Designing Around New Operation/Maintenance Needs

WEST COAST WATER/WASTEWATER UTILITIES
WORKSHOP ON WORKFORCE DEVELOPMENT

January 29, 2010
Metro Vancouver

- Metro Vancouver is a federation of 22 municipalities, one electoral area, and one treaty First Nation
- Provide regional services such as water, wastewater, solid waste, air quality, parks, etc.
- 1400 employees
- 2.2 million people (2/3 of the population of British Columbia)
- Located in the lower mainland of British Columbia, Canada
Water Supply and Treatment

Surface water supply from three protected watersheds (Capilano, Seymour and Coquitlam)

Over 310 miles of large diameter transmission mains

22 reservoirs

15 pump stations
Wastewater Collection and Treatment

33 pumping stations

275 miles of trunks and interceptor sewers

3 secondary treatment plants

2 primary treatment plants
### Trends Driving Metro Vancouver Over the Next 5-10 Years

1. Regulations Proliferate.

2. Financial Climate. Massive funding is required for infrastructure needs.

3. Increased demands for efficiency.

4. **Changing Workforce.** Workforce development is vital, as the work environment will continue to evolve.

5. **Expanding Infrastructure Needs.** Infrastructure management is becoming a critical issue for utilities.

6. High Customer and Stakeholder Expectations.

7. **Extensive Application of Technology.** Information technology and automation expanding rapidly.

8. Increasing Demands on Limited Resources. Growing populations and restrictions on water sources.
Water System Changes

• 1940’s: Chlorination at the three sources

• 1980-90’s: Rechlorination facilities built in distribution system

• 2000: Ozonation & corrosion control at Coquitlam source
Water System Changes

• 2009: 1800MLD Seymour-Capilano Filtration Plant (Seymour source filtered)
Water System Changes

- 2009: New SCADA system and System Control Centre (@ SCFP)

- 2011: UV Disinfection Facility at Coquitlam source

- 2013: Capilano source filtered (tunnels complete)
Water Treatment Operations - 2005

Small group with multiple job descriptions developed over time

- Water Treatment Division Manager
  - Superintendent Water Treatment
    - Supervisor
      - Technical Foreman
      - Chlorination Mechanics I, II, III
      - Water Treatment Worker I and II
      - Utility Worker I and II

Total staff: ~10
Water Treatment Operations - 2007

Parallel structure and standardized job descriptions

- Water Treatment Division Manager
  - Superintendent Water Treatment
    - Operations Supervisor
      - Foreman
      - Water Treatment Operators
      - Utility Workers
  - Superintendent SCFP
    - Operations Supervisor
      - Foremen
      - Water Treatment Operators
  - Engineer
    - Assistant Operations Supervisor

Total staff: ~40
Water Treatment & Systems Control

Parallel structure and standardized job descriptions

Water Treatment Division Manager

- Superintendent Water Treatment
- Operations Supervisor
  - Foreman
  - Water Treatment Operators
  - Utility Workers

- Operations Supervisor
- Assistant Operations Supervisor
- Water Treatment Operators
- Utility Workers

- Superintendent SCFP
- Assistant Operations Supervisor
- Foremen
- Water Treatment Operators

- Superintendent Systems Control
- Software Specialist
- Engineers
- Utility Systems Controllers

Total staff: ~60
Workforce Change Strategies

- Accelerated succession
- Hire multi-skilled workers
- Onboarding
- Innovative hiring
- Job redesign
Knowledge Retention & Transfer

- Engineering standards
- Project management guidelines
- Technology tools (decision support, asset management, document management)
- Technical (O&M) knowledge and experience
  - Procedures
  - Training Program
“If you do what you’ve always done...you’ll get what you’ve always got.”
SCFP Procedures Development

• Gather resource materials
  – Design reports
  – Drawings
  – Process/programming narratives
  – Equipment manuals
  – Equipment list (asset identification)

• Task identification workshops
  – 530 Tasks that required procedures ~1,250 procedures

• Prioritization
• Procedure development workshops
• Desk and field verification
## Critical Task Inventory Worksheet

<table>
<thead>
<tr>
<th>Tasks or Activities</th>
<th>Major Loss Exposures</th>
<th>Risk Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unload CGT-LM</td>
<td>People, Equipment, Materials, Environment</td>
<td></td>
</tr>
<tr>
<td>Collect CGT Sample-LM</td>
<td>People - exposure, Piping, Chemicals, Outside Catchment, Truck Connections</td>
<td></td>
</tr>
<tr>
<td>Check CGT Pump Calibration-LM</td>
<td>People - exposure, production</td>
<td></td>
</tr>
<tr>
<td>Adjust CGT Feed Rate-CRA, CRM, LM</td>
<td>Materials - production</td>
<td></td>
</tr>
<tr>
<td>Switch CGT Tanks-CRA, CRM, LM</td>
<td>People - exposure, Piping, Chemicals, Outside Catchment, Truck Connections</td>
<td></td>
</tr>
<tr>
<td>Unload CAP-LM</td>
<td>People, Equipment, Materials, Environment</td>
<td></td>
</tr>
</tbody>
</table>

**SEVERITY**

(0 – 6)

**FREQUENCY OF EXPOSURE**

(1 – 3)

**PROBABILITY OF LOSS**

(-1, 0, +1)

**CRITICALITY**

Sum (S,F,P)

- **P** – People
- **E** – Equipment
- **M** – Materials
- **E** – Environment

**Accessing Procedures:**

- SCFP Home Page

**Consider Safety, Health Damage, Fire, Quality, Production Problems, Etc. Consider PEME:**

People, Equipment, Materials and Environment
# Operations Procedures

**ASSOCIATED EQUIPMENT:**
- P-THK-23-010A, P-THK-23-011A

**PURPOSE:**
To clean CGT tank.

**REFERENCES:**
- P-23:002-01
- Ferric Chloride MSDS
- Aluminium Sulphate MSDS

**MATERIAL REQUIREMENTS:**
- Rain gear, rubber boots, chemical goggles, full face shield (or full face respirator if required), chemical resistant gloves

**POTENTIAL LOSS SUMMARY:**
- People: exposure
- Equipment: none
- Materials: none
- Environment: environmental spill

---

**SCFP-OP-23 Clean CGT Tank.doc**
**SCFP-OP-23-Clean CGT tank**

### HIRA (Hazard Identification & Risk Assessment):

<table>
<thead>
<tr>
<th>Hazard / Exposure</th>
<th>Details</th>
<th>P</th>
<th>C</th>
<th>R</th>
<th>Control Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Other</td>
<td>Yes</td>
<td>3</td>
<td>3</td>
<td>B</td>
<td>-</td>
</tr>
<tr>
<td>21 Chemical Material Contact</td>
<td>Yes</td>
<td>3</td>
<td>3</td>
<td>B</td>
<td>-</td>
</tr>
<tr>
<td>29 Work Design / Ergonomic Hazards</td>
<td>Yes</td>
<td>3</td>
<td>2</td>
<td>C</td>
<td>-</td>
</tr>
<tr>
<td>30 Slipping / Tipping Hazard</td>
<td>Yes</td>
<td>3</td>
<td>2</td>
<td>C</td>
<td>-</td>
</tr>
</tbody>
</table>

**PREREQUISITE CONDITIONS:**

1. CGT tank to be cleaned is not required for service.
SCFP-OP-23-Clean CGT tank

<table>
<thead>
<tr>
<th>Status</th>
<th>Position</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>CGT tank is off line</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Request EEO to switch CGT tank to CGB
2. Request CRO to switch HVAC ventilation to High Rate mode
3. Close CGT TNK effluent isolation valve and apply operations hold lock
4. Apply operations hold lock to CGT TNK loading valve
5. Drape plastic over CGT pumps to protect from overspray
6. Connect vacuum truck to CGT TNK sump vacuum pump connection and provide suction
7. Open CGT TNK drain valve to drain CGT tank

Note: Ensure water level in containment area does not reach CGT pumps.

8. Open CGT TNK top hatch
9. Hose CGT tank with water until clean
10. Close CGT TNK drain valve when CGT tank is empty
11. Hose down containment area and outside of CGT tank
12. Shut down vacuum truck when CGT TNK sump is empty and disconnect
13. Close CGT TNK top hatch
14. Remove operations hold locks at CGT TNK loading and CGT TNK effluent isolation valves
15. Return valve positions to normal field status
16. Return HVAC ventilation to Normal mode

This procedure is complete when:
- CGT tank is clean.
- CGT tank is in normal operating condition.
- Area is clean and secure.
SCFP-OP-23-Clean CGT tank

<table>
<thead>
<tr>
<th>Equipment No.</th>
<th>Piping Field</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-THK-23-010A</td>
<td></td>
<td>Closed</td>
</tr>
<tr>
<td>F-THK-23-011A</td>
<td></td>
<td>Closed</td>
</tr>
<tr>
<td>F-LSH-23-01A1</td>
<td></td>
<td>Closed</td>
</tr>
<tr>
<td>F-LSH-23-01A2</td>
<td></td>
<td>Closed</td>
</tr>
<tr>
<td>F-V-23-1107</td>
<td></td>
<td>Closed</td>
</tr>
<tr>
<td>F-V-23-1108</td>
<td></td>
<td>Closed</td>
</tr>
<tr>
<td>F-V-23-1109</td>
<td></td>
<td>Closed</td>
</tr>
<tr>
<td>F-V-23-1110</td>
<td></td>
<td>Open</td>
</tr>
<tr>
<td>F-V-23-1111</td>
<td></td>
<td>Open</td>
</tr>
<tr>
<td>F-V-23-1112</td>
<td></td>
<td>Open</td>
</tr>
</tbody>
</table>
SCFP Blended Training Program

- Troubleshooting guides
- Scenario Training
- Field Training
- Web based Training
Web Based Training
Web Based Training

The ultraviolet light disinfection system provides primary disinfection of protozoa at the SCFP. UV light inactivates the micro-organisms in the water by causing a molecular rearrangement in the DNA (deoxyribonucleic acid) of the micro-organisms. This DNA disruption prevents the micro-organisms from causing infection by stopping them from reproducing into viable organisms.

Filtered water from the filters flows to the UV reactors for micro-organism inactivation. The UV reactors provide the UV equipment for UV inactivation to occur. The UV reactors are located in the filter gallery at the outlet of each filter. Each UV reactor is equipped with 4 rows of 12 quartz sleeves.
Web Based Training
Field Training

• Walkthrough & Skills Demonstration Guides
  – Provides a structural framework for performance-based training in the field
  – Simulates actual performance under typical working conditions
  – Prioritized similar to procedures
Field Training

LEARNING OBJECTIVES

For successful completion of this walkthrough guide, you must be able to:

- Draw a diagram of the Coagulation and Flocculation system.
- Identify the boundaries of the system.
- Locate, identify, and demonstrate how to use all the PPE required for the Coagulation and Flocculation area.
- Identify all hazards in the Coagulation and Flocculation area.
- Locate, identify, and state the purpose of the listed components for the system.
- Trace the process flows to and from all major equipment within the system.
- Describe the operating principles and critical issues of all the major equipment.
- Perform the following procedures correctly and without supervision:
  - Adjust COT feed rate
  - Calibrate COT pump
  - Clean up COT
  - Unload COT
  - Start up COT system
  - Shut down COT system
  - Adjust CAP feed rate
  - Calibrate CAP pump
  - Clean up CAP
  - Unload CAP
  - Start up CAP system
  - Shut down CAP system
  - Start up injection manifold raw water pumps
  - Shut down injection manifold raw water pumps
  - Start up flocculation system
  - Shut down flocculation system
Field Training

• Walkthrough & Skills Demonstration Guides
  – Provides a structural framework for performance-based training in the field
  – Simulates actual performance under typical working conditions
  – Prioritized similar to procedures
LEARNING OBJECTIVES

For successful completion of this walkthrough guide, you must be able to:

- Draw a diagram of the Coagulation and Flocculation system.
- Identify the boundaries of the system.
- Locate, identify and demonstrate how to use all the PPE required for the Coagulation and Flocculation area.
- Identify all hazards in the Coagulation and Flocculation area.
- Locate, identify, and state the purpose of the listed components for the system.
- Trace the process flows to and from all major equipment within the system.
- Describe the operating principles and critical issues of all the major equipment.
- Perform the following procedures correctly and without supervision:
  - Adjust COT feed rate
  - Calibrate COT pump
  - Clean up COT
  - Unload COT
  - Start up COT system
  - Shut down COT system
  - Adjust CAP feed rate
  - Calibrate CAP pump
  - Clean up CAP
  - Unload CAP
  - Start up CAP system
  - Shut down CAP system
  - Start up injection manifold raw water pumps
  - Shut down injection manifold raw water pumps
  - Start up flocculation system
  - Shut down flocculation system
Classroom Training

- Apply knowledge learned in Web Based and Field Training and creative thinking
  - Team learning
  - Team development
  - Very small class size

- Train-the-Trainer Seminars

  Dynamic structure allows flexibility to re-initiate course but with new scenarios as the plant continues to operate
# Classroom Scenario

<table>
<thead>
<tr>
<th>Activity</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 1. Give a brief overview of the Coagulation and Flocculation System.  
Slide 1 – Entire facility  
Slide 2 – Coagulation and Flocculation System  
Slide 3 – Coagulation System  
Slide 4 – Flocculation System | |
| 2. Review theme learning objectives for the scenario.  
Slide 5 – Global Learning Objectives | |
| 3. Introduce scenario:  
You have just noticed that the particle counts in the flocculation effluent seem to be increasing dramatically. What would you do? | |
| 4. Allow group to brainstorm for 5 – 10 minutes.  
Possible prompt(s) to help discussion if stalled:  
What are some of the possible causes of this?  
What are some of the potential implications of this (e.g., downstream effects)? | |
| There are a number of possible causes and effects for this part of the scenario. Once the entire scenario is complete, review any possible causes and effects that the learners may have missed (refer to activity 12). | |
Troubleshooting Guides

Source Supply and IWet Blending
- Coagulation
- Flocculation
- Filtration and Backwashing
- Disinfection
- UV Disinfection
- Sodium Hypochlorite System
- Corrosion Control - Lime System
- Carbon Dioxide System
- Clearwells

Treated Water Distribution
- Plant Drainage and Overflows
- Calcium
- Thiosulphate System
- Washwater Recovery and Treatment
- Residuals Handling
- Activated Sludge - Activated Sludge
- SCFP Plant Wide Equipment
- All Areas

Possible Solutions
- verify CDACS in normal field status
- start pumps
Assessment

- Formal knowledge and skill based reviews for web based training and field training

- Informal assessment for classroom training
Program Administration

- Technical Administration
- Content Administration
- Learning Administration
Schedule & Resources

• Schedule
  – July 2006 to December 2009

• Resources
  – 1 person full time for project management and technical reviews
  – Equivalent of 2+ subject matter experts (operators, engineers, consultants, etc.) throughout contract duration for content development and review
“Depending on the size of the project and your staff previous experience, complete operator training and documentation may cost
~ 0.25% to 0.75% of the total project cost
– do not use low bid for this part of your project
– you get what you pay for”

- Gerry Stevens, AECOM

• SCFP capital = $300M, therefore $750,000 to $2.25M for training & documentation

• SCFP procedures and training program development project contract ~$1M = 0.33%
Lessons Learned

• Plan, plan, plan
  – Include all stakeholders in scoping
  – Do a gap analysis
  – Budget and resources (Multi-year? Phased approach?)
  – Technical limitations (Platform? Bandwidth?)

• Reference materials availability
Lessons Learned

• Know your audience ("Learners")
  – Base skills/knowledge
  – Target skills/knowledge
  – Consider different learning styles & needs
  – IT skills? Access?
  – Blended approach

• Document templates
Lessons Learned

• Ongoing management
  – Content
  – Documents
  – Program
  – Software

• Effectiveness Measurement
  – ROI (pre-tests, etc.)
  – Feedback on learning tools and learning content
Results

• “Blended training” program accommodates various learning and teaching styles
• Consistent training to all employees
• Minimized impact on experienced staff during training
• Training documented
• Shortened timeframe to train a new employee
• Enhanced problem-solving and communication skills
• Staff enabled to engage in innovation and optimization
• Customized reference materials (library)
• Program is being replicated for the water distribution system and the wastewater treatment plants
Testimonials

“…a great tool to complement my knowledge about the operation gained previously from the PFSs…”
Tahir Maloku, Water Treatment Plant Operator

“As a new operator here at the SCFP, I found the web-based training to be highly effective at putting the diverse systems into perspective. It allowed me to gain a detailed understanding of the theory and operation of the various systems prior to field work. It would have taken a far greater amount of time to walk the various systems and discover all the feeds and flows. I particularly enjoyed the graphical representations of flows and chemistry…”
Rob Chilton, Water Treatment Plant Operator

“These courses are very user friendly and I can surf in different parts of them easily. The graphics are very clear and neat, and related notes are in perfect and brief shapes…”
Reza Fereidouni, Water Treatment Plant Operator

“The complete package provided a great foundation for staff to operate equipment during early commissioning in support of the Seymour Tie – in, and media washing. The classroom training provides a great forum for team building and trouble shooting..”
Alistair Wardlaw, Plant Supervisor
Questions?

Jennifer Crosby
Senior Project Engineer
Water Treatment & Systems Control
604.451.6568
jennifer.crosby@metrovancouver.org