2011 LOCK MAINTENANCE WORKSHOP

Pittsburgh, Pennsylvania

15-17 February, 2011

Mark Sawka, P.E., Chief, Structural & Architectural Design Section

Portland District

OVERVIEW ---

COLUMBIA-SNAKE RIVERS INLAND

WATERWAY NAVIGATION SYSTEM

HSS

EXTENDED SYSTEM OUTAGE

The Dalles Miter Gate

John Day Lift Gate and Friction Sheave

The Dalles/John Day Tainter Valves

OTHER WORK

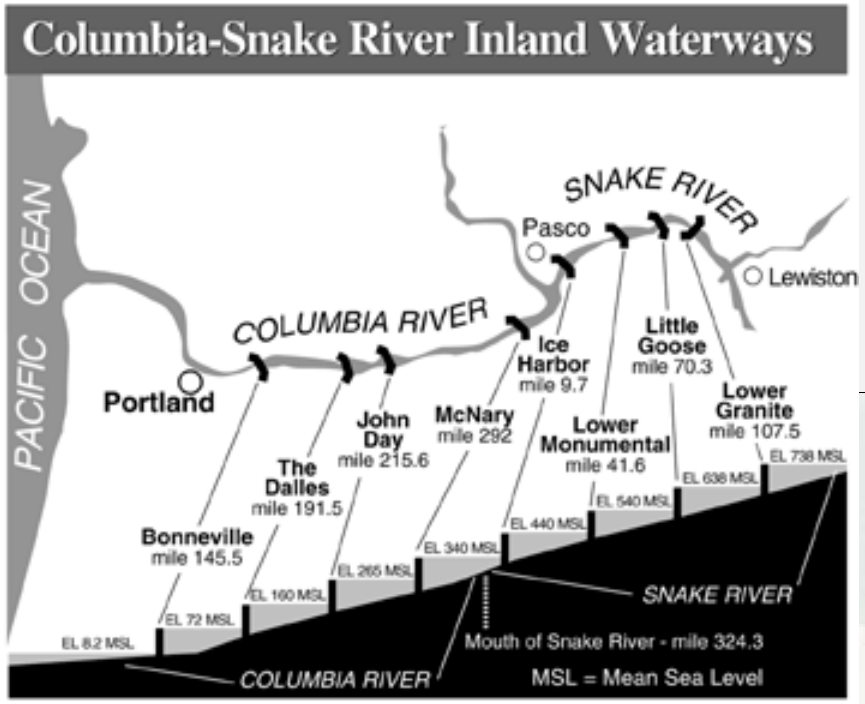
Self Lubricating Bushings

US Army Corps of Engineers

BUILDING STRONG®

Columbia-Snake Rivers Inland Waterway System

	Bonneville	The Dalles	John Day	McNary	Ice Harbor	Lower Monumental	Little Goose	Lower Granite
Inside Celar Dimensions, Feet	86 x 675	86 x 675	86 x 669	86 x 675	86 x 665	86 x 666	86 x 668	86 x 675
Maximum Lift, Feet	70	90	113	83	103	103	101	105
Upstream Gate, Type	Miter	Tainter	Sub Lift	Miter	Tainter	Sub Lift	Tainter	Tainter
Downstream Gate, Type	Miter	Miter	Vert Lift	Miter	Vert Lift	Vert Lift	Miter	Miter
Minimum Tailwater Elevation, Feet	5.0	70.0	155.0	257.0	335.0	437.0	533.0	633.0



Operation of The Columbia River Navigation System

350 miles of navigable waterways from Portland, Or to Lewiston, ID.

Seven to Ten Lockage's per day.

Scheduled Maintenance Outage occurs two weeks in March each year.

Two extended outages planned for 2011 and 2014

Hydraulic Steel Structures

NWP has 1400 HSS

NWD HSS Community of Practice

National Technical Focus Team:

Phil Sauser, MVP, Team Lead

National TFT PDT:

- **Larry Winters, SWL**
- **John Jaeger, John J LRH**
- **Tom North, NWP**
- **Travis Adams, NWP**
- **Cameron Chasten, NAP**
- **William Wigner SAJ**
- **Guillermo Riveros ERDC-ITL-MS**
- **Peter Rossbach, Peter HQ02**
- **Thomas Ruf MVS**
- **Bruce McCracken NWD**

Hydraulic Steel Structures – Initiatives

Fit for Service Criteria Document

Provides methodology for evaluation of existing structures.

Guide Specification (055913)

Improved Provisions for Contractor shop quality

Improved Documentation for weld submittals and welds

Fracture critical members

Increased NDT and documentation of NDT

Guidelines for Improvements in Steel Detailing

Better fatigue detailing

Incorporate lessons learned from past projects

NWD Spillway Gate Testing and Maintenance Policy

Extended System Outage Overview

December 2010 through March 2011

Case Studies of Application of new HSS design guidelines and HSS specification

John Day Friction Sheave Replacement
John Day Tainter Valves Replacement
John Day Downstream Gate Replacement

The Dalles Tainter Valves Replacement
The Dalles Replacement Miter Gate Replacement

TEAM MEMBERS (JD GATE, TD GATE, TAINTER VALVES):

Travis Adams (NWP)
Matt Hanson (NWP)
Ron Wridge (NWP)
Matt Hess (NWP)
Dave Hamernik (NWP)
Bryan Mason (NWP)
Jeff Ament (NWP)
Daly Doucet (NWP)
Jason Chase (NWP)
Tom North (NWP)
Richard Amacher (NWP)
Kevin Hace (NWP)
Jordan Reimer (NWP)

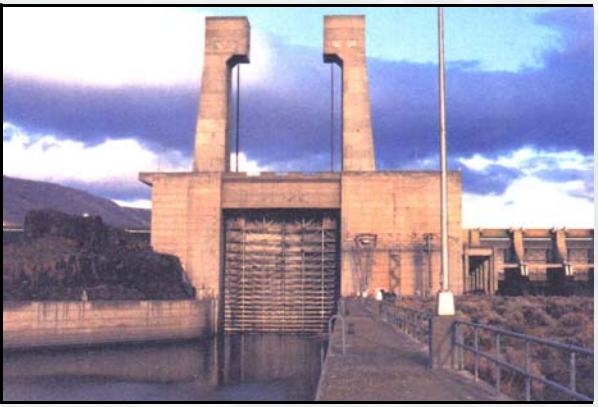
Bob Hollenbeck (NWW)
Bruce Collison (NWW)

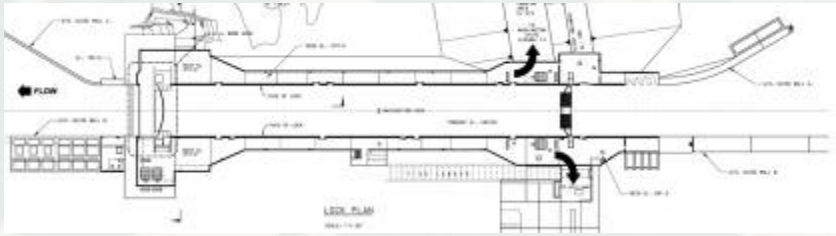
Bruce Barker (ERDC)
Guillermo Riveros (ERDC)
Richard Stockstill (ERDC)
Allen Hammack (ERDC)

Norton Corrosion (Cathodic Protection)

Phil Fish and Associates (Design Review)

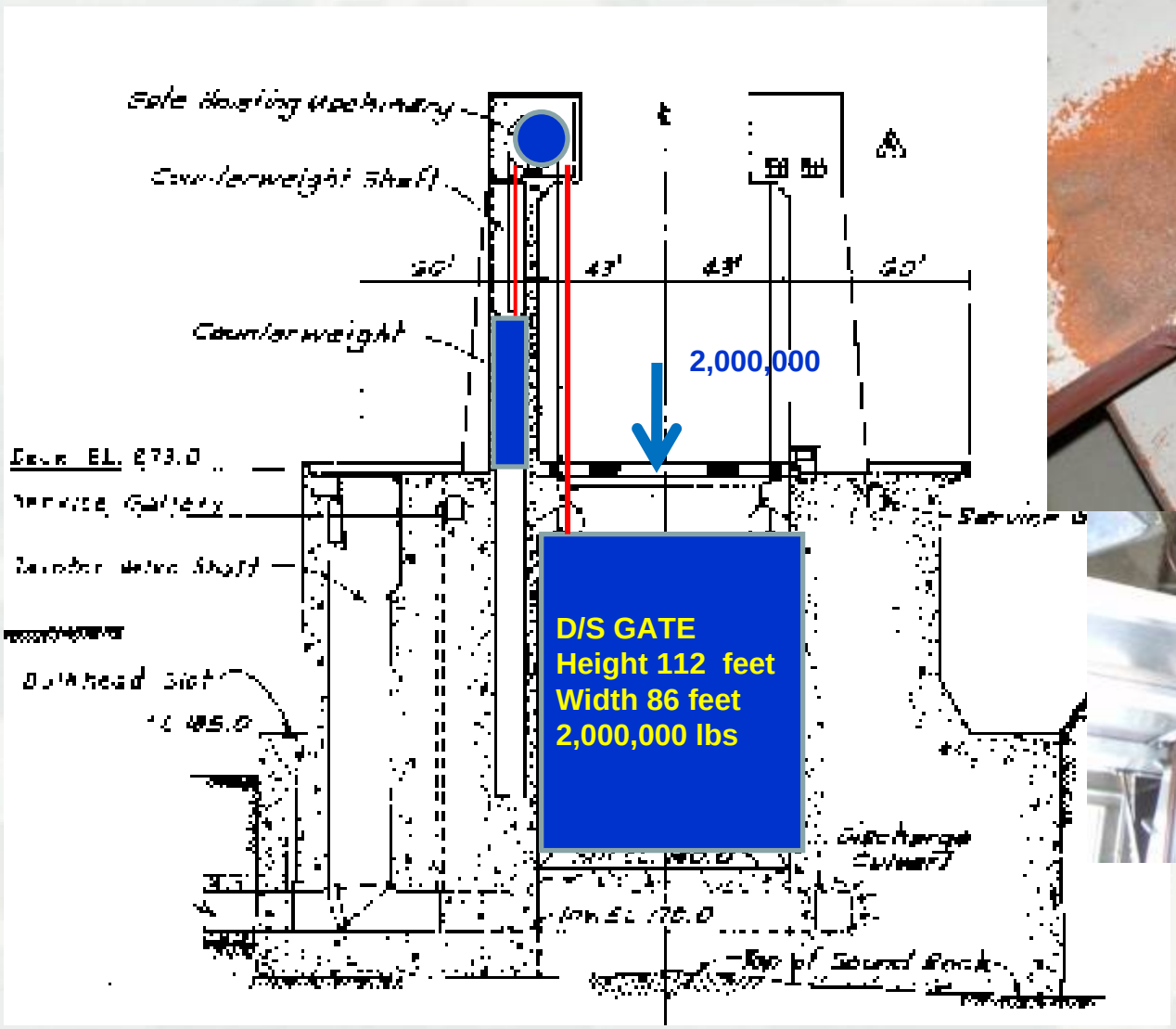
JOHN DAY LOCK





REPLACING: ONE DOWNSTREAM GATE; TWO FRICTION SHEAVES, FOUR TAINTER VALVES

JOHN DAY LOCK – ORIGINAL D/S LIFT GATE, FRICTION SHEAVE



Nav Lock opened 1968

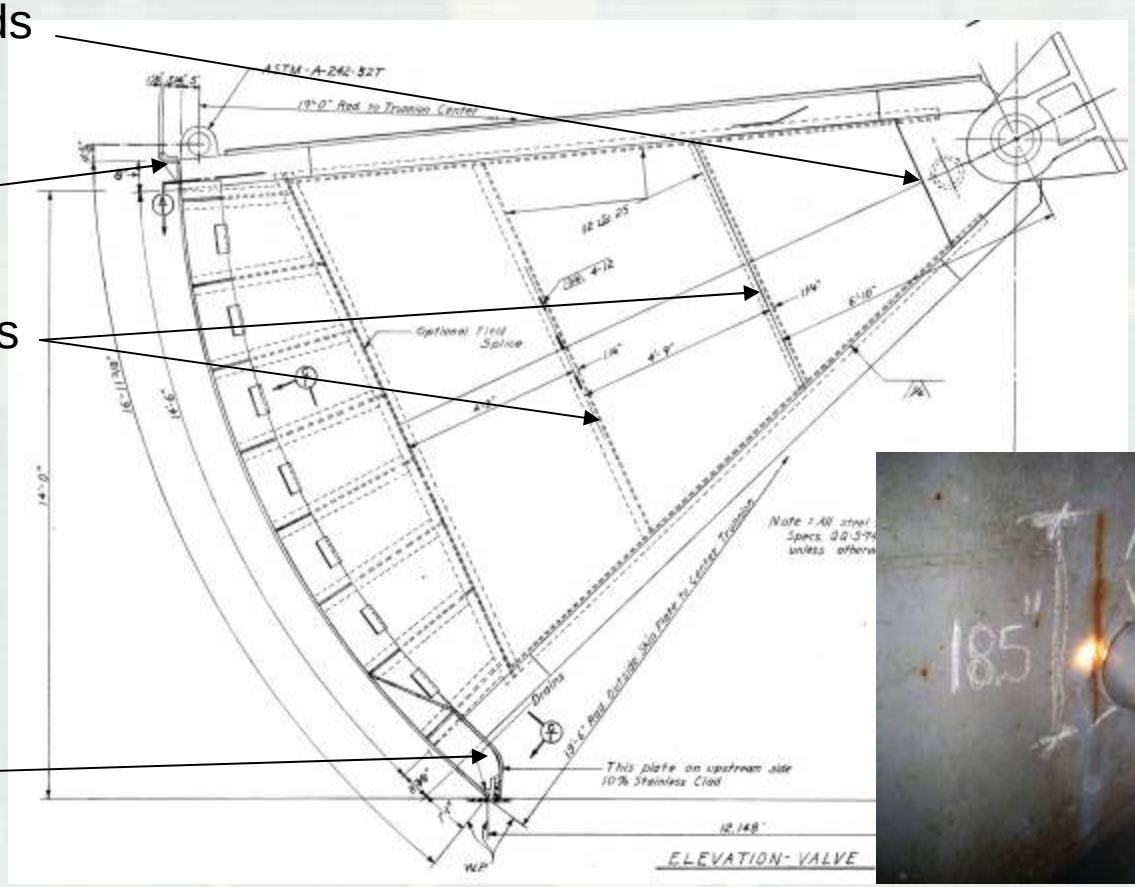
JOHN DAY LOCK – ORIGINAL TAINTER VALVES

Cracking in Trunnion Plate & Spreader Pipe Welds

Cracking in Lifting Eye Welds

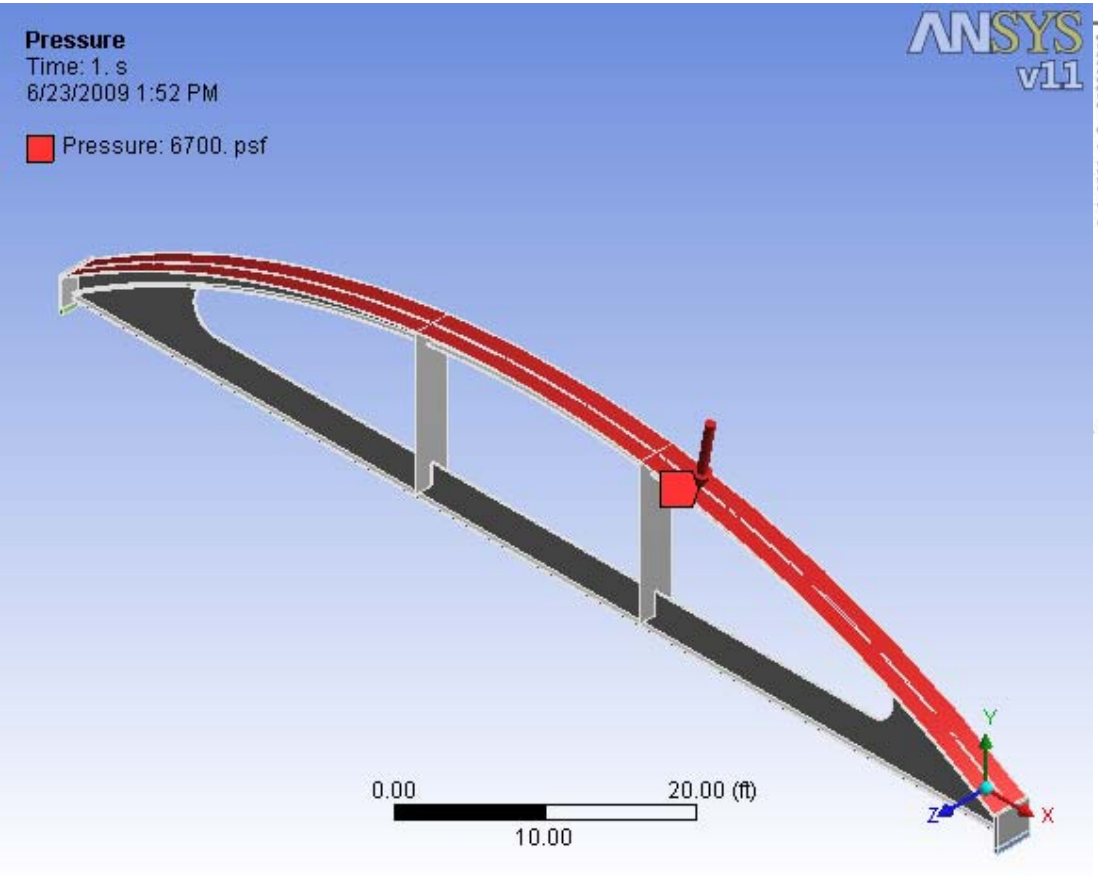
Cracks in Plug Welds

Cracking in Lower Trunnion Arm Welds



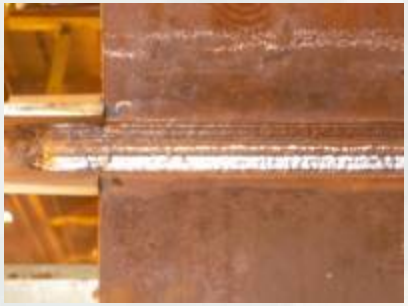
FOUR TAINTER VALVES EACH AT JOHN DAY AND THE DALLES
14feet x14 feet
45,000 lbs each

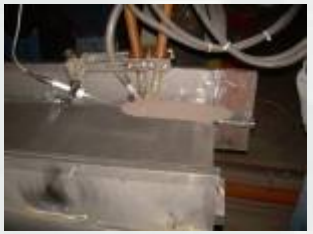
JOHN DAY LOCK – NEW D/S VERTICAL LIFT GATE


Pressure
Time: 1. s
6/23/2009 1:52 PM
Pressure: 6700. psf
ANSYS
v11
0.00
20.00 (ft)
10.00
Y
Z
X

DOWNSTREAM GATE
Height 112 feet
Width 86 feet
2,000,000 lbs

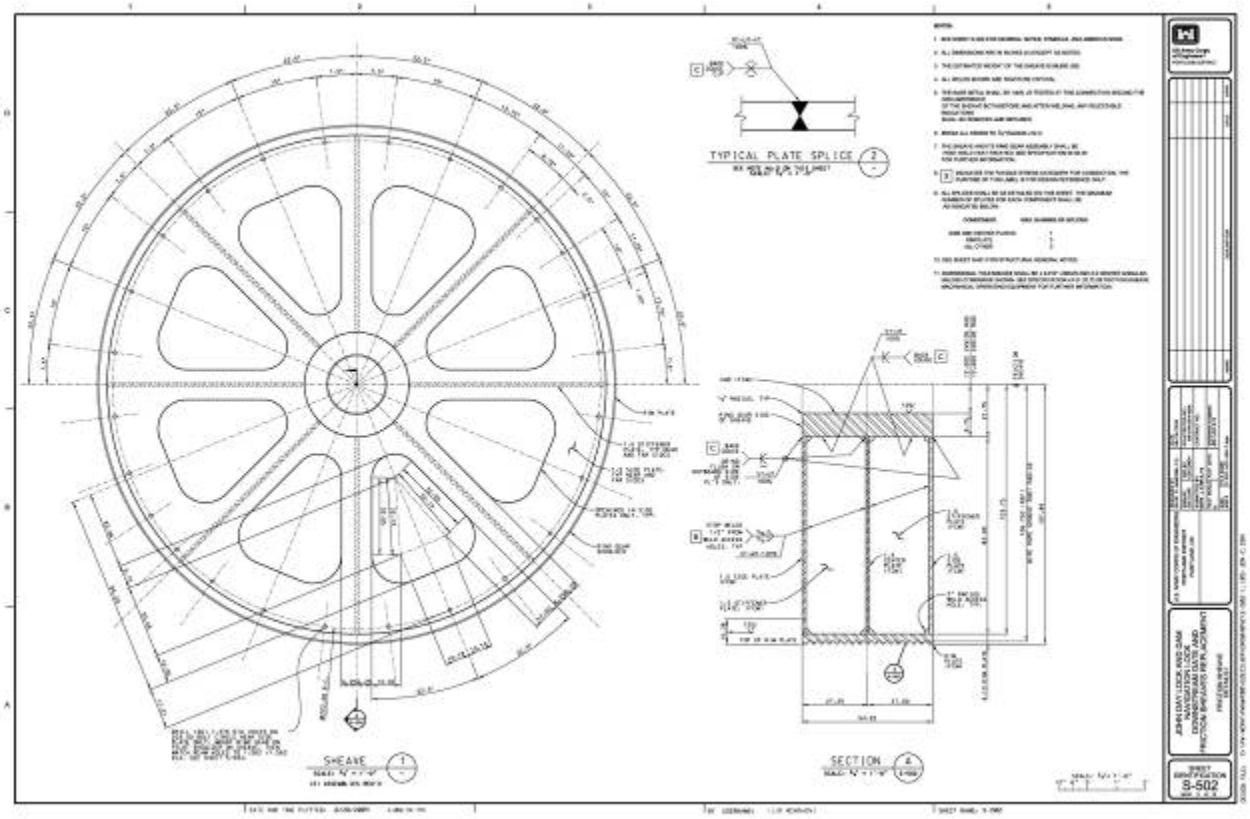
JOHN DAY LOCK – NEW D/S VERTICAL LIFT GATE FABRICTION

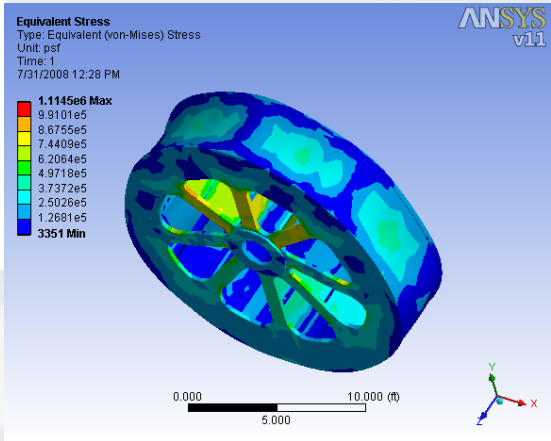




JOHN DAY D/S GATE INSTALLATION

JOHN DAY LOCK – NEW FRICTION SHEAVE

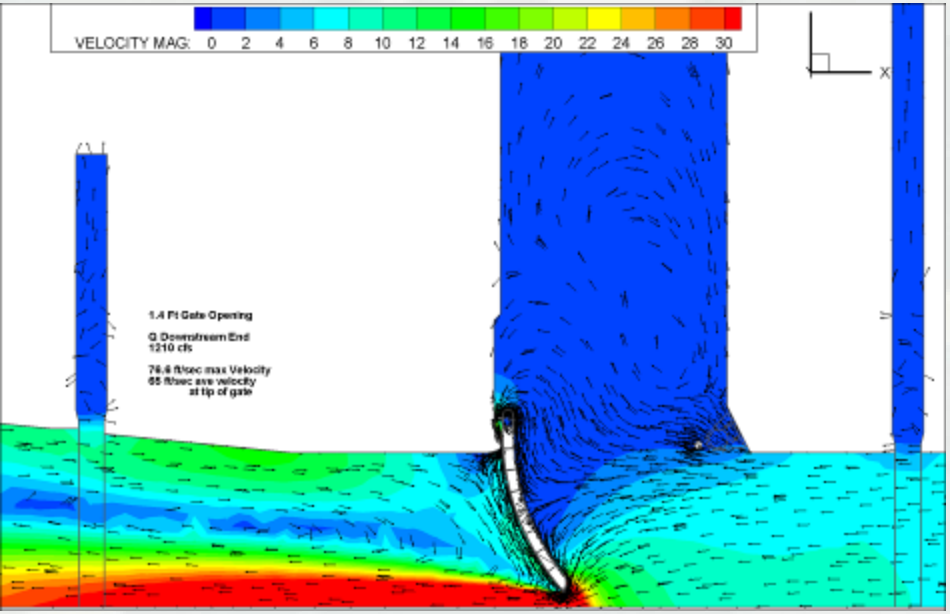


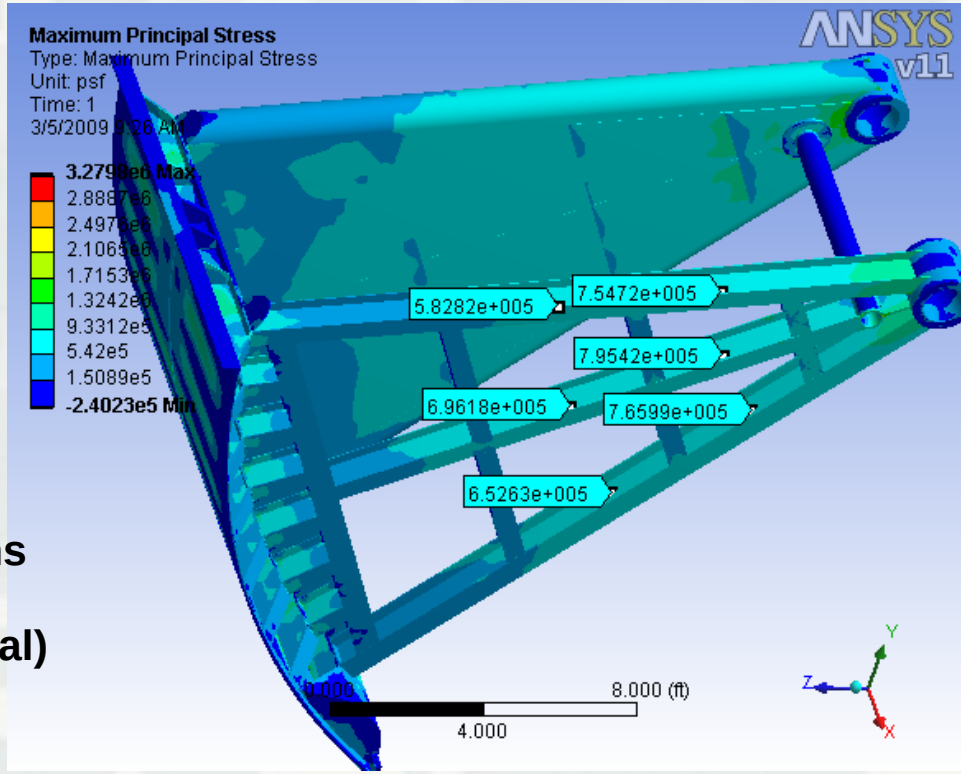


REPLACING: ONE DOWNSTREAM GATE; TWO FRICTION SHEAVES, FOUR TAINTER VALVES

JOHN DAY FRICTION SHEAVE FABRICATION

JOHN DAY/THE DALLES TAINTER VALVES





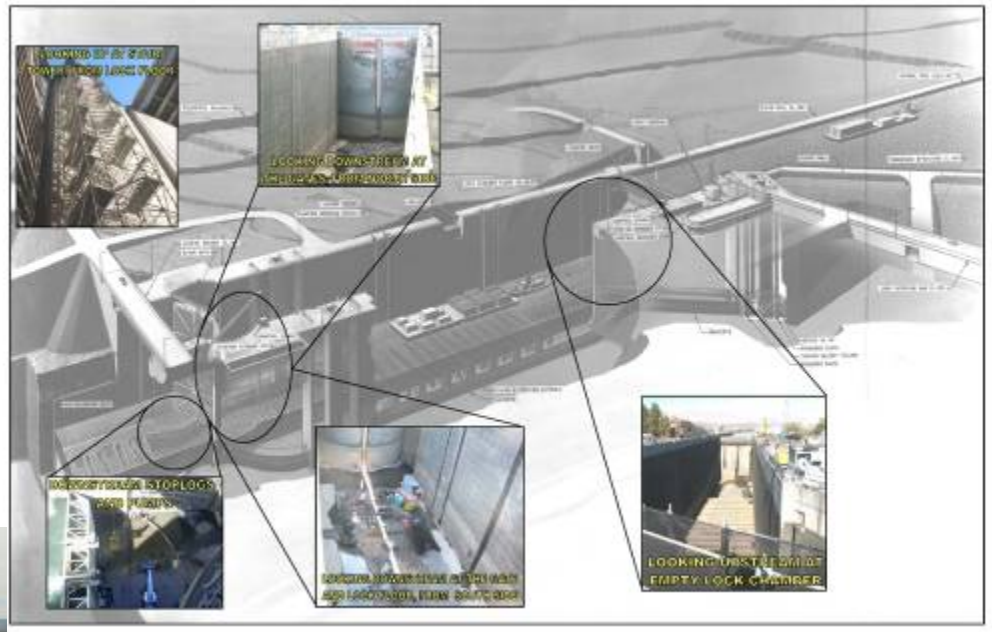
Corps Design Guidance is 27 Years Old

- **Does Not Address Fatigue**
- **Does Not Address High Head Situations**

ERDC Recommend Modeling (CFD and Physical)

John Day/The Dalles Tainter Valves

THE DALLES LOCK



REPLACING: ONE DOWNSTREAM GATE; FOUR TAINTER VALVES

THE DALLES MITER GATE – ORIGINAL GATE

Constructed from 1954 to 1956

Delivered in nine pieces and field spliced

Fixed/Rigid Diagonals – no adjustability

Leaf Weight: 678 kips

THE DALLES MITER GATE – 1979 TO 2007 REPAIR HISTORY

1979

Same Crack – Re-cracked
Through Repair

2005

2007

NOTE – All Cracks Shown All Years Were Repaired

The Dalles Miter Gate – 1979 to 2007 Repair History

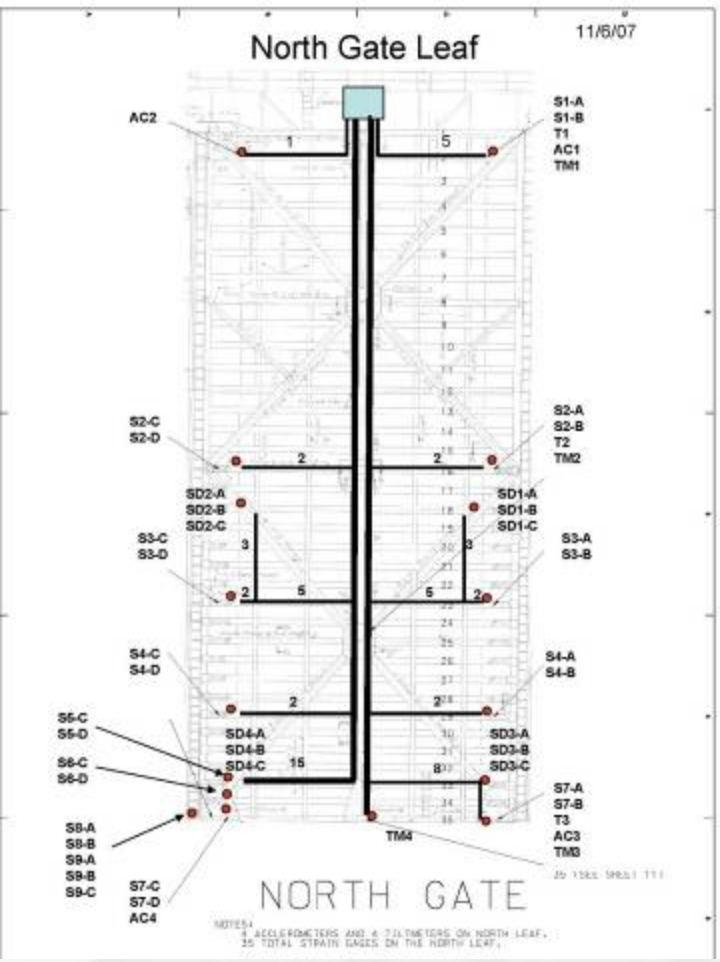
- Miter gate does not make miter or quoin contact. Load is being transferred elsewhere through the pintle area and into areas where the quoin/miter do make contact
- The gate was not designed for this loading condition

Quoin Block Showing No Contact

Gate in Closed Position – No Miter Contact

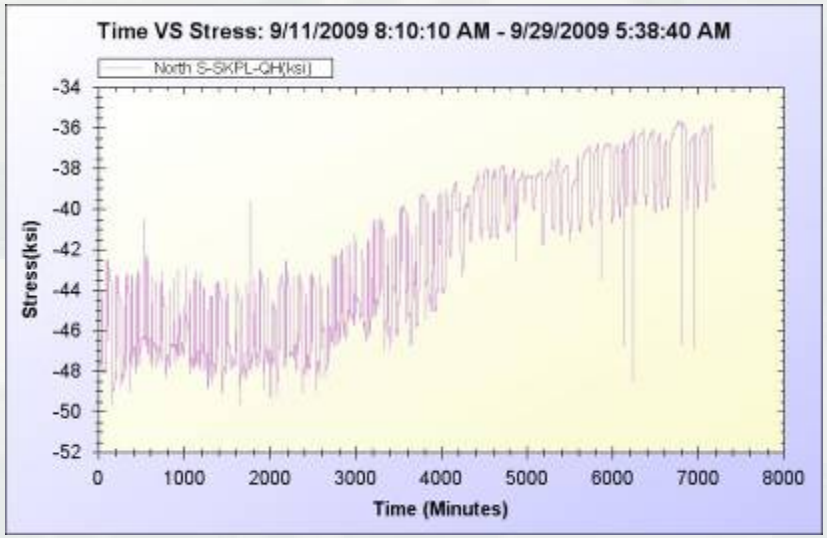
Miter Block Eroded

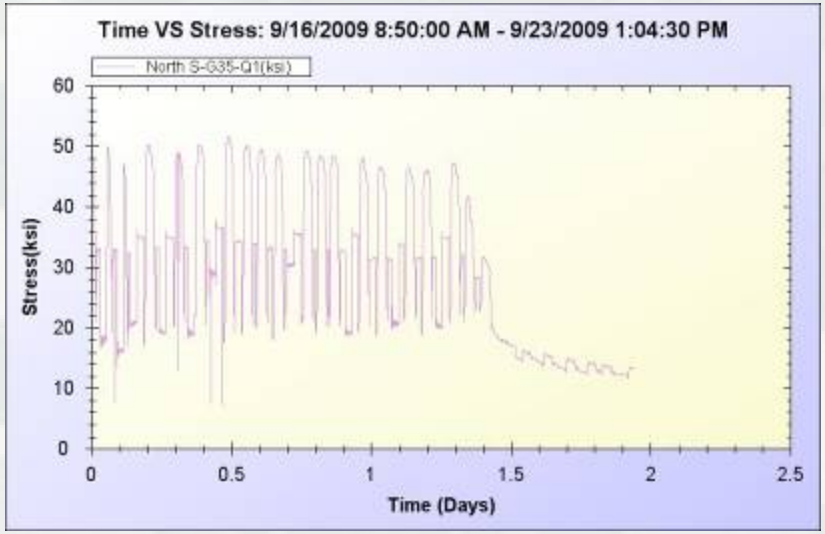
THE DALLES MITER GATE – 2007 INSTRUMENTATION

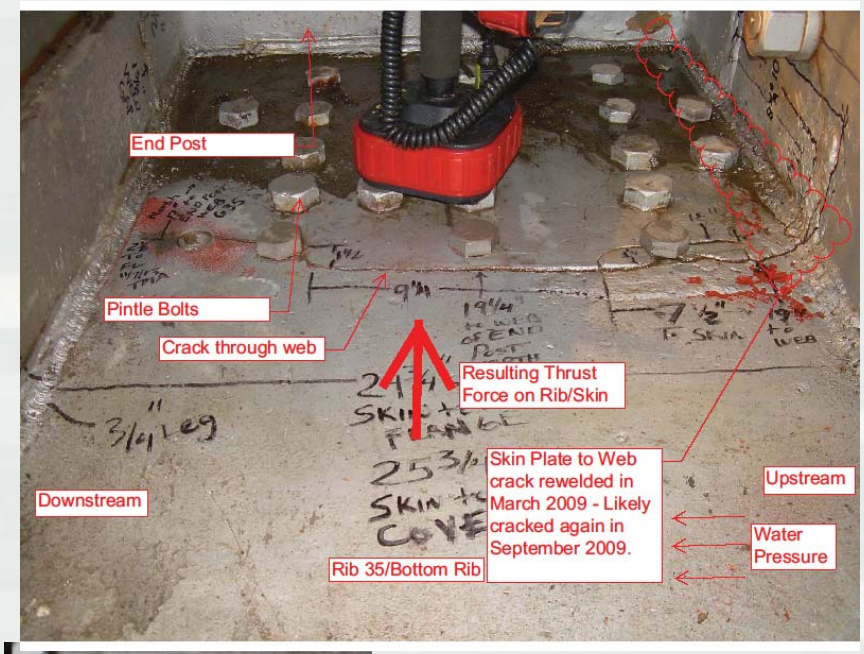


ERDC installs 60 strain gages, 4 tiltmeters,4 accelerometers, and a data acquisition system which provides near real time remote access to instrumentation via web interface

THE DALLES MITER GATE – 2009 EMERGENCY OUTAGE







Noise reported by Project

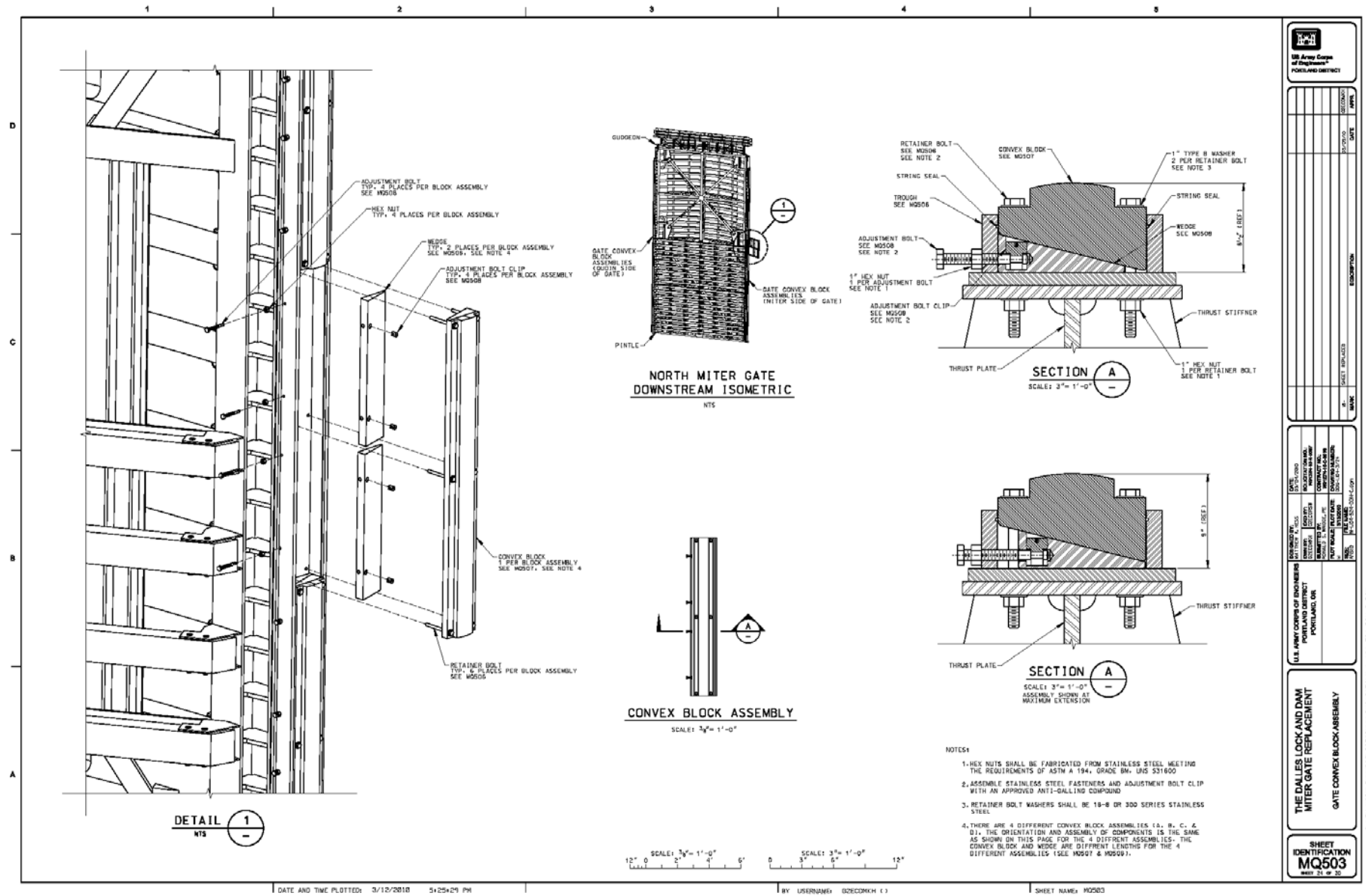
Instrumentation indicates sharp change in stress; likely cracking

Emergency Outage and Emergency Contract Repairs

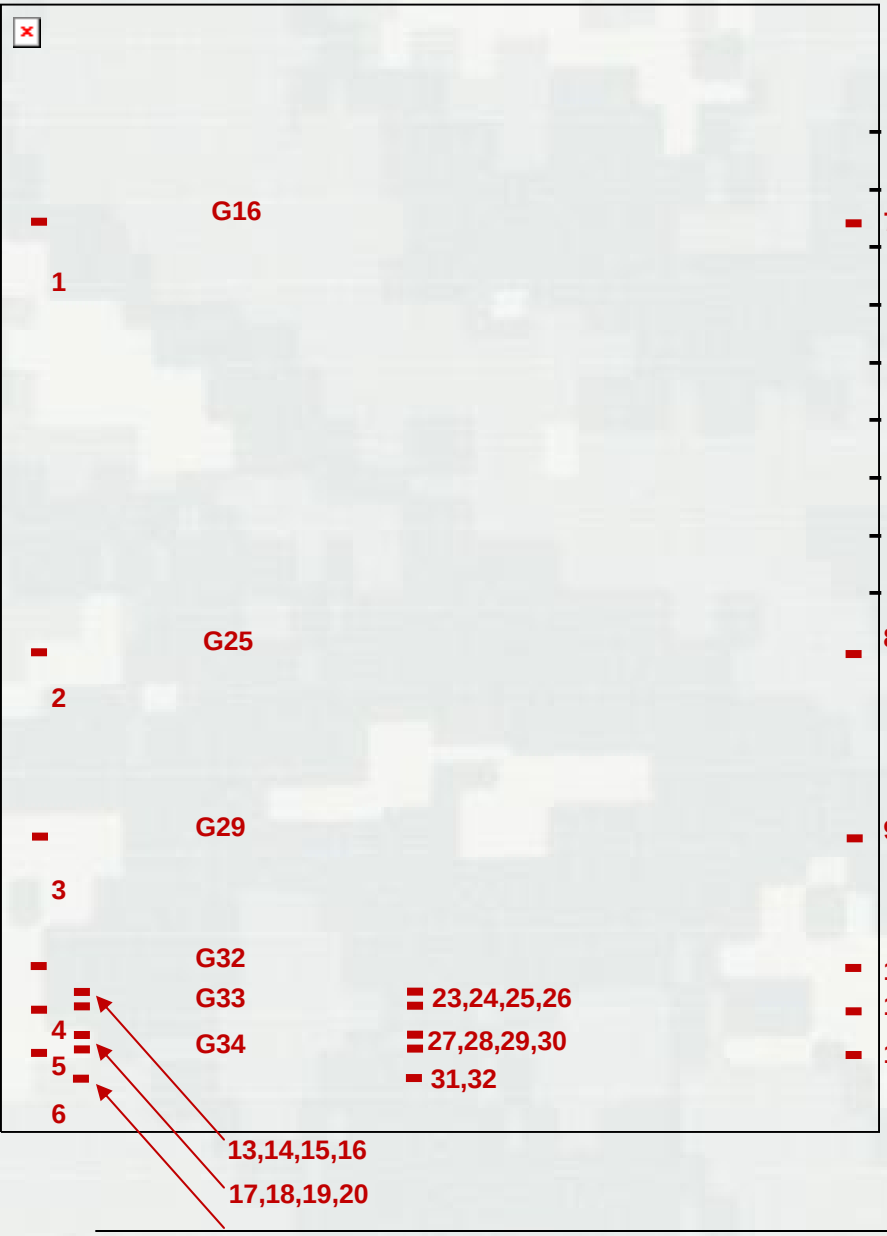
THE DALLES MITER GATE – 2009 EMERGENCY REPAIRS

Bolted Repairs to Bridge Failed Welds

The Dalles Replacement Miter Gate

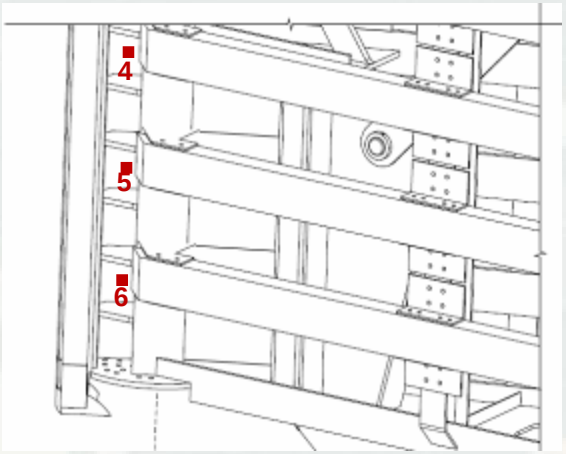


The Dalles Replacement Miter Gate – SMART Gate Technology



Instrumentation Summary:

- 6 Strain Gages on thrust web quoin side
- 6 Strain gages on thrust web miter side
- 8 Strain gages on flange and skin plate of G33
- 8 Strain gages on flange and skin plate of G34
- 4 Strain gages on flange and skin plate of G35
- 6 Strain gages on diagnals (one on each)
- 3 Tilt meters located on G1 and G34 as shown
- 2 RTD's on G16 (co-located with strain gages)
- 2 RTD's on G34 (co-located with strain gages)



The Dalles Replacement Miter Gate – SMART Gate Technology

THE DALLES REPLACEMENT MITER GATE – FIRST LEAF

QUESTIONS?

DISTRICT TACKLES HUGE NAVIGATION LOCK GATE REPLACEMENT

LOCK GATE REPLACEMENT

Story by Scott Clemans, Public Affairs Office

Photos by Scott Clemans; David Mackintosh, John Day Lock and Dam Project; and David Nishimura, Construction Branch

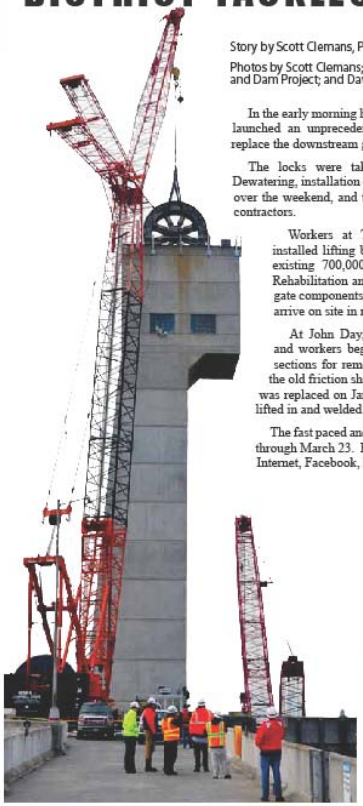
In the early morning hours of Dec. 10, 2010, Portland District launched an unprecedented 14-week, $42 million project to replace the downstream gates at The Dalles and John Day dams.

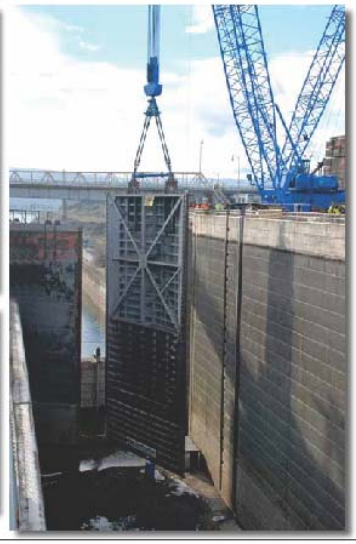
The locks were taken out of service Friday morning. Dewatering, installation of bulkheads and fish salvage took place over the weekend, and then the locks were handed over to the contractors.

Workers at The Dalles removed lead paint and installed lifting beams and eyes, and lifted out the two existing 700,000-pound gate sections Jan. 6 and 10. Rehabilitation and repair of the concrete foundation and gate components continues; the new gate sections should arrive on site in mid-February.

At John Day, scaffolding went up around the gate and workers began cutting it into four 500,000-pound sections for removal Jan. 4-12. Workers also prepared the old friction sheaves in the towers for removal; the first was replaced on Jan. 10. The new gate sections are being lifted in and welded together now.

The fast paced and technically demanding work continues through March 23. For more information, visit the District's Internet, Facebook, Flickr, Twitter and YouTube sites.





LOCK GATE REPLACEMENT

8 — January - February 2011 Corps'pondent

January - February 2011 Corps'pondent — 9

Regional Navigation Design Team Meeting
15-16 September 2010
Paducah, Kentucky

Applications of Self Lubricating and Materials The Dalles Miter Gate - Composites Material Use Quoin and Miter Blocks

Portland District

Prepared By:
Ronald S. Wridge, PE

Applications in NWP

NON-NAVIGATION

Bonneville Swing Bridge
- Center Pivot Bearing
- Centering/Lifting Wedges
- Balance Wheels

Multiple Projects
- Tainter Gate Trunnion Bushings
- Tainter gate Thrust Washers
- Tainter Gate Hoist Rope Anchorages
- Numerous Applications in Fish Facilities, Power Generation, etc

NAVIGATION

Bonneville
- Floating Mooring Bit, Guide and Reaction Rollers
- Floating Mooring Bit, Lower Guide Plates
- Filling and Emptying Valve Trunnion Bushings
- Miter Gate Pin Bushings

The Dalles
- Filling and Emptying Valve Trunnion Bushings
- Filling and Emptying Valve Crosshead and Line Shaft Bushings
- Sector Gear Pin Bushing
- Sector Gear Support Roller Bushings (being fabricated)
- Miter Gate Pin Bushings
- Miter Gate Pintle/Gudgeons (being fabricated)

John Day
- Filling and Emptying Valve Trunnion Bushings
- Filling and Emptying Valve Crosshead and Line Shaft Bushings
- U/S Lift Gate Reaction Roller
- U/S Lift Gate End Guide Roller
- U/S Lift Gate Counterweight Guide Blocks
- U/S Lift Gate End Plate Rub Plate
- D/S Lift Gate Reaction Roller
- D/S Lift Gate End Guide Roller

Typical Design Criteria/Parameters

Polyester Composites

Design Contact Stresses

Dynamic 5,000 to 10,000 psi
Static 15,000 to 20,000 psi
Crush 50,000 psi

Coefficient of Friction

6% to 10% Actual
15% Design

Surface Texture of Mating Surface

16 micro-inch (frequent)
63 micro-inch (infrequent)

Mating Surface Material

Stainless Steel

Surface Hardness

35 (or harder) Rockwell C

Epoxy Bonded or Shrink Fit

Radial Clearance Rule of Thumb

0.001 inches per inch bore diameter

Chamfer Loaded Edges to Reduce Edge Failure

Testing Results

USACE HDC/NWP, BC Hydro, and PowerTech (CERL Technical Report 99-104)

USACE HDC/NWP, BC Hydro Developed testing procedures, plan, and Rating System Wet/Dry Applications

Testing Performed by PowerTech

Manufacturers submitted samples

Materials ranked by performance

Panama Canal Commission and PowerTech September 2004

Self Lubricating Pintle Bushing

200,000 cycles in brackish and silt laden water

11,000 psi

Lessons Learned

Specify Materials That Have Been Successfully Tested By Independent Party (PowerTech)

Bonded in Place Performs Better Shrink Fit

17400 Stainless Steel is an Excellent Mating Surface

Marine Application in Brackish Water ---- 316 is Preferred

Graphite Should not be used as lubricant

Plugged Bronze are Less Effective

Use Stainless Steel Centering Wires to Center Bushing in Housing When Bonding

In-house Design

Advantages, Disadvantages, Cost Differences

Advantages

- Lower Coefficient of Friction (0.06 to 0.1)
- Higher allowable loads
- Reduce Environmental Impacts of Petroleum Based Lubricatns
- Decreased maintenance
- Dependable Lubrication in the Loaded Zone
- Surety of Lubrication System
- Easier to Machine
- Eliminates Galvanic Corrosion
- Reduces the Occurrence of Stick Slip
- Allows For Easy Replacement

Disadvantages

- Newer Technology, newer design paradigms
- Typically Requires Stainless Steel Mating Surfaces
- Recommended for Low PV Applications

Cost Differences

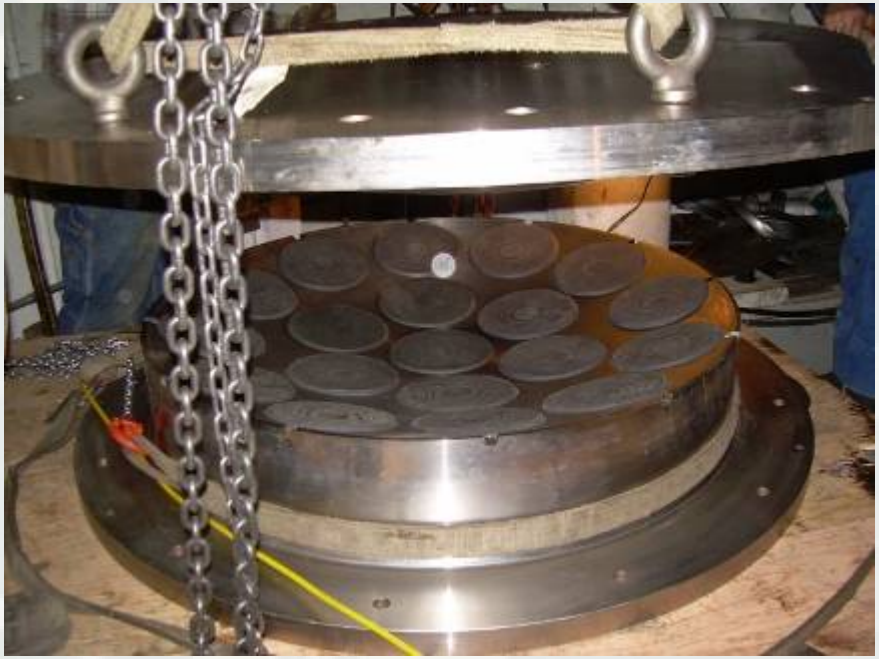
- Capital Costs are roughly the same
- Lower Life Cycle for Self Lubricating (advantage)

Applications in NWP:

Bonneville Swing Bridge: Center Pivot Bearing, Centering/Lifting Wedges, Balance Wheels

Applications in NWP:

Bonneville Swing Bridge: Center Pivot Bearing



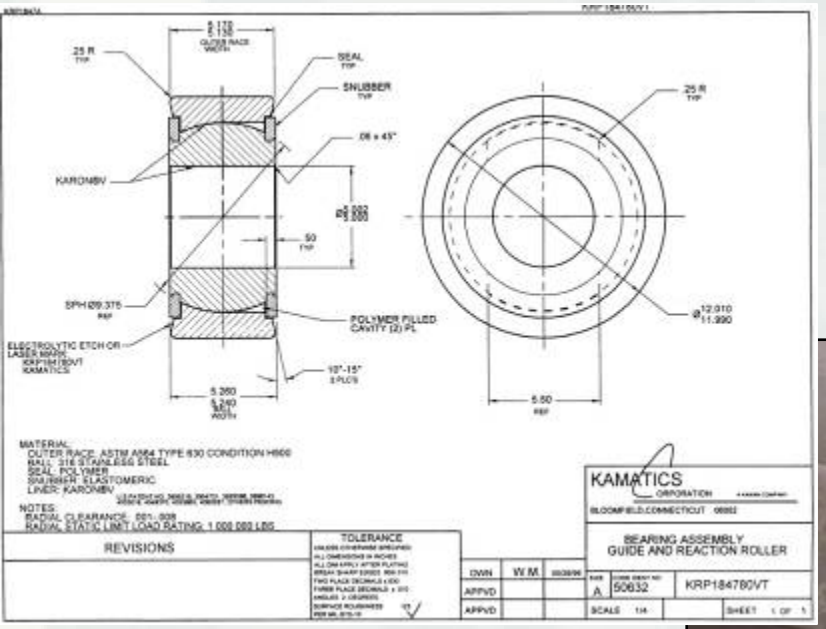
Applications in NWP: NAVIGATION

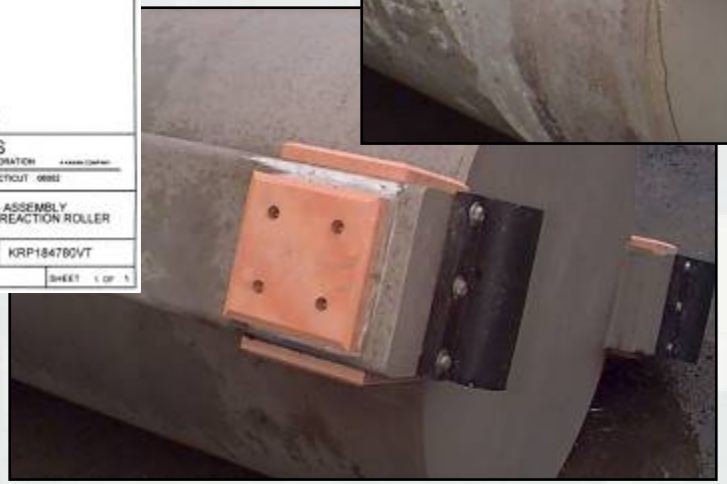
Bonneville: Floating Mooring Bit, Guide and Reaction Rollers, Floating Mooring Bit, Lower Guide Plates

Applications in NWP: NAVIGATION

Bonneville: Floating Mooring Bit, Guide and Reaction Rollers, Floating Mooring Bit, Lower Guide Plates

- Stick-slip operation of the FMB's occurred immediately after the lock became operational in 1993
- Initial FMB modifications were completed in 1994
- Significant stick-slip operation of the FMB's reoccurred within one year after initial modifications
- Final FMB modifications were completed in March 1997



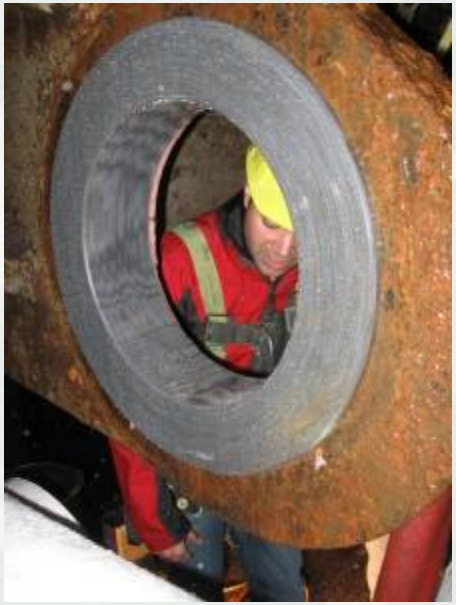


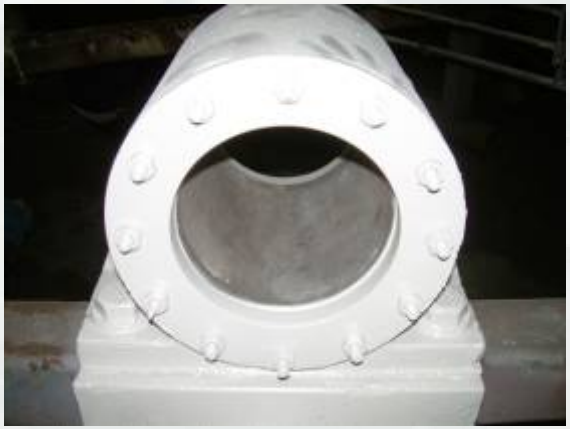
Applications in NWP: NAVIGATION

Bonneville: Filling and Emptying Valves

Applications in NWP:

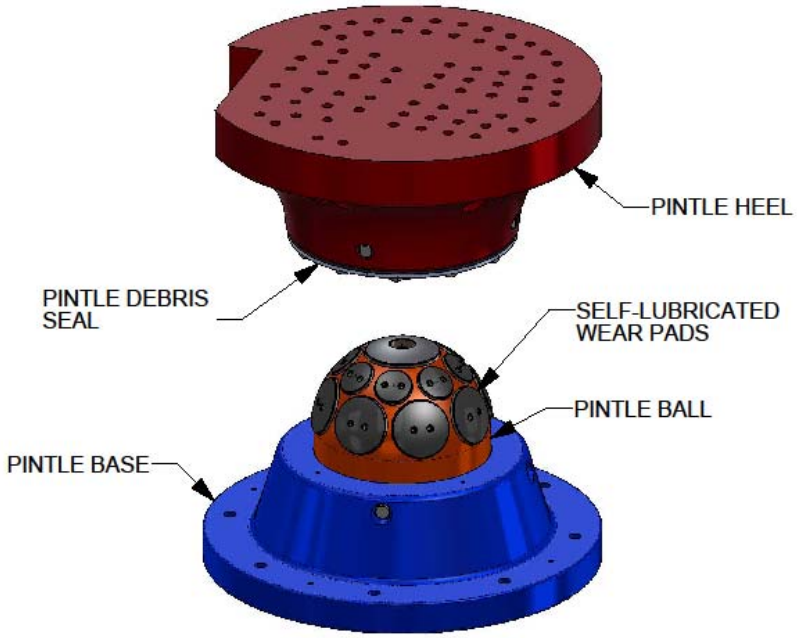
The Dalles: Filling and Emptying Valve Trunnion Bushings, Crosshead and Line Shaft Bushings, Sector Gear Pin Bushing, Sector Gear Support Roller Bushings, Miter Gate Pin Bushings, Miter Gate Pintle/Gudgeons



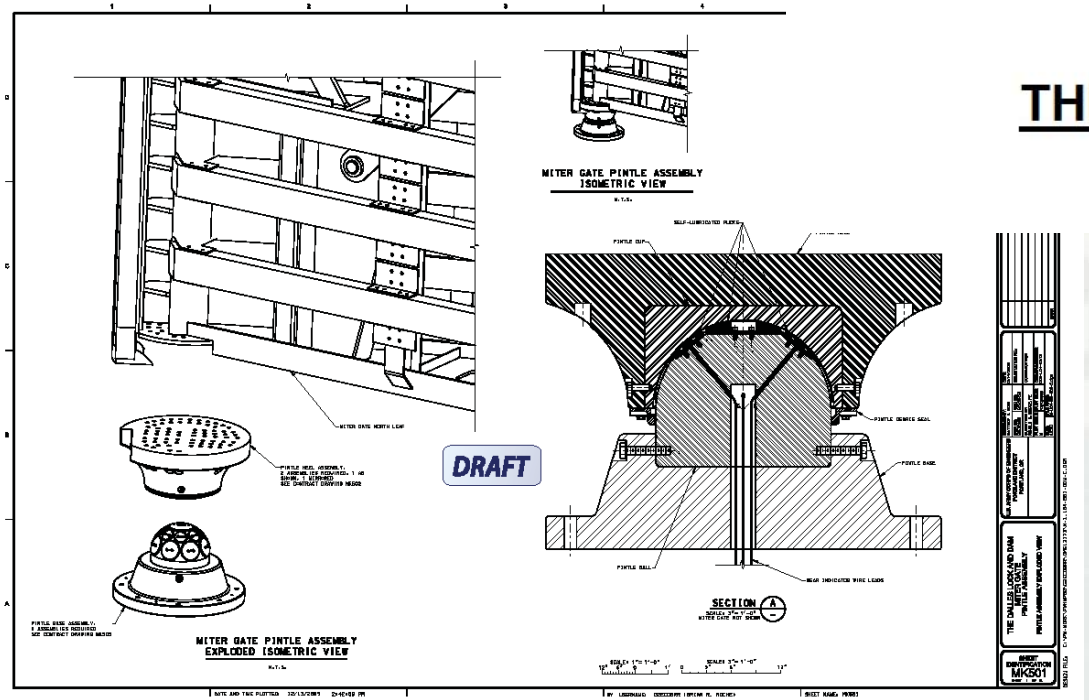


Applications in NWP:

The Dalles: Miter Gate Pintle

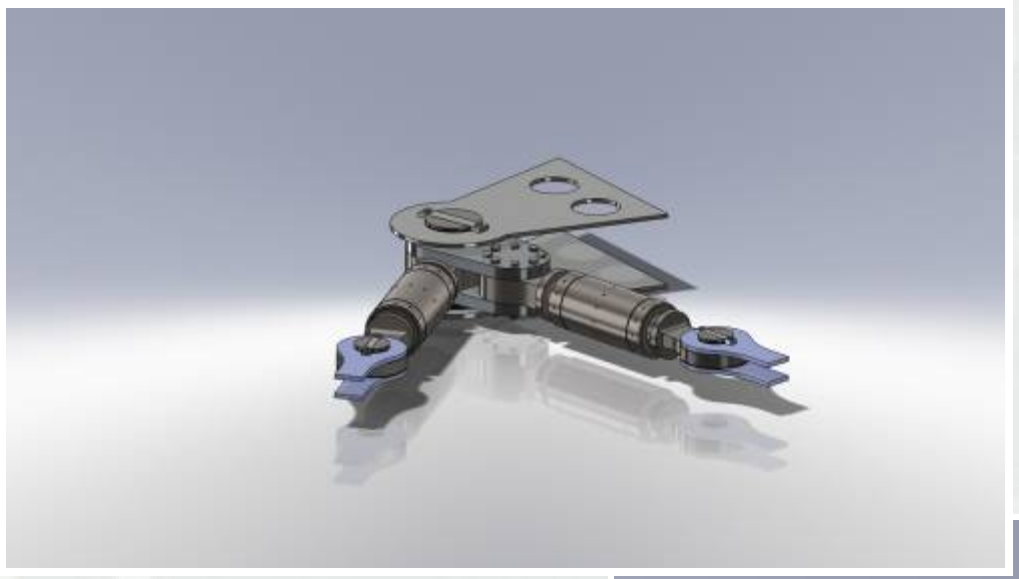


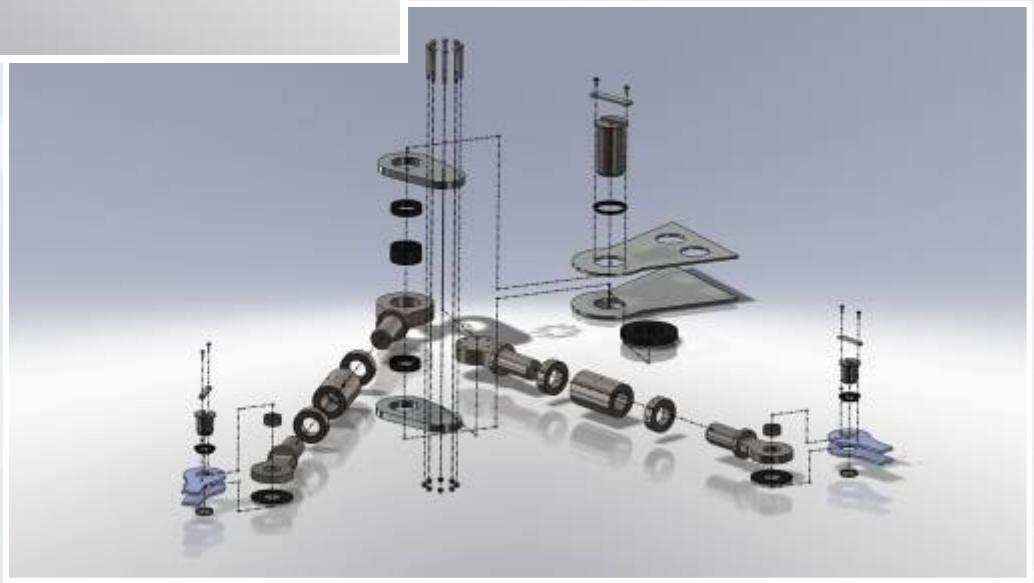
THE DALLES MITER GATE PINTLE ASSEMBLY



Applications in NWP:

The Dalles: Miter Gate Gudgeons





The Dalles Miter Gate:
Composites Material Use in Adjustable Quoin & Miter Blocks: