

NASA and steel Liners

New York Tunnel Siphon under NY Harbor

TVA Blue Ridge Penstock, GA

Silver Lake Tunnel LADWP, Burbank CA

NASA Steel Reline Concept

Nash Williams President

New York Harbor Tunnel Liner





- Narrows Channel is one of the most heavily used water transportation corridors in the World
- Two older New York DEP water mains prohibited dredging and needed to be relocated to a lower depth which required a new tunnel
- A Tunnel Boring Machine (TBM) began operations in 2012 boring out a 10 foot diameter tunnel 100 feet below sea level. The National Welding Corp (NWC) scope involved installing a 72" steel tunnel liner 9500 feet long from Staten Island to Brooklyn within this tunnel.
- Hurricane Sandy hit October 2012, flooded and destroyed the TBM which delayed NWC work 3 years and mandated accelerating installation which began and ended summer of 2015.

TBM Launch Shaft



Segmented Concrete Liner

Steel Liner Install





Threading pipe into launch shaft



Loading the Locomotive





Installing Steel Liner









Adjusting to meet plans

New York Harbor Siphon





Production Welding

Blue Ridge Penstock Rehabilitation



Blue Ridge Dam Project



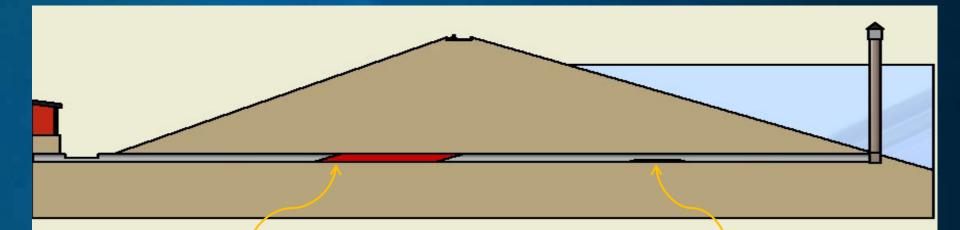


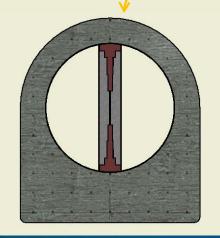
- Tennessee Valley Authority (TVA) is the owner of the 90 year old Blue Ridge Dam
- A 168" riveted steel penstock under this dam feeds a 25 MW hydroelectric plant at the dam base
- A section of the penstock began to deform from external loading and required structural reinforcement.

- Original remedy was to install a steel reinforced, concrete filled girder through the center of the penstock 160' long by 18" thick and weighing 300 tons
- TVA ultimate was to remove the girder and install a 147" x 1" thick steel liner then grout the annular void
- National Welding Corp. was hired remove the girder, develop the installation means and install the new penstock

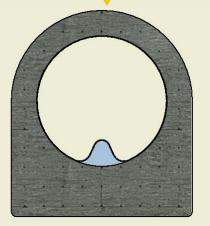
Dam and Penstock Section View







PENSTOCK GIRDER



PENSTOCK BULGE

Penstock Buckling 60' Long x 36" Tall



PENSTOCK BUCKLING OCCURRED DUE TO EXTERNAL LOADING.



300 Ton Steel/Concrete Girder



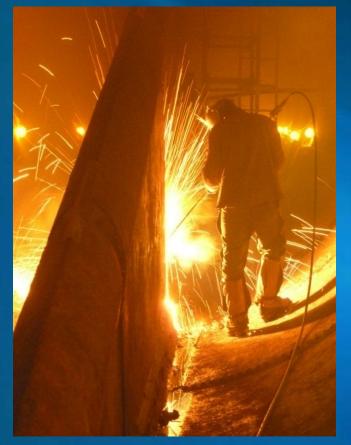




GIRDER MEASURED 160 FEET LONG X 18" THICK AND 14' TALL (FLOOR TO CEILING) STEEL AND CONCRETE MIX

300 Ton Girder Removed







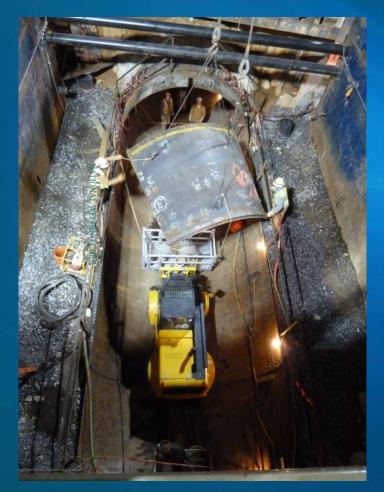
THERMIC (OXYGEN) LANCE CUTTING TO REMOVE STEEL AND CONCRETE GIRDER



Reducer Assembly



168" TO 147" REDUCER INSTALLED IN QUARTER SECTIONS WEIGHING 4000 LBS EACH







Install Rail Sections & Carrier





Penstock Installation





8" ANNULAR SPACE WITH 50,000 LB PIPE REQUIRED VERY ACCURATE TOLERANCES & GOOD CONTROLS



Final Section (tight fit!)

Silver Lake Steel Tunnel Liner





- 120" dia. segmented precast concrete tunnel casing with 96" x .563" x 3,200' butt welded steel tunnel liner
- The steel liner providing a minimum 6" annular space which was later filled with 1000 PSI grout.
- After hydro testing both ends of the tunnel pipe were connected to the existing system by conventional cut and cover methods using bell and spigot welded steel pipe.

Tunnel Pipe Welding







- Pipe seams over 25 lbs. of weld metal and anticipated to delay the tunnel liner
- Alternate FCAW-G (Flux Cored Arc Welding with Gas) was proposed which is much faster, cleaner and has many superior properties to stick but was rejected.
- Mandated stick welding caused welding progress to lag several weeks behind installation
- Actual welding time for Stick was 2.5 to 3 times longer than Flux Core welding

Tunnel Liner Installation







- Project was performed during the hot season (August and September) with mandated around the clock installation
- The pipe was lowered by crane to the installation carrier at the tunnel shaft then transported to the installation location beginning at the far end of the tunnel

Liner Assembly



- The first pipe was positioned against and secured
- Additional pipe was placed onto the previously installed pipe utilizing a butt weld with steel backing
- Pipe was centered within the tunnel casing then tack welded to provide a temporary connection
- After adjusting to the final location the pipe was blocked to prevent further movement and secured for final fitting and welding operations

Ridges Basin Penstock



Bureau of Reclamation







Olmsted Split Steel Liner



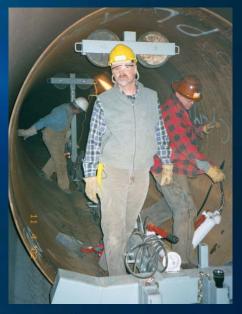
Bureau of Reclamation UT











Specialized Equipment









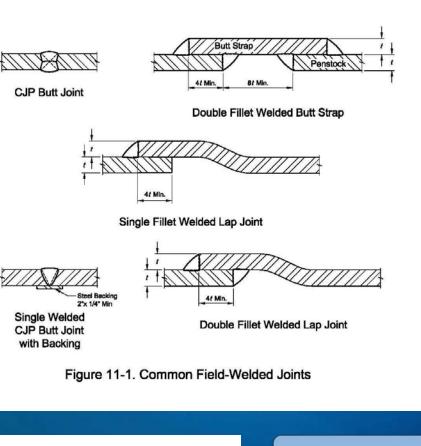
NASA High Pressure Pipe Reline





Welded Joints





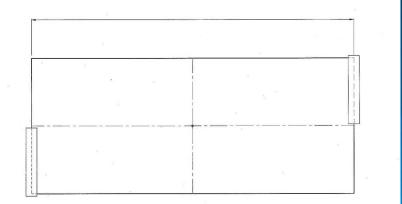


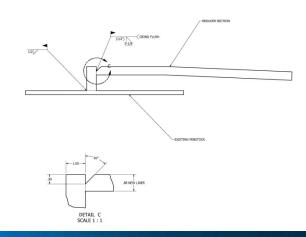
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General Details

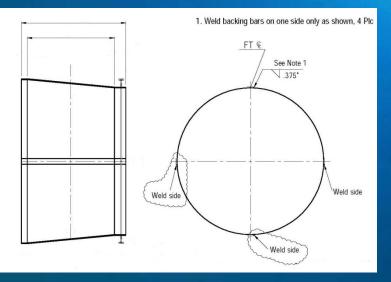


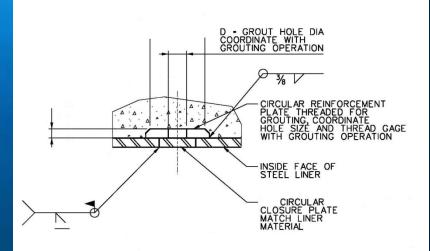




Termination Connection

Pipe configuration





Grout Opening Connection

Reducer Connection

Reducer and Blocking Examples





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Weld Inspection Methods



Ultrasonic Testing (UT)

- May be performed immediately after the joint has cooled from welding.
- May be performed with access to on side of the joint.
- Radiographic Testing (RT) cannot be performed without ID and OD access

Magnetic Particle (MT)

• Fillet weld inspection



NASA Project Preparations

1) **Sandblast and clean the host pipe**. This should be performed through the existing manways without breaching the current system. Cleaning will provide unencumbered access for inspection and running templet (s) through the host line.

2) Verify the pipe geometry. Our preliminary CAD sketches indicate that beginning from the A-Stand connection, the first installed 110' of new 64" pipe can be made in 30" long sections and the subsequent 500' can be made in 15'-20' long sections.

3) **Build a light weight templet** which can be broken down to fit through an existing manway then be reassembled within the host pipe to replicate the proposed pipe sizes. A duplicate templet could be added with a spacer bar to replicate the longer pipe lengths. Travel through the pipeline with the templet on a dolly to verify there is adequate clearance. Pay particular attention around the bends.

4) Actual 64" OD pipe cut lengths will be determined after running the templet. The final pipe lengths will be ordered and backing bars installed at the factory.

NASA Construction Sequence



1) Remove the top half of a 30' long pipe section from the 66" pipeline as a point of access and final tie-in location.

2) Place trench shoring to stabilize the section and prepare means for personnel access. The removed section should include approx. 12" new 66" pipe near the starting point which will be the new access/tie-in section. A reducer would be used for the tie-in.

3) A new 36" manway would be included in the tie-in section to provide continued access for the subsequent activities.

4)Install the first 110' of steel liner in 30" lengths beginning within A-Stand then install the subsequent 500' in 20' lengths until reaching the access/tie-in location.

5) The termination at A-Stand will be by using a transition with a sloped fillet to minimize turbulence. The termination at the access tie-in will be using a butt welded reducer.

6) Laterals would be installed subsequent to the steel liner and would be additive to this scope.

7) Butt welds inspected by 100% UT, fillet welds inspected by MT and any repairs would be performed followed by re-inspection using the same methods.

Post Pipe Installation Activities



1) Grout the annular space using a non-shrink grout mix. The grout will be pumped from within the pipe using 2" diameter ports.

2) High PH grout acts to passivate liner steel from external. Port plugs will be threaded into opening, seal welded and ground smooth after completion.

3) New 64" steel liner will be sandblasted to an SP-10 profile and recoated using field epoxy as was used on B-Stand

4) Manways will be placed using new gaskets and fasteners then secured.

5) Approximate durations based on current knowledge:

- Pipe Fabrication 3-4 months including submittals
- Sandblasting clean and templet 4 weeks
- Liner Install 10-12 weeks
- Grouting 2-3 weeks
- Final Sandblast and coating 4 weeks

In summary 19 weeks critical path.

Exclusions:

- 1) Final/actual design determined by others (NASA).
- 2) This liner concept anticipates using full pipe rings.



- 3) General support, backhoe, crane, trench box, dewatering etc. by others
- 4) Assumes oversight and support by Healtheon or NASA approved Contractor





Chicago TARP Steel Liner Construction

National Welding Corporation Assemble, Fit, and Weld Steel Tunnel Liner

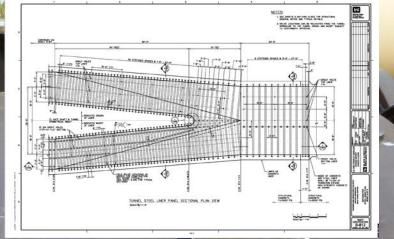
Kiewit Infrastructure- General Contractor, Excavate, Concrete Lining, and oversight

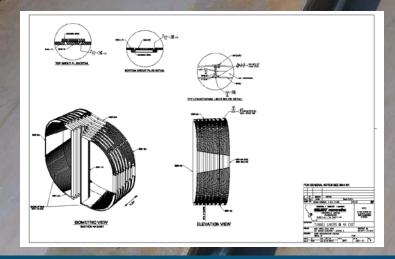
Preassembly Planning

• 354 ft of steel liner

Design

• Bifurcation from (33 ft dia) to 19x32 ft rectangular section





 Changing Geometry • "T" Steel rings

33

Surface **Subassembly**





MCCOOK Mts



33 ft. Diameter **Pieces Assembled** Onsite



34



Rinal Fit-up and weld-out



FCAW Welding

Seam Fitting

Roundness Tolerance









Handling 33 Foot Diameter Sections

Sections Lowered Down 300 ft Shaft



Tunnel installation

ts **BIFURCAITON**

OK







Finished Steel Tunnel Liner

Key Elements of Success

Team Approach

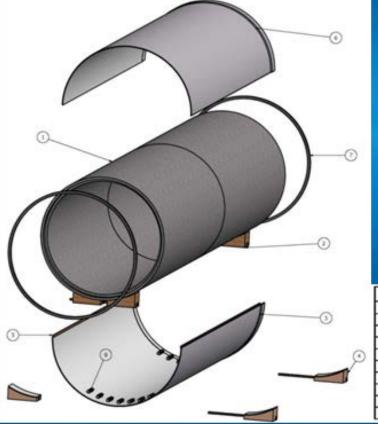
Experienced Team Members

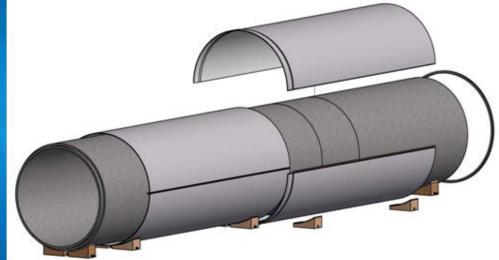
Careful Planning

SCR (Steel Cylinder Reinforcement) For Pipeline Repair or Upgrades



Patented (SCR) Steel Cylinder Reinforcement system to reinforce existing pipelines from the exterior





Steel Cylinder Reinforcement (SCR)						
Parts List						
ITEM	QTY	DESCRIPTION				
1	1	EXISTING (HOST) PIPELINE				
2	4	SUPPORT BLOCKS, HOST PIPELINE				
3	1	SCR BOTTOM HALF				
4	4	SUPPORT BLOCKS, SCR BOTTOM				
5	2	LONG SEAM BACKING BAR				
6	1	SCR TOP HALF				
7	2	SCR SEAL RING				
8	VARIES	ANNULAR SPACER BLOCKS				

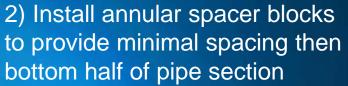


SCR Installation Sequence



Illustrated by a full scale demonstration

1) Clean host pipe, support and install shrink sleeves at seal locations





3) Install spacer blocks then top half of pipe section



SCR Installation (Ctnd)



4) Install SCR half pipe sections



5) Weld two longitudinal seams to create a flexible cylinder enclosure

7) Insert seal retaining rings

6) Install temporary seals





SCR Installation (Cntd)





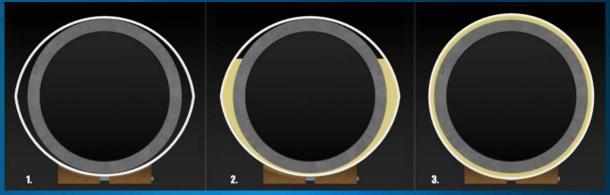
8) Fill annular space with nonshrink grout, vent air then pressurize until initial set. This will maintain rounding of the SCR cylinder.

> 9) Remove seals and install a subsequent SCR

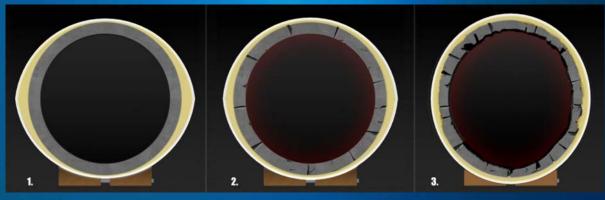


Pressurized Grout and Seals





This exaggerated view demonstrates that our pressurized grout and seals round and maintain cylinder roundness.



Without pressurization the steel cylinder would ultimately be forced to round after the host pipe structure fails, which would cause nonsymmetrical loading to the cylinder.