CHELAN COUNTY PUD
INCIDENT ANALYSIS CHARTER

Rocky Reach C-8 Incident

Date 2/9/15

Purpose
Form a team to investigate the C-8 incident at Rocky Reach to establish the facts related to the incident, determine the factors that directly caused or contributed to the incident, and make recommendations to be taken to prevent a recurrence. The team will consist of District personnel along with outside safety professionals to assist in the investigation.

Scope
The team will investigate the incident activities and report on their findings by
- Gathering facts and evidence
- Document the facts as they are identified
- Review all supporting documentation
- Develop conclusions (root cause) and corrective actions
- Write a summary, identify conclusions, and provide corrective action recommendations
- Submit a final report

Sponsor: Steve Wright
Name
Signature

Team Leader: Kirk Hudson
Name
Signature

Team Members: Ron Franklin
Name
Signature
Mark Graham
Name
Signature
Phil Penhallegon
Name
Signature
Rocky Reach C-8 Incident

Incident Analysis

Level of Severity- 3

Incident Date: February 4, 2015

INVESTIGATION TEAM

Team Sponsor         Kirk Hudson, Managing Director Generation & Transmission (*9, #17)
Team Leader          Brian Clarke, Managing Partner, G.E.W., LLC (*28)
Team Member          Heather McMurdo, Human Performance Program Manager, Energy NW (*10)
Team Member          Ron Franklin, Director, Safety & Health Division (*12, #33)
Team Member          Jim Gray, Operations Superintendent, Rock Island (#35)
Team Member          Jim Kaiser, Chief Operator, Rock Island (#35)
Team Member          Philip Penhallegon, Journeyman Mechanic, Central Maintenance – (#28)
Team Member          Gina Peterson, Journeyman Wireman, Rock Island (#26)
Team Member          Mark Graham, Safety & Health Coordinator (*28, #8)
Team Member          Dan Kavet, Technical Documentation Specialist (#15)

* Indicates years of experience in Incident Analysis

# Indicates years of experience at Chelan County Public Utility District (PUD)
INVESTIGATION PROTOCOL

On Thursday, February 5th, an outside Incident Analysis Consultant was contacted to 1) evaluate the incident and 2) make recommendations for process improvement. In addition, a Performance Program Manager from Energy Northwest was also contacted to assist in the analysis.

On Monday, February 9th, a team of PUD employees and the two outside experts met to establish a process of analyzing the incident and suggesting recommendations for improvement. In addition to the outside analysts, the team consisted of internal subject matter experts including a Plant Operations Superintendent, Hydro Mechanic, Chief Operator, Hydro Wireman, two members of the District’s Safety & Health Division, and a Technical Documentation Specialist. Team members brought well over two hundred years of collective experience in their professions. The subject matter experts were drawn from the Rock Island Hydro Project.

On February 13, 2014, the investigation team began conducting interviews with the various employees involved in the incident. Over a 12 day period, the following staff was interviewed:

- General Manager
- Managing Director, Generation & Transmission
- Hydro Operations Director
- Central Maintenance Director
- Rocky Reach Operations Superintendent
- Rocky Reach Maintenance Superintendent (Acting)
- Rocky Reach Hydro Planner Mechanical
- Rocky Reach Chief Operator
- Rocky Reach Relief Operator
- Central Maintenance Foreman Mechanic
- Central Maintenance Mechanic (2)
- Rocky Reach Plant Wireman (2)

In the course of the investigation, a comprehensive review of data and documents included but was not limited to:

- Plant operations logs
- System Operations logs
- PeopleSoft time entry reports
- Operations and Maintenance Instructions (OMIs)
- Standard and Emergency Operations Procedures
- WAC Code 296.45
- PUD Generation Energy Isolation Program
- Key individual phone records
- Maximo work order tracking
- Job Safety Analysis (JSA)
INCIDENT SUMMARY

On January 21st, Rocky Reach (RR) generating unit C-8 was shut down to investigate an unusual smell. On January 22nd the Plant Wireman Foreman was issued a clearance on the unit and an inspection was begun. On January 28th, that clearance was transferred to the CM Wireman Foreman. Also on January 28th, a CM Mechanic Foreman was issued a clearance to underwater the unit and inspect the turbine runner.

On the morning of Wednesday, February 4, 2015, Plant management directed the CM Wireman Foreman to stop testing of C-8 stator windings and prepare for inspection of units C-9 and C-11. Plant management also directed the CM Mechanical Foreman from C-10 to start preparing for relocation of headgates from C-8. A component of this assignment required the removal of headgates from C-8 and their installation in C-11. The Mechanic and Wireman Foreman worked through the Plant Chief Operator to release tags on C-8 to allow the unit to be configured for the removal of the headgates.

On the afternoon of Wednesday, February 4th, the wiremen were in the process of completing their testing on C-8 stator windings while mechanic crew began removing the unit's headgates. As the first headgate was being removed, water started flowing into the unit's scroll case and through the turbine blades. This resulted in the unexpected rotation of the rotor, increasing to a speed that did not exceed 115 rpm. Loud noise and a substantial amount of smoke were emitted from the unit. PUD employees and one contractor employee working in the vicinity immediately vacated the Powerhouse. The headgate was lowered back on seal stopping the flow of water into the unit and allowing the rotor to stop rotating. During the inspection, it was identified that the wicket gates were tagged at 100% Open, allowing water to rotate the turbine runner.

The Incident Analysis Team’s findings and recommendations are on the following pages.
CONDENSED TIMELINE

Jan 21    C-8 forced outage due to an unusual smell
Jan 22    Plant Wireman Foreman was issued clearance on C-8
Jan 28    CM Mechanic Foreman was issued a clearance on C-8
          Plant Wireman Foreman transferred C-8 clearance to CM Wireman Foreman
Feb 3     1:00 pm Rocky Reach and CM Management met to discuss winding inspection options. They agreed to inspect C-9 during planned outage and C-11 would follow.
          Feb 4, 2015 Day of Event
7:00 AM   CM Electrical Crew working on inspecting stator windings on C-8
          CM Mechanical Crew working on C-10 completing inspections
9:00 AM   Director Hydro Operations calls RR Operations Superintendent to request stopping work on C-10 to prepare for inspection of C-9 and C-11.
9:04 AM   Series of phone calls ensued to communicate the decision to inspect C-11 before C-9.
9:28 AM   CM Mechanic Foreman directed to move headgates from C-8 to C-11.
9:55 AM   CM Mechanic Foreman contacted Chief Operator requesting tags pulled on C-8.
10:00 AM  CM Electrical Foreman and his crew signed off on C-8 clearance (electrical clearance did not include “wicket gates”). Crew was reminded to stay off rotor.
10:10 AM  CM Electrical Foreman contacted Chief Operator authorizing tags be pulled from C-8
10:20 AM  Relief Operator removed mechanic and wiremen tags from C-8 energy isolation points.
12:30 PM  CM Mechanic Journeyman checked Winter/Kennedy Taps for unit water-up status. These were not functioning properly.
12:35 PM  CM Mechanic Journeyman went to scroll case roof hatch/cover and checked for water
2:04 PM   CM Mechanical crew received approval from Plant Operator to lift headgates.
2:13 PM   C-8 rotor started to move and came up to a high rate of speed while two CM Wiremen were sitting on the stator. Hydro Operator Supervisor and contract employee also near C-8 on Generator floor.
          RR Wireman Foreman called Control Room and told them that C-8 was rotating.
2:15 PM   C-8 headgate put back on sill.
2:22 PM   Unit stops rotating.
*For detailed timeline, see Attachment #1
ROOT CAUSES

The following is a non-prioritized list of the most significant causes of this incident. Some of these root causes are very specific, while others identify possible program improvements. Also identified during this incident analysis were contributing factors to the incident which are addressed in the following pages.

1. There was no formal management process in this instance for redirecting crews when changing the scope/priority of work.
2. When the C-8 tags were released, the wicket gates were not verified to be secured in the CLOSED position.
3. There was no positive confirmation that the scroll case was completely watered-up before the headgate was pulled.
RECOMMENDATIONS

1. **Training**
   Retrain all Clearance holders on the Clearance process as written, as well as all individuals who are users of, or exposed to, the In-Plant Clearance (IPC). Include their responsibility in following the Clearance program; their authority and accountability/ownership in complying with it; and the PUD’s expectations of Clearance holders and/or Supervisors in demonstrating and communicating work practices.

2. **Management Direction**
   Establish a clear management process for redirecting crews when the scope/priority of work is changing. Ensure adequate time is allowed for communication and review of documentation.

3. **Clearances**
   Update the Clearance process clarifying:
   - (a) when the process is required,
   - (b) how the Clearance process is used,
   - (c) who can request Clearances, and
   - (d) when and how contractors are to be integrated into the Clearance/isolation processes.
   Develop a procedure for verification of isolation point sources that are “released” within a Clearance.
   Determine the feasibility of identifying specifically when the wicket gates should be tagged.
   Reformat the Clearance forms for easier tracking and clarification of tags.
   Establish a task force to evaluate the feasibility of developing a software program to manage the Clearance process on-line.

4. **Coordination Meeting**
   Establish a practice such that anytime more than one crew is working on a unit, communication (i.e face-to-face meeting, radio/phone) contact must be held between the Plant Operator, involved Foremen (inclusive of contractors), and IPC Holder before any clearance tags are added or removed.

5. **Scroll Case Pressure**
   Verify the Winter-Kennedy taps are functioning properly prior to unit shutdown. Install a pressure gauge on top of the upper scroll case hatch to verify the scroll case water pressure. The gauge shall identify the proper pressure to confirm full scroll case.

6. **Wicket Gates**
   Identify the feasibility of engineering an annunciation system if the wicket gates are “Open” and headgates are moved or hooked/prepared to be moved.

7. **Work Orders**
   Establish a stakeholder group to evaluate the purpose of work orders and how they are to be used for safety. Develop a hazard/risk matrix to identify the hazard/impact potential of various tasks that will provide guidance as to the level of detail work orders, job plans, and procedures are to be completed. In addition, identify when Supervisors and Safety Professionals must review and/or approve job plans.
8. **Documentation**

Review all current standard operating procedures (SOPs) and Operations and Maintenance Instructions (OMIs) for completeness and accuracy. Identify missing tasks (i.e., there was no SOP found for headgate removal/installation). Establish a process of updating documentation after equipment has been replaced or modified. Place documentation on a review schedule (i.e., every three years).
Indirect Contributing Factors

Clearance
- IPC (In-Plant Clearance) process not clearly understood.
- Less than adequate Rocky Reach Plant specific training for newly assigned Foreman.

JSA
- No JSA developed for lifting headgates.
- No JSA developed for lifting stop logs.
- No clear direction when a new JSA is required.
- No Supervisor or Safety Department review of JSAs.

Rotor
- Equipment, supplies and tools should have been removed from the rotor prior to the headgate being removed.

Wicket Gate
- Not “absolutely” understood by all if “100%” wicket gates are open or closed

Radio Communication
- Different work groups, at times, use different channels for radio communication thus making it difficult for others to stay informed on status of critical work.

Work Order Process
- Work order was not developed fully to include “all” applicable safety concerns
- Work order delivered with limited time for foreman and crew to review before implementation
- Daily Morning Meeting conducted, however, no attendance by personnel working on C-8 or C-10 (CM Mechanical Foreman, CM Electrical Foreman, others).

Authority Real or Perceived
- Multiple employees indicated they felt uneasy regarding the change in direction but did not voice their concerns.
- Supervisors and Managers did not encourage or ask employees if they had questions or concerns.

Hours Worked
- Four employees involved worked in excess of 20 consecutive days.

Plant Operators Distractions
- Flows above average and spill required.
- New SCADA system down. Control System Engineer in Control Room troubleshooting.
- Concern that C-8, C-10, and fish ladder were unwatered.
- Elevator out of service extending Operator’s time to walk clearances.
- Higher than average requests for new clearances as well as processing existing clearances.
Daily Morning Meetings

- Daily plant coordination meetings may have attendance limited to plant staff and not contractors or other employees working in the plant.
Indirect Recommendations

Clearances (see Recommendation No. 3 above)

- Assemble a team of stakeholders to review/reevaluate the process as well as the layout of the Clearance.
- Develop an easy-to-understand flow chart identifying when a Clearance is needed, as well as the flow of the Clearance process itself (after above is completed).
- Develop a system/process to oversee/verify when primary isolation sources are released to ensure all personnel (employees as well as contractors) are “in the clear.”

JSAs

- Consider disbanding the JSA process for a Pre-Task Plan (PTP) process (inclusive of quality, environmental, public, facility, others affected, etc.).
- Clearly identify when a new JSA is required before any new task begins, as well as when the JSA needs only to be refreshed.
- Update JSAs to include where to get additional safety and quality resources.
- Update JSAs format to include an area where supervision and Safety can identity that the specific JSA has been reviewed.
- Work with stakeholders to develop a format for the PTP specific to Chelan PUD.

Rotor

- Reinforce the practice requiring all personnel, equipment, tools, and supplies be removed from the top of the rotor. Verify the stator/rotor air gap is free of obstacles when/if there is a possibility of rotor movement. Reference “Generation Energy Isolation Program,” 3.12.

Wicket Gates

- Consider only using the terms “Open” or “Closed” for indicating gate position on Clearance sheet.

Radio Communication

- Establish a radio protocol for high impact tasks (i.e., headgate removal/installation and rotor disassembly). Ensure one crew member is on the plant channel (rather than “talk-around”) and actively monitoring all plant communication. Notify the Plant Operators of the “talk around” channel the crew is on.
Work Orders

- Identify a process where the work order is established based on the urgency of the task and the severity of possible impact. Ensure that the work order includes the level of detail, information and resources required to perform the work. Finally, ensure that crews, Foremen, Plant Operators, Planners and management have enough time to review and clearly understand the work.
- Identify a hazard matrix to determine the level of risk involved in the work. Identify appropriate staff to review and/or approve new work orders and/or major “changes” before work is allowed to proceed.
- Consider creating a communication flow chart to manage unplanned work orders where all appropriate parties may need to review and/or approve.

Hours Worked

- Investigate the feasibility of establishing overtime and consecutive days worked guidelines.

Authority Real or Perceived

- Reinforce the outreach communication from Senior Management (General Manager and Managing Directors) to each and every employee at the PUD that they have stop work authority and are strongly encouraged to bring safety concerns and/or observations forward. This authority is not just a “slogan of the month” but is an expectation of employees.

Operators Distractions

- Evaluate appropriate staffing levels for large work volume or changing situations in light of minimum staffing for Control Room.

Daily Plant Coordination Meetings

- Require attendance of all Plant and CM Foreman, supervisors, contractors and Safety personnel involved in work in the plant at the Daily Plant Coordination Meeting.
Attachment #1 Detailed Timeline

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Activity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td></td>
<td>Regulatory reporting requirements change.</td>
<td>Approximately 50% of Planners time is now responding to Regulatory agencies.</td>
</tr>
<tr>
<td>21-Jan</td>
<td></td>
<td>C-8 forced outage due to unusual smell.</td>
<td>Unit immediately taken off line.</td>
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<tr>
<td></td>
<td></td>
<td>Stator windings consultant to direct testing.</td>
<td>Alstom hired - 4 wiremen and one foreman assigned to testing.</td>
</tr>
<tr>
<td>22-Jan</td>
<td></td>
<td>Plant Wire Foreman issued clearance on C-8.</td>
<td>Wicket gates and stop logs were not on Clearance.</td>
</tr>
<tr>
<td>27-Jan</td>
<td></td>
<td>C-8 Headgates and intertie lines tags removed for divers.</td>
<td>Unit watered up and gates lifted so divers can clean sills.</td>
</tr>
<tr>
<td>28-Jan</td>
<td></td>
<td>Plant Wire Foreman transferred C-8 clearance to CM Wire Foreman.</td>
<td>1st time this wireman foreman had Clearance in Powerhouse</td>
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<tr>
<td></td>
<td></td>
<td>CM Mechanic Foreman issued a clearance on C-8</td>
<td>This was to inspect turbine runner.</td>
</tr>
<tr>
<td>2-Feb</td>
<td></td>
<td>CM Mechanic Foreman issued a clearance on C-10.</td>
<td>This was to inspect turbine runner.</td>
</tr>
<tr>
<td>3-Feb</td>
<td>1:00 PM</td>
<td>Rocky Reach/CM Management met to discuss winding inspection options.</td>
<td>The crews were not notified at this time.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Agreed to inspect C-9 during planned outage and C-11 would follow.</td>
<td>Clearances remain in place for electrical and mechanical C-8 and C-10.</td>
</tr>
<tr>
<td>4-Feb</td>
<td>6:00 AM</td>
<td>Rocky Reach Electrical crew starts work.</td>
<td>Testing wire with Alstom. Began closing hatches.</td>
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<td></td>
<td>CM Electrical Crew working on testing stator windings on C-8 and CM Mechanical Crew working on C-10 completing inspections.</td>
<td>Gates in these locations for stator inspection. Spare set of gates racked in C-5. Operators note a number of Clearances (4). Discussion at HQ office.</td>
</tr>
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<td></td>
<td>7:00</td>
<td>Head gates in C-8 and C-10. C-9 and C-11 available and on-line.</td>
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<td>7:00</td>
<td>Operators start--2 on shift.</td>
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<td>7:40</td>
<td>Managing Director Generation &amp; Transmission and Director Hydro Operations discuss revising sequence of inspections.</td>
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<td></td>
<td>8:30</td>
<td>CM Mechanic Foreman requested clearance on C-9.</td>
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<td></td>
<td>9:00</td>
<td>Director Hydro Operations calls RR Operations Superintendent to request stopping work on C-10 in order to prepare for inspection of C-9 and C-11.</td>
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<td></td>
<td>9:04-9:13</td>
<td>Series of phone calls ensued to communicate the decision.</td>
<td>Calls went through four people before getting to CM Foreman.</td>
</tr>
<tr>
<td></td>
<td>9:28</td>
<td>Acting RR Maintenance Superintendent calls Acting CM Maintenance Superintendent to explain request. CM Mechanic Foreman also in attendance and directed to move headgates from C-8 to C-11.</td>
<td>This would require clearance tags be removed to allow the unit to be watered-up.</td>
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<td>9:34</td>
<td>C-11 Work Order created for CM Mechanic crew.</td>
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<td>9:40</td>
<td>CM Wireman Foreman directed to move to C-10.</td>
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<td></td>
<td>9:45</td>
<td>CM Mechanic Foreman notified CM Wireman Foreman of re-direct.</td>
<td>CM Wireman Foreman was asked to remove his tag to allow watering-up of unit. Wicket gates position was not verified. They were at 100% open.</td>
</tr>
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<td></td>
<td>9:45</td>
<td>CM Mechanic crew signs off clearance tags.</td>
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<td>Date</td>
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<td>Activity</td>
<td>Notes</td>
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<td>9:50</td>
<td>CM Diving Foreman calls Chief Operator requesting clearances on C-9 and C-11.</td>
<td>Required clearances to perform this work. Dive crew was not in the water.</td>
</tr>
<tr>
<td></td>
<td>9:55</td>
<td>CM Mechanic Foreman contacted Chief Operator requesting tags pulled on C-8 and a Clearance on C-11.</td>
<td>Chief Operator was busy processing other Clearance request and gave it to the Relief Operator.</td>
</tr>
<tr>
<td></td>
<td>10:00</td>
<td>CM Electrical Foreman and his crew sign-off on C-8 Clearance (Electrical Clearance did not include “wicket gates”). Crew was reminded to stay off rotor. Wiremen relocated to “sitting on stator.” Disassembled rotor parts were left stored on top of rotor.</td>
<td></td>
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<tr>
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<td>10:10</td>
<td>CM Electrical Foreman contacted Chief Operator authorizing tags pulled from C-8.</td>
<td>Headgates, North and South Intertie lines. Wicket gates were never on the wireman’s Clearance.</td>
</tr>
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<td></td>
<td>10:20</td>
<td>Relief Operator removes mechanic and wiremen tags from C-8 energy isolation points.</td>
<td>Head gates, stop logs and intertie fill lines only.</td>
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<td></td>
<td>10:30</td>
<td>Interties were opened by Operator with the intent of refilling C-8.</td>
<td>Draft tube and scroll case hatches were replaced.</td>
</tr>
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<td></td>
<td>12:30</td>
<td>CM Mechanic Journeyman checked Winter/Kennedy Taps for unit water-up status. These were not functioning properly.</td>
<td>No indication of water pressure.</td>
</tr>
<tr>
<td></td>
<td>12:35</td>
<td>CM Mechanic Journeyman went to scroll case roof hatch/cover and checked for water.</td>
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<td>12:40</td>
<td>Mechanical Crew #2 notified unit was full and was dispatched to remove stop logs on C-8.</td>
<td>Control Room was contacted that stop logs were being pulled.</td>
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<td></td>
<td>1:00</td>
<td>CM Mechanic Foreman was asked to attend the weekly CM/Rocky Reach Planning Meeting.</td>
<td>Attended by RR Operation Superintendent, Acting RR Maintenance Superintendent, RR Plant Mechanical Engineer, RR Mechanical Planner, Acting CM Mechanical Maintenance Superintendent, CM Journeyman Mechanic, Hydro Biologist and the CM Mechanic Foreman. RR Operations Superintendent outlined C-9 and C-11 work. CM Mechanic Foreman was given work order numbers for the work--approximately 12 for both units. No JSA is developed by Mechanical nor Electrical crew for new work 2 stop logs left to pull.</td>
</tr>
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<td></td>
<td>1:15</td>
<td>Mechanical Crew #1 was dispatched to pull headgates on C-8.</td>
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<td></td>
<td>1:45</td>
<td>CM Mechanic Foreman checked on stop log crew.</td>
<td>Assumed they would be on C-10.</td>
</tr>
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<td></td>
<td>1:55</td>
<td>RR Operations Superintendent walks to Generator floor and sees electrical crew working on C-8.</td>
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<td></td>
<td>2:00</td>
<td>C-10 Work Order packet is delivered to CM Wireman Foreman.</td>
<td>Delivered by RR Electrical Planner.</td>
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<td></td>
<td>2:04</td>
<td>CM Mechanical Crew receives approval from Operator to lift head gate.</td>
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<tr>
<td></td>
<td>2:04</td>
<td>First headgate lift attempted and crane electrical system tripped out.</td>
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</tr>
<tr>
<td>Date</td>
<td>Time</td>
<td>Activity</td>
<td>Notes</td>
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<tr>
<td>2:05</td>
<td></td>
<td>CM Mechanic Foreman drives to the headgate crew.</td>
<td>When he arrived the crew had just tried to lift the headgate but the crane cut-out.</td>
</tr>
<tr>
<td>2:07</td>
<td></td>
<td>Crane was reset and Foreman signaled the crane operator to lift headgate again</td>
<td>Headgate lifted off sill and stopped for burping. No bubbles evident.</td>
</tr>
<tr>
<td>2:09</td>
<td></td>
<td>Crane operator signaled again to lift headgate; CM Mechanic Foreman hears air coming from vent in center slot</td>
<td>Headgate lifted more and stopped for burping. No bubbles evident. Foreman hears air he believes to be coming out of the vent when actually air was being sucked in. CM Mechanic Foreman thinks everything normal. Driving his foreman truck.</td>
</tr>
<tr>
<td>2:10</td>
<td></td>
<td>Foreman leaves crane crew to go back into Powerhouse to close interties</td>
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<tr>
<td>2:12</td>
<td></td>
<td>Crane operator notices the crane doesn't sound right. Starts down with headgate.</td>
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<tr>
<td>2:13</td>
<td></td>
<td>C-8 rotor starts to move and comes up to a high rate of speed while two RR wiremen are sitting on the stator. RR Operations Superintendent and contract employee also near C-8 on Generator floor. RR Wireman Foreman calls Control Room and tells them that C-8 was rotating.</td>
<td>Control Room notified over plant radio.</td>
</tr>
<tr>
<td>2:14</td>
<td></td>
<td>Crane operator notified to put the C-8 headgate back down.</td>
<td>Chief Operator called crane operator by cell phone.</td>
</tr>
<tr>
<td>2:15</td>
<td></td>
<td>CM Mechanic Foreman was notified of unit rotation; called crane crew to lower gate back down and was informed the gate was already going back down. C-8 headgate put back on sill.</td>
<td>RR Operations Supt called by cell phone; Mechanic crew's radios were on “talkaround” channel.</td>
</tr>
<tr>
<td>2:22</td>
<td></td>
<td>Unit stops</td>
<td></td>
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</tbody>
</table>
Attachment #2 Powerhouse Cross Section