Markland L/D Ohio River
Louisville District
Board of Investigation Briefing, Downstream Miter Gate Failure

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Deputy Commander

Pittsburgh District

USACE Brief - 7 December

LRD Brief – 5 November

LRL Brief – 22 October

On site Investigation 28-30 September

US Army Corps of Engineers

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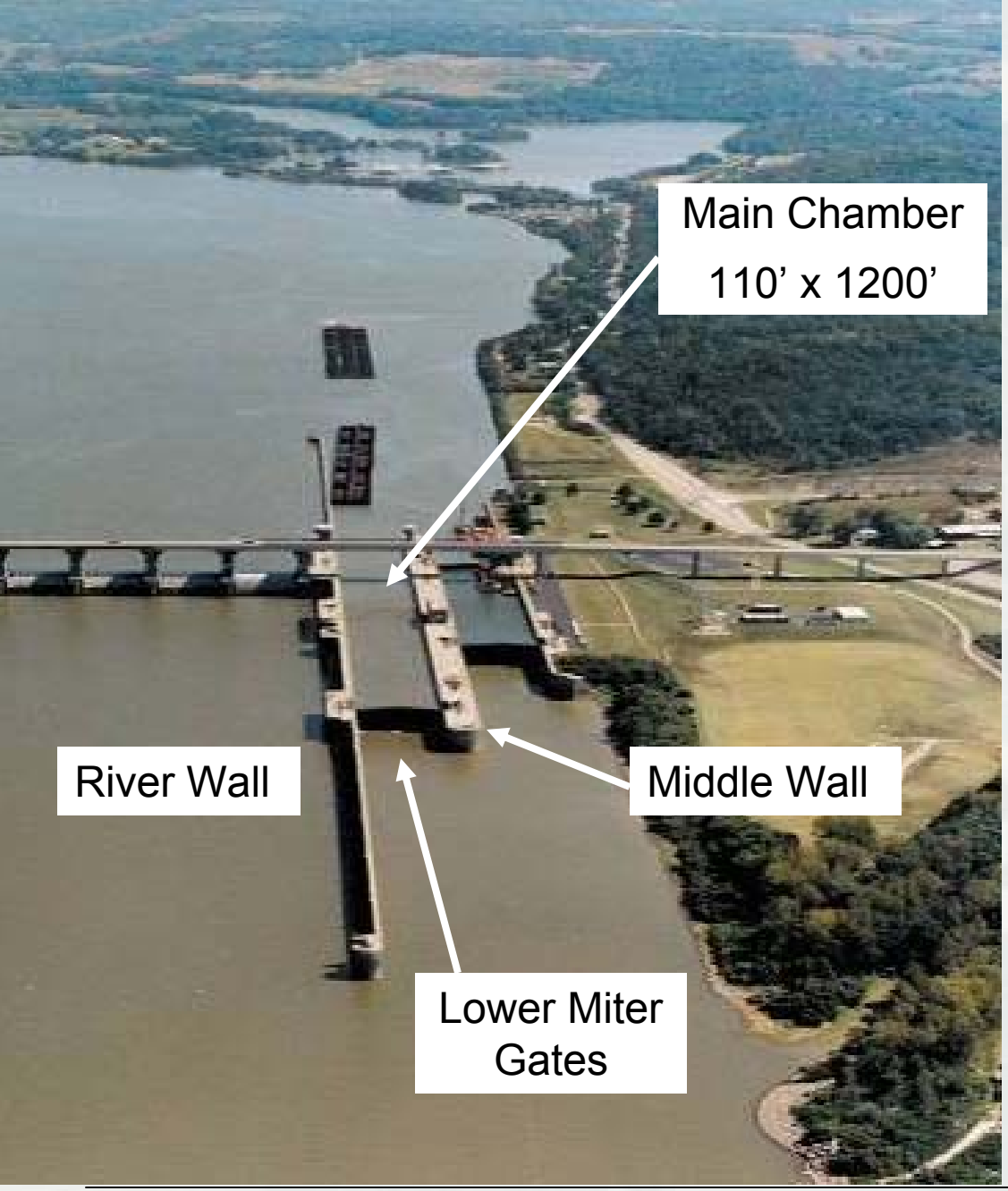
Agenda

- Lock Description
- Accident Summary
- Findings
- Conclusion
- Recommendations
- Questions

❖ Board Members

- ► David Sneberger, Chief of Locks and Dams Branch, Pittsburgh District
- ► Aaron McGee, Russellville Project Office, Little Rock District
- ► Kevin Sprague, Chief of Lock Operations and Maintenance Sections, Detroit District



Markland Lock Description

General

- Two adjacent parallel lock chambers
- Main chamber is 110 feet by 1,200 feet
- Auxiliary lock is 110 feet by 600 feet.
- 35-foot lift height.

Lock Hydraulic System

- Uses constant delivery pumps
- Loaded as required

Gate to Valve Interlock

- Allow the fill valves to open only if the lower miter gates are closed
- Should the gates open and remain open for more than approximately ten seconds after a filling or emptying operation is started, the valves will automatically close.

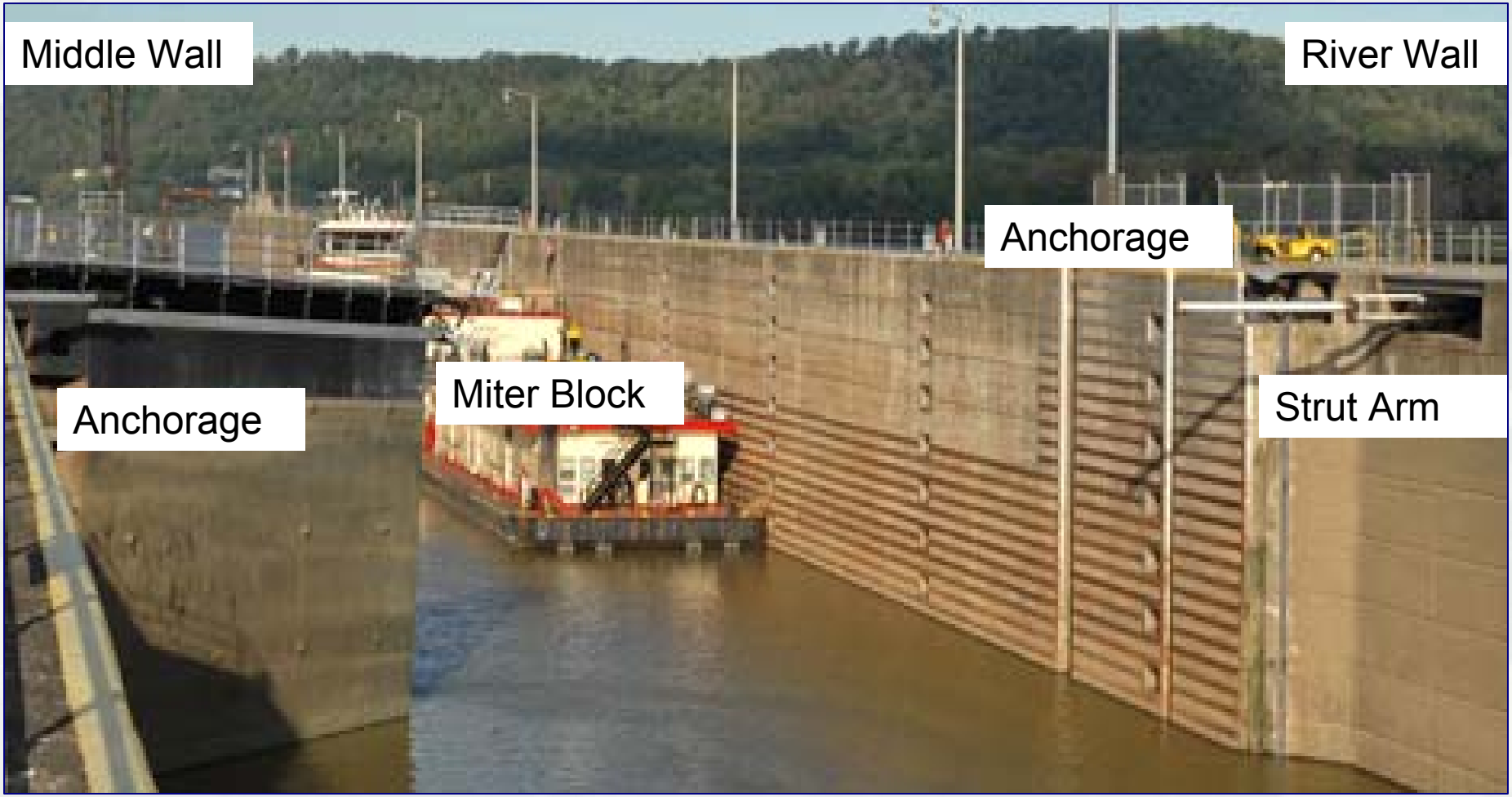
Accident Summary
Date: 27 September 2009 Time: 0745

- Lock operations on the lower 1200 foot miter gate.
- River Wall Filling Valve was 98% opened at the time of the lower miter gate closing.
- The flow of water in the main chamber did not allow the lower miter gates to complete a proper miter.
- The main chamber continued to fill until the improper miter failed.
- Both gates swung far beyond their normal mitered position and until the river wall leaf was torn from its anchorage.
- The middle wall leaf suffered anchorage and miter block damage.

Damage Summary

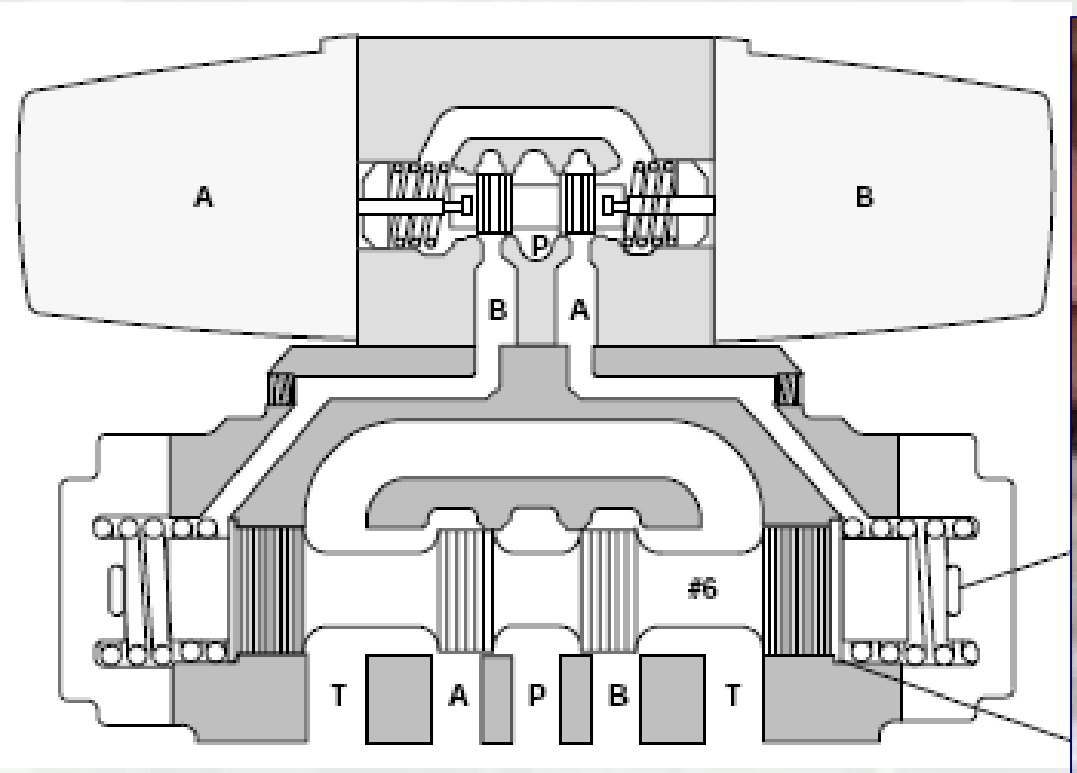
- Downstream Miter Failure - $9,000,000
  - Final Estimate Still Pending
- Loss of Lower River Wall Gate Leaf with Anchorage and Strut Arm Damage
- A partial loss of the Lower Middle Wall Miter Gate with Anchorage and Strut Arm Damage
- The loss of the River Wall Filling Valve pilot valve assembly.
- Damage to the Private Vessel, CQ Princess – ($1,200 claim)

Damage Photo



Causation Theory

- 0544 M/V Colby calls for lockage. **The filling valves solenoid overheats.**



Causation Theory

- 0630 New lock operators come on duty. No issues**.**
- 0720 The Vessel COLBY is in the chamber.
- 0735 **Operator observes the position of the River Wall Filling Valve to be at -3% (zero/closed).**
  - ► **Pressure change causes the pilot valve spool to shift to open.**
- 0744 The Vessel COLBY leaves the chamber.
- 0744-0750 **The River Wall Filling Valve is fully open.**
- 0750 The Vessel CQ PRINCESS has entered the chamber
  - ► **Operator starts lower gate closure without verifying value gages**.

Conclusions

- Direct Cause - **failure resulted from an improper miter of the downstream miter gates as a result of closing the gates with the River Wall Filling Valve fully opened.**

Indirect Causes

- Unintentional opening of the river wall filling valve due to an ATYPICAL equipment failure.
- The Lock Operator did not observe the valve position display just prior to initiating the downstream gate closure.

Indirect Causes

- The Lock Operator did not recognize the strong flows leaving the chamber.

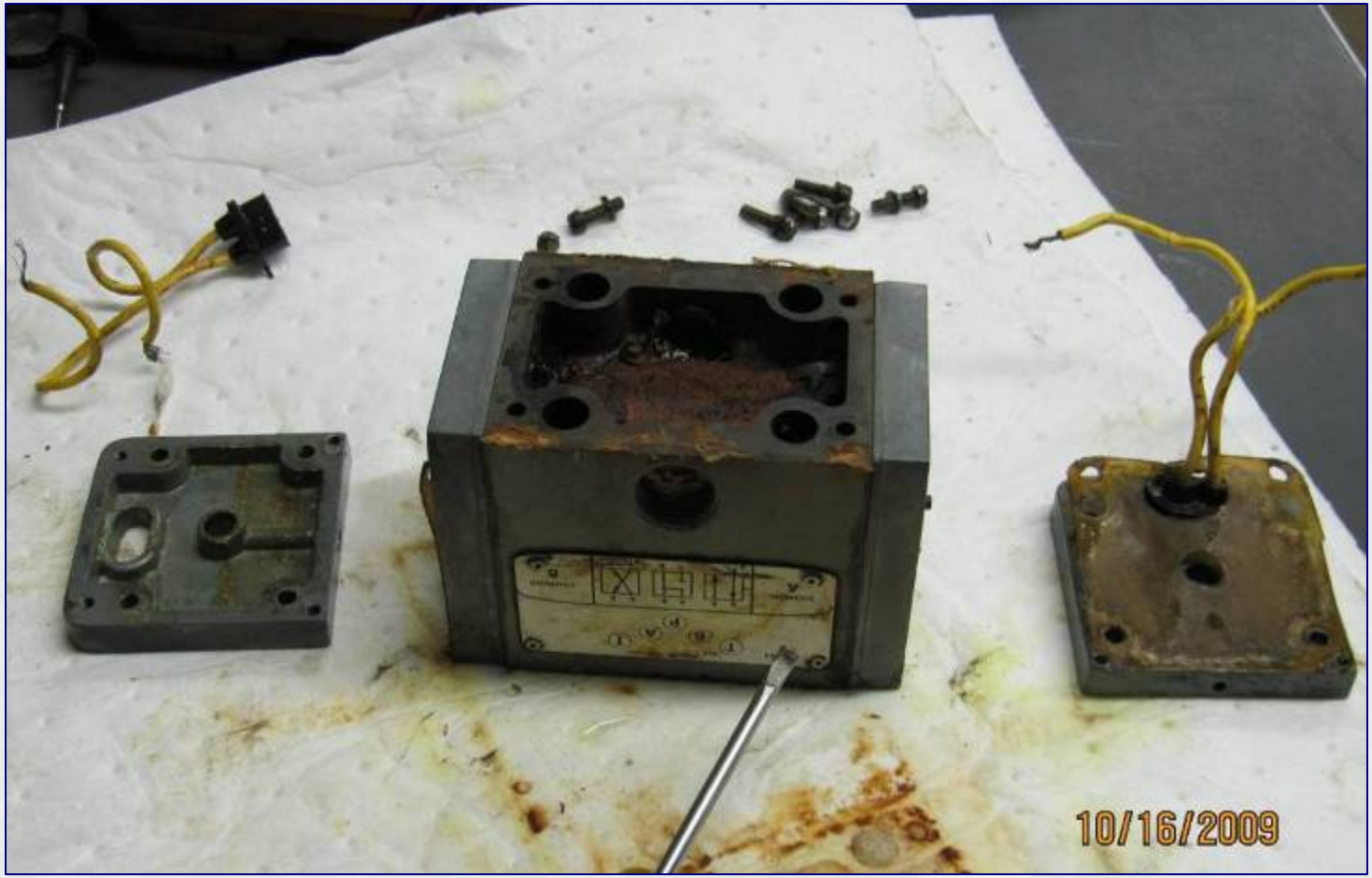
- Vessels COLBY and the CQ PRINCESS did not notify the lock operators of a strong push while exiting and observed currents while entering, respectively.

❖ **It is highly probable that if the lock operators had realized the changes in the hydraulic conditions (flow in the chamber) this accident would not have occurred.**

Contributing Factors

- Inexperience and complacency of the locking crew to recognize changes in conditions.
- The AHA was lacking in the area of the sequence of actions in the locking operation.
- The facility did not have maintenance records readily available for the 4-way valve assembly.
  - Deteriorated condition of the pilot valve
  - For over a decade, the pilot valve was wrapped in plastic.
- The facility lacked a Standard Operating Procedure for locking operations.

Pilot Valve Inspection



Heavy Corrosion on Dry Side of Valve Body

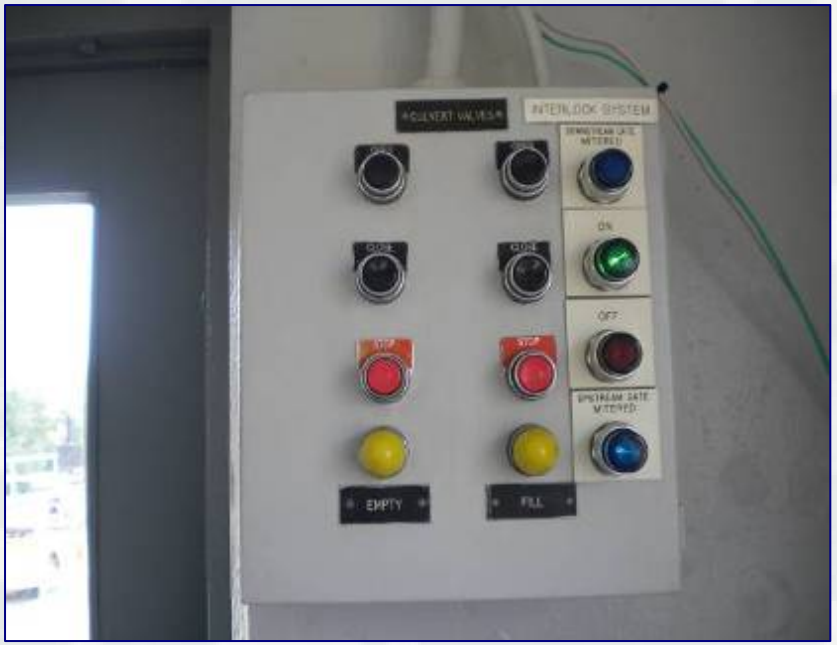
Pilot Valve Inspection

Dry Side “B” Push Pin exiting the Valve Body
Note the Moisture and Heavy Corrosion

Contributing Factors

- Poor ergonomic and physical layouts of the control stations' control indicators panels and filling valve indicator rod

- Markland Interlock System does not have a VALVE to GATE component that prevents gate operation if the wrong valves are opened.



Valve Rod Indicators

Recommendations

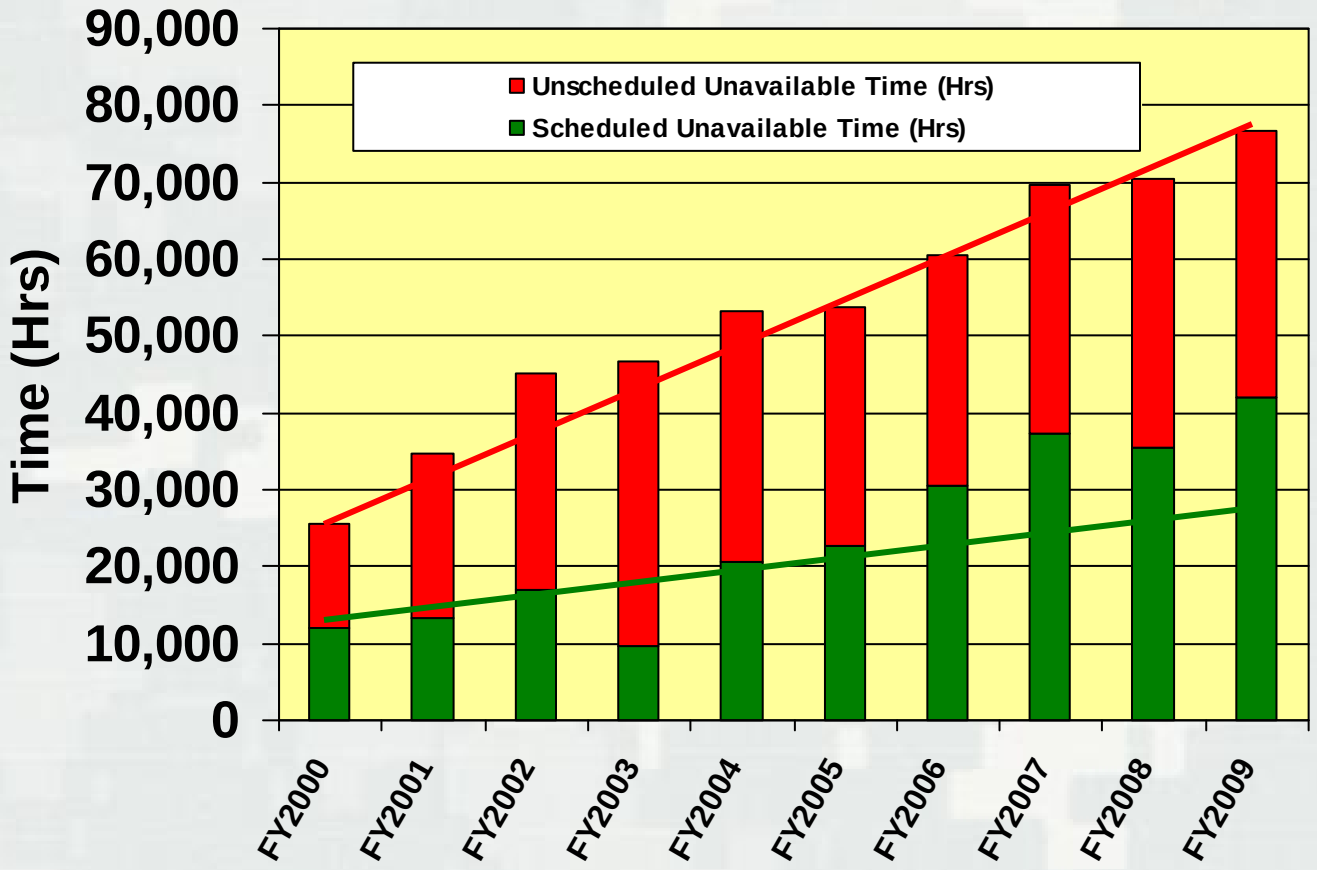
- Continue with the implementation of FEM.
- Establish a maintenance interval and procedures for solenoids and gate indicators.
- Conduct review and add Valve to Gate Interlock capability
- Improvement of ergonomics for control shelter layout.

Recommendations

- Standardize lock operation procedures, training and certification
- Increase public/customer awareness to report any unusual conditions.
- Develop a system wide failure mode analysis.

* Develop a writen Checklist for each lock operation (LTG Van Antwerp).

Ohio River Navigation Maintenance: Scheduled and Unscheduled Outages



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