

*Presentation
to the*

***2005 Tri-Service Infrastructure Systems
Conference***

***Thomas J. Quigley, Brian K. Kleber
and Thomas R. Ruf***

***U.S. Army Corps of Engineers
St. Louis District***

August 3, 2005



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Mel Price – Auxiliary Lock Downstream Miter Gate Repair

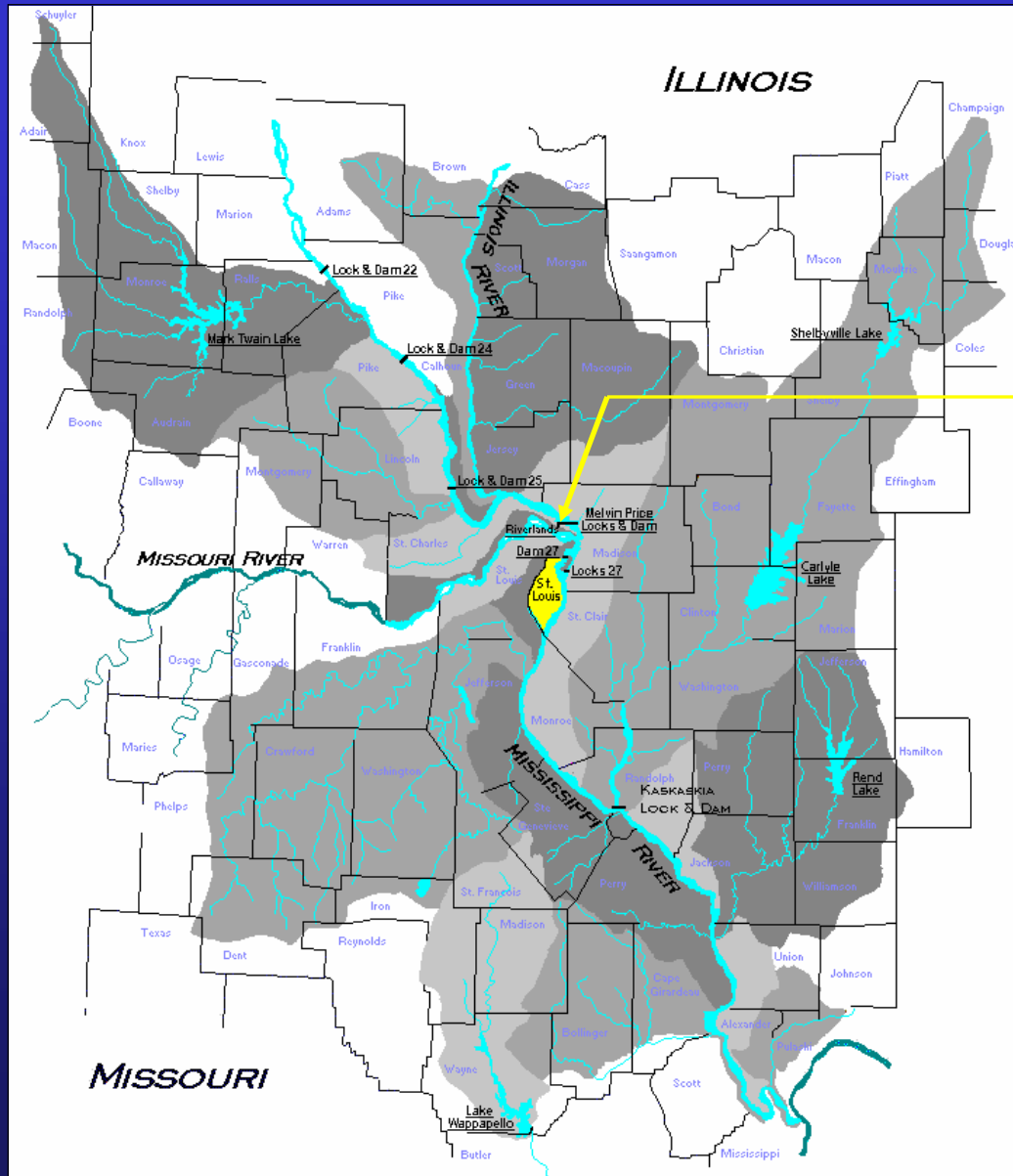


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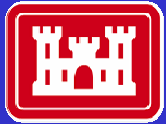
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Mel Price Locks and Dam



Project
Location

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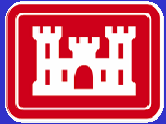


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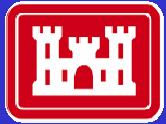
Mel Price Accident

3 October 2004

What Happened?

Why Did It Happen?

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Mel Price Accident

What Happened?

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Miter Gate Functioning Normally



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Gate Leafs Forced Downstream From Normal Mitered Position



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Gate Leafs Forced Downstream From Normal Mitered Position



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Damage Summary

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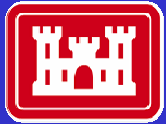


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Damage to Gate Anchorages



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Damage to Gate Anchorages



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Damage to Gate Anchorages



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Failed Operating Struts

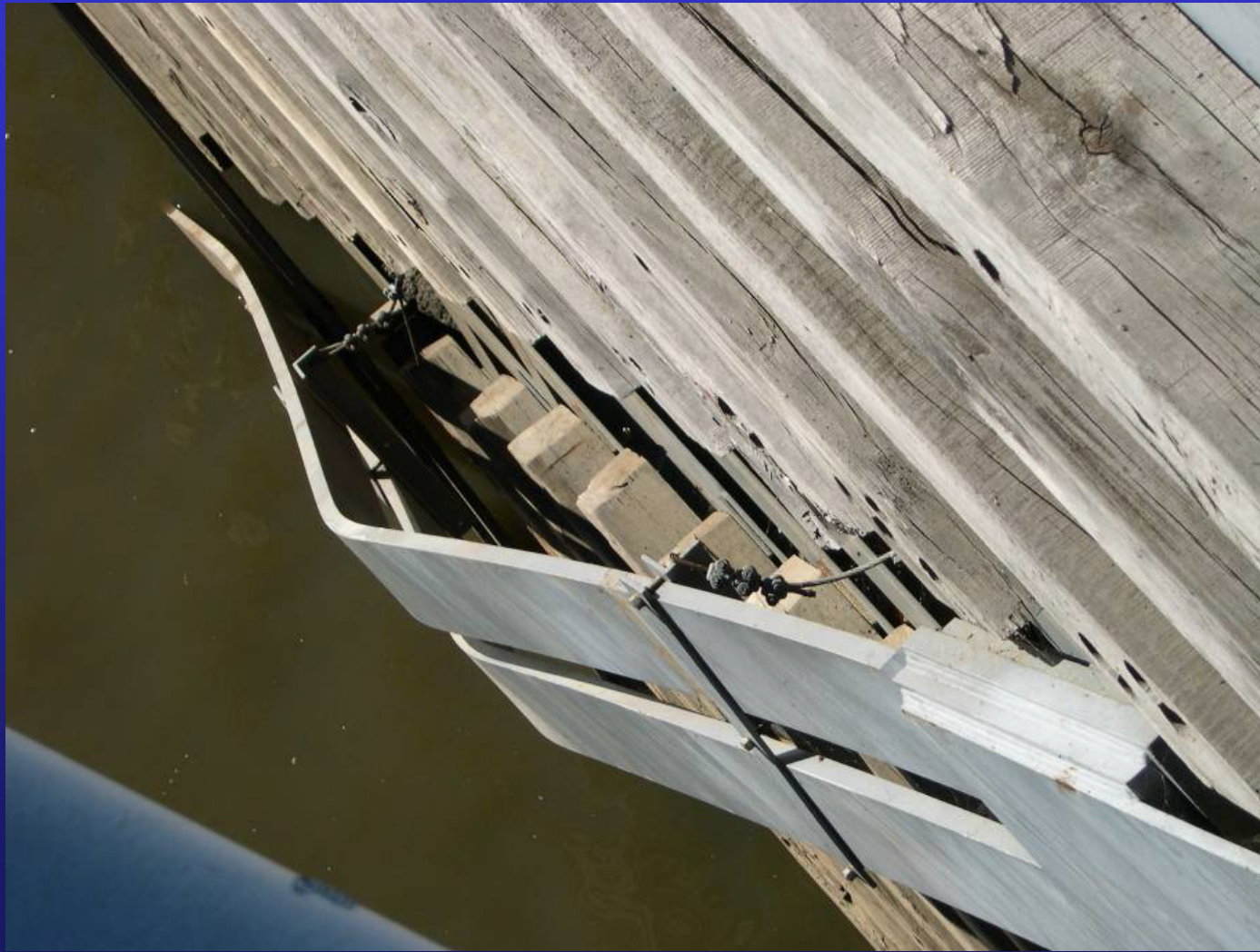


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Diagonal Failure



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Damage to Miter End of Leafs

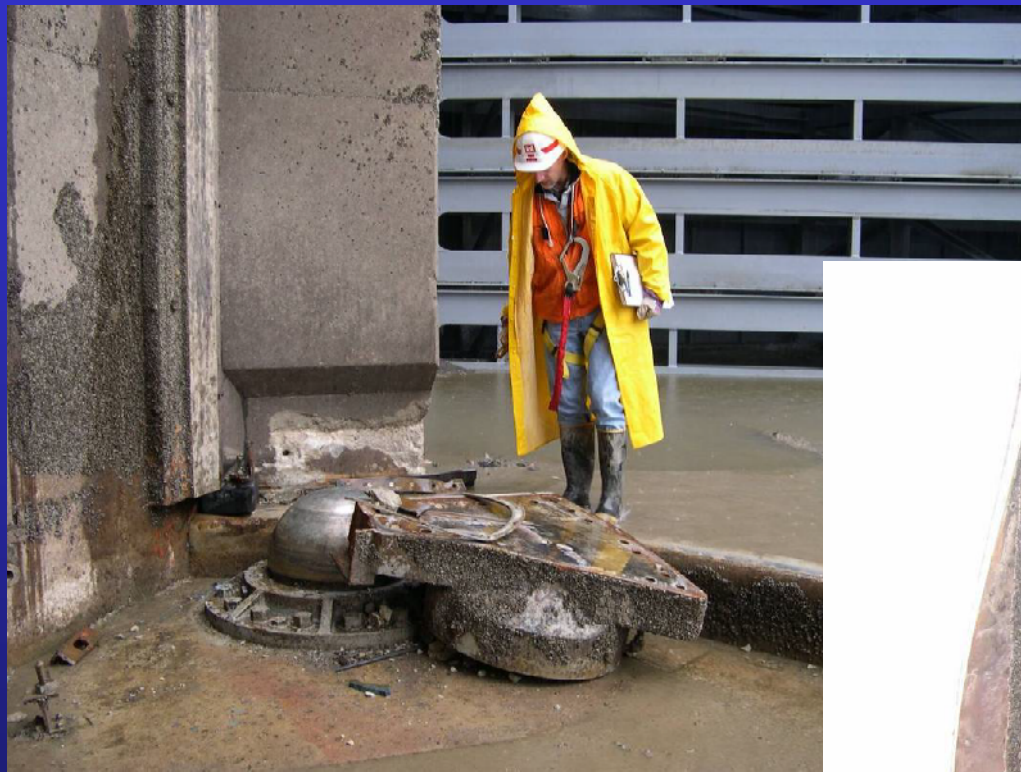


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Pintle Socket Sheared Off



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Bent & Cracked Pintle Socket



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Pintle Ball Retainer Sheared Off



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Bottom Seal Damaged



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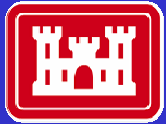
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Mel Price Accident

**Why
Did It Happen?**

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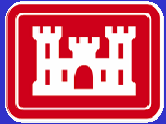


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Gate Operating Arm

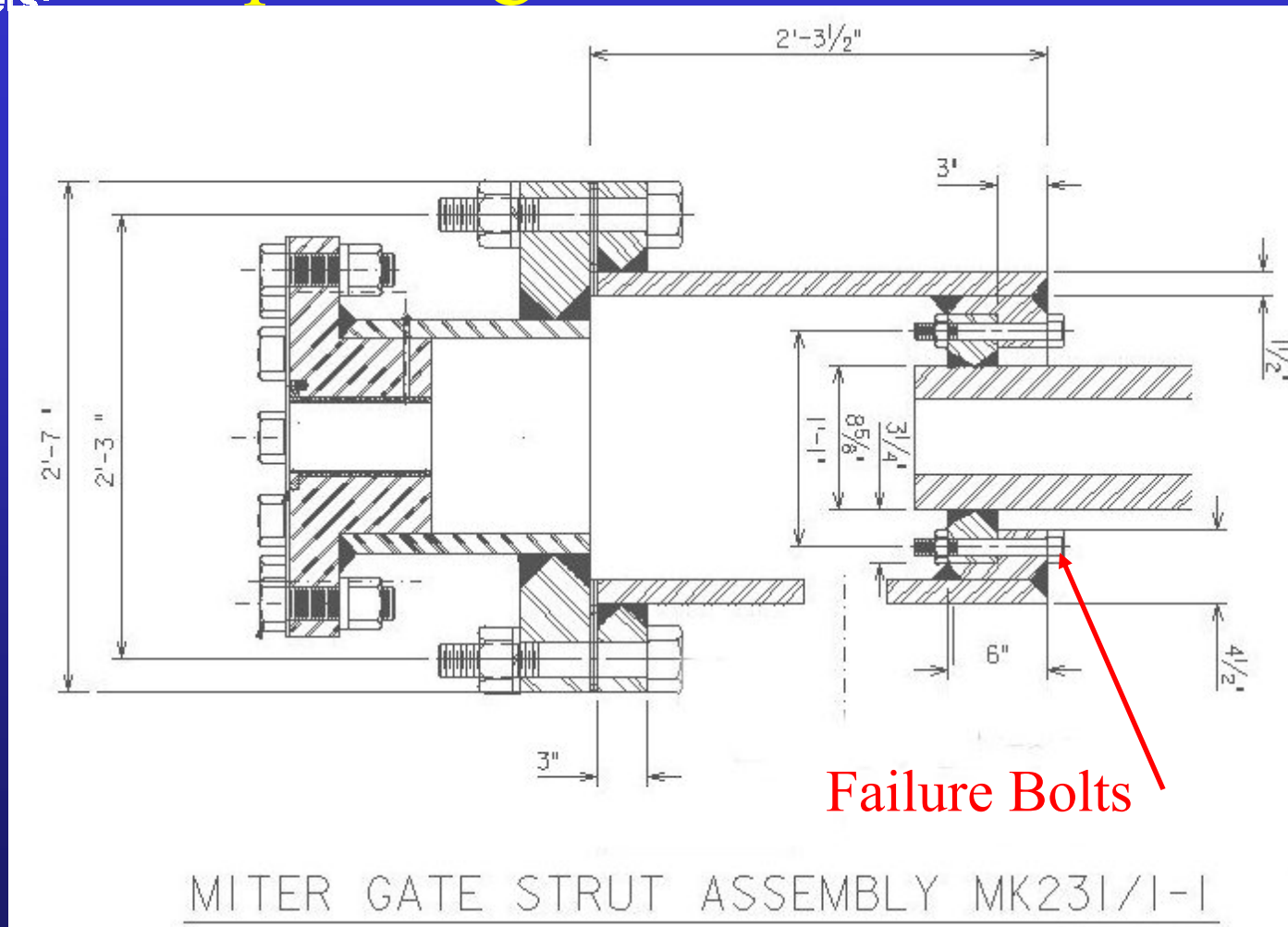


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Operating Arm Failure Tube

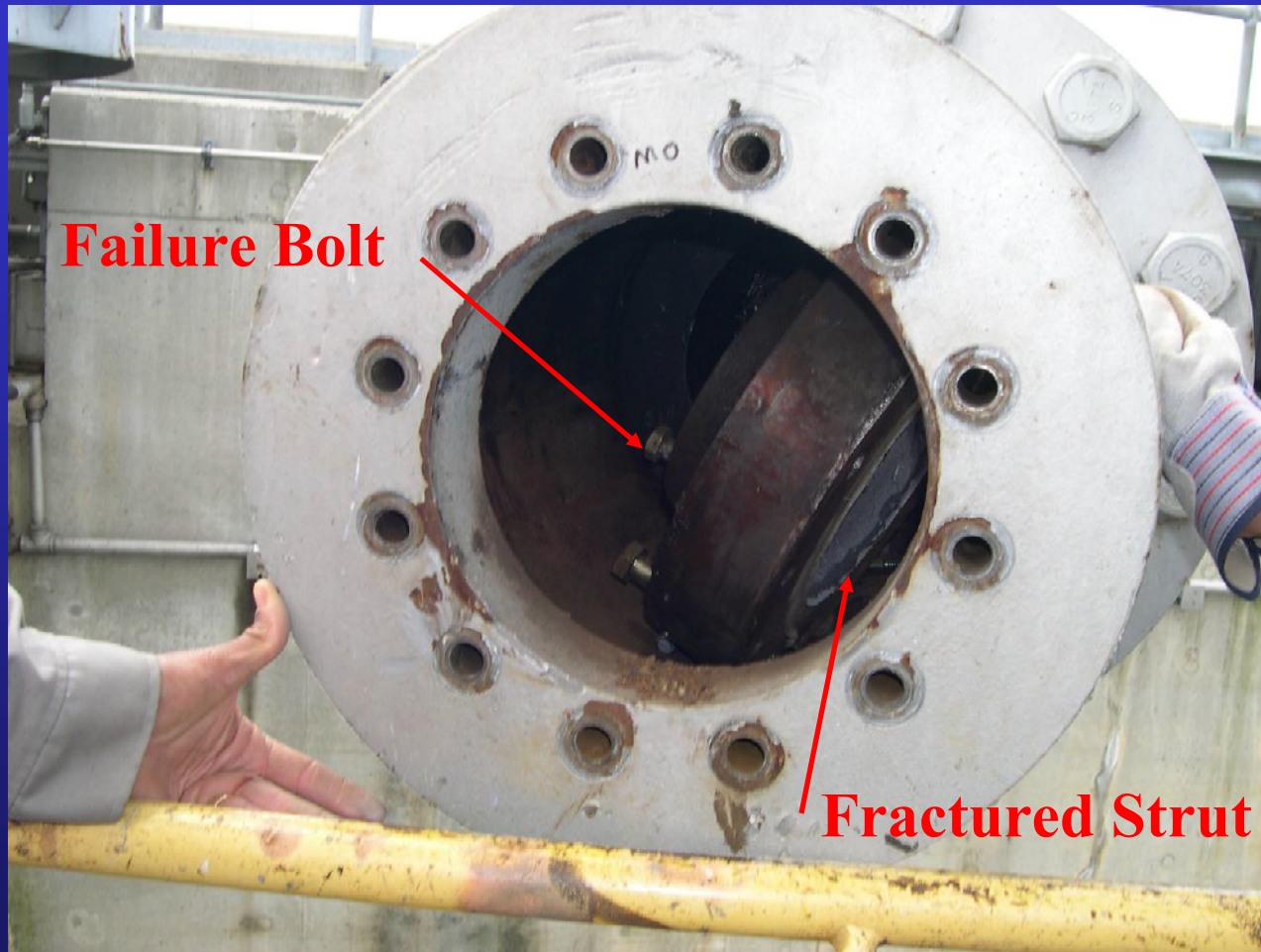


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Failure Tube



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Normal Miter Block Position



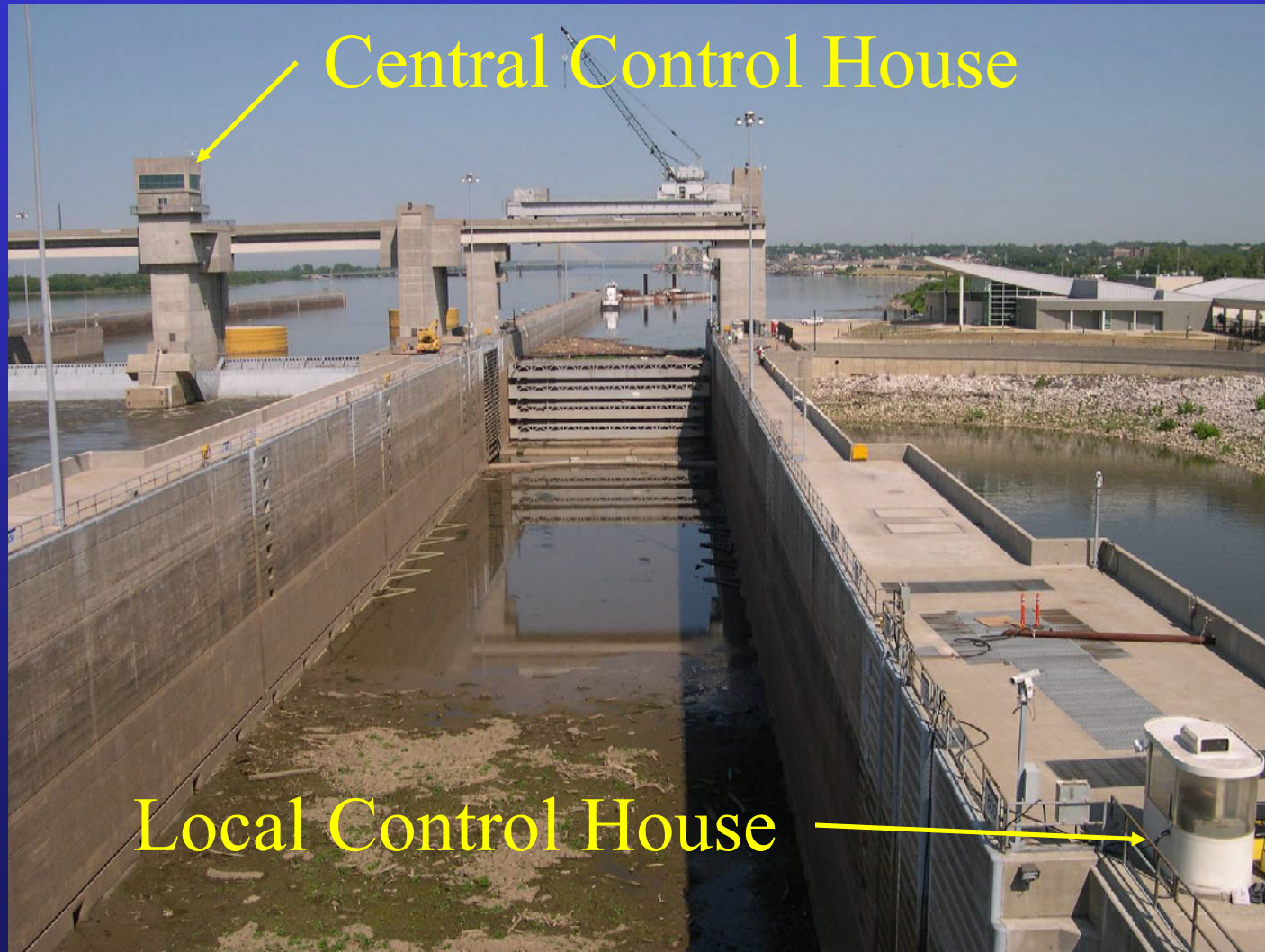
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Gate Control Stations



Central Control House

Local Control House

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Magnetic Proximity Switch on Gate



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Switches on Machinery Rack



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Modification of PLC Logic



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Miter Gate Sill



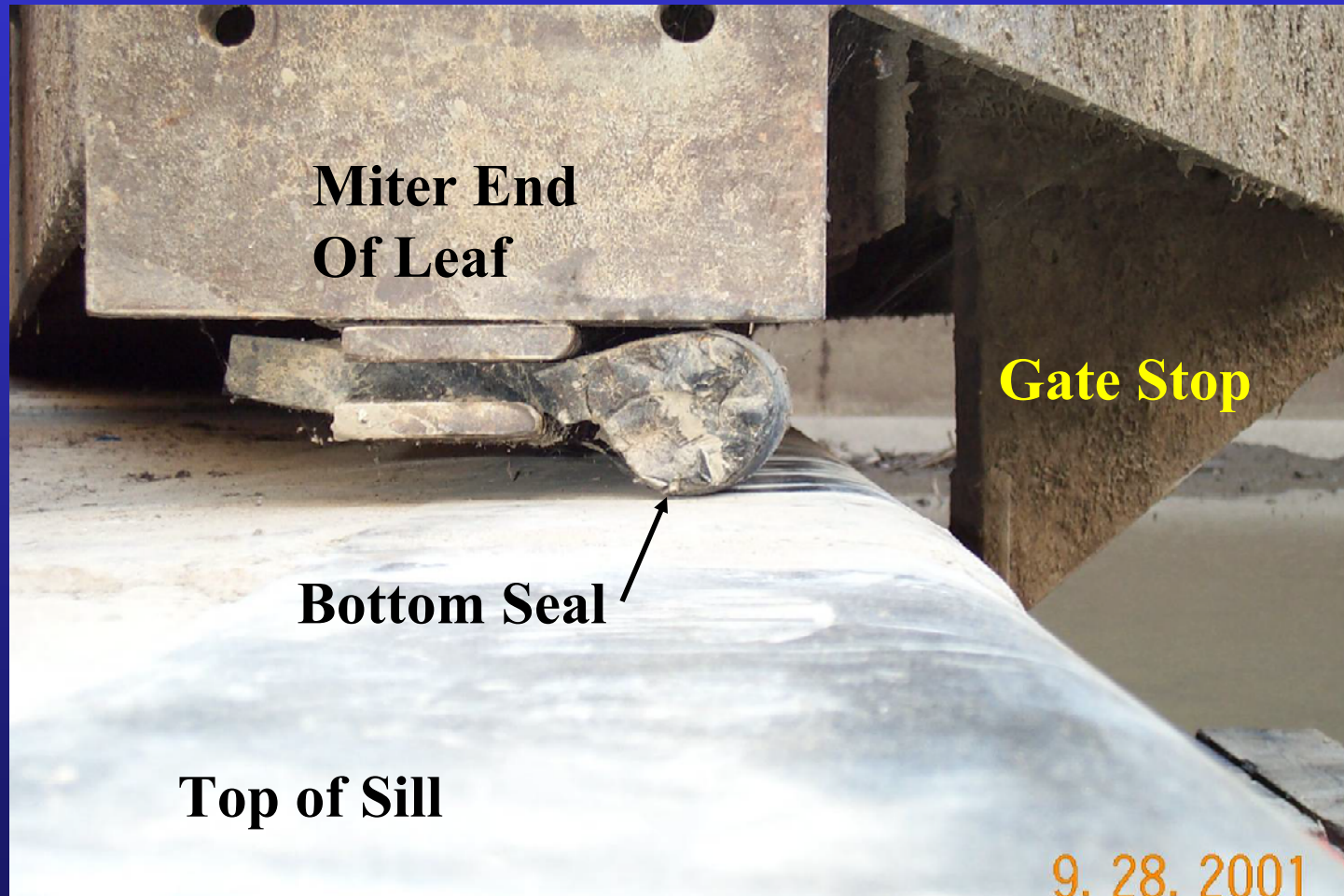
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Miter Gate Sill



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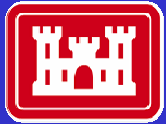
Investigation Report

Findings



- Increased hydraulic system relief pressures and fracture of the strut failure tube failure bolts.
- Leaves not mitered.
- PLC programming incorrectly indicated that the downstream gate was mitered (closed).
- No operator verification of miter or intervention.
- Filling of lock chamber with the downstream gate leaves not in miter.
- Appreciable unbalanced head on the unmitered downstream gate leaves
- Catastrophic failure – miter gate leaves move past miter

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Actions Taken By MVS

Based on Report Recommendations

1. Standard Operator Procedures and Training
2. Programming Ladder Logic Control
3. Additional Miter Gate Switch
4. Policy on Changes and Inter-Office Coordination
5. Relief Valve Gages and Mechanical Linkages

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All-Discipline Team



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Concentrate On Critical Activities

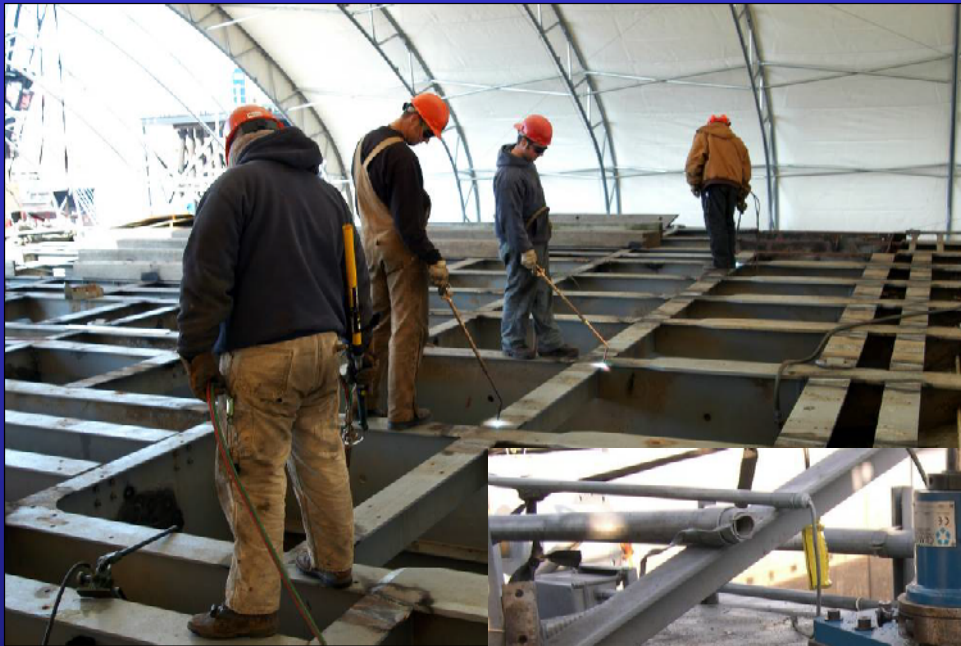


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Variety of Contract Instruments



Best Value
AE IDIQ
MIPR
Purchase Order
Lump Sum Contract
Credit Card

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Team Visits



Engineers conferring with Contractor

Diagonal Stressing Team



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What We Did Right



- All-Discipline Team
- Communicate, Communicate, Communicate
- Concentrated On Critical Activities
- Hired Contract Employee To Schedule Service Base And Contractor Work
- Contingency Planning
- Used Any and All Contract Options
- Team Project Visits To See Progress
- **Kept Exec Office Involved**
- **Risk reduction measures to keep the main lock operating.**

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Gate Repairs



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Gate Repairs

Pulling Gate

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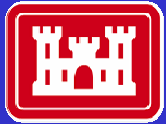


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Position of Leafs After Accident



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Cutting Gate Anchors



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Removing Illinois Leaf



Rock Island
District

Crane "Hercules"

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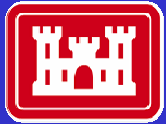


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Placing Illinois Leaf on Spare Gate Barge



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Guy Cables Installed



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Guy Cables Installed



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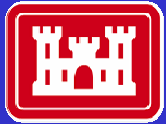


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Both Leafs Secured on Spare Gate Barge



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Damage Inspection

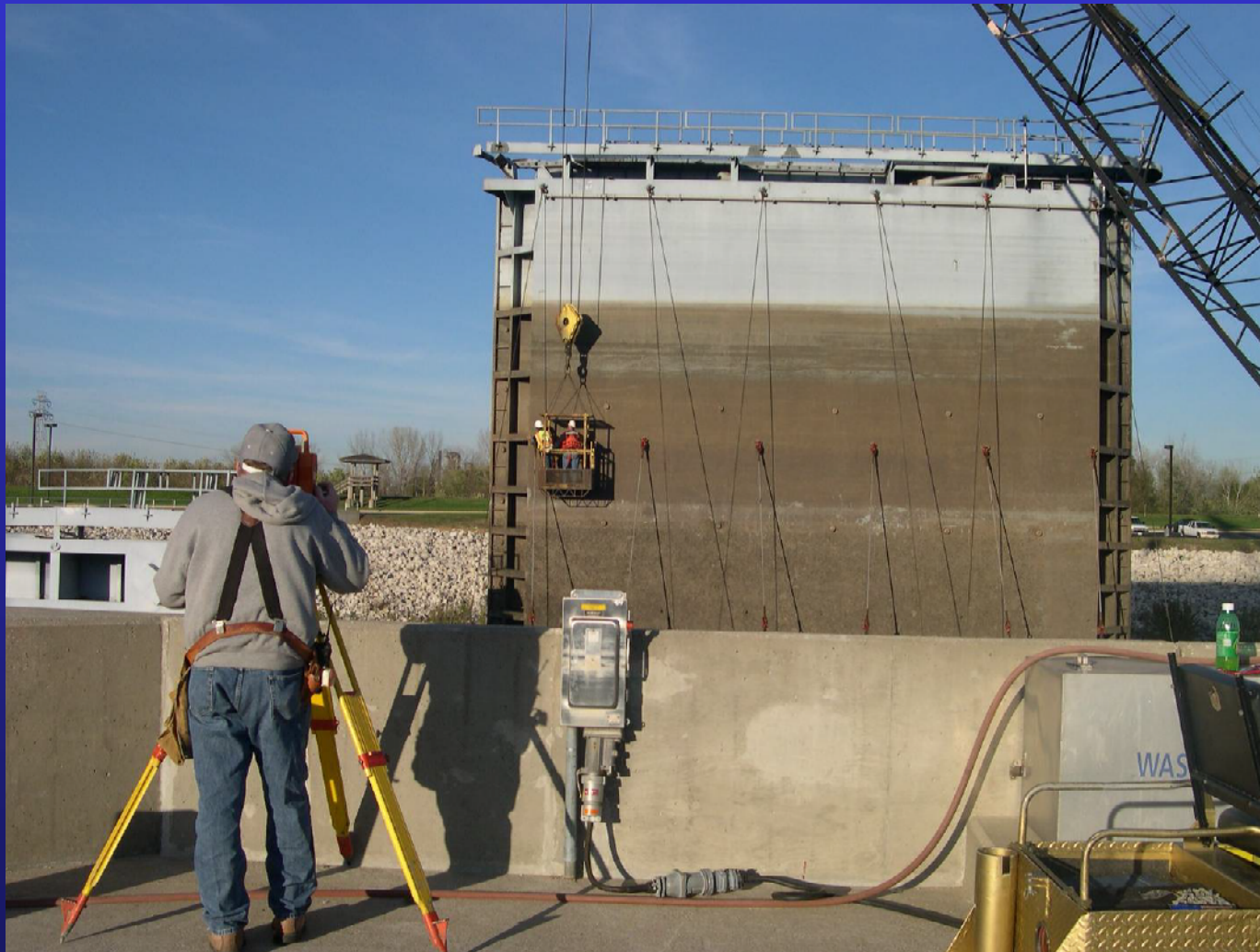


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Surveying Damaged Gate



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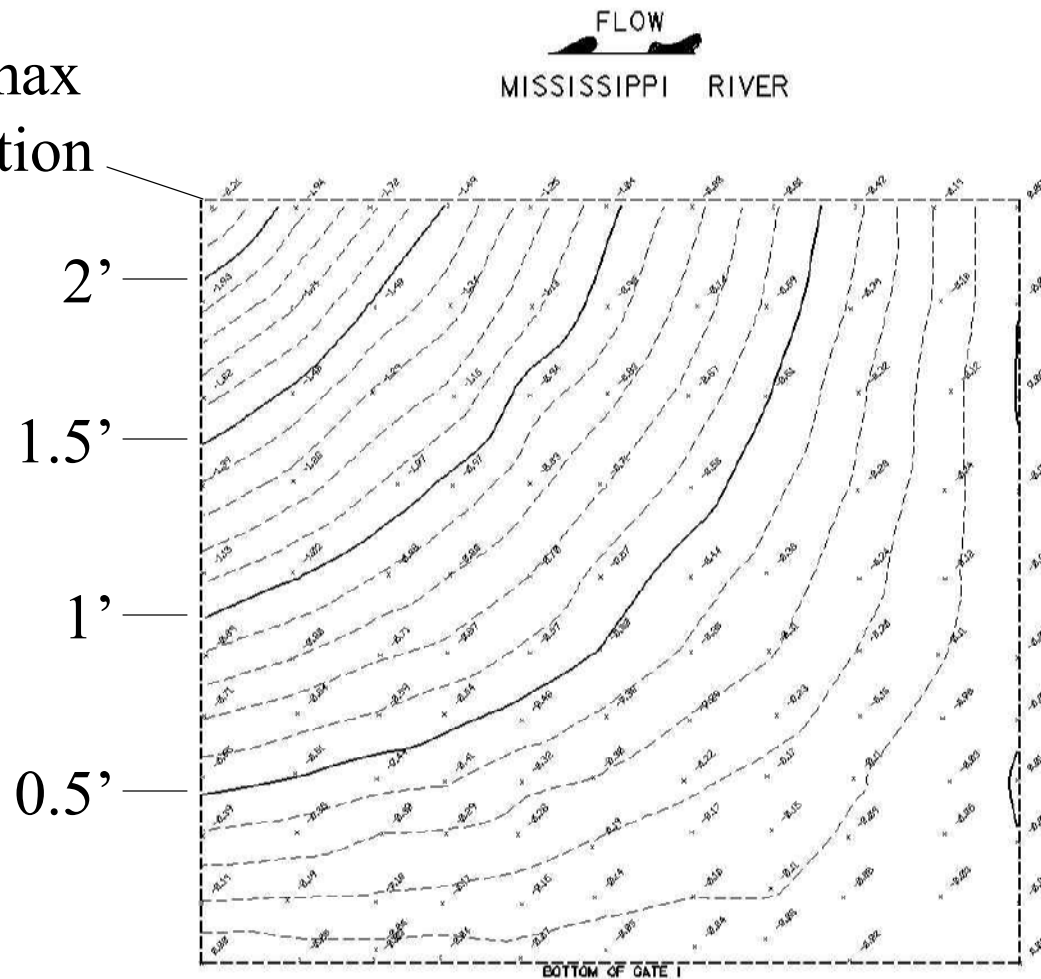


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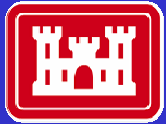
Survey Results – Illinois Leaf



2.21' max
deflection



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What Do We Do Now?



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Panel of Experts

- Retired construction and operations personnel from USACE (Similar Failure At Bankhead)
- Steel structures engineering experts from various universities
- Heat straightening expert
- Structural engineers from other USACE offices
- St. Louis District structural engineers, lock operations personnel and Rivers Project Office personnel

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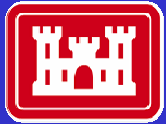
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Conclusions From Panel of Experts

- Gate could be repaired
- Repair would be quicker than replacement
- Heat straightening could be used
- Leafs should be layed down for repairs

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Gate Repairs

Laying Leafs Down

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Original Lifting Beam For Vertical Lifting Only



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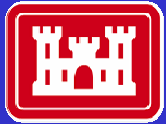


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Redesigned Lifting Beam



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Lifting Beam In “Green Monster” Test Rack



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Installing Lifting Beam



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Turning Feet for Gate Laydown



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Removing Guy Cables



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Shreve Moving Leaf For Lay Down



**“Louisville”
District**

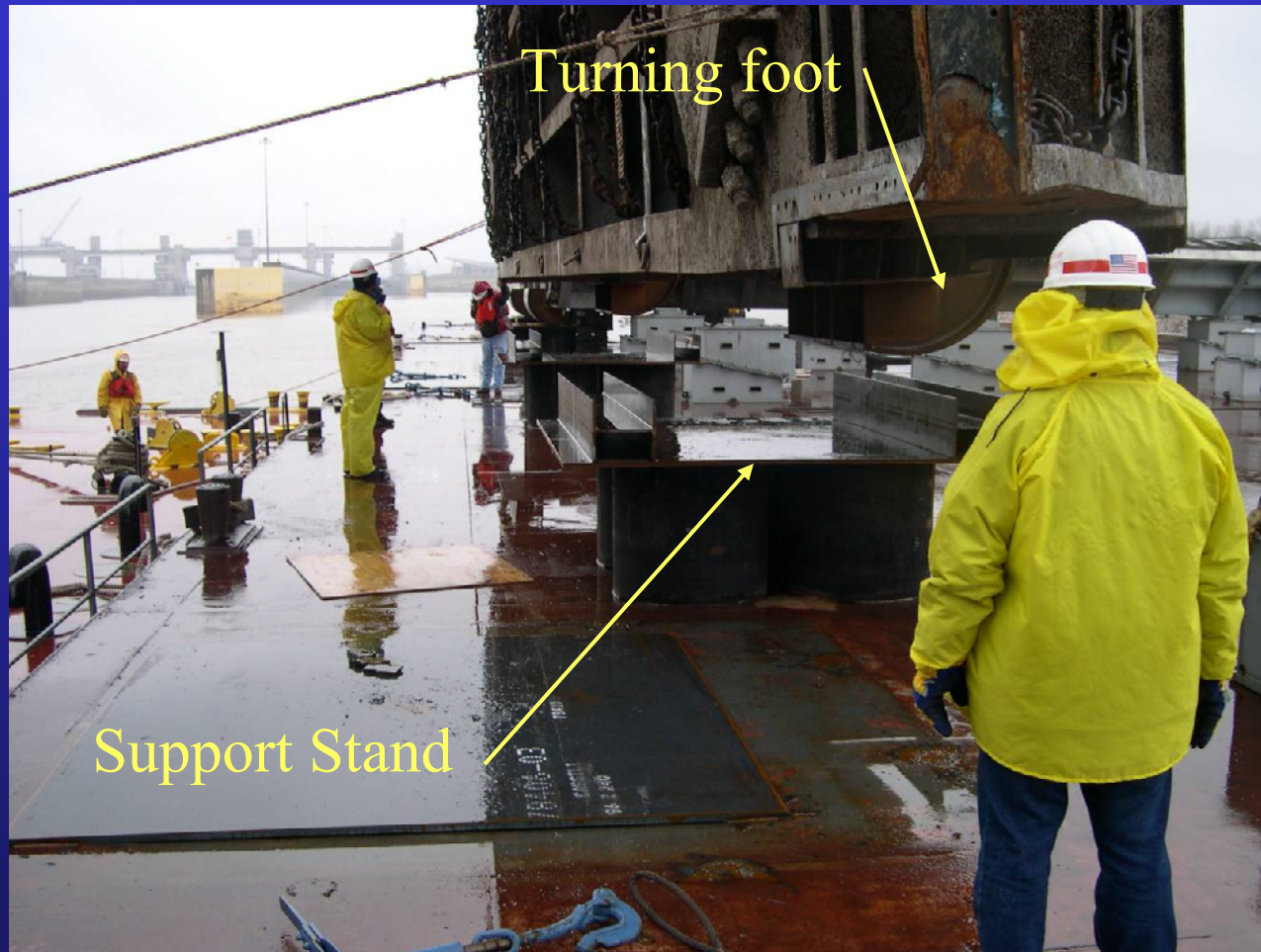
Crane “Shreve”

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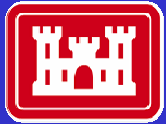


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Aligning Turning Feet on Support Stands



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In Position for Laydown



Crane Barge Sewell Winch Used to
Initiate Rotation



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Rotation on Turning Feet



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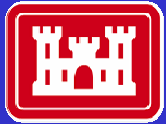


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Shreve Setting Leaf Horizontal



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Gate on Support Stands



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Gate Leafs in Horizontal Position



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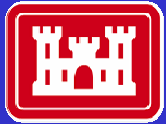


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Leaf Supported In Deflected Position



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Enclosure on Delong Barge at Service Base



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Gate Repairs

Heat Straightening

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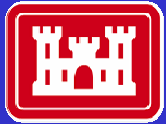


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Heat Straightening Crew



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Heat Straightening



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Spot Heats



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Heat Straightening Diagonals



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Diaphragms Before Heat Straightening



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Diaphragm After Heat Straightening



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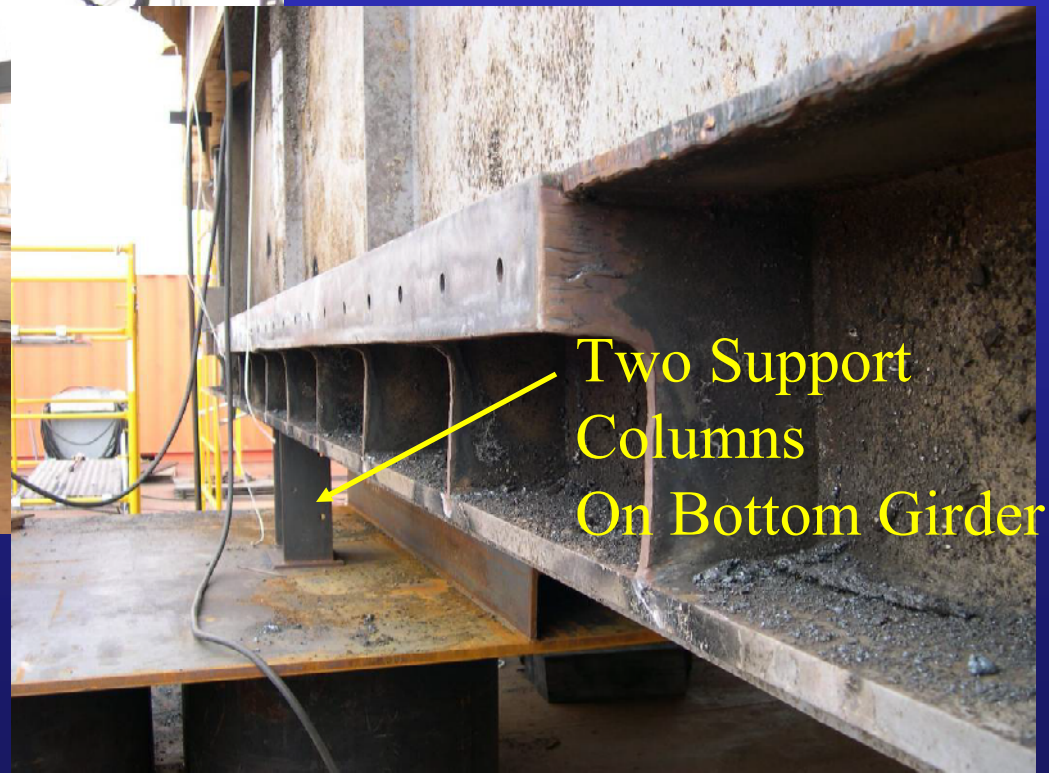
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Support Condition For Checking Straightness

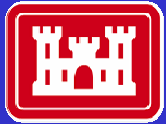


Single Support
On Top Girder



Two Support
Columns
On Bottom Girder

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Gate Repairs

Structural Repairs

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Revised Strut Arms and New Pintle Sockets



No Failure Bolts

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Machining Strut Arm at Service Base

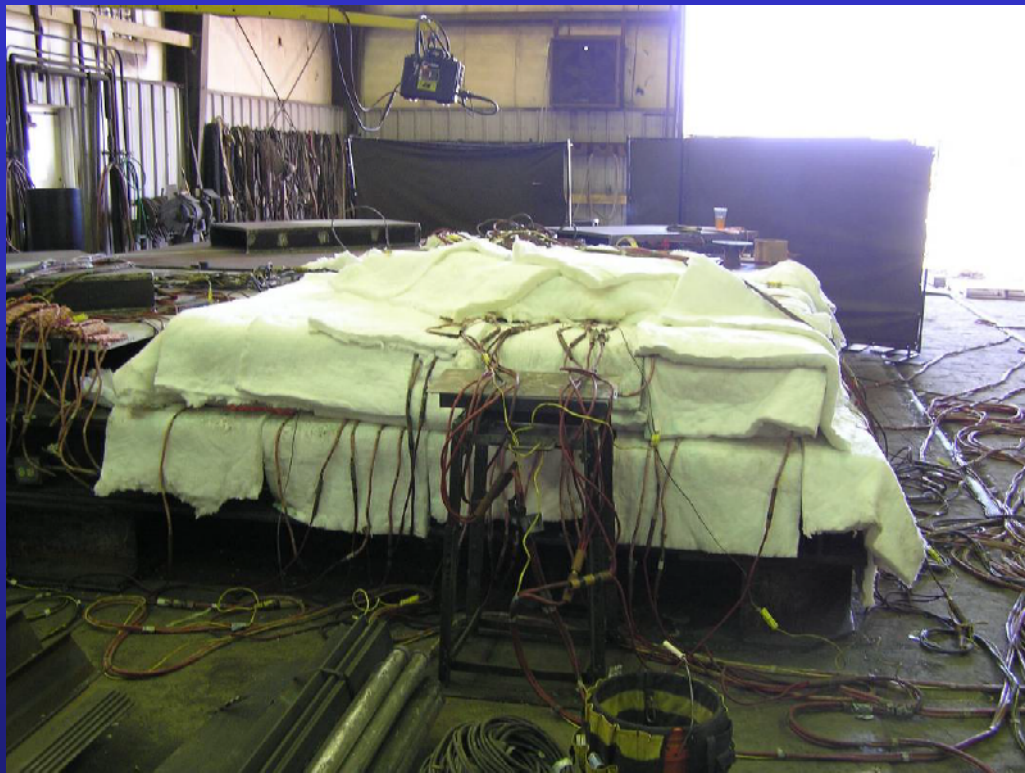


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Fabrication Work at Service Base

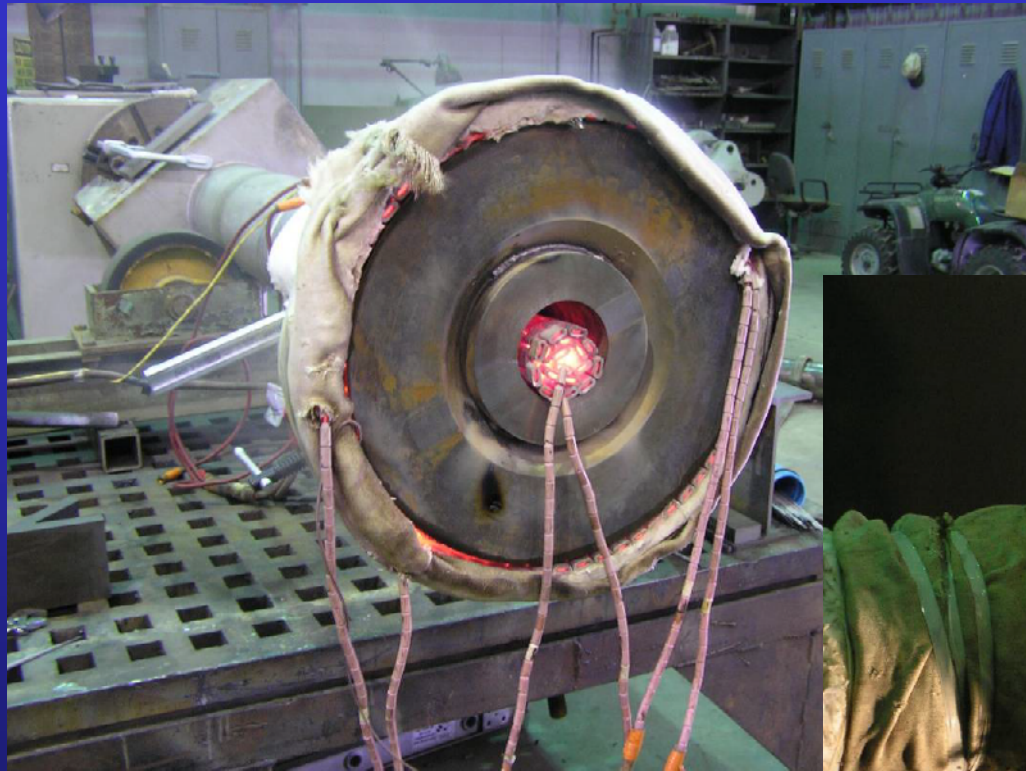


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Welding Strut Arm at Service Base



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Modified Bottom End of Diagonal



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Modified Bottom Diagonal Gussets



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Modified Bottom End of Diagonal



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Castings Supplied By Rock Island Arsenal



Anchor Bars
And Gudgeon
Barrels



Pintle
Sockets

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Gate Stops on Miter Gate Sill



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Lifting Repaired Leafs Vertical

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Installing Lifting Device



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Shreve Lifting Leaf Vertical

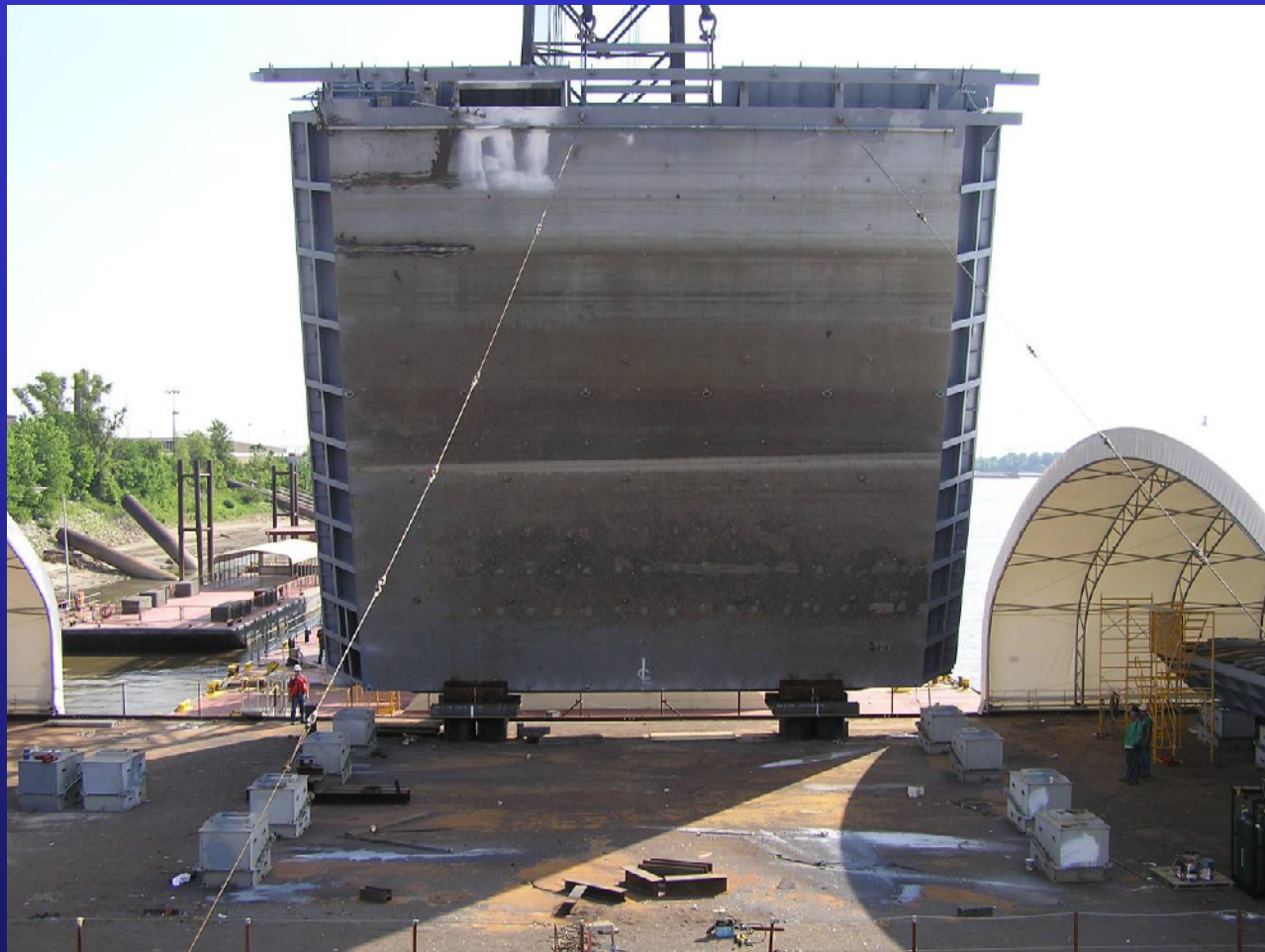


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Shreve Lifting Leaf Vertical



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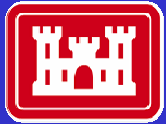
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Placing Leaf In Toaster



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Leafs In Toaster for Transport to Lock



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Reinstalling Gate

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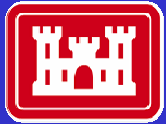


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Repaired Illinois Leaf in Place



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Welding & Boring Gudgeon Pin Plates



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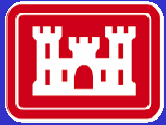


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Welding & Boring Gudgeon Pin Plates



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Installing Missouri Leaf



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Repaired Gate Leafs in Place



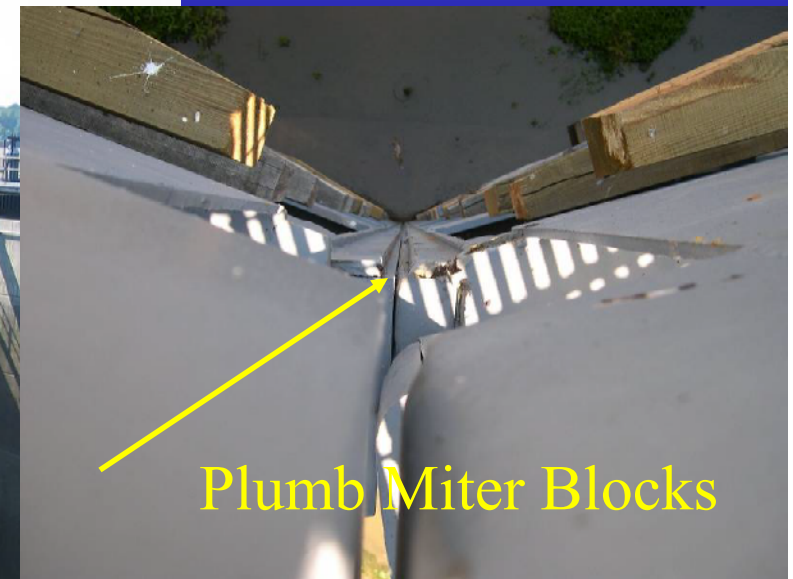
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Repaired Gate Leafs in Place



Plumb Miter Blocks

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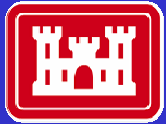


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July 2005 - Auxiliary Lock Back In Service



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Thank You !!!

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