FLNRO Process Based Specification for CCA Treatment of Coastal Douglas-fir Wood

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PRESENTATION OUTLINE

• FLNRO Engineering Branch – Overview
• Background for development of process based CCA treatment specification
• Description of CCA process specification for CCA Treatment of Coastal Douglas-fir Wood
• Test results of penetration
• Ongoing work
• Q & A
FLNRO ENGINEERING BRANCH

Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRO)

- FLNRO has many responsibilities for activities on the Crown land base

- Key FLNRO mandate includes being the lead agency in BC responsible for administration of forest resource roads including Forest Service Roads (Crown owned roads)

- Engineering Branch (of FLNRO) is responsible for establishing engineering policy and standards for Forest Service Roads
ENGINEERING BRANCH MISSION

• To provide a safe resource road network which balances public, community, First Nations, commercial and industrial use

• Engineering Branch – HQ
  • Establishes policy and standards for engineering works on Forest Service Roads (FSRs)
  • Establish design, material and construction standards for bridges on FSRs
ENGINEERING BRANCH MISSION

Statistics on Resource Road Network in BC

- 600,000 km of resource roads provincially
- 60,000 km Forest Service roads (FSRs)
  - ~6,000 Bridges on FSRs
  - Treated wood components:
    - Timber decks
    - Glulam beams
    - Wood piles
PHOTOS OF PRESERVATIVE TREATED BRIDGE COMPONENTS

Timber Deck Systems
PHOTOS OF PRESERVATIVE TREATED BRIDGE COMPONENTS

Treated Timber Decks
PHOTOS OF PRESERVATIVE TREATED BRIDGE COMPONENTS

Glulam Beams
(i.e., Glued laminated timber)
PHOTOS OF PRESERVATIVE TREATED BRIDGE COMPONENTS

Wood Piles & Ballast Walls
Challenges at the time (2009ish):

- Limited reference to standards for lumber and for treated wood
- Referenced conformance to CAN/CSA-080 “Wood Preservation” as a general ‘catch-all’
- No checks for quality assurance for lumber or for treated wood; no 3\textsuperscript{rd} party verification of treatment results

Possibly received wood materials of questionable quality, and where preservative treatment was specified the treated wood supplied may have consisted of only ‘dip treatment’
FLNRO DEVELOPMENT OF STANDARDS FOR LUMBER AND TREATED WOOD MATERIALS

Objectives to remedy challenges:

• consistent quality timber materials; meet Canadian Lumber Standards

• industrial quality treated wood that will provide long term performance for the intended use

• conform to CSA-080 Series “Wood Preservation”, and Best Management Practices

• ensure quality assurance for lumber and for treated wood

To establish standards that provide for performance and service life expectancy, and to establish a level playing field for suppliers
FLNRO DEVELOPMENT OF STANDARDS FOR LUMBER AND TREATED WOOD MATERIALS

• FSR bridge design and construction standards include standards for lumber and treated wood materials:
  o Bridge Timbers & Lumber Material Standard
  o Pressure Treated Wood Standard for Timber Deck Bridge Components
  o Process Specification for CCA Treatment of Coastal Douglas-fir Wood

https://www2.gov.bc.ca/gov/content/industry/natural-resource-use/resource-roads/engineering-standards-guidelines/bridge-design-construction/material-standards
BACKGROUND HISTORY BEHIND DEVELOPMENT OF PROCESS BASED CCA TREATMENT SPECIFICATION

- Engaged experts & practitioners in the timber & wood treatment industry
  - Paul Morris, Ph.D. (FPInnovations) – involved in development of CSA-080 Series
  - David Reekie (Canadian Softwood Inspection Agency)
  - Allan Miller (Stella Jones)
  - Les Cool (Welco Lumber)
  - Stuart Sing (Canadian Mill Services Association)
  - Others
Key requirements for lumber:

- Rough lumber material
- Conforming to various wood species depending on bridge component
- Graded in accordance with NLGA grading rules
  - No. 1 grade for cross-ties and stringers
  - No. 2 grade for all other timber components
- All rough lumber to be:
  - Full sawn
  - Trimmed for removal of sniped, splintered, or uneven lengths
  - Trimmed full to length (tolerances specified), and double-end trimmed
- Lumber quality verified by:
  - grade stamp or
  - Certificate of Inspection, prepared by Accredited Grading Agency
FLNRO BRIDGE TIMBERS & LUMBER MATERIAL STANDARD

Reference NLGA (National Lumber Grades Authority), as approved by Canadian Lumber Standards Accreditation Board, for required lumber grades

Allowable Species
- preferred wood species for structural characteristics (D Fir-L)
  - Coastal D-Fir
  - Interior D-Fir
  - Western Larch
- Other wood species allowed dependent on treated or not, and bridge component

<table>
<thead>
<tr>
<th>Bridge Component</th>
<th>Allowable Untreated Lumber Species</th>
<th>Allowable Lumber Species and Use Category if Treated (Refer to Pressure Treated Wood Standard for Timber Deck Bridge Components)</th>
<th>Required Lumber Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber guardrail, riser blocks and brackets (e.g., untreated 250 mm x 250 mm size)</td>
<td>D Fir-L (^4) (preferred)</td>
<td>Coastal D-Fir</td>
<td>No. 2 or better (e.g., NLGA Para. 131c – “No. 2” – Structural Posts and Timbers for 250 mm x 250 mm size)</td>
</tr>
<tr>
<td></td>
<td>Hem-Fir North (^5) or SPF West (^6) (if justified by life cycle cost analysis for site-specific crossing)</td>
<td>Hem-Fir North</td>
<td></td>
</tr>
<tr>
<td>Timber deck running planks (wear planks) (e.g., untreated 75 mm x 250 mm size for wear planks to sub-deck; e.g., untreated 100 mm x 300 mm size for wear planks to cross-ties)</td>
<td>D Fir-L (preferred)</td>
<td>Coastal D-Fir</td>
<td>No. 2 or better (e.g., NLGA Para. 124c – “No. 2” – Structural Joists &amp; Planks for 75 mm x 250 mm size)</td>
</tr>
<tr>
<td></td>
<td>Hem-Fir North or SPF West (if justified by life cycle cost analysis for site specific crossing)</td>
<td>Hem-Fir North</td>
<td></td>
</tr>
<tr>
<td>Timber sub-deck planks (e.g., 100 mm x 300 mm for sub-deck planks to cross-ties)</td>
<td>D Fir-L</td>
<td>Coastal D-Fir</td>
<td>No. 2 or better (e.g., NLGA Para. 124c – “No. 2” – Structural Joists &amp; Planks for 100 mm x 300 mm size)</td>
</tr>
<tr>
<td>Timber cross-ties (e.g., 200 mm x 200 mm, 200 mm x 250 mm, 200 mm x 300 mm, 250 mm x 300 mm size, etc.)</td>
<td>D Fir-L</td>
<td>Coastal D-Fir</td>
<td>No. 1 or better (e.g., NLGA Para. 131b – “No. 1” – Structural Posts and Timbers for 200 mm x 200 mm size, 200 mm x 250 mm size or 250 mm x 300 mm size)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>(e.g., NLGA Para. 130b – “No. 1” – Structural Beams and Stringers for 200 mm x 300 mm size)</td>
</tr>
<tr>
<td>Ballast wall timbers (e.g., treated 150 mm x 300 mm size)</td>
<td>None. Must treat ballast wall timbers</td>
<td>Coastal D-Fir</td>
<td>No. 2 or better (e.g., NLGA Para. 130c – “No. 2” – Structural Beams and Stringers for 150 mm x 300 mm size)</td>
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<td>(e.g., NLGA Para. 130c – “No. 2” – Structural Beams and Stringers for 200 mm x 400 mm size)</td>
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<tr>
<td>Timber sills (e.g., treated 200 mm x 400 mm; 305 mm x 305 mm, etc.)</td>
<td>None. Must treat timber sills</td>
<td>Coastal D-Fir</td>
<td>No. 2 or better</td>
</tr>
</tbody>
</table>
Evaluated wood treatment options:

**Oil Borne:**
- Creosote (CR)
- Pentachlorophenol in Type A Oil (PCP-A)

**Desired criteria:**
- An economical *waterborne* preservative
- Treatment type readily available in BC
- Treatment to be effective with D-Fir
- 3rd party inspection

**Water Based:**
- Ammoniacal Copper Zinc Arsenate (ACZA)
- Chromated Copper Arsenate, Type C (CCA)
“CCA is considered an excellent treatment for most softwood species. Achieving the required penetrations in Douglas-fir may be extremely difficult.

CCA is not recommended … for treatment of interior Douglas-fir.”


**Table 6 of CSA-080.1-15**

<table>
<thead>
<tr>
<th>Species</th>
<th>UC1 and UC2</th>
<th>UC3</th>
<th>UC4.1</th>
<th>UC4.2</th>
<th>UC5A</th>
<th>Permanent wood foundations</th>
<th>Shakes and shingles</th>
<th>Sawn cross-arms</th>
<th>High-way bridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Interior</td>
<td></td>
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</tbody>
</table>

CCA is not recommended for treatment of **Interior** Douglas-fir
BACKGROUND HISTORY BEHIND DEVELOPMENT OF PROCESS BASED CCA TREATMENT SPECIFICATION

• Focussed on CCA:
  • Economical
  • Less environmental “baggage”
  • Fewer implications for handling
  • Readily available within BC
  • Best option considering alternatives
  • Better than what we have
  • Worth an attempt

Recognized that not likely to attain CSA-080 Series results for penetration (and sometimes for retention) - thus

Ministry decision to move forward with development of a process based specification for CCA treatment of Coastal Douglas-fir
DESCRIPTION OF FLNRO CCA PROCESS SPECIFICATION

• Prior to pressure treatment, carry out the following:
  • Dry wood to average Moisture Content of between 23 and 30%
  • Incise wood on all faces to improve the penetration of wood preservative into impermeable wood by making a series of small, shallow slits cut into the wood by an incising machine
    • Incise wood to depth of 10 mm, and density of 4,500 / m²
  • Pre-frame / pre-cut wood to size and length, as much as possible, as this reduces breaches to the treated shell
DESCRIPTION OF CCA PROCESS SPECIFICATION

- Apply CCA treatment using processes and procedures (e.g., steam limits) that conform with CSA-080 for Use Category UC4.1, and adhering to the following requirements:
  - Apply heat treatment to kill any existing fungus infection to 56 degrees C for 30 minutes
  - Use a CCA solution strength between 2 and 2.5% concentration
  - Ensure the preservative solution temperature is between 20 and 25 degrees C
  - Ensure initial vacuum time is a minimum of 30 minutes after reaching full vacuum as per CSA-080
  - Apply a treatment pressure between 150 and 180 psi for a minimum of 6 hours

Treating Cycle Data
- Cylinder #, and cylinder charge #
- Vacuum (initial), and time elapsed
- Solution strength & temperature
- Treatment pressure, and time elapsed
- Vacuum (final), and time elapsed
- Retention by gauge
DESCRIPTION OF FLNRO CCA PROCESS SPECIFICATION

• To minimize preservative migration (loss) from CCA treated wood for bridge installations across water, the supplier must:

  • Produce treated wood in accordance with the Best Management Practices: For the use of treated wood in aquatic and wetland environments

  The BMPs provide:

    o quality assurance procedures
    o specific recommendations for each preservative type
    o processes to minimize mobility of preservative (e.g., CCA fixation)
    o processes to maximize cleanliness of wood surface
    o guidelines for installation and maintenance of treated wood

  [Link to BMPs]

  [http://preservedwood.org/portals/0/documents/BMP.pdf](http://preservedwood.org/portals/0/documents/BMP.pdf)
DESCRIPTION OF FLNRO CCA PROCESS SPECIFICATION

Post-treatment Preservative Fixation

• To minimize preservative migration (loss) from CCA treated wood for bridge installations across water, the supplier must:
  • After treatment, apply appropriate procedures to maximize preservative fixation in accordance with CSA-080

As per CSA-080.2-15 (Clause 5.5): “A fixation process shall be used after CCA treatment to ensure the chemical reduction of soluble hexavalent chromium and substantially immobilize CCA components in the wood before removal from protected storage….”

• The fixation process for CCA treated wood can be achieved by one of the following chosen as a function of time:
  • kiln drying
  • steam conditioning
  • hot water batch

Graphic Source: FPInnovations
DESCRIPTION OF FLNRO CCA PROCESS SPECIFICATION

• 3rd party Quality Assurance (QA) inspection required
  • Inspections at the treatment plant to verify conformance with process specification
  • Tests of preservative retention and penetration

• Documentation requirements:
  • Inspection reports of CCA Process
    • record of pressure treatment and treating cycle summary
    • record of retention and penetration test results
  • Statement of CCA Treatment Process Conformance
CSA-080 Compared to Retention Results

- Ref. CSA-080.1-15 (Table 10)
- Preservative retention requirements depend on
  - preservative type
  - UC #
  - wood species
- Coastal D-Fir, UC4.1, CCA
  - $0.4 \text{ lb/ft}^3 = 6.4 \text{ kg/m}^3$

Test results from ministry orders indicate that process specification results in meeting or exceeding the retention requirements of CSA-080
CSA-080 Compared to Penetration Results

Ref. CSA-080.2-15 (Table 5)

- # required test borings depend on - wood species, product thickness & preservative type

- CCA treated Coastal D-Fir need:
  - minimum of 20 boring samples per charge
  - 80% of boring penetration test results must meet penetration requirement

<table>
<thead>
<tr>
<th>Species</th>
<th>Incising‡</th>
<th>Penetration depth†</th>
<th>Number of borings required</th>
<th>Percentage of borings required to meet penetration requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Douglas fir</td>
<td>Required</td>
<td>Products &lt; 114 mm thick</td>
<td>Products ≥ 114 mm thick</td>
<td>Products All Marine (UC5A) CR, CR-S, and CR-PS All other preservatives</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 mm and 90%</td>
<td>13 mm and 90%</td>
<td>13 mm and 90%</td>
</tr>
</tbody>
</table>

(See Clauses 9.1.8.1, 9.1.10.4, and 9.7.3.1 and Tables 8, 9, 11, and 13 to 15.)
PENETRATION TEST RESULTS USING FLNRO CCA PROCESS SPECIFICATION FOR COASTAL D-FIR

2013-2018 Results for Coastal D-Fir - % of total results greater or equal than a particular penetration depth (1700 Borings)

2009-2011 Results for Coastal D-Fir - % of total results greater or equal than a particular penetration depth (428 Borings)

2009-2011 Results for Interior D-Fir - % of total results greater or equal than a particular penetration depth (120 Borings)

Non-compliant order

CCA Treatment Penetration (mm)

% Penetration Greater or Equal Than

- 13 mm for ≥ 114 mm thick

80.00

0.00

0 5 10 15 20 25 30 35 40
ONGOING WORK

Considerations to Address Past and Ongoing Delivery Concerns of Treated Wood Orders

1. Continue to work with contract timber and treatment suppliers to make sure they understand the standards and expectations

2. Encourage ordering of treated timber deck / misc. wood well in advance because:
   - there are no stock piles of industrial treated wood, and
   - wood has to be ordered, then fitted into a treatment schedule at the treating plant

3. Possibly pre-order Coastal D-Fir, get it treated locally by a treater that can meet the FLNRO treatment standards, store in ministry yard, ready as a source of material for assembly or use in the future

4. Possibly pre-order fully assembled, treated timber deck modules, and store in yard

5. Possibly combine bulk orders from various business areas

6. Continue to monitor results