”
- **10.24.8.1 Qualification of inspectors:** “Welding inspectors shall be qualified by the CWB to the requirements of CSA Standard W178.2.”
- **10.24.10.8 Field Welding:** “Any company undertaking field welding in accordance with this Section shall be certified to Division 1 or 2 of CSA Standard W47.1.”





# CSA Standard S6 “Canadian Highway Bridge Design Code”

- **10.24.3.3 Electrodes:** “The selection, supply, and storage of electrodes and fluxes shall be in accordance with Clause 5 of CSA Standard W59.”
- **10.24.3.4 Shear connectors:** “Shear connectors shall be of a headed stud type in accordance with Appendix H of CSA Standard W59.”
- **10.24.5 Welded construction:** “All welding procedures, including those related to quality of work, techniques, repairs, and qualifications, shall comply with CSA Standard W59. The electroslag and electrogas welding processes specified in Clause 5 of CSA Standard W59 shall not be used for welding quenched and tempered steels or for welding components of members subject to tension stress or stress reversal.”





# CSA Standard S6 “Canadian Highway Bridge Design Code”

- **10.4.6 Welding electrodes:** “Welding electrodes, electrode/gas, or electrode/flux combinations shall be low hydrogen (i.e., a level of H16 or less) and shall comply with CSA W47.1, CAN/CSA-W48, and CSA W59. Welding consumables with Charpy V-notch toughness requirements in compliance with Tables 10.14 A and 10.14 B, as applicable, and certified by the Canadian Welding Bureau to CAN/CSA-W48 shall be used. In the absence of an applicable CAN/CSA-W48 requirement, the applicable Standard(s) in the American Welding Society A5 series of Standards shall be used.”





# CSA Standard W59 requirements for electrodes, workmanship and technique

## **General:**

- *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 welds shall not exceed nor be less than those specified by design requirements and detail drawings without approval of the Engineer.*
- *The location of welds shall not be changed without approval of the Engineer.*





# CSA Standard W59 requirements for electrodes

## **Electrodes:**

- *The electrode classifications used in this Standard 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 5.3 provides requirements for selection of the hydrogen level for electrodes to be used in accordance to the base material that has to be welded.*
- *Table 5.3 provides the minimum preheat and interpass temperature for base material to be welded.*





# CSA Standard W59 requirements for electrodes

## **Electrodes:**

- *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 and A588 steels.*
- *All low-hydrogen electrodes shall be delivered in sealed containers or shall be reconditioned:*
  - (a) Carbon steel electrodes shall be baked for at least 2 h at a temperature between 230 ° C (450 ° F) and 260 ° C (500 ° F) before being used.*
  - (b) Low-alloy steel electrodes shall be baked for at least 1 h at a temperature between 370 ° C (700 ° F) and 430 ° C (800 ° F).*





# CSA Standard W59 requirements for electrodes

## **Electrodes:**

*(c) Alternative baking temperatures for low-hydrogen electrodes may be used if such procedures have been developed and are recommended by the manufacturer; the use of these alternative procedures shall be approved by the Engineer.*

- 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  $120^{\circ}\text{C}$  ( $250^{\circ}\text{F}$ ).*
- Low-hydrogen electrodes of the E49 classification that are not used within 4 h after removal from ovens shall be reconditioned.*





# CSA Standard W59 requirements for workmanship and technique

## ***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 shop primer is acceptable if it conforms to the primer recommended by the Standard or as accepted by the Contractor's Engineer; but the primer has been applied in a single coat to a maximum thickness of 100 microns (4 mils) dry film thickness in the welding area.*





# CSA Standard W59 requirements for workmanship and technique

## *Preparation of material:*

- *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.*
- *Oxygen-fuel gouging shall not be used on quenched and tempered steels.*
- *The standard also provides limitations on roughness and notch requirements*
- *Deeper notches may be repaired by welding when approved by the Contractor's Engineer. Such weld repairs shall be made by suitably preparing the defective area, welding with low-hydrogen electrodes to an approved procedure, and grinding the completed weld smooth and flush with the adjacent surface to produce a competent finish.*





# CSA Standard W59 requirements for workmanship and technique

## *Preparation of material:*

- *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.*
- *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.*





# Examples of poor welds / defects

- 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 or cyclic).



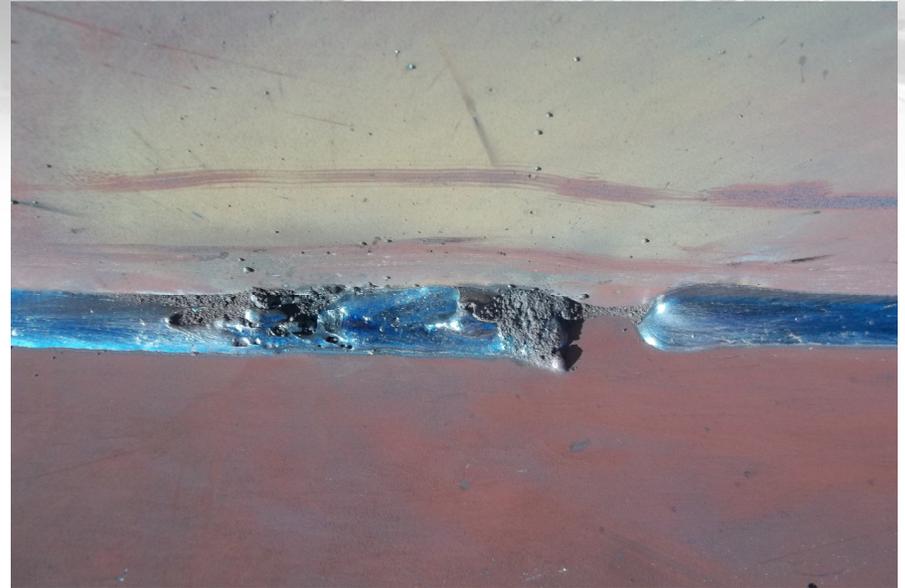


# Examples of poor welds / defects



Incorrect profile and out of line weld

- Insufficient care in positioning the welding gun or the automatic machine
- Incorrect bead placement by the welder / operator



Intermittent weld and severe surface porosity





# Examples of poor welds / defects

- Arc Strikes can arise from touching the welding area or outside of it with either the electrode holder or with the electrode.
- It creates a quenched and brittle condition on the base material that may create high static or normal fatigue stresses.
- 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).





# Examples of poor welds / defects

- Unsatisfactory surface appearance and improper bead profile
- Incorrect technique and improper machine settings
- Faulty or wet electrodes and unsuitable base metal (e.g. high sulphur) may cause similar defects





# Examples of poor welds / defects

Some types of faults that can be visible on the surface of the weld:

- Incorrect weld profiles: overlap, excessive convexity, excessive reinforcement, undercut, excessive concavity, out of line beads
- Fusion faults: incomplete fusion (Lack of fusion) and incomplete penetration
- Cracking: transverse crack in the weld, transvers crack in the HAZ, toe crack, weld metal crack, root crack, crater crack
- Surface irregularities: badly shaped ripples, spatters, arc strikes





# Q & A

