

Fulton River Dam

**DAM SAFETY REPORT
FOR
MECHANICAL AND ELECTRICAL EQUIPMENT**



Prepared by:



Klohn Crippen Berger

For

FISHERIES AND OCEANS CANADA

13 JANUARY 2009



January 13, 2009

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Log No. 001-L

Fisheries and Oceans Canada
200 – 401 Burrard Street
Vancouver, BC V6C 3S4

Attn: Mr. Tim Renaud
Project Engineer

Dear Mr. Renaud:

**Re: Fulton River Dam
Dam Safety Report for Mechanical and Electrical Equipment**

We are pleased to present our final Dam Safety Report for Mechanical and Electrical Equipment at DFO's Fulton River Facility. We have recommended a number of maintenance items that need attention, especially with regard to inspecting the regulating gates when flow to the spawning channels can be shut-off. In addition, the source of the leakage in the dam outlet also needs identifying and repairs made if required. KCBL are able to assist with these inspections should you require.

Please contact me if you have any questions.

Yours truly,

KLOHN CRIPPEN BERGER LTD.

A handwritten signature in blue ink, appearing to read "Andrew Mack", written over a horizontal dashed line.

Andrew Mack. P.Eng.
Project Manager

AM/

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DISCLAIMER

This report is an instrument of service of Klohn Crippen Berger Ltd. (KCBL) and was prepared for Fisheries and Oceans Canada (the "Client") for a dam safety review of mechanical and electrical equipment at Fulton River Dam.

In the preparation of this dam safety report, KCBL has endeavored to observe the degree of care and skill generally exercised by other consultants undertaking similar studies at the same time, under similar circumstances and conditions, and in the same geographical area. KCBL makes no warranty, express or implied.

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4. The observations, findings and conclusions in this report are based on conditions that existed at the time of the work described herein and should not be relied upon to precisely represent conditions at any other time.

Fulton River Dam

DAM SAFETY REPORT
FOR
MECHANICAL AND ELECTRICAL EQUIPMENT

13 January 2009



Prepared By:

Andrew G. Mack, P.Eng.
Design Manager



Reviewed By:

Dan Campbell, P.Eng.
Senior Reviewer

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0	24 December 2008	Draft Issue
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1. INTRODUCTION

1.1 Scope of service

KCBL prepared this report for Fisheries and Oceans Canada (DFO) in response to a request for an inspection of mechanical and electrical equipment at DFO's Fulton River Facility to comply with the Canadian Dam Association Guidelines. The requested inspection was for the mechanical and electrical components, as specifically related to dam safety. Nevertheless, while at site, other mechanical and electrical components were inspected as time permitted.

The hydrotechnical, geotechnical, and structural aspects of dam safety have been assessed by others. These inspections are the subject of various other reports. KCBL's scope of service is for mechanical and electrical components only.

1.2 Documentation

The following documentation related to dam safety was provided by DFO:

- EBA Engineering Consultants Ltd. 2002. *Re-Inspection of Water Supply Tunnels to Fulton River and Pinkut Creek Spawning Channels*. Prepared for DFO.
- EBA Engineering Consultants Ltd. 2008a. *Re-Inspection of Water Supply Tunnels & Related Facilities for the Fulton River Spawning Channel*. Prepared for DFO.
- EBA Engineering Consultants Ltd. 2008b. *2007 Inspection, Fulton Dam*. Prepared for DFO.
- Fisheries and Oceans Canada. 2007. *Fulton River Facility, Operation and Maintenance Manual - Draft*.
- Patrick Fawkes & Associates. 1986a. *Fulton River Project, Dam Breach Inundation Studies*. Prepared for DFO.
- Patrick Fawkes & Associates. 1986b. *Fulton River Project, Dam Breach Inundation Studies*. Prepared for DFO. Inspection Report of Fulton Lake Dam. Prepared for DFO.
- UMA Engineering Ltd. 1997. *Fulton Dam, Dam Safety Review*. Prepared for DFO.
- Various structural, hydrotechnical, mechanical and electrical drawings.

1.3 Previous Electrical and Mechanical Review

The last comprehensive inspection of the electrical and mechanical equipment at the Fulton River Dam was by UMA Engineering Ltd. (UMA) in 1997. UMA made several recommendations for maintenance work to the mechanical and electrical equipment. In summary, the recommendations were:

➤ Low-Level Outlet:

- Review the hoist system to ensure the system is safe, including checking the hoist chain capacity against load and replace if necessary;
- Annually check the low-level outlet gate skinplate thickness and repair when the depth of defects reaches 3/8 in,
- Regularly inspect the wheel roller bearings and replace as required (the wheel bearings cannot be greased because of corroded grease nipples), and
- Replace the leaking gate seal – operators reported that a section of seal was missing in the bottom gate.

➤ Regulating Works:

- Carry out a fan brake test and set rate of emergency closure,
- Check condition of bypass gate as it could not be accessed during UMA's inspection,
- Check capacity setting of bypass gate actuator to prevent buckling of the operating stem, and
- Remove inoperative electrical equipment.

We understand that, of these recommendations, only the hoist system and hoist chain capacity has been reviewed; and as a result, the Regulating works monorail structure is being strengthened to reduce deflections.

1.4 Hazard Classification

In their August 1997 dam safety report, UMA previously gave the Fulton Dam a High Hazard Classification in accordance with the Canadian Dam Safety Guidelines. This classification was supported by EBA Engineering Consultants Ltd. in 2007 dam safety inspection report. For the purposes of inspecting the mechanical and electrical equipment, KCBL have assumed the same classification; however, we have not made an independent review of the classification.

2. SITE VISIT

Andrew Mack of KCBL travelled to site on 16 September 2008, and met with Tim Renaud, DFO's project engineer in charge of the Fulton Dam Facilities. At site they also met with several operating staff: the manager of the Fulton facility, Brad Thompson and the Maintenance Manager, Denis Merkley.

The purpose of the visit was to review the following mechanical and electrical equipment:

- Regulating works intake gates, hoist, and backup diesel generator;
- Regulating works outlet hollow cone valves and controls, and
- Low-level outlet gate house.

Visual inspections of these components were carried out; no operational or material testing was done. Because the facility was providing water to the fish spawning channels, the tunnel was not dewatered; therefore, the Regulating works intake gates could not be fully inspected and the inside of the hollow cone valves were not inspected.

The low-level outlet gates were in the closed position and were unable to be inspected.

The inspection check-lists in Appendix I summarize the observations made during the inspection. The following summarizes the inspection.

3. REGULATING WORKS

3.1 Intake

3.1.1 Service Gate

The service gate provides the primary dam safety shut-off for the regulating works. The regulating works outlet hollow cone valves provide secondary shut-off for the regulating works. However, because there is a penstock between the regulating works and the outlet at the spawning channel, there is no secondary shut-off for the penstock.

Because the spawning channels were in use, the tunnel could not be dewatered to inspect the gate. The service gate was in the open position during the site visit and only the top portion of the gate could be seen. From the limited view, the gate appeared in good condition, with only minor corrosion. The seals and wheels were not able to be inspected. The service gate should be inspected by closing the bulkhead gate, dewatering the tunnel and inspecting both the upstream and downstream side of the gate.

The service gate is raised and lowered by a dedicated wire-rope hoist located in the gate house. Although not tested, the wire rope hoist appeared in satisfactory condition, having recently been painted and the drum and wire rope greased.

From EBA's 2008 Fulton Reinspection Report, Photo 3 shows that there is some leakage from under the gate. This should be investigated further to determine the leakage source and severity and whether repairs are needed.

An emergency closure test should be carried out on the gate to confirm the closure rate is set as specified in the original operating and maintenance manual.

3.1.2 Bulkhead Gate

We were unable to gain access to the bulkhead gate during the site visit. The bulkhead gate should be removed from its slot and the gate's condition assessed.

The bulkhead gate is lifted and lowered using an overhead monorail hoist. We understand that the hoist system was recently reviewed by others, so KCBL did not include the hoist in our inspection. UMA recommended in their 1997 dam safety review a check of the capacity of the hoist support structure. As a result, modification to the gate house structure is planned to reduce deflection of the hoist monorail beam.

3.1.3 By-Pass Slide Gate

The by-pass slide gate is a standard off-the-shelf slide gate with an electric screw type actuator, which is located in the gate house and connected by the operating stem to the slide gate. Because the tunnel was filled at the time of the inspection, the by-pass slide gate was not inspected. From EBA's 2008 Fulton Reinspection Report, Photo 3 shows that there is some leakage from this gate. This leakage should be investigated further to determine the source and severity of the leakage. If required, repairs should be carried out.

3.1.4 Controls

Controls for the service gate and by-pass slide gate are local manual only.

The service gate is operated by an electrically driven wire rope hoist. A drum holding brake and fan brake control emergency closure of the service gate. Manual release of the holding brake will initiate an emergency closure of the service gate without electrical power. The fan brake controls lowering speed.

3.1.5 Standby Diesel Generator

The standby diesel generator for the dam and outlet works is housed in the regulating works gate house. Facility staff report that the diesel generator is tested regularly. Site staff report that there are approximately four line outages per year. Not all outages require the use of the diesel generator because operation of the valves or gates may not be required at the time.

3.2 Outlet

3.2.1 Hollow Cone Valves

An external inspection of the hollow cone valves was carried out. The exterior of the valves had been recently painted. Site personnel indicated that the valves had been recently repaired, including filling of corrosion pitting, and painting. The valves appeared in reasonable condition. KCBL were not provided with any report on the condition of the valves, or depth of corrosion pitting prior to our inspection.

The 36" valve was operated while KCBL engineers were on site. The valve appeared to operate satisfactorily with no undue vibration or difficulty in operation.

The control room for the gates had an accumulation of debris, including paper, boxes, and paint tins. Rubbish should be removed to reduce the fire hazard.

3.2.2 Controls

The actuators and controls for the valves are located in a control room above the valves. The actuators had been recently painted. One of the valve actuators was not operational due to an electrical problem. The site staff indicated that they were getting the problem looked at. In the meantime, the valve is being operated manually using the handwheel.

4. LOW-LEVEL OUTLET

4.1 Gates

The low-level outlet has two gates, an upper gate and a lower gate. Both gates were closed during the inspection. There is some leakage from these gates as evident by water flowing from the outlet. The amount of leakage is estimated to be 100 L/s based on 50 mm water depth over the outlet weir. This depth was not measured, but estimated from standing at the gatehouse level. It is possible that the depth of flow was greater. The leakage is considered greater than would normally be acceptable.

The cause of the leakage should be investigated and repairs carried out if required. Leakage past the gate seals may not be a major concern if no other damage is evident and operations or safety are not effected; however, if the source of the leakage is erosion of the concrete around the embedded parts, then the concrete should be repaired.

If the gates or concrete need repairs that require the gates removed or opened, or access is required to the upstream side of the gates, then the low-level outlet will need to be isolated while the repairs are carried out. Because the low-level outlet lacks a stoplog or bulkhead gate, a method for isolating the gates needs to be developed. Initially, the area can be inspected by gaining access through the outlet, which will require rappelling down the dam abutment and walking up the outlet, taking appropriate safety precautions. Once the cause of the leakage is known an appropriate plan can be developed for repairs. If repairs are needed that require isolation of the gates, then one possible method of isolation would be to fabricate and install a new stoplog and guides. The guides would be attach to the upstream face of the dam in front of the trashracks and the stoplog lowered into position.

There are some precautions noted in the operating and maintenance manual for the low-level outlet gates:

“The dam outlet will normally be used only to assist in passing snowmelt floods that are greater than average. There are three restrictions on the use of the dam outlet:

- 1. The low-level gate should not be used when the reservoir level is below El. 2525, to prevent erosion of the cofferdam upstream.*
- 2. The gate should be fully opened, when in use, to prevent the gate vibrating.*
- 3. The gate cannot be closed when the reservoir level is above El. 2545 feet.”*

The low-level outlet gates are used for regulating large floods, and as such are relevant to dam safety. The gates should be tested, which should be done when the reservoir level is below El. 2545 feet so that the gate can be closed.

The gates should also be removed from the slot and their condition inspected.

4.2 Controls

The low-level gates are raised and lowered using a ten (10) ton monorail hoist. DFO have reported that the hoists were recently inspected.

5. RECOMMENDATIONS

KCBL recommends the following electrical and mechanical work be completed to maintain operation of the facilities:

- Carry out an emergency closure test of the service gate in the regulating works under flow conditions. The lowering speed should be checked and adjusted if needed.
- Remove the bulkhead gate in the regulating works and inspect for corrosion, seal condition, and condition of the wheels and bearings.
- Dewater the tunnel and inspect the service gate and by-pass gate for leakage and check the source and severity of the leakage. Depending on access, the condition of the gate guides should also be assessed, checking for corrosion or other signs of degradation.
- Inspect the dam low-level outlet to determine the source of leakage and inspect the concrete for any damage such as erosion or spalling.
- Remove and inspect the dam low-level outlet gates (both upper and lower). The inspection should check the condition of the paint, seals, wheels, and bearings and any signs of corrosion.
- Repair the actuator for the hollow cone valve.

APPENDIX I

Inspection Checklists



Dam Safety Review - Inspection Checklist

Project: Fulton Dam

Klohn Crippen Berger

Structure: <u>Dam</u>	Date: <u>16 September 2008</u>
Feature: <u>Low Level Outlet</u>	Weather: <u>Sunny, 23°C</u>
Detail: _____	Reservoir Level: <u>5 ft over spillway</u>
Inspector: <u>A. Mack</u>	

Item	Rating	Remarks
Skinplate / Beams Wheels and bearings Roller paths Gate guides Gate / Guide Heating Lifting cables Dogging device Seals/leakage Clearances other unusual conditions		Not inspected, gate closed. Operator reported that if the gate is lifted it will not reclose. Leakage from the outlet channel noted. Depth of water over outlet weir estimated to be at least several inches. (Was not able to get to weir and physically measure.) The operator reported that both gates were in the closed position. Although leakage is not affecting the operation of the dam, the leakage needs to be repaired. The leakage may be due to concrete erosion; if left unrepaired the erosion may become worse.
Notes: Gate not tested during inspection.		

Rating

- S Satisfactory, will fulfil intended purpose
- F Fair, will fulfil intended purpose, maintenance required
- P Poor, may not fulfil intended purpose, maintenance/repair required
- U Unsatisfactory, will not fulfil intended purpose, repair required
- E Emergency repair needed, give details



Dam Safety Review - Inspection Checklist

Project: Fulton Dam

Klohn Crippen Berger

Structure:	Intake	Date:	16 September 2008
Feature:	Gate	Weather:	Sunny, 23°C
Detail:		Reservoir Level:	5 ft over spillway
Inspector:	A. Mack		

Item	Rating	Remarks
Skinplate / Beams	S	} Not inspected, gate in open position, unable to access.
Wheels and bearings		
Roller paths		
Gate guides		
Gate / Guide Heating		
Lifting cables	S	
Dogging device	S	} Not inspected, gate in open position, unable to access.
Seals/leakage		
Clearances		
other unusual conditions		
Notes: Gate not tested during inspection.		

Rating

- S Satisfactory, will fulfil intended purpose
- F Fair, will fulfil intended purpose, maintenance required
- P Poor, may not fulfil intended purpose, maintenance/repair required
- U Unsatisfactory, will not fulfil intended purpose, repair required
- E Emergency repair needed, give details



Klohn Crippen Berger

Dam Safety Review - Inspection Checklist

Project: Fulton Dam

Structure:	<u>Intake</u>	Date:	<u>16 September 2008</u>
Feature:	<u>Hoist</u>	Weather:	<u>Sunny, 23°C</u>
Detail:	<u></u>	Reservoir Level:	<u>5ft above spillway</u>
Inspector:	<u>A. Mack</u>		

Item	Rating	Remarks
Hoist		
• structure	S	Hoist not operated due to fisheries constraints. Inspection visual only.
• motor	S	
• gearbox	S	
• fan brake	S	
• wire rope	S	
Hoist weather protection	S	Not tested. An emergency closure test should be carried out.
Operation		
Indicators (mechanical)	S	
Position Transducers	S	
Limit Switches	S	
Controls	S	
Operating Procedures	S	
Maintenance Records	S	
Test Records	S	
Other unusual conditions		
Notes: Hollow cone valve position instrumentation not working in intake gate house. Overhead hoist not inspected or tested. DFO note that there is a separate inspection report on the overhead hoist done by others.		

Rating

- S Satisfactory, will fulfil intended purpose
- F Fair, will fulfil intended purpose, maintenance required
- P Poor, may not fulfil intended purpose, maintenance/repair required
- U Unsatisfactory, will not fulfil intended purpose, repair required
- E Emergency repair needed, give details



Klohn Crippen Berger

Dam Safety Review - Inspection Checklist

Project: Fulton Dam

Structure:	<u>Intake</u>	Date:	<u>16 September 2008</u>
Feature:	<u>Standby Generator</u>	Weather:	<u>Sunny, 23°C</u>
Detail:	<u></u>	Reservoir Level:	<u>5ft over spillway</u>
Inspector:	<u>A. Mack</u>		

Item	Rating	Remarks
Automatic/Manual Transfer Switch	S	Manual. Diesel genset only started when there is a power outage and when power is required.
Fuel Tank	S	
Enclosure		
• venting	S	
• exhaust	S	
• heating	S	
Battery Charging	S	
Operational Test		Not operated.
• persons to operate		No reported problems.
• ease of operation		
• raise gate		
• control system		
Emergency Communication System		None. Relies on daily checks.
Operating Procedures	S	Old. Being updated.
Maintenance / Test Records	S	
Other unusual conditions		
Notes: Regulating valve remote indication in generator room is not operational and should be removed.		

Rating

- S Satisfactory, will fulfil intended purpose
- F Fair, will fulfil intended purpose, maintenance required
- P Poor, may not fulfil intended purpose, maintenance/repair required
- U Unsatisfactory, will not fulfil intended purpose, repair required
- E Emergency repair needed, give details



Dam Safety Review - Inspection Checklist

Project: **Fulton Dam**

Klohn Crippen Berger

Structure: Regulating Works Date: 16 September 2008
Feature: Outlet Weather: Sunny, 23°C
Detail: _____ Reservoir Level: 5 ft over spillway
Inspector: A. Mack

Item	Rating	Remarks
Valves	S	Recently painted
Valve actuators	S	Recently painted. One actuator has electrical problems, requires manual operation.
Operating linkages	S	
Seals/leakage	S	No leakage noted.
other unusual conditions	S	

Notes:
36 in Valve was operated during inspection. Other valves were not operated.

Rating

- S Satisfactory, will fulfil intended purpose
- F Fair, will fulfil intended purpose, maintenance required
- P Poor, may not fulfil intended purpose, maintenance/repair required
- U Unsatisfactory, will not fulfil intended purpose, repair required
- E Emergency repair needed, give details



Klohn Crippen Berger

Dam Safety Review - Inspection Checklist

Project: Fulton Dam

Structure:	<u>All</u>	Date:	<u>16 September 2008</u>
Feature:	<u>Communications</u>	Weather:	<u>Sunny, 23°C</u>
Detail:	<u></u>	Reservoir Level:	<u>5ft above spillway</u>
Inspector:	<u>A. Mack</u>		

Item	Rating	Remarks
Normal Facilities		
• type	S	PLC Phone system, email, VHF radio
• adequacy	S	
Standby/Emergency Facilities		
• type	S	Emergency power diesel system.
• adequacy	S	Not automatic, only started if needed when mains are down
Normal Power Supply		
• type	S	Main hydro line. Operators report mains can be down up to 4 times per year, at which time the diesel is used if required.
• reliability	F	
Auxiliary/Emergency Power		
• type	S	Station diesel. Not tested. No problems reported.
• tested		
• maintenance	S	
Remote controls		No remote control or indication
Annunciation/Indication		
Failure History		No reported failures; Communications system adequate for remote site
Notes: Diesel only started if required. Diesel is started manually.		

Rating

- S Satisfactory, will fulfil intended purpose
- F Fair, will fulfil intended purpose, maintenance required
- P Poor, may not fulfil intended purpose, maintenance/repair required
- U Unsatisfactory, will not fulfil intended purpose, repair required
- E Emergency repair needed, give details



Klohn Crippen Berger

Dam Safety Review - Inspection Checklist

Project: Fulton Dam

Structure:	<u>All</u>	Date:	<u>16 September 2008</u>
Feature:	<u>Dam Safety Documentation</u>	Weather:	<u>Sunny, 23°C</u>
Detail:	<u>OM&S Manual</u>	Reservoir Level:	<u>5ft above spillway</u>
Inspector:	<u>A. Mack</u>		

Item	Rating	Remarks
Issue Date		1969
Date of Last Revision		1988. Currently being updated
Current Copy at Dam?		Yes.
Adequacy of instructions?		OK. Being updated.
Are instructions understood?		Reported by operators as complex.
Is flood routing covered?		Yes
Any special instructions?		
Are inspections recorded?		Yes. Computerized maintenance log.
Frequency of inspections?		Daily, plus regular maintenance.
Are checklists available?		Yes.
Are changes required?		New O&M manual being developed.
Notes:		

Rating

- S Satisfactory, will fulfil intended purpose
- F Fair, will fulfil intended purpose, maintenance required
- P Poor, may not fulfil intended purpose, maintenance/repair required
- U Unsatisfactory, will not fulfil intended purpose, repair required
- E Emergency repair needed, give details



Klohn Crippen Berger

Dam Safety Review - Inspection Checklist

Project: Fulton Dam

Structure: All Date: 16 September 2008
Feature: Dam Safety Documentation Weather: Sunny, 23°C
Detail: Operating Log Reservoir Level: 5ft over spillway
Inspector: A. Mack

Item	Rating	Remarks
Frequency of entry.	S	Daily
Information recorded:	S	Dam level Valve openings River flow Channel flow Inflow
Are changes required?	No	
Other observations		
Notes:		

Rating

- S Satisfactory, will fulfil intended purpose
- F Fair, will fulfil intended purpose, maintenance required
- P Poor, may not fulfil intended purpose, maintenance/repair required
- U Unsatisfactory, will not fulfil intended purpose, repair required
- E Emergency repair needed, give details

APPENDIX II

Photographs



Figure 1: Flow over spillway.



Figure 2: Regulating works hollow-cone valve actuators.

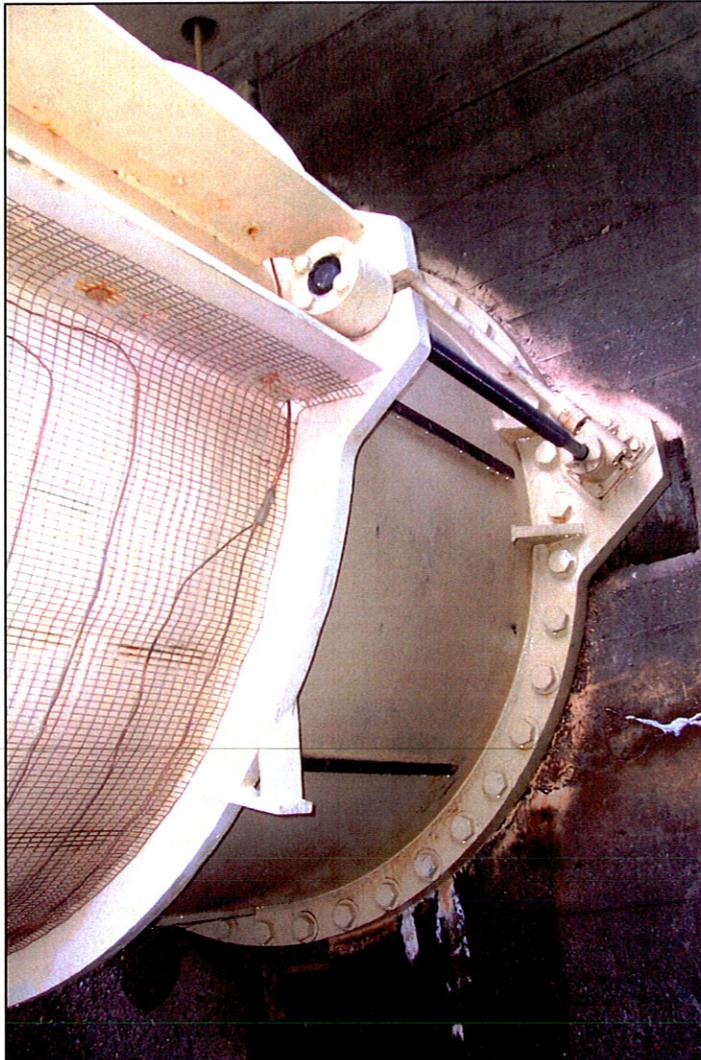


Figure 3: Hollow-cone valve recently painted.



Figure 4: 36 in Hollow cone valve in operation.

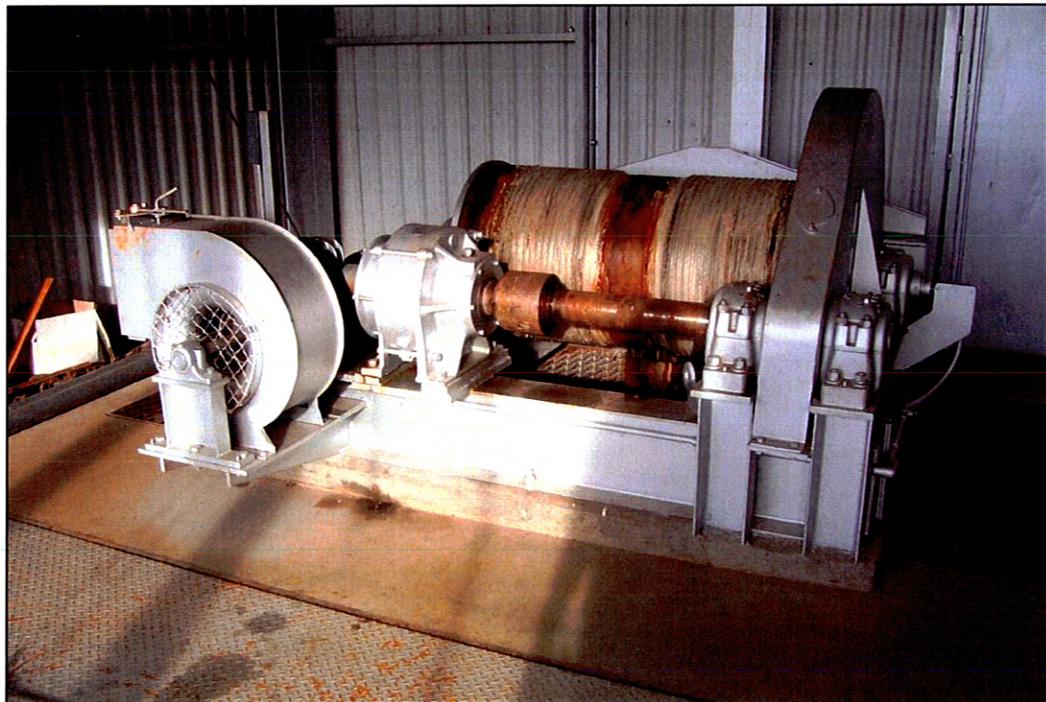


Figure 5: Service Gate hoist for regulating works.



Figure 6: Regulating works Service Gate.

