Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) In-Plant Bridge & Cattleguard Inspection Services
Quality Assurance - History

History of QA for Ministry of Forests (Lands, and Natural Resource Operations):

- Prior to 1982 ➔ Own Forces / Glulam
- 1982 – 1988 ➔ Steel Introduced
- 1988 – 1997 ➔ MoT In-Plant Inspectors
- 1997 – 2002 ➔ Shared MoT/Private
- 2002 – present ➔ Privatized
Quality Assurance - History

Prior to 1982 – Own Forces / Glulam
  - Glued-laminated structures
    - Intermittent in-plant inspections by MoF
    - Numerous problems with members not inspected, most requiring replacement before design life reached
    - Attempt by industry to introduce QC
Quality Assurance - History

1982 – 1988 –> Steel Introduced
- Steel girders introduced
- Minimal quality control
- Inspection assumed to be performed by Designer
- Problems encountered:
  - Inaccurate and poor quality fabrication
  - Variation in steel quality
- Premature cost of replacement of bridge structures
1988 – 1997 – MoT In-Plant Inspectors
- Standards and specifications for design, materials & fabrication introduced
- Precast concrete components introduced
- MoT in-plant inspectors performed quality assurance based out of Lower Mainland
- Quality assurance concept superceded inspection
1997 – 2002 --> Shared MoT/Private
- MoT beginning to be unable to service MoF due to attrition
- MoT travelled from lower mainland
- Shared responsibility for quality assurance between MoT & private industry (competitive process)
- Reid Crowther / Sargent & Associates provided local presence

2002 – Present --> Privatized
- Privatized (Both MoT & MoF)
- Competitive process
- Sargent & Associates
Objectives of Quality Assurance Program

1. Quality in Conformance with Contract Documents
2. Consistency of Fabrication
3. Reliance by Engineer of Record
4. Efficiency
5. Fabricator’s Perspective
1. Quality in Conformance with Contract Documents

- Quality Control (QC) v. Quality Assurance (QA)
- MFLNRO Requirements for Fabrication
- Reasons for Quality Assurance
- Example Deficiencies
Quality Control vs Quality Assurance

**Quality Control:**
- Manufacturer’s documented system to ensure product meets the project requirements

**Quality Assurance:**
- Independent verification by the Owner’s rep that product meets the project requirements – usually spot checks
MFLNRO Requirements

i. Previous Fabrication Experience Requirements

ii. Fabricator Certification:
   - Steel Structures:
     – Fusion Welding of Steel (CSA Standard W47.1)
   - Precast Concrete Structures:
     – Precast Concrete – Materials and Construction CSA Standard A23.4
i) Previous Fabrication Experience

MFLNRO Bridge Material Standard Template Language:

- Bidders, as identified in their quote, must satisfy one of the following requirements:
  - The bidder has successfully designed (or retained a qualified engineer to design), fabricated, supplied and delivered on-time and otherwise satisfactorily fulfilled all terms of contracts for at least 5 bridges, similar in size, scope and complexity to those specified in this document, within the past 2 years and, at the request of the ministry, be able to provide proof* of such performance;
  
  OR

  - The bidder has not successfully designed (or retained a qualified engineer to design), fabricated, supplied and delivered on-time, at least 5 bridges, similar in size, scope and complexity to those specified in this document, within the past 2 years, but can provide proof* that they are capable of performing this project within the time limits and requirements specified in this document.

- Steel fabricator to have a QC Program in accordance with CSA W47.1 and W59
ii) Fabricator Certification
Steel Structures

**CWB (Canadian Welding Bureau) Certification:**

- Certifies a fabricator meets the requirements of CSA Standard W47.1 – Fusion Welding of Steel
  - Division 1: In–house Welding Engineer
  - Division 2: Retained Welding Engineer (Revised in 2003)
  - Division 3: No Welding Engineer (Misc. Steel Only)
- In–house welding supervisors
ii) Fabricator Certification
Steel Structures

CWB Scope:

- Initial certification
- Semi-annual audits of a fabricator’s plant – usually lasts 2–3 hours
- Approve weld procedures
- Test welders – issue Welder’s Tickets
- Spot-check of weld quality & consumables during audit
ii) Fabricator Certification
Steel Structures

Limitations of CWB Certification:

- It is not a requirement of CSA W47.1 for the fabricator to have a QC program
- Retained / employed Welding Engineer reports to the Company – no independence
- CWB is concerned only with welding. Fabrication fit-up, etc. is not covered
- Very unlikely that any particular MoF project will be part of any CWB audit
- CWB assumes no responsibility for either a certified company’s QC methods or a purchaser’s inspection program
ii) Fabricator Certification
Steel Structures

List of Certified Fabricators for Steel who Currently Manufacture MFLNRO Bridge Components

- Rapid-Span Structures Ltd. (Div. 1)
- Rapid-Span Bridges Inc. (Div. 1)
- Surespan Structures Ltd. (Div. 2)
- Pacific Industrial & Marine Ltd. (Div. 2)
- Magnum Fabricators Ltd. (Div. 2)
- Alpha Welding (Div. 3)
- Majestic Bridge Building Inc. (Div. 2)
- Stinger Welding Ltd. (Div. 2)
- Beamac Installations Ltd. (Div. 2)
- Marcon Metalfab Inc. (Div. 2)
- LE Steel Fabricators Ltd. (Div. 2)
- APT Industries Ltd. (Div. 3)
- Specialty Machine Works Ltd. (Div. 2)
ii) Fabricator Certification
Precast Concrete

Canadian Standards Association:
- Certifies that a precast concrete manufacturer meets the requirements of CSA Standard A23.4 – Precast Concrete – Materials & Construction
- Fabricator must have a documented QC system
- (Historical Anecdote)
ii) Fabricator Certification
Precast Concrete

**CSA Scope:**

- Quarterly audits of a pre-caster’s plant – usually lasts 4–6 hours
- Audits QC documentation
- Audit material test reports (aggregates, cement, etc.)
- Spot-check pre-casting practices
- Mostly a “paper audit”
ii) Fabricator Certification
Precast Concrete

CSA Limitations:
- Standards Council of Canada (SCC) has authority to accredit certifying agencies
- CSA accredited by SCC
- Recent lack of performance by CSA
- Introduction of CPCI
- Unlikely any particular MFLNRO project will be part of audit
- Fabricator QC program can be heavily influenced by production
ii) Fabricator Certification
Precast Concrete

List of Certified Fabricators for Precast Concrete who Currently Manufacture MFLNRO Bridge Components

**CSA Certified Plants**
- Rapid-Span Precast Ltd.
- Surespan Structures Ltd.
- Pioneer Precast Ltd.
- Lockwood Bros Concrete Products
- Armtec/Con–Force Structures Ltd.
- MSE Precast Ltd.
- APS Architectural Precast Structures Ltd.

**CPCI Certified Plants**
- Surespan Structures Ltd.
- Lockwood Bros Concrete Products (Pending)
- Armtec/Con–Force Structures Ltd.
- MSE Precast Ltd.
- APS Architectural Precast Structures Ltd.
Reason for Independent Quality Assurance (QA)

- “CWB” & CSA certification is essentially an “honour system”. Neither organization will certify a specific product meets project requirements.
- Fabricators QC program can be heavily influenced by production. Only way to ensure unscrupulous manufacturers do not “cut corners” on quality.
- Provides consistency of fabrication across the Province.
- Due Diligence and risk management on behalf of the Ministry.
- Reliance on QA by Engineer of Record.
Construction projects have a 1 year warranty period. MFLNRO implemented requirement of 1 year warranty for direct purchases.

Many manufacturing defects may not show up for a number of years.
Quality Assurance Checklist Forms

- Structural Steel
- Precast Concrete
Common Deficiencies

Steel Fabrication:
- Fabrication not in conformance with approved design drawings and specifications
- Material not as specified
- Incorrect selection of consumables
- Welder qualifications (expired or no ticket)
- Fabrication exceeds fit-up and dimensional tolerances
- No welding procedures; failure to follow
- Stress raisers in fracture critical members
- Weld defects (size, profile, porosity, workmanship)
- Inappropriate heating or bending of plate
Example Deficiencies – Steel

Poor (gaps, bad profile, spatter)

Good
Example Deficiencies – Steel

Weld slag and spatter on base plate connection
Example Deficiencies – Steel

Incomplete weld on guardrail post
Example Deficiencies—Steel

Underfilled weld joint
Example Deficiencies– Steel

Undersized weld on a cattleguard
Example Deficiencies – Steel

Galvanizing starting to flake off
Example Deficiencies – Steel

Overheating flange to straighten
Example Deficiencies – Steel

Faulty stud repairs
Example Deficiencies – Steel

Incorrect diaphragm material being metalized
Example Deficiencies – Steel

All steel portable

Slot in web which would have gone undetected
Common Deficiencies

Precast Concrete:

- Improperly located / inadequate reinforcing
- Poor forming (dimensions, cleanliness)
- Missing, improperly located and incorrect inserts / hardware
- Inadequate concrete cover
- Concrete not meeting specifications
- Poor consolidation (honeycomb, voids)
- Poor finishing (surface defects)
- Premature shipping (insufficient strength)
Example Deficiencies – Concrete

Slab girder voids
Example Deficiencies– Concrete

Broken deck panel corner
Example Deficiencies – Concrete

Shrinkage Cracks
Example Deficiencies – Concrete

Improper hardware casting
Example Deficiencies—Concrete

Proper Repair Procedure Implementation
Example Deficiencies – Concrete

Appropriate repairs being implemented in the field
Example Deficiencies

- Random sampling of results from approximately 20% of the past year’s fabrication
Examples of Reliance on MFLNRO Backup Support

- 3 Steel Portable Bridges – Coast Region
- Steel Plate Girders – Northern Region
- Field Repair of Precast Bridge – Southern Region
- Field Repair of Precast on Steel Girder – Southern Region

Heat discolouration on splice

Multiple fabrication issues
(3 Steel Portable Bridges)
2. Consistency of Fabrication

- Comments from Program Initiation to date
- Comments from cattleguard experience
- Self-policing by fabricators
3. Engineer of Record

- Responsibility
- Experience with Fabrication
- Bridge fabrication quality control/quality assurance is a specialized field requiring unique training, knowledge, experience and specialized equipment
- Practicality of Timely Response and Access During Fabrication
- Reliance on Quality Assurance Program
4. Efficiency

- Strategic location of Experienced Quality Assurance Personnel
- Central Location for coordination
- Combine MFLNRO QA with Other Transportation Authorities
Staff Location Relative to Fabricators

Vancouver Island Based QA Personnel
- Glenn Sargent, M.A.Sc., P.Eng. - Structural Steel, Prestressed Concrete, Bearings
- Paul Sargent, M.Eng., P.Eng. - Prestressed Concrete
- Gong Wang, M.A.Sc., P.Eng. - Prestressed Concrete
- Dean Henshaw, P.Eng. - Prestressed Concrete
- Joe Jarmy, P.Eng. - Prestressed Concrete
- Christian Copic - Prestressed Concrete
- Michael Ora - Prestressed Concrete
- Kevin Hunter - Structural Steel
- Norm Seal - Structural Steel Back-up
- Ross Raine - Coating

Victoria Fabricators
- United Engineering Ltd. - Structural Steel

Duncan Fabricators
- Duncan Structures Ltd. - Prestressed Concrete, Structural Steel
- Pacific Industrial Marine Ltd. - Structural Steel

Northern Interior Forest Region
- Prince George Fabricators
  - MasterCraft Building Inc. - Structural Steel
  - Morgan Valutac Ltd. - Structural Steel

Prince George Based QA Personnel
- Cy Fahey - Structural Steel
- Mark Shaw - Structural Steel

Williams Lake Fabricators
- Scarce Industries Ltd. - Galvallum

Annanagon Fabricators
- RapidSpan Structures Ltd. - Structural Steel
- RapidSpan Precast Ltd. - Prestressed Concrete
- Lumberjack Steel Concrete Products - Prestressed Concrete

Chehalis Based QA Personnel
- Ron Howley - Structural Steel
- Tim Bailey - Prestressed Concrete
- Fred Hay - Structural Steel Back-up
- Dave Hay - Prestressed Concrete Back-up

Okanagan Colleagues Fabricator
- Aube Welding and Steel Fabricating - Merrit

Lower Mainland Fabricators
- AFT Industries Ltd. - Structural Steel
- Borden Establishments Ltd. - Structural Steel
- ComFor Structures Ltd. - Prestressed Concrete
- Magna Precast Ltd. - Structural Steel
- Pioneer Precast Products Ltd. - Prestressed Concrete
- Fraser Valley Welding & Fabricating Ltd. - Galvallum
- Javelin Holdings Ltd. - Structural Steel
- L&B Steel Products Ltd. - Structural Steel
- Westcoast Metal Fab Inc. - Miscellaneous Steel

Lower Mainland Based QA Personnel
- Peter Onewa - Structural Steel, Prestressed Concrete, Bearings, Coatings
- Angelic Wore - Prestressed Concrete, Structural Steel
- Kurt Klein - Structural Steel
- Dan Rohe - Prestressed Concrete
- Northem Compression & Inspection Services Ltd. - Coatings Back-up
All pre-fabricated bridge components for Ministry of Forest bridges shall be inspected in the plant by a ministry-appointed inspector. No work shall leave the plant until the inspector has declared the materials were produced in accordance with the approved designs and drawings.

—Forest Service Bridge Design and Construction Manual
Independent inspection is cost-effective insurance to ensure good value to the Province.

From a fabricator’s perspective, it assures a “level playing field” during the bid process.

Extra “set of eyes” can be an advantage to the manufacturer.
CHBDC General Quality Requirements
C1.4.4.6 Quality Control and Assurance

- The provisions of the Code have been formulated and calibrated on the assumption that high standards of construction will be adhered to.

- High standards of construction require that only competent and conscientious Constructors be entrusted with the work.
"Our problem is we built most of the facilities in the '60s and '70s, and built them in a hurry. The result is that the quality control was not there."

Prof. Saeed Mirza, McGill University
“You can argue, debate and twist and turn about all the factors, but the main cause of the collapse was the misplaced reinforcements. Period.”

Georges Archer, former president of the CSCE.

De la Concorde, Montreal, Constructed 1970, Collapsed 2006
“The city hired an independent company here to spot check welds completed in Spain. The company determined some of the welds do not comply”

Mac Logan, City of Calgary Transportation General Manager