Goodfellow Incorporated

# NOTICE OF UNDERTAKING

Pressure Treated Lumber Treatment Plant
Deer Lake Industrial Park
Deer Lake, Newfoundland

Submitted By: Goodfellow Inc.
March 31, 2011

Table of Content



LIST OF APPENDICES:

NAME OF THE UNDERTAKING: Pressure Treated Lumber Treatment Plant

PROPONENT:

(i) Name of Corporate Body: Goodfellow Inc

(ii) Addresss: 8 Wellon Drive, Deer Lake Industrial Park, Deer Lake, Newfoundland

(iii) Chief Executive Officer:

Name: Richard Goodfellow

Official Title: President

Address: 225 rue Goodfellow, Delson, Quebec, J5B 1V5

Telephone No: 450-635-6511

(iv) Principal Contact Person for Purposes of Environmental Assessment:

Name: Des Ball

Official Title: Manager

Address: 4 Wellon Drive, Deer Lake Industrial Park, Deer Lake, Newfoundland, A8A 2G5

Telephone No: 709-635-2993

THE UNDERTAKING:

(i) Nature of the Undertaking: The proposed Goodfellow facility for Deer Lake, Newfoundland will produce pressure treated lumber to local businesses and consumers throughout Newfoundland and Labrador. The facility will be located in the Deer Lake Industrial Park, and will produce between 5 and 8 million board feet of pressure treated lumber per year, using a variety of local and imported white lumber materials.

(ii) Purpose / Rational/Need for the Undertaking: Goodfellow distributes approximately 8 million board feet of pressure treated lumber to approximately 100 customers across Newfoundland from its distribution yards in Deer Lake and Mount Pearl, Newfoundland. Treated lumber is supplied from its treatment facility in Elmsdale, Nova Scotia, which uses white lumber from various mills located across Canada.

Goodfellow proposes to establish a small treating facility (6’ x 42’ cylinder) in Deer Lake adjacent to our distribution yard (approx 2 acres additional ) and to treat approximately 4 to 5 million board feet in the first year of operation. Newfoundland origin wood treated would be 5/4” x 6” Decking, 2 x 4 x 8’ to 12’, 2 x 6 x 8’ to 12’ and 4 x 4 and 6 x 6 x 8’ & 10’ post – stock. (Approx 65% of total). All other sizes 2 x 8 / 2 x 10 etc would be imported from the mainland as white-wood and pressure treated at the plant. Any excess wood will be exported in the treated state back to the mainland.

The proposed treatment facility in Deer Lake will use local lumber, reduce handling and travel costs, decreasing greenhouse gas emissions, and stimulate economic growth within the community of Deer Lake.

DESCRIPTION OF THE UNDERTAKING:

(i) Geographical Location: The proposed site is located at 8 Wellon Drive in the Deer Lake Industrial Park, Deer Lake, Newfoundland. The site is currently a vacant cleared lot and occupies an area of 0.645 Ha +/-. The location of the site is shown on Figure 1.

Adjacent land use is a mix of commercial/industrial businesses or undeveloped land for future expansion of the industrial park. Undeveloped lands exist north across Wellan Drive and to the east of the property. Commercial/industrial properties located south of the site include an RCMP detachment, Central Dairies, and Department of Transportation Garage. The existing Goodfellow building material distribution centre adjoins the southwest section of the property. The northwest adjoining property is a small industrial business.

(ii) Physical Features: Goodfellow's proposed pressure treated lumber plant will be constructed in the Deer Lake Industrial Park. The facility will include a single storey industrial building and associated storage yards for treated and untreated/white lumber.

The Industrial Park contains a variety of commercial and industrial businesses, including: a truss plant, steel fabrication, auto body shop, fire commissaries office, and Farmers Dairy distributor, all located within 1 km of the proposed undertaking. The facility will also be located less than 1 km from the interchange of the TransCanada Highway No.1, the municipal waste water treatment facility, major hydro transmission lines, and Deer Lake Town centre.

No environmental affects are anticipated, beyond those typical of conventions development within a business park setting. The treatment facility will use an "environmentally responsible" product, which will not result in adverse affects on the receiving environment surrounding the site. The facility will be designed and constructed following industry standards that contain most aspects for the operations. Only treated lumber that has acclimated and packaged will be removed from the treatment plan for short-term storage in designed areas of the site. Environmental affects monitoring will be established prior to and during operation of the facility.

(iii) Construction: Construction of the proposed treatment facility will begin upon issue of approvals, with an anticipated construction period of five months. Construction procedures will conform to the National Building Codes, as well as other applicable construction codes of practice and Municipal By-Laws.

As presented in the attached preliminary design, the planned facility consists of a single warehouse-structure measuring 24.4m (80’) by 36.6m (120’) in area. The structure will be wood frame construction on a poured concrete foundation. Features of the building will comply with the *Recommendations for the Design and Operation of Wood Preservation Facilities, 2004 – Technical Recommendations Document (TRD).*

Standard erosion and sedimentation controls will be employed during construction to avoid sediment laden runoff from leaving the property. Upon completion of the facility, cleared areas will be covered with the structure, asphalt, gravel or suitable landscape materials to retain surface soils.

Appropriate measures will also be taken during dry periods to avoid the generation of dust during construction, as well as future site activities. Security fences will also be constructed around the final operation to protect inventory and reduce off-site issues associated with solid waste from the site.

(iv) Operations: The treatment plant will operate during normal business hours, five days a week, with possible Saturday shifts required during peek seasonal periods.

The proposed Deer Lake Pressure Treated Lumber Facility will utilize Alkaline Copper Quaternary (ACQ) to treat various species of white lumber. A Material Safety Data Sheet for ACQ is provided in Appendix 2. The operation includes five epoxy coated steel aboveground storage tanks of varying capacity. Bulk volume of concentrate ACQ (50% solution) will be transported to the facility in 1000 Litre totes and transferred to a 40,000 litre concentrate tank. Two 38,000 litre storage tanks will contain dilute working solutions of ACQ. A 35,000 litre tank will be used for water storage for mixing the concentrate to working solution. The final 17, 000 litre seal water tank is used to collect working solution and de-pressurizes the system following a treatment cycle. All tanks will be contained within the treatment facility.

The floor area, including recessed retort area and interior tank farm, has been designed and will be constructed to contain a minimum of 110 percent of all liquids present in the facility at a given time, as required by the TRD. Leak detection will be provided beneath the building between the subgrade HDPE liner and concrete foundation and floor slab.

The process will have an estimated annual water consumption of 2.7 million litres, using municipally supplied water. The facility will treat approximately 12 million board feet of lumber per year.

In simply terms, the treatment process is essentially a closed system whereby “lifts” of white lumber are placed in a pressure vessel or retort and placed under vacuum at 22 pounds, the retort is filled with working solution (approximately 8 % ACQ), placed under pressure (<150 psi) for a duration dependant on wood species. Once pressure treated, the pressure is release and the working solution is pumped back into the work tanks and reused.

Treated wood is left in the treatment area inside the plant to drip and dry for a period of 72 to hours before being tagged, bagged and moved to the storage yard. Minimal liquid discharges to the receiving environment from the treated lumber after leaving the treatment plant. Fixations tests are performed in accordance to the TRD to evaluate treatment effectiveness.

As required by the federal TRD process, a network of groundwater monitoring wells would be installed to evaluate groundwater conditions before, during, and upon decommissioning of the treatment operation. Monitoring parameters and frequency would be developed in consultation with the local Department of the Environment.

(v) As with all other Goodfellow treatment operations, site-specific contingency plans will be developed for the Deer Lake Facility outlining key responsible parties and contact information, spill containment and clean up procedures, fire emergency procedures and reporting requirements.

(vi) Occupations: The plant will directly employ approximately five full-time staff. Many indirect employment benefits will result from the operation including local mills, trucking companies and lumber distributors across the region.

Project-related Document: Pressure treated lumber facilities throughout Canada operate under the *Recommendations for the Design and Operation of Wood Preservation Facilities, 2004 – Technical Recommendations Document (TRD)*, developed in conjunction with Environment Canada.

APPROVAL OF THE UNDERTAKING:
Additional approval required for the planned undertaking include a municipally issued building permit. This approval is pending; however, there has been no indication noted to date suggesting an issue with obtaining approval, construction or operation of the facility in the Industrial Park.

SCHEDULE:
Construction of the proposed treatment facility will begin upon issue of approvals, with an anticipated construction period of five months. Assuming approvals are granted by May 1, 2011, the plant should be operational by mid to late September, 2011. If the plant is not operational by September, the entire fall construction window will be jeopardized.

FUNDING:

Project Estimate:

| | |
|---|---|
| - Land 2 acres @ $10,000 / acre (or less) | $20,000 |
| - Land improvements – fill, water, sewer, utilities, etc. | $100,000 |
| - Equipment – Cylinder & Tanks (from decommissioned plant St-Andre, Quebec), Vacuum Pumps, Pressure Pumps, Piping, etc. | $250,000 |
| - Building & Infrastructure (80' x 120' - Wood or Steel structure) | $240,000 |
| - Lift truck, computer, equipment, misc. | $140,000 |
| **TOTAL Estimated Capital Requirement** | **$750,000** |
| - Inventory & Receivables (60 days) | |
| - 1 million fbm @ $500/m | $500,000 |
| - Receivable 60 days | $750,000 |
| **TOTAL** | **$1,250,000** |

AVAILABLE RESOURCES

| | |
|---|---|
| - Operating line Goodfellow | $1.25 m |
| - Capex – Goodfellow | $500 m |
| - Repayable loan 3 yr. non-interest bearing Gov't of NL (BAF) | $150 m |
| - Direct grant BAF | $100 m |
| **TOTAL** | **$750 m** |

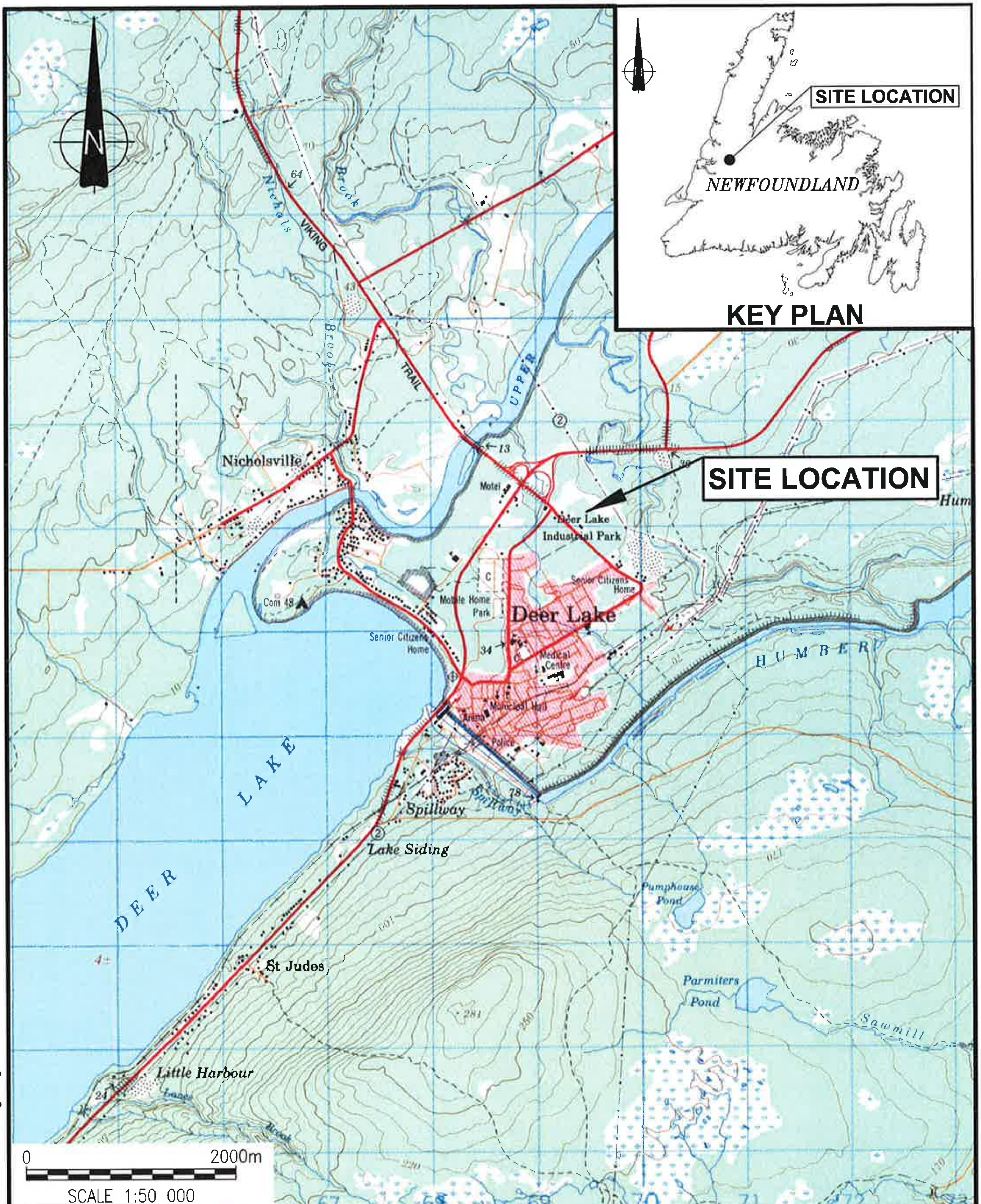
No other sources of funding are required. Loan would be secured by plant.

Pressure Treating has been a profitable business for over 30 years for Goodfellow. Margins are low, but the reduced trucking and use of local resources will ensure the projects profitability and sustainability.

Date

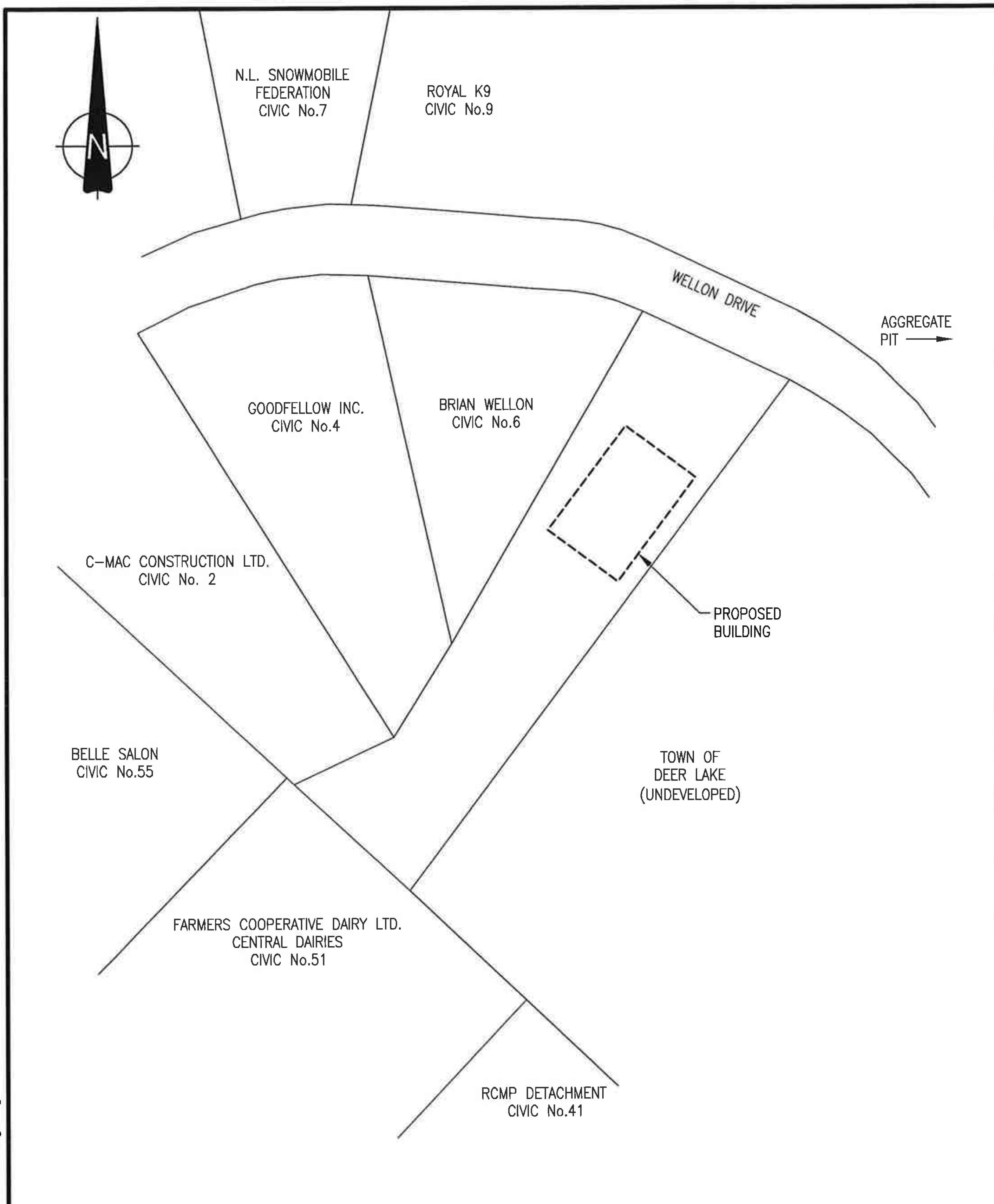
Richard Goodfellow, President

# APPENDIX 1
Site Figure




FileName:g:\cad\008142\march 2011 deer lake\fig 1.dwg

| | | |
|---|---|---|
| DILLON CONSULTING | PROJECT: GOODFELLOW DEER LAKE, NL | PROJECT NO. 00-8142 |
| DATE: MARCH 2011 | TITLE: SITE LOCATION | FIGURE NO. 1 |




APPROXIMATE SCALE: 1:1500

| | | |
|---|---|---|
| DILLON CONSULTING | PROJECT **GOODFELLOW DEER LAKE, NL** | PROJECT NO. **00-8142** |
| DATE **MARCH 2011** | TITLE **SITE PLAN AND SURROUNDING PROPERTIES** | FIGURE NO. **2** |

FileName:g:\cad\008142\march 2011 deer lake\fig 2.dwg


DILLON CONSULTING

DATE MARCH 2011

PROJECT GOODFELLOW DEER LAKE, NL

PROJECT NO. 00-8142

TITLE AERIAL PHOTOGRAPH - 2001

FIGURE NO. 3

FileName:g:\cad\008142\march 2011 deer lake\fig 3.dwg

Appendix 2
ACQ Material Safety Data Sheet

# Timber Specialties Co.

# Material Safety Data Sheet

MATERIAL SAFETY DATA SHEET: **NW Treated Wood**

## SECTION I

| | |
|---|---|
| **MSDS NUMBER:** | 263-Tim |
| **MSDS CODE:** | TIM |
| **SYNONYMS:** | N/A |
| **MANUFACTURED BY:** | Customers of Timber Specialties Co. |
| **DIVISION:** | WPD |
| **EPA REGISTRATION NUMBER:** | N/A |
| **VENDOR:** | N/A |
| **EMERGENCY PHONE:** | 905-854-2244 |
| **OTHER CALLS:** | 905-854-2244 |
| **ADDRESS:** | 35 Crawford Cres., Campbellville, Ontario L0P 1B0 |
| **MSDS PREPARED BY:** | Teri Muchow |
| **DATE PREPARED:**<br>**DATE LAST REVISED:** | February 7, 2003<br>September 11, 2008 (replaces April 7, 2008) |

## IMPORTANT INFORMATION

- **Do Not Burn Preserved Wood**
- **Do Not Use Preserved Wood As Mulch**
- **Treated Or Untreated Wood Dust May Cause Eye, Skin & Respiratory Irritation**
- **Some Wood Species May Cause Allergic Skin Or Respiratory Effects In Sensitized Individuals**
- **Wear Dust Mask & Goggles and Cover Skin When Cutting Or Sanding Wood**
- **Wear Gloves When Working With Treated or Untreated Wood**
- **Prolonged Contact with Treated Wood During Construction or Other Extensive or Abrasive Handling May Cause Skin Irritation, and in Extreme Circumstances Can Result in Chemical Burns.**
- **Some Preservative May Migrate Into The Soil/Water Or Dislodge From Wood**

## SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

| **TRADE NAME: NW Treated Wood**<br><br>INGREDIENT NAME | CAS | OSHA PEL/TWA | ACGIH TLV/TWA | % |
|---|---|---|---|---|
| Wood/Wood Dust (*This represents the maximum amount of wood dust that could be generated if the wood was completely machined. Exposure limits are for all species except western red cedar, which has a TLV of 0.5 $mg/m^3$*) | N/A | 15 $mg/m^3$ (Total Dust)<br>5 $mg/m^3$ (Respirable dust) | 1 $mg/m^3$ (Inhalable) | 90 – 98 |
| Monoethanolamine (MEA) | 141-43-5 | 3 ppm TWA<br>6 mg/m3 TWA | 3 ppm TWA<br>6 ppm STEL | 1.1 – 4.4 |
| Copper complex expressed as Copper Oxides | Proprietary | 0.1 mg/m3 TWA (fume) | 0.2 mg/m3 TWA (fume) | 0.3 – 1.3 |
| Boric Acid | 10043-35-3 | N/A | 2 mg/m3 TWA<br>6 mg/m3 STEL | 0.2 – 0.7 |
| ***This product contains <u>one</u> of the below listed Quaternary Ammonium compounds depending on which preservative is used at the treating plant.*** | | | | |
| Alkyl dimethyl benzyl ammonium chloride | 68391-01-5 | N/A | N/A | 0.2 – 0.6 |
| Didecyl dimethyl ammonium carbonate and Didecyl dimethyl ammonium bicarbonate | Proprietary | None Established | None Established | 0.2 – 0.6 |

## PERCENTAGE OF ACTIVE INGREDIENTS PER RETENTION LEVEL

| | 2.4 $kg/m^3$ (0.15 pcf) | 4.0 $kg/m^3$ (0.25 pcf) | 6.4 $kg/m^3$ (0.40 pcf) | 9.6 $kg/m^3$ (0.60 pcf) |
|---|---|---|---|---|
| Copper complex expressed as Copper Oxides | 0.27 | 0.45 | 0.72 | 1.07 |
| Quaternary ammonium compound | 0.15 | 0.22 | 0.36 | 0.53 |

| | |
|---|---|
| INHALATION: | Wood dust, treated and untreated, is irritating to the nose, throat and lungs. Symptoms may include nasal dryness, deposits or obstructions in the nasal passages, coughing, sneezing, dryness and soreness of throat and sinuses, hoarseness, and wheezing. Prolonged or repeated inhalation of wood dusts may cause respiratory irritation, recurrent bronchitis and prolonged colds. Some species may cause allergic respiratory reactions with asthma-like symptoms in sensitized individuals. Prolonged exposure to wood dusts by inhalation has been reported to be associated with nasal and paranasal cancer. |

CHRONIC OVEREXPOSURE: Prolonged exposure to wood dusts by inhalation has been reported to be associated with nasal and paranasal cancer. Some wood species may cause dermatitis or allergic skin reactions in sensitized individuals.
CHEMICAL LISTED AS A CARCINOGEN OR POTENTIAL CARCINOGEN?: NatureWood and its components are not listed as carcinogens by ACGIH, NIOSH, or IARC. ACGIH, NIOSH and IARC classify wood dust as a human carcinogen or occupational carcinogen. This classification is based on an increased incidence of nasal and paranasal cancers in people exposed to wood dusts.
MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: Pre-existing eye, respiratory system and skin conditions.
TOXICITY: While acute toxicity testing has not been performed on the treated wood, the following information is available on the chemical components that may have been used in the treating of Naturewood.

| **Monoethanolamine (CAS #141-43-5)** | **Copper complex (expressed as Copper oxides)** |
|---|---|
| Oral LD50 Rat: 1720 mg/kg<br>Oral LD50 Mouse: 700 mg/kg<br>Dermal LD50 Rabbit: 1 mg/kg<br>IDLH: 30 ppm | Oral LD50 Rat: 1350 mg/kg<br>Inhalation LC50 Rat: 2000 ppm/4H<br>Dusts as mists as Cu: 100 mg/m3 IDLH (related to copper) |
| **Boric Acid (CAS #10043-35-3)** | **Alkyl Dimethy benzyl ammonium chloride (CAS #68391-01-5)** |
| Oral LD50 Rat: 2660 mg/kg<br>Oral LD50 Mouse: 3450 mg/kg | Oral LD50 Rat: 735 mg/kg for males and females combined<br>Dermal LD50 Rat: 3350 mg/kg for males and females combined |
| **Didecyl dimethyl ammonium carbonate and Didecyl dimethyl ammonium bicarbonate* (CAS Proprietary)** | |
| Oral $LD_{50}$ (rat): 245 mg/kg<br>Skin Irritation (rabbit): Corrosive<br>Photosensitization (Guinea pig): Not a sensitizer or photoallergen | |

## EMERGENCY AND FIRST AID PROCEDURES

**EMERGENCY PHONE NUMBER OF MANUFACTURER: 905-854-2244**

| | |
|---|---|
| 1. INHALATION: | If dusts are inhaled, remove person to fresh air. If symptoms persist, get medical attention. |
| 2. EYE CONTACT: | Immediately flush eyes with plenty of water for at least 15 minutes. Seek medical attention if symptoms persist. |
| 3. SKIN CONTACT: | For skin contact, wash immediately with soap and water. Continue flushing skin with water for 15 minutes. If irritation persists, get medical attention. If wood splinters are injected under the skin, get medical attention immediately. |
| 4. INGESTION: | If the material is swallowed, get immediate medical attention or advice – Do not induce vomiting. |

NOTE TO PHYSICIAN: Respiratory ailments and pre-existing skin conditions may be aggravated by exposure to wood dust.

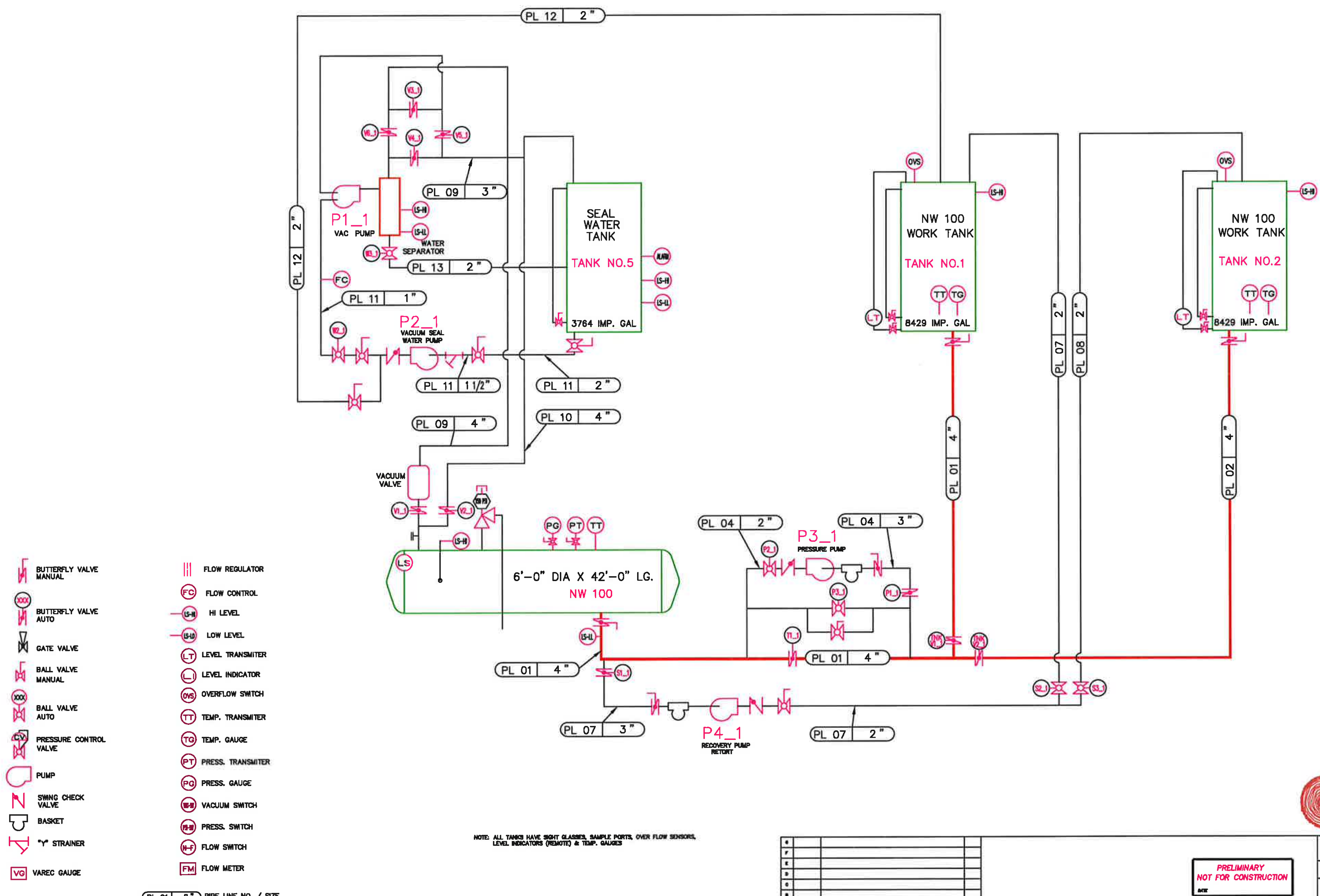
## SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

US DOT SHIPPING DESCRIPTION: Not regulated.

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Avoid working with freshly treated wet wood. If not possible, wear long sleeve shirt, long pants and gloves when working with freshly treated wet wood. Clothing should be removed and replaced if it becomes wet due to contact with freshly treated wood. Avoid contact of wood and wood dusts with skin and eyes. Avoid inhalation of airborne contaminants as a result of cutting or sawing treated wood. Do not eat, drink or smoke when handling this material or in areas where dusts of this product are present.
OTHER PRECAUTIONS: Do not generate airborne dusts in the presence of an ignition source when sawing, cutting or grinding wood. Wash hands after handling and before eating. Maintain good housekeeping procedures, such as sweeping regularly to avoid accumulation of dusts. Store away from excessive heat, sparks and open flame.

Appendix 3
Proposed Treatment Plant Design

# P & I D NW 100 TREATING PROCESS
## 6'–0"DIA X 42'–0" LG
## P.L.C. CONTROL PROCESS




NOTE: ALL TANKS HAVE SIGHT GLASSES, SAMPLE PORTS, OVER FLOW SENSORS, LEVEL INDICATORS (REMOTE) & TEMP. GAUGES

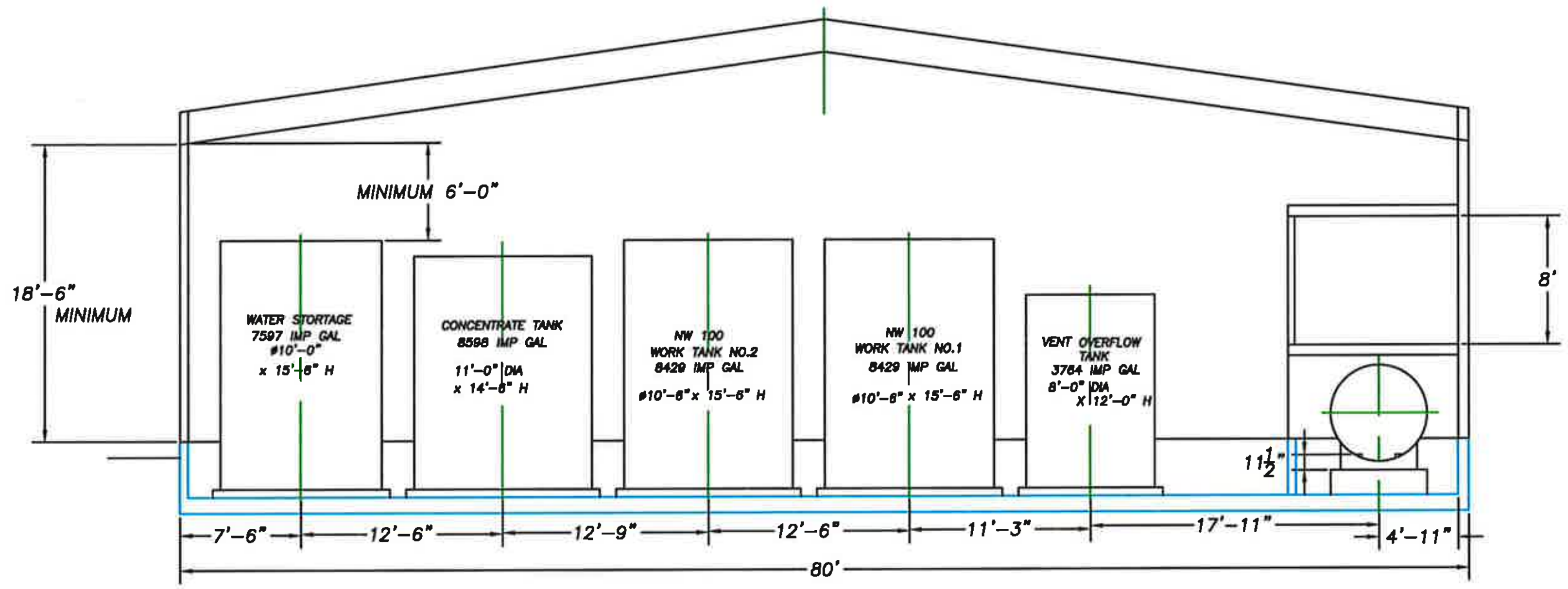
PRELIMINARY
NOT FOR CONSTRUCTION

Timber Specialties Co.
Campbellville, Ontario, Canada

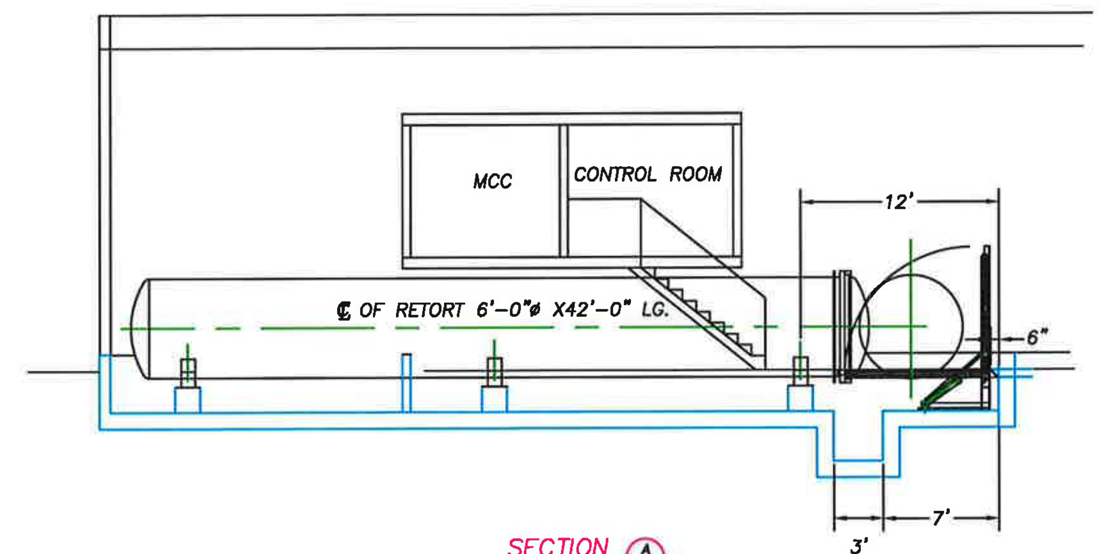
| | | | | |
|---|---|---|---|---|
| TP10NF01 | NTS<br>AUG.2010 | | | B.S. |

GOODFELLOW INC.
DEER LAKE NF

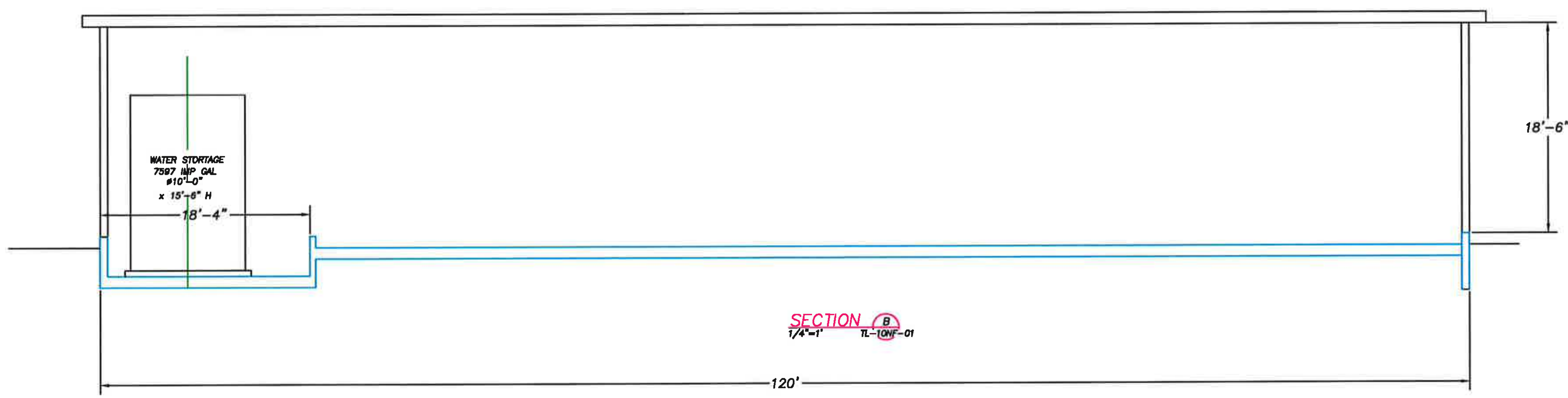
P & I D TREATING PROCESS | TP–10NF–01




SECTION C
1/4"=1' TL–10NF–01




SECTION A
1/4"=1' TL–10NF–01




SECTION B
1/4"=1' TL–10NF–01

PRELIMINARY
NOT FOR CONSTRUCTION

| REV. | DATE | DESCRIPTION | BY |
|---|---|---|---|
| G | | | |
| F | | | |
| E | | | |
| D | | | |
| C | | | |
| B | | | |
| A | | | |

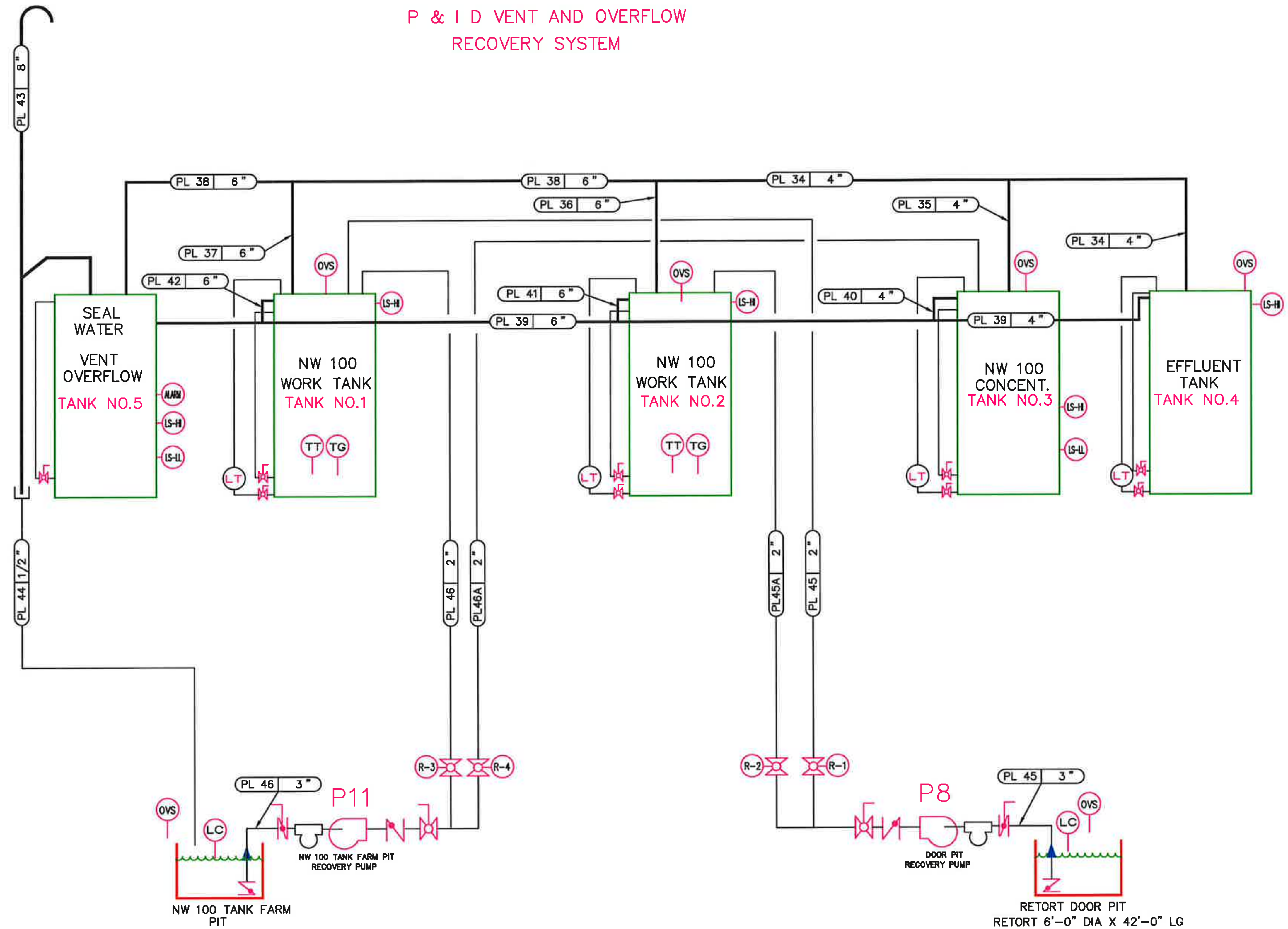
Timber Specialties Co.
Campbellville, Ontario, Canada

| TL10NF02 | 3/16"=1' JULY 2010 | | | B.S. |
|---|---|---|---|---|

GOODFELLOW INC.
DEER LEKE N.F.

TREATING PLANT LAYOUT SECTION | TL–10NF–02

# P & I D VENT AND OVERFLOW RECOVERY SYSTEM




- VG VAREC GAUGE
- BUTTERFLY VALVE MANUAL
- BUTTERFLY VALVE AUTO
- GATE VALVE
- BALL VALVE MANUAL
- BALL VALVE AUTO
- PRESSURE CONTROL VALVE
- PUMP
- SWING CHECK VALVE
- BASKET
- "Y" STRAINER
- FLOW REGULATOR
- HI LEVEL
- LOW LEVEL
- LT LEVEL TRANSMITER
- LEVEL INDICATOR
- OVS OVERFLOW SWITCH
- TT TEMP. TRANSMITER
- TG TEMP. GAUGE
- PT PRESS. TRANSMITER
- PG PRESS. GAUGE
- VACUUM SWITCH
- PRESS. SWITCH
- FLOW SWITCH
- FM FLOW METER
- PL 40 2" PIPE LINE NO. / SIZE

NOTE: ALL TANKS HAVE SIGHT GLASSES, SAMPLE PORTS, OVER FLOW SENSORS, LEVEL INDICATORS (REMOTE) & TEMP. GAUGES

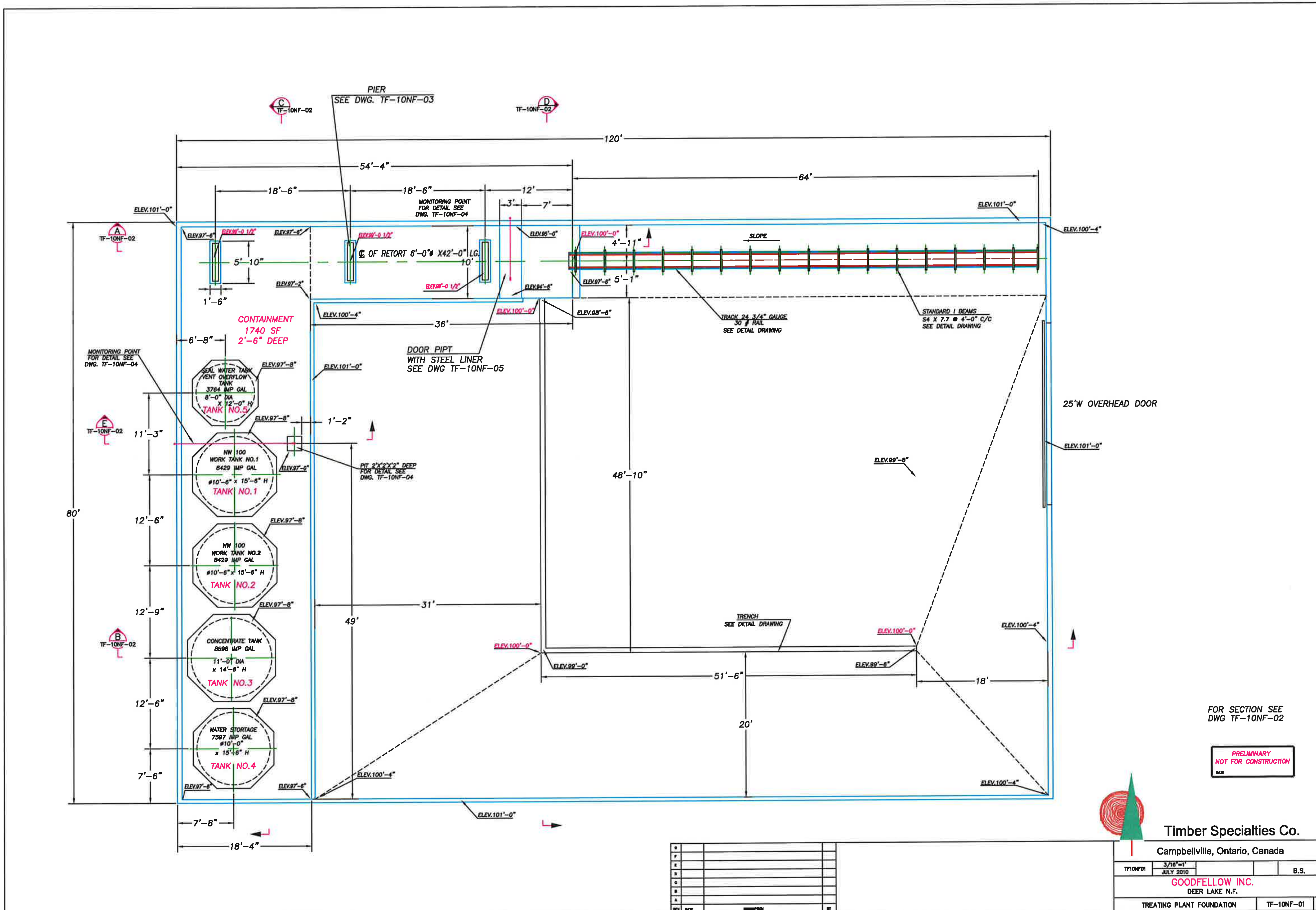
Timber Specialties Co.

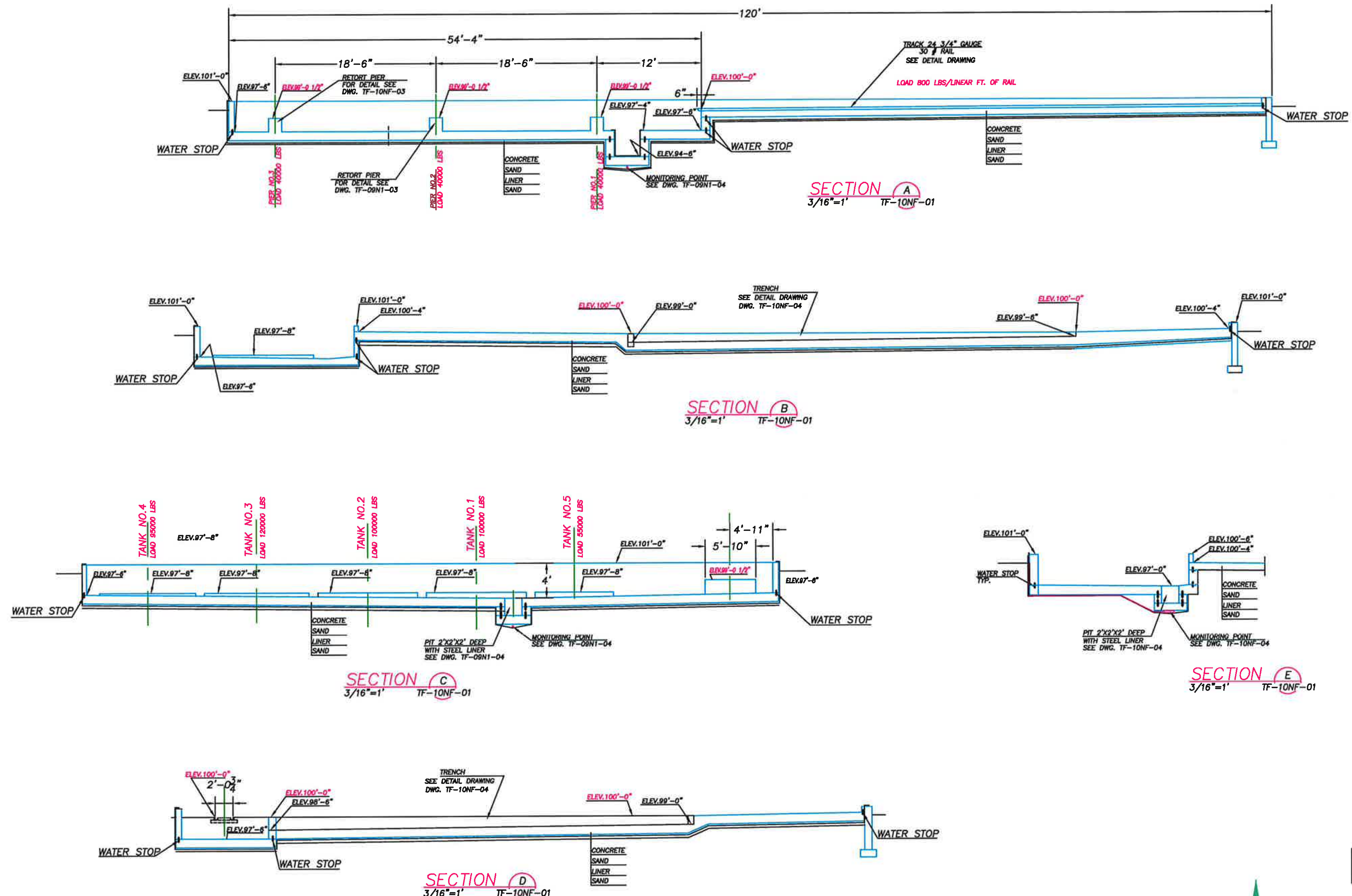
Campbellville, Ontario, Canada

| | | | | |
|---|---|---|---|---|
| TP10NF03 | NTS<br>AUG.2010 | | | B.S. |

GOODFELLOW INC.
DEER LAKE NF.

| | | |
|---|---|---|
| P & I D VENT AND OVERFLOW | TP-10NF-03 | 0 |


PIER
SEE DWG. TF-10NF-03
TF-10NF-02
120'
54'-4"
64'
18'-6"
18'-6"
12'
3'
7'
MONITORING POINT FOR DETAIL SEE DWG. TF-10NF-04
ELEV.101'-0"
ELEV.100'-4"
℄ OF RETORT 6'-0"ø X42'-0" LG.
5'-10"
10'
4'-11"
5'-1"
1'-6"
SLOPE
TRACK 24 3/4" GAUGE 30 # RAIL SEE DETAIL DRAWING
STANDARD I BEAMS S4 X 7.7 @ 4'-0" C/C SEE DETAIL DRAWING
CONTAINMENT
1740 SF
2'-6" DEEP
36'
6'-8"
DOOR PIPT
WITH STEEL LINER
SEE DWG TF-10NF-05
SEAL WATER TANK VENT OVERFLOW TANK 3764 IMP GAL 8'-0" DIA x 12'-0" H
TANK NO.5
1'-2"
PIT 2'X2'X2' DEEP FOR DETAIL SEE DWG. TF-10NF-04
NW 100 WORK TANK NO.1 8429 IMP GAL ø10'-6" x 15'-6" H
TANK NO.1
NW 100 WORK TANK NO.2 8429 IMP GAL ø10'-6" x 15'-6" H
TANK NO.2
CONCENTRATE TANK 8598 IMP GAL 11'-0" DIA x 14'-8" H
TANK NO.3
WATER STORTAGE 7597 IMP GAL ø10'-0" x 15'-6" H
TANK NO.4
80'
11'-3"
12'-6"
12'-9"
12'-6"
7'-6"
48'-10"
49'
31'
25'W OVERHEAD DOOR
ELEV.99'-8"
TRENCH SEE DETAIL DRAWING
ELEV.100'-0"
ELEV.99'-0"
51'-6"
18'
20'
7'-8"
18'-4"
FOR SECTION SEE DWG TF-10NF-02
PRELIMINARY NOT FOR CONSTRUCTION
Timber Specialties Co.
Campbellville, Ontario, Canada
TF10NF01
3/16"=1'
JULY 2010
B.S.
GOODFELLOW INC.
DEER LAKE N.F.
TREATING PLANT FOUNDATION
TF-10NF-01



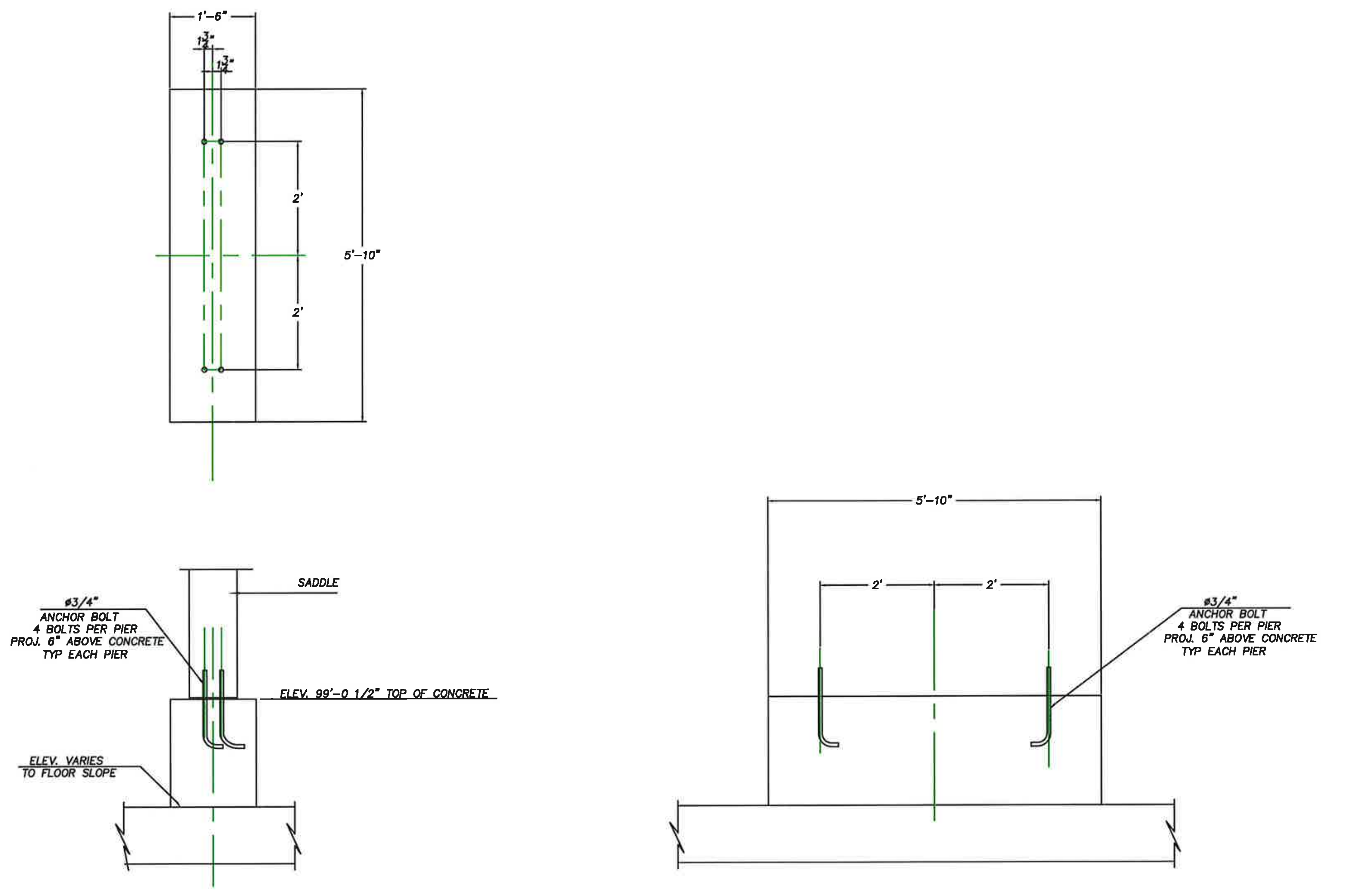

PRELIMINARY
NOT FOR CONSTRUCTION

Timber Specialties Co.
Campbellville, Ontario, Canada

| | | | |
|---|---|---|---|
| TF10NF02 | 3/16"=1' JULY 2010 | | B.S. |

GOODFELLOW INC.
DEER LAKE N.F.

TREATING PLANT FOUNDATION SECTION | TF-10NF-02




ELEV. TYP.
PIER 1 , 2 , 3

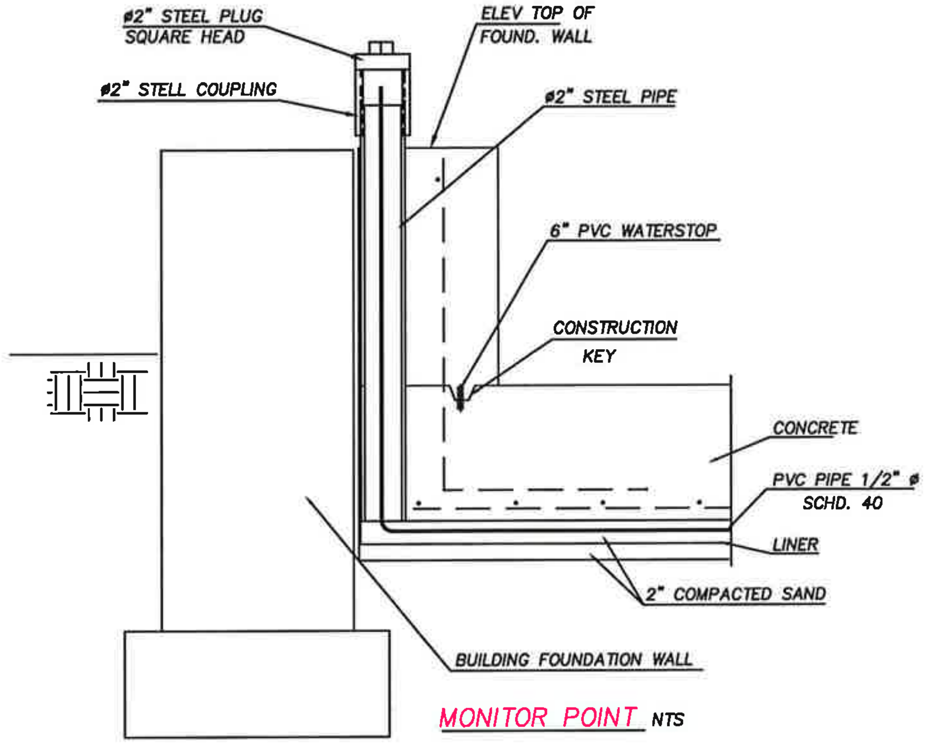
PRELIMINARY
NOT FOR CONSTRUCTION

Timber Specialties Co.
Campbellville, Ontario, Canada

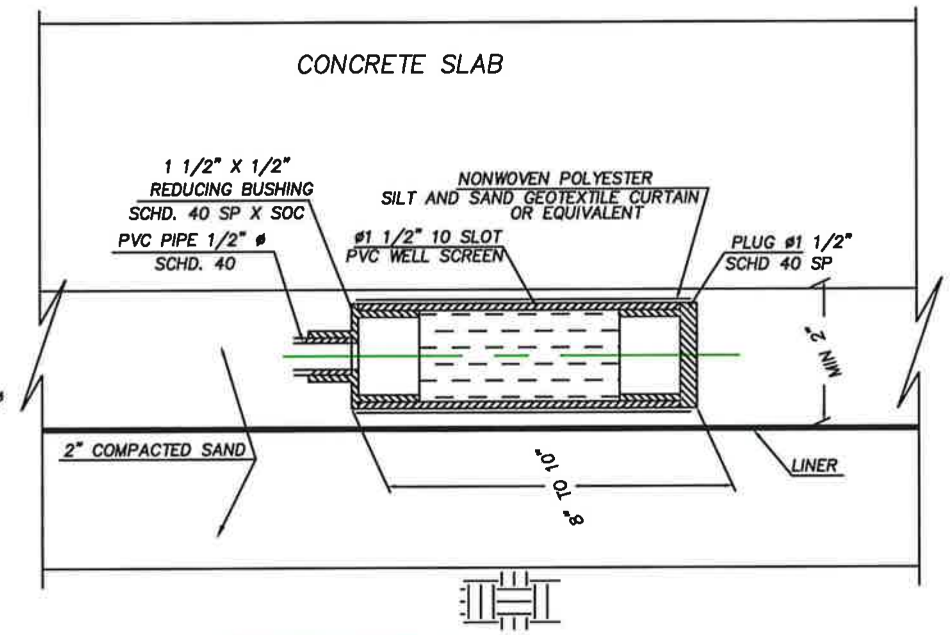
| | | | |
|---|---|---|---|
| TF10NF03 | 1"=1' / AUG. 2010 | | B.S. |

GOODFELLOW INC.
DEER LAKE NF.

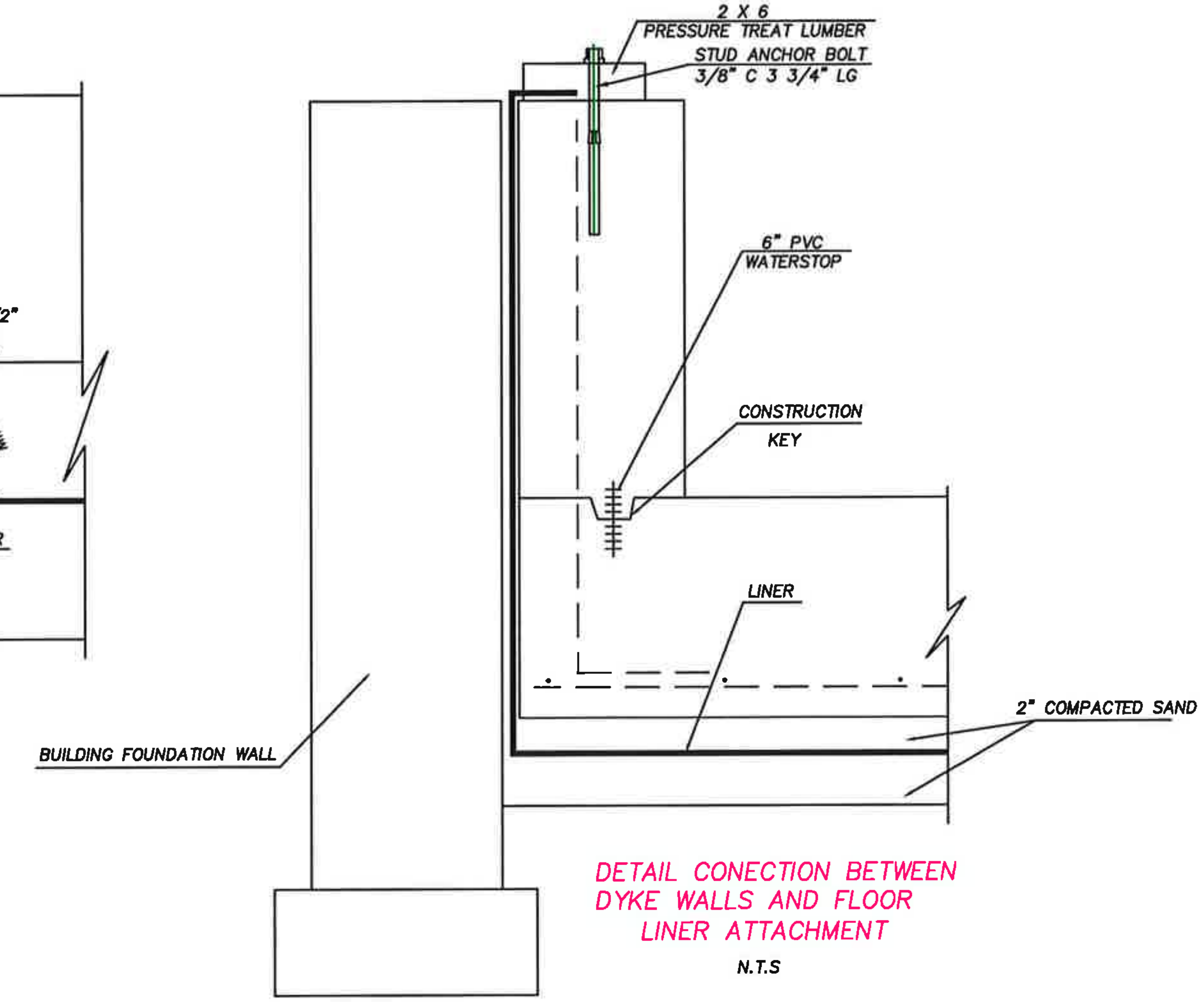
| | | |
|---|---|---|
| FOUNDATION DETAIL PIER NO.1,2,3 | TF–10NF–03 | 0 |



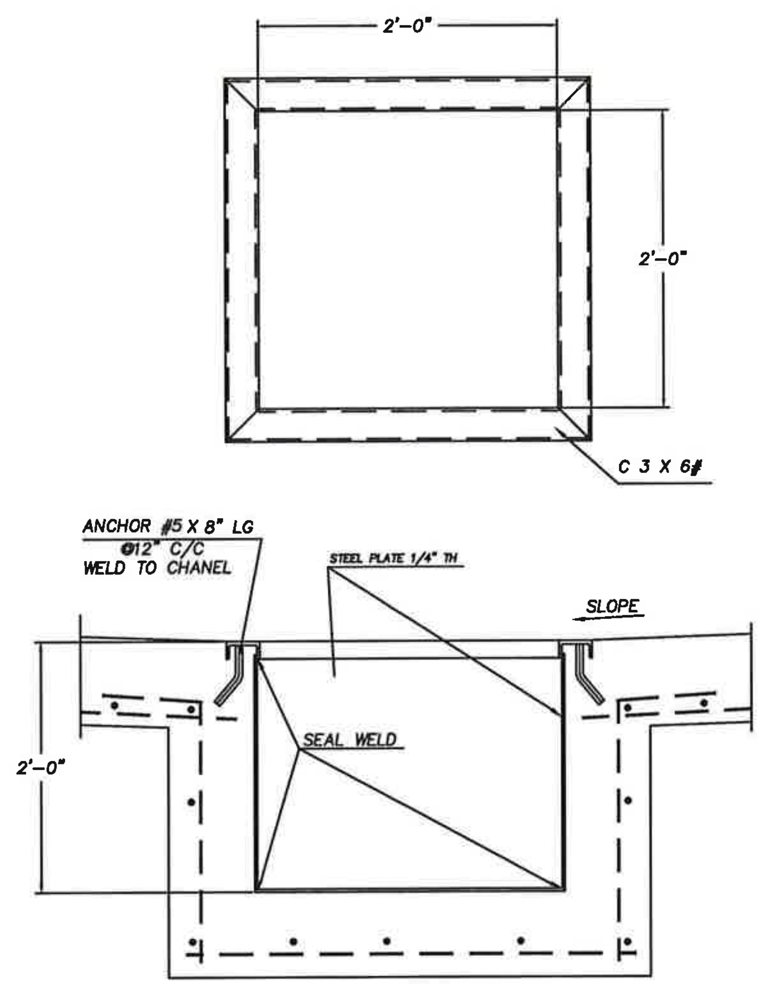

MONITOR POINT NTS




MONITOR POINT NTS

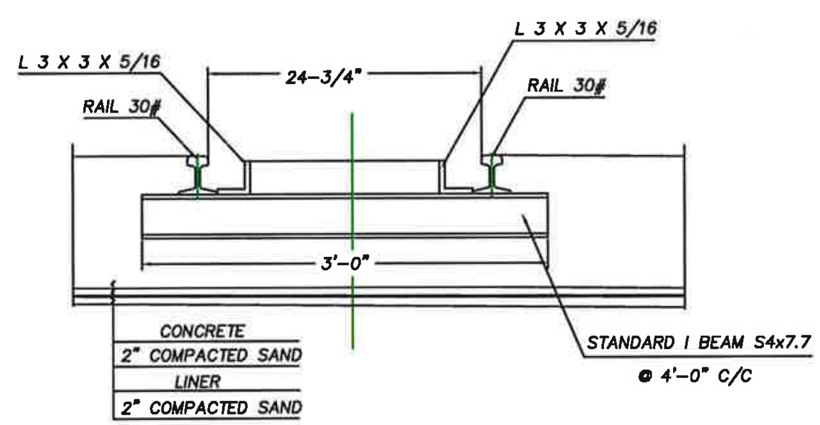



DETAIL CONECTION BETWEEN
DYKE WALLS AND FLOOR
LINER ATTACHMENT
N.T.S

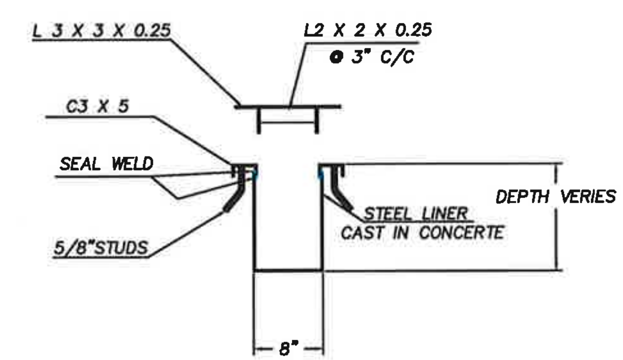



PIT DETAIL

PIT 2' X 2' X 2' DEEP
N.T.S.




TRACK DETAIL
N.T.S.




TRENCH

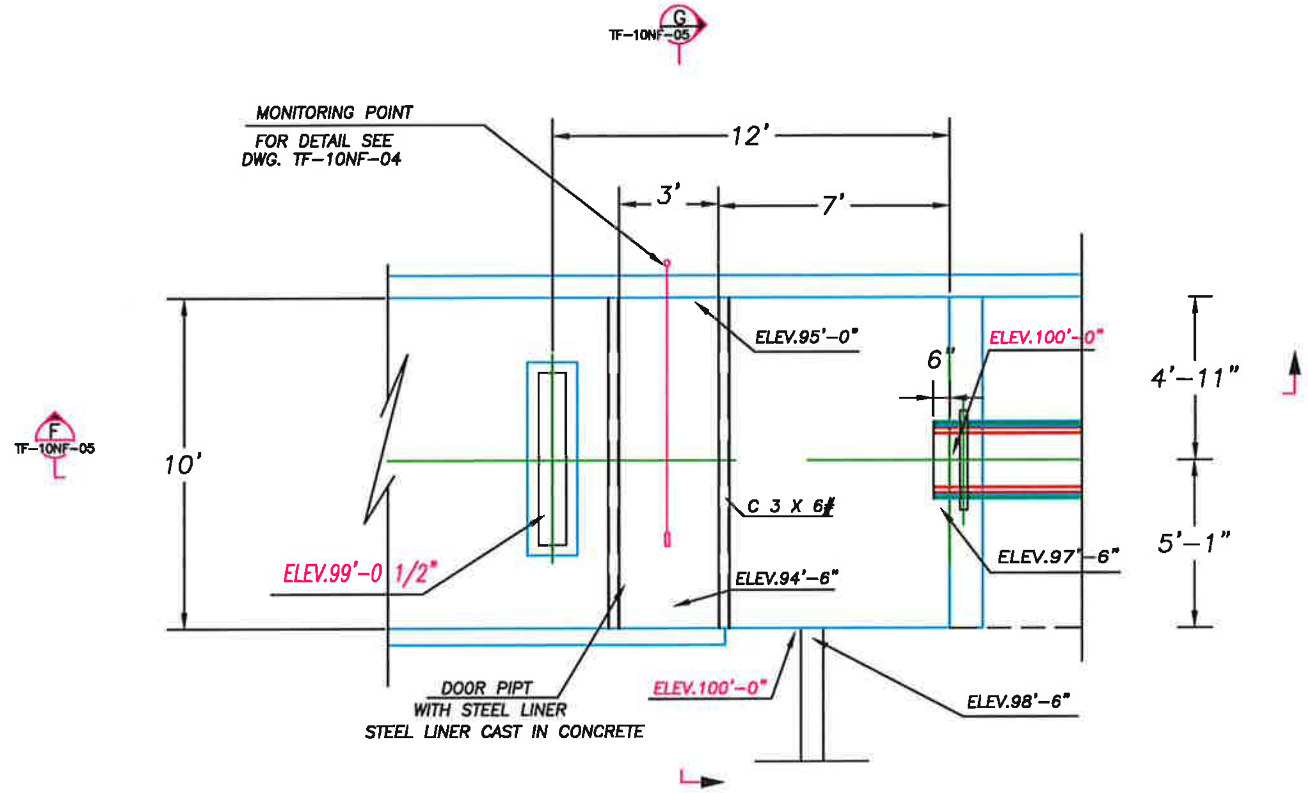
PRELIMINARY
NOT FOR CONSTRUCTION

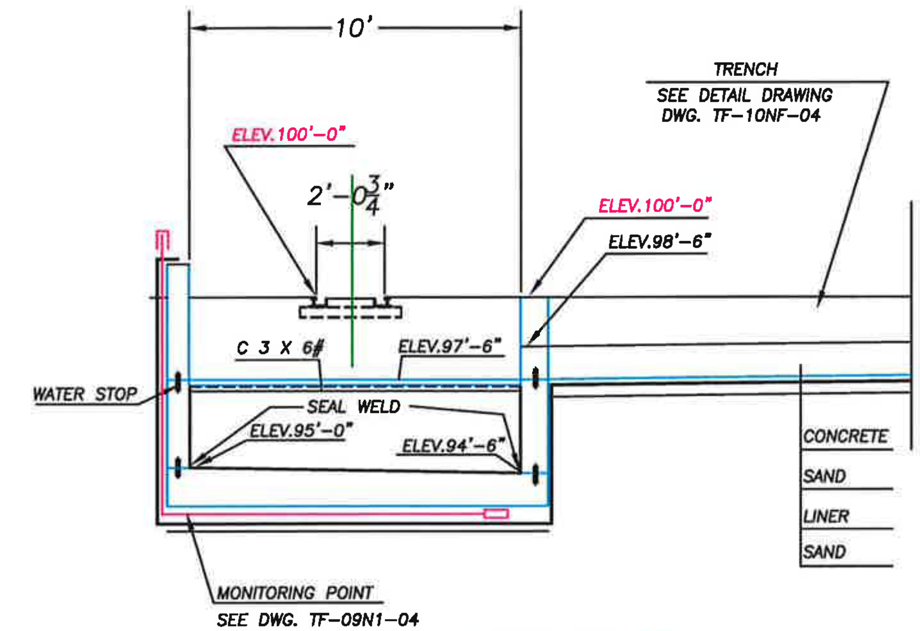
Timber Specialties Co.
Campbellville, Ontario, Canada

| | | | |
|---|---|---|---|
| TF10NFD4 | 3/8"=1' AUG.2010 | | B.S. |

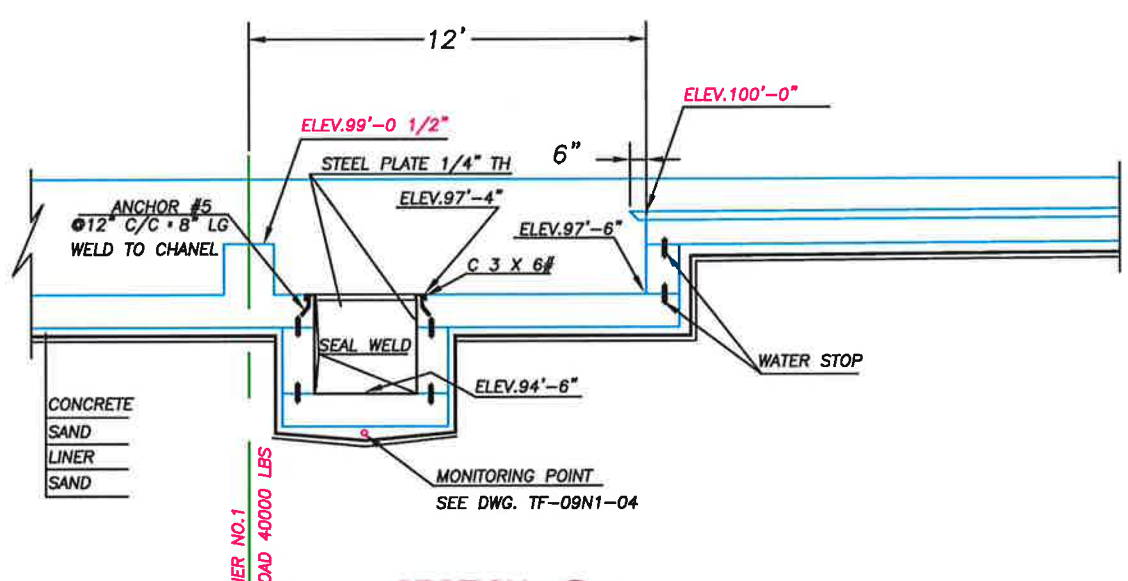
GOODFELLOW INC.
DEER LAKE NF.

| | | |
|---|---|---|
| FOUNDATION DETAILS | TF-10NF-04 | 0 |




SECTION G
3/8"=1' TF-10NF-05




SECTION F
3/8"=1' TF-10NF-05

PRELIMINARY
NOT FOR CONSTRUCTION

Timber Specialties Co.
Campbellville, Ontario, Canada

| | | | |
|---|---|---|---|
| TF10NF05 | 3/8"=1' AUG. 2010 | | B.S. |

GOODFELLOW INC.
DEER LAKE N.F.

TREATING PLANT FOUNDATION DOOR PIT | TF-10NF-05

Appendix 4

*Recommendations for the Design and Operation of Wood Preservation Facilities, 2004 – Technical Recommendations Document*

Environment Canada    Environnement Canada

# Recommendations for the design and operation of wood preservation facilities, 2004

## Technical recommendations document

Report EPS 2/WP/6

Prepared for
Environment Canada
(National Office of Pollution Prevention)
and the
Canadian Institute of Treated Wood
by
G.E. Brudermann, Frido Consulting

# Recommendations for the design and operation of wood preservation facilities, 2004

Technical recommendations document

April 2004

# Recommendations for the design and operation of wood preservation facilities, 2004

## Technical recommendations document

Report EPS 2/WP/6

Prepared for

Environment Canada
(National Office of Pollution Prevention)

and the

Canadian Institute of Treated Wood

by

G.E. Brudermann, Frido Consulting

Ce document est également disponible en français sous le titre *Recommandations pour la conception et l'exploitation des installations de préservation du bois, 2004 : document de recommandations techniques.*

This guidance manual (also referred to as the 2004 TRD) may be cited as follows:

Environment Canada. 2004. Recommendations for the design and operation of wood preservation facilities, 2004: technical recommendations document. Prepared for the National Office of Pollution Prevention, Environment Canada, and the Canadian Institute of Treated Wood by G.E. Brudermann, Frido Consulting. Report EPS 2/WP/6. Available from Environment Canada, Ottawa. Binder and CD. 326 pages.

(It supercedes the five 1988 EPS reports [EPS 2/WP/1, EPS 2/WP/2, EPS 2/WP/3, EPS 2/WP/4, and EPS 2/WP/5] and the previous version of the binder of the same name that was published in March 1999.)

Cat. no.: En40-578/2004E
ISBN: 0-662-36697-2

For additional copies of this binder contact

Environmental Protection Service Publications
Environmental Technology Advancement Directorate
Environment Canada
Ottawa, Ontario CANADA
K1A 0H3
Phone: 819.994.5629 or toll free at 1.800.724.3232
Fax: 819.994.5629
E-mail: epspubs@ec.gc.ca

This document is available on the Environment Canada Web site at the following address:
http://www.ec.gc.ca/toxics/wood-bois/pubs/trd_e.htm



Health and safety information in this publication is provided for general guidance only. It is the responsibility of the owners and operators to ensure that workers are provided with adequate health and safety information.

The printing processes used in producing this document conform to environmental performance standards established by the Government of Canada under *Canada's National Guidelines on Lithographic Printing Services*. These standards aim to ensure the environmental integrity of printing processes through reductions in toxic emissions to the environment, reductions in loading of wastewater, reductions in the quantity of materials sent to landfills, and the implementation of resource conservation procedures.

The paper used in the interior of this document conforms to Canada's *National Printing and Writing Paper Guideline* and/or *Uncoated Mechanical Printing Paper Guideline*. These guidelines set environmental performance standards for fibre-use efficiency, chemical oxygen demand, energy use, global warming potential, acidification potential, and solid waste.

The printing processes and the paper used in the interior of this document are fully certified under Canada's sole ecolabelling program – the Environmental Choice[M] Program (ECP). The Program's official symbol of certification – the EcoLogo[M] – features three stylized doves intertwined to form a maple leaf, representing consumers, industry and government working together to improve Canada's environment.

# Contents of binder

# Regulatory Note

Each wood preservation facility must provide the operators with the most recent labels for all registered pesticides used in the facility.

Pesticide labels are legal documents and must be complied with in accordance with the *Pest Control Products Act*. This includes adherence to use rates, directions for use, and usage of the personal protective equipment recommended on the label. Each facility is responsible for inserting a copy of the most recent label for each registered pesticide used within the facility into this manual. The pocket in the next page is provided for this purpose. Electronic copies of labels may be obtained at http://www.eddenet.pmra-arla.gc.ca/4.0/4.01.asp.

*Recommendations for the design and operation of wood preservation facilities, 2004: technical recommendation document* (2004 TRD), is a guidance manual that establishes best management practices (BMPs) for the design and operation of heavy duty wood preservation facilities. Its primary purpose is to establish benchmarks for design and operation that wood preservation facilities should strive to achieve. The recommendations in this guidance manual are consistent with good pollution prevention practices and environmentally sound management. Conformance with the manual should minimize the environmental and human health effects potentially associated with heavy duty wood preservation facilities.

The target audiences for this guidance manual are the owners and operators of wood preservation facilities and those who are designing new facilities or retrofitting existing ones. In many instances the manual contains general summary information on topics such as potential environmental and human health hazards and environmental effects potentially associated with exposure to these preservatives. Pesticide label compliance is essential to minimizing the risks associated with their use. This should not preclude the users of this guidance manual from obtaining other, more comprehensive information on these topics. This includes the regulatory documents published by Health Canada's Pest Management Regulatory Agency that outline the health and environmental risks of individual pesticides (http://www.hc-sc.gc.ca/pmra-arla/english/pubs/pubs-e.html).

This guidance manual has been designed to allow facilities to insert additional information, so that all information relevant to the design and operation of a facility can be found in one convenient location. For example, facilities are encouraged to keep recent copies of their pesticide labels in this binder. As information may change over time, facilities should ensure that all information is current. At a minimum, annual reviews of content by the facility manager or designated health and safety individual are recommended.

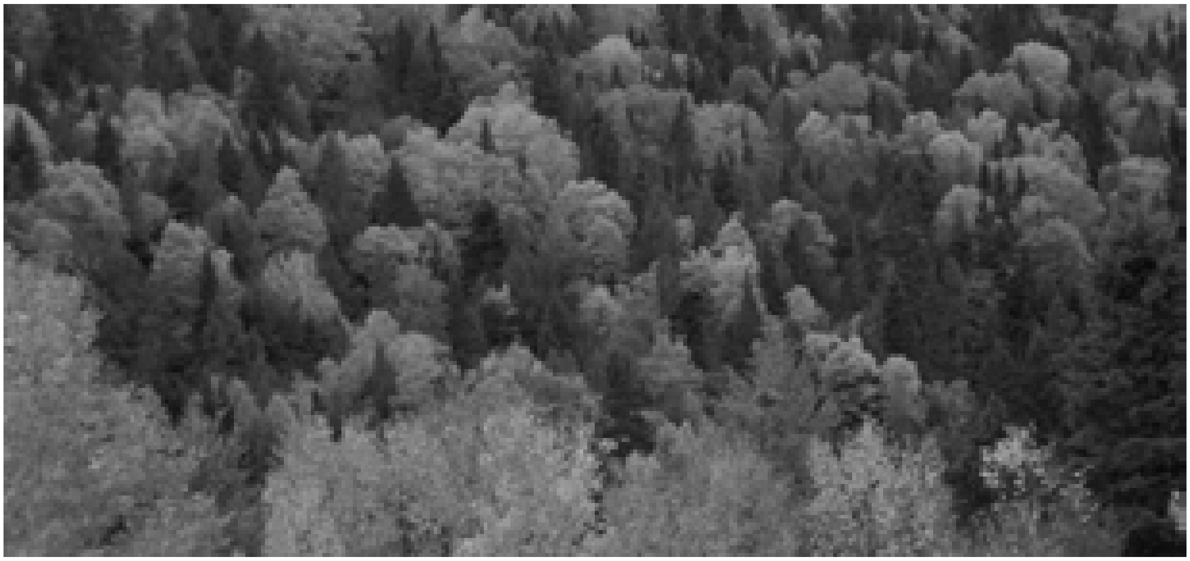
Relation to Federal, Provincial, Territorial and Aboriginal Regulations

This guidance manual provides the Best Management Practices for the wood preservation industry; it does not have regulatory authority unless a federal, provincial, territorial or aboriginal authority having jurisdiction has adopted its recommendations. Conformance with this guidance manual does not absolve a facility from its other legal obligations under the applicable laws and regulations of municipal, aboriginal, provincial, territorial or federal authorities.

Provincial regulation of heavy duty wood preservation facilities and industrial operations in general varies across Canada. Each facility should consult with all authorities that may have jurisdiction over it and its operations.

Pocket for pesticide labels

Please insert copies of the most recent labels for the registered pesticides used within your facility



# Foreword

Wood exposed outdoors is subject to degradation by various organisms, including fungi, insects and marine borers. The impregnation of wood with preservative chemicals retards or prevents its destruction by these agents. By design, such preservative chemicals must be toxic to the target organisms. However, their use may also affect non-target biota and the environment, unless proper safeguards are taken. Like many other industrial chemicals, wood preservatives require proper handling to prevent hazards in the workplace and during transportation and storage, as well as to avoid emissions from the process and the treated product.

In 1984, Environment Canada, as part of a federal strategy to protect the environment and human health from potentially toxic commercial chemicals, evaluated use practices within the wood preservation industry. The department subsequently initiated a technical steering committee to develop technical recommendations for facility design and operations.

The objectives were to develop recommendations that would outline practices to:

- reduce or eliminate the release of wood preservative chemicals to the environment;
- minimize the exposure of workers to wood preservative chemicals.

The development process, which included the participation of representatives from federal and provincial government agencies, the wood preservation industry, forest industry labour unions, and workers' compensation boards, concluded with the publication of five technical recommendations documents (TRDs) in 1988 (1, 2, 3, 4, 5). The documents covered good practices for pressure treatment with each of the major wood preservatives then in use: chromated copper arsenate (CCA), ammoniacal copper arsenate (ACA), pressure treatment with pentachlorophenol (PCPP), thermal treatment with pentachlorophenol (PCPT) and creosote.

These documents have since been widely applied in Canada to the construction of new facilities and the upgrading of existing wood preservation plants. In addition, international technical guide documents for the preservation industry have made use of information contained in the Canadian TRDs from 1988 (6, 7).

The measures recommended in the 1988 TRDs were based on knowledge of the existing technology and the properties of the preservative chemicals at the time of their development. However, since the publication of the 1988 TRDs, a variety of new and modified operating technologies have been developed, environmental compliance criteria have changed, and knowledge of the properties of the chemicals has been expanded. Hence, it was deemed necessary to review the TRDs, update information where appropriate, and include any new technologies to take advantage of improved design and operational practices.

In response to the need to update the 1988 TRDs, Environment Canada and the Canadian Institute of Treated Wood (CITW) initiated development of a single revised TRD, which was published in March 1999(8). A review of the 1988 TRDs was organized by CITW and was undertaken by industry members. The industry comments were compiled by Frido Consulting. Relevant industry information, as well as additional information from the open literature or from experts and regulatory agencies, was also used to update the recommendations. The document underwent four draft stages, each entailing reviews and comments by industry, as well as federal and provincial regulatory personnel. It was finalized by a technical coordinating committee.

As indicated above, the 1988 recommendations were presented in five comprehensive documents. These have been found to be user-friendly in format and general content. However, there were many subjects and recommendations common to all, leading to duplication. To eliminate such duplication, the 1999 TRD included all preservatives and treatments in a single manual. Although the 1999 manual followed the contents and format of the 1988 TRDs as closely as possible, general background information and recommendations applicable to all preservatives were separated from information specific to individual preservatives. This structure made information about individual preservatives easier to find and facilitates additions of new preservatives and any other incidental information.

Following publication of the 1999 manual (1999 TRD) , the working group proceeded with a voluntary program to implement the recommendations at all wood preservation facilities in Canada. The goal of the program is to have all facilities conform with the intention of the TRD by 2005. To meet this goal, the TRD Implementation Program was developed with the following steps:

- Two rounds of information sessions were held across Canada to inform wood preservation facilities about the program.
- A baseline assessment, referred to as Assessment 2000, was conducted at every facility to determine conformance with the TRD.
- Each facility was required to submit an implementation plan by Dec. 31, 2001, which would describe how it intended to correct deficiencies from Assessment 2000.
- On Dec. 31 of years 2002 to 2005 inclusive, facilities are required to submit annual update reports to demonstrate continual improvement towards the 2005 goal.

- Random audits are conducted to determine whether the work conducted at facilities meets the intention of the TRD.

The program generated questions and additional knowledge regarding Best Management Practices. As a result, the 1999 TRD was revised and this updated document was published.

This updated manual, which maintains the format and content of the 1999 version, is meant to provide necessary information on the physico–chemical properties of the industrial wood preservatives. It includes new chapters on the preservatives alkaline copper quaternary (ACQ), copper azole (CA-B) and inorganic boron, which are newly registered in Canada. Ammoniacal copper arsenate (ACA) has been replaced by the new preservative "ammoniacal copper zinc arsenate" (ACZA). As well, the manual contains design and operational measures to enable safe operations in wood preservation facilities in terms of worker exposure and health risks as well as environmental impact.

The document is divided into three major parts: I - General background information and recommendations for wood preservation facilities, II - Preservative-specific information and recommendations for wood preservation facilities, and III - Appendices. Part I contains recommendations applicable to all currently used preservative chemicals. Part II includes specific recommendations for individual preservatives: these are supplementary to those made in Part I and must be used in conjunction with them. Part III contains a summary of the applicable legislation and space for additional documents.

The recommendations contained in this document may not be the only options available to attain the stated objectives. Alternative approaches may be equally effective or more suitable for site-specific conditions. When programs are developed for a particular facility, the recommendations provided may be modified if it can be demonstrated that an alternative approach, more suitable to the plant's conditions, would be equally effective in attaining the objectives. Although the recommendations do reflect currently available best practices, local regulatory authorities may want to deviate to accommodate local conditions.

The CD attached to the inside front of this binder contains a supporting document: "Technical guidelines for the design and operation of wood preservation facilities, 2004: technical guidance document." The technical guidance document contains detailed information and interpretation of general TRD requirements, which will help facilities to conform with the TRD. It also provides clarity, which will ensure consistency from facility to facility.

## References

1. Konasewich, D.E., and F.A. Henning. 1988. Creosote Wood Preservation Facilities: Recommendations for Design and Operation. Report EPS 2/WP/1. Environment Canada, Ottawa.

2. Konasewich, D.E., and F.A. Henning. 1988. Pentachlorophenol Wood Preservation Facilities: Recommendations for Design and Operation. Report EPS 2/WP/2. Environment Canada, Ottawa.

3. Konasewich, D.E., and F.A. Henning. 1988. Chromated Copper Arsenate (CCA) Wood Preservation Facilities: Recommendations for Design and Operation. Report EPS 2/WP/3. Environment Canada, Ottawa.

4. Konasewich, D.E., and F.A. Henning. 1988. Ammoniacal Copper Arsenate (ACA) Wood Preservation Facilities: Recommendations for Design and Operation. Report EPS 2/WP/4. Environment Canada, Ottawa.

5. Konasewich, D.E., and F.A. Henning. 1988. Pentachlorophenol (PCP) Thermal Wood Preservation Facilities: Recommendations for Design and Operation. Report EPS 2/WP/5. Environment Canada, Ottawa.

6. Das, G., and V.N.P. Mathur. 1994. Generic Code of Good Practices for Wood Preservation Facilities. International Research Group on Wood Preservation document presented at annual conference in Indonesia.

7. United Nations Environment Programme. 1994. Environmental Aspects of Industrial Wood Preservation: A Technical Guide. UN Technical Report Series No. 20.

8. Environment Canada. 1999. Recommendations for the Design and Operation of Wood Preservation Facilities. Prepared for the National Office of Pollution Prevention, Environment Canada, and the Canadian Institute of Treated Wood by G.E. Brudermann, Frido Consulting. Available from Environment Canada, Ottawa. Binder.

# Acknowledgements

The current update of this manual was jointly sponsored by Environment Canada and the Canadian Institute of Treated Wood (CITW). The guidance and assistance provided by the representatives of these organizations, C. Englot and H. Walthert, were greatly appreciated.

This manual is based and largely relies on the information contained in the preservative-specific TRDs issued in April 1988. Those documents were co-authored by Dr. D.E. Konasewich and Dr. F.A. Henning of Envirochem Services, whose excellent work is acknowledged.

Special thanks are extended to all CITW members and personnel from Environment Canada who reviewed the 1999 TRD and shared information on current industry practices, best management practices and best available technologies.

# Part I

## General Background Information and Recommendations

# CHAPTER A

# General Background Information and Recommendations

# Contents

## List of tables

## List of figures

# 1 The Need for Wood Preservation

## 1.1 Introduction

Wood preservation is the pressure or thermal impregnation of chemicals into wood to a depth that will provide effective long-term resistance to attack by fungi, insects and marine borers. By extending the service life of timber, wood preservation reduces the harvest of already stressed forestry resources, reduces operating costs in industries such as utility and railroads, and ensures safe conditions where timbers are used as support structures. In addition, a significant part of the treated wood volume is used for residential construction to improve the value of homeowners' investments and provide outdoor living space that is an essential part of the Canadian way of living.

The chemicals predominantly used in Canada for wood preservation are:

- aqueous formulations of arsenic, copper and chromium; borate; or copper, in combination with organic pesticides;
- pentachlorophenol in petroleum oil; and
- creosote and creosote/petroleum oil mixtures.

## 1.2 Wood Deterioration

Timber is subject to several types of deterioration following its removal from the forest. Wood-decaying fungi and insects drastically reduce the usefulness of unprotected lumber and other forest products. Decay reduces wood to its basic components: carbon dioxide and water. This may happen quite rapidly depending on the exposure conditions. As an example, untreated red pine posts were found to be serviceable for only 4.5 years, whereas creosote-treated posts lasted between 40 and 48 years under the same conditions (1). Similarly, railway ties used in North America would have an average life of five years without treatment, whereas treated ties under normal service conditions last in excess of 30 years. Protection is also needed against wood-boring insects. For example, termites are responsible for extensive damage to wood in storage and in service in southern Ontario and on the Pacific Coast. Marine structures, such as untreated dock pilings along North American coasts, can be destroyed by marine borers in less than one year. In contrast, properly preserved wood structures in marine waters are reported to perform for 30 to 45 years (2).

The main enemies of wood and the wood destroyers of greatest commercial importance are decay fungi. The growth of these fungi is dependent upon the temperature, moisture content, oxygen level and nature of the wood. Wood products, such as construction lumber, railway ties, bridge timbers, fence posts and utility poles, are usually in direct contact with moist soil or in locations where moisture collects and cannot readily evaporate. When there is no practical means of controlling the moisture, oxygen level or temperature, the options for the protection of such wood products are limited to the application of chemicals, which prevent fungal growth by making the wood unsuitable as a food source. Simultaneously, the treatment can also protect the wood from other wood-destroying organisms, such as insects and marine borers.

## 1.3 Wood Preservation Chemicals

The preservation of wood by chemical means can be traced back over 4000 years, to the time when the Egyptians apparently used bitumen to treat wooden dowel-pins in the stonework of temples (3). During the Roman Empire, tar, linseed oil, oil of cedar, and mixtures of garlic and vinegar were used for the preservation of wooden statues. Charring of wood surfaces and soaking in brine, alum, arsenic or copper salts were other methods used in Roman times and in the Middle Ages (4). Investigations to define alternative wood preservation agents were reported in the late 1600s. Efforts escalated during the 1800s, when economic considerations, prompted by the need for durable wooden ships and railway ties and trestles, spurred the search for effective preservatives and application methods (5). A review of the many chemicals and chemical formulations used historically and currently can be found in the above references and in texts such as those written by Hunt and Garratt (6) and Wilkinson (7).

Creosote and the full-cell treatment process have been used since the early 1800s, whereas the empty-cell processes were introduced in the first decade of the 20th century. Pentachlorophenol and the water-borne arsenical preservatives became of commercial significance in Canada during the 1950s and 1970s respectively. Current research has yielded not only modifications to existing formulations and treatment technologies but also the introduction of new preservative chemicals. The voluntary withdrawal of CCA from residential markets in 2003 prompted the introduction of new organometallic preservatives, namely alkaline copper quaternary (ACQ) and copper azole (CA-B).

The choice of wood preservatives depends upon the character of the wood to be treated, the anticipated service and the properties of the chemical or formulation. Wood preservation formulations must:

- protect against attacking organisms;
- be able to penetrate wood;
- remain in the wood for the length of the intended service;
- be chemically stable;
- be safe to handle;
- be economical to use;
- not weaken structural strength;
- not cause significant dimensional changes within the wood.

Other factors that determine selection of chemicals or formulations include fire resistance, colour or odour; paintability, corrosiveness, electrical conductivity and environmental considerations.

In Canada the predominant wood preservative chemicals or formulations in commercial use are:

- CCA (chromated copper arsenate). Major CCA-treated products include fence posts, foundation lumber and plywood, utility poles and construction timber.
- ACQ (alkaline copper quaternary). Major ACQ-treated products include lumber for patios and fencing in residential construction.

- CA-B (copper azole). Major CA-B-treated products include lumber for patios and fencing in residential construction.
- Borates. Uses are for wood components in interior applications.
- ACZA (ammoniacal copper zinc arsenate). Major ACZA-treated products include marine structures and construction timbers.
- PCP (pentachlorophenol). Major PCP-treated products include utility poles and cross-arms.
- Creosote. Major uses include treatment of railway ties, utility poles for export, and pilings and timbers for marine applications.

The development of alternative chemicals for wood preservation is the subject of ongoing research. The actual use of alternative chemicals will depend on industry and safety evaluations, and on approval under the *Federal Pest Control Products Act*, now administered by the Pest Management Regulatory Agency of Health Canada

## 1.4 The Value of Wood Preservation

A recent study showed that the Canadian preservation industry (8) in 1995 consisted of 64 active plants and treated about 2 million $m^3$ (70 million $ft^3$) of wood representing a value of $700 million. That wood volume amounts to 13% of Canada's lumber consumption and virtually 100% of Canada's pole production. Controlled studies have shown that wood preservation enhances the lifetime utility of wood by a factor of 5 to 10 or more, depending on the species, end use and efficacy of the treatment. If treated wood products had to be replaced by untreated wood, the annual Canadian log harvest would have to increase by 12.5%, which represents 66 million trees grown on 162 000 acres of boreal forest land. The total area of forest land required to sustain this level of production was estimated to be about 1.5 million acres, roughly the area of Prince Edward Island. This emphasizes the considerable contribution that the industry makes to forest conservation (8).

Substituting alternative materials (such as steel, concrete or plastics) for treated wood in industrial applications (not including residential) would incur increases in material costs to users of 100% to 200%, or $250 to $500 million per year, not including attendant cost increases in installation and maintenance (9). Such applications represent about 52% of total wood industry output.

Wood preservation also allows the more efficient use of the forestry resource by increasing the use potential of various wood species and the use of smaller and faster growing trees.

In 2000 a total of 67 plants operated in Canada. The product volume treated in 1999 was estimated at 3.5 million $m^3$ (122 million $ft^3$). It was valued at $724.6 million (10).

# 2 Overview of Wood Preservation Facilities

## 2.1 The Canadian Preservation Industry

There were 67 preservation plants operating in Canada in 2000 (10). Of these, 64 had pressure treatment facilities, two employed both pressure and thermal treatments and one used thermal treatment only. All except three plants used CCA. CCA was the sole preservative in 51 operations, while creosote and PCP were the sole preservatives in one plant each. Thirteen plants were involved in multipreservative operations: seven with CCA and PCP; five with CCA, creosote and PCP; and one with CCA, ACZA, PCP and creosote. One treated with borates exclusively.

Treatment plants exist in all provinces, except Prince Edward Island. The early plants were conveniently located to serve the railways. However, newer plants are concentrated in areas where there is great demand for consumer lumber, which represents more than 50% of the total industry output (9). The provinces with the most plants are Ontario, with 18, and British Columbia, with 16 (10).

## 2.2 Description of Current Plant Designs

### 2.2.1 General Plant Designs

Wood preservation plants generally consist of four components (9):

- yards for storage of untreated and treated wood;
- wood processing facilities (peelers, framing lines, kilns, etc.);
- impregnation facilities;
- offices, laboratory space.

The size of storage yards can vary significantly depending on the plant's treatment capacity and the manner of drying the wood. Air seasoning, which is generally used for poles, ties and large timbers, requires a large storage space. However, plants that process lumber particularly for the residential market may kiln dry or process wood under a "treatment service only" agreement, in which case smaller white wood inventory space is required. The storage cycle of treated wood is generally short, necessitating only a limited yard or shed area. Plants that provide storage for their customers, for example, the major railways and utilities, are an exception.

Wood processing equipment may include pole peelers, saws, framing lines, sorting tables, incisors, kilns, stackers and the like. Railway tie plants are equipped with special adzing, boring and incising machines.

The designs of impregnation facilities are specific to the treatment process employed and the preservatives used. A more detailed description can be found in the relevant preservative-specific sections. The following is a general description.

### 2.2.2 Preservation Processes

Preservation processes are aimed at injecting requisite amounts of preservative liquids deep into the wood to provide long-term protection against wood destroyers. In North America, the majority of preserved wood is treated by pressure impregnation processes. Thermal treatments are of secondary importance. The applied treatment parameters for all processes are limited by standards — in Canada, this standard is CAN/CSA 080 (11) — to ensure effective treatments without damage to the wood. Special requirements are contained in the *Best Management Practices for the Use of Treated Wood in Aquatic Environments* issued by the Canadian Institute of Treated Wood (CITW) (12).

*Wood Conditioning*

Before wood can be successfully impregnated with preservatives, the bark has to be removed and the moisture content reduced by a process involving drying or conditioning. This may be achieved by air seasoning, kiln drying or by a process carried out in the treatment cylinder, for example, a steam/vacuum process or boiling-under-vacuum (Boultonizing) in the presence of the treating solution. The method chosen depends on the wood product, specifications, the available equipment, desired moisture levels and the preservative used. For example, kiln drying is most common for lumber destined for the residential market; air seasoning is most economical for large commodities, such as ties, timbers and poles; a steam/vacuum process is preferred for poles to be treated with PCP/oil; and Boultonizing is common with ties and marine pilings to be treated with creosote or creosote/oil solutions.

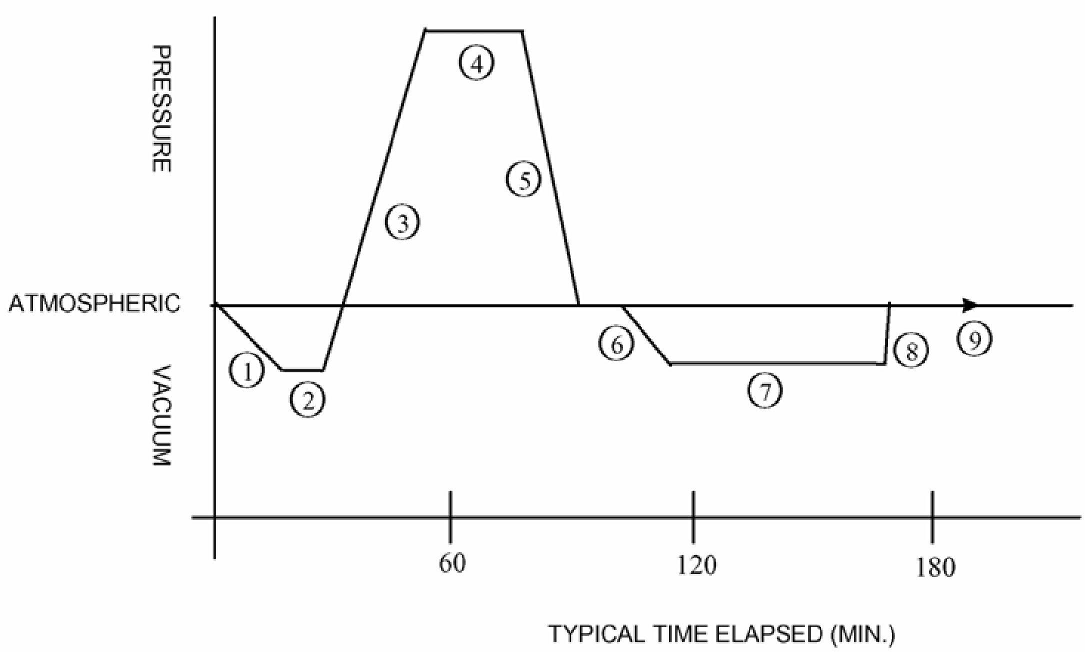
Sawn wood, which generally exposes refractory heartwood, requires "incising" to enable good preservative penetration. Incising is a process whereby the wood surfaces are punctured by toothed rollers. Various incising patterns are available to ensure good penetration without causing undue structural damage. Individual pieces are generally cut to final size and shape prior to treating to ensure good preservation of all exposed faces. Machining after treatment may expose untreated wood, in which case subsequent field treatments must be applied. Even properly applied field preservation cannot protect such exposed wood as effectively as either pressure or thermal treatments.

*Full-Cell (Bethell) Process*

The full-cell process was introduced in 1838. It is the only process employed for all treatments with CCA, and the other waterborne preservatives, as well as for creosote, where high preservative retentions are specified, as is the case with marine structures (Figure 1).

After a wood charge is placed into the pressure cylinder, the treatment process commences with the application of an initial vacuum for half an hour to an hour. The preservative solution is then admitted to the cylinder, while maintaining the vacuum. In case of the water-borne

**Figure 1 The Full-Cell (Bethell) Pressure Treatment Process**




**Process Steps:**

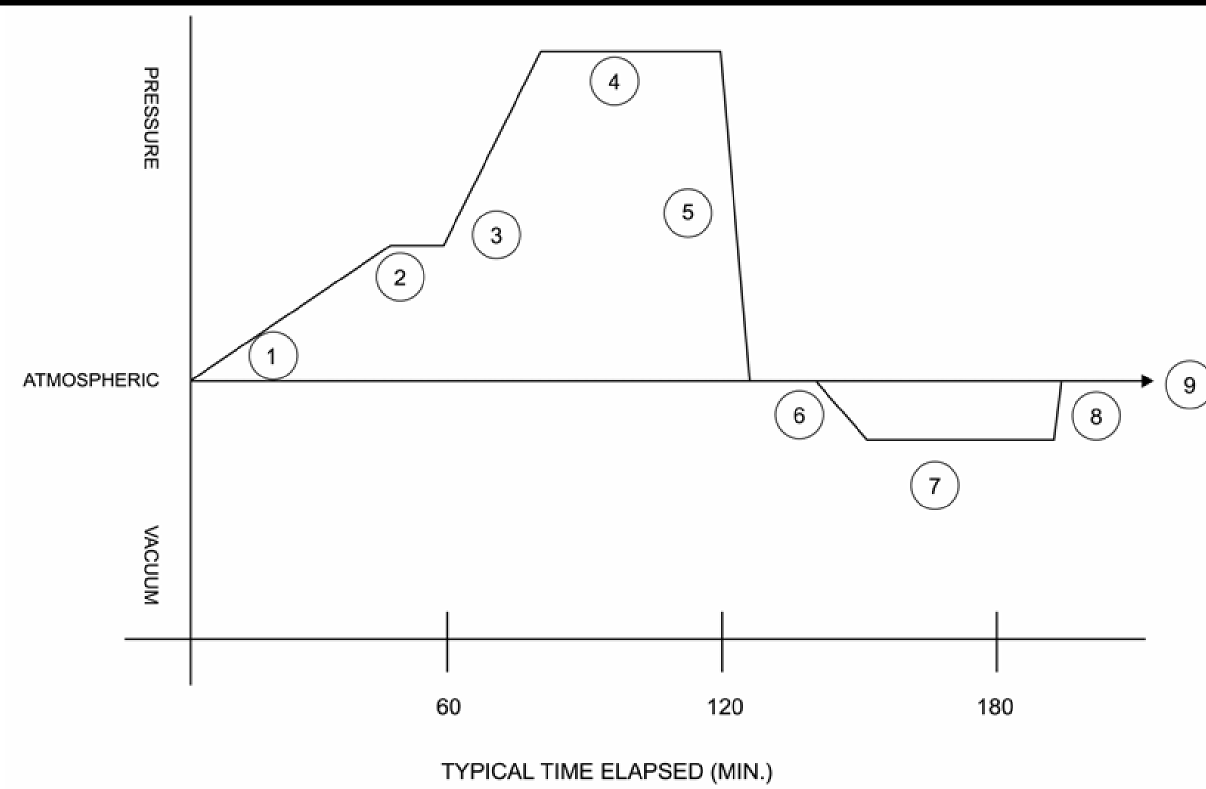
1 Initial vacuum
2 Fill with preservative
3 Pressure increase
4 Pressure impregnation cycle
5 Pressure release
6 Preservative pump-out
7 Final vacuum
8 Vacuum release
9 Treated wood discharge

preservatives, the solution is at ambient temperature, whereas oil-borne preservatives are heated (70 to 90°C). After the cylinder is filled, pressure is applied, usually to a maximum of 1040 kPa, and held until a predetermined amount of preservative has been injected into the wood. This pressure cycle may take from 30 minutes to several hours. At that point the pressure is released and the excess preservative is returned to a storage tank for use on subsequent treatments. The impregnation stage is usually followed by a final vacuum in the case of CCA and the other water-borne preservatives or an expansion bath and a final vacuum in the case of creosote. These processes remove excess preservative from wood subsurfaces and are aimed at rendering the product surfaces as dry as possible.

*Empty-Cell Processes*

This category includes two processes, the Rueping and the Lowry, both of which are used with creosote and pentachlorophenol for treatment of utility poles, railway ties, posts and construction lumber and timber. The processes are designed to give deep penetration, while minimizing the preservative retention (Figure 2).

**Figure 2 The Empty-Cell (Rüping) Pressure Impregnating Process**




**Process Steps:**

1 Initial pressure
2 Fill with preservative
3 Pressure increase
4 Pressure impregnation cycle
5 Pressure release
6 Preservative pump-out
7 Final vacuuum
8 Vacuum release
9 Treated wood discharge

The Rueping process applies an initial air pressure (200-500 kPa for 15 minutes) to the wood charge in the cylinder prior to admitting the preservative. The pressure compresses the air inside the wood. Hot preservative is then admitted to the wood, without releasing the air pressure. The pressure is increased to a typical maximum of 1040 kPa and held until a predetermined solution absorption has been achieved. When the pressure is released at the completion of the impregnation cycle, the compressed air in the wood expands and expels excess preservative. This effect, which is called the “kickback,” is usually enhanced by a quick final vacuum. Excess preservative is returned to storage for use in subsequent treatments.

The Lowry process is similar to the Rueping process, except that no initial air is applied and the preservative is admitted at atmospheric pressure. The remainder of the process continues in the same manner as the Rueping process. There is usually a smaller amount of preservative recovered by the kickback in a Lowry process.

*Thermal Treatment Process*

This process is applied with PCP/oil solutions for the full-length treatment of dry utility poles and cross-arms of thin-sapwood species (11). A pressure vessel is not required to carry out the process. Instead, most thermal treatments are carried out in horizontal, rectangular tanks that are covered by lids. During the cycle, dry wood is first immersed in hot preservative (88 to 113°C) for a minimum of six hours (hot bath). Thereafter, the hot preservative is quickly replaced by preservative at ambient temperature, in which the wood is held for at least two hours (cold bath). Excess preservative is returned to the storage tank.

A variation of this process is the “pole butt” treatment, whereby only the lower ends of poles (butts) are impregnated with preservative. This process is carried out in upright, cylindrical tanks and employs process parameters similar to the full-length treatments described above.

*After-Impregnation Processes*

After application of the pressure cycle, process steps are generally added to remove excess preservative from the wood, so as to render wood surfaces clean and dry or to fix the preservative chemically to the wood. Such processes are now quite common and are aimed at easing potential environmental and human exposures to preservative chemicals.

Most treatment cycles are followed by a final vacuum, which equilibrates internal pressure, removes air and preservative from the surface fibres of wood and, in the case of oil-borne treatments that use elevated temperatures, cools the wood. For creosote and PCP, a final vacuum may not be adequate to create clean surfaces. In these cases, the impregnation cycle may be followed by an expansion bath or a final steam cycle, both of which add a final vacuum step. These processes can be quite effective, but the final steam cycle creates large volumes of contaminated water that must be treated to meet all discharge criteria.

*Storage After Treatment*

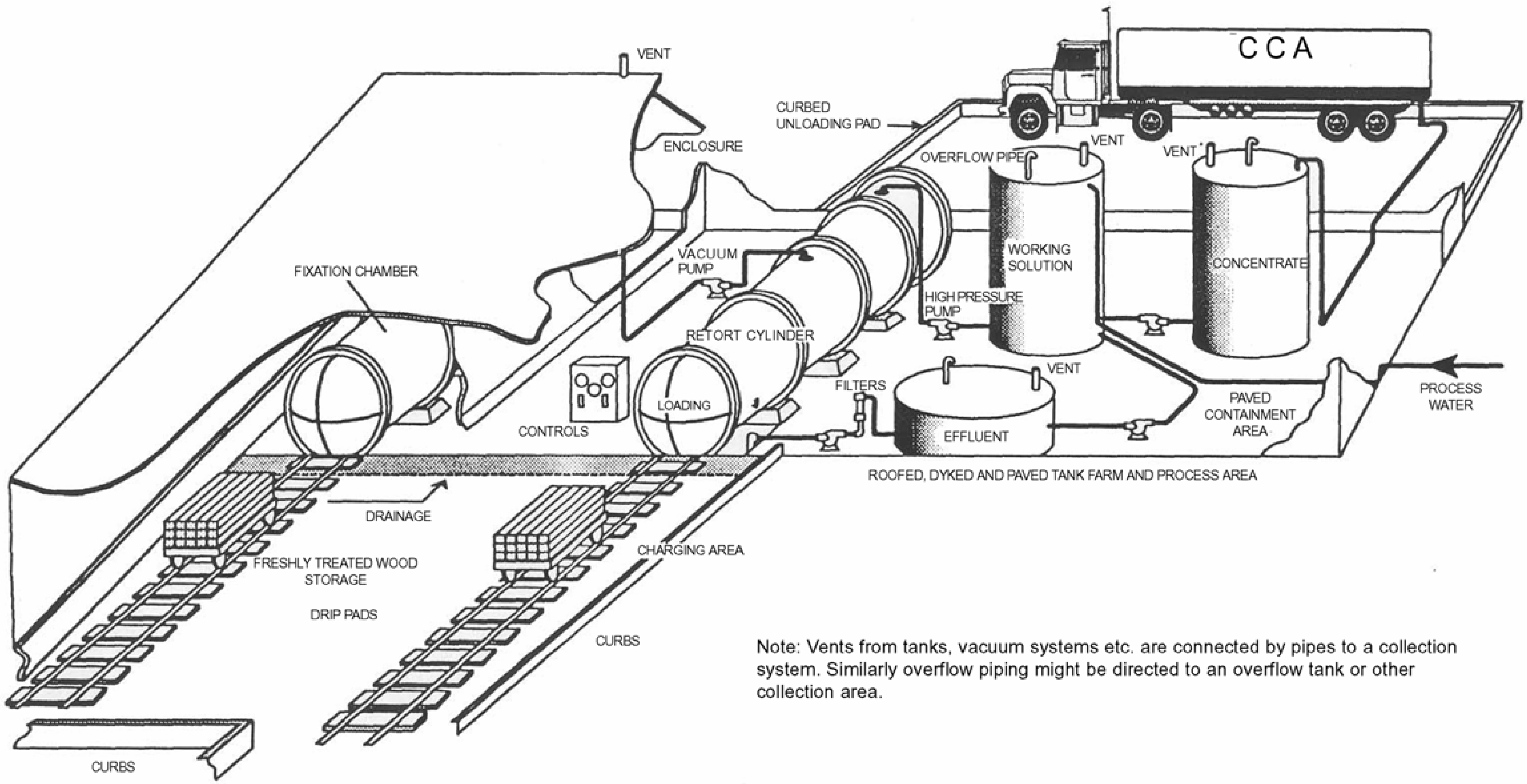
Treated wood, removed from the cylinder, is generally stored on a drip pad until preservative drippage has stopped. The duration of this storage may vary from hours to days. Alternatively, many CCA treatment plants now carry out an accelerated fixation process to ensure a high level of leach resistance of the preservative chemicals. Such a process entails a heating cycle, usually in the presence of high humidity. Special fixation chambers may be employed or the process may be carried out in drying kilns (13). From the drip pad of the fixation facility, the wood may be transferred to a designated yard area for storage until shipment or may be directly loaded onto railcars or trucks for immediate shipment.

### 2.2.3 Current Treatment Plant Designs

*CCA Plant Designs*

Most CCA plants are housed within a heated building (9). Figure 3 is a schematic view of a typical CCA plant. The centrepiece is the pressure vessel, also called a retort or cylinder. Cylinders are commonly 1.8 m in diameter and 24.4 m long. They are normally charged and discharged through a single door by means of trams that run on tracks. Other designs use conveyors to move wood in and out of the cylinder and may involve doors at either end to enter and exit the wood. Pumps are provided to apply process conditions (i.e. vacuum or pressure) as well as to transfer liquids from and to the cylinder and between tanks. A tank farm typically includes a concentrate tank, one or more tanks for working solutions, and an effluent recovery tank or makeup water tank. The process controls and instrumentation vary in sophistication, depending on the degree of automation. Most CCA plants have systems that are fully automated to control the impregnation process parameters. A number of plants have recently added heated storage areas for treated wood or special facilities for accelerating the fixation of the preservative components in the treated wood (13, 14). Paved drip areas for treated wood were enlarged in many plants, and some have roofs over some or all of the treated wood storage area.

During 2003 a significant number of CCA plants converted to application of either ACQ or CA-B. The general plant components involved with CCA apply to these chemicals as well, although additional tankage and heating equipment might be installed and the accelerated fixation facilities for CCA do not apply.




Note: Vents from tanks, vacuum systems etc. are connected by pipes to a collection system. Similarly overflow piping might be directed to an overflow tank or other collection area.

**Figure 3 Conceptual Drawing of a CCA Treatment Facility**

Similarly, borates can be applied in facilities that use the basic CCA layout. A roofed area is required for storage of treated material prior to wrapping, which is essential, because borates are water soluble and would leach when exposed to precipitation.

*ACZA Plant Design*

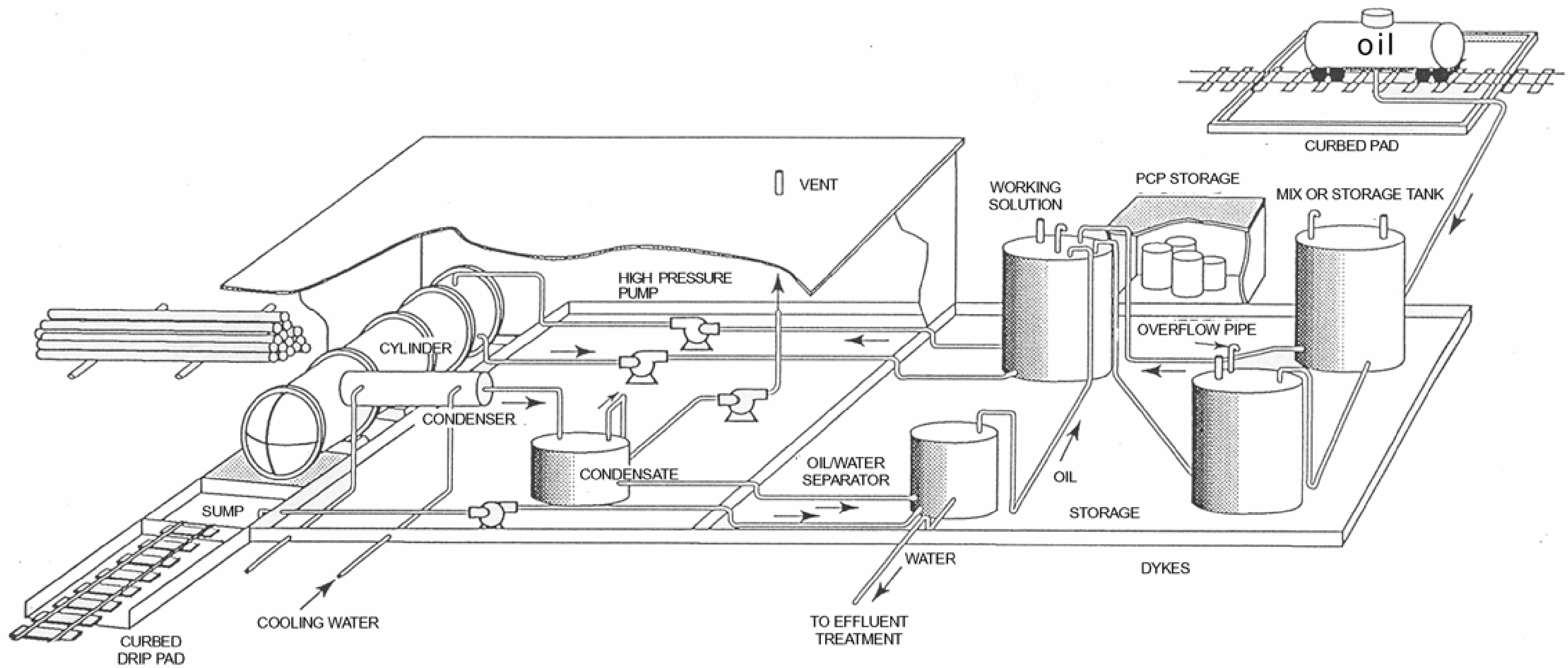
There is only one ACZA plant operating in Canada. This plant is enclosed and automated. The equipment is similar to that in CCA plants. Additional tankage is required for storage of the aqua ammonia and for mixing the ingredients to prepare a working solution.

*Creosote and PCP Plant Designs*

Creosote and PCP/oil solutions are often used interchangeably in the same treatment facility. Hence, plants using these preservatives have a similar layout (Figure 4). The pressure cylinders are usually somewhat larger than those used in water-borne preservation plants (2.1 m in diameter and 36.5 m in length). Tank farms are generally placed outdoors, and tanks are equipped with internal heating devices. The production equipment, including the cylinder, pumps, condensers, controls and effluent treatment systems, is within a treating house. Facilities treating with PCP or creosote solutions require a heat source for warming the preservative and to carry out specific processes, such as steam conditioning. When treating with PCP, either an autoclave or a designated mix tank is used to dissolve the solid preservative in a suitable oil solvent. Effluent treatment facilities may consist of an oil/water separator, a flocculation system and carbon filtration. An air filtration system to collect exhausts from treatment vessels, vacuum systems and tank vents may also be part of the installations. The vacuum systems are equipped with condensers and condensate collection tanks.

*Thermal Treatment Plant Designs*

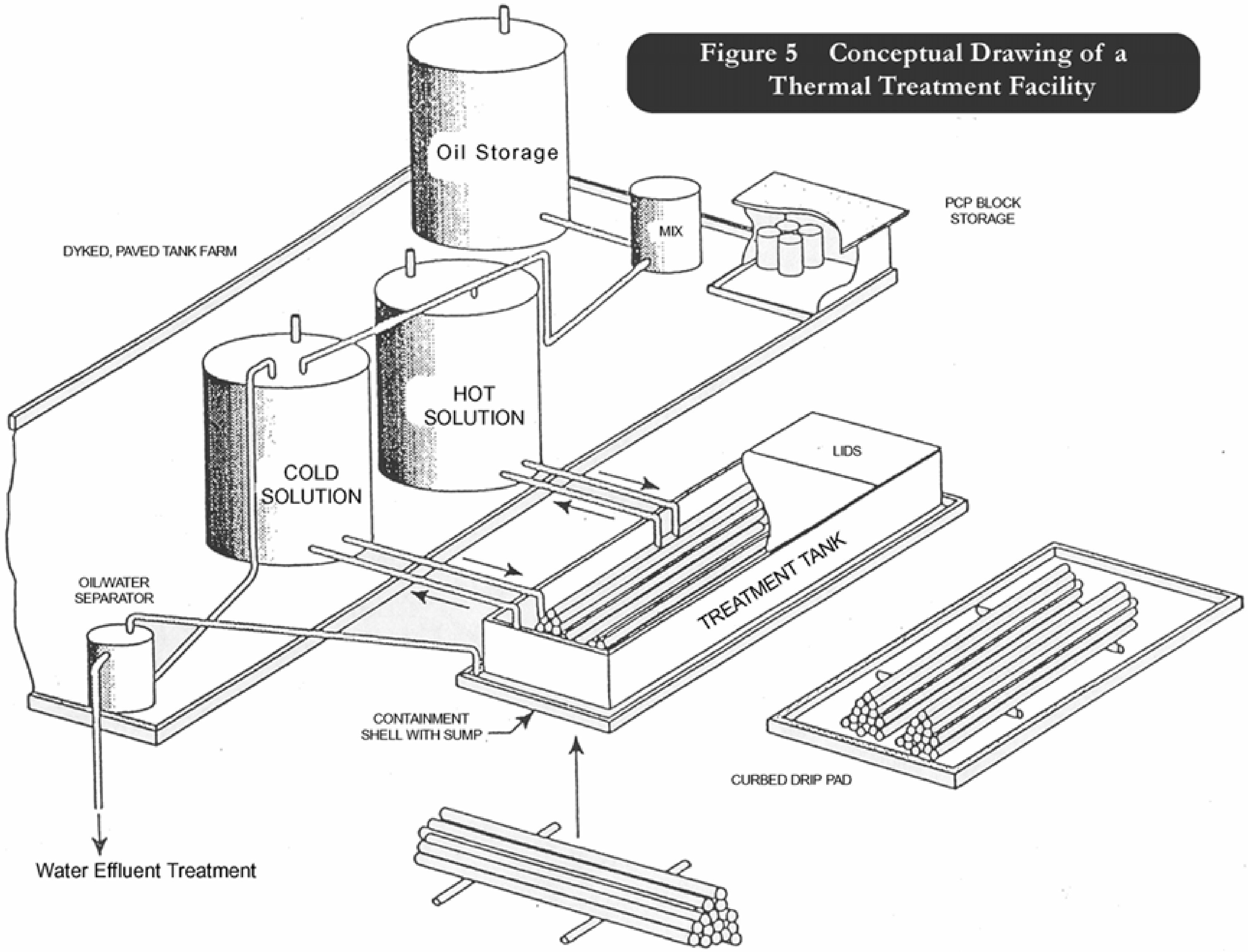
As Figure 5 shows, thermal plant facilities have less sophisticated impregnation equipment and process controls than pressure treatment facilities. The treatment vessel is a rectangular tank, which may be provided with spill containment. A tank typically measures 3.65 m x 3.00 m x 24.00 m and may be equipped with removable lids and hold-down bars for restraining the poles during treatment. Wood is loaded into the tanks by forklifts or grapples. An outdoor tank farm would contain a PCP/oil mix tank, as well as oil storage and hot and cold preservative solution storage tanks. Transfer pumps accomplish the removal of solution from the treatment vessel to the storage tanks. As with PCP pressure treatment facilities, the effluent treatment system may involve oil/water separation, flocculation and carbon filtration. One plant applies thermal treatments in a closed cylinder.




Note: Tank and vacuum system vents may be connected by pipes to a recycling or filtration system.

**Figure 4 Conceptual Drawing of an Oil-Borne Pressure Treatment Facility (Creosote or PCP/Oil)**

## Figure 5 Conceptual Drawing of a Thermal Treatment Facility



# 3 Description of Preservative Properties

The commercial preservatives used in Canada have a long history of success in preserving a large variety of wood products. Not only are they effective in preventing wood deterioration, but each preservative also has physical and chemical properties that make it suitable for one or another product. No one preservative is considered suitable for all possible product applications; each has found a niche of preferential use.

The preservatives in use have a range of physical, chemical and toxicological characteristics that determine their potential for causing harm and, therefore, the best modes of handling them during operation. Their specific properties are described in Part II - Preservative-specific Information and Recommendations.

## *3.1 Toxicity, Hazards and Risks*

The following explanations should allow a better understanding of the potential risks to humans and the environment (15):

**Toxicity**: any harmful effect of a chemical on an organism, including humans, or the environment. Exposure to wood preservatives can be in three basic forms: as pure active ingredients, as formulations, or as the treated wood. Toxicity can be short-term (acute toxicity), as defined by criteria such as the median lethal dose ($LD_{50}$) or the medium lethal concentration ($LC_{50}$), or long-term (chronic toxicity) that may have several effects, including cancer.

**Hazard**: the set of inherent properties of a chemical substance or mixture that makes it capable of causing adverse effects on humans or the environment, when a certain degree of exposure occurs.

**Risk**: the predicted or actual frequency of occurrence of an adverse effect of a chemical or a mixture from a given exposure to humans or the environment.

In most wood preservatives, the active ingredients are combined with other substances, most commonly solvents. Such preservative formulations may exhibit different physical and toxicological properties from the undiluted preservative. This factor needs to be taken into account when recommendations for proper designs and operational practices are proposed.

## *3.2 Human Health Concerns*

Wood preservatives can be harmful to humans, if not properly handled. The exposure routes by which they can enter the human body are inhalation (vapour, dust, aerosol, etc.), ingestion (solid, liquid) and through the skin (vapour, liquid, solid). Exposure limits are given for individual preservatives in Part II - Preservative-specific Information and Recommendations. Such limits are usually also contained in the material safety data sheets issued by chemical manufacturers.

Plant operators should obtain references to or copies of relevant material safety data sheets (MSDS) from their preservative supplier and follow the requirements of the pesticide label.

### 3.3 Environmental Concerns

The properties of a preservative chemical or formulation are also important in determining its environmental fate and its potential for contaminating the treatment plant and other sites. A preservative can enter the environment in many ways, such as by spillage or leaching, as effluent or air emission. Subsequently it may be subject to a wide variety of processes that may eliminate it from the environment completely, modify it into a more or less harmful substance, or transfer it to another environmental medium (15).

The main physico-chemical properties that determine the migration of a chemical are (15):

- solubility in water and in organic solvents;
- vapour pressure;
- adsorption/desorption in soil or sediment;
- stability;
- partition coefficient between octanol and water;
- reactivity with co-contaminants and soil microbes.

Detailed information on the environmental considerations for each preservative is contained in Part II - Preservative-specific Information and Recommendations.

## 4 Description of Preservative Applications and Potential Chemical Discharges

The use of wood preservatives at treatment plants creates the potential for human exposure and may lead to chemical discharges to the environment. The actual impact of any chemical depends upon many factors, including the site, facility characteristics, processes employed and operational practices. Due to their physical, chemical and toxicological properties, as well as their modes of application, each type of preservation facility requires specific attention to ensure safe operation.

*See Part II - Preservative-specific Information and Recommendations.*

# 5 Personnel Protection

## 5.1 Precautions and Hygiene

The potential hazards of exposure to preservative solids or their solutions include immediate and long-term toxic effects from ingestion, skin contact or inhalation of vapours or other airborne contaminants. These potential hazards can be adequately controlled by proper protective measures. The severity and speed of damage to tissue and probability of health effects following contact depend on the extent of the exposure and are generally highest with concentrated solutions. These factors diminish as the solution is diluted. The general rule for dealing with exposure is as follows: **the higher the concentration of a preservative to which a worker is exposed, the greater the need for protective measures and immediate response if contact occurs**. If there is any doubt as to the concentration, the response should be the same as for the most concentrated form.

The first aid procedures for exposures to specific preservatives and objectives for an overall worker protection program are contained in Part II - Preservative-specific Information and Recommendations.

First aid personnel must be properly trained and should maintain regular contact with chemical suppliers and/or industrial medical advisors for information on up-to-date response measures. Table 1 outlines general precautions and personal hygiene measures for an overall worker protection program.

## 5.2 Regulatory Controls

Most regulatory criteria established by worker protection agencies are based on threshold limit values (TLVs) and biological exposure indices, as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Part II - Preservative-specific Information and Recommendations presents the ACGIH-recommended limits for individual preservatives to define acceptable levels of exposure in the wood preservation workplace.

The hygiene and protective measures as well as precautions recommended in this document represent general good practice to ensure minimal worker exposure. However, such measures to protect workers may differ from various federal and provincial regulations. For example, under the federal *Pest Control Products Act* all pesticides including all wood preservatives are required to be registered and to carry a label issued by Health Canada. The pesticide label contains specific requirements for handling and use of the preservative as well as the protective measures that apply. The user must be familiar with these and must comply with them.

## 5.3 Biological Monitoring of Exposed Workers

Biological monitoring is a useful tool for evaluating the long-term effectiveness of the protective measures applied. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g. plant operators and quality control personnel) is recommended and can be achieved using established procedures for determining the presence of the various preservatives and their components. Among these procedures are analyses of urine, blood or hair. Note that biological monitoring might not be possible for all preservative ingredients and solvents used. The monitoring programs should be carried out and interpreted by qualified occupational hygienists or occupational physicians. If there is concern for confidentiality and/or sample handling procedures, these can be addressed and resolved by a joint management-worker committee.

A comprehensive occupational health and safety program is important for worker health and safety. Two components of such a program are environmental and worker health monitoring, which may be used to assess worker exposure to wood preservatives. Since occupational health and safety is under provincial jurisdiction, the appropriate workers' compensation board or department of labour should be contacted for specific requirements for wood preservation facilities.

**Table 1 General Precautions and Personal Hygiene for Personnel Working in Wood Preservation Facilities**

| **General Precautions** | |
|---|---|
| **Objective** | **Recommendations** |
| Assure that workers are familiar with all aspects of preservative usage. | • Provide documentation and training to educate workers about the chemical properties of, hazards of exposure to, and emergency procedures associated with use of the preservative.<br>• Implement preventive measures to minimize ingestion or inhalation of, and skin or eye contact with, preservatives, preservative solutions and contaminated waters. |
| Assure that first aid can be applied when necessary. | • Install and regularly check emergency eyewashes and showers.<br>• Provide all necessary first aid equipment for first response as indicated in Part II of this document.<br>• Ensure that first aid is always available from qualified (trained) personnel.<br>• Ensure first aid personnel are familiar with updated emergency response procedures.<br>• Identify medical contacts who are readily available during all working hours. |
| **Personal hygiene** | |
| Implement personal hygiene practices that minimize potential exposure to preservatives. | • Do not carry, store or consume food or drink in working areas (e.g. areas where preservatives are stored or used, or where freshly treated wood is stored).<br>• Do not carry or smoke cigarettes in working areas.<br>• Wash hands thoroughly before leaving working areas and before eating, drinking, smoking or using the toilet facilities.<br>• Do not expose cuts or abrasions to preservatives.<br>• Wash skin immediately if contact with preservative solutions occurs.<br>• Get immediate first aid if skin or eyes contact preservative solutions. Even small contact exposures should receive immediate cleaning and treatment.<br>• Change outer clothing immediately if splashed with preservative solutions. Change clothing daily if any incidental contact with the treatment chemical occurs. Wash contaminated clothing separately from other clothing.<br>• Wear impermeable footwear in all working areas. Preservative solutions may penetrate leather shoes and apparel.<br>• Shower daily immediately after work.<br>• All work clothing and boots must be left at the plant. |

# 6 Site Selection

## 6.1 Purpose

Preliminary assessment of an industrial site involves an evaluation of technical site characteristics (e.g. hydrogeology, topography and soils) and of socio-economic and geographic factors (e.g. cost, land use and availability, proximity to raw materials, markets and transportation routes). This section highlights site features that contribute to the control of any potential chemical releases from wood preservation facilities.

In many cases, natural site characteristics may impose constraints on the technical features of a facility. Early recognition of less desirable characteristics will allow development of a compensating design and speed site approval.

## 6.2 Assessment Factors

Active plant sites have the potential for chemical contamination of groundwater and surface water. The extent of potential contamination is dependent on the type of chemical, its physical and biological properties, plant design and operating practices, and site-specific characteristics including soil type, geology, hydrology (subsurface), climate, topography and drainage.

This section describes environmentally important site characteristics and how those characteristics can affect the eventual impact of a chemical release. These characteristics are important in designing features of a wood preservation plant that:

a) minimize the possibility of off-site contamination via groundwater and surface water;
b) minimize chronic on-site contamination to protect worker health during operation;
c) facilitate decommissioning in the event of partial or complete closure.

The preliminary assessment factors rely on readily available information. Table 2 lists the site features that must be considered in an environmental impact assessment.

### 6.2.1 Regional Geology

Geologic information about many areas of Canada may be obtained from federal and provincial surveys. Information that should be obtained includes:

- Texture of unconsolidated material — Fine-grained material is more likely to retain chemical contaminants than coarse material.
- Depth to bedrock — Shallow soils imply a limited ability to retain spilled chemicals.
- Aquifer recharge and discharge zones — Potential for hydraulic connections to regional groundwater and sensitive surface waterbodies should be considered.
- Discontinuities such as faults, fissures, joints, fractures — Discontinuities may cause "short-circuiting" of a contaminant plume.

**Table 2 Site Features Affecting the Design of a Wood Preservation Facility**

| | Suggested degree of mitigating design/operational measures | |
|---|---|---|
| Site features | Slight | Severe |
| Soil texture | Loam, silty loam, silty clay loam, clay loam, sandy clay | Gravel |
| Permeability (cm/h) | < 0.5 | > 50 |
| Topography (% slope) | 0 - 9 | > 30 |
| Soil depth to bedrock (cm) | > 200 | < 60 |
| Depth to groundwater (cm) | >200 | < 60 |
| Flooding | None | Frequent (>once/20 years) |
| Drainage | Slow | Very rapid |
| Distance to surface waterbody (lake or river) | Depends on interaction with other site features (e.g. permeability of soil) | Directly adjacent |

### 6.2.2 Soils

Soil properties should be assessed to evaluate the potential for leaching of treatment chemical constituents. Physical properties to consider include depth, permeability, texture, water-holding capacity and shrink-swell potential; chemical properties to consider include cation exchange capacity (CEC), anion exchange capacity (AEC), organic carbon content, and iron and aluminum oxide content. Soils with high amounts of organic carbon will have higher capacities for sorption of neutral organic compounds; those with high AEC will provide greater retention of dissociated phenols; while those with high CEC will provide greater retention of organic bases. High AEC, high levels of aluminum oxides, and/or high levels of calcium compounds will enhance the retention of arsenate and chromate anions, while high CEC, high clay content and high organic matter will enhance the retention of the copper cation.

Soil depth and soil types are routinely indicated on soil maps (and often on geology maps). Although the available maps may not indicate the exact soil composition of a small site (e.g. 2 ha), they can be used for preliminary assessment purposes.

### 6.2.3 Geotechnical Description (including subsurface hydrology and water table data)

Published maps and reports on regional geology and soils are adequate references for establishing subsurface hydrogeology at the preliminary site assessment stage. However, site-specific hydrologic data will be required if one or more of the following conditions are identified during preconstruction assessment:

- the site is located over a shallow, unconfined aquifer;
- the site is located over an aquifer used for a potable or irrigation water supply;
- the aquifer has hydrologic connections with other aquifers in the area and/or regional groundwater flow patterns.

The additional information required must be defined in consultation with the appropriate regulatory agency.

### 6.2.4 Topography

Topographical information is easily obtained from published government maps. In general, steep sites should be avoided due to runoff problems and erosion. However, topography is a site selection parameter that can be addressed by facility design. Slope gradients between 1% and 10% should present few problems. Upland flat and terraced landforms are desirable locations for treatment facilities. Floodplains are acceptable if they lie above the 100-year flood level; otherwise special design provisions must be implemented.

### 6.2.5 Climate

Climactic variables, such as precipitation (form, historical 1-hour and 24-hour maximums, and annual total amount), temperature regime and wind patterns, influence chemical loss during storage of treated wood and leaching in the subsurface. Climactic variables can also influence conditioning needs for wood prior to preservation treatment and can affect worker exposure to emissions. Information on such climactic variables is generally available from Environment Canada. However, definitive criteria are difficult to establish for climactic influences. For example, the amount of precipitation will influence leaching potential, but this parameter can be alleviated by selecting sites with soils of low permeability and/or by introducing compensating design features at the facility.

### 6.2.6 Proximity to Sensitive Uses

Sites located adjacent to waterbodies (e.g. lakes, rivers, marine waters) or above aquifers used for drinking or irrigation water supplies, food manufacturing plants and beverage processing plants should be considered cautiously by the wood preservation industry. If such a site is selected, exceptional design approaches and operational and monitoring procedures will be required. Desirable minimum distances between facilities and sensitive waterbodies depend upon previously discussed factors such as soil type, regional geology, topography and climate. If a selected site is adjacent to waterbodies used by migratory fish, then the plans must be reviewed by both Environment Canada and Fisheries and Oceans Canada.

## *6.3 Selection Procedures*

After compiling the data for potential sites, the developer is faced with a decision-making process for site selection. The process integrates environmental protection with economic considerations. On the basis of economic factors alone, a less environmentally acceptable site might be most desirable. However, since the less acceptable environmental features will add to the cost of adapting the design and operation of the plant to the site, environmental protection must be interpreted as a real location cost at such a site.

All factors previously described should be considered. Techniques used to select a site on the basis of environmental acceptability include criteria ranking, matrices, decision trees or mathematical modelling. Since assessment techniques among regulatory agencies may vary considerably, local and provincial regulatory agencies (and federal agencies where necessary) must be consulted.

Table 2 provides examples of site characteristics requiring very little environmental mitigation as well as those requiring significant mitigation. Deviations from the most desirable characteristics suggest various degrees of mitigating design and operational measures:

- Slight mitigating design/operational measures are necessary for sites that are well suited to the location of a treatment facility. The site will require only low-cost maintenance and monitoring to assure environmental protection.
- Moderate mitigating design/operational measures present more of a problem, but in general sites requiring such measures are acceptable.
- Severe mitigating design/operational measures such as special innovative designs may partially overcome the constraints of a marginally suitable site. Design costs are likely to be high. Extensive monitoring efforts will be required, adding to the cost of the location.
- Very severe mitigating/operational measures indicate that a site may be economically impractical and should not be considered.

Site features and the degrees of mitigating design/operational measures shown in Table 2 are based on siting criteria suggested by various investigators (16, 17).

# 7 Design Recommendations

This section suggests approaches to designing wood preservation facilities that protect workers and the environment from harmful exposure to preservative chemicals. Recommendations are based on currently available best practices. The design aspects are intended to achieve the following general objectives:

- to prevent or reduce direct contact of personnel with preservative chemicals;
- to provide maximum reduction of preservative releases to the environment by providing secure containment;
- to enable prompt response and effective corrective measures to assure worker safety and environmental protection after abnormal events (e.g. tank rupture).

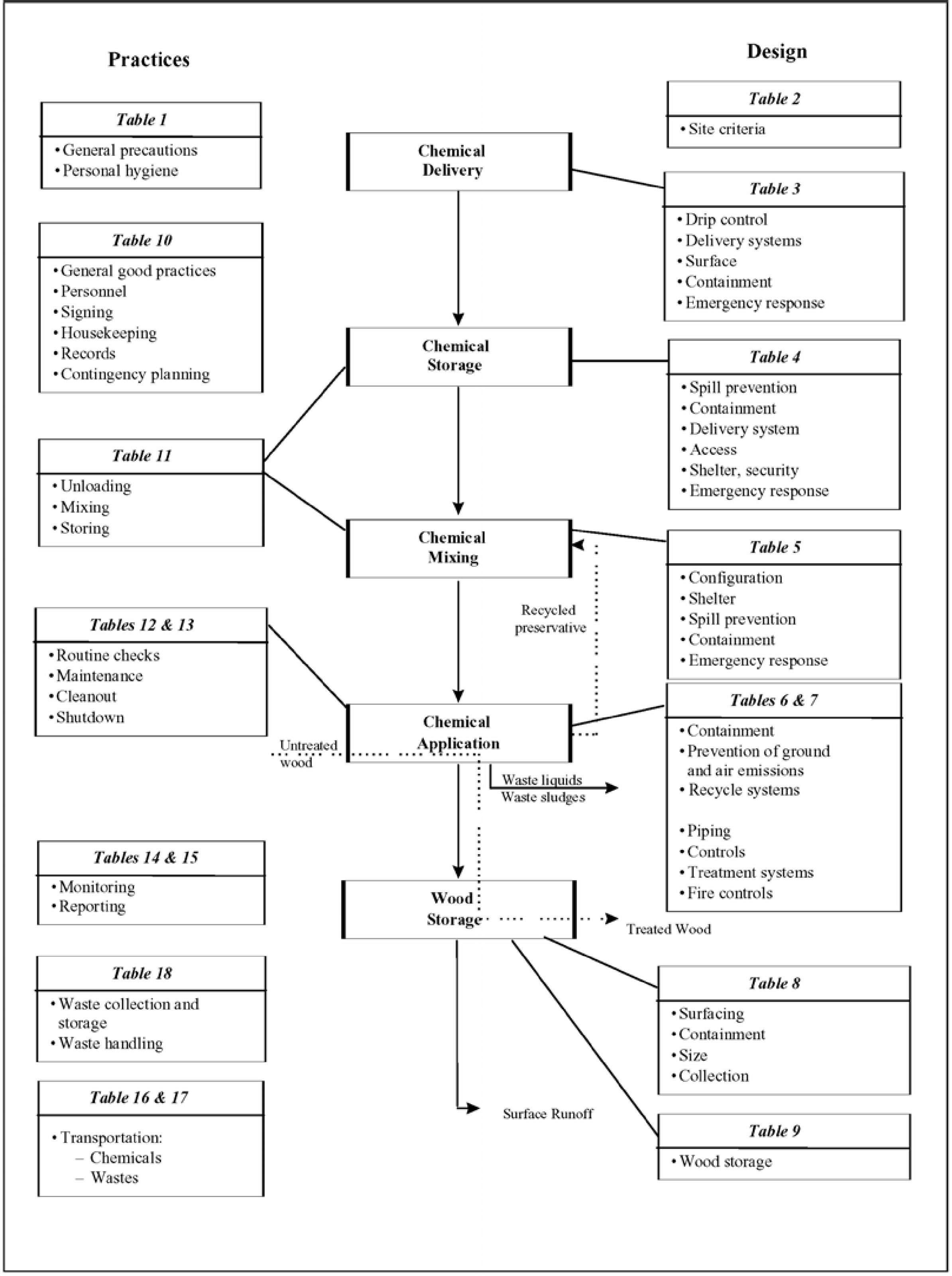
Figure 6 presents an overview of the subject areas covered by the design objectives. It is based on the typical handling and use of preservatives. Means of achieving the objectives outlined in Figure 6 are presented in Tables 3 to 9.

It is intended that all new wood preservation facilities be designed to achieve the specific objectives listed in these tables. Existing facilities should review their abilities to comply with the objectives, and gaps, if present, should be addressed using the suggested features or alternative but similarly effective features. Assessment 2000 aided plants in the determination of shortcomings in design and operation, and through the Strategic Options Process for the industry, plants have pledged to meet the objectives of the TRD by the end of 2005.

The recommended design features in the tables may not be the sole options available to attain the stated objectives. Alternative approaches may exist that would be equally effective or more suitable to site-specific conditions. Where this is the case, an appropriate design feature that has not been included in these recommendations could be used at a specific facility.

Note that roofing is a recommendation for several process areas. But galvanized roofing may contribute to stormwater runoff toxicity from mobilized zinc. Particular caution with such roofs should be exercised at sites near waterbodies or in areas of low pH precipitation.

Figure 6 Overview of Design Recommendations for Preservation Facilities



## Table 3  Recommended Design Features for Chemical Delivery Areas

| Delivery format | Design feature | Recommendations |
|---|---|---|
| **Bulk liquid** (delivered by truck or rail tanker) | **Objective:** To provide an off-loading area that enhances spill prevention and containment. | |
| | **Off-loading pad** | • Provide an impervious pad that drains to a containment area.<br>• Design to prevent settling or cracking of the pad. |
| | **Surfaces** | • Seal surfaces to prevent leakage and enhance cleanability. |
| | **Joints** | • Provide liquid-tight joints (if applicable). |
| | **Drip control** | • Provide local drip catchment to minimize contamination of the containment system.<br>• Provide for wash down of minor drips or spills with recovery of washwater (or infiltrating precipitation) for reuse. |
| | **Access** | • Locate off-loading area away from high yard traffic routes.<br>• Restrict access during delivery. |
| | **Delivery system piping** | • Install permanent delivery systems with rigid, accessible, visible delivery lines (not buried). Piping in sealed, contained channels with leak detection is an optional approach.<br>• Protect delivery systems from mechanical damage.<br>• Provide mechanically secure connections between the tanker and delivery hook-up point.<br>• Clearly identify all delivery lines.<br>• Use top delivery to concentrate storage tanks. |
| | **Backflow prevention** | • Install backflow preventers on delivery line. |
| | **Security** | • Install locking valves on delivery lines; restrict access. |
| | **Overflow prevention** | • Provide maximum visibility of the delivery system from the point of off-loading.<br>• If visibility is limited, use audible alarms to detect tank overflow during delivery. |
| | **Emergency response** | • Provide accessible storage for spill-response equipment, absorbent and personnel protection equipment.<br>• Install a phone or manual alarm switch near the off-loading area. |
| **Containerized liquid** (drums) | **Objective:** To provide an off-loading area that enhances spill prevention and containment. | |
| | **Off-loading pad/shelter** | • Provide an off-loading area near the storage area |
| | **Containment** | • Ensure containment for a worst event spill (e.g. 4 drums or 1 pallet load). |
| | **Surfaces** | • Provide a sealed surface. |
| | **Container handling** | • Design for safe manipulation of containers. |
| | **Emergency response** | • As for bulk off-loading areas. |

**Table 4  Recommended Design Features for Chemical Storage Areas**

<table>
<tr><th>Storage format</th><th>Design feature</th><th>Recommendations</th></tr>
<tr><td rowspan="3">Bulk liquids<br>• Solvents<br>• Concentrates<br>• Working solutions<br>• Contaminated surface runoff<br>• Drip return</td><td colspan="2">Objectives:<br>◊ To provide positive spill prevention features.<br>◊ To provide spill containment capability of 110% of the volume for a single tank, and in multiple tank containment to provide 100% of the largest tank plus 10% of the aggregate volume of the remaining tanks or 110% of the volume of the largest tank, whichever is greater (18).</td></tr>
<tr><td>Tanks</td><td>• Engineer construction materials and dimensions in consultation with chemical suppliers and applicable codes.<br>• Provide tanks in sound physical condition, with no rust or serious physical damage.<br>• Mount tanks on containment pad surfaces.<br>• Mount tanks in stable positions and anchor securely.<br>• Locate tanks within a dyked area.<br>• Shelter from the weather (where appropriate) and protect from mechanical impact, vandalism.<br>• Protect against freezing (as recommended for external tanks).<br>• Provide means for detecting leaks in insulated tanks (e.g. identify inspection points, undertake regular leakage tests).<br>• Vent interior tanks to the exterior or into a dedicated overflow tank (never vent directly into the workplace):<br>– protect vents against release of entrained liquids or overflow (e.g. direct overflow piping to sumps or containment areas).</td></tr>
<tr><td>Spill containment</td><td>• Install impervious, structurally sound floors.<br>• Provide structurally sound dykes, seal all joints.<br>• Provide a dyked containment volume (as stated under the objectives above).<br>• Engineer containment for long-term integrity (leak-proof for infiltration and exfiltration).<br>• Provide either an impermeable top coat to floors and dykes or a liner under the containment area.<br>• Consider providing means for detecting subsurface leakage from containment systems (where warranted by site-specific conditions; e.g. where the site overlays sensitive groundwater systems).<br>• Provide for directing all spills, washes and infiltrating water to tankage (contaminated liquids must be treated to applicable limit before discharge).<br>• Provide effective capability for transferring spilled liquids from containment areas.<br>• Provide surface drainage to prevent pooling of minor spills and washdowns.<br>• Design to minimize tracking of fluids from containment surfaces.</td></tr>
</table>

**Table 4 Recommended Design Features for Chemical Storage Areas (continued)**

| Storage format | Design feature | Recommendations |
|---|---|---|
| **Bulk liquids** (continued) | **Piping and valves** | • Design according to applicable codes.<br>• Use rigid, permanent piping throughout. Tank car/truck unloading requires shielded and protected hose connection.<br>• Provide visible, accessible piping with a simple layout (to facilitate early leak detection and easy repair).<br>• Maximize above-floor piping or open containment channels for subgrade piping. **Do not bury** piping!<br>• Properly engineer piping systems for material and dimensions.<br>• Identify piping systems and valves (e.g. by labelling and/or colour coding).<br>• Provide mechanical impact protection for vulnerable exposed piping.<br>• Provide freezing protection for piping (as required). |
| | **Drip containment** | • Provide local collection/containment (isolated from large containment areas) at drip points (e.g. under pumps, valves, flanges, etc.). |
| | **Spill prevention / detection** | • Install reliable, accurate level indicators on all tanks.<br>• Provide mechanical impact protection on glass sight gauges (including provision for containing and stopping release from broken gauge tubes).<br>• Install shut-off valves on all rupturable lines and tank gauges.<br>• Install permanent overflow piping from tanks directly to a definitive contained area.<br>• Install reliable, independent high-level alarms on tanks (visual and audible alarm).<br>• Interlock high-level alarms to tank feed pump (auto shut-off).<br>• Consider installation of 24-hour monitoring alarms (with remote) for immediate detection of major spills.<br>• Install emergency communication means (e.g. telephone, manual alarm button) at potential major spill points. |
| | **Backflow prevention** | • Design to protect against inadvertent transfers to/from interconnected tanks. |
| | **Shelter** | • The preferred location for tanks containing aqueous liquids (all solutions) is in an interior centralized process area.<br>• The preferred location for oil-type liquids is in an exterior centralized tank farm area.<br>• If possible, roof exterior tank farms to minimize the quantity of infiltrating precipitation. |
| | **Security** | • Provide security precautions to prevent vandalism or access by unauthorized persons. |

**Table 4 Recommended Design Features for Chemical Storage Areas (continued)**

| Storage format | Design feature | Recommendations |
|---|---|---|
| **Bulk liquids** (continued) | **Emergency response** | • Provide accessible storage for spill response equipment, absorbents and personnel protection equipment.<br>• Provide appropriate measures for fire detection and suppression, as well as for rapid, effective fire control with containment of liquid firefighting residues and treatment to required limits before discharge.<br>• Install a telephone and manual alarm switch near the off-loading area. |
| **Drummed liquids** | **Objective:** To provide secure storage with containment for the worst event spill. | |
| | **Location** | • Provide safe, easy access to the mixing area. |
| | **Shelter** | • Provide storage in an enclosed, secure area, segregated from other chemicals. |
| | **Ventilation** | • Provide adequate ventilation for routine operations and emergency situations. |
| | **Containment** | • Store in a paved, curbed or dyked area with no floor drains:<br>– provide containment capacity for the worst event spill (no less than 4 drums),<br>– provide for effective cleanup (including recovery of washdown water) in the event of a spill. |
| | **Surfaces** | • Seal surfaces and joints to facilitate cleanability and surface impermeability. |
| | **Emergency response** | • Provide accessible storage for spill response equipment, absorbents and personnel protection equipment. |

**Table 5 Recommended Design Features for Chemical Mixing Systems**

| Chemical form | Design feature | Recommendations |
|---|---|---|
| **Bulk concentrate** | **Objective:**<br>◊ To provide a mixing system with effective spill prevention features.<br>◊ To provide a mixing system that minimizes worker contact with base ingredients and concentrates. | |
| | **Configuration** | • Use permanent, closed systems (rigidly piped, tank to tank). |
| | **Location/shelter** | • Locate in a contained area. |
| | **Spill prevention** | • Install high-level alarms to prevent mixing tank overflow.<br>• Interlock high-level alarms to tank feed pumps. |
| | **Spill containment** | • Provide all applicable features for spill containment of bulk liquids described in Table 4. |
| | **Drip containment** | • Provide local drip collection at all potential drip points. |
| | **Splash protection** | • Discourage open transfer operations; if unavoidable, provide reliable splash protection. |
| | **Emergency reponse** | • Provide emergency response features described in Table 3. |

**Table 6 Recommended Design Features for Treatment Process Systems: General Recommendations**

| Design feature | Recommendations |
|---|---|
| **Objectives:**<br>◊ To minimize and contain all releases of preservative chemicals.<br>◊ To recover and recycle releases that occur. | |
| **Spill containment** | • Provide spill containment capability of 110% of the volume for a single tank, and in multiple tank containment provide 100% of the largest tank plus 10% of the aggregate volume of the remaining tanks or 110% of the largest tank, whichever is greater.<br>• Locate treatment cylinders and process tanks in an area with:<br>– continuous, structurally sound concrete floors or with slabs or sections with sealed joints,<br>– sealed surfaces for cleanability and impermeability,<br>– reinforced dyke walls and sealed joints,<br>– graded surfaces for ready drainage of wetted surfaces,<br>– walkway grates (or alternative design) to minimize worker exposure and prevent tracking of chemicals from containment areas — keep surfaces clean.<br>• Provide either an impermeable top coat to floors and dykes or a liner under the containment area.<br>• Engineer containment for long-term integrity (leak-proof for infiltration and exfiltration).<br>• Provide permanent, isolated drainage/transfer systems to direct all spills, washes and infiltrating water to tankage. Treat contaminated liquids to applicable limits before discharge.<br>• Isolate control and transfer equipment to avoid damage from spilled liquids in containment areas. |
| **Process control area** | • Segregate the operator control area from retort and tank spill containment areas.<br>• Locate the process control area for maximum visibility of treatment systems.<br>• Provide proper lighting in all operating areas. |
| **Process emissions to air** | • Provide control equipment for any air emissions vented to the interior, including tank and any emissions subject to environmental controls.<br>– prevent worker exposure to vacuum pump exhausts,<br>– install additional control equipment as required to comply with applicable air emissions limits,<br>– provide traps to remove entrained liquids,<br>– assess levels of workplace air contaminants. Provide ventilation in areas where excessive levels may occur,<br>– where applicable, condense emissions and return to storage. |
| **Fire control** | • Provide fire controls as decided on site-specific basis in consultation with the local fire department.<br>• Provide containment for contaminated runoff waters and residues generated by firefighting activities (e.g. blockage of storm drains, adjacent ditches). |
| **Weather protection (winter operations)** | • Protect equipment from freezing temperatures, particularly where water is or may be present.<br>• Winterize process control area. |

**Table 7 Recommended Design Features for Treatment Process Systems**

| Design feature | Recommendations |
|---|---|
| **Objectives:**<br>◊ To provide fail-safe operation of the treatment system.<br>◊ To minimize the potential for preservative spills. | |
| **Treating cylinder** | • Treatment cylinder and pressurized components must meet all pressure vessel certifications stipulated by the provincial ministry responsible for such certification.<br>• Install an effective protection device to prevent doors opening when the cylinder is pressurized or filled with preservative:<br>– provide independent backup protection,<br>– install independent indication and/or alarm/interlocks between the cylinder door and the control point (where the door is not visible from the control point).<br>• Design to facilitate drainage of excess preservative. |
| **Piping and recycle systems** | • Design an overall system that is effective at containing and recycling all chemicals with minimum potential for release and dispersal and minimum infiltration of water.<br>• Select and install piping as per Table 4. |
| **Sumps** | • Provide leakproof design (e.g. impermeable surfaces, sealed joints).<br>• Provide a tertiary containment for sumps (e.g. steel lining or other suitable materials or devices) in addition to the concrete containment and impermeable liner or coating.<br>• Provide overflow protection if sump is not in containment area (e.g. install independent high-level alarms). |
| **Process controls** | • Design for simple, unambiguous operation (regardless of the degree of automation).<br>• Establish a clear relationship between process controls and process functions in order to minimize operator error. |

**Table 8 Recommended Design Features for Freshly Treated Wood Drip Areas**

| Design feature | Recommendations |
|---|---|
| **Objectives:**<br>◊ To minimize losses of preservative chemicals from treated wood to the environment by:<br>- providing adequate controls to ensure minimization of preservative drippage prior to removal to unprotected storage areas,<br>- controlling the generation and disposal of contaminated runoff waters. | |
| **General design** | • Consider integrated design provisions for:<br>– shelter from precipitation, dust, debris,<br>– efficient drip and runoff collection and containment,<br>– surface drainage and return of fluids to process with minimum dispersal from tracking by personnel and vehicles. |
| **Drip area** | • Provide a sufficiently sized and contained area to hold all freshly treated wood until visible dripping ceases.<br>• Roofing, as an alternative to collection and treatment of contaminated waters, might be necessary in areas of high precipitation. |
| **Containment** | • Provide impermeable and curbed charge unloading and drip areas, sloped to enable collection and storage of all runoff and infiltrating precipitation (for reuse or controlled discharge under terms of existing regulatory standards).<br>• Provide drip areas with either an impermeable top coating on floors and dykes/berms or a liner underneath. |

**Table 9  Recommended Design Features for Treated Wood Storage Areas**

| Design feature | Recommendations |
|---|---|
| **Objective:** | To minimize and control releases of contaminated surface waters from treated wood storage areas. |
| **Storage areas** | • Where applicable, fix the preservative prior to yard storage.<br>• Store treated wood under roof or wrap and provide impermeable flooring where continuing dripping or leaching may cause excessive runoff or ground contamination.<br>• Elevate treated wood packages above the ground by placing them on supports to avoid treated wood contact with runoff water.<br>• Maintain minimum inventories of treated wood.<br>• Segregate treated wood storage areas from uncontaminated runoff water to minimize the need for water treatment and/or recycling.<br>• Locate unsurfaced ground storage areas away from surface waterbodies.<br>• Routinely monitor contaminant levels in storage area runoff.<br>• Evaluate options for storage area surfaces on the basis of factors such as groundwater, usage, probability of bleeding/leaching and expected levels of precipitation (large paved areas will result in large quantities of runoff waters but may be necessary if groundwater is used for drinking water supply).<br>As per the National Fire Code of Canada (19):<br>• "yard storage areas shall be separated from mill operations and other structures by an acceptable clear space permanently available for fire-fighting operations."<br>• "storage site shall be maintained free of combustible ground vegetation including grass and weeds for at least 4.5 m from the stored material and at least 30 m from bush or forested area."<br>• "lumber treated with combustible liquids shall be stored in piles separated from other stored material, . . . not less than 4.5 m."<br>• "at least two fire department access routes shall be provided." |

# 8 Operational Recommendations

In addition to the design objectives described in section 7, a preservation facility must develop operating procedures to protect both workers and the environment from harmful exposure to preservative chemicals. The protective measures recommended in this document must be used in conjunction with those provided on the pesticide labels issued by the Pest Management Regulatory Agency (PMRA) under the *Pest Control Products Act*. The operating procedures should:

a) minimize direct contact of personnel with wood-preserving chemicals;
b) minimize releases of chemicals to the environment;
c) facilitate clear and accurate definition of responsibility and action when emergency response is required.

Recommended operating practices are presented in Tables 10 to 13 and include:

- general practices (Table 10);
- procedures for handling and storing chemicals (Table 11);
- practices for operating process systems (Table 12);
- practices for maintenance, cleanout and shutdown of preservation systems (Table 13).

The recommendations may not be the sole options available to attain the objectives. Alternative approaches may be equally effective or more suitable in view of site-specific conditions. When programs are developed for a particular facility, the specific recommendations may be modified if it can be demonstrated that an alternative approach, more suitable to plant-specific conditions, would be equally effective in attaining the objectives.

It is recommended that all existing and new wood preservation facilities meet the objectives outlined in Tables 10 to 13 by implementing the practices or their equivalents. Detailed operating procedures for each facility should be incorporated into a written operations manual available to all personnel. Responsibility and accountability for implementing procedures should be clearly assigned to supervisory personnel and to workers.

**Table 10 Recommended General Practices for Operating Wood Preservation Facilities**

| Operation | Recommendations |
|---|---|
| **Personnel** | **Objective:** To enhance worker protection by providing education and medical surveillance.<br>• Train all forepersons, on-scene supervisors, operators and handlers in good work practices.<br>• Provide periodic review and update of education and training.<br>• Provide pre-employment medical checkup and annual ongoing medical surveillance (see section 5). |
| **Procedures** | **Objective:** To assure that worker responsibilities are well understood, and that site-specific procedures are available in hard copy for reference.<br>• Prepare (and have readily available) explicit written instructions for all aspects of chemical use, facility operation, maintenance and emergency response.<br>• Identify and communicate precautions for all other on-site handlers of treated wood (including quality control personnel, sorters and transporters). |
| **Signing*** | **Objective:** To assure clear and accurate signing of all wood preservation use areas.<br>• Identify the contents of all tanks (e.g. CCA work tank, PCP oil storage tank).<br>• Identify the function of each tank (e.g. concentrate tank, work tank).<br>• Prominently display personnel safety precautions and first aid procedures.<br>• Prominently display emergency response procedures.<br>• Prominently display emergency telephone numbers for medical aid, facility management, local environmental control agencies. |
| **Personal hygiene and safety precautions** | • Follow precautions outlined in section 5, Table 1. |
| **Housekeeping** | **Objective:** To maintain a clean, orderly site.<br>• Define and practice regular housekeeping standards (suggest daily).<br>– contain all contaminated debris,<br>– minimize generation and accumulation of wastes, such as empty drums and containers (provide secure designated storage or dispose of in the appropriate manner).<br>• Visually inspect for, record and report leaks routinely as defined in the facility's procedure manual (preferably daily).<br>• Contain and repair leaks promptly. |
| **Record keeping** | **Objectives:**<br>◊ To provide a secondary level of control for chemical losses.<br>◊ To enable a rapid assessment of potential hazards, in the event of a catastrophic incident (e.g. tank rupture, fire).<br>• Maintain accurate daily records for:<br>– chemical delivery, use and inventory,<br>– equipment condition and maintenance.<br>• Record and compare bulk tank volumes before and after facility shutdowns in excess of two days.<br>– if changes in volume are apparent, check for tank leaks and/or irregular practices. |

*All signing is preferably done in accordance with workplace hazardous materials informations system (WHMIS) requirements. (Note: At this time, wood preservation chemicals are not yet included under WHMIS legislation.)

**Table 10 Recommended General Practices for Operating Wood Preservation Facilities (continued)**

| Operation | Recommendations |
|---|---|
| **Spill response** | **Objective:** Maintain a state of readiness to implement the plan in case of a chemical spill. |
| | • Establish a spill contingency plan (section 12.1).<br>• Carry out spill response drills. |
| **Firefighting** | **Objective:** To maintain a state of readiness in case of fire emergency. |
| | • Establish a fire contingency plan (section 12.2) and maintain a state of readiness to implement the plan in case of fire emergency (including routine checks of the pressure and proper function of firefighting equipment; drills with all affected personnel in cooperation with the local fire department).<br>• Communicate with the local fire department about chemicals in storage and use and emergency procedures.<br>• When a fire alarm call is made, notify firefighters of chemical quantities in stock and verify the status quo of storage locations.<br>• Provide self-contained breathing apparatus for all personnel exposed to smoke. (Only trained firefighting personnel should be allowed at the fire scene.)<br>• Make advance preparation to contain and properly dispose of contaminated fire residues to the greatest degree possible.<br>– runoff water, soot and ash from fire areas are presumed to be contaminated and provision should be made to contain these residues,<br>– analyze fire residues and involved ground soils (as applicable) to determine the need for and scope of special cleanup and disposal activities,<br>– dispose of contaminated firefighting waters as “contaminated runoff,”<br>– dispose of solid treated wood fire residues as “contaminated solid wastes.” |

**Table 11 Recommended Operating Practices for Chemical Handling and Storage**

| Operation | Recommendations |
|---|---|
| **Unloading chemicals** | **Objective:** To assure that unloading of treatment chemicals occurs in a safe manner as per section 4 of the National Fire Code of Canada (24). |
| | • Assure that the delivery of preservation chemicals to the plant is undertaken by personnel who are trained in emergency response procedures (as required by Transportation of Dangerous Goods Regulations).<br>• Assure that personnel with recognized first aid training are on-site at the plant during the unloading procedure (personnel can include the truck driver).<br>• Assure that ready access to emergency advice and aid is available during all chemical unloading periods.<br>• Restrict access to the unloading area during chemical transfer operations. Prohibit nearby pedestrian or vehicle traffic. |
| **Preparation of wood preservation solutions** | **Objective:** To assure worker safety during handling of treatment chemicals. |
| | • Follow the personnel safety precautions for all procedures (Table 1).<br>• Avoid inhalation, ingestion or skin or eye contact with all preservative chemicals.<br>• Thoroughly empty and clean preservative containers (if applicable):<br>– recycle rinse water (for water-borne formulations),<br>– return containers to suppliers or reuse sound containers for storage of wastes,<br>– dispose of unusable containers only in landfills specifically approved for such disposal (section 9). |
| **Storage of wood preservation chemicals** | **Objective:** To assure that all preservative chemicals are safely stored. |
| | • Assign responsibility for storage areas to trained personnel.<br>• Label storage tanks, identifying contents by chemical name, type of solution and concentration: e.g. CCA concentrate (50%), CCA work solution (1% to 4%).<br>• Place chemical identity placards, fire or spill emergency response procedures, personnel safety precautions and first aid procedures at storage room entrances.<br>• Check and maintain the integrity of storage tanks and storage containers:<br>– clean up all leaks or spills and implement remedial actions immediately.<br>• Provide secure storage areas; restrict access to authorized personnel only. |

## Table 12 Recommended Operating Practices for Process Systems

| Operation | Recommendation |
|---|---|
| **Routine checks** | Objective: To define procedural practices that will enhance environmental and worker safety. |
| Worker safety | Follow all precautions listed in Table 1. |
| Work solutions | • Regularly check and record quantities of treatment solution in storage.<br>• Test and record solution strengths at regular intervals.<br>• Ensure that solutions do not become excessively contaminated. |
| All process components | • Visually check the complete system for leaks: take immediate action to stop leaks.<br>• Check sludge levels in retorts: clean out as appropriate, in accordance with facility policy, observe personnel safety precautions (see Table 1). |
| Tank vents | • Test tank vents to assure the absence of blockage (suggest once/month). |
| Charges | • Secure loads to avoid uncontrolled floating and jamming.<br>• Stack loads to allow good drainage of preservative from all wood surfaces after treatment. |
| Treating cylinder | • Check door seals for damage and wear: replace door seals at regular intervals or as required if damaged or worn.<br>• Check cylinder doors for proper seal after loading charges: ensure that all bolts on doors are securely fastened or that the hydraulic collar has moved to its regular endpoint. |
| Recycle systems | • Check filters: clean or replace if necessary. |
| Trams | • Clean soil and debris from trams to prevent contamination of the preservative.<br>• Use tram design that will facilitate ready drippage during “drain” stage.<br>• Thoroughly clean trams before alternative preservative treatments are used. |
| **Checks during treating** | Objective: To monitor the treatment system to quickly identify potential/actual problems. |
| System integrity | • Closely monitor process systems for leaks during initial stages of treatment.<br>• Check for leaks or abnormal conditions throughout pressurized system at least once per shift or once per charge (whichever is more frequent).<br>• Compare recording instrument readings with indicating gauges and thermometers.<br>• Note malfunctions of recording devices, thermometers, gauges (including level floats) and arrange for prompt repairs.<br>• Carefully observe pressures during treatment to make certain that maximum limits are not exceeded (maintain records of treatment cycles, tank gauge readings and chemical consumption).<br>• Define (in writing) operator actions for abnormal situations of concern (e.g. response to equipment breakdown). |
| **Post-treating checks** | Objective: To prevent worker contact with treatment solution and with freshly discharged loads. |
| Retort opening | • Ensure that retorts cannot be opened when liquid and/or pressure remains.<br>• Avoid breathing preservative mists. If airborne concentrations are unknown or are at or above TLVs, wear an approved respirator.<br>• Wear goggles during retort door openings. |
| Charge removal | • Wear impermeable gauntlets during handling of freshly treated charges.<br>• Pull charges only when the superficial excess preservative has sufficiently drained and the charges are essentially drip-free. |
| Load jams | • Follow standard regulatory safety procedures for tank entry.<br>• Do not enter retorts until purged with fresh air (and cooled): if retort TLV levels exceed regulatory values or the concentration is unknown, then the attendant entering the cylinder must wear a self-contained full-face respirator mask, impermeable coveralls, boots and gauntlets, if TLV levels are below regulatory limits; wear NIOSH-approved respirator, impermeable coveralls, boots and gauntlets.<br>• Assure presence of and constant communication with a standby attendant.<br>• Shower immediately after tank entry. |

NIOSH = National Institute for Occupational Safety and Health.

**Table 13 Recommended Operating Practices for Maintenance, Cleanout and Shutdown of Treatment Systems**

| Operation | Recommendations |
|---|---|
| **Equipment maintenance** | **Objective:** To assure that equipment is maintained in a manner that will minimize releases of preservative chemicals and minimize worker exposure to them and their by-products. |
| | • Maintain all equipment in good operating condition.<br>• Comply with National Fire Code of Canada 4.4.11 recommendations for maintenance.<br>• Consider preparing explicit written maintenance procedures with assigned responsibility and accountability.<br>• Follow all personnel safety precautions during maintenance procedures (Table 1).<br>• Drain and/or clean wood preservation chemicals from equipment prior to maintenance:<br>– equipment should be flushed thoroughly with water, with reuse of the water for work solution preparation (where applicable).<br>• Use extreme caution if contaminated equipment must be welded (toxic fumes can be generated):<br>– thoroughly clean surfaces to be welded,<br>– wear an approved respirator when welding equipment contaminated with preservatives or their components,<br>– provide good ventilation in the work area,<br>– contain all sparks and remove flammable materials from the repair area. |
| **Cleanout** | **Objectives:**<br>◊ To prevent accumulation of preservative solutions and sludges within the treatment system.<br>◊ To assure worker safety during cleanout operations. |
| | • Observe personnel safety precautions during all procedures (Table 1).<br>• Wash down and/or scrape drip pads at regular intervals to prevent accumulation of preservative residues. (The cleanup frequency should be determined by site-specific factors including the probability of worker exposure, vehicle traffic and washdown by rain.)<br>– if possible, recover and reuse drainage from drip pads (or provide appropriate treatment or disposal).<br>• Provide appropriate treatment for washwater (if applicable).<br>• Routinely inspect sludge levels in storage and mix tanks and clean out if necessary.<br>– during cleanup, inspect gauge floats or similar equipment within tanks.<br>• Routinely inspect treatment cylinders for sludge accumulation and clean if necessary:<br>– purge cylinders with fresh air sufficiently to permit entry,<br>– if airborne concentrations are unknown, at, or above TLVs, the attendant must wear self-contained breathing apparatus, impermeable gloves, boots and coveralls,<br>– a standby attendant must always be present and continuous communication must be provided,<br>– follow standard safety procedures for entry of confined spaces,<br>– prevent skin contact with sludges,<br>– collect, drain and store contaminated material in sealed drums pending disposal (Table 4),<br>– the attendant must shower immediately after cleaning retorts or tanks. |
| **Alarms** | • Test all alarms and safety devices at regular intervals (as specified by the manufacturer). |
| **Long-term shutdown** | **Objective:** To assure orderly shutdown prior to long-term closure. |
| | • Thoroughly clean all equipment that has been in contact with preservatives.<br>• Collect all solvents and washwaters generated by cleanup operations (Table 4).<br>• Hold solutions in closed tanks for prolonged shutdown:<br>– drain all open tanks or sumps to closed storage tanks,<br>– assure that temperatures in storage areas are above freezing levels or provide adequate freezing protection for all stored liquids.<br>• In case of permanent shutdown, arrange for reuse of treatment solutions at another facility; reuse is preferable to disposal. |

# 9 Process Emissions

The preservation of wood in treatment facilities generates liquid and solid wastes and may also produce emissions to the air. There are numerous approaches available for control, treatment and disposal of process wastes and emissions. Due to the specific characteristics of the various preservatives, designs and operating procedures for pressure or thermal facilities, the issues are generally specific to individual facilities.

Information on wastes and emissions for each type of facility, as well as their recommended disposal practices, are contained in Part II - Preservative-specific Information and Recommendations.

# 10 Emission and Site Monitoring

Site monitoring and assessment is recommended at wood preservation facilities, in accordance with the design and operating objectives described in this manual, to verify that chemicals are being properly managed at the site and to achieve environmental and worker health protection. Furthermore, archiving of the assessment records will provide an orderly evaluation of site decommissioning activities, if a plant shutdown does occur.

Environmental monitoring requirements for most facilities would normally be developed in consultation with the provincial environmental regulatory agency. Additional consultation with Environment Canada would be required if the facilities were to affect federally managed resources (e.g. facilities located on or adjacent to Indian lands, or adjacent to waters used by anadromous fish, such as salmon). Worker health monitoring programs may be developed in consultation with the provincial workers' compensation board and/or department of labour.

The level of detail and scope of these monitoring activities depends on site characteristics, facility design and the regulatory requirements. Components of a site environmental and worker exposure and health monitoring program are suggested in Tables 14 and 15.

**Table 14 Recommended Routine Environmental Monitoring**

| Item | Recommendations |
|---|---|
| **Authority/reporting** | • Develop a site-specific monitoring plan.<br>• Define reporting requirements.<br>• Re-evaluate the plan if the facility expands or changes the design or operating practices. |
| **Soils** | • Consider implementing a soil monitoring program (with emphasis on unsurfaced grounds) including:<br>– all areas where preservative chemical is routinely stored, processed or handled,<br>– all freshly treated wood storage areas,<br>– all treated wood storage areas,<br>– drainage ditches or areas exposed to surface runoff (including overflow from drip pads and paved areas).<br>• Define sampling frequency (e.g. annual), sample type (e.g. surface, core), and required analyses (e.g. constituents, detection levels, quality control) in consultation with the regulatory agency. |
| **Surface waters** | • Consider implementing a monitoring program for adjacent waterbodies:<br>– define monitoring frequencies and required analyses (e.g. constituents, detection levels, quality control) in consultation with the regulatory agency,<br>– define concentrations of concern. |
| **Groundwaters** | • Consider implementing a groundwater monitoring program using permanent monitoring points down-gradient of uncontained process areas and treated wood storage areas:<br>– define well construction,<br>– define sampling frequencies and required analyses (e.g. constituents, detection levels, quality control).<br>• Give special attention to on-site wells used for drinking water. |
| **Air emissions** | • Identify air emission sources using data provided in workplace exposure study (Table 15).<br>• Monitor air emissions as required by emission permits. |
| **Liquid waste streams** | • Identify liquid waste discharges (including stormwater runoff):<br>– determine concentrations of preservative constituents,<br>– estimate total mass rates of emissions (suggested).<br>• Thereafter, monitor as required for all discharges governed by permits. |

**Table 15 Recommended Routine Workplace Monitoring**

| Item | Recommendations |
|---|---|
| **Authority/reporting** | • Develop a facility-specific plan, preferably in consultation with the regional workers' compensation board.<br>• Define reporting formats. |
| **Contact exposure** | • Identify existing and potential sources of skin exposure by periodic walk-through inspections. |
| **Air inhalation exposure** | • Define an initial monitoring program (e.g. sampling techniques, frequency of sampling, etc.), preferably in consultation with the regulatory agency responsible for worker safety.<br>• For the purpose of defining worker health protection measures, provide an initial evaluation of peak and average levels of preservative constituents in air at significant points of worker exposure. Include areas such as:<br>– cylinder doors (openings),<br>– kiln interiors,<br>– all vents to exhausts that discharge to enclosed work areas,<br>– receiving areas for all vents/exhausts that discharge to areas frequented by personnel,<br>– all enclosed preservative process areas,<br>– areas adjacent to freshly treated wood storage.<br>• Provide for subsequent monitoring, if required by regulatory agency.<br>• Make personnel samplers available for spot monitoring (as required) if high emission levels are suspected. |
| **Biological monitoring** | • Conduct initial screening medical exams to identify sensitive individuals (section 5).<br>• Define a schedule for:<br>– medical exams to confirm the absence of symptoms or signs of exposure to preservative constituents,<br>– biological monitoring of workers for preservative constituents (e.g. arsenic concentration in urine). |

# 11 Transportation of Preservative Solids, Solutions and Wastes

The transportation of preservative solids, solutions and the wastes generated by their use is regulated under the federal *Transportation of Dangerous Goods Act* (TDGA) and the *Canadian Environmental Protection Act, 1999* (CEPA 1999 ). The acts do not apply to the transportation of lumber and forestry products treated with preservatives or to treated wood wastes. The regulation of intraprovincial movement of dangerous goods is a provincial responsibility.

Transported dangerous goods must be classified according to the TDG regulations. The local Transport Canada office should be contacted for classification requirements for preservative solids, solutions and the wastes generated by their use. The treating company has to be aware that all preservatives and preservative wastes require transportation that conforms to regulations set out under the TDGA and CEPA 1999. These regulations cover, amongst others, packaging, shipping documentation, interprovincial and Canada–U.S. shipments, labeling and placarding and the reporting of dangerous occurrences.

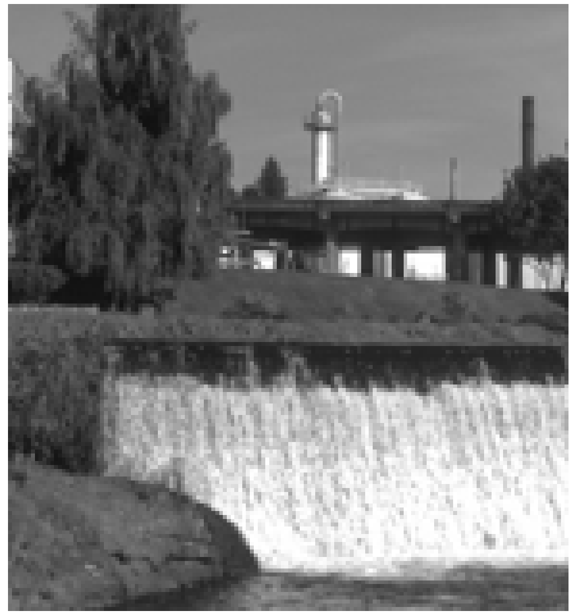
Table 16 suggests more specific transportation procedures for preservative chemicals, which are based on good operating practice and which complement the regulations. It is the intent of these control measures to minimize the potential for accidental release in transit and to provide an effective mechanism for safely managing spills if they do occur.

**Table 16  Recommended Transportation Practices for Preservative-Containing Solutions or Wastes**

| Feature | Recommendations |
|---|---|
| **Container specifications** | • Containers for transporting preservatives must be:<br>– free from mechanical defects,<br>– protected against physical abuse,<br>– filled and closed in the manner prescribed for wood preservatives by the Regulations for the Transportation of Dangerous Commodities by Rail, 1986, as amended, published by the Canadian Transport Commission. |
| **Container labelling** | • Comply with TDG Act label requirements.<br>• Affix the proper labels to each container.<br>• Label each container on at least two sides. |
| **Vehicle placarding** | • Affix vehicle placards for the class and quantity of material shipped as designated by the TDG regulations.  Note: Vehicles carrying preservative-treated commodities need not be placarded. |
| **Securing vehicle loads (e.g. drummed wastes)** | • Replace drum spouts with leak-proof bungs prior to transit.<br>• Strap drums or blocks vertically to pallets.<br>• Strap drums or blocks horizontally to each other.<br>• Brace or tie down loads to prevent shifting (do not rely on the vehicle floor or sides to prevent shifting).<br>• Ensure a stable load consistent with the vehicle floor strength.<br>• Secure other load items to prevent drum or wrap punctures and to prevent abuse to blocks. |
| **Responsibilities of truck driver, ship captain or railroad crew** | • Know the nature of the load.<br>• Carry suitable emergency equipment and be trained in its proper use.<br>• Know and follow correct procedures for the reporting of accidents or spills:<br>– immediately telephone the 24-hour contact identified in the shipping manifest,<br>– if more than 5 kg is spilled, also telephone the emergency contact,<br>– know and comply with any other requirements of the shipper/manufacturer.<br>• Immediately replace lost or damaged placards or labels (carry spares). Notify the receiver of goods that preservative materials are in transit.(Note:  Some provinces allow only licensed carriers to transport hazardous wastes.) |
| **Loading procedures** | • Ensure that personnel have the means and ability to transfer bulk materials safely.<br>• Assure that all procedures involving transfer of oil or other flammable preservative solutions are in accordance with section 4.11 of the National Fire Code of Canada.<br>• Set vehicle handbrakes securely and place wheel blocks prior to unloading.<br>• Assure the presence of a person who knows the hazards of the preservative and who is trained and prepared to respond to spills and other emergencies.<br>• If leakage or spillage occurs, decontaminate the vehicle prior to returning it to service.<br>• Dispose of absorbents and spill cleanup materials as per the appropriate tables in Part II for specific preservative systems. |
| **Shipping documents** | • TDG regulations stipulate a shipping document (products) or a manifest (wastes). |

TDG = Transportation of Dangerous Goods.

# 12 Spill and Fire Contingency Planning



Facilities using preservative chemicals should prepare a detailed contingency plan to ensure that response to spills and fires is safe and effective. Although the details of a contingency plan are facility-specific, the following provisions are typical of most spill contingency plans. A generic spill and fire contingency plan is available from the Canadian Institute of Treated Wood (CITW). This can be adapted to individual plant conditions. It is recommended that the individual facility plan be filed with the authority and/or municipality having jurisdiction.

## *12.1 Spill Contingency Planning*

### 12.1.1 General Components

A contingency plan should:

I. Have policy, purpose and organizational structure.
II. Be geared to the most probable spill size.
III. Address the following phases of spill response:
   a. discovery and notification;
   b. evaluation and initiation of action;
   c. containment and countermeasures;
   d. cleanup, mitigation and disposal;
   e. documentation and cost accounting.
IV. Clearly assign duties and roles to responsible personnel and organizations.
V. Outline equipment requirements for spill control.
VI. Include procedures for updating the plan on a scheduled basis.
VII. Outline training needs for plant personnel in prevention and response.
VIII. Coordinate with other chemical spill prevention plans and procedures if appropriate.
IX. Be submitted to chemical suppliers and the cleanup consultant or contractor for review.
X. Subsequently be submitted to appropriate government agencies including the local fire department for review.

### 12.1.2 Implementation Capability

A contingency plan should:

I. Describe location, capability and limitations of cleanup and containment equipment.
II. Pre-arrange for use of the best available cleanup and containment equipment.
III. Identify detailed response options and strategies.
IV. Provide for training programs and regular practice sessions.
V. Identify communication requirements with police, fire departments and regulatory agencies.

VI. Describe how communications will be maintained among all parties during response operations.
VII. Describe steps to be taken as a routine precaution against spills.
VIII. Address human safety issues.
IX. Assign selected personnel to respond to public and media calls.
X. Provide for sampling of and data collection about runoff waters.

### 12.1.3 Environmental Protection and Other Liability Risks

A contingency plan should:

I. Identify high-risk areas and operations.
II. Discuss expected chemical and physical behaviour of spill materials.
III. Identify and prioritize sensitive environments for protection.
IV. Detail specific actions planned for minimizing damage to resources.
V. Define explicit standards for the components and extent of effective cleanup.
VI. Include provisions for responding to spills under all anticipated weather conditions.
VII. Pre-arrange all response capability needed for the estimated worst case spill.

### 12.1.4 Examples of Action Steps

Safety of people is a prime concern. If a spill occurs:

I. Stop the flow of preservative solutions or any liquids containing preservative components:
   a. use common sense;
   b. act quickly;
   c. shut off pumps, close valves, etc., if this can be done without risk;
   d. if applicable, shut down mechanical production systems first (e.g. lumber movement) to prevent injury.
II. Warn people in the immediate vicinity:
   a. do not allow unauthorized personnel to enter the area;
   b. provide proper protective equipment for on-site personnel;
   c. avoid any contact with skin, eyes, clothing or shoes.
III. Contain the spill:
   a. act promptly;
   b. block off drains, culverts and ditches;
   c. surround spilled material with earth, peat, straw, sand, booms or commercial sorbents;
   d. use a liquid-recovery type vacuum cleaner (or empty cylinder and vacuum pump) for recovery of pools.
IV. Obtain assistance as needed from:
   a. company personnel (advise at earliest opportunity);
   b. chemical suppliers;
   c. fire/police/public works/highways department/contractors (depending on the situation).
V. Notify applicable government agencies:
   a. prompt notification is especially important for spills that have entered or may enter receiving waters;
   b. spills to marine waters require contact with Environment Canada;

c. spills to waterbodies with anadromous fish or spills on or adjacent to Indian lands require contact with Environment Canada and the provincial emergency program office;
d. for all other spills, contact the provincial emergency program office.

VI. Commence recovery, cleanup, restoration action:
a. recover pools using vacuum systems and contain recovered liquid for reuse;
b. use an inert absorbent to complete cleanup;
c. carry out cleanup and disposal in consultation with provincial and federal regulatory personnel.

## *12.2 Fire Contingency Planning*

Not all preservatives or their components are flammable, and they may behave differently in fires depending on their physico-chemical characteristics. All preservative substances can emit toxic fumes during fires. The contingency plan recommendations made here are of a general nature. More information on contingency planning for specific preservatives can be found in Part II - Preservative-specific Information and Recommendations.

### 12.2.1 General Components

A fire contingency plan should:

I. Be prepared in consultation with local fire authorities.
II. Describe policy, purpose and organizational structure.
III. Assure that creosote, petroleum oil solutions (including PCP/oil solutions) and other flammable liquids are stored as per the National Fire Code of Canada (18).
IV. Be geared to the most probably affected area.
V. Address the following phases of fire response:
a. discovery and notification;
b. evaluation and initiation of action;
c. cleanup, mitigation and disposal;
d. documentation and cost accounting.
VI. Assure that proper fire extinguishing agents are available in adequate quantities.
VII. Clearly assign duties and roles to responsible personnel and organizations.
VIII Include procedures for updating the plan on a scheduled basis.
IX. Coordinate with other fire prevention plans and programs as appropriate.
X. Be submitted to local fire department for review.

### 12.2.2 Action Steps

Fire contingency plans and defined action steps will be site-specific. Nonetheless, an overall strategy should include provisions to ensure that:

I. Water can be used to cool fire-exposed containers.
II. Appropriate firefighting media are available.
III. Firefighters are protected from dusts, gas and smoke emissions by the use of respirators.
IV. An evacuation plan is prepared for populations with potential exposure to the smoke plume.
V. Contaminated runoff waters are contained.
VI. The provincial emergency program office is notified if runoff waters could have entered receiving waters.

# 13 Solid Wastes and Sludges

The manufacture of treated wood generates solid wastes and sludges that require careful handling and eventual disposal (see recommendations in Table 17). Preservative- and operation-specific characteristics determine the types of wastes that may be generated and the procedures to handle them. Wastes may include wood debris, treated or untreated, such as cut-offs and broken sections of product, as well as contaminated filters, wraps, solution precipitates and sludges periodically removed from sumps, cylinders, tanks and containment areas. Other wastes are sludges from wastewater treatment processes (e.g. flocculated material) and contaminated soils. The principles of waste minimization and the recovery and reuse of preservatives should be practised to the utmost to limit the volumes of waste at the plant.

A provisional code of practice for the management of post-use treated wood has been prepared by the Hazardous Waste Task Group of the Canadian Council of Ministers of the Environment (19). This would also apply to treated waste wood from preservation plants.

**Table 17 Recommended Practices for Handling Solid Wastes and Sludges**

| Feature | Recommendations |
|---|---|
| **Objective:** To minimize and safely process plant wastes. | |
| **Minimization** | • Appropriately condition wood prior to treatment.<br>• Avoid the introduction of debris, soil, snow, ice and other foreign matter from wood and trams into the treatment vessel.<br>• Keep the treatment solution clean and ensure that solution concentrations and component balances are in accordance with acceptable standards (CAN/CSA 080).<br>• Minimize the frequency of switching from one preservative to another in a single treatment vessel:<br>– avoid mixing trams,<br>– thoroughly clean vessels, ancillary piping, etc., and trams prior to a switch.<br>• Do not exceed the stipulated limitations of process parameters (e.g. temperature). |
| **Collection** | • To be carried out by personnel trained in potential chemical hazards and appropriate handling methods.<br>• All personal hygiene and general precautions as outlined in section 5 must be followed.<br>• Prescribed practice for vessel entry must be observed (see Table 13, Cleanout).<br>• Collect, drain (where appropriate) and place wastes and sludges into sealed drums. |
| **Storage** | • Provide a roofed and paved enclosure to store all wastes. |
| **Records/reporting** | • Label all drums to indicate contents (type of waste).<br>• Maintain current and complete records (inventory) for all solid wastes and sludges stored on-site (pending disposal).<br>• Undertake all reporting and disposal activities in accordance with applicable regulations. |
| **Transportation** | • Classify waste in accordance with the *Transportation of Dangerous Goods Act*.<br>• Follow all instructions as outlined in Table 16. |

# 14 References


1. Doyle, E., and R.P. Dubois. 1989. Performance of Preservative Treated Stakes at Petawawa and Ottawa Field Test Plots. Report to Canadian Forestry Service by Forintek Canada Corp.
2. Bramhall, G. 1966. Marine Borers and Wooden Piling in British Columbia Waters. Department of Forestry Publication No. 1138.
3. Wallis-Taylor, A.J. 1925. The Preservation of Wood. William Rider and Son Ltd., London, U.K.
4. Hösli, J.P. 1991. "United States Wood Preservation Patents in the 19th Century.": 185–192.
5. Fuller, B., et al. 1977. The Analysis of Existing Wood Preserving Techniques and Possible Alternatives. Mitre Technical Report 7520.
6. Hunt, G.M., and G.A. Garratt. 1967. Wood Preservation. McGraw Hill Book Co., New York.
7. Wilkinson, J.G. 1981. Industrial Timber Preservation. Associated Business Press, London, U.K.
8. Stephens, R.W., G.E. Brudermann, D.E. Konasewich and J.D. Chalmers. 1996. Wood Preservation SOP: Socioeconomic Background Study. Report for Environment Canada.
9. Stephens, R.W., G.E. Brudermann, P.I. Morris, M.S. Hollick and J.D. Chalmers. 1994. Value Assessment of the Canadian Pressure Treated Wood Industry. Report by Carroll-Hatch (Int.) Ltd. for the Canadian Forestry Service.
10. CAN/CSA 080. 1997. National Standard of Canada: Wood Preservation. Canadian Standards Association, Rexdale, Ontario.
11. Anon. 1995. Best Management Practices for the Use of Treated Wood in Aquatic Environments. Canadian Institute of Treated Wood. Draft.
12. Brudermann, G.E., P.A. Cooper and T. Ung, 1991. Wood Preservation Facilities: Environmental and Worker Exposure Assessment 1988–1991. Report for Environment Canada.
13. Environment Canada (EC). 1994. Review: Canadian Wood Preservation Industry Survey. Conducted by EC Regions — 1991/93. Draft.
14. United Nations Environment Programme. 1994. Environmental Aspects of Industrial Wood Preservation: A Technical Guide. UN Technical Report Series No. 20.
15. Brown, K.W., G.B. Evans, and B.D. Frentrup. 1984. Hazardous Waste Land Treatment. Butterworth Publishers, Boston.
16. Monenco Consultants Ltd. 1985. Guide to the Environmental Aspects of Decommissioning Industrial Sites. Environment Canada, Environmental Protection Service, Ottawa.
17. Anon. 1994. National Fire Code of Canada: 1990 Fourth Revisions and Errata. National Research Council Canada, NRCC 30621, January 1994.

18. Stephens, R.W., G.E. Brudermann and J.D. Chalmers. 1995. Provisional Code of Practice for the Management of Post-Use Treated Wood. Carroll-Hatch (International) Ltd., North Vancouver, British Columbia.

19. Stephens, R.W., G.E. Brudermann and D.E. Konasewich. 2001. Summary of the Results of Environment Canada's Assessment 2000 Program for the Canadian Wood Preservation Industry. Report to Environment Canada SOP-TRD Assessment/Implementation Working Group.

# Part II

## Preservative-specific Information and Recommendations

# CHAPTER G

# Alkaline Copper Quaternary (ACQ) Wood Preservation Facilities

## Preservative-specific Information and Recommendations

This chapter must be used in conjunction with Part I - General Background Information and Recommendations.

# Contents

## List of tables

## List of figures

# 1 Production and Use

Alkaline copper quaternary (ACQ) is a waterborne formulation that is prepared on-site at wood preservation facilities. There are currently three formulations in use, Type B, Type C and Type D. The Type B formulation uses ammonia as the carrier, Type C uses an amine (ethanolamine) as carrier and alkylbenzyl dimethyl ammonium chloride (ADBAC) as co-biocide and the Type D formulation uses an amine (ethanolamine) as the carrier and didecyl dimethyl ammonium chloride (DDAC) as co-biocide. The term "alkaline" is used generally to describe either ammonia or ethanolamine formulations. With either carrier, the formulation is completed by addition of copper oxide and quaternary ammonium compound (quat) to water. ACQ is a relatively new technology that was developed in Canada and technically advanced in the U.S. It has been in commercial production in Europe, Japan and the U.S. since the late 1980s. Wood products treated with ACQ preservative are imported to Canada from the U.S., and commercial production is expected to become significant in Canada in 2003 (Table 1).

The preservative is shipped to wood treating facilities as components. Manufactured amine copper (ACQ-C.2) and ammonia copper (ACQ-C) are shipped in tank trucks or by rail at concentrations of 8 to 10%. The quaternary (quat) component is shipped in totes at concentrations of about 50%. ACQ is prepared as a ready-to-use working-strength solution by addition of a known quantity of ammonia copper or amine copper to a measured amount of water in a mix tank. Quat is then added to achieve a copper to quat ratio of 2:1 by weight in the working solution. Agitation is used in the mixing process that yields a clear blue solution.

ACQ is suited for treatment of all commercially used species and can be applied to those species that are refractory and difficult to impregnate. Major products are lumber and timbers, posts, fencing, decking, playground equipment, foundations, utility poles and plywood. ACQ is suitable for aboveground and ground contact, fresh-water immersion and saltwater splash areas but is not appropriate for use in saltwater marine immersion. It is often used where environmental sensitivities exist for the intended use of the treated wood product. Markets for ACQ are similar to those for CCA and ACA (1). See Table 1 for ACQ usage in Canada.

**Table 1 ACQ Usage in Canada**

| Feature | Characteristics |
|---|---|
| Delivery format | As individual components by rail, tank trucks and totes.<br>• ammonia copper or amine copper<br>• quaternary ammonium compound |
| Suppliers to Canadian facilities | Chemical Specialties Inc., Charlotte, N.C.<br>Timber Specialties Inc., Campbellville, Ont. |
| Estimated use quantity (2003) | 600 000-$m^3$ treated wood (21.5 million cubic feet) |
| Concentration of work solutions | 1 to 5% as total actives |
| Typical preservative retention in treated wood | 4.0- to 12.8-$kg/m^3$ treated wood (0.25 to 0.8 $lb/ft^3$) |
| Major products | Lumber and timbers, fencing, decking, posts, plywood and utility poles |

Single-cylinder preservation plants sometimes use more than one preservative. This is not recommended with ACQ as an ongoing practice, but can be done if appropriate precautions are taken and strictly followed. ACQ solutions are basic in pH, while others, such as CCA, are acidic. This situation dictates complete flushing of one preservative from the cylinder, piping and all sumps and collection areas before introduction of the other preservative. In addition, one of ACQ's advantages is that it is free of ingredients such as arsenic and chromium. This environmental and operational advantage may be lost if ACQ is mixed with the components of other preservatives.

# 2 Physical and Chemical Properties

Copper and quat, the two active components of ACQ, are used because of their biocidal and insecticidal properties and their ability to be retained by wood for long-term protection. Ammonia or amine are used as solvent carriers along with water and are deposited in the wood cells. The physical and chemical properties of ACQ and its constituents are outlined in Tables 2 to 5. The quat can either be didecyl dimethyl ammonium chloride (DDAC) or alkylbenzyl dimethyl ammonium chloride (ADBAC, ABAC).

**Table 2 Physical and Chemical Properties of ACQ Solution**

| | | |
|---|---|---|
| **Transportation and storage information** | | |
| **Prepared state**: Treating solution on-site (not transported) | **Storage temperature:** Ambient | **Containers/materials**: Plastic, poly-lined or stainless steel. Mild steel for solutions |
| **Concentration**: (by wt., as oxides) Working solution 1% to 5% | **Hoses**: Use PVC, rubber, polyethylene or stainless steel fittings only. | **Labels and classification**: Check with the Department of Transport. |
| **Classification:** Corrosive liquids, N.O.S. | **Venting:** Provide scrubbing to meet air discharge regulatory limits. | |
| **Physical and chemical properties** | | |
| **Physical state**: Liquid (20°C, 1 atm.) | **Floatability**: Mixes with water | **Colour**: Dark blue |
| **Specific gravity@15°C**: 1.20 | **Freezing point**: -5°C (23°F) | **Odour**: Sharp, characteristic ammonia or amine smell |
| **Vapour pressure**: N/E | **Flash point**: Not applicable | |
| **Solubility**: Freely soluble (water) | **pH @15°C**: 9.9 | |
| **Hazard data** | | |
| **Fire** | **Reactivity** | |
| *Extinguishing data*: Liquid is non-flammable. Water, foam, halon, carbon dioxide, and dry chemical extinguishing materials may be used. | *With water*: No reaction, soluble. | |
| *Fire behaviour*: This product is an irritant, potentially corrosive, and it presents a contact hazard to firefighters. May decompose in a fire to produce copper compounds, ammonia and nitrogen oxides. | *With common materials*: Copper, tin, aluminum and zinc alloys are readily corroded. Avoid contact with strong acids. | |
| *Ignition temperature*: Not flammable. | *Stability*: Stable. | |
| *Burning rate*: Not applicable. | | |

**Table 3 Physical and Chemical Properties of Ammoniacal Copper Solution**

| | |
|---|---|
| **Identification** | |
| **Common synonym**: ACQ-C | **Manufacturer**: Chemical Specialties, Inc., Charlotte, N.C. |
| **Transportation and storage information** | |
| **Shipping state**: Liquid concentrate | **Venting**: No requirement |
| **Concentration**: 5%-10% copper, 10%-20% ammonium hydroxide | **Containers/materials for shipping**: Plastic (poly), or stainless steel |
| **Classification**: Corrosive liquid | **Labels**: Required. Check with Department of Transport |
| **Storage temperature**: Cool, dry location. Avoid excessive heat. | |
| **Physical and chemical properties** | |
| **Physical state**: Liquid | **Vapour density**: Not established |
| **Vapour pressure**: Not established | **Flash point**: Not flammable |
| **Solubility**: Freely soluble (water) | **Explosive limits**: Not applicable |
| **Floatability:** Sinks and readily mixes in water | **Colour/appearance**: Dark blue, aqueous liquid |
| **Specific gravity @15°C (59°F)**: 1.20 | **Odour**: Ammonia smell |
| **Boiling point**: Not established | **pH @ 15°C**: 9.9 |
| **Hazard data** | |
| **Fire**<br>*Extinguishing data*: Liquid is not flammable. Most extinguishing agents can be used on fires involving ammoniacal copper solutions.<br>*Fire behavior*: Liquid is not flammable. When involved in a fire, this material may decompose and produce copper compounds, ammonia and nitrogen oxides. Irritant, potentially corrosive and presents a contact hazard to firefighters.<br>*Ignition temperature*: Not flammable<br>*Burning rate*: Not applicable | **Reactivity**<br>*With water*: No reaction, soluble<br>*With common materials*: Avoid contact with copper, tin, aluminum and zinc alloys. Corrosive. Incompatible with strong acids.<br>*Stability*: Stable |

**Table 4 Physical and Chemical Properties of Amine Copper Solution**

| | |
|---|---|
| **Identification** | |
| **Common synonym**: ACQ-C2 | **Manufacturer**: Chemical Specialties, Inc., Charlotte, N.C. |
| **Transportation and storage information** | |
| **Shipping state**: Liquid | **Venting**: Open containers slowly in well ventilated area. |
| **Concentration**: 9% copper from mixed ethanol amine complexes | **Containers/materials for shipping**: Plastic, polylined steel drums, stainless steel. |
| **Classification**: Corrosive liquid | **Labels**: Required. Check with Department of Transport. |
| **Storage temperature**: 10°-30°C (50°-86°F) | |
| **Physical and chemical properties** | |
| **Physical state**: Liquid | **Vapour pressure**: Not available |
| **Specific gravity (water=1**): 1.22 | **Flash point**: Not applicable |
| **Solubility**: Soluble in water | **Explosive limits**: Not applicable |
| **Floatability**: Sinks and mixes readily with water | **pH**: 9–10 |
| **Melting point**: Not applicable | **Colour**: Blue |
| **Boiling point**: Not available | **Odour**: Faint ammonia like odor. Odour threshold 3 ppm (amine compound) |
| **Vapour density (air = 1):** >1 | |
| **Hazard data** | |
| **Fire**<br>*Extinguishing data*: Not flammable. Most extinguishing materials are compatible for surrounding area.<br>*Fire behaviour*: Severely irritates contaminated tissue and presents contact hazard for firefighters. May decompose and produce irritating vapours and toxic gases (carbon monoxide, carbon dioxide, copper compounds and nitrogen oxides)<br>*Burning rates*: Not applicable | **Reactivity**<br>*With water*: No reaction<br>*With common materials*: Incompatible with strong oxidizing agents, strong acids and materials that are not compatible with water<br>*Stability*: Stable |

**Table 5 Physical and Chemical Properties of Quaternary Ammonium Compounds**

| | |
|---|---|
| **Identification** | |
| **Common synonym**: Quat, DDAC, ADBAC | **Manufacturer**: Various |
| **Transportation and storage information** | |
| **Shipping state**: Liquid | **Venting**: Open containers slowly and in well ventilated areas. |
| **Concentration**: 50% by weight | **Containers/materials**: Plastic or polylined steel |
| **Classification**: Corrosive material | **Labels**: Pesticide label required |
| **Storage temperature**: 10°-30°C (50°-86°F) | |
| **Physical and chemical properties** | |
| **Physical state**: Liquid | **Vapour pressure**: Not established |
| **Specific gravity (water=1)**: 0.891 | **Flash point**: Not applicable |
| **Solubility**: Soluble in water | **Explosive limits**: Not applicable |
| **Floatability**: Floats on water, mixes readily | **pH**: 6.6–9.0 |
| **Melting point**: Not established, liquid | **Colour**: Clear, colourless to pale yellow |
| **Boiling point**: Not established, liquid | **Odour**: Faint, alcohol-like |
| **Vapour density (air=1)**: >1 | |
| **Hazard data** | |
| **Fire**<br>*Extinguishing data*: Not flammable. Most fire extinguishing materials are compatible for surrounding areas.<br>*Fire behavior*: May decompose and produce irritating vapours and toxic gases (carbon monoxide, carbon dioxide and nitrogen oxides)<br>*Ignition temperature*: This product must be substantially preheated before ignition can occur.<br>*Burning rate*: Not applicable | **Reactivity**<br>*With water*: No reaction. Soluble<br>*With common materials*: Reacts with strong oxidizing agents, strong acids and materials that are incompatible with water.<br>*Stability*: Stable |

**Table 6 Physical and Chemical Properties of Ethanolamine**

| | |
|---|---|
| **Identification** | |
| **Common synonym**: Ethanolamine, MEA, glycinol | **Manufacturer**: Various |
| **Transportation and storage information** | |
| **Shipping state**: Liquid | |
| **CAS No.**: 141-43-5 | |
| **Physical and chemical properties** | |
| **Physical state**: Liquid | **Vapour pressure**: 0.2 mm Hg at 20°C |
| **Specific gravity (water=1)**: 1.01 | **Flash point**: 85°C (closed cup) |
| **Solubility**: Soluble in water | **Explosive limits**: Not applicable |
| **Floatability**: Mixes readily with water | |
| **Melting point**: 10°–12°C | **Colour**: Clear, colourless |
| **Boiling point**: 170°C | **Odour**: ammonia-like |
| **Vapour density (air=1)**: 2.1 | |
| **Hazard data** | |
| **Fire**<br>*Flammability*: Flammable.<br>*Fire behaviour*: May decompose and produce irritating vapours and toxic gases. | **Reactivity**<br>*With water*: No reaction. Soluble, hygroscopic.<br>*With common materials*: Reacts with strong oxidizing agents, strong acids and materials that are incompatible with water. |

# 3 Environmental Effects

## *3.1 Distribution in the Natural Environment*

Ammonia and copper are found naturally in the environment. Amines are derived from ammonia and are not naturally occurring. Quats are synthetically produced and are not naturally occurring; so all Quat found in the environment is assumed to be from human-made sources. Typical background levels of naturally occurring ACQ constituents are listed in Table 7.

Considerable variation occurs in natural concentrations of copper and ammonia in soils and waters (2). Because ammonia concentrations may vary both spatially and temporally, it is important to determine background levels immediately prior to operation of a facility, to enable meaningful future assessments of pollution control.

## *3.2 Aquatic Toxicity*

In considering the aquatic toxicity of ACQ, the following points should be borne in mind:

- Ammonia copper, amine copper and quats are individually delivered and handled at ACQ facilities; therefore the toxicity of each as well as the toxicity of the mixture should be considered.

- The valence of copper may change in the environment, and these changes may reduce or enhance copper's toxicity. No studies have been reported in the literature on valence inter-conversion of copper in soils, groundwater or surface runoff waters at or from wood preserving facilities. Nonetheless, it is known that reduced forms of copper rarely occur in aqueous environments (2).

The guidelines and limitations for copper noted in Table 7 are based on total concentrations, reflecting their recommendations of many scientific reviews that indicate that the current state of knowledge does not enable water quality limitations to be based on either valence state or dissolved fractions in water (3).

The observed chronic toxicity and acute toxicity values of ammonia, copper, didecyl dimethyl ammonium chloride (DDAC) and ACQ treating solution for salmonid species are summarized in Table 8.

In British Columbia, where DDAC is used in anti-sapstain formulations, provincial regulations state that the concentration of DDAC in effluent shall not exceed 700 μg/L (10).

**Table 7 Natural Background Levels and Canadian Limitations for Ammonia and Copper**

| | Typical background levels in environment | |
|---|---|---|
| **Component** | **Surface waters (mg/L)** | **Soils (mg/L)** |
| Copper (Cu) | <0.001 to 0.04 | 2-100 |
| Ammonia ($NH_3$) | <0.01 | 1-5 ppm (as $NH_4^+$) |

| Element | IJC Recommendations[(a)] Great Lakes waters | Canadian drinking water objectives[(b)] | Canadian water quality guidelines [(c)] |
|---|---|---|---|
| Ammonia | 0.02 mg/L (non-ionized) for the protection of aquatic life | No guideline in place | Guideline varies from 0.043 to 153 mg/L depending on pH; e.g. 2.2 mg/L at pH 6.5 to 7.5 and 10°C; 0.45 mg/L at pH 8.5 and 10°C[(d)] |
| Copper | 0.005 mg/L for the protection of aquatic life | Maximum acceptable 1.0 mg/L Objective[(c)] :< 1.0 mg/L | For protection of aquatic life:<br>0.002mg/L hardness 0 to 60mg/L as $CaCO_3$<br>0.003mg/L hardness 60 to120mg/L as $CaCO_3$<br>0.004mg/L hardness 120 to 180mg/L as $CaCO_3$<br>0.006mg/L hardness >180mg/L as $CaCO_3$ |
| DDAC | | | For protection of aquatic life [(b)]<br>0.0015 mg/L |

(a) Recommendations of the International Joint Commission of the Governments of Canada and the United States, 1987 (3).
(b) CCME 2003, Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment (4).
(c) Guidelines consider local conditions (e.g. background levels) (5).
(d) Guideline is based on total ammonia concentration (non-ionized and ionized forms) (5).

**Table 8 Aquatic Toxicity of Ammonia, Copper and Quat (DDAC)**

| Element | Concentration (mg/L) | Effect |
|---|---|---|
| Ammonia | 0.03<br><br>0.1 to 1.4 | • no effect concentration for salmonid growth<br>• 96-h $LC_{50}$* Rainbow trout (6) |
| Copper (+2) | 0.002<br>0.006 to 0.015<br><br>0.02-0.89 (depending upon water hardness) | • avoidance Atlantic salmon (7)<br>• cough-frequency increase Brook trout (7)<br>• 96-h $LC_{50}$*<br>• Rainbow trout |
| Quat (DDAC) | 1.24 | • 96-h $LC_{50}$* Rainbow trout (8) |
| ACQ 3% treating solution | 0.0015% | • 48-h $EC_{50}$* *Daphnia magna* (9) |

*$LC_{50}$ is defined as that concentration which results in death of 50% of the fish population within 96 hours. $EC_{50}$ is defined as that concentration, which results in the immobility of 50% of the test population within 48 hours. Because mortality could not be confirmed in all cases in the *Daphnia magna* test, this result is based on immobility of the test organisms and is presented as an $EC_{50}$.

# 4 Human Health Concerns

Ammonia and copper are found naturally in food, water and air. The following tables provide estimated daily intakes of these elements by the general population (11).

One safety objective of industrial usage of any chemical (in this case ammoniacal copper, amine copper or quat) is to minimize worker exposure to the chemical, ideally so that natural intake levels are not exceeded. If safeguards are not provided or implemented, then a variety of human health effects may occur depending on the duration and manner of exposure, concentration of chemicals, chemical forms (valence), and varying metabolic sensitivities of individual workers.

The data in Tables 9 to 12 suggest a potential for the constituent chemicals of ACQ to cause adverse effects on human health, particularly at sites where excessive exposure may occur. Various investigators have suggested that the following protective measures be adopted within the wood preserving industry:

- use of clean and undamaged impervious gloves when handling treating solutions and freshly-treated products, to reduce potential for dermal exposure (12);
- adequate worker education and good safety practices at all sites (13);
- proper eye, skin and respiratory protection (13);
- precautions during formulation of treating solutions (12).

**Table 9 Potential Health Effects of Exposure to Ammonia Copper Solutions**

| Exposure category | Type of exposure | Possible health effect | |
|---|---|---|---|
| | | Short-term exposure | Longer-term exposure |
| General population | Estimated daily intake from food, water and air of: Ammonium hydroxide: 572 mg Copper oxide: 3 mg | None reported | None reported |
| Properly protected worker | Minimal | None reported | None reported |
| Exposed worker with significant skin or eye contact | Skin or eye contact | Skin: mild irritation<br>Eyes: irritation, pain and reddening (14) | Skin: ulceration, chemical burns, dermatitis<br>Eyes: may cause blindness |
| Exposure to contaminated aerosols | Inhalation of vapours | Corrosive irritation or burns to nose, throat and lungs, coughing, difficulty breathing (15) | Chemical pneumonitis, pulmonary edema, death |
| Ingestion | Ingestion of work solution or concentrates | Irritation and burns of the mouth, throat, esophagus, and digestive system (14) | May be fatal |

**Table 10 Potential Health Effects of Exposure to Amine Copper Solutions**

| Exposure category | Type of exposure | Possible health effect | |
|---|---|---|---|
| | | Short-term exposure | Longer-term exposure |
| General population | Estimated daily intake from food, water and air of: Copper oxide: 3 mg Amine: Not established | None reported | None reported |
| Properly protected worker | Minimal | None reported | None reported |
| Exposed worker with significant skin or eye contact | Skin or eye contact | Skin: irritation, reddening<br>Eyes: irritation, pain and reddening | Skin: ulceration, chemical burns, dermatitis<br>Eyes: May cause blindness |
| Exposure to contaminated aerosols | Inhalation of vapours | Corrosive irritation or burns to nose, throat and lungs, wheezing, difficulty breathing, visual disturbances | Liver and kidney disorders, adverse lung effects, pulmonary edema, death |
| Ingestion | Ingestion of work solution or concentrates | Irritation and burns of the mouth, throat, esophagus, and digestive system | May be fatal |

**Table 11 Potential Health Effects of Exposure to Quaternary Ammonium Compounds**

| Exposure category | Type of exposure | Possible health effect | |
|---|---|---|---|
| | | Short-term exposure | Longer-term exposure |
| General population | Not applicable | None reported | None reported |
| Properly protected worker | Minimal | None reported | None reported |
| Exposed worker with significant skin or eye contact | Skin or eye contact | Skin: redness, itching<br>Eyes: redness, watering, blurred vision | Skin: Dermatitis<br>Eyes: Tissue damage, blindness |
| Exposure to contaminated aerosols | Inhalation of vapours | Respiratory irritation, dizziness, central nervous system effects | Potentially fatal lung damage, chemical pneumonitis |
| Ingestion | Ingestion of work solution or concentrates | Gastric distress, nausea, vomiting, diarrhea | Severe ingestion overexposure may be fatal |

**Table 12 Potential Health Effects of Exposure to ACQ Solutions**

| Exposure category | Type of exposure | Possible health effect | |
|---|---|---|---|
| | | Short-term exposure | Longer-term exposure |
| General population | Estimated daily intake from food, water and air of:<br>Ammonium hydroxide: 572 mg (11)<br>Copper oxide: 3 mg | None reported | None reported |
| Properly protected worker | Minimal | None reported | None reported |
| Exposed worker with significant skin or eye contact | Skin or eye contact | Skin: Irritation, reddening<br>Eyes: irritation, reddening, pain, blurred vision | Skin: ulceration, chemical burns, dermatitis<br>Eyes: May cause blindness |
| Exposure to contaminated aerosols | Inhalation of vapours | Corrosive irritation or burns to nose, throat and lungs, coughing, difficulty breathing, central nervous system effects | Chemical pneumonitis, pulmonary edema, liver and kidney disorders, death |
| Ingestion | Ingestion of work solution or concentrates | Irritation and burns of the mouth, throat, esophagus, and digestive system, gastric distress, vomiting | May be fatal |

# 5 Description of Preservative Application and Potential Chemical Discharges

## 5.1 Description of Process

ACQ preservatives, whether amine or ammonia versions, are water-based products, which are applied by pressure treatment in essentially the same manner as CCA and ACZA (Figure 1). Vacuum and pressure cycles are varied depending on the wood species and size of the wood product being treated, such that they achieve penetration of the preservative into the wood to meet the desired standard (16) or specification. ACQ is prepared on-site at wood preservation facilities from concentrates of either ACQ-C (ammonia version) or ACQ-C2 (amine version) and quat with water to form a working strength solution of 1.0 to 5.0% actives (copper plus quat). The strength of the working solution is determined by the amount of preservative to be retained in the wood. The working solution is applied to wood that has been loaded into pressure cylinders varying in size depending on the wood products being treated. They are generally from 20 to 50 m long, and about 2 m in diameter.

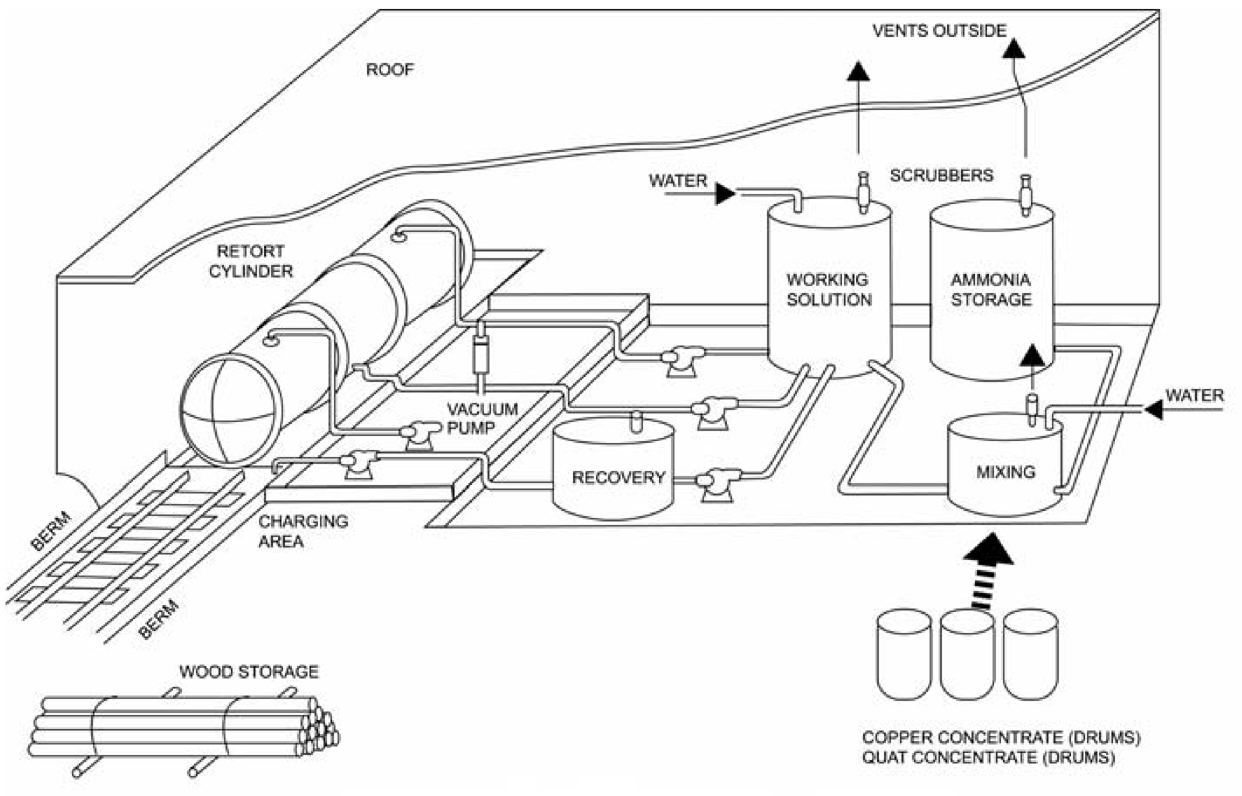
The treatment process used in ACQ treatment plants consists of the basic steps as shown in Figure 2. Application of an initial vacuum to remove air from the wood cells precedes flooding with ACQ working solution and application of pressures of up to 1040k Pa (150 psig) until the target ACQ penetration and retentions are achieved. Pressure is then released and a final vacuum drawn to remove excess preservative solution. The excess solution is returned to the working tank for reuse with subsequent charges. The treated wood is then removed from the treating cylinder and stored on a drip pad until all drippage has ceased, and it can be safely moved to a storage yard. Various methods are being used to enhance the removal of solvent (ammonia or amine) to minimize potential leaching of the preservative actives from the wood.

The specific treatment times and pressures are dictated by the species of the wood, the wood product and the moisture content of the wood. A predetermined range of process parameters is defined by the applicable treatment standards (16), and quality control tests are carried out to ensure that a minimum treated product quality is maintained. The treated wood is stored on-site until ready for shipment.

## 5.2 Potential Chemical Releases

The potential sources and releases from plants using ACQ are illustrated in Figure 3. Based on the plant design and operational practices, various potential emission sources exist that may affect the environment and/or worker health.

**Figure 1 Conceptual Diagram of an ACQ Treatment Facility**




Note: The current ACQ formulation uses ethanolamine not ammonia as a solvent. For that formulation no ammonia tank would be required.

**Figure 2 The Full-Cell ACQ Pressure Treating Process**

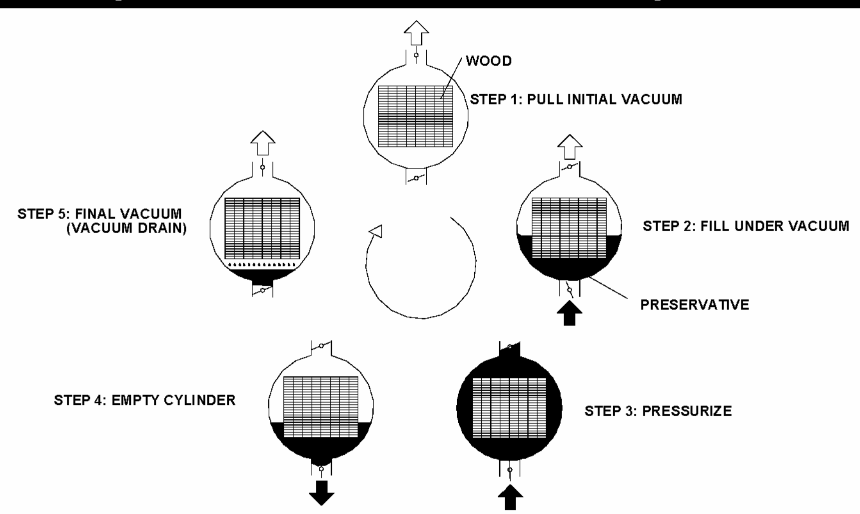
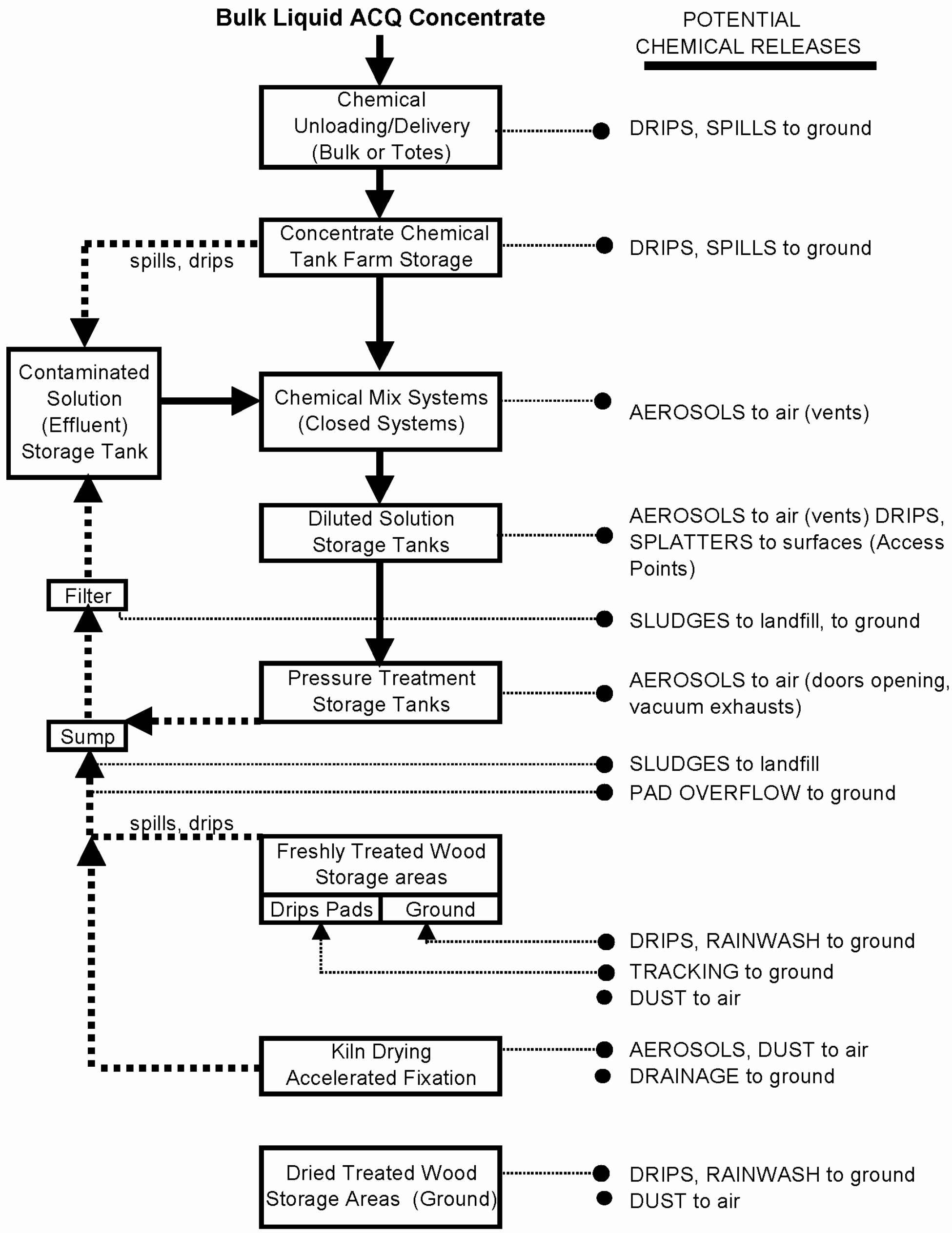


**Figure 3 Potential Releases from ACQ Pressure Treating Plants**



*Liquid Discharges*

The ACQ process uses water-borne ingredients and can be operated as a "closed system." Solution that drips from freshly treated wood or contaminated storm runoff water can be reused in the process. Primary facility design features that should be used for ACQ containment and recycling include:

- concrete containment surfaces and dyking with a second barrier for major process areas including the cylinder and tanks;

- containment surfaces for chemical drips from treated wood on the cylinder discharging track and in the freshly treated wood storage area;

- a collection sump to receive residual preservative from the cylinder (following the treatment cycle), and the accumulated contaminated runoff from other containment surfaces and contaminated stormwater. This material can then be reused in the treatment process following filtration to remove dust and debris.

Under normal operating practices in a properly designed facility there should not be any contaminated liquid discharges. The most common potential sources of contaminated liquid discharges in an ACQ facility are stormwater runoff waters from unpaved and unroofed treated product storage areas. The quantities of preservative in these waters depend on many factors, including quantity of precipitation, fixation method, elapsed fixation time and temperature prior to a precipitation event, and soil characteristics of the storage yard. Uncontained liquid releases other than stormwater are generally confined to yard soils, particularly those locations near drip pads in charging/unloading areas and where containment surfaces are used for freshly treated wood. These contaminated yard soils have potential for causing groundwater contamination.

*Solid Wastes*

Solid waste generation at ACQ facilities should be small. During normal operating conditions solid waste sources are limited to filters, and to dirt and debris that is periodically scooped from the sump, cylinder and tanks. Treated wood debris and contaminated articles are another source.

*Air Emissions*

The use of the ammonia formulation implies a significant potential for ammonia emissions at the ACQ facility if proper controls are not in place, and likewise with ethanolamine emissions when the amine formulation is used. Potential sources of release for either of these components include storage and mix tank vents, vacuum pump exhausts, vapours released when cylinder doors are opened, and freshly removed wood charges. Air emission levels should be monitored and appropriate controls such as scrubbers employed where necessary. Air emissions are generally intermittent and restricted to localized areas.

Concentrations of ACQ active components have generally been measured to be below occupational health limits. However, as was the case with ACA facilities, emissions of ammonia have the potential to be higher, dictating the use of a combination of process controls and personal protective equipment, specifically on mixing and in the immediate vicinity of cylinder doors during openings and vacuum exhausts. (12)

### *5.3 Potential Effects of Chemical Releases*

The actual impact of any chemical release depends on many factors including the location of the wood preservation facility relative to ground or surface waters, the amount and concentration of preservative released, the frequency of releases and contingency measures in place at the facility.

There have been no documented environmental or worker health effects as a result of “normal” usage of ACQ preservatives at wood preservation facilities. However, improperly designed and/or operated facilities would have the potential to contaminate site soils and groundwaters, to levels that would prevent the use of such groundwaters for drinking.

Human health effects could occur as a result of improper controls during preparation of ACQ, exposure to minor spills and residues in working areas, and improper handling of, in particular, freshly treated products.

# 6 Personnel Protection

## 6.1 First Aid

When exposure to a chemical occurs, the severity and speed of damage to human health depends on the concentration. The general rule is as follows: high concentration demands the highest level of protection. Immediate response is required if a worker is exposed to ammonia copper, amine copper, quats or ACQ work solutions. Tables 13 to 16 outline first aid measures for exposure to ACQ and its constituents.

**Table 13 First Aid for Exposure to Ammonia Copper Solutions**

| Exposure | First action | Second action |
|---|---|---|
| Eye contact | • Open victim's eyes while keeping the eyes under gently running water for 15 minutes. Use sufficient force to open eyelids. Have victim "roll" eyes. | • Get medical attention |
| Skin contact | • Remove contaminated clothing, taking care not to contaminate eyes. Run water over affected areas for 15 minutes. | • Get medical attention |
| Inhalation | • Remove victim to fresh air. If necessary, use artificial respiration to support vital functions. | • Get medical attention |
| Ingestion | • If professional advice is not available, do not induce vomiting. Victim should drink milk, egg whites, or large quantities of water. | • Call physician or poison control center for further advice. Get medical attention. |

**Table 14 First Aid for Exposure to Amine Copper Solutions**

| Exposure | First action | Second action |
|---|---|---|
| Eye contact | • Open victim's eyes while keeping the eyes under gently running water for 15 minutes. Use sufficient force to open eyelids. Have victim "roll" eyes. | • Get medical attention |
| Skin contact | • Remove contaminated clothing, taking care not to contaminate eyes. Run water over affected areas for 15 minutes. | • Get medical attention |
| Inhalation | • Remove victim to fresh air. If necessary, use artificial respiration to support vital functions. | • Get medical attention |
| Ingestion | • If professional advice is not available, do not induce vomiting. Victim should drink milk, egg whites, or large quantities of water. | • Call physician or poison control center for further advice. Get medical attention. |

**Table 15 First Aid for Exposure to Quaternary Ammonium Compounds**

| Exposure | First action | Second action |
|---|---|---|
| Eye contact | • Open victim's eyes while keeping the eyes under gently running water for 15 minutes. Use sufficient force to open eyelids. Have victim "roll" eyes. | • Get medical attention |
| Skin contact | • Remove contaminated clothing, taking care not to contaminate eyes. Run water over affected areas for 15 minutes. | • Get medical attention |
| Inhalation | • Remove victim to fresh air. If necessary, use artificial respiration to support vital functions. | • Get medical attention |
| Ingestion | • Do not induce vomiting unless directed by medical personnel. Have victim rinse mouth with water if conscious. Victim should drink milk, egg whites, or large quantities of water. | • Call physician or poison control center for further advice. Get medical attention. |

**Table 16 First Aid for Exposure to ACQ Working Solutions**

| Exposure | First action | Second action |
|---|---|---|
| Eye contact | • Open victim's eyes while keeping the eyes under gently running water for 15 minutes. Use sufficient force to open eyelids. Have victim "roll" eyes. | • Get medical attention |
| Skin contact | • Remove contaminated clothing, taking care not to contaminate eyes. Run water over affected areas for 15 minutes. | • Get medical attention |
| Inhalation | • Remove victim to fresh air. If necessary, use artificial respiration to support vital functions. | • Get medical attention |
| Ingestion | • Do not induce vomiting unless directed by medical personnel. Have victim rinse mouth with water if conscious. Victim should drink milk, egg whites, or large quantities of water. | • Call physician or poison control center for further advice. Get medical attention. |

First aid personnel should periodically verify up-to-date response measures with chemical suppliers and/or industrial physicians.

## *6.2 Regulatory Controls*

Most regulatory criteria established by worker protection agencies are based on the threshold limit values (TLVs) and biological exposure indices recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). The ACGIH-recommended limits for ammonia, copper and quat are summarized in Table 17.

*Skin and Eye Contact*

The ACGIH does not provide a recommended limit for ACQ, as such. For skin and eye contact with individual components of ACQ, the ACGIH provides the following comments (17).

- A TLV of 18 mg/$m^3$ ammonia has been selected to protect against irritation to eyes and the respiratory tract and to minimize the discomfort among unaccustomed workers. A short-term exposure limit of 24 mg/$m^3$ is suggested.
- A TLV of 7.5 mg/$m^3$ ethanolmine has been selected to protect against irritation to eyes and the respiratory tract. A short-term exposure limit of 15 mg/$m^3$ is suggested.
- A TLV of 1 mg/$m^3$ (inhalable particulates) for copper has been established, and is based on inhalation.
- Adequate skin, inhalation and eye protection is required during handling of quats. A TLV for quats has not been established.

In cases where ACGIH-recommended limits are based only upon "inhalation" as the route of exposure, these limits may not adequately take into account other routes of exposure. The ACGIH has suggested that in such cases "biological exposure indices may be useful as a guide to safe exposure" (17).

*Inhalation*

The ACGIH has defined TLVs for many substances based on exposure by inhalation and/or skin exposure. The ACGIH limits for copper, amine and ammonia are based solely on exposure by inhalation. The TLVs are stipulated by the ACGIH as those "airborne concentrations of substances to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effects." The TLVs for copper, amine and ammonia (17) are defined in Table 17 with the following provisos of the ACGIH:

- "The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use": (i.e. proof or disproof of the cause of an existing disease or physical condition).
- "The limits are not fine lines between safe and dangerous concentration."
- "In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical."
- "When two or more hazardous substances, which act upon the same organ system are present, their combined effect, rather than that of either individually, should be given primary consideration."

*Ingestion*

Oral intake of ACQ must be avoided. Ingestion of ACQ-containing liquids is unlikely if workers follow the safety precautions outlined in Table 18. Upper limits of ingestion are not prescribed by regulation, because it is generally expected that no such intake will occur. Reported fatal single dose levels for some components of ACQ include:

- 30 mL of 25% ammonia solution (15);
- 1.5 to 3.5 g of copper as copper $^{+1}$ (18).

No values for oral toxicity of amine or quat to humans are defined; however, the following measurements indicate their toxicity to rats:

- ethanolamine $LD_{50}$ oral-rat: 210mg/kg
- DDAC $LD_{50}$ oral-rat: 450mg/kg

**Table 17 Levels of Concern for ACQ Exposure in the Workplace**

| Route of entry | Basis for recommendation | Recommendations/comments |
|---|---|---|
| Skin and eye contact | ACQ and ammonia are corrosive | • Protective measures should be used by workers in contact with ACQ solutions. (Table 18).<br>• Avoid direct contact of skin and eyes with all ACQ solutions and ingredients.<br>• Sensitive individuals should take special care to avoid exposure.<br>*Comment*: current material safety data sheets should always be readily available to workers. |
| Inhalation | ACGIH TLV-time weighted averages (TWA):<br>Ammonia: 18 mg/m$^3$ air<br>Copper: 1 mg/m$^3$ air<br>Amine: 8 mg/m$^3$ air<br>Quat: Not established | • Full face protection and good ventilation should be used during chemical unloading and open mixing operations.<br>• Provide respiratory protection, eye protection and good ventilation:<br>- during unloading and mixing operations and when removing charges of wood,<br>- when welding contaminated equipment,<br>- when ACQ mist or spray is present.<br>• Self-contained breathing apparatus should be used for firefighting activities where ACQ is present.<br>*Comment:* current material safety data sheets should always be readily available to workers. |
| Ingestion | Literature reports a lethal dose level for 25% ammonia solution of 30 mL; and for copper $^{+1}$ of 1.5 to 3.5 g. | Prevent ingestion of any quantity of ACQ solutions. |

## 6.3 Safety Precautions

**Table 18 Safety Precautions for Personnel Working with ACQ Solutions**

| **Objective**: To ensure safe workplace practices for each activity during the treatment process. | |
|---|---|
| **Activity** | **Recommendations** |
| Unloading bulk containers | • Wear protective apparel and equipment as specified by the appropriate component material safety data sheet (MSDS).<br>• Prohibit foot or vehicle traffic between the point of delivery and the transport vehicle.<br>• Ensure that at least two individuals trained in handling ACQ are present at all times during unloading operations (i.e. at least one person other than the truck driver; may include forepersons, supervisors and management employees).<br>• Ensure that all connections are secure and leak proof.<br>• Provide an emergency eyewash and shower in the immediate unloading area. |
| Unloading drums or totes | • Wear protective apparel and equipment as specified by the appropriate component MSDS.<br>• Prohibit foot or vehicle traffic in the area.<br>• Ensure that all connections are secure and leak proof.<br>• Provide adequate equipment for safe, controlled handling of the containers. |
| Preparing ACQ work solutions | • Wear protective apparel and equipment as specified by the appropriate component MSDS.<br>• Thoroughly clean and hose down the work area to containment area following solution preparation.<br>• Dispose of debris and empty containers according to appropriate component MSDS.<br>• Thoroughly clean protective equipment after use. Reuse all rinse waters for preparing treating solutions.<br>• Provide an emergency eyewash and shower in the immediate area. |
| Sampling procedures | • Wear protective apparel and equipment as specified by the appropriate component MSDS.<br>• Use sample containers approved for the application and any shipment.<br>• Wash the outside of sample containers immediately after sampling solutions.<br>• Wash hands thoroughly after all sampling operations |
| Cleaning cylinders or storage tanks | • Follow all standard precautions for vessel entry and confined space (as per provincial health and safety regulations).<br>• Wear protective apparel and respiratory equipment as specified by the appropriate component MSDS.<br>• Flush vessels as required to establish safe entry conditions, or use an approved self-contained breathing apparatus prior to entry.<br>• Always have a standby attendant present, and observe regulations regarding lockout/tagout procedures for confined space entry.<br>• Collect and store contaminated waste material in sealed and labelled drums.<br>• Wash all protective equipment immediately after use. Reuse all rinse waters for preparing treating solutions.<br>• Shower after completion of cleanup tasks. |
| Removing treated charges from cylinders | • Wear gauntlets during door openings and when moving loads of freshly treated wood<br>• Avoid breathing preservative mists. Wear an approved respirator if airborne concentrations are unknown or at or above TLVs.* |
| Handling treated lumber | • Wear impermeable** gloves.<br>• Wear impermeable** gloves, apron, boots and eye protection if there is potential for getting splashed by ACQ solution. |
| Handling and maintaining contaminated equipment | • Thoroughly flush equipment with water prior to handling. Reuse all rinse waters for preparing treating solutions.<br>• Wear impermeable** gloves, apron, boots and eye protection if there is potential for getting splashed by ACQ solution. |

**Table 18 Safety Precautions for Personnel Working with ACQ Solutions (continued)**

| **Objective**: To ensure safe workplace practices for each activity during the treatment process. | |
|---|---|
| **Activity** | **Recommendations** |
| Welding | Welding can produce toxic fumes. In addition to the precautions for handling and maintaining contaminated equipment:<br>• Obtain the specific approval of the plant supervisor before welding. Follow all standard precautions for vessel entry and confined space (as per provincial health and safety regulations).<br>• Block or disconnect lines from tanks before initiating welding operations.<br>• Completely drain and thoroughly rinse tanks or lines prior to welding operations.<br>• Ensure that equipment is completely dry from cleaning solvent residues.<br>• Wear a respirator or provide effective, local exhaust ventilation during welding to prevent potential exposure to toxic fumes.<br>• Provide good general ventilation of the work area.<br>• Comply with all additional provincial workplace safety rules. |

* An initial workplace monitoring program will have determined the need for respirator use. The results of the program are assumed to be indicative of conditions in subsequent facility operations, unless procedural or design changes have occurred.

** Heavy-duty, lined polyvinyl chloride, vinyl-coated, neoprene, NBR, or rubber.

# 7 Design Recommendations

This section suggests approaches for the design and operation of ACQ wood preservation facilities for protection of workers and the environment from harmful effects. Recommendations are based on "best practices" currently in use and must be used in conjunction with the basic design criteria listed in Part I, Chapter A - General Background Information and Recommendations, section 7. The design aspects are intended to achieve the following general objectives:

a) to prevent or reduce direct contact of personnel with ACQ wood preservative chemicals;
b) to reduce releases of ACQ to the environment to the greatest degree possible by providing secure containment of ACQ solutions; and
c) to enable prompt response and effective corrective measures to assure worker safety and environmental protection after abnormal events (e.g., tank rupture)

Means of achieving these design objectives at ACQ wood preservation facilities are presented in Tables 19 to 24. The recommended design features in these tables may not be the sole options available to attain the stated objectives. Alternative approaches may exist which would be equally effective or more suitable to site-specific conditions. If an alternative approach can be demonstrated to be equally effective in attaining the desired objective, an appropriate design feature that has not been included in the recommendations could be used at a specific facility.

Figure 4 presents an overview of subject areas for the design recommendations listed in Tables 19 to 24. The figure is based on the handling and use of ACQ at wood preservation facilities and is cross-referenced to indicate the appropriate table for each subject area.

It is intended that all new wood preservation facilities be designed to achieve the specific objectives listed in Tables 19 to 24. Existing facilities should review their abilities to comply with the objectives and gaps, if present, should be alleviated using the suggested features or alternative but similarly effective features.

**Table 19 Recommended Design Features for Chemical Delivery Areas**

(Use in conjunction with Part I Chapter A - General Background Information and Recommendations, Table 3.)

| Delivery format | Design feature | Recommendations |
|---|---|---|
| **Bulk liquids:** ACQ-C or ACQ-C2 amine and Ammonia-based concentrates (Delivered by truck or rail tanker) | **Objective**: to provide an off-loading area that enhances spill prevention and the containment of spills and to prevent the release of harmful air emissions. | |
| | Emergency response | • Provide accessible storage for spill response equipment, absorbent and personnel. |
| **Containerized liquids:** Ammonia and amine copper concentrates Quat concentrate(totes and drums) | Off loading pad/shelter | • Provide an off-loading area near the storage area. |
| | Containment | • Assure provision for containment of worst event spill. |
| | Surfaces | • Provide a sealed surface. |
| | Container handling | • Design for safe, convenient manipulation of containers. |
| | Emergency response | • Provide accessible storage for spill response equipment and personnel protection equipment. |

**Figure 4  Overview of Design Recommendations for ACQ Facilities**

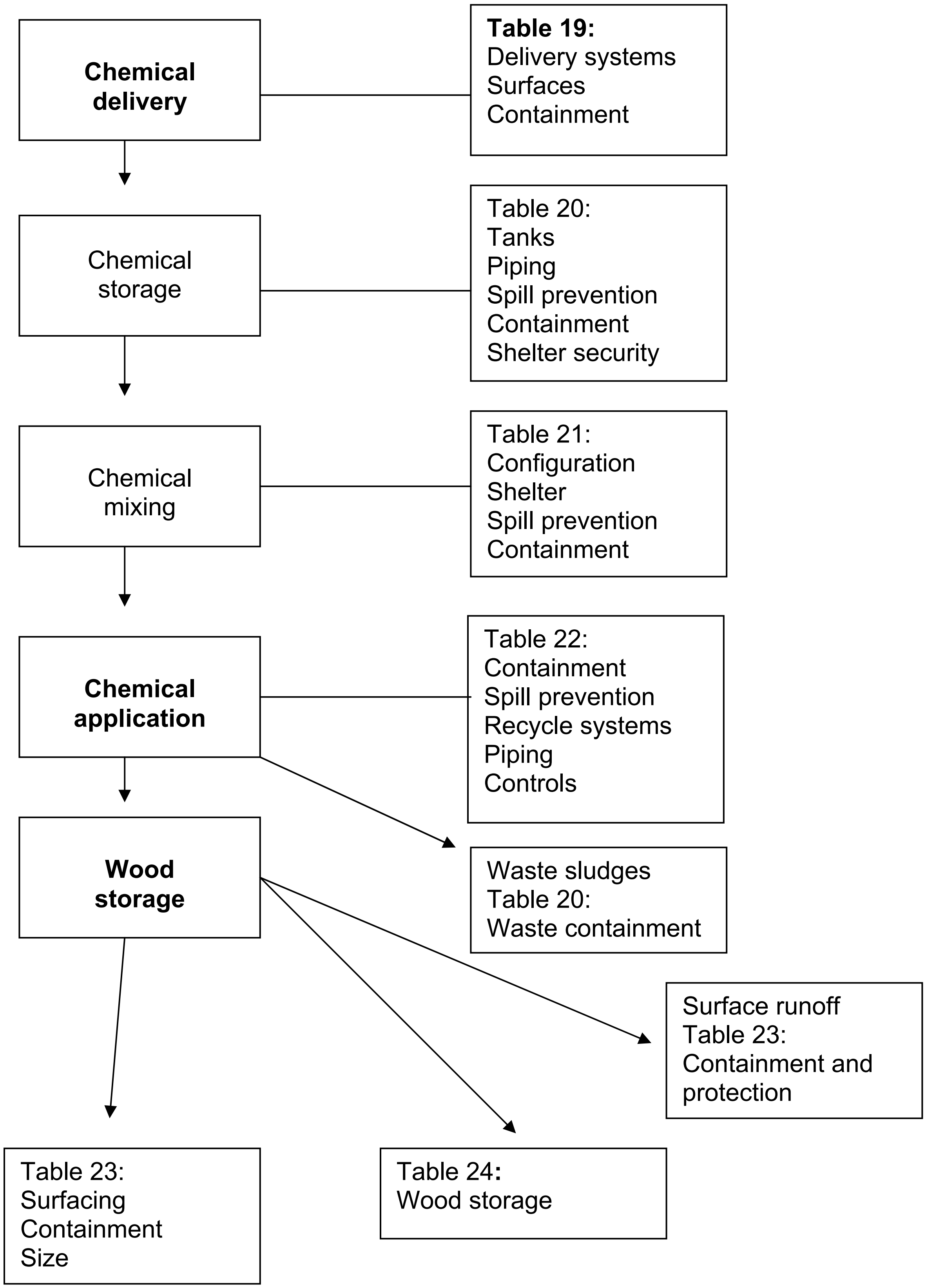


**Table 20 Recommended Design Features for Chemical Storage Areas**

(Use in conjunction with Part I, Chapter A - General Background Information and Recommendations, Table 4.

| Storage format | Design | Recommendations |
|---|---|---|
| • **Bulk ACQ liquids**<br>• working solutions<br>• contaminated surface runoff<br>• drip return | Objectives: To provide positive spill prevention features. | |
| | To provide spill containment capability for 110% of the volume for a single tank, and in multiple-tank containment provide 100% of the largest tank plus 10% of the aggregate volume of the remaining tanks or 110% of the largest tank whichever is greater, plus 15 cm additional containing wall for single tanks in isolated containment. | |
| | Tanks | • Engineer tank materials and construction in consultation with chemical suppliers and applicable codes.<br>• Vent tanks to the exterior (never vent to the workplace);<br>- protect vents against release of entrained liquids or overflow (e.g., direct overflow piping to sumps or containment areas). |
| | Spill containment | • Provide water sprays and/or ventilation to control ammonia vapours |
| | Backflow prevention | • Install backflow preventers on all waterlines at plant entry.<br>• Use top entry of waterlines to tanks (as secondary backflow protection).<br>• Waterlines must comply with all applicable local codes.<br>• Design to protect against inadvertent transfers to/from interconnected tanks. |
| | Vapour control | • Install control equipment as required to comply with applicable air emission limits for ammonia and amine vapours. If scrubbers are used, design for recycle and reuse of scrubber fluid. |
| | Shelter | • Preferred location for ACQ tankage (all solutions) is in a well-ventilated (open sites) tank farm.<br>• If possible, roof exterior tank farms to minimize the quantity of infiltrating precipitation.<br>• Protect from freezing. |
| | Security | • Provide security precautions to prevent vandalism and access by unauthorized persons. |
| | Emergency response | • Provide accessible storage for spill-response equipment, absorbents (sawdust for work solutions, drip return, runoff) and personnel protection equipment.<br>• Provide appropriate measures for rapid, effective fire control with containment of liquid firefighting residues and treatment to required limits before discharge.<br>• Provide for emergency ventilation in enclosed spaces.<br>• Install a phone and manual alarm switch near the off-loading area. |

**Table 20 Recommended Design Features for Chemical Storage Areas (continued)**

| Storage format | Design | Recommendations |
|---|---|---|
| Drummed liquids | Objective: To provide secure storage with containment for the worst-event spill. | |
| Amine and ammoniacal copper concentrate and | Location | • Provide safe, easy access to the mixing area. |
| Quat concentrate | Shelter | • Provide storage in an enclosed, secure area, segregated from other chemicals. |
| | Ventilation | • Provide adequate ventilation for both routine and also emergency requirements. |
| | Containment | • Store in paved, curbed or dyked area with no floor drains.<br>• Provide containment capacity for the worst-event spill (no fewer than 4 drums).<br>• Provide for effective cleanup (including recovery of washdown water) if a spill were to occur. |
| | Surfaces | • Seal surfaces and joints to facilitate cleanability and surface impermeability. |
| | Emergency response | • Provide accessible storage for spill-response equipment, absorbents and equipment for personnel protection as identified in Table 18.<br>• Provide appropriate measures for rapid, effective fire control with containment of liquid firefighting residues and treatment to required limits before discharge. |
| Drummed wastes: Filter cartridges, sludges, contaminated debris | | • Provide a paved area for storing all drummed wastes pending removal to approved disposal<br>• Provide a covered area for drummed wastes. |

**Table 21 Recommended Design Features for Chemical Mixing Systems**

(Use in conjunction with Part I, Chapter A - General Background Information and Recommendations, Table 5.)

| Chemical form | Design feature | Recommendations |
|---|---|---|
| • aqua ammonia<br>• working solutions<br>• drip return<br>• contaminated surface runoff | Objectives:<br>• To provide a mixing system with effective spill-prevention features.<br>• To provide a mixing system that minimizes worker contact with ACQ and its components. | |
| | Configuration | • Use permanent, closed systems (rigidly piped, tank to tank). |
| | Location/shelter | • Locate mixing and working solution tanks in an enclosed, heated area, particularly if subfreezing temperatures are encountered during operation. |
| | Spill prevention | • Install high-level alarms to prevent mixing tank overflow.<br>• Interlock high-level alarms to tank feed pumps.<br>• Provide equipment to enable safe, controlled manipulation of ingredients drums.<br>• Provide equipment for transferring drum contents with minimum worker contact and minimum spill potential. |
| | Spill containment | • Provide all applicable features for "spill containment of bulk liquids"(Chemical storage area, Table 19). |
| | Splash protection | • Discourage open transfer operations, if unavoidable, provide reliable splash protection |

**Table 22 Recommended Design Features for Treatment Process Systems**

(Use in conjunction with Part I, Chapter A - General Background Information and Recommendations, Table 6)

| Design feature | Recommendations |
|---|---|
| Objectives:<br>• To minimize and contain all releases of ACQ.<br>• To recover and recycle liquids that are released. | |
| Spill containment | • Reuse contaminated liquids or treat contaminated liquids to applicable limits before discharge.<br>• Isolate control and transfer equipment to avoid damage from spilled liquids in containment areas. |
| Ventilation | • Provide adequate routine and emergency ventilation to control preservative component vapour levels in all work areas. |
| Process emissions to air | • Vent all air emissions (including tank vents and vacuum pump exhausts) to the building exterior.<br>• Install control equipment as required to comply with applicable air emission limits for ammonia and/or amine.<br>• Install traps on otherwise uncontrolled vents (to remove entrained liquids). |

**Table 23 Recommended Design Features for Freshly Treated Wood Drip Areas**

(Use in conjunction with Part I, Chapter A - General Background Information and Recommendations, Table 8)

| Design feature | Recommendations |
|---|---|
| Objective:<br>• To minimize losses of preservative chemicals from treated wood:<br>– by providing proper conditions for preservative fixation in freshly treated wood;<br>– by controlling the generation and disposal of contaminated runoff waters. | |
| Fixation/ stabilization areas | • Provide for storage of all freshly treated wood in a specially designated area, with assured recovery of dripped material and precipitation. Holding time must be sufficient to allow adequate fixation of preservative chemicals (as determined by consideration of wood types, treatment processes, operational practices and other relevant factors) to ensure minimal leaching of chemical, when removed to unprotected area . |
| Containment | • Provide for paved charge unloading and drip areas, sloped to enable collection and storage of all runoff and infiltrating precipitation (for reuse or controlled discharge under terms of existing regulatory standards<br>• Where storage of runoff waters would be difficult, roofing should be provided. |

**Table 24 Recommended Design Features for Dry Treated Wood Storage Areas**

(Use in conjunction with Part I, Chapter A - General Background Information and Recommendations, Table 9.)

| Design feature | Recommendation |
|---|---|
| Objective: To minimize and control releases of contaminated surface waters from treated wood storage areas. | |
| Storage areas | • Where practical, store all dry treated wood under roof or wrap.<br>• Segregate treated wood storage areas from other storage areas and segregate contaminated from uncontaminated runoff water to minimize the need for water treatment and/or recycling. |

# 8 Operational Recommendations

The recommendations for good operating practice listed in this section must be used in conjunction with those in Part I, Chapter A - General Background Information and Recommendations, section 8.

In addition to the design objectives described in section 7, an ACQ facility should develop operating procedures to protect both workers and the environment from potentially harmful exposure to ACQ solutions. The operating procedures should:

a) minimize direct contact of personnel with wood-preserving chemicals;
b) minimize releases of wood-preserving chemicals to the environment;
c) facilitate clear and accurate definition of responsibility and action when emergency response is required.

Recommended operating practices are presented in Tables 25 to 28 and include:

- general practices (Table 25);
- procedures for handling and storing wood preservation chemicals (Table 26);
- practices for operating process systems (Table 27);
- practices for maintenance, cleanout, and shutdown of preservation systems (Table 28).

**Table 25 Recommended General Operating Practices for ACQ Pressure Treatments**

(Use in conjunction with Part I, Chapter A - General Background Information and Recommendations, Table 10)

| Operation | Recommendations |
|---|---|
| Objective:<br>• To assure that worker responsibilities are well understood and that site-specific procedures are available in hardcopy for reference | |
| Procedures | • Prepare (and have readily available) explicit written instructions for all aspects of chemical use, facility operation, maintenance and emergency response.<br>• Identify and communicate precautions for all other on-site handlers of treated wood (including quality control personnel, sorters and transporters). |

**Table 26 Recommended Operating Practices for Chemical Handling and Storage**

(Use in conjunction with Part I, Chapter A - General Background Information and Recommendations, Table 11.)

| Operation | Recommendations |
|---|---|
| Objective:<br>• To assure worker safety during handling of ACQ concentrate and work solutions.<br>• To assure that ACQ solutions are safely stored. | |
| Preparation of wood Preservation solutions | • Follow the personnel safety precautions for all procedures (Table 18).<br>• Avoid inhalation, ingestion, or skin or eye contact with ACQ work solutions.<br>• Thoroughly rinse empty copper and quat concentrate containers.<br>• Recycle rinse water.<br>• Return containers to suppliers or reuse sound containers for storage of wastes.<br>• Dispose of unusable containers only in landfills specifically approved for such disposal (section 9). |
| Storage of wood Preservation chemicals | Assign responsibility for storage areas to trained personnel.<br>• Label storage tanks with the identification of contents by chemical name, type of solution and concentration (e.g. aqua ammonia, ACQ work solution).<br>• Post chemical identity placards, fire and spill emergency response procedures, personnel safety precautions and first aid procedures at storage room entrances.<br>• Provide secure storage areas; restrict access to authorized personnel. |

**Table 27 Recommended Operating Practices for Process System**

(Use in conjunction with Part I, Chapter A - General Background Information and Recommendations, Table 12)

| Operation | Recommendations |
|---|---|
| Objectives:<br>• To define procedural practices that will enhance environmental and worker safety.<br>• To prevent worker contact with treatment solution and with freshly charged loads. | |
| Tank vents | • Test tank vents to assure the absence of blockage (suggest once/month). |
| Trams | • Clean soil and debris from trams to prevent contamination of the preservative.<br>• Thoroughly clean trams if alternative preservative treatments are used.<br>• Wear impermeable gauntlets during handling of freshly treated charges. |
| Retort opening and charge removal | • Pull charges only when the superficial excess preservative has sufficiently drained.<br>• Avoid exposure to ACQ, amine or ammonia mists, aerosols or vapours.<br>• If airborne concentrations are unknown, or, at or above TLVs, wear an approved respirator (full-face mask is recommended). |
| Load jams | • Assure presence of a standby attendant.<br>• Shower immediately after tank entry.<br>• Follow standard regulatory safety procedures for tank entry. |

* NIOSH = National Institute for Occupational Safety and Health.

**NOTE ON PRESERVATIVE FIXATION/STABILIZATION:**

Currently very little is known about the leachability of ACQ, methods of prevention and plant methods to verify the degree of fixation. Hence plants must take all necessary precautions to minimize charge drippage (e.g. charge tilting, extended vacuums, hot air purging of cylinder) and allow for at least 24 hours of storage at a minimum of 20$^{o}$C on a drip pad that allows recovery of all drip liquid. It is preferable if this pad is roofed.

**Table 28 Recommended Practices for Maintenance, Cleanout and Shutdown of Treatment Systems**

(Use in conjunction with Part I, Chapter A - General Background Information and Recommendations, Table 13)

| Operation | Recommendations |
|---|---|
| Objectives:<br>• To assure that equipment is maintained in a manner that will minimize releases of ACQ solution and minimize worker exposure to ACQ and its by-products.<br>• To prevent accumulation of ACQ solutions and sludges within the treatment system.<br>• To assure worker safety during cleanout operations.<br>• To assure orderly shutdown prior to long-term closure. | |
| Equipment maintenance | • Follow all personnel safety precautions during maintenance procedures (Table 18).<br>• Drain and/or clean wood preservation chemicals from equipment prior to maintenance.<br>• Flush equipment thoroughly with water and recycle rinse waters to work solutions.<br>• Thoroughly purge all ammonia vapours and provide effective ventilation.<br>• Use extreme caution if contaminated equipment must be welded (toxic fumes can be generated).<br>• Thoroughly clean surfaces to be welded. |
| Cleanout | • Observe personnel safety precautions during all procedures (Table 18).<br>• Wash down drip pads regularly to prevent accumulation of ACQ. (The washdown frequency should be determined by site-specific factors including the probability of worker exposure, vehicle traffic and wash down by rain).<br>• Reuse washwater for work solution preparation.<br>• Routinely inspect sludge levels in storage and mix tanks; clean out if necessary. Determine sludge levels of concern (requiring removal) in consultation with ACQ suppliers or technical personnel.<br>• Purge cylinders with fresh air sufficient to permit entry.<br>• If airborne concentrations are unknown, at, or above TLVs, the attendant must wear self-contained breathing apparatus in addition to gloves, rubber boots and impermeable coveralls.<br>• If airborne concentrations are below TLVs, wear respirators (do not exceed the ammonia concentration limit of the cartridge), impermeable gloves and boots, and impermeable coveralls.<br>• Provide a constant standby attendant and continuous outside communication.<br>• Follow standard safety procedures for entry of confined spaces.<br>• Prevent skin contact with sludges.<br>• Remove sludges with equipment used only for cleanout purposes.<br>• Collect, drain and store contaminated material in sealed drums pending disposal (Table 29).<br>• The attendant should shower immediately after cleaning retorts or tanks. |
| Alarms | • Test all alarms and safety devices at regular intervals (or as specified by the manufacturer). |
| Long-term shutdown | • Thoroughly clean all equipment that has been in contact with waterborne solutions.<br>• Collect all washwaters generated by cleanup operations (Table 29).<br>• Hold solutions in closed tanks for prolonged shutdown.<br>• Drain all open tanks or sumps.<br>• Assure that temperatures in storage areas are above freezing levels or provide adequate freezing protection for all stored liquids.<br>• In case of permanent shutdown, reuse of treatment solutions at another facility is preferred to disposal. |

# 9 Process Emissions and Disposal

## 9.1 Control, Treatment and Disposal

Potential process emission sources at ACQ wood preservation facilities were described in section 5.2 and Figure 3. The main categories of process wastes and emissions that may be encountered at ACQ facilities, and recommended disposal methods, are presented in Table 29.

## 9.2 Liquids Containing ACQ

Liquid process wastes (i.e. >1% total oxides) are not normally discharged from ACQ plants. Liquid solutions (such as drips and washwaters) containing ACQ are routinely collected and reused as make-up waters in preparing new treatment solutions. If unusual circumstances (such as prolonged plant shutdown) prevent on-site reuse, transport such solutions to another facility using ACQ. Disposal should be considered only as a last alternative.

If disposal is unavoidable, specific approval must be obtained from the appropriate regulatory agency. If no suitable means of disposal are readily available, the solutions should be sealed in leakproof containers (see Tables 2–6 to assure compatibility with materials used for containers), labelled and stored in a secure area.

Contaminated storm runoff should be minimized. Various approaches can be used including proper wood treatment process operation (i.e. assure solution quality, proper material placement on trams, and appropriate treatment cycles and final vacuum), roofed areas for treated product storage, adequate fixation prior to storage in the open environment and containment of storm runoff waters. In areas of high rainfall, complete containment may not be economically feasible. If the release of ACQ-contaminated runoff does occur, then guidance (and possibly specific approval) may have to be obtained from the appropriate provincial environmental regulatory agency. Control specifications may depend on factors such as the concentration of contaminants, the volume and frequency of the discharges and the sensitivity of the receiving environment. The discharge of ACQ-contaminated runoff into waters inhabited by fish is subject to the provisions of section 33(2) of the federal *Fisheries Act*, because ACQ contains components deleterious to fish.

## 9.3 Solids with High ACQ Concentrations

For the purpose of this document, solids with "high ACQ concentrations" include sludges from sumps and cylinders, and disposable cartridge filters used to filter recycled waters. Recovery of the components (copper and quat) would be ideal, but this option is not commercially feasible in Canada at this time. The preferred means of disposal for ACQ-contaminated sludges and cartridge filters is solidification and burial in an approved, secure (hydrogeologically isolated) chemical landfill. It is the responsibility of the waste generator to obtain and comply with approvals required by the jurisdiction in which the disposal site/facility is located.

Solids with high concentrations of ACQ should be drained and stored in leakproof containers while awaiting disposal. Large quantities of such solids should be stored in a specially designed area that is curbed and lined with impermeable material. The area should be roofed or covered by a leakproof tarpaulin to protect the wastes from precipitation. Any seepage or leachate generated at the site should be contained.

### 9.4 Miscellaneous Solid Wastes

Miscellaneous solid wastes (e.g. empty copper concentrate and quat drums, cuttings from ACQ-treated lumber) from ACQ wood preservation plants may be disposed of as approved by the provincial regulatory agency. The ingredient drums should be rinsed with water prior to disposal, and the rinse water should be used for the preparation of work solutions.

### 9.5 Air Emissions

Air emissions at ACQ facilities are normally localized; effects, if any, would be confined within the boundaries of the facilities. Air emissions from ACQ facilities include vapours from:

- ammonia/copper or amine/copper storage tank vents,
- ACQ mixing and storage tank vents,
- vacuum pump discharge,
- opening of retort cylinder doors, and
- freshly treated charges.

Although information is not yet available for ACQ facilities, there have been studies on the ammoniacal copper arsenate preservative ACA. Monitoring of mists (12) in the vicinity of several ACA retorts during cylinder door openings has shown arsenic and copper concentrations below published ACGIH threshold limit values (17). Ammonia emissions in the vicinity of ACA retort cylinder door openings and in the vicinity of freshly treated wood have been reported at concentrations above occupational health limits. For example, Todd and Timbie (12) measured airborne ammonia concentrations of up to 250 ppm within localized areas of one ACA facility. These concentrations were much above occupational health limits of 35 ppm for a 15-minute exposure and 25 ppm. for an 8-hour exposure. Concern about ammonia releases and control measures at an ACA facility also has been expressed in an Environment Canada report (13).

## 10 Emission and Site Monitoring

Site monitoring and assessment is required at ACQ facilities, in accordance with the design and operating objectives described in this document, to verify that wood preservative chemicals are being properly managed at the site and to ensure environmental and worker health protection. Also, assessment records will allow an orderly assessment of site decommissioning requirements if a plant is shut down.

Environmental monitoring requirements for most ACQ facilities would normally be developed in consultation with the appropriate provincial environmental regulatory agency. Additional consultation would be required with Environment Canada if the facilities have a potential to impact on federally managed resources (e.g. facilities located on or adjacent to Indian lands, or facilities located adjacent to waters used by anadromous fish such as salmon). Worker health monitoring requirements would be developed in consultation with a provincial workers' compensation board and/or department of labour.

The level of detail and scope of these monitoring activities depends on site characteristics, facility design and the requirements of the regulatory agencies. Components of a site environmental and worker health-monitoring program are suggested in Tables 14 and 15 of Part I, Chapter A - General Background Information and Recommendations.

**Table 29 Recommended Disposal Practices for Wastes Contaminated with Ammoniacal Copper Quat**

| Waste category | Examples | Recommendation |
|---|---|---|
| Liquid ACQ solutions | ACQ concentrates and ACQ work solutions<br><br>Drips from freshly treated lumber<br>Washwaters | • Reuse as make-up for work solutions (standard practice at ACQ plants). |
| Contaminated solid wastes | Debris and bottom sludge from storage tanks and sumps<br><br>Debris and sludges from recycle filters (if applicable) that have contacted ACQ | • Drain, drum and dispose of in a secure chemical landfill with prior approval of the regulatory agency. |
| Miscellaneous solid wastes | Empty concentrate drums | • Rinse thoroughly and dispose of in sanitary landfills designated subject to approval by the regulatory agency. |
| | Scraps, cuttings and shavings from ACQ-treated lumber and solid fire residues. | • Dispose of in accordance with provincial regulatory requirements |
| Contaminated storm runoff | Any storm runoff or contaminated liquid discharge that contains quat at levels that exceed provincial concentrations of copper in the receiving environment exceeding 0.005 mg/L, or whose discharge results in ammonia in the receiving environment exceeding 0.020 mg/L. | • Prevent or minimize contamination of storm runoff.<br><br>• Contain and reuse contaminated runoff<br>• Monitor surface water discharges (in consultation with the provincial regulatory agency) to assess contaminant concentrations. |
| Firefighting water runoff | As above (contaminated storm runoff) | • Contain and reuse contaminated runoff as makeup for work solutions (to the greatest possible extent).<br>• If reuse is not practical, consult with the provincial regulatory agency to determine acceptable disposal. |

# 11 Transportation of ACQ Components, Solutions and Wastes

The transportation of ACQ components, solutions, and wastes are regulated under the federal *Transportation of Dangerous Goods Act*. The act does not apply to the transportation of treated wood or treated wood wastes. The regulation of intraprovincial movement of dangerous goods is a provincial responsibility.

The stipulated transportation procedures are abstracted in Part I, Chapter A - General Background Information and Recommendations, section 11.

# 12 Spill and Fire Contingency Planning

Preparedness for emergencies is essential in any wood preservation plant. Hence, facilities using ACQ should prepare and have readily available detailed contingency plans to ensure that response to spills and fires is quick, safe and effective. It is recommended that the individual facility plans be filed with the authorities having jurisdiction.

## *12.1 Spill Contingency Planning*

In addition to the recommendations in the corresponding section 12.1 of Part I, Chapter A - General Background Information and Recommendations, the following recommendations apply to ACQ facilities if a spill of solvent, liquid ingredient or ACQ solution occurs:

- Immediately put on an appropriate full-face mask.
- Always stay upwind to avoid potential exposure to fumes.
- For ammonia spills use water spray to knock down vapours.
- If tanks other than normal work tanks are used for salvage purposes, assure compatibility of materials (e.g. do not use galvanized or aluminum tanks).

## *12.2 Fire Contingency Planning*

In addition to the recommendations in the corresponding section 12.2 of Part I, Chapter A - General Background Information and Recommendations, the following recommendations apply to ACQ facilities in case of a fire.

Although the components and solutions of ACQ are not flammable, precautions should be taken in the event that a fire occurs. Gases could be released from the preservative materials if heated, and mixtures of ammonia and air in enclosed spaces with an ignition source could be explosive.

Using water blankets and water spray to suppress toxic gases and to keep oxidizable materials at temperatures below that for ignition are additional items for the fire contingency plan as recommended in section 12.2 of Part I, Chapter A - General Background Information and Recommendations.

# 13 References


1. Stephens, R.W., G.E. Brudermann, P.I. Morris, M.S. Hollick and J.D. Chalmers. 1994. *Value Assessment of the Canadian Pressure Treated Wood Industry*. Report by Carroll-Hatch (Int.) Ltd. for the Canadian Forestry Service.
2. Spear, P.A. and R.C. Pierce. 1979. *Copper in the Aquatic Environment: Chemistry, Distribution and Toxicology*. National Research Council of Canada, Associate Committee on Scientific Criteria for Environmental Quality, Ottawa.
3. International Joint Commission. 1987. *New and Revised Great Lakes Water Quality Objectives*. IJC report to the governments of the United States and Canada.
4. Canadian Council of Ministers of the Environment. 2003. *Canadian Environmental Quality Guidelines*. Ottawa.
5. Canadian Council of Resource and Environment Ministers. 1987. *Canadian Water Quality Guidelines.* Prepared by the Task Force on Water Quality Guidelines, Environment Canada, Ottawa.
6. Aquatic Ecosystem Objectives Committee. 1985. *Annual Report to the Great Lakes Service Advisory Board of the International Joint Commission.* IJC Regional Office, Windsor, Ontario.
7. International Joint Commission. 1976. *Great Lakes Water Quality, 1975*. Appendix A. Report of the Water Quality Objectives Subcommittee. IJC, Windsor, Ontario.
8. Agriculture Canada, Health and Welfare Canada, Environment Canada, Fisheries and Oceans, Canadian Forestry Service. 1988. Discussion Document on Anti-Sapstain Chemicals. Draft Copy.
9. Domtar Inc., 1993. *Acute Toxicity Tests on Daphnia magna using 3% ACQ Treating Solution.*
10. British Columbia Schedule – Anti-Sapstain Chemical Waste Control Regulation. September 1990.
11. Health and Welfare Canada. 1978. *Guidelines for Canadian Drinking Water Quality*: supporting documentation. Department of National Health and Welfare, Ottawa.
12. Todd, A.S. and C.Y. Timbie. 1983. *Industrial Hygiene Surveys of Occupational Exposure to Wood Preservation Chemicals*. U.S. Report of Health and Human Services, National Institute for Occupational Safety and Health, Cincinnati, Ohio.
13. Henning, F.A. and D.E. Konasewich. 1984. *Description and Assessment of Four Eastern Canadian Wood Preservation Facilities.* Environmental Protection Service, Environment Canada, Ottawa.
14. U. S. Department of Agriculture. 1980. *The Biologic and Economic Assessment of Pentachlorophenol, Inorganic Arsenicals, Creosote*. USDA Technical Bulletin 1658-1.
15. Dreisbach, R.H. 1983. *Handbook of Poisoning*. Lange Medical Publications, Los Altos, California.

16. CAN/CSA 080. 1997. *National Standard of Canada – Wood Preservation.* Canadian Standards Association, Rexdale, Ontario. *Note various annual amendments to 2003.*

17. American Conference of Governmental Industrial Hygienists. 2002. *Threshold Limit Values and Biological Exposure Indices*. ACGIH, Cincinnati, Ohio.

18. U.S. Department of Health, Education and Welfare/U.S. Environmental Protection Agency. 1980. *Registry of Toxic Effects of Chemical Substances.* U.S. HEW, Washington, D.C.