PCWA-L-174

Placer County Water Agency

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March 28, 2005

Mr. Takeshi Yamashita, Regional Engineer
FEDERAL ENERGY REGULATORY COMMISSION
901 Market Street, Suite 350
San Francisco, CA 94103

Re: FERC Project No. 2079, Gate Opening Incident

Dear Mr. Yamashita:

Enclosed are three copies of the final report of the independent licensed professional electrical engineer's evaluation and recommendations concerning the Ralston Afterbay Dam float and gate controls and the Oxbow Powerhouse black start feature design. Request was made for this evaluation by your letter dated October 29, 2004. The report, dated March 16, 2005, is entitled, Evaluation of Incident at Ralston Afterbay Dam, and it was performed under a contract between Placer County Water Agency (PCWA) and Black & Veatch (B&V). The independent licensed professional electrical engineer was Bruce A. Benson, P.E., an employee of B&V.

The report presents findings, recommendations and the basis for the recommendations. The recommendations are initially presented under paragraph 2.3 on pages 2-1 and 2-2. These recommendations are repeated, sometimes with more detail, in the portion of the report describing the various areas of investigation in pages 3-1 through 4-3. Finally, the recommendations are listed again in the final section of the report beginning on page 6-1, entitled, "Conclusions and Recommendations."

Some of the recommendations follow two paths: The first path begins with replacing main parts of the existing gates control apparatus and components; the second path begins with not replacing these main parts and, therefore, the second path's recommendations focus on actions to improve the reliable function of these main parts. The two main parts I am referring to are the float control system and the gate control cabinets.

It is our plan to implement the first part recommendations, specifically, after we receive FERC's approval for our proposed plan and schedule and California State Division of Safety of Dams concurrence (DSOD), we plan to contract with an engineering firm to write a specification required for obtaining a contractor to implement the recommendations and to provide an engineer's estimate for that cost. We plan for the contractor to perform the work in the Fall, 2006.

Water Conservation Is A Moral Obligation

We will not be able to implement some of the recommendations until the existing, seventeen-year-old, project-wide SCADA system is replaced, which is scheduled to be done in 2007. The radial gates will remain in manual mode until the recommendations have been implemented and we have been cleared to use automatic mode by FERC and DSOD.

If you have any questions, please call me at (530) 885-6917 or (530) 367-2291 or you may reach me by email at sjones@pcwa.net.

Sincerely,

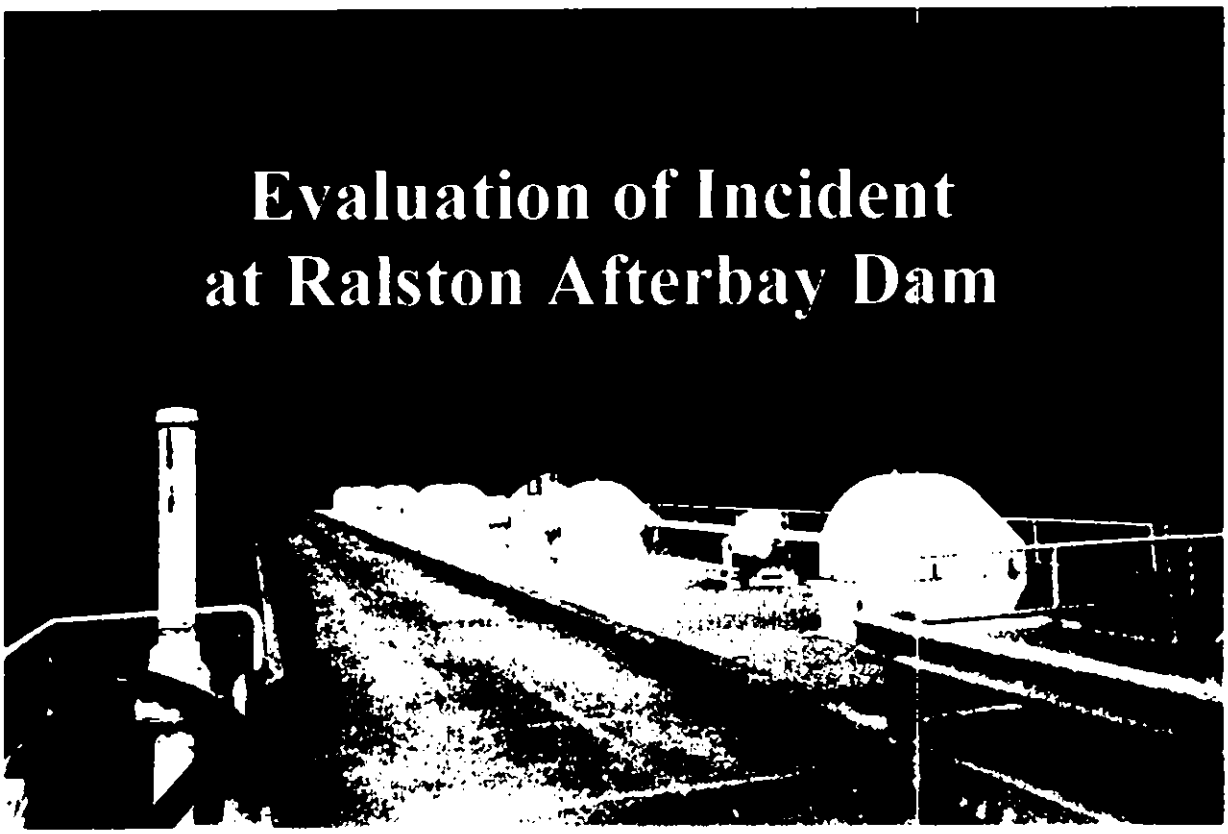
PLACER COUNTY WATER AGENCY

Stephen J. Jones
Power System Manager

cc: David Breninger

Placer County Water Agency

Evaluation of Incident at Ralston Afterbay Dam



Final Report

Submitted by Black & Veatch
March 16th, 2005

BLACK & VEATCH

Evaluation of Incident at Ralston Afterbay Dam

FINAL REPORT

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1.0 INTRODUCTION

1.1 Background

The Oxbow Powerplant is located on the Middle Fork American River. The powerplant has a single 7,400 kVA generating unit at 4.16kV. Water from the Ralston Afterbay Dam intake structure is conveyed by penstock to the powerhouse located a few hundred yards downstream of the dam.

On the morning of August 5, 2004, during testing of the black start feature at Oxbow Powerhouse, two of the five radial gates. Gates 1 and 4, came open at about 6:00 a.m. and released about 1,400 AF from the reservoir over about an hour and three quarters. The Emergency Action Plan was activated to warn the public and locate any people that might be in the path of the water. Radial gates 1 and 4 were under the control of Float Controllers that were programmed to begin opening the gates, one gate at a time, if the reservoir level rose to an abnormally high level. The reservoir was not at an abnormally high level when the two gates came open. The testing of the black start feature required the normal source of power to the dam to be shutoff and the backup engine-generator at the dam to start and provide backup power. A transfer switch malfunctioned during the black start testing. Part of this malfunction included the burning out of two operating coils in the transfer switch. Some investigation, testing and analysis have been done since the morning of the water release. The Float Controllers have remained out of service and the gates can only be operated by a qualified employee going to the dam. The Federal Energy Regulatory Commission (FERC) has directed that PCWA obtain the services of an independent licensed professional engineer to evaluate the float control and gate control systems and to certify that the electrical system and control logic for the gates are in good working order.

Black & Veatch was contracted by PCWA to provide electrical engineering services to perform the required evaluations and prepare this independent report.

1.2 Scope

The scope of this evaluation includes completion of the following activities:

A. Review Existing Documentation.
   PCWA provided the following existing documentation for review:
   - Existing drawings – See Attachment A for a list of drawings reviewed.
   - Incident Report to FERC dated August 19, 2004. Includes SCADA log and Sierra Control Systems site evaluation.
   - PG&E Report dated September 20, 2004.
   - Test Report to FERC dated November 5, 2004.

- Description of Afterbay Dam New Transfer Switch Operation.
- Instruction Manual for Model 6532 Sequence Gate Controller.
- Instruction Manual for Model WLT-804 Water Level Transducer.
- Instruction Manual for Gate Position Water Level Transducer.

B. Site Investigation.
Review existing site conditions, control and monitoring systems, equipment and wiring.

C. Witness Testing.
PCWA performed the operational tests requested by Black & Veatch.

D. Report Preparation.

2.0 EXECUTIVE SUMMARY

2.1 General

Black & Veatch has reviewed the existing drawings and documentation provided by PCWA. B&V personnel Bruce Benson, registered P.E. in electrical engineering, and Gene Walklin, field technician, spent four days on-site investigating the conditions and witnessing tests performed by PCWA. Following is a summary of the conclusions and recommendations made based on our review of the documentation and site investigation.

2.2 Conclusions

Ultimately, we were not able to find a definitive cause for the gate opening incident on August 5, 2004. If functioning properly, the gate controllers (GC) should not have caused Gates 1 and 4 to open as they did. In order to develop a scenario where the gate controller sends inadvertent raise commands to both gates, you have to postulate more than one failure occurring. Although two simultaneous failures may seem to be an extreme scenario, the PCWA test on 10/11/04 documents both a reservoir elevation signal failure and gate controller sending both Gates 1 and 4 a raise command and at the same time sending Gate 4 a lower command. We also do not know why GC 2-3 did not also respond similarly to GC 1-4, but have observed that GC 2-3 recovers from loss of power and reads the correct reservoir elevation faster than GC 1-4. The gate controllers operate in a manner that appears to be inconsistent with the vendor's operation sequence as listed in the manuals. Both gate controllers exhibited erratic countdowns at random intervals, i.e. countdowns that ran down to 1, jumped back up to 5, counted down to 1, jumped back to 5, then counted down normally.

A failure occurred in the Automatic Transfer Switch (ATS) during the incident. It is not possible to positively state that the ATS was the exact cause of the incident, or the ATS failure was caused by some other fault.

The water level transducers do not have any power source available during transfer from one power source to the other, or during prolonged periods of outages. Should power not be available to the transducers, but available to the gate controllers, no operations are supposed to be possible for the gate controller. The two WLT80's that provide level signals to the gate controllers are ganged together on a single float that does not report the entire range possible behind the gates.

While there is a SCADA cabinet located at the Oxbow Powerhouse, there is no SCADA workstation or display.

2.3 Recommendations

In general, the existing gate controllers, gate local control cabinets, and SCADA system are limited and narrow in scope for spill gate control and monitoring. It is suggested that the gate controllers be replaced with a more flexible system allowing the ability to add additional software interlocks and inputs and communicate directly with the SCADA system. If a standard

programmable logic controller (PLC) is provided, PCWA personnel could troubleshoot the actual programming instead of not knowing what is going on inside the "black box".

The SCADA system should be expanded to monitor gate traveling and both gate open and closed limit switches, not just one contact for gate open/closed. The SCADA system should monitor the ATS position and alarms. The SCADA system should have a workstation in the Oxbow Powerhouse providing a local operator with access to the same information being sent to other facilities and improving local control and remote coordination.

Due to the age of the local gate control cabinets and the need for additional contacts to indicate that the gate is moving to be input to the SCADA, it is recommended that the control cabinets be replaced.

If these replacements are not implemented, then the following recommendations are provided for utilizing the existing equipment.

The gate controllers should not provide automatic float control operation until they have been more exhaustively tested by Sierra Control Systems Inc. to include verification that the program is not corrupted. Provide a backup or ride through power source for the gate controllers.

Wire gate open and closed limit switches to SCADA, not one contact used for both positions that can give false closed indication. Fill or cover openings where devices have been removed on enclosures and replace or install door seals to restore enclosure integrity.

Repair or replace the Afterbay annunciator system.

Provide two independent water level signals to each gate controller (the same goes for the Oxbow Powerhouse unit controller). Ideally they should be signals that function over the full range of the gate openings. The water level signal used by Ralston to make decisions about float control should match (at least be calibrated to) the signal used by the Oxbow float controller to control the generating unit.

The water level display in the Oxbow Powerhouse should be full range or turn off when out of range – it should not display a higher than actual level.

Add a 12VDC battery to each water level transducer for backup power.

Install a SCADA workstation in the Oxbow Powerhouse for display of Afterbay alarms, gate status, and water levels during maintenance activities.

Replace the water level transducer and gate position signal wiring with twisted pair and a properly grounded shield cables, run in a dedicated conduit separate from AC circuits.

3.0 REVIEW EXISTING DOCUMENTATION

3.1 General

PCWA provided copies of reports, drawings, and instruction manuals which have been reviewed by Black & Veatch. PCWA has been very cooperative, offering to provide any information requested. The following evaluates the existing documentation provided.

3.2 Existing Drawings

Attachment A lists the existing drawings provided for review. Followings are comments on specific drawings reviewed:

- Drawing 241-08-203, RALSTON AFTERBAY DAM OXBOW P.H. INTAKE SINGLE LINE DIAGRAM 120/208 V.A.C.CIRCIUTS. This diagram provides the single line for the Dam Engine Generator and Automatic Transfer Switch, Gate Control House, Recorder House, and the Intake Structure.

  The Gate Control House Lights & Power Panel and the Recorder House Lights & Power Panel are both 120/208 VAC, 3 phase panelboards.

  Note that both gate controllers are fed from the same 120 VAC breaker in the Gate Control House Lights & Power Panel, shown as A.B. Gate Control (G.E. Recorders). This was confirmed in the field - one circuit from the panelboard is wired to the controller cabinet terminals and then the power is wired to both controllers. Therefore, a problem on the power circuit would effect both controllers.
  Recommendation: Provide an uninterruptible power supply for the gate controllers adequately sized for the engine generator startup and transfer scheme. According to the gate instruction manual, the controllers can also be powered from 125 VDC. PCWA may investigate using the gate control house 48 VDC battery system for a future new controller. The source supplying power for microprocessor based controls should be uninterruptible.

  The power for the water level transducers is fed off of the same 120 VAC breaker in the Recorder House Lights & Power Panel, shown as Conv. Outlet Recorders. Therefore, a problem on the power circuit would effect all four water level transducers. Each gate local motor starter is fed from a 208 VAC, 3 phase breaker in the Recorder House Lights & Power Panel. Therefore, in order for Gates 1 and 4 to be moving during the incident, all three phases of the Recorder House Power Panel would have to be available.

- Drawing 241-08-205, RALSTON AFTERBAY DAM ELEMENTARY DIAGRAM GATE CONTROL. This drawing is the schematic diagram for the gate local motor starters.

  Relay LS-1A is energized whenever the motor starter has control power and the gate is not 100% closed. A contact from relay LS-1A is wired to the SCADA that is closed when control power is available and the gate is open 1 to 100%. This contact will open on loss of starter control power regardless of gate position. Therefore, the SCADA could get a false indication that the gate is closed when it is actually open.

Recommendation: Provide a limit switch contact with positive indication that the gate is closed. Suggest separate contacts for gate closed and gate not closed (open). Wire the contacts to SCADA and revise programming.

A key switch has been added to the front of the local motor starter to override the overtravel upper limit during extreme conditions. The drawing does not adequately identify this feature.
Recommendation: Revise the drawing to show the key switch overrride.

The drawing indicates that the cabinet heater and motor heater are wired in parallel directly to the starter control power. A toggle switch has been added to control the cabinet heater. Because a toggle switch was added, the heater may not always be energized when it is required to prevent condensation.
Recommendation: Review the need for heater controls. If required, replace the toggle switch with a thermostat.

The drawing does not show any contacts that close when the gate is traveling open or closed (contactor energized).
Recommendation: Provide separate contacts that close when the Raise and Lower contactor is energized. Wire these contacts into the SCADA for monitoring and alarm.

- Drawing 241-08-206, RALSTON AFTERBAY DAM ELEMENTARY DIAGRAM ANNUNCIATOR AND ALARMS. This drawing is the schematic diagram for the Recorder House Annunciator No.4 and other dam area alarms.

- Drawing 241-08-207, DIAGRAM OF CONNECTIONS RALSTON AFTERBAY DAM CONTROL HOUSE. This drawing is the connection diagram for the Afterbay Control House including the float controllers. This drawing indicates the fact that the water level signals were not wired to the controllers using shielded cable as recommended on page 12 of the controller manual. Circuit C10 conductors landed on TB1 terminals ABWL1 and ABWL2 need to be traced out and shown correctly on the drawing, there is not a signal shown connected on TB5 – possibly Circuit C20 from dwg 241-08-208?

- Drawing 241-08-208, DIAGRAM OF CONNECTIONS RALSTON AFTERBAY DAM RECORDER HOUSE. This drawing is the connection diagram for the Afterbay Recorder House including the water level transducers. This drawing also indicates the fact that the water level signals were not wired to the controllers using shielded cable. Circuit C20 needs to be traced out and shown correctly on the drawing.
Recommendation: Review the use of each of the water level signals as described in Section 3.3. Install twisted, shielded cables for the water level signals run in a conduit separate from any cables with 120/208 VAC. Suggest showing the battery connection to the Chart Recorder on the drawing.

- Drawing 241-08-209, DIAGRAM OF CONNECTIONS RALSTON AFTERBAY DAM DAM AREA. This drawing is the connection diagram for the gate controller cabinets (local

motor starters) and gate position instrumentation. The gate position signal shown is slidewire position feedback, the WLT-72 Gate Position Transducer is not on the drawing.
Recommendation: Revise the drawing to show the external gate position transmitter 4-20mA signal. Install twisted, shielded cables for the gate position signals run in a conduit separate from any cables with 120/208 VAC.

- Drawing 253-20-101, OXBOW POWER PLANT SINGLE LINE DIAGRAM METER AND RELAY. This drawing is the single line for the plant and identifies the Station Service Breakers 52-1 and 52-2 that were being opened and closed as part of the black start testing.

- Drawing 253-20-118, OXBOW POWER PLANT ELEMENTARY DIAGRAM ANNUNCIATOR AND AUDIBLE ALARMS. This drawing is the elementary diagram for the 60kV and miscellaneous alarms. There is only one common alarm for the afterbay.

- Drawing 253-20-900 Sheet 1 of 7, TI (ETI) MICRO MODEL 8642 REMOTE TERMINAL UNIT (RTU) DIGITAL OUTPUT RELAY CARDS. This drawing has SCADA outputs including the signal to transfer the unit load control to float mode. Refer to Section 6 for additional evaluation of the gate controllers.

- Drawing 253-20-900 Sheet 3 of 7, TI (ETI) MICRO MODEL 8642 REMOTE TERMINAL UNIT (RTU) DIGITAL INPUT (STATUS) CARDS. This drawing indicates the following SCADA input signals from the Afterbay Dam:
  - Gate 1 Open Indication
  - Gate 2 Open Indication
  - Gate 3 Open Indication
  - Gate 4 Open Indication
  - Gate 5 Open Indication
  - Afterbay Engine Generator Fail to Start
  - Afterbay Engine Generator Running
  - Water Level Channel Failure
  - Afterbay Annunciator Alarm (Sheet 4 of 7)

Refer to Section 6 for additional evaluation of SCADA monitoring.

3.3 PCWA Incident Report to FERC dated August 19, 2004

PCWA submitted a letter to FERC dated August 19, 2004 documenting the incident and subsequent investigation. Not all of the documents referenced in the letter are applicable to the scope of this evaluation (ex. Emergency Action Plan, downstream gauging information..) and were not provided by PCWA for review. Following are comments to the letter and attached documents reviewed:

- Letter from Mr. Stephen Jones addressed to FERC.
  Refer to Page 2, second paragraph indicating the float was "hanging up in the float well". This signal is critical to operation of the river system and is the only Afterbay level transmitted remotely to Ralston Powerhouse.
  Recommendation: Verify proper operation of float signal.

Refer to Page 2, third paragraph indicating that the SCADA time tags about 14 minutes ahead of actual time.
Recommendation: The SCADA time should be corrected and kept accurate.

Refer to Page 3, second paragraph indicating an intermittent bad contact in Auto/Manual SS (Station Service) Control Switch.
Recommendation: Replace control switch.

- SCADA log for August 5, 2004 and associated Timelines.
  The SCADA log provides a good record of many of the events taking place during the time of the incident and also shows a lack of certain monitored events that would have been helpful.

  The SCADA log may give an incorrect indication that the gate is closed. The Radial Gate Timeline should not be read as a standalone document, but should be compared with the SCADA log or the Electrical, Mechanical, Hydraulic, and Operator Sequence of Events. For instance, at 6:27:22 and also at 6:42:12 there is a Gate 1 and Gate 4 Closed input signal, however, this is also the exact time when the station service bus is killed to simulate black start. SCADA has one contact input that is used to generate the gate open and gate closed indication. The relay must be energized to indicate gate open and without power, SCADA will get a gate closed signal regardless of the actual gate position.
  Recommendation: See the comments above on Drawing 241-08-205. Review the alarms and data available to the SCADA and revise as necessary.

- Sierra Control Systems Site Evaluation
  After review of the site evaluation, Black & Veatch agrees with the recommendation to connect the controllers to a UPS or battery system. Refer to the Radial Gate Controllers Selector Switch Settings table – Switch 18 displayed 0.2 which is supposed to be the difference between the two gate positions (Switches 16 and 17 which both display 0.3). Sierra Control Systems should verify that the controller is calculating this value correctly.

- Tudor Engineering Company report dated August 6, 1973.
  The Tudor Company report was reviewed. This report is not applicable to the recent incident because the old timers and recorder scheme have been replaced with the Model 6532 Gate Controllers.

3.4 PG&E Incident Investigation Report dated September 20, 2004

The PG&E Incident Investigation Report has been reviewed. Following are comments to the report.

Refer to page 3, Finding #5. PG&E noted that there are no indications for spill gate operations in the Oxbow Powerhouse. Also, there is no SCADA monitoring computer in the Oxbow Powerhouse control room. B&V agrees that the lack of SCADA information in the powerhouse is a problem - refer to Section 6 for additional recommendations.

Response to PG&E's Recommendations

#	Description	B&V Response
1	Investigate Dam Generator Power Quality	Agree
2	Replace Gate 1 & 4 Controller	Replace both controllers – See Section 6 for additional evaluation.
3	Change power supply to DC or UPS	Agree
4	Test Water Level Transmitters	Agree
5	Extend range of float well 1	Agree – to provide consistent monitoring with SCADA signal (well 3)
6	Consider changing floatwell equipment to DC	Agree - Per instruction manual. DC backup is already available, just need to connect.
7	Review black start feature.	Review not required because there is not a remote control interface for the gates from the powerhouse or SCADA. black start only impacts gate control by the loss/transfer of power.
8, 11, 12,13	Coordination between Drum operators and PCWA personnel.	Agree.
9	PCWA should monitor SCADA from Ralston or Oxbow during testing.	Agree. Recommend SCADA monitor be installed in Oxbow Powerhouse.
10	Add spillgate open/close and water level indication to Oxbow control room.	Agree.
14	Evaluate gate actuator circuits.	See PCWA test report dated November 5, 2004. Also refer to Section 5. PCWA should test the complete system including movement of the gates.
15	Consider disabling gate controllers during the summer.	PCWA issue.

3.5 PCWA Test Report dated November 5, 2004

The PCWA Test Report has been reviewed. Following are comments to the report.

Refer to page 3 description of the test at 2:19 pm and Figure 3. This test resulted in an erroneous Gate 1 Raise Command and recorded a high abnormal/spiked reservoir output signal when the input signal was disconnected. Because this test is based on physically disconnecting the input wires, it is not as representative a duplication of the August 5 incident as the other three tests.

Refer to Figure 4. This figure documents the controller issuing a raise command to both Gates 1 and 4 at the same time, which the manufacturer's information indicates should not occur. In addition, the figure documents both a Gate 4 Raise Command and Lower Command being sent at the same time which should not occur.

Response to PCWA's Recommendations

#	Description	B&V Response
1	Use shielded wires for water level signals.	Agree.
2	Wire two water level transducers to each controller.	Agree.
3	Replace interposing relays.	Agree.
4	Power controllers and transmitters from inverter or battery.	Agree – provide uninterrupted power.
5	Add controls to prevent simultaneous raises to two gates.	Agree.
6	Install controls to lock out extended raise commands.	See pages 11 and 18 of the controller instruction manual. The ten minute reset period is the maximum delay and if variable reset period is selected, control actions can occur at shorter intervals. Adding controls is a possible solution.
7	Inspect control cabinets, refurbish and replace as required.	Agree.

3.6 Instruction Manuals

Instruction manuals for the Model 6532 Sequence Gate Controller, Model WLT-804 Water Level Transducer, and Gate Position Water Level Transducer have been reviewed.

The Gate Controller manual page 12 recommends shielded cable for the transducers.

The Water Level Transducer manual page 1 describes a battery backup feature. Manual Drawing 72-946 indicates the battery backup circuit.
Recommendation: Add the battery backup feature to the water level transducers.

4.0 SITE INVESTIGATION

4.1 General

Black & Veatch personnel Bruce Benson, electrical engineer, and Gene Walklin, field technician, were on-site from February 7th to the 10th, 2005 conducting the site investigation and witness testing. During this time, they went to Ralston Afterbay, Oxbow Powerhouse, PCWA Maintenance Shop, and the Ralston Powerhouse. PCWA personnel Frank Nann, Communications Technician, and John Nypl, Electrical Technician, were on-site to escort the B&V team around the facilities, answer questions, open cabinets, and perform testing. Both Frank and John were extremely helpful, cooperative, open and supportive of our efforts. Their conduct was highly professional at all times and contributed to the productive time spent on site.

Following are observations made during the site investigation.

4.2 Ralston Afterbay - Recorder House

The Recorder House is located on the Ralston Afterbay Dam and encloses a Light & Power Panel, Annunciator, and three float wells with transducers.

Float Well 1 has a float tape system and one transducer which provides the signal to the Oxbow Powerhouse float controller to control the generating unit in float control mode. Float Well 2 has a float tape system with one transducer connected by chain linkage to a second transducer. Each transducer is connected to one of the gate controllers. Float Well 3 has a float tape system connected to one transducer which is connected by chain linkage to a battery powered chart recorder. The Float Well 3 transducer provides the signal to SCADA. Floats 1 and 2 have a limited upper range of the Afterbay, their tapes do not extend to the lower levels. Float 3 has full water level range capability.

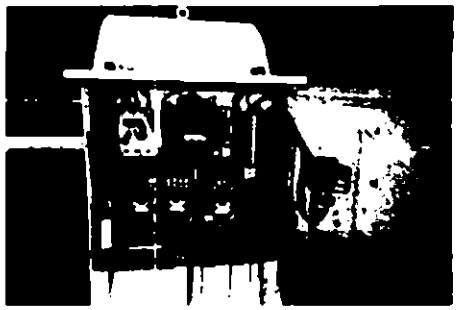
Recommendation: The water level signals should be connected using twisted shielded cables run in a conduit dedicated for instrument signals.

The Afterbay Annunciator cover had been removed. The cover should be re-installed. Refer to Section 6 for additional evaluation and recommendation.

4.3 Ralston Afterbay – Gate Control Cabinets

Each gate has a control cabinet located on the dam for local manual operation. The control cabinet has a 208 VAC 3 phase motor starter. The contactors in the Gate 1 motor starter have been replaced, but the other gates' contactors appear to be original supply. Observed control cabinet conditions are as follows:

- Many enclosures had controls or displays removed without the cabinet holes being filled. exposing the interior to the weather.
- Door gasket seals are either non-existent, weathered, or torn.
- Conduit runs were not grounded on either end.
- Conduit was not sealed to prevent insects or moisture entry.
- Gate position cables/wiring used single conductors.
- Wasp nest remnants, spider webs and minor debris found in most cabinets.



Recommendation: Holes should be filled and gaskets replaced to protect the interior devices from the elements. Conduits should be properly grounded and sealed. The gate position signals should be connected using twisted shielded cables run in a conduit dedicated for instrument signals. Cabinets should be cleaned. Refer to Section 3.2. Drawing 241-08-205 for additional recommendations.

4.4 Ralston Afterbay – Gate Control House

The Gate Control House, located at the entrance to the top of the dam, encloses the Light & Power Panel, 48 VDC Battery Bank, Gate Controllers, Communication Termination Board, Engine Generator, and Automatic Transfer Switch.

The cabinet housing the gate controllers has a large opening where a device has been removed.
Recommendation: The cabinet interior should be cleaned and openings filled to limit exposure of the controllers and other devices to dust. A few of the controller cabinet indicating lamps need to be replaced.

The gate control house is not air conditioned and gets very hot in the summer.
Recommendation: Verify the temperature conditions inside the gate control house and determine if the controller can operate within the environment. Add air conditioning if required.

4.5 Oxbow Powerhouse

There is another float controller on a panel in the control room. This controller provides a float control mode for the generating unit. When designed, it was determined that the float would only need to cover the operational range of the unit in float control mode. approximately ten feet. Because the water level was below this range, the only Afterbay Level display in the control room was not accurate.
Recommendation: Revise the float tape system and provide an accurate water level display in the control room along the full range of the afterbay. It is important for this signal to be calibrated and match the other transducer providing the SCADA signal which is monitored remotely and used to make decisions on generating unit float control.

The float controller indicated both a high alarm and a low alarm condition. This should be investigated further.

Annunciator flags were dropped for Water Level Channel Signal Failure and Ralston Afterbay Dam Annunciator.

The control room does not have a SCADA workstation or any indication of spillway gate position.
Recommendation: Provide a SCADA workstation in the control room. This will provide local access to the same information being sent to other facilities, improving local control and remote coordination.

The facility showed obvious evidence of routine maintenance and good housekeeping practices. Some of the control room panels had controls or displays removed, without the holes being filled or covered. This is not as major a problem in the powerhouse, since all enclosures are inside the building and not subject to weather or harsh conditions.

4.6 PCWA Maintenance Shop

The failed Automatic Transfer Switch (ATS) was inspected at the maintenance shop. It had been replaced the day of the incident due to the Normal and Emergency position operating solenoids having been burned out. The ATS was partly dis-assembled. Most of the circuitry was no longer in place to inspect. The removed auxiliary and timing relays were in a cardboard box. Inspection of the contacts of the ATS showed moderate to heavy pitting and arc flash signs on the Normal side, and light pitting and arc flash signs on the Emergency side. The mechanical mechanism was stiff and hard to operate. The mechanism operating solenoids were indeed burned out, exhibiting signs of high heat or flame damage.

ATS Nameplate Data:
Zenith S/N P4841 Type 6MT20E-4AABCEJPSTW
Size 4 200 Amps per pole 600 Volts 60 Cycles 3 Phase

4.7 Ralston Powerhouse

Larry Corsini, PCWA Senior Operator, provided a discussion on the SCADA displays for the Oxbow Powerhouse and Ralston Afterbay. Attachment B is a printout of the SCADA display showing spill gate position (either open or closed – not percent open) and other afterbay alarm points monitored remotely.

5.0 WITNESS TESTING

5.1 General

PCWA personnel Frank Nann and John Nypl performed all of the testing, as requested by Black & Veatch personnel. Attachment C provides the SCADA logs printed from the Ralston Powerhouse for the testing periods.

5.2 Summary of Testing

Following is a summary of the tests performed by PCWA.

2/08/05 TESTING

Prior to testing on 2/8, normal conditions of the gate controls, water level transducers, and ATS were observed. The afterbay level was low. The following readings were taken:

WLT80 #1 Level 1174.09' – Reading is not correct because this float has a limited range. The counterweight was up against the stop – level was out of range.
WLT80 #2A Level 01.56' (Based on a base elevation of 1170'), float has a limited range.
WLT80 #2B Level 01.56' (Chain driven by WLT #2A) (Based on a base elevation of 1170').
WLT80 #3 Level 1171.54' – Provides level to Ralston Powerhouse SCADA only via overhead communications cable, has full range of water level.

Gate Control Cabinet Local Manual Control Test

The gate motor leads were lifted from their contactor to prevent inadvertently opening a gate. First, the Gate Control Cabinet local manual controls were tested for proper operation of Gates 1 - 4. The test procedure included the following:

Pressed the Local Raise button for Gate 1, the contactor operated.
Pressed the Local Lower button for Gate 1, the contactor did not operate.
Pressed the Local Raise button for Gate 2, the contactor operated.
Pressed the Local Lower button for Gate 2, the contactor did not operate.

It was determined that a jumper from "LINDx" to L1 would be required within the controllers to allow the Lower command to function and override the closed limit switch. Temporary jumpers were installed in all enclosures.

Pressed the Local Raise button for Gate 1, the contactor operated.
Pressed the Local Lower button for Gate 1, the contactor operated.
Pressed the Local Raise button for Gate 2, the contactor operated.
Pressed the Local Lower button for Gate 2, the contactor operated.
Pressed the Local Raise button for Gate 3, the contactor operated.
Pressed the Local Lower button for Gate 3, the contactor operated.
Pressed the Local Raise button for Gate 4, the contactor operated.
Pressed the Local Lower button for Gate 4, the contactor operated.

Refer to the SCADA log for 02/08/05 time period 11:40:53 to 11:46:05. The gate open signal indicates the time period when the jumper was installed. Some of the gate position multiple status changes could be the result of powering the starter on and off and installing the jumper. Erroneous status changes occurred at 11:42:05, including Gate 5 which was not involved in the testing.

Gate Controller Manual Control Test

From the Afterbay Gate Control House, the Gate Controllers Auto/Off/Manual toggle switches were put in the Manual position. It was found that the Gate Controllers could not operate the interposing relays because the control panel Float/Manual switches were in Manual mode meaning control from the local gate control cabinets. After placing the control panel Float/Manual switches in the Float position, the interposing relays operated and caused the contactors to operate in the gate control cabinets. The following tests were performed with each individual gate controller placed in manual mode:

Pressed the Local Raise switch for Gate 1, the gate controller indicator light functioned, the interposing relay and contactor operated.
Pressed the Local Lower switch for Gate 1, the gate controller indicator light functioned, the interposing relay and contactor operated.
Pressed the Local Raise switch for Gate 4, the gate controller indicator light functioned, the interposing relay and contactor operated.
Pressed the Local Lower switch for Gate 4, the gate controller indicator light functioned, the interposing relay and contactor operated.
Pressed the Local Raise switch for Gate 2, the gate controller indicator light functioned, the interposing relay and contactor operated.
Pressed the Local Lower switch for Gate 2, the gate controller indicator light functioned, the interposing relay and contactor operated.
Pressed the Local Raise switch for Gate 3, the gate controller indicator light functioned, the interposing relay and contactor operated.
Pressed the Local Lower switch for Gate 3, the gate controller indicator light functioned, the interposing relay and contactor operated.

Refer to the SCADA log for 02/08/05 time period 11:46:05 to 11:48:15. The gate open signal indicates the time period when the jumper was installed. Some of the gate position multiple status changes could be the result of powering the starter on and off and installing the jumper. Erroneous status changes occurred at 11:48:15, including Gate 5 which was not involved in the testing.

Readings were again taken at the water level transducers and compared to the gate controller readouts, and were found to match.

WLT80 #1 Level 1178.01' - Oxbow (PH)
WLT80 #2A Level 01.23' - Gate controller #1 (Gates #2&3)
WLT80 #2B Level 01.23' – Gate controller #2 (Gates #1&4)
WLT80 #3 Level 1170.84' – Ralston PH SCADA

Note the difference between water level transducers #2A/B and #3 of 0.39 ft, earlier in the day they matched. Proper water level transducer operation should be verified.

Recorder Setup.

A strip chart recorder was setup for recording gate commands. The following channel assignments were made:

Channel	Signal
1	Reservoir 1&4 Level, 4-20mA Analog, Gate Controller output
2	Reservoir 2&3 Level, 4-20mA Analog, Gate Controller output
3	AC Power for both gate controllers
4	Not Used
5	Logical Raise Gate 1 command
6	Logical Lower Gate 1 command
7	Logical Raise Gate 2 command
8	Logical Lower Gate 2 command
9	Logical Raise Gate 3 command
10	Logical Lower Gate 3 command
11	Logical Raise Gate 4 command
12	Logical Lower Gate 4 command

Portions of the strip chart printouts are included as figures in Attachment D.

Loss of Normal Power – Transfer to Emergency Generator Power

We tested loss of normal AC power and transfer to emergency power supplied by the engine generator at the dam.

Opened Normal Power Circuit Breaker
Emergency Generator started.
Emergency power available to gate house.
Normal power circuit breaker restore to closed position.
ATS transferred manually back to normal source.

The strip chart recorder did not stay powered on during power outage. A DC source was connected to the strip chart recorder and the test was repeated. Refer to Figure 1 documenting this test, note that the reservoir elevation for Gate Controller (GC) 1-4 stayed high and fluctuated longer (over 2 seconds) than the reservoir elevation signal for GC 2-3 which only spiked. During this period there were not any erroneous gate commands.

Normal Operation

Refer to Figure 2 - While monitoring the typical controller operation it was noted that GC 1-4 sent a second Gate 4 Lower command within 10 seconds of the previous command. The gate lower commands are being issued because the gate positions are 0.2 (not fully closed) and the elevation is below the high setpoint.

02/09/05 TESTING

Gate controller setpoints/readouts were logged:

Item	Information	Controller #1 (Gates 2&3)	Controller #2 (Gates 1&4)
00	Actual Level	1171.23	1171.24
01	Setpoint	1177.10	1177.61
02	No. 1 Response time	41.0	38.0
03	Deadband	0.15	0.15
04	Reset period	601.0	600.0
05	No. 1 Maximum Run Time	30.0	30.0
06	Low alarm	1173.02	1174.29
07	High alarm	1175.99	1176.01
08	Last command	30.0	30.0
09	Average level	1171.23	1171.24
10	Countdown	Changes	Changes
11	Not used	N/A	N/A
12	No. 2 Response time	42.0	39.0
13	Active gate	1.	Toggles
14	Alarm code	._0	._0
15	No. 2 Maximum run time	30.0	30.0
16	Gate No. 1	0.3	0.2
17	Gate No. 2	0.2	0.1
18	Difference	0.2	0.1
19	Difference Setpoint	12.5	10.4

While observing routine operation of the gate controllers with gate motor leads disconnected, hand switch in Float position, the countdown appeared to operate erratically at times, counting seconds down from 240 skipping down to 1, jumping back up to 5, counting down to 1 again, jump back to 5 and finally count down to 0 and issuing a command to a gate. This happened at random times, sometimes as much as three times in a row, sometimes not for 30 minutes. Both controllers skipped during countdown. This definitely caused concern that the controllers did not appear to be operating correctly and should be replaced or at least thoroughly tested by Sierra Controls.

According to Sierra Controls, the controllers have a step change detection scheme that determines if an immediate gate output is required due to an error change of 0.50 ft occurring in over a four second time period. Usually this feature is activated by the operator changing the setpoint or a rapid change in the measured water level. Because the erractic countdown timing was noted during periods when the input signals and setpoints were not being changed, we do not think that the jump in timing is the result of this normal feature.

While observing operation of gate controllers, it was discovered that the wires on relays LS-xA (x=gate number) in the gate motor control enclosure were all labeled differently, leading one to assume they were wired differently. Operation appeared to be identical however.

Test Controller Response to High Reservoir Elevation

The following tests were made to verify gate controls operations with levels changed (changed WLT80 level manually to simulate higher level):

Gate 1 raise command was sent, interposing relay and motor contactor operated.
Gate 2 raise command was sent, interposing relay and motor contactor operated.
Gate 3 raise command was sent, interposing relay and motor contactor operated.
Gate 4 raise command was sent, interposing relay and motor contactor operated.

Loss of Normal Power – Transfer to Emergency Generator Power

Again, we tested power transfer via ATS to observe gate controller settings after a power outage looking for a change.

Control panel switches were placed in Manual.
Normal power circuit breaker opened.
Generator starts
Enabled delay override, allowing ATS to transfer.

The strip chart recorder was set up with the same channels as the previous day. Refer to Figure 3 documenting this test, note that the reservoir elevation for Gate Controller (GC) 1-4 stayed high longer (over 3 seconds) than the reservoir elevation signal for GC 2-3 which was high for 1 second. During this period there were not any erroneous gate commands. There was no change to the gate controller settings, after power resumed and gate controllers rebooted, GC 2-3 gave a Gate 2 close command, and GC 1-4 gave a Gate 1 close command as expected. During this test, the Afterbay Annuniciator did not drop any flags even though there was a loss of control power. This annunciator should be replaced or thoroughly tested.

Switched all gate hand switches to Float. Restored normal power using override. Checked controller settings, no appreciable difference. Upon restoration to Float control, GC 2-3 gave a Gate #2 close command, and GC 1-4 gave a Gate # 1 close command as expected.

Modify Gate Position – Test Controller Operation.

Set the WLT80 #2A/B manually to 1177.80. Both gate controllers show a high alarm.

Modified Gate 4 analog gate position input signal to read 13.3% open (Gate 1 showing 0.26%) for a difference of 13.2% as displayed by gate controller. GC 1-4 attempted to open Gate 1 as expected. This was to see if the controller could be fooled into operating one gate when higher than the difference setpoint allows. This worked as expected, i.e. correctly. It attempted to operate the Gate that was lowest while a high level alarm was in effect. The gate controller had to switch from the last gate used, Gate 4, to Gate 1 to perform properly. That is what happened.

Set Gate 1 position to 40.3%, difference setpoint at 10.4%. Gate controller attempted to open Gate 4 as expected.

Moved to GC 2-3. Set Gate 2 position to 57.2%, Gate 3 position to 40.9%, read difference of 15.9%. GC 2-3 attempted to open Gate 3 as expected.

Set Gate 4 front panel toggle switch to Manual while it was the last used gate. GC 1-4 attempted to open Gate 1 as expected. This verified that a gate set to manual would actually make the controller use the remaining gate on the controller as expected.

Set Gate 2 front panel toggle switch to Auto while Gate 3 was the last used gate. The gate controller attempted to open Gate 3 on the next countdown as expected, verifying that the controller would not switch to the other gate when the difference still called for the lower gate to open.

Physical Relay Inspection

John removed the first gate Raise interposing relay of each gate controller for physical inspection. No signs of contact sticking or welding were found.

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Test Controller Response to Removal of Elevation Signal

Lifted WLT80 FSK signal input for GC 1-4. Gate controller went into failure mode, countdown stopped as expected. No commands were issued after countdown period would have run out. After returning signal wires to terminal, controller resumed operation, jumping countdown to 0 and attempting to close Gate 4. The strip chart recorder was setup similar to the previous days testing. Figure 4 documents this test. During the period the signal wire was lifted, the output of the gate controller showed an erratic high level as shown on the earlier strip chart recordings. The erratic signal cleared as soon as the signal wire was returned to the terminal.

Lifted WLT80 FSK signal input for GC 2-3. Gate controller went into failure mode, countdown stopped as expected. No commands were issued after countdown period would have run out. After returning signal wires to terminal, controller resumed operation, jumping countdown to 0 and attempting to close gate.

The same test was re-run with power removed from the gate controllers, then lifting the WLT80 signals, then returning power to the gate controllers. No differences in the operation were noted from previous test.

With 60 seconds remaining on the countdown, removed power to the WLT80s to observe if the controller went into failure mode as expected, or would allow faulty operation. Also to see exactly what happened to the gate controller output levels.

Gate controller went into failure mode, countdown stopped.

Restored power to WLT80s. Failure mode cleared, each controller attempted to close the first gate as expected.
Commands stopped as expected.

After restoring power, GC 2-3 went to a 240 sec countdown, GC 1-4 jumped immediately to a 5 second countdown, counted down to 1, jumped to 5 seconds, counted down to 0 and attempted to close Gate 1. GC 2-3 counted down to 120 seconds, jumped to 5 seconds, counted down to 1, jumped to 5 seconds, counted down to 0 and attempted to close Gate 2. After both controllers finished their 30 second command cycle, they returned to normal countdowns.

With 70 seconds on countdown, removed power.
Failure mode occurred on both gate controllers.
Restored power. Error mode cleared.
GC 2-3 countdown resumed at 22 seconds, counted down to 1, jumped to 5 seconds, counted down to 0 and attempted to close Gate 2. 5 seconds later the command stopped early. Countdown reset normally. Countdown resumed at 240 seconds, counted down to 1, jumped to 5 seconds, jumped to 5 seconds, counted down to 0 and attempted to close Gate 2.

This concluded our witness testing of the gate controls.

6.0 CONCLUSIONS and RECOMMENDATIONS

6.1 Conclusions

Ultimately, we were not able to find a definitive cause for the gate opening incident on August 5, 2004. Following are conclusions for each major feature evaluated:

Gate Controllers

If functioning properly, the gate controllers should not have caused Gates 1 and 4 to open as they did. In order to develop a scenario where the gate controller sends inadvertent raise commands to both gates, you have to postulate more than one failure occurring. The fact that Gate 1 was full open (approx. 30 feet) and Gate 4 was open ten feet indicates a controller failure because the gates should have been within the position difference setpoint, approximately 10 %, of each other. Although two simultaneous failures may seem to be an extreme scenario, Figure 4 of the PCWA test on 10/11/04 documents both a reservoir elevation signal failure and GC failure sending both Gates 1 and 4 a raise command and at the same time a Gate 4 Lower command. We also do not know why GC 2-3 did not also respond similarly. We have observed GC 2-3 recover from loss of power and read the correct reservoir elevation faster than GC 1-4. The gate controllers operate in a manner that appears to be inconsistent with the vendor's operation sequence as listed in the manuals.

Both gate controllers exhibited erratic countdowns at random intervals, i.e. countdowns that ran down to 1, jumped back up to 5, counted down to 1, jumped back to 5, then counted down normally. This behavior is not accounted for in the Sierra Control Systems Inc. manuals, suggesting a possible corrupted program in both gate controllers.

The gate controllers do not have any uninterruptible power source available during the transfer from one power source to the other, or during prolonged periods of outages. During transfer, there is at least a one minute period when the controller does not have power and then the controller has to reboot after return of power. Both gate controllers are powered from a single circuit breaker in the Gate House. This means that a single tripped breaker can stop operation of all four float controlled gates.

The gate controller interposing relays appear not to have been replaced when the gate controllers were installed, leaving what appears to be the original relays in place.

Both gate controllers have high and low level alarm setpoints which operate the front panel alarm LEDs, and activate an alarm output that is not used.

Local Gate Control Cabinet

The local gate control cabinets are located on top of the dam and do not provide weatherproof protection to the internal devices. The raise/lower contactors do not have gate traveling status or position wired to the SCADA. The gate closed relay can provide false indication to SCADA on loss of power.

Automatic Transfer Switch

As stated, a failure occurred in the ATS. It was obvious that arcing had occurred on the normal side, but not conclusive as to if one or more contacts had been welded closed at least temporarily. Based on the present dismantled condition of the ATS, it is not possible to positively state that the ATS was the exact cause of the incident, or the ATS failure was caused by some other fault. The emergency generator was replaced approximately a month prior to the incident, however the ATS was not replaced until after failing the day of the incident. The new generator & ATS were a different manufacturer and type than the old system. There is no readily apparent difference between the new ATS and the failed ATS electrically, however the ATS should have been replaced at the same time as the emergency generator to ensure proper coordination.

Water Level Transducers

The water level transducers do not have any power source available during transfer from one power source to the other, or during prolonged periods of outages. Should power not be available to the transducers, but available to the gate controllers, no operations are supposed to be possible for the gate controller. The water level transducers have the option of being powered by a 12VDC battery as well as the 120VAC supply, which is not used. All three water level transducers are powered from a single circuit breaker through a commercial quality power strip on the dam. The two WLT80's that provide level signals to the gate controllers are ganged together on a single float that does not report the entire range possible behind the gates. Each gate controller can utilize two separate level signals and alarm upon a difference between them.

Afterbay Annunciator

The Afterbay alarm annunciator appears to require repair or maintenance since flags did not trip when expected due to loss of power during transfers. Alarms for the Afterbay equipment at the Oxbow PH consist solely of limited annunciator alarms which must be cleared after alarming. If power is off for maintenance, the annuciator may not operate, or alarms may be attributed to the maintenance activity at the PH.

SCADA

While there is a SCADA computer located at the Oxbow PH, there is no SCADA workstation at the powerhouse where an operator can view Afterbay alarms or spill gate status. The SCADA does not monitor gate traveling or ATS status.

6.2 Recommendations

In general, the existing gate controllers, gate local control cabinets, and SCADA system are limited and narrow in scope for spill gate control and monitoring. It is suggested that the gate controllers be replaced with a more flexible system allowing the ability to add additional software interlocks and inputs and communicate directly with the SCADA system. The new system could combine control of all four gates together. If a standard programmable logic controller (PLC) is provided, PCWA personnel could troubleshoot the actual programming instead of not knowing what is going on inside the "black box".

The SCADA system should be expanded to monitor gate traveling and both gate open and closed limit switches, not just one contact for gate open/closed. The SCADA system should monitor the ATS position and alarms. The SCADA system should have a workstation in the Oxbow Powerhouse.

Due to the age of the local gate control cabinets and the need for additional contacts to indicate gate traveling (raise/lower contactor energized), it is recommended that the control cabinets be replaced.

If these replacements are not implemented, then the following recommendations are provided for utilizing the existing equipment. Other recommendations are noted in Sections 3 and 4 above.

Gate Controller

The gate controllers should not provide automatic float control operation until they have been more exhaustively tested by Sierra Control Systems Inc. to include verification that the program is not corrupted.

Provide a backup or ride through power source for the gate controllers. This can be done by the simple addition of an uninterruptible power supply (UPS), or powering them from a DC voltage source supplied by batteries. Consider separating each gate controller load to a separate circuit breaker in the applicable power panel.

Suggest adding the gate controller alarm outputs into the SCADA system for logging and alarm purposes.

Local Gate Actuator and Control Cabinet

Wire gate open and closed limit switches to SCADA, not one contact used for both positions that can give false closed indication. Fill or cover openings where devices have been removed on enclosures and replace or install door seals to restore enclosure integrity.

Water Level Transducers

Provide two independent water level signals to each gate controller (the same goes for the Oxbow PH gate controller). Ideally they should be signals that function over the full range of the gate openings. The water level signal used by Ralston to make decisions about float control should match (at least be calibrated to) the signal used by the Oxbow float controller to control the generating unit.

The water level display in the Oxbow Powerhouse should be full range or turn off when out of range – it should not display a higher than actual level because the float counterweight is against the stop.

Add a 12VDC battery to each water level transducer for backup power.

Afterbay Annunciator

Repair or replace the Afterbay annunciator system.

SCADA

Install a SCADA display in the Oxbow Powerhouse for observation of alarms, setpoints and levels during maintenance activities.

General Electrical Installation

Replace water level transducer and gate position signal wiring with twisted pair with a properly grounded shield, run in a dedicated conduit separate from AC circuits. Although no crosstalk or interference was observed during our visit, an intermittent problem or one time spike could cause a problem with the wiring as it is currently installed.

Clean all electrical enclosures of all foreign materials.

Install grounding clamps on all conduits within power panels or carrying signals, and ground them to the enclosure ground block to reduce possibility of EMI problems.

Seal conduit openings at enclosures on the Afterbay dam to prevent entry of insects or moisture.

LIST OF ATTACHMENTS

ATTACHMENT A

LIST OF EXISTING DRAWINGS PROVIDED FOR REVIEW

Drawing Number	Title
X-KO591-E	BATTERY CABINET INTERCONNECTION DRAWING OXBOW PH
241-08-203	RALSTON AFTERBAY DAM OXBOW P.H. INTAKE SINGLE LINE DIAGRAM 120/208 V.A.C.CIRCIUTS
241-08-205	RALSTON AFTERBAY DAM ELEMENTARY DIAGRAM GATE CONTROL
241-08-206	RALSTON AFTERBAY DAM ELEMENTARY DIAGRAM ANNUNCIATOR AND ALARMS
241-08-207	DIAG. OF CONNECTIONS RALSTON AFTERBAY DAM CONTROL HOUSE
241-08-208	DIAG. OF CONNECTIONS RALSTON AFTERBAY DAM RECORDER HOUSE
241-08-209	DIAG. OF CONNECTIONS RALSTON AFTERBAY DAM DAM AREA
253-20-101	OXBOW POWER PLANT SINGLE LINE DIAGRAM METER AND RELAY
253-20-102	OXBOW POWER PLANT SINGLE LINE DIAGRAM 120/208 V. A.C AND 125 V. D.C. CIRCUITS
253-20-104	OXBOW POWER PLANT ELEMENTARY DIAGRAM UNIT START-STOP AND ROTATION DETECTION
253-20-107	OXBOW POWER PLANT ELEMENTARY DIAGRAM EXCITATION AND VOLTAGE REGULATION
253-20-109	OXBOW POWER PLANT ELEMENTARY DIAGRAM TURBINE AND GOVERNOR
253-20-110	OXBOW POWER PLANT ELEMENTARY DIAGRAM TURBINE LOAD CONTROL
253-20-114	OXBOW POWER PLANT ELEMENTARY DIAGRAM STATION SERVICE AND MAIN TRANSFORMER
253-20-117	OXBOW POWER PLANT ELEMENTARY DIAGRAM ANNUNCIATOR AND AUDIBLE ALARMS
253-20-118	OXBOW POWER PLANT ELEMENTARY DIAGRAM ANNUNCIATOR AND AUDIBLE ALARMS
253-20-900 Sht 1 of 7	TI (ETI) MICRO MODEL 8642 REMOTE TERMINAL UNIT (RTU) DIGITAL OUTPUT RELAY CARDS ELEMENTARY DIAGRAM OXBOW POWERHOUSE
253-20-900 Sht 2 of 7	TI (ETI) MICRO MODEL 8642 REMOTE TERMINAL UNIT (RTU) HIGH SPEED ACCUMULATOR & ANALOG INPUT CARDS ELEMENTARY DIAGRAMS OXBOW POWERHOUSE

253-20-900 Sht 3 of 7	TI (ETI) MICRO MODEL 8642 REMOTE TERMINAL UNIT (RTU) DIDGITAL INPUT (STATUS) CARDS ELEMENTARY DIAGRAM OXBOW POWERHOUSE
253-20-900 Sht 4 of 7	TI (ETI) MICRO MODEL 8642 REMOTE TERMINAL UNIT (RTU) DIDGITAL INPUT (STATUS) CARDS ELEMENTARY DIAGRAM OXBOW POWERHOUSE
253-20-900 Sht 5 of 7	TI (ETI) MICRO MODEL 8642 REMOTE TERMINAL UNIT (RTU) MAIN TERMINAL PANEL DIAGRAM OF CONNECTIONS OXBOW POWERHOUSE
253-20-900 Sht 6 of 7	TI (ETI) MICRO MODEL 8642 REMOTE TERMINAL UNIT (RTU) MAIN TERMINAL PANEL DIAGRAM OF CONNECTIONS OXBOW POWERHOUSE
253-20-900 Sht 7 of 7	REMOTE TERMINAL UNIT (RTU) INTERPOSING RELAY PANEL DIAGRAM OF CONNECTIONS OXBOW POWERHOUSE

9:59

DISPLAY MFWTR | MIDDLEFORK HYDRO DATA

I-BAY SPILL GATES		GAGING STATIONS	GAGE HT.	ALARM STATUS
GATE POS	FEET OP	R1 (DUNCAN CREEK)	6.23	
#1 CLOSED	0.2	R2 (DUNCAN CREEK)	1.70	NORMAL NORMAL
#2 CLOSED	0.1	R3 (FR.MEADOWS)	5.17	NORMAL NORMAL
#3 CLOSED	0.0	R4 (ABOVE MFPH)	5.10	NORMAL
#4 CLOSED	0.1	R5 (I-BAY RELEASE)	23.55 CFS	NORMAL
CONTROL : SUPVY		R6 (HELLHOLE RELEASE)	3.96	LOW
DOOR POS : CLOSED		R11 (HORSESHOE BAR)	12.70	NORMAL NORMAL
OV TRV/UV: NORMAL		R27 (S.F. LONG CANYON)	1.69	NORMAL NORMAL
A-BAY SPILL GATES		R28 (N.F. LONG CANYON)	0.81	NORMAL NORMAL
GATE POS		RESERVOIRS	ELEVATION	ALARM STATUS
#1 CLOSED		FRENCH MEADOWS	5190.20	NORMAL NORMAL
#2 CLOSED		HELLHOLE	4490.43	
#3 CLOSED		INTERBAY	2526.31	NORMAL
#4 CLOSED		AFTERBAY	1171.36	LOW
#5 CLOSED				

OVER TRV/UV : ALARM DOOR POSITION: OPEN
ENG GEN RUN : STOPPED AFTERBAY DAM DRAINAGE GALLERY : NORMAL
ENG GEN FAIL : NORMAL STREAM MAINT VALVE FAIL TO OPEN: NORMAL

Command:
02/09/05 ¦ 09:54:26 OXBOW PH DOOR OPEN/CLOSE CLOSED

02/09/05 ¦ 09:59:53 OXBOW PH DOOR OPEN/CLOSE OPEN
02/09/05 ¦ 09:59:55 OXBOW PH DOOR OPEN/CLOSE CLOSED

10:06

1

UNIT SUMMARY

	MW	MVAR	KV	AMPS	LOAD CONTROL	PH DOOR	STATION ANNUN	ON/OFF	LOC/REM
FMPH	-0.50	0.68	4.10	119	-----	CLOSED	NORMAL	RUNNING	REMOTE
MF1	29.90	-0.19	13.50	1253	MANUAL	OPEN	NORMAL	RUNNING	REMOTE
MF2	29.77	0.16	13.50	1248	MANUAL	------	------	RUNNING	REMOTE
RAPH	50.07	-5.27	13.32	2212	FLOAT	OPEN	NORMAL	RUNNING	REMOTE
OXPH	5.60	-0.49	4.05	796	MANUAL	CLOSED	NORMAL	RUNNING	REMOTE
HHPH	FUTURE	FUTURE	FUTURE	----	-----	FUTURE	NORMAL	RUNNING	------

WATER SUMMARY

RESERVOIR	ELEV	STREAM STAGE	GAGE HT.	STREAM STAGE	GAGE HT.
FRENCH MEADOWS	5190.20	DUNCAN CREEK R1	6.23	SF LONG CANYON	1.69
HELL HOLE	4490.43	DUNCAN CREEK R2	1.70	ABOVE MFPH	5.12
INTERBAY	2526.24	FRENCH MEADOWS	5.16	INTERBAY (CFS)	23.40
AFTERBAY	1171.32	HELL HOLE	3.96	BELOW AM BAR	12.71
INTERBAY DOOR	CLOSED	NF LONG CANYON	0.81	AFTERBAY DOOR	OPEN

Command: ALARMS ACKNOWLEDGED!
02/09/05 ¦ 09:59:55 OXBOW PH DOOR OPEN/CLOSE CLOSED

ATTACHMENT B

ATTACHMENT C

Feb8.5

02/08/05 | 00:01:03 SYSTEM STATUS REPORT - COMMUNICATION ALARMS DISABLED <00:07:10>

FRENCH MEADOWS POWERHOUSE			
GEN KWHR OUT:	83.8	GEN KWHR OUT METER:	57574.3
GEN KWHR IN:	9.2	GEN KWHR IN METER:	9424.6
SS#1 KWHR:	90.0	SS#1 KWHR METER:	56243.1
MIDDLEFORK POWERHOUSE			
GEN #1 KWHR OUT:	570.8	GEN #1 KWHR OUT MET	69031.9
GEN #1 KWHR IN:	10.4	GEN #1 KWHR IN MET	5249.0
GEN #2 KWHR OUT:	568.0	GEN #2 KWHR OUT MET	88827.5
GEN #2 KWHR IN:	10.4	GEN #2 KWHR IN MET	4564.6
STA SERV #1 KWHR:	369.7	STA SERV #1 KWHR MET	41218.1
STA SERV #2 KWHR:	0.0	STA SERV #2 KWHR MET	14187.7
STA SERV #3 KWHR:	0.0	STA SERV #3 KWHR MET	29872.7
RALSTON POWERHOUSE			
GEN KWHR OUT:	999.2	GEN KWHR OUT MET	23706.4
GEN KWHR IN:	0.0	GEN KWHR IN MET	0.0
STA SERV #1 KWHR:	211.0	STA SERV #1 KWHR MET	20753.8
STA SERV #2 KWHR:	1.2	STA SERV #2 KWHR MET	4.0
OXBOW POWERHOUSE			
GEN KWHR OUT:	95.1	GEN KWHR OUT METE	29618.9
GEN KWHR IN:	0.0*	GEN KWHR IN METE	0.0*
STA SERV #1 KWHR:	51.5	STA SERV #1 KWHR METE	5927.0
STA SERV #2 KWHR:	0.0	STA SERV #2 KWHR METE	14700.3

FRENCH MEADOWS POWERHOUSE RTU ACCUMULATORS	
GEN OUT	1526.3
GEN IN	206.6
SS#1	195.1
MIDDLEFORK POWERHOUSE RTU ACCUMULATORS	
GEN #1 OUT	6251.9
GEN #1 IN	507.0
GEN #2 OUT	2182.5
GEN #2 IN	419.6
STA SERV #1	1202.1
STA SERV #2	2987.7
STA SERV #3	759.7
RALSTON POWERHOUSE RTU ACCUMULATORS	
GEN OUT	4761.4
GEN IN	0.0
STA SERV #1	1140.8
STA SERV #2	4.0
OXBOW POWERHOUSE RTU ACCUMULATORS	
GEN OUT	6182.9
GEN IN	
STA SERV #1	966.0
STA SERV #2	1.3

02/08/05	02:56:24 RALSTON SIERRA CONTROL RCVR	ALARM	<03:02:31>
02/08/05	03:46:06 MF #1 NEEDLE POS	OPEN	<03:52:13>
02/08/05	03:46:28 MF #2 NEEDLE POS	OPEN	<03:52:35>
02/08/05	04:02:25 RALSTN I/BAY HI WATER LEVEL	ALARM	<04:08:32>
02/08/05	04:02:25 I-BAY ALARM	HIGH	<04:08:32>
02/08/05	04:03:06 RA LOAD CONTROL	MANUAL	<04:09:13>
02/08/05	04:04:22 MF #2 NEEDLE POS	CLOSED	<04:10:29>
02/08/05	04:06:38 RA NEEDLE POS	CLOSED	<04:12:45>
02/08/05	04:06:53 RA 2NEEDLE/6NEEDLE POSITION	6NEEDLE	<04:13:00>
02/08/05	04:07:35 MF #1 NEEDLE POS	CLOSED	<04:13:42>
02/08/05	04:08:10 MF #1 NEEDLE POS	OPEN	<04:14:17>
02/08/05	04:08:38 RA NEEDLE POS	OPEN	<04:14:45>
02/08/05	04:10:04 MF #2 NEEDLE POS	OPEN	<04:16:11>

02/08/05	04:23:10	RALSTN I/BAY HI WATER LEVEL	NORMAL	<04:29:17>
02/08/05	04:23:10	I-BAY ALARM	NORMAL	<04:29:17>
02/08/05	04:43:20	RA LOAD CONTROL	FLOAT	<04:49:27>
02/08/05	04:47:10	MF2 VOLT ADJUST	NORMAL	<04:53:17>
02/08/05	08:22:16	MF2 VOLT ADJUST	ABOVE	<08:28:23>
02/08/05	08:24:04	RA PH DOOR POS	OPEN	<08:30:11>
02/08/05	08:24:11	RA PH DOOR POS	CLOSED	<08:30:18>
02/08/05	08:25:49	RA PH DOOR POS	OPEN	<08:31:56>
02/08/05	08:25:57	RA PH DOOR POS	CLOSED	<08:32:04>
02/08/05	08:31:03	MF1 VOLT ADJUST	NORMAL	<08:37:10>
02/08/05	08:55:35	RA PH DOOR POS	OPEN	<09:01:42>
02/08/05	08:55:40	RA PH DOOR POS	CLOSED	<09:01:47>
02/08/05	08:57:36	RA PH DOOR POS	OPEN	<09:03:43>
02/08/05	08:57:43	RA PH DOOR POS	CLOSED	<09:03:50>
02/08/05	09:04:36	RA PH DOOR POS	OPEN	<09:10:43>
02/08/05	09:04:43	RA PH DOOR POS	CLOSED	<09:10:50>
02/08/05	09:08:12	RA PH DOOR POS	OPEN	<09:14:19>
02/08/05	09:08:19	RA PH DOOR POS	CLOSED	<09:14:26>
02/08/05	09:10:52	RA PH DOOR POS	OPEN	<09:16:59>
02/08/05	09:11:00	RA PH DOOR POS	CLOSED	<09:17:07>
02/08/05	09:21:14	RA PH DOOR POS	OPEN	<09:27:21>
02/08/05	09:21:21	RA PH DOOR POS	CLOSED	<09:27:28>
02/08/05	09:27:28	RA PH DOOR POS	OPEN	<09:33:35>
02/08/05	09:47:38	AFTERBAY DOOR ALARM	OPEN	<09:53:45>
02/08/05	10:06:22	OXBOW WATER LEVEL CHANNEL FAIL	ALARM	<10:12:29>
02/08/05	10:06:25	OXBOW WATER LEVEL CHANNEL FAIL	NORMAL	<10:12:32>
02/08/05	10:38:50	OXBOW WATER LEVEL CHANNEL FAIL	ALARM	<10:44:57>
02/08/05	10:39:34	OXBOW WATER LEVEL CHANNEL FAIL	NORMAL	<10:45:41>
02/08/05	10:39:36	OXBOW WATER LEVEL CHANNEL FAIL	ALARM	<10:45:43>
02/08/05	10:39:50	OXBOW WATER LEVEL CHANNEL FAIL	NORMAL	<10:45:57>
02/08/05	10:56:46	MF2 VOLT ADJUST	NORMAL	<11:02:53>
02/08/05	11:40:53	OXBOW AFTERBAY GATE #2	OPEN	<11:47:00>
02/08/05	11:41:08	OXBOW AFTERBAY GATE #2	CLOSED	<11:47:15>
02/08/05	11:42:05	OXBOW AFTERBAY GATE #1	OPEN	<11:48:12>
02/08/05	11:42:05	OXBOW AFTERBAY GATE #2	MULTIPLE STATUS CHANGES	
<11:48:12>				
02/08/05	11:42:05	OXBOW AFTERBAY GATE #2	CLOSED	<11:48:12>
02/08/05	11:42:05	OXBOW AFTERBAY GATE #3	MULTIPLE STATUS CHANGES	
<11:48:12>				
02/08/05	11:42:05	OXBOW AFTERBAY GATE #3	CLOSED	<11:48:12>
02/08/05	11:42:05	OXBOW AFTERBAY GATE #4	MULTIPLE STATUS CHANGES	
<11:48:12>				
02/08/05	11:42:05	OXBOW AFTERBAY GATE #4	CLOSED	<11:48:12>
02/08/05	11:42:05	OXBOW AFTERBAY GATE #5	MULTIPLE STATUS CHANGES	
<11:48:12>				
02/08/05	11:42:05	OXBOW AFTERBAY GATE #5	CLOSED	<11:48:12>
02/08/05	11:42:09	OXBOW AFTERBAY GATE #1	MULTIPLE STATUS CHANGES	
<11:48:16>				
02/08/05	11:42:09	OXBOW AFTERBAY GATE #1	OPEN	<11:48:16>
02/08/05	11:42:14	OXBOW AFTERBAY GATE #1	CLOSED	<11:48:21>
02/08/05	11:43:33	OXBOW AFTERBAY GATE #3	MULTIPLE STATUS CHANGES	
<11:49:40>				
02/08/05	11:43:33	OXBOW AFTERBAY GATE #3	CLOSED	<11:49:40>
02/08/05	11:43:54	OXBOW AFTERBAY GATE #3	OPEN	<11:50:01>
02/08/05	11:43:59	OXBOW AFTERBAY GATE #3	CLOSED	<11:50:06>
02/08/05	11:44:24	OXBOW AFTERBAY GATE #4	OPEN	<11:50:31>
02/08/05	11:46:05	OXBOW AFTERBAY GATE #4	CLOSED	<11:52:12>
02/08/05	11:46:37	OXBOW AFTERBAY GATE #3	OPEN	<11:52:44>
02/08/05	11:46:39	OXBOW AFTERBAY GATE #3	MULTIPLE STATUS CHANGES	
<11:52:46>				
02/08/05	11:46:39	OXBOW AFTERBAY GATE #3	OPEN	<11:52:46>
02/08/05	11:47:00	OXBOW AFTERBAY GATE #3	CLOSED	<11:53:07>
02/08/05	11:47:25	OXBOW AFTERBAY GATE #2	MULTIPLE STATUS CHANGES	

<11:53:32>			
02/08/05	11:47:25	OXBOW AFTERBAY GATE #2	CLOSED <11:53:32>
02/08/05	11:47:28	OXBOW AFTERBAY GATE #2	MULTIPLE STATUS CHANGES
<11:53:35>			
02/08/05	11:47:28	OXBOW AFTERBAY GATE #2	OPEN <11:53:35>
02/08/05	11:47:30	OXBOW AFTERBAY GATE #2	MULTIPLE STATUS CHANGES
<11:53:37>			
02/08/05	11:47:30	OXBOW AFTERBAY GATE #2	CLOSED <11:53:37>
02/08/05	11:47:33	OXBOW AFTERBAY GATE #2	OPEN <11:53:40>
02/08/05	11:47:49	OXBOW AFTERBAY GATE #2	CLOSED <11:53:56>
02/08/05	11:48:03	OXBOW AFTERBAY GATE #1	OPEN <11:54:10>
02/08/05	11:48:15	OXBOW AFTERBAY GATE #1	CLOSED <11:54:22>
02/08/05	11:48:15	OXBOW AFTERBAY GATE #2	MULTIPLE STATUS CHANGES
<11:54:22>			
02/08/05	11:48:15	OXBOW AFTERBAY GATE #2	CLOSED <11:54:22>
02/08/05	11:48:15	OXBOW AFTERBAY GATE #3	MULTIPLE STATUS CHANGES
<11:54:22>			
02/08/05	11:48:15	OXBOW AFTERBAY GATE #3	CLOSED <11:54:22>
02/08/05	11:48:15	OXBOW AFTERBAY GATE #4	MULTIPLE STATUS CHANGES
<11:54:22>			
02/08/05	11:48:15	OXBOW AFTERBAY GATE #4	CLOSED <11:54:22>
02/08/05	11:48:15	OXBOW AFTERBAY GATE #5	MULTIPLE STATUS CHANGES
<11:54:22>			
02/08/05	11:48:15	OXBOW AFTERBAY GATE #5	CLOSED <11:54:22>
02/08/05	11:58:06	MF #2 NEEDLE POS	CLOSED <12:04:13>
02/08/05	12:03:04	MF #1 NEEDLE POS	CLOSED <12:09:11>
02/08/05	12:08:17	RA NEEDLE POS	CLOSED <12:14:24>
02/08/05	12:28:16	RA NEEDLE POS	OPEN <12:34:23>
02/08/05	12:54:43	MIDDLEFORK PH DOOR POS	OPEN <13:00:50>
02/08/05	13:03:01	OXBOW ENGINE GENERATOR	RUNNING <13:09:08>
02/08/05	13:07:32	OXBOW ENGINE GENERATOR	STOPPED <13:13:39>
02/08/05	13:07:36	OXBOW ENGINE GENERATOR	RUNNING <13:13:43>
02/08/05	13:07:38	OXBOW ENGINE GENERATOR	STOPPED <13:13:45>
02/08/05	13:17:52	MIDDLEFORK PH DOOR POS	CLOSED <13:23:59>
02/08/05	13:44:39	RALSTON SIERRA CONTROL RCVR	NORMAL <13:50:46>
02/08/05	15:05:58	FM POWERHOUSE DOOR POSITION	OPEN <15:12:05>

Ralston - SCADA ALARM SUMMARY

02/09/05	02:56:54 RALSTON SIERRA CONTROL RCVR	ALARM
02/09/05	04:41:45 MF #1 NEEDLE POS	OPEN
02/09/05	04:42:14 MF #2 NEEDLE POS	OPEN
02/09/05	07:07:56 RALSTN I/BAY HI WATER LEVEL	MULTIPLE STATUS CHANGES
02/09/05	07:07:56 RALSTN I/BAY HI WATER LEVEL	NORMAL
02/09/05	07:07:56 RALSTN I/BAY LO WATER LEVEL	ALARM
02/09/05	07:07:56 I-BAY ALARM	MULTIPLE STATUS CHANGES
02/09/05	07:07:56 I-BAY ALARM	LOW
02/09/05	07:07:59 RALSTN I/BAY LO WATER LEVEL	NORMAL
02/09/05	07:07:59 I-BAY ALARM	NORMAL
02/09/05	08:39:00 MIDDLEFORK PH DOOR POS	OPEN
02/09/05	09:05:11 RA PH DOOR POS	OPEN
02/09/05	09:13:26 AFTERBAY DOOR ALARM	OPEN
02/09/05	09:54:23 OXBOW PH DOOR OPEN/CLOSE	OPEN
02/09/05	10:30:38 OXBOW ANNUNCIATOR HORN/ALARM	ALARM
02/09/05	10:30:43 OXBOW ANNUNCIATOR HORN/ALARM	NORMAL
02/09/05	10:59:08 MIDDLEFORK PH DOOR POS	CLOSED
02/09/05	11:12:55 OXBOW AFTERBAY GATE #1	OPEN
02/09/05	11:32:12 OXBOW AFTERBAY GATE #2	OPEN
02/09/05	11:32:12 OXBOW AFTERBAY GATE #3	OPEN
02/09/05	11:32:12 OXBOW AFTERBAY GATE #4	OPEN
02/09/05	11:32:12 OXBOW AFTERBAY GATE #5	OPEN
02/09/05	11:32:14 OXBOW AFTERBAY GATE #1	CLOSED
02/09/05	11:32:14 OXBOW AFTERBAY GATE #2	CLOSED
02/09/05	11:32:14 OXBOW AFTERBAY GATE #3	CLOSED
02/09/05	11:32:14 OXBOW AFTERBAY GATE #4	CLOSED
02/09/05	11:32:14 OXBOW AFTERBAY GATE #5	CLOSED
02/09/05	11:33:34 OXBOW AFTERBAY GATE #1	OPEN
02/09/05	11:35:19 OXBOW AFTERBAY GATE #1	CLOSED
02/09/05	11:36:35 OXBOW AFTERBAY GATE #2	OPEN
02/09/05	11:36:54 OXBOW AFTERBAY GATE #2	CLOSED
02/09/05	11:37:50 OXBOW AFTERBAY GATE #3	OPEN
02/09/05	11:37:59 OXBOW AFTERBAY GATE #3	CLOSED
02/09/05	11:38:33 OXBOW AFTERBAY GATE #4	OPEN
02/09/05	11:38:43 OXBOW AFTERBAY GATE #4	CLOSED
02/09/05	11:48:11 MF #2 NEEDLE POS	CLOSED
02/09/05	11:52:25 MF #1 NEEDLE POS	CLOSED
02/09/05	11:58:11 RA NEEDLE POS	CLOSED
02/09/05	12:00:46 RALSTON SIERRA CONTROL RCVR	NORMAL
02/09/05	12:20:36 RA NEEDLE POS	OPEN
02/09/05	12:21:15 OXBOW PH DOOR OPEN/CLOSE	CLOSED
02/09/05	12:47:49 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/09/05	12:47:51 OXBOW ENGINE GENERATOR	RUNNING
02/09/05	12:48:08 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL
02/09/05	13:07:17 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/09/05	13:07:25 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL
02/09/05	13:07:53 OXBOW ENGINE GENERATOR	STOPPED
02/09/05	13:44:34 OXBOW PH DOOR OPEN/CLOSE	OPEN
02/09/05	13:54:02 OXBOW PH DOOR OPEN/CLOSE	CLOSED
02/09/05	14:00:04 FM POWERHOUSE DOOR POSITION	OPEN
02/09/05	14:23:21 OXBOW AFTERBAY ANNUNCIATOR	ALARM
02/09/05	14:47:01 FM POWERHOUSE DOOR POSITION	CLOSED

Ralston Powerhouse SCADA Log Placer County Water Agency, Foresthill, CA

02/10/05	02:00:05 MF #2 NEEDLE POS	OPEN
02/10/05	02:00:14 MF #2 NEEDLE POS	CLOSED
02/10/05	02:51:19 RALSTON SIERRA CONTROL RCVR	ALARM
02/10/05	02:59:26 MF #2 NEEDLE POS	OPEN
02/10/05	02:59:41 MF #2 NEEDLE POS	CLOSED
02/10/05	04:13:37 RALSTN I/BAY HI WATER LEVEL	MULTIPLE STATUS CHANGES
02/10/05	04:13:37 RALSTN I/BAY HI WATER LEVEL	NORMAL
02/10/05	04:13:37 RALSTN I/BAY LO WATER LEVEL	ALARM
02/10/05	04:13:37 I-BAY ALARM	MULTIPLE STATUS CHANGES
02/10/05	04:13:37 I-BAY ALARM	LOW
02/10/05	04:13:41 RALSTN I/BAY LO WATER LEVEL	NORMAL
02/10/05	04:13:41 I-BAY ALARM	NORMAL
02/10/05	04:43:55 MF #2 NEEDLE POS	OPEN
02/10/05	04:46:08 MF #1 NEEDLE POS	OPEN
02/10/05	08:07:02 AFTERBAY DOOR ALARM	OPEN
02/10/05	08:11:30 RA PH DOOR POS	OPEN
02/10/05	08:30:57 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/10/05	08:32:28 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL
02/10/05	08:38:58 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/10/05	08:39:27 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL
02/10/05	08:58:25 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/10/05	08:59:06 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL
02/10/05	09:10:54 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/10/05	09:11:25 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL
02/10/05	09:25:19 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/10/05	09:25:42 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL
02/10/05	09:29:54 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/10/05	09:31:28 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL
02/10/05	09:38:36 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/10/05	09:39:20 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL
02/10/05	09:44:55 OXBOW WATER LEVEL CHANNEL FAIL	ALARM
02/10/05	09:45:21 OXBOW WATER LEVEL CHANNEL FAIL	NORMAL

ATTACHMENT D

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