THE OFFICE OF PUBLICSAFETY

Structural Welding Requirements and the Building Official

May 2015

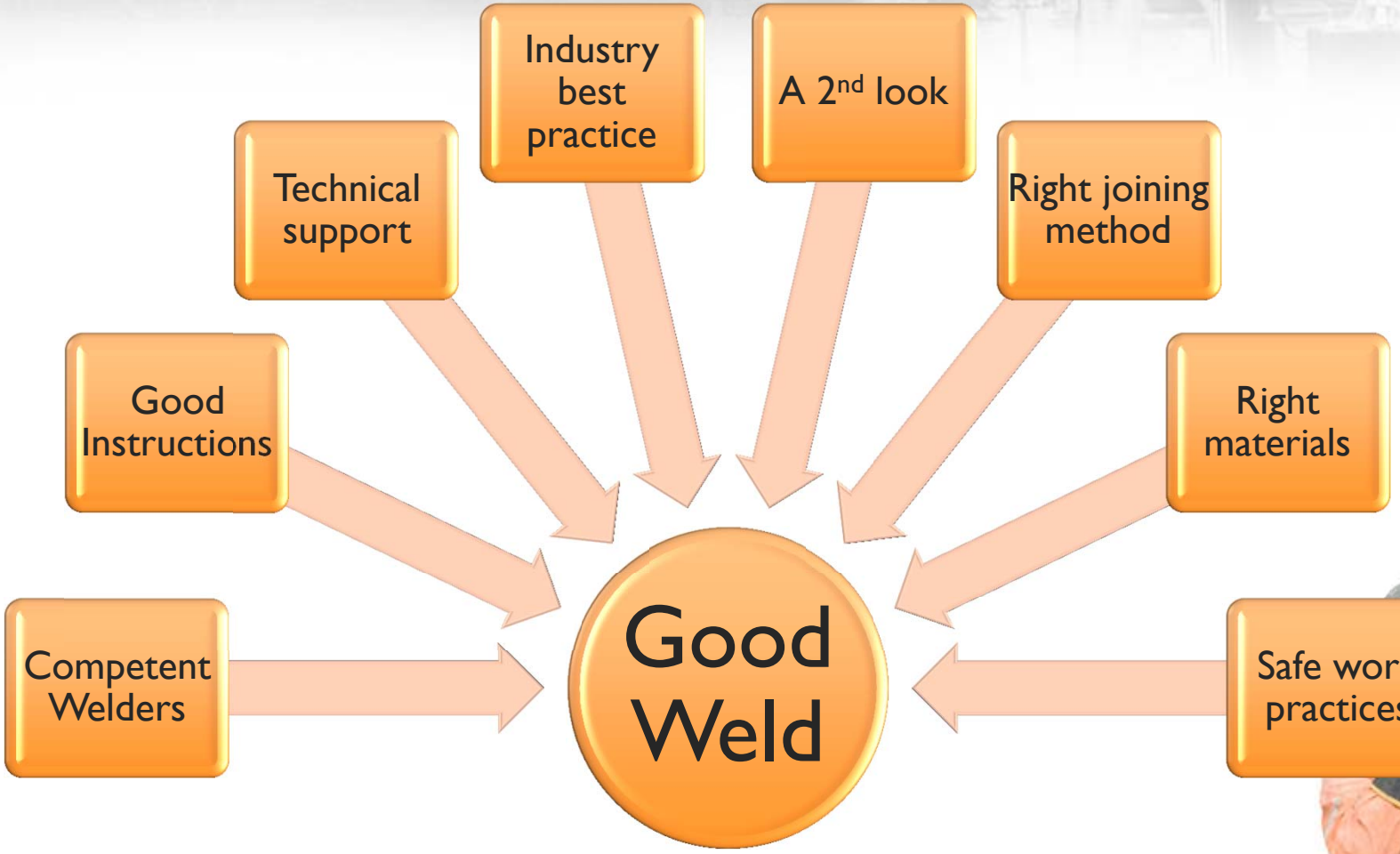
THE CWB GROUP - CANADIAN WELDING BUREAU

CWB

Agenda

- What Makes a Good Weld?
- What is the CWB?
- Structural Steel Requirements
  - CWB Certification
- Pre Engineered Building Requirements
  - A660 Certification
- How to verify Certification
- Common Questions

What Makes a "Good" Weld?



CSA Welding Standards

- Qualifying fabricators, 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"

The Safety of the Public

Column base

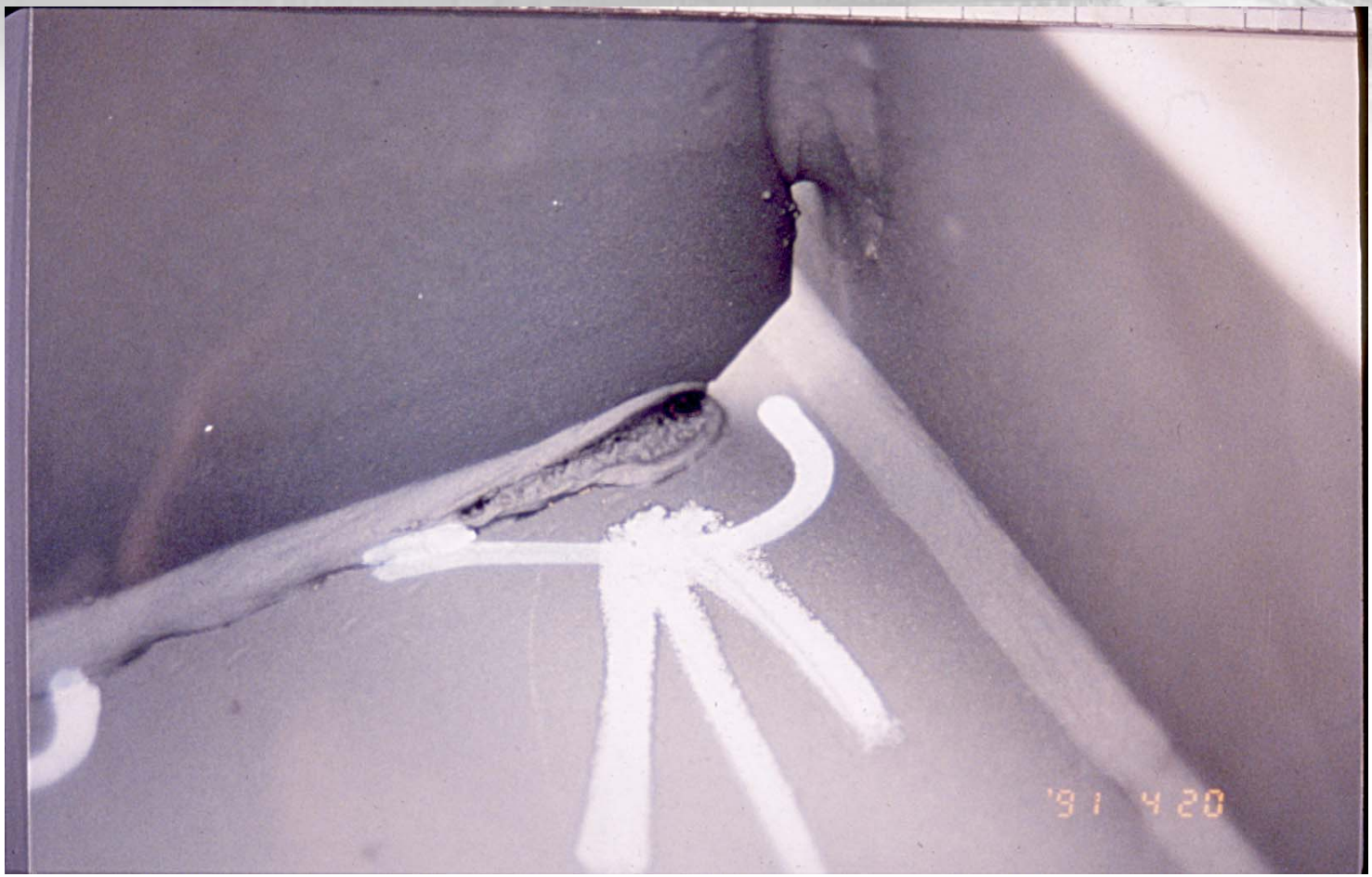
The Safety of the Public

Column base

The Safety of the Public

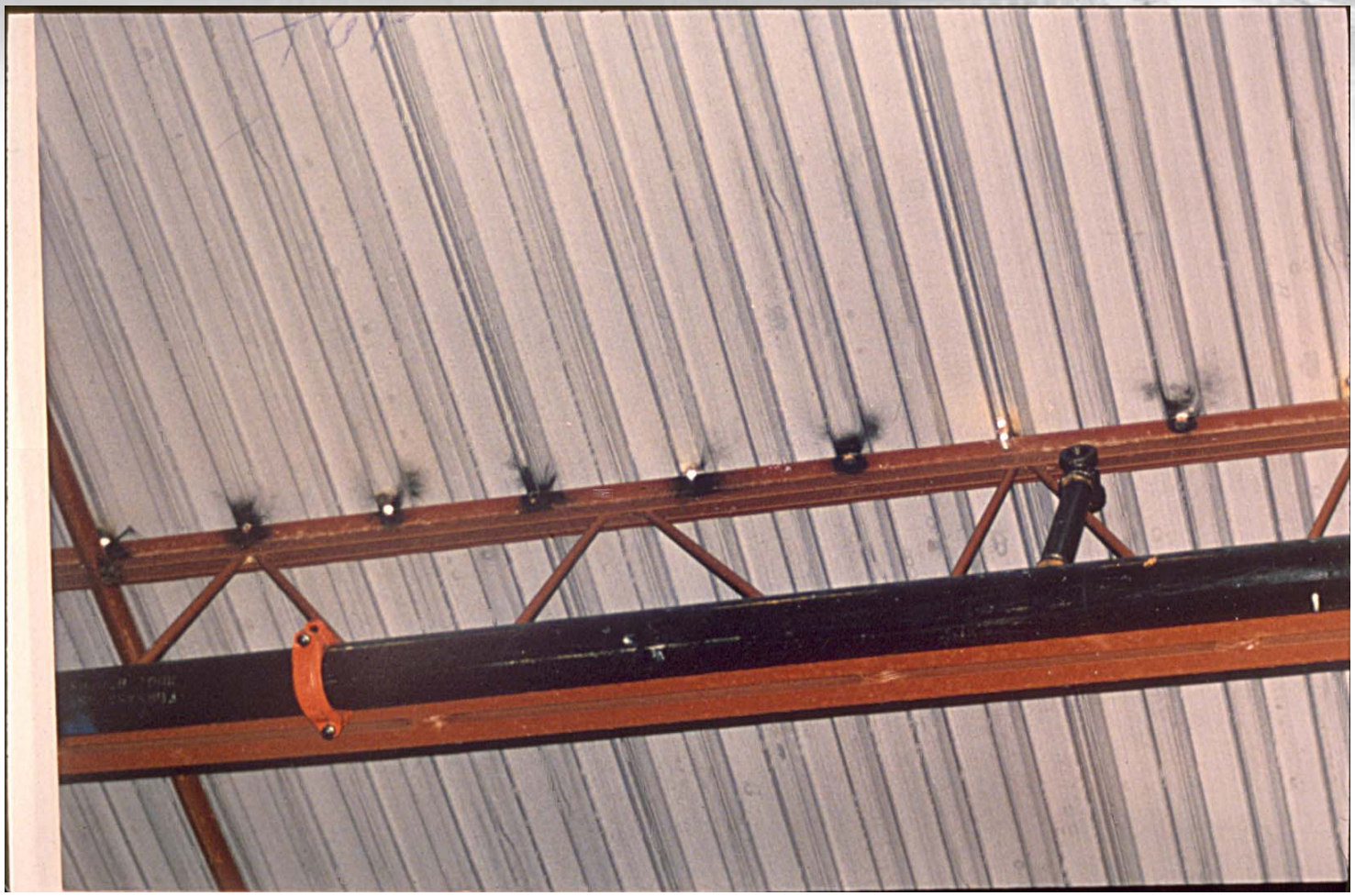
Beam too short

The Safety of the Public



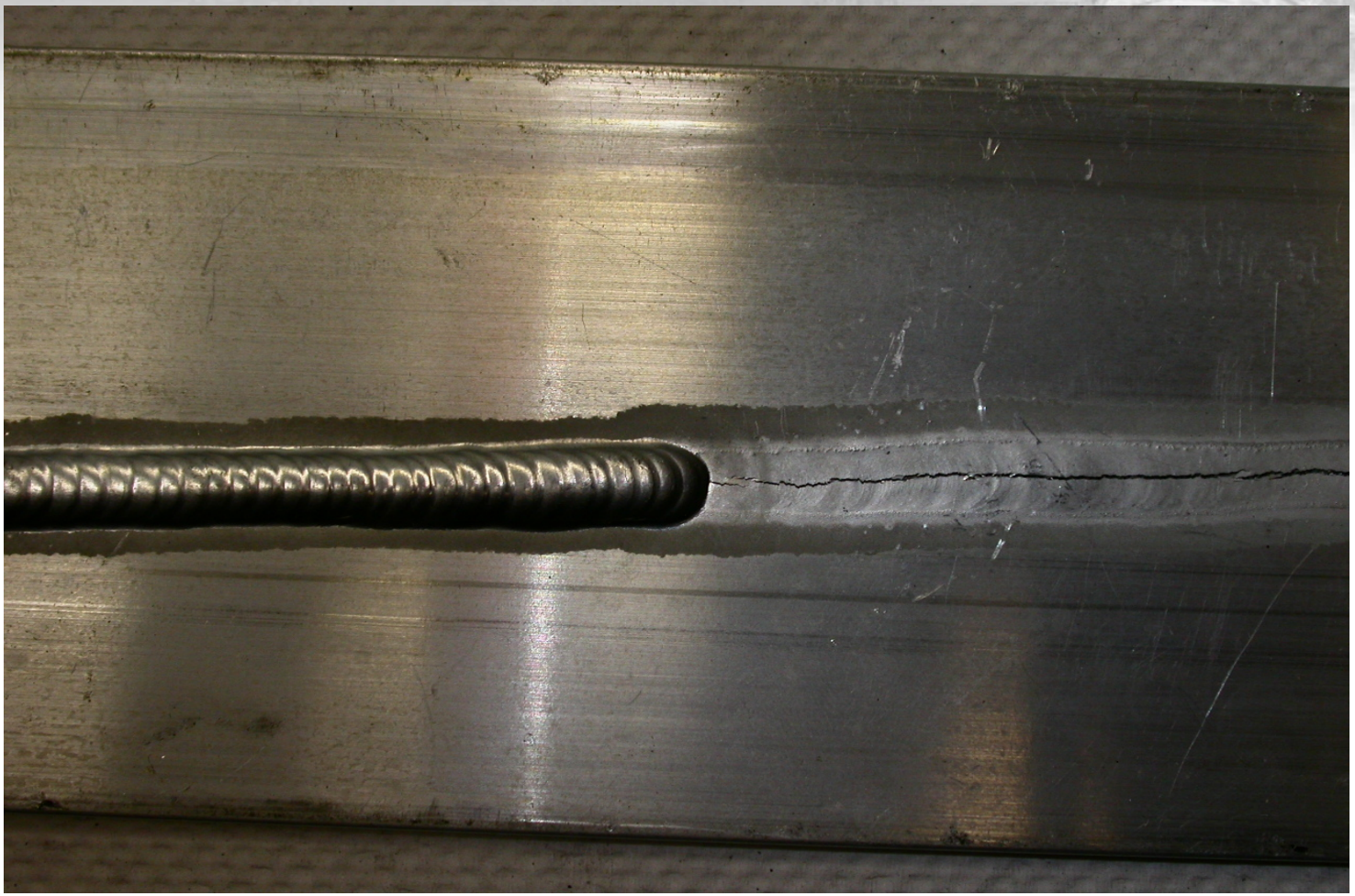
Weld crater

The Safety of the Public



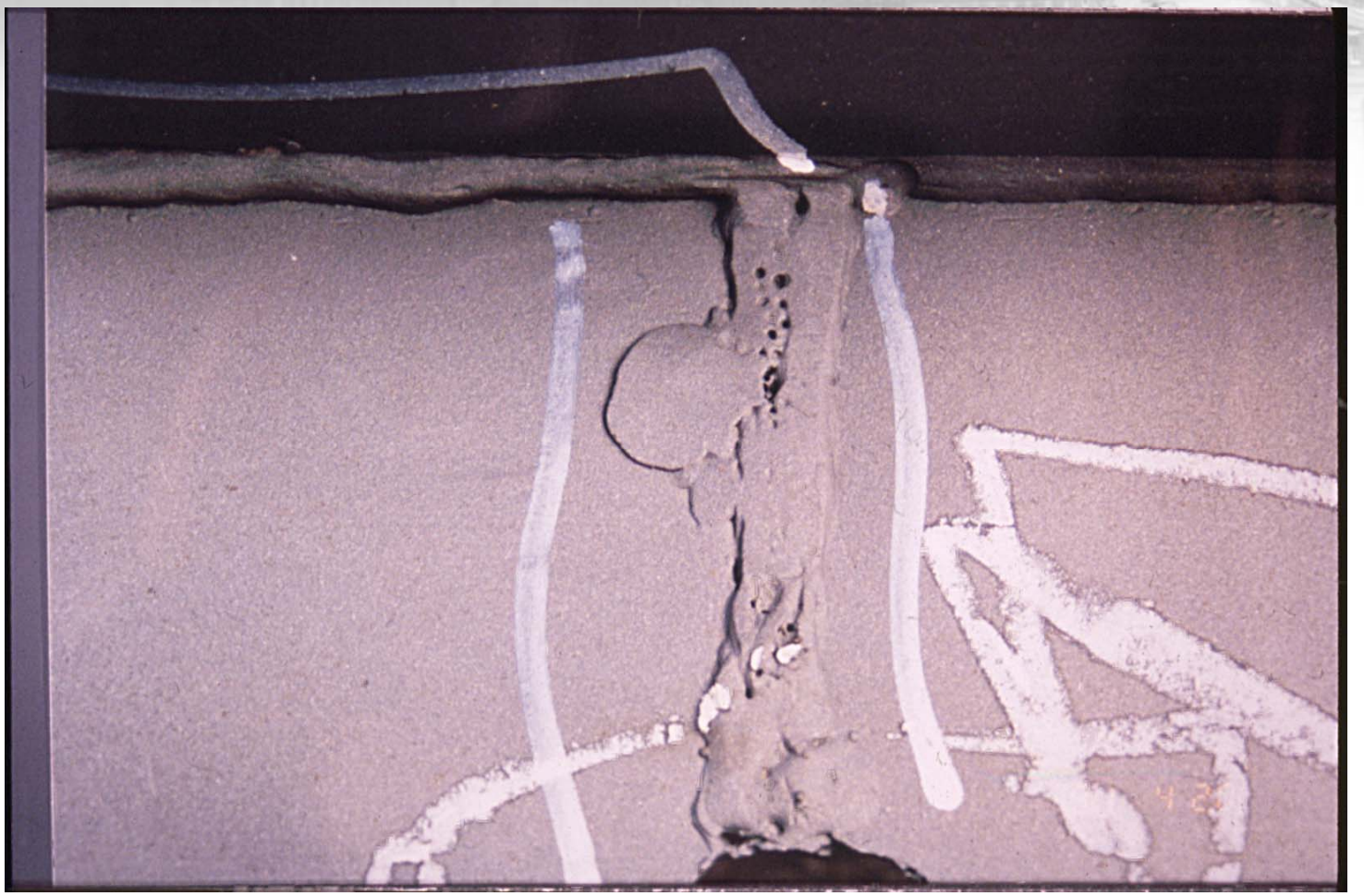
Damaged joist / deck

The Safety of the Public



Weld crack in aluminum

The Safety of the Public



Just plain bad…..

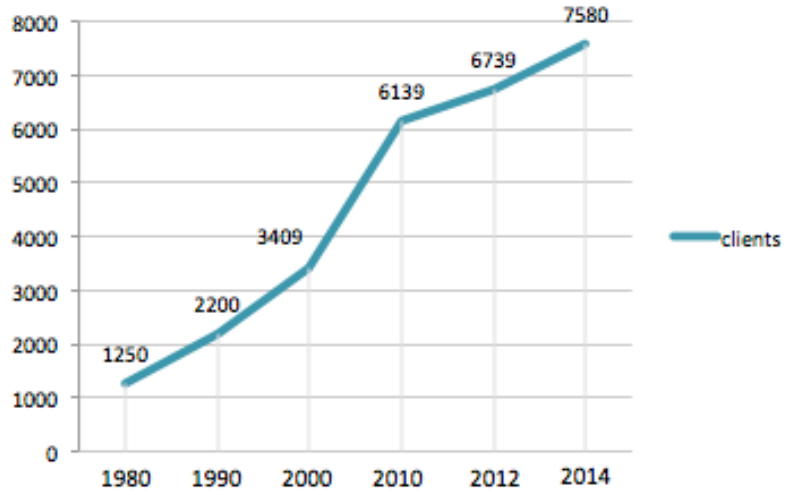
CWB: History

- 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



Certification References

STEEL BUILDING SYSTEMS

National & Provincial Building Codes-

Section 4.3.4.3

Steel Building Systems

"Steel building systems shall be manufactured by companies certified in accordance with the requirements of CSA A660, 'Certification of Manufacturers of Steel Building Systems' "

- **CSA A660** Certification of Manufacturers of Steel Building Systems

STRUCTURAL STEEL

National & Provincial Building Codes-

Section 4.3.4.1

Design Basis for Structural Steel

"Buildings and their structural members made of structural steel shall conform to CAN/CSA S16-09, Design of Steel ' Structures "

- **CAN/CSA S16-09** Design of Steel Structures
  - **Clause 16.5.16** Welding Open Web Steel Joists
  - **Clause 16.8.5** Installation of Steel Deck
  - **Clause 24.3** Fabricator and Erector Qualification
  - **Clause 24.2** Resistance Welding
  - **Clause 28.7** Steel Building Systems
    - **CSA A660** Certification of Manufacturers of Steel Building Systems

COLD FORMED STEEL

National & Provincial Building Codes-

Section 4.3.4.2

Design Basis for Cold Formed Steel

"Buildings and their structural members made of cold formed steel shall conform to CAN/CSA S136-07 North American Specification for the Design of Cold Formed Steel Structural Members"

- **CAN/CSA S136-07** North American Specification for the Design of Cold-formed Steel Structural Members
  - **Clause E2a** Welding Connections
    - **CSA W55.3** Certification of Companies for Resistance Welding of Steel and Aluminum
    - **CSA W47.1- 2009** Certification of Companies for Fusion Welding of Steel

CONCRETE

National & Provincial Building Codes-

Section 4.3.3.1

Design Basis for Plain, Reinforced and Pressed Concrete

"Buildings and their structural members made of plain, reinforced or prestressed concrete shall conform to CSA A23.3-04 Design of Concrete Structures"

- **CSA A23.3-04 (R2010)** Design of Concrete Structures
  - **CSA A23.1-09** Concrete Materials and Methods of Concrete Construction
    - **Clause 6.6.10** Welding of Reinforcement
      - **CSA W186** Welding of Reinforcing Bars in Reinforced Concrete Construction
    - **Clause 6.7** Welding of Hardware
      - **CSA W59** Welded Steel Construction (Metal Arc Welding)

STRUCTURAL ALUMINUM

National & Provincial Building Codes-

Section 4.3.5.1

Design Basis for Aluminum

"Buildings and their structural members made aluminum shall conform to CSA S157-05 Strength Design in Aluminum"

- **CSA S157-05 (R2010)** Strength Design in Aluminum
  - **Clause 14.7** Welding
    - **CSA W47.2** Certification of Companies for Fusion Welding of Aluminum

National/Provincial Building Codes - Welding Requirements

PROVINCIAL BUILDING CODES

CSA A23 Precast Concrete	CSA S16 Design of Steel Structures	CSA S157 Design of Aluminum Structures
CSA W186 (Qualification, Fabrication & Quality)	CSA W47.1 (Qualification)	CWA W47.2 (Qualification)
	CSA W48 (Electrodes)	CSA W59.2 (Fabrication & Quality)
	CSA W59 (Fabrication &Quality)	
	CSA W178.2 (Inspection)	

CAN/CSA Standard S16

Limit States Design of Steel Structures

Welding Requirements

- Fabricator shall be a CSA W47.1 certified company in Division 1 or 2
- Fabricator may sublet to a Division 3 company (assist in fabrication or erection)
  - But…Division 3 companies can't take on work directly
- Joint design and quality requirements must meet CSA W59

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: 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"
  - 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 welder(s)
  2. Qualified welding procedures
  3. Qualified welding supervisor(s)
  4. Qualified welding engineer(s)

- In practical terms, this means that a welding fabricator must have:
  - Competent individuals making the welds, who are…
    - Following proven and documented "recipes", in a shop…
      - Overseen by competent "bosses".

- When all elements are in place, high quality welds will result!
  - Certification ensures these key elements are in place and working

CSA W47.1: Steel 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

CSA W47.1

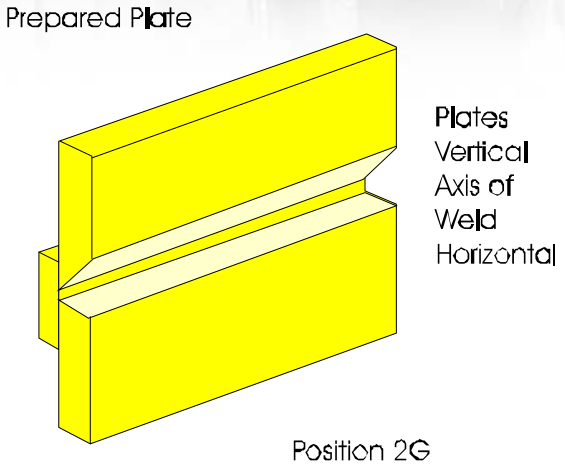
- Fabricators must define the "scope" of their certification
  - Like any quality system, the work that falls within the control of the system must be clear to both the employees of the organization, the independent certification body and the customers
- This is done through a statement on a Fabricator's certificate and made available to the public
- Examples:
  - *"Fabrication of structural steel"*
  - *"Erection of structural and miscellaneous structural steel."*
  - *"Repair and maintenance of cranes and crane runways."*

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 CSA W47.1 company
  - Normally, valid only for 2 years

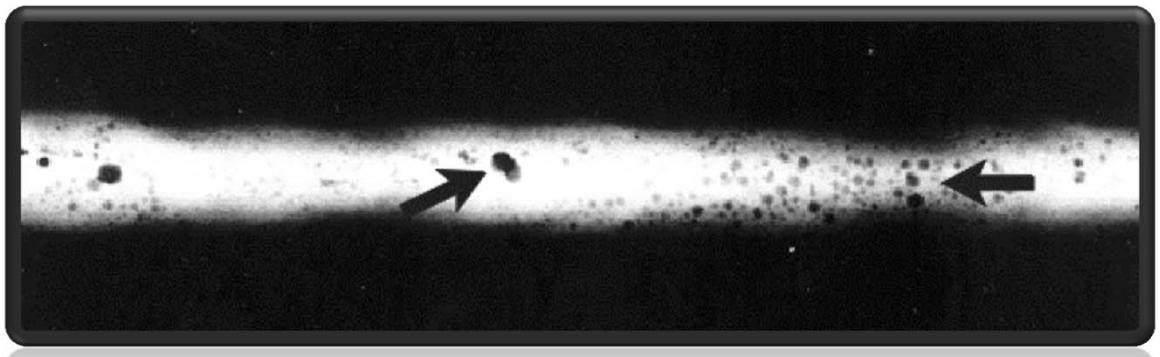
Requirement #1: Qualified Welders

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

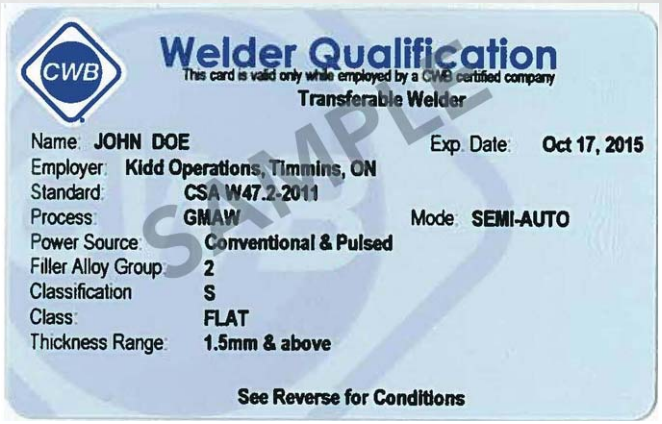


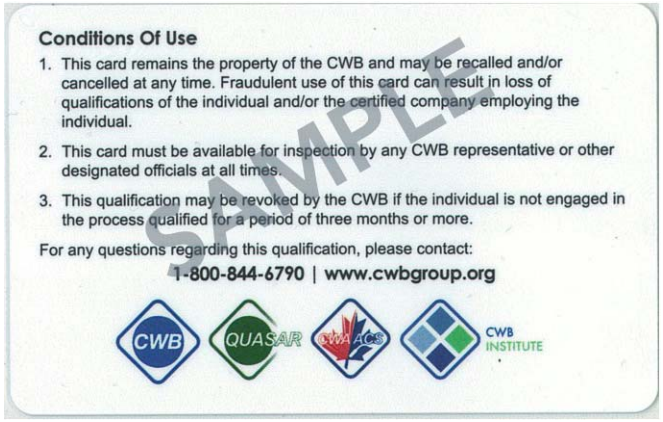
Requirement #1: Qualified Welders

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



Requirement #1: Qualified Welders





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 are in place and followed
  - 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

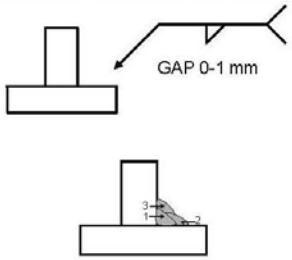
WELDING PROCEDURE DATA SHEET

WPDS NO.: GMAW-2F
DATE: 5/27/2008 Rev.: 0

Company Name:	Canadian Welding Bureau
Address:	7250 West Credit Avenue, Mississauga, ON L5N 5N1
Ref. Standards:	CSA W47.1/ W59
Ref. WPS:	GMAW-1

Welding Processes:	1	GMAW	Pulsed: ☐ Yes ☑ No	2	Pulsed: ☐ Yes ☐ No
Shielding Gas Type:		90%Ar/ 10% CO2		
Positions:	Horizontal			
Process Mode:	☐ Manual ☑ Semi-Auto ☐ Machine ☐ Auto			
Joint Type:	☐ Butt ☑ Tee ☐ Corner ☐ Lap ☐ Edge			
Penetration:	☐ Complete ☐ Partial ETT=		☑ Fillet	
Backing:	Material: N/A	Thickness:		
Backgouging:	☐ Yes Method:			
	☑ No Depth:			
Electrode Extension:	20 mm			
Nozzle Diameter(s):	16 mm			
Flux Classification:	N/A			
Tungsten Electrode:	Type: N/A	Dia.:		
Cleaning Procedures	Wire brush, clean between passes			
CSA W186 Rebar Splice Type:	☐ Direct Splice ☐ Indirect Splice ☐ Lap Splice ☐ Rebar to Structural Member Only			

Joint Configuration & Pass/Layer Sequence



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	E 49 A 3 C G6 (ER49S-6)	N/A	Cl. 5.2.4.5, CSA W59

SAMPLE

Welding Parameters

Thickness ( )	Weld Size/ ETT	Layer	Pass Number	Welding Process	Dia. (mm)	Wire Feed Speed (m/min)	Current A	Volt V	Current Polarity	Welding Speed (mm/min)	Burn-Off Rate ( )	Gas Flow Rate (l/min	Heat Input ( )
	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

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.weldquality.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

Letter Of Validation
(Proof of certification)

LETTER OF VALIDATION

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@cwbgroup.org | Web: www.cwbgroup.org

How can I Verify CWB Certification?

- The following items are not proof of certification **on their own**:
  - Welder Tickets
  - Welding Procedures
  - Wall Certificates
  - Welding Supervisor Certificates
- These documents are part of the certification program, but none can be used on their own to prove certification

Wall Certificate

(not proof of certification)

CANADIAN WELDING BUREAU

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 the DIVISION 2

INITIAL CERTIFICATION DATE: April 14, 2011

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

Registrar & Manager Q.A. *Authorized Signing Officer*

Certification is validated yearly via a "Letter of Validation", a copy of which is available from the company

Accredited CB-PS (Certification Body-Product/Services)

The Canadian Welding Bureau is accredited by the Standards Council of Canada

Welder Ticket

(not proof of certification)

Welder Qualification

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

Transferable Welder

Name: **Joe Welder**
Exp. Date: **May 06, 2013**
Employer: **ABC Company, Anytown, ON**
Thickness Range: **3mm & above**
Material: **Carbon Steel**
Mode of Transfer: **Spray/Globular/Pulsed**
Process: **GMAW**
Mode: **SEMI-AUTO**
Standard: **CSA W47.1**
Single Electrode Mechanized
Classification: **S**
Single Electrode Automatic
Class: **FLAT**

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

Welding Supervisor Card

(not proof of certification)

Welder Supervisor
Superviseur en soudage

PRESENTED TO/ PRÉSENTÉE A

Who has completed the welding supervisor examinations as required by CSA Standard

Qui a complété les examens de superviseur en soudage, tel que requis par la norme CSA

Valid while employed with:
Valide tant qu'employé par:

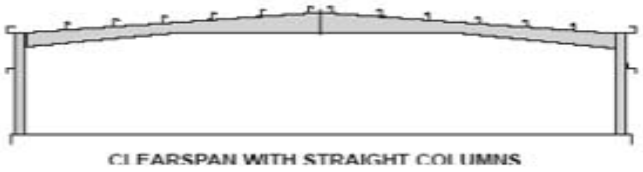
Issue Date/ Date d'émission

Authorized Signature/ Signature autorisée

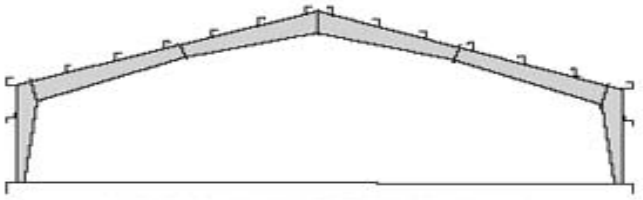
Steel Building Systems: CSA A660

What is a steel building system?

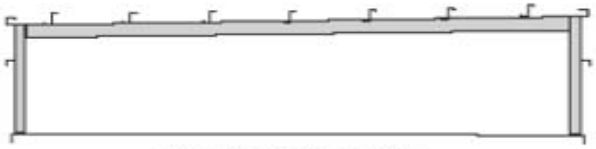
- "an integrated assembly of manufactured steel primary structural components, secondary structural components of *any material*, and cladding of *any material*, specifically designed by the manufacturer to support and transfer loads and provide a complete or partial building shell."



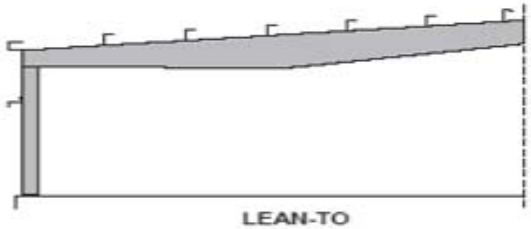
CLEARSPAN WITH STRAIGHT COLUMNS



CLEARSPAN WITH TAPERED COLUMNS

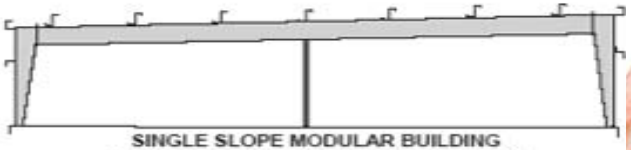


SINGLE SLOPE CLEARSPAN



LEAN-TO

MODULAR BUILDING WITH 2 INTERIOR COLUMNS
(3 MODULES)



SINGLE SLOPE MODULAR BUILDING
WITH 1 INTERIOR COLUMN (2 MODULES)

CAN/CSA A660

Examples of A660 applications :

- Traditional Pre-engineering Buildings
- Fabric Covered Buildings
- Mini Storage Building

Benefits of CAN/CSA A660

- New clause in NBC 2005

  4.3.4.3. Steel Building Systems

  (1) Steel building systems shall be manufactured by companies certified in accordance with the requirements of CSA A660, "Certification of Manufacturers of Steel Building Systems"

- Quality management system that involves:

  Detailed audit of the manufacturers' design systems to ensure compliance to Canadian Standards.

  Thorough review of the manufacturer's fabrication from raw material to finished product

  Similar to the more common ISO 9001 certification but much more detailed and specific to steel building manufacture.

Verification of A660 Certification

 Certification of manufacturers of steel building systems

Certificate of design and manufacturing conformance

This Certificate is to affirm that all components of the steel building system described below, to be supplied by the named manufacturer certified in accordance with CSA A660, have been or will be designed and fabricated in accordance with the following Standards to carry the loads and load combinations specified.

1. DESCRIPTION

Manufacturer's name and address _____
Manufacturer's Certificate No. under CSA A660 _____
Customer order number _____
Building type and size _____
Intended use and occupancy _____
Importance category [*NBC*, Sentence 4.1.2.1.(3)] _____
Site location _____
Applicable building code _____
Builder's name and address _____
Owner's name and address _____

2. DESIGN STANDARDS **Engineer's initials*** _____

National Building Code of Canada, 2005, Part 4: *Structural Design*
CSA S16-09, *Design of steel structures*
CSA S136-07, *North American specification for the design of cold-formed steel structural members*
Other (specify) _____ dated _____

3. MANUFACTURING STANDARDS _____

(a) Fabrication has been or will be in accordance with CSA S16 and CSA S136, as applicable.
(b) Welding has been or will be performed in accordance with CSA W59 and CSA S136, as applicable.
(c) The manufacturer has been certified in accordance with CSA W47.1, for Division 1 or 2, and/or CSA W55.3, if applicable.
(d) Welders have been qualified in accordance with CSA W47.1.

4. PURLIN STABILITY _____

Purlin braces are provided in accordance with CSA S136, Clause D3 and Appendix B, Clause D3.2.3. In particular, for a standing seam roof supported on movable clips, braces providing lateral support to both top and bottom purlin flanges have been or will be provided. The number of rows is determined by analysis but in no case is it less than 1 for spans up to 7 m inclusive or less than 2 for spans greater than 7 m.

- All buildings must be supplied with a "*Certificate of Design and Manufacturing Conformity*"
- Many permit sets of drawings include the certificate

What about other National standards / equivalency?

- There are no domestic or international equivalents to CWB certification requirements for structural steel or pre-engineered buildings.
- Other national systems, such as that of the American Welding Society (AWS) do not include key concepts such as independent and on-going verification and welding supervisors / engineers
- Not sure? Call the CWB

What about Steel Fabricated outside of Canada?

- Regardless of the country of manufacture, structural steel destined for Canada must comply to CSA Standards.
- CWB certification is available to fabricators worldwide
  - Currently, over 500 certified companies outside of Canada

What about BC Safety Authority Tickets?

- In Canada, welding of pressure vessels and pressure piping is covered by provincial legislation
  - In BC, the Safety Authority adminsters codes related to this type of work
- It is not permitted to substitute one system for the other - either CSA Standard W47.1 or ASME IX must be used where specified.
- Not adhering to the correct standard may jeopardize the quality of the final product and impact public safety.
  - Although these standards are established for two different scopes, many projects require the use of both systems.

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

- The design standard for structures, CSA S16, 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. a municipal building official) based on their level of comfort with the risks related to non-compliance with the design standard and/or provincial building code.
  - As the certification body for CSA W47.1, the CWB has no authority in this regard.

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- Some possible options include:
  1. Remove and replace the structure with one fabricated by a company certified by the CWB to CSA W47.1
  2. 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);
  3. Conduct visual and, if determined necessary, NDE inspection on the welded component.

Help from the CWB

- The CWB Office of Public Safety is here to help Building Officials.
- We can assist through:
  - Validation of claims of certification / certification documentation
  - Construction site visits to validate certification
  - Complimentary educational session for Building Departments
  - Web and telephone support.
    - www.weldquality.org
    - 1-800-844-6790

Q & A