HEAVY MOVABLE STRUCTURES, INC.
TWENTIETH BIENNIAL SYMPOSIUM

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Rehabilitation of CSX Marley Neck Swing Bridge: Construction Challenges

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SHERATON HOTEL
NEW ORLEANS, LA

Project Background

Purpose of Project

In 2017, CSX initiated a construction management at risk (CMAR) program with the purpose of rehabilitating movable bridges within their network to improve operational reliability and convert various bridges to remote operations. As a continuation of the work performed under the CMAR program, the rehabilitation of CSX Marley Neck bridge commenced in January 2023. The project included structural upgrades, new electrical & controls systems, new signals and communications systems, and significant operational improvements to the mechanical systems.

History and Importance of Bridge

The Marley Neck Swing Bridge is located in Baltimore, MD. Design of the 350' single track span was completed in 1929 and the bridge constructed shortly thereafter. A mechanical rehabilitation was completed in the 1980's and an electrical/controls rehabilitation was completed in 2015. Rail traffic services mostly industrial facilities such as chemical and building material plants located on the Baltimore Harbor.

Figure 1: Marley Neck Swing Bridge Full Open

Figure 2: Marley Neck Swing Bridge Partially Open

Existing Conditions

Electrical System

The bridge machinery is powered and operated through all electromechanical components. During the 2015 upgrades motors were replaced and new conduits, conductors, and equipment was installed. A new controls system was installed that provided automatic bridge operation through an HMI screen on the bridge. This also included the addition of two shore stations that enabled the bridge to be opened and closed from the shore by push of an open button.

Deficiencies identified to address in the rehabilitation –

- PLC equipment was outdated, and unknown faults occurred during operations.
- Motor soft starters were often faulting.
- Control relays were "chattering" or failing.
- The shore stations did not have a screen to show bridge faults. If the moveable span got stuck open, a boat would need to be taken out to the bridge to troubleshoot.
- No remote capability and remote monitoring devices available.
- Navigation lighting insufficient per current federal standards.
- Signals system was outdated, and upgrades were required to enable remote capability.

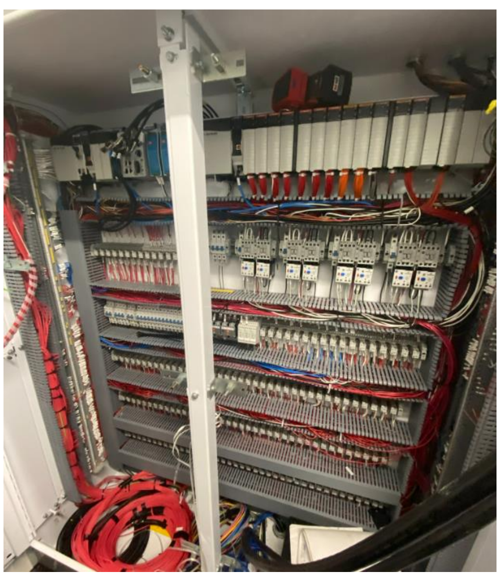


Figure 3: Existing PLC System

Figure 4: Existing Center Wedge Motor

Mechanical System

The bridge mechanical components such as open gearing, bearings, shafts were all original. No major rehabilitation had been completed in the past 90+ years. This particular bridge had a significant quantity of open gearing for the end wedge, center wedge, rail lock, and span drive system which increased complexity and failure points of the existing systems.

Deficiencies identified to address in the rehabilitation –

- Center pivot bearing was worn, no longer centered, and leaking oil due to pieced collar system.
- Span drive system was in poor condition. Brass bushings were pushing out of bearings, gear teeth had significant wear, operations during open and closing operations were loud and movements irregular.
- Centering latch bar would often get stuck in the centering saddle preventing the bridge from opening.
- Motor brakes were unreliable and would fail often.
- Center and end wedge linkages were in incorrect positions.
- Old machinery castings were starting to crack at stress points.

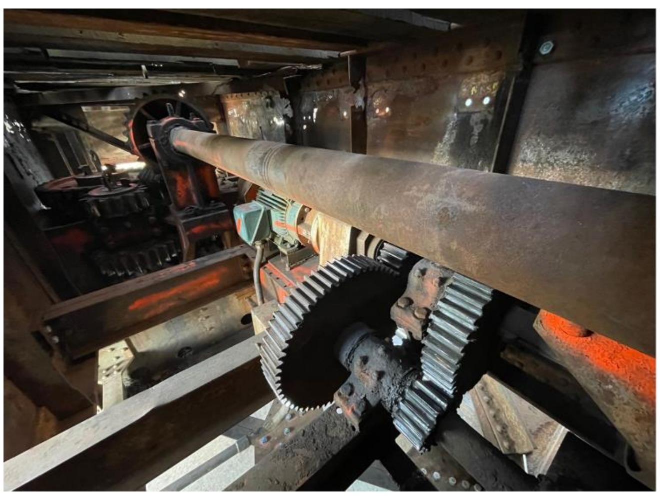


Figure 5: Existing Span Drive Machinery

Figure 6: Existing End Wedge Open Gearing

Structural System

The structural elements of the truss and stringers were generally in acceptable condition. The pivot girders exhibited the most section loss due to the surrounding machinery. The critical area of concern were 2 large holes that got cut through the stringers to provide access to machinery during and old rehabilitation. In addition to structural improvements, access to perform maintenance on the bridge was insufficient with many areas difficult to access.

Deficiencies identified to address in the rehabilitation –

- Lack of access to perform maintenance at the ends of the span.
- Two large holes cut out of the stringers required stiffening.
- Platforms to support and access the new controls and signals houses did not exist.
- Existing fender system was in poor condition.

Figure 7: Web Cut Out in Stringer

Major Scopes of Work

Electrical

Figure 8: New Bridge Control Panel

Figure 9: New Electrical Buildings

1. Bridge Control System:
    a. New relay & PLC cabinet.
    b. New drive & motor starter cabinet.
    c. Two new shore station HMI cabinets.
    d. All new VFDs, starters, relays, switches, buttons, etc.
    e. Addition of remote functionality.
2. Navigation Lighting:
    a. New fender lighting and top truss navigation lights.
3. Lightning Protection
    a. New grounding and surge protection devices installed.
4. Cameras
    a. Bridge mounted cameras to view up/down track and upstream/downstream of channel.
5. Channel Sensors
    a. New sensors to monitor marine traffic in the navigation channels.
6. Signals System
    a. New signals bungalow, conduit, conductors, and proximity switches.
7. Electrical Demolition
    a. Removal of all existing conduit, wiring, junctions boxes and related devices.

Mechanical

Figure 10: New Span Drive Machinery

1. Span Drive System
    a. Demolition of existing drive machinery open gearing, bearing, shafts, and supports.
    b. Furnish and install of new motor, gearbox, machinery supports, and turned bolts.
    c. Replacement of existing bull gear on main drive shaft assembly.
2. Span Stop
    a. Removal of existing latch bar system
    b. Install of new span stop to align bridge when closing.

3. Pivot Bearing
    a. Demolition and removal of existing pivot bearing.
    b. Install of new two piece disc and contained pivot bearing oil box.
4. End Wedges
    a. Replacement of motors and segmental gearing.
    b. New turnbuckles and pins.
5. Center Wedges
    a. Replacement of motor and motor support.
    b. New turnbuckles and pins.
    c. New linkage arms.
6. Rail Locks
    a. Replacement of motor and motor support.
    b. Install of new rotary cam limit switch.

Figure 11: Center Pivot Bearing Replaced

Structural

1. Platforms
    a. Support beams for new signals and controls housings.
    b. End of span access for rail locks and end wedge machinery maintenance.
    c. Various access platforms to eliminate fall hazards.
2. Stringer Hole Stiffening
    a. Install of stiffening plate around existing torch cut hole.
    b. Drilling of arrest holes to prevent existing cracks from growing .
3. Top Truss Access Platform
    a. Install of new staircase to top of bridge.
    b. New access platform on top of bridge to access wireless antenna equipment.
4. Fender Rehabilitation
    a. Replacement of existing fender system in kind.

Figure 12: Stringer Hole Stiffening

Figure 13: Fender Replacement

Project Challenges and Risks

United States Coast Guard Coordination

Marley Neck bridge is located adjacent to the United States Coast Guard (USCG) Station at Hawkins Point as shown below. USCG vessels are required to immediately respond to emergencies which require vessels to pass through the CSX Marley Neck Bridge navigation channel. Due to this, the bridge is left normally open. With the project location in close proximity to the USCG station, the following challenges were encountered:

- Planning of work of any activities that could impact bridge operation needed to be carefully thought out. Failure of the bridge to open due to planned work could directly impact USCG response time.
- Each time the bridge was closed to perform any construction work, the USCG had to be notified and timeframe of closure given via marine radio. This level of communication was atypical but necessary to avoid delays in responding to emergencies.
- Due to security reasons, the USCG could not disclose planned vessel movements. Instances would occur where the bridge was closed to perform work, but incoming or outgoing vessel traffic would require bridge opening shortly after closing.

To reduce project impacts due to USCG traffic, weekly updates on work were provided to the USCG. Tentative plans detailing work to be performed in the bridge open or closed position was communicated. In addition, scopes of work that affected bridge operations were planned to be performed over 2-month period. For these 2 months, a 2-hour notice of bridge operation was submitted and approved by the USCG. This notice allowed the bridge to be maintained in the span closed position during the workday. If a vessel needed to pass through the navigation channel, a minimum 2-hour notice from the passing vessel was required before the span was required to open for marine vessels. This avoided submission of multiple closure deviation requests where scheduled work had a high risk of potential delay due to unforeseen existing conditions. Also, during the 2-hour notice to open deviation, the USCG would also relocate vessels to the other side of the bridge to respond promptly to emergencies. Regular and consistent communication proved key in creating a successful relationship with the USCG.

Figure 14: Overview of USCG Station Location

Automatic and Unmanned Bridge Operation

Prior to start of construction, Marley Neck Bridge already operated in a fully automatic mode with no bridge tender present. The bridge would be operated by the locomotive engineers/conductors utilizing 2 shore control stations on each of the approach spans. The “open” push button would be pressed, and the bridge would automatically close and signal for rail traffic to pass. During construction the unmanned, automatic means of operation needed to be always maintained creating additional challenges noted below:

- Increased complexity of work planning was required to return the bridge to its automatic operating state each shift. Many of the previous CMAR bridge rehabilitation projects had 24/7 bridge tenders that could operate the bridge manually if an issue occurred.
- Work impacting bridge operations needed to be complete in (1) 8-hour shift.
- Client labor constraints only allowed the bridge to tended 24/7 for 1 week during system cutover from the existing to new control systems.
- Troubleshooting issues was increasingly difficult without having continuous personnel on-site during nightshift operations of the bridge.

For example, replacement of 2 end wedge motors, 2 rail lock motors, and 1 center wedge motor was scheduled to begin. Each motor needed to be replaced in one day and bridge returned to automatic operations by end of shift. A center wedge motor and rail lock motor were successfully replaced one after the other, however field modifications to the existing control system and utilization of the old PLC system was required. When issues did occur, troubleshooting proved cumbersome. Failure points began to occur which started to severely impact bridge reliability due to the inability to manually operate the bridge during off hours. To reduce risk of operational impacts to both marine and rail traffic, the project schedule was replaced to replace the motors during a 3-day period and tie into the new system only.

Figure 15: Existing HMI Controls

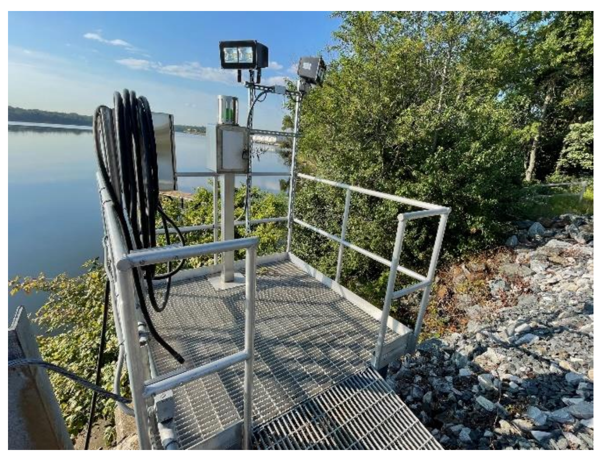


Figure 16: Existing Operator Shore Station Panel

Pivot Bearing Replacement

Replacement of the center pivot bearing was a challenging scope of work to complete. Scope included jacking of the moveable span utilizing (4) 250-T jacks, removing the old pivot bearing bronze discs and retaining collars, and installing a new fully contained pivot bearing and oil box system. Several constraints included:

- 12-hour rail traffic shutdown was required.
- 12-hour navigation channel shutdown was required and USCG emergency response capabilities needed to be maintained.
- Existing conditions of existing pivot bearing system was unknown until the span was lifted.
- Access was limited with 3’ of headroom clear underneath the pivot girders.

Given the above, replacement of the pivot bearing was originally pursued in the span open position. This would leave no impacts to the USCG which took priority in planning. With the unknowns of the existing fender system capability to support bridge structure if a significant end span imbalance occurred, this option was eliminated. Having to complete the work under a marine outage, coordination the local USCG station was required to submit and extended marine outage request. To ensure emergency response could be maintained, the USCG relocated vessels on the other side of the bridge and larger vessels moved out of Curtis Creek prior to the closure. Every 2 hours updates on progress were provided to the USCG station to assist in their logistical planning.

Figure 17: Jacking Bridge to Replace Center Pivot Bearing

In addition, detailed work planning was developed to react as quickly as possible to existing issues. Identification of hold points where all work would need to be suspended and bridge returned to service was imperative to avoid rail and marine traffic impacts if severe issues discovered. An example of this plan can be seen in the supplemental attachment.

The most unexpected issue discovered was how difficult it was to remove the bottom steel disc. A 1.5 hour planned task doubled to 3 hours when 2 ton come-a-longs with a combination of 25-T jacks refused to free the disc of the lower boss insert. The most effective method of removal utilized a series of steel wedges and sledgehammers to slowly pry the disc up. The limited access and manual nature of the method was extremely cumbersome but ultimately successful.

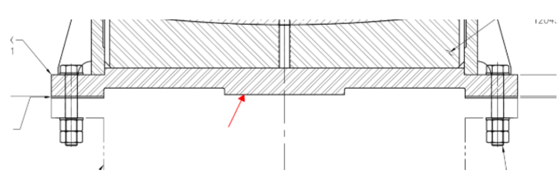


Figure 19: Lower Boss Insert Cross Section

Span Drive Machinery Install

The highest risk scope of work included demolition and install of the span drive system. To reduce complexity, a new machinery skid with a single gearbox and motor was designed to reduce the existing 24 open gears to a total of 6. To perform the work, the following considerations needed to be accounted for:

- The existing dual drive system would need to be reduced to a single drive system increasing stresses incurred on the remaining drive system.
- There would no longer be a secondary drive machinery system to revert back to, if failure of the single drive system occurred.
- The size and weight of the skid limited means of install given marine traffic constraints.

To verify the bridge would be operational on a single motor, the dual drive system was isolated to a single drive system and the span was operated. The single motor test was successful; however, it was discovered that due to the additional torque on the single motor, the existing motor support would deflect significantly. This caused a poor gear mesh when operating. Additional support beams were installed temporarily to prevent the deflection. In case of motor failure, the secondary motor that was demoed was staged next to the running motor and a temporary air winch was installed on the piers to assist in closing the bridge if a major issue occurred. Lastly, an on call local tugboat service was utilized if the all other options failed to open or close the bridge.

Figure 20: Torque Arm Install Around Shaft to Isolate Dual Drive Systems

To install the new machinery skid, lifting the skid onto a barge and manually hoisting it to the bridge was originally considered. However, the skid could only be lifted in the bridge closed position with multiple hours required. This option was eliminated due to impacts to marine traffic. Instead, the section of track panel was removed allowing the machinery skid to be directly lowered in. This method required the bridge to be in the closed position as well, but track equipment could easily be cleared and bridge opened within 15 minutes of notice versus several hours. Extensive planning and preparation was required to ensure a successful install limited rail and marine outages. An example of this plan can be seen in the supplemental attachment.

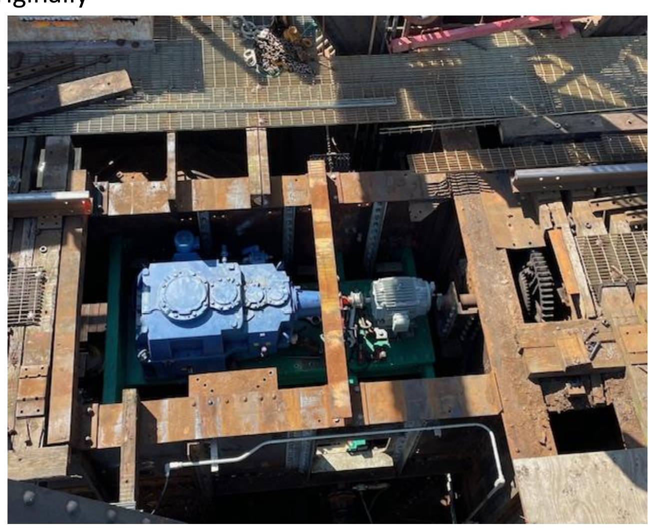
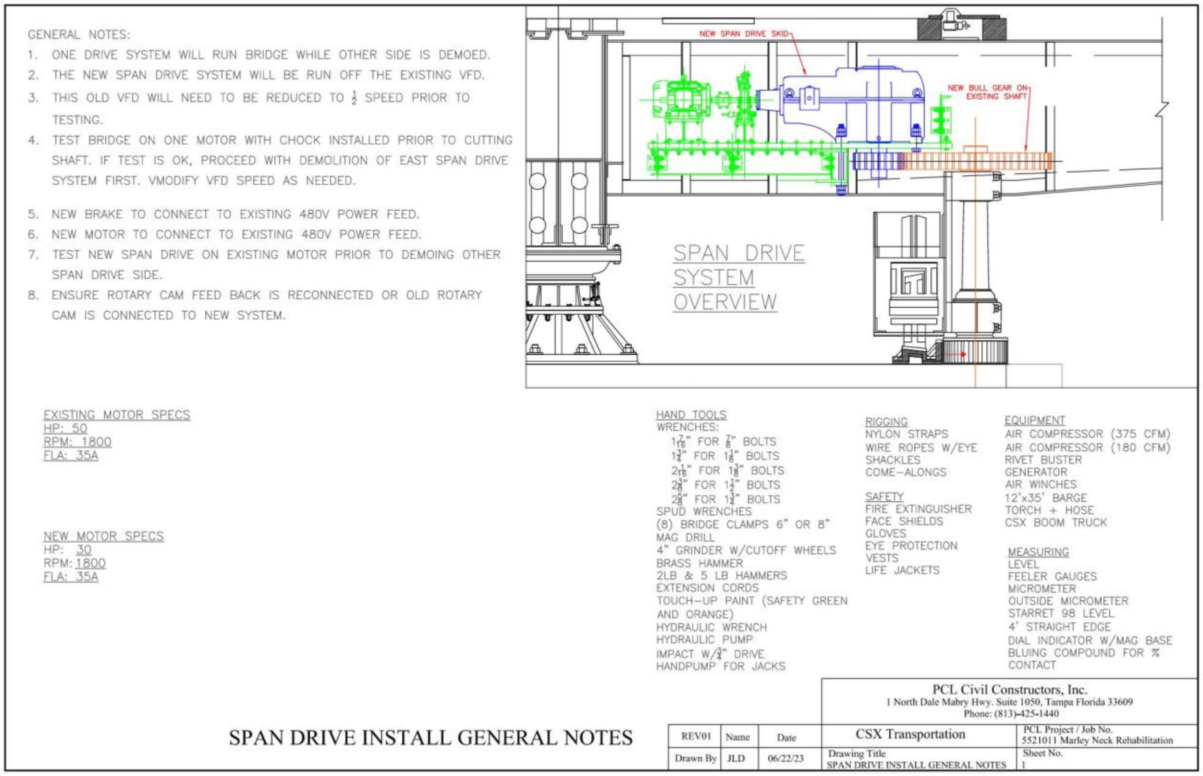
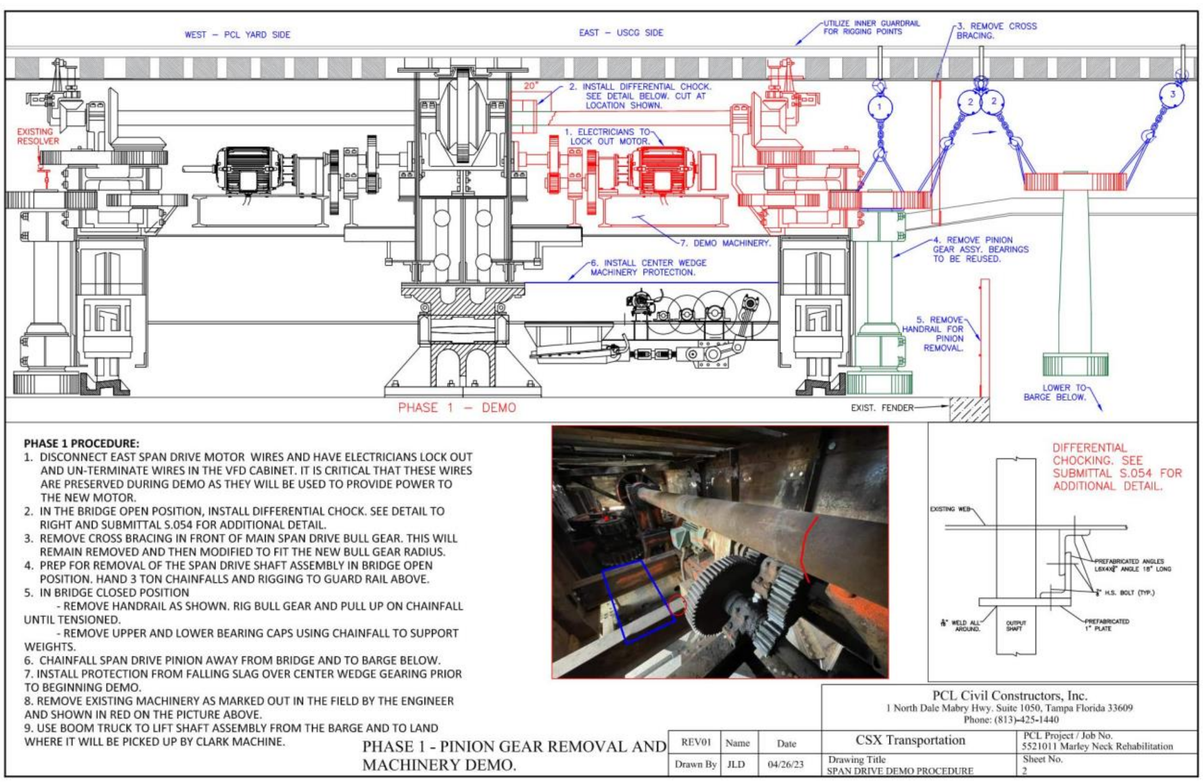
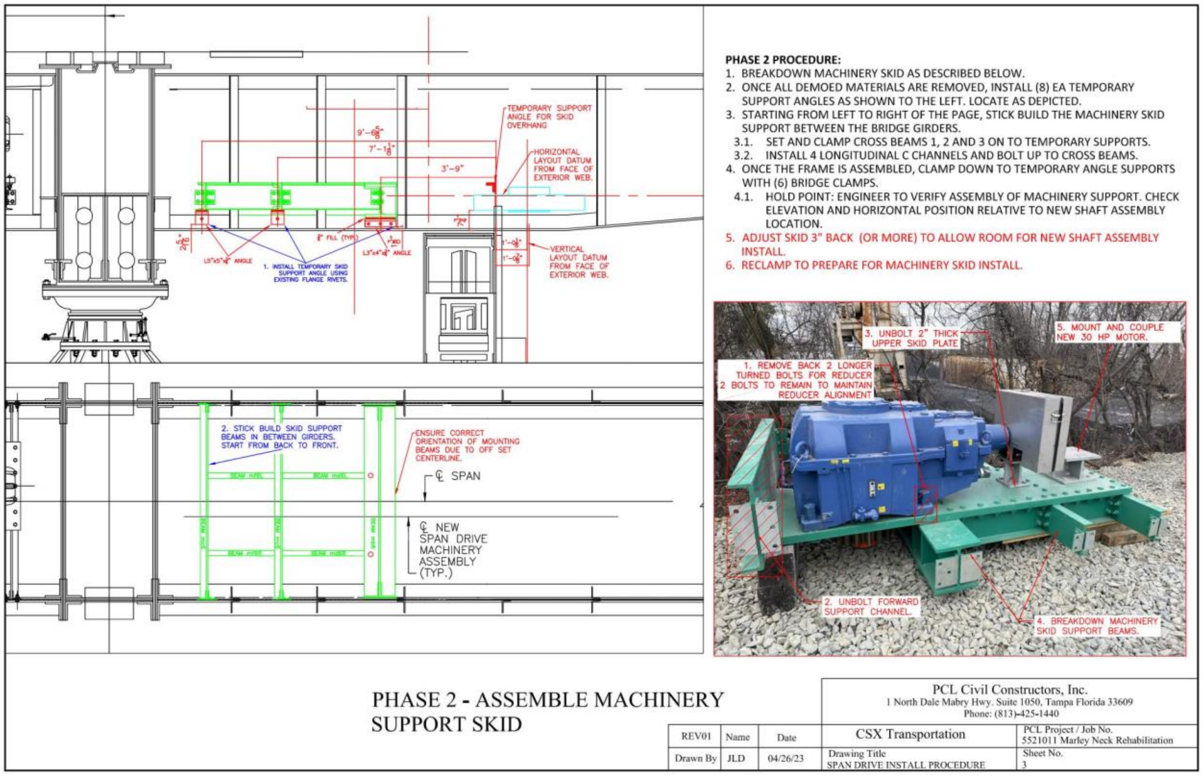


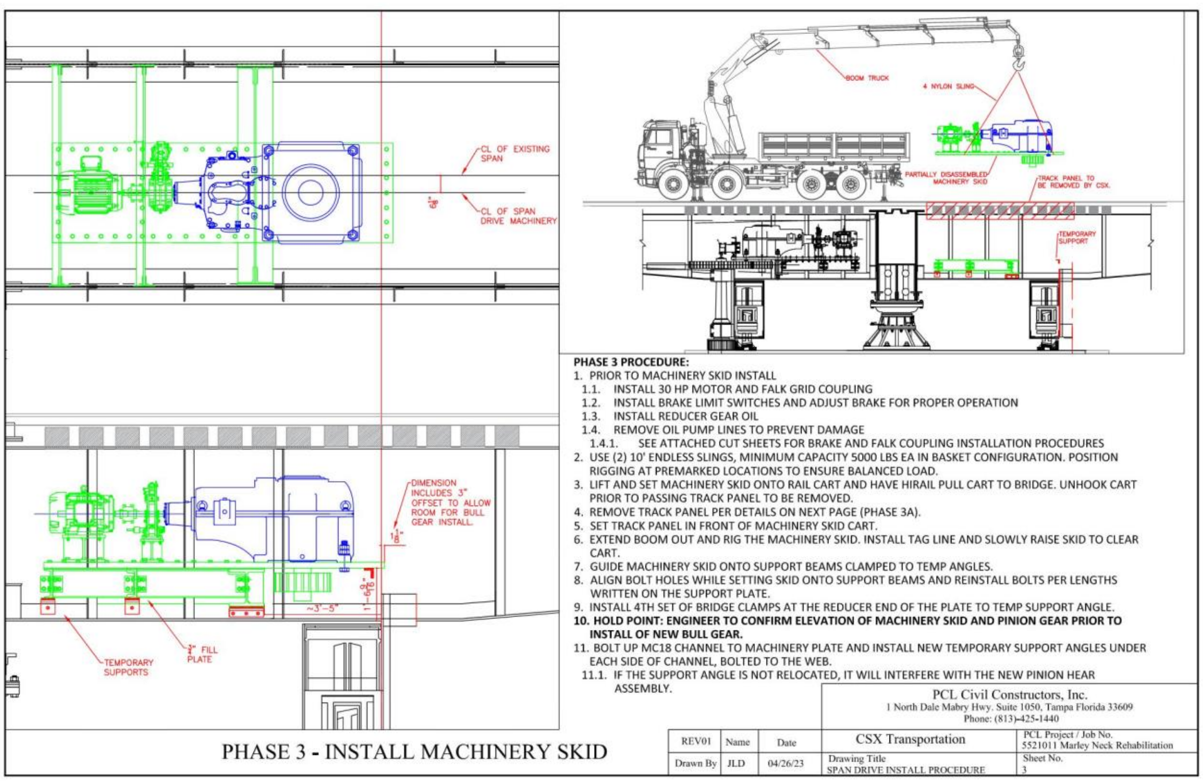
Figure 21: Track Panel Removed and New Machinery Skid Installed

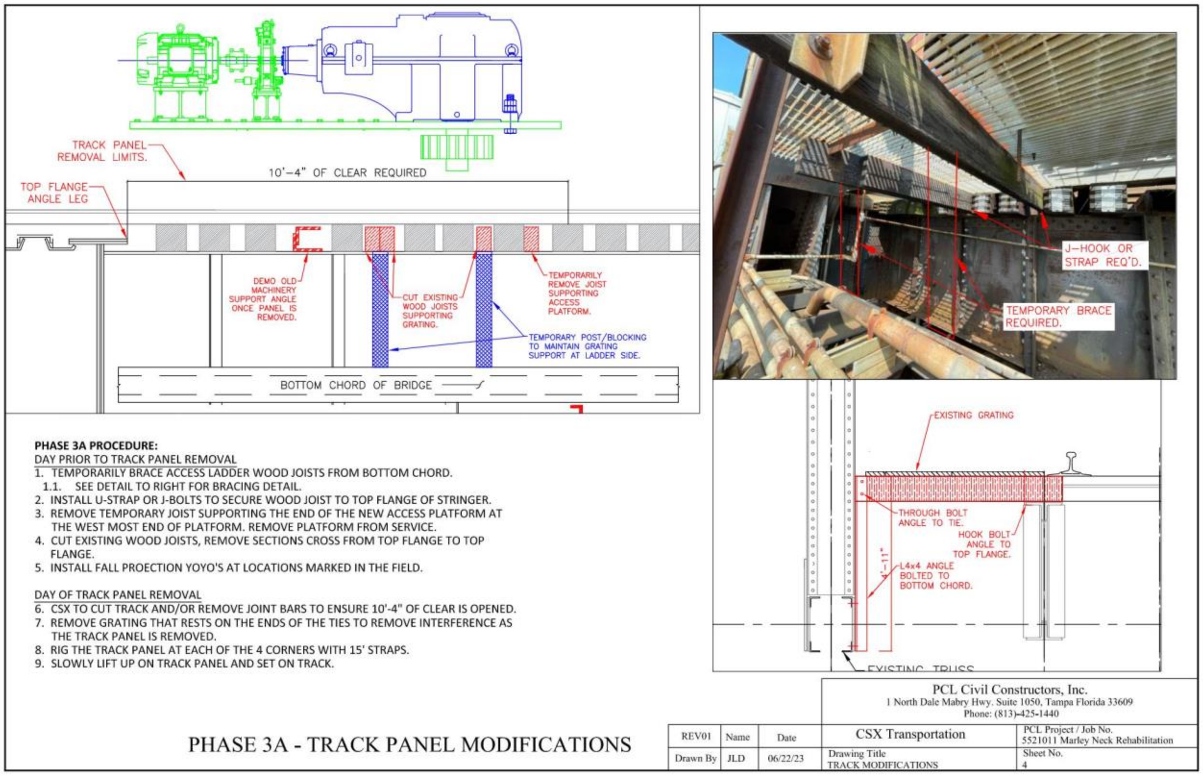
Supplemental Attachment

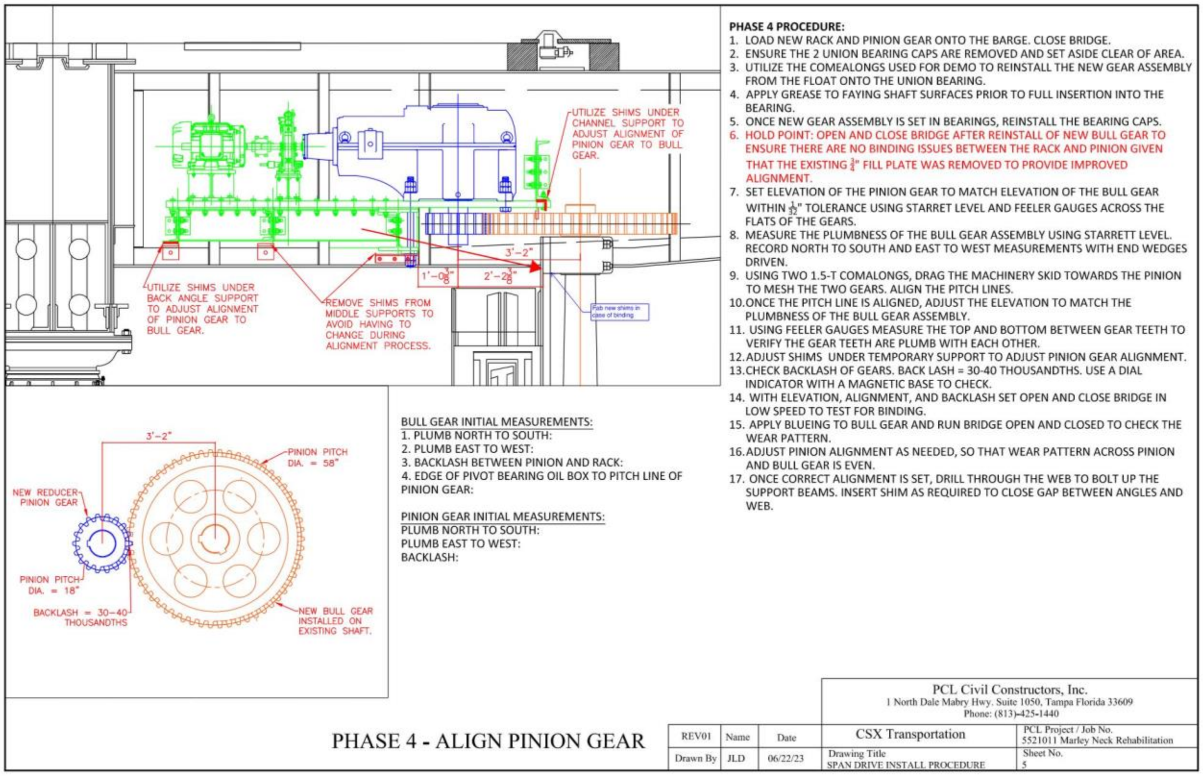





PHASE 2 PROCEDURE:
1. BREAKDOWN MACHINERY SKID AS DESCRIBED BELOW.
2. ONCE ALL DEMOED MATERIALS ARE REMOVED, INSTALL (8) EA TEMPORARY SUPPORT ANGLES AS SHOWN TO THE LEFT. LOCATE AS DEPICTED.
3. STARTING FROM LEFT TO RIGHT OF THE PAGE, STICK BUILD THE MACHINERY SKID SUPPORT BETWEEN THE BRIDGE GIRDERS.
3.1. SET AND CLAMP CROSS BEAMS 1, 2 AND 3 ON TO TEMPORARY SUPPORTS.
3.2. INSTALL 4 LONGITUDINAL C CHANNELS AND BOLT UP TO CROSS BEAMS.
4. ONCE THE FRAME IS ASSEMBLED, CLAMP DOWN TO TEMPORARY ANGLE SUPPORTS WITH (6) BRIDGE CLAMPS.
4.1. HOLD POINT: ENGINEER TO VERIFY ASSEMBLY OF MACHINERY SUPPORT. CHECK ELEVATION AND HORIZONTAL POSITION RELATIVE TO NEW SHAFT ASSEMBLY LOCATION.
5. ADJUST SKID 3" BACK (OR MORE) TO ALLOW ROOM FOR NEW SHAFT ASSEMBLY INSTALL.
6. RECLAMP TO PREPARE FOR MACHINERY SKID INSTALL.
TEMPORARY SUPPORT ANGLE FOR SKID OVERHANG
HORIZONTAL LAYOUT DATUM FROM FACE OF EXTERIOR WEB.
VERTICAL LAYOUT DATUM FROM FACE OF EXTERIOR WEB.
1. INSTALL TEMPORARY SKID SUPPORT ANGLE USING EXISTING FLANGE RIVETS.
2. STICK BUILD SKID SUPPORT BEAMS IN BETWEEN GIRDERS. START FROM BACK TO FRONT.
ENSURE CORRECT ORIENTATION OF MOUNTING BEAMS DUE TO OFF SET CENTERLINE.
℄ SPAN
℄ NEW SPAN DRIVE MACHINERY ASSEMBLY (TYP.)
1. REMOVE BACK 2 LONGER TURNED BOLTS FOR REDUCER 2 BOLTS TO REMAIN TO MAINTAIN REDUCER ALIGNMENT
2. UNBOLT FORWARD SUPPORT CHANNEL.
3. UNBOLT 2" THICK UPPER SKID PLATE
4. BREAKDOWN MACHINERY SKID SUPPORT BEAMS.
5. MOUNT AND COUPLE NEW 30 HP MOTOR.
PHASE 2 - ASSEMBLE MACHINERY SUPPORT SKID
PCL Civil Constructors, Inc.
1 North Dale Mabry Hwy. Suite 1050, Tampa Florida 33609
Phone: (813)-425-1440
REV01 Name Date
CSX Transportation
PCL Project / Job No. 5521011 Marley Neck Rehabilitation
Drawn By JLD 04/26/23
Drawing Title SPAN DRIVE INSTALL PROCEDURE
Sheet No. 3


BOOM TRUCK
4 NYLON SLING
PARTIALLY DISASSEMBLED MACHINERY SKID
TRACK PANEL TO BE REMOVED BY CSX.
TEMPORARY SUPPORT
CL OF EXISTING SPAN
CL OF SPAN DRIVE MACHINERY
DIMENSION INCLUDES 3" OFFSET TO ALLOW ROOM FOR BULL GEAR INSTALL.
TEMPORARY SUPPORTS
$\frac{3}{4}$" FILL PLATE
PHASE 3 PROCEDURE:
1. PRIOR TO MACHINERY SKID INSTALL
1.1. INSTALL 30 HP MOTOR AND FALK GRID COUPLING
1.2. INSTALL BRAKE LIMIT SWITCHES AND ADJUST BRAKE FOR PROPER OPERATION
1.3. INSTALL REDUCER GEAR OIL
1.4. REMOVE OIL PUMP LINES TO PREVENT DAMAGE
1.4.1. SEE ATTACHED CUT SHEETS FOR BRAKE AND FALK COUPLING INSTALLATION PROCEDURES
2. USE (2) 10' ENDLESS SLINGS, MINIMUM CAPACITY 5000 LBS EA IN BASKET CONFIGURATION. POSITION RIGGING AT PREMARKED LOCATIONS TO ENSURE BALANCED LOAD.
3. LIFT AND SET MACHINERY SKID ONTO RAIL CART AND HAVE HIRAIL PULL CART TO BRIDGE. UNHOOK CART PRIOR TO PASSING TRACK PANEL TO BE REMOVED.
4. REMOVE TRACK PANEL PER DETAILS ON NEXT PAGE (PHASE 3A).
5. SET TRACK PANEL IN FRONT OF MACHINERY SKID CART.
6. EXTEND BOOM OUT AND RIG THE MACHINERY SKID. INSTALL TAG LINE AND SLOWLY RAISE SKID TO CLEAR CART.
7. GUIDE MACHINERY SKID ONTO SUPPORT BEAMS CLAMPED TO TEMP ANGLES.
8. ALIGN BOLT HOLES WHILE SETTING SKID ONTO SUPPORT BEAMS AND REINSTALL BOLTS PER LENGTHS WRITTEN ON THE SUPPORT PLATE.
9. INSTALL 4TH SET OF BRIDGE CLAMPS AT THE REDUCER END OF THE PLATE TO TEMP SUPPORT ANGLE.
10. HOLD POINT: ENGINEER TO CONFIRM ELEVATION OF MACHINERY SKID AND PINION GEAR PRIOR TO INSTALL OF NEW BULL GEAR.
11. BOLT UP MC18 CHANNEL TO MACHINERY PLATE AND INSTALL NEW TEMPORARY SUPPORT ANGLES UNDER EACH SIDE OF CHANNEL, BOLTED TO THE WEB.
11.1. IF THE SUPPORT ANGLE IS NOT RELOCATED, IT WILL INTERFERE WITH THE NEW PINION HEAR ASSEMBLY.
PHASE 3 - INSTALL MACHINERY SKID
PCL Civil Constructors, Inc.
1 North Dale Mabry Hwy. Suite 1050, Tampa Florida 33609
Phone: (813)-425-1440
REV01 Name Date
CSX Transportation
PCL Project / Job No. 5521011 Marley Neck Rehabilitation
Drawn By JLD 04/26/23
Drawing Title SPAN DRIVE INSTALL PROCEDURE
Sheet No. 3


TRACK PANEL REMOVAL LIMITS.
10'-4" OF CLEAR REQUIRED
TOP FLANGE ANGLE LEG
DEMO OLD MACHINERY SUPPORT ANGLE ONCE PANEL IS REMOVED.
CUT EXISTING WOOD JOISTS SUPPORTING GRATING.
TEMPORARILY REMOVE JOIST SUPPORTING ACCESS PLATFORM.
TEMPORARY POST/BLOCKING TO MAINTAIN GRATING SUPPORT AT LADDER SIDE.
BOTTOM CHORD OF BRIDGE
J-HOOK OR STRAP REQ'D.
TEMPORARY BRACE REQUIRED.
EXISTING GRATING
THROUGH BOLT ANGLE TO TIE.
HOOK BOLT ANGLE TO TOP FLANGE.
1'-11"
L4x4 ANGLE BOLTED TO BOTTOM CHORD.
PHASE 3A PROCEDURE:
DAY PRIOR TO TRACK PANEL REMOVAL
1. TEMPORARILY BRACE ACCESS LADDER WOOD JOISTS FROM BOTTOM CHORD.
1.1. SEE DETAIL TO RIGHT FOR BRACING DETAIL.
2. INSTALL U-STRAP OR J-BOLTS TO SECURE WOOD JOIST TO TOP FLANGE OF STRINGER.
3. REMOVE TEMPORARY JOIST SUPPORTING THE END OF THE NEW ACCESS PLATFORM AT THE WEST MOST END OF PLATFORM. REMOVE PLATFORM FROM SERVICE.
4. CUT EXISTING WOOD JOISTS, REMOVE SECTIONS CROSS FROM TOP FLANGE TO TOP FLANGE.
5. INSTALL FALL PROECTION YOYO'S AT LOCATIONS MARKED IN THE FIELD.
DAY OF TRACK PANEL REMOVAL
6. CSX TO CUT TRACK AND/OR REMOVE JOINT BARS TO ENSURE 10'-4" OF CLEAR IS OPENED.
7. REMOVE GRATING THAT RESTS ON THE ENDS OF THE TIES TO REMOVE INTERFERENCE AS THE TRACK PANEL IS REMOVED.
8. RIG THE TRACK PANEL AT EACH OF THE 4 CORNERS WITH 15' STRAPS.
9. SLOWLY LIFT UP ON TRACK PANEL AND SET ON TRACK.
PCL Civil Constructors, Inc.
1 North Dale Mabry Hwy. Suite 1050, Tampa Florida 33609
Phone: (813)-425-1440
PHASE 3A - TRACK PANEL MODIFICATIONS
REV01 | Name | Date
Drawn By | JLD | 06/22/23
CSX Transportation
Drawing Title
TRACK MODIFICATIONS
PCL Project / Job No.
5521011 Marley Neck Rehabilitation
Sheet No.
4


UTILIZE SHIMS UNDER CHANNEL SUPPORT TO ADJUST ALIGNMENT OF PINION GEAR TO BULL GEAR.
3'-2"
1'-0 3/8"
2'-2 3/8"
UTILIZE SHIMS UNDER BACK ANGLE SUPPORT TO ADJUST ALIGNMENT OF PINION GEAR TO BULL GEAR.
REMOVE SHIMS FROM MIDDLE SUPPORTS TO AVOID HAVING TO CHANGE DURING ALIGNMENT PROCESS.
Fab new shims in case of binding
3'-2"
PINION PITCH DIA. = 58"
NEW REDUCER PINION GEAR
PINION PITCH DIA. = 18"
BACKLASH = 30-40 THOUSANDTHS
NEW BULL GEAR INSTALLED ON EXISTING SHAFT.
BULL GEAR INITIAL MEASUREMENTS:
1. PLUMB NORTH TO SOUTH:
2. PLUMB EAST TO WEST:
3. BACKLASH BETWEEN PINION AND RACK:
4. EDGE OF PIVOT BEARING OIL BOX TO PITCH LINE OF PINION GEAR:
PINION GEAR INITIAL MEASUREMENTS:
PLUMB NORTH TO SOUTH:
PLUMB EAST TO WEST:
BACKLASH:
PHASE 4 PROCEDURE:
1. LOAD NEW RACK AND PINION GEAR ONTO THE BARGE. CLOSE BRIDGE.
2. ENSURE THE 2 UNION BEARING CAPS ARE REMOVED AND SET ASIDE CLEAR OF AREA.
3. UTILIZE THE COMEALONGS USED FOR DEMO TO REINSTALL THE NEW GEAR ASSEMBLY FROM THE FLOAT ONTO THE UNION BEARING.
4. APPLY GREASE TO FAYING SHAFT SURFACES PRIOR TO FULL INSERTION INTO THE BEARING.
5. ONCE NEW GEAR ASSEMBLY IS SET IN BEARINGS, REINSTALL THE BEARING CAPS.
6. HOLD POINT: OPEN AND CLOSE BRIDGE AFTER REINSTALL OF NEW BULL GEAR TO ENSURE THERE ARE NO BINDING ISSUES BETWEEN THE RACK AND PINION GIVEN THAT THE EXISTING 3/4" FILL PLATE WAS REMOVED TO PROVIDE IMPROVED ALIGNMENT.
7. SET ELEVATION OF THE PINION GEAR TO MATCH ELEVATION OF THE BULL GEAR WITHIN 1/32" TOLERANCE USING STARRET LEVEL AND FEELER GAUGES ACROSS THE FLATS OF THE GEARS.
8. MEASURE THE PLUMBNESS OF THE BULL GEAR ASSEMBLY USING STARRETT LEVEL. RECORD NORTH TO SOUTH AND EAST TO WEST MEASUREMENTS WITH END WEDGES DRIVEN.
9. USING TWO 1.5-T COMALONGS, DRAG THE MACHINERY SKID TOWARDS THE PINION TO MESH THE TWO GEARS. ALIGN THE PITCH LINES.
10. ONCE THE PITCH LINE IS ALIGNED, ADJUST THE ELEVATION TO MATCH THE PLUMBNESS OF THE BULL GEAR ASSEMBLY.
11. USING FEELER GAUGES MEASURE THE TOP AND BOTTOM BETWEEN GEAR TEETH TO VERIFY THE GEAR TEETH ARE PLUMB WITH EACH OTHER.
12. ADJUST SHIMS UNDER TEMPORARY SUPPORT TO ADJUST PINION GEAR ALIGNMENT.
13. CHECK BACKLASH OF GEARS. BACK LASH = 30-40 THOUSANDTHS. USE A DIAL INDICATOR WITH A MAGNETIC BASE TO CHECK.
14. WITH ELEVATION, ALIGNMENT, AND BACKLASH SET OPEN AND CLOSE BRIDGE IN LOW SPEED TO TEST FOR BINDING.
15. APPLY BLUEING TO BULL GEAR AND RUN BRIDGE OPEN AND CLOSED TO CHECK THE WEAR PATTERN.
16. ADJUST PINION ALIGNMENT AS NEEDED, SO THAT WEAR PATTERN ACROSS PINION AND BULL GEAR IS EVEN.
17. ONCE CORRECT ALIGNMENT IS SET, DRILL THROUGH THE WEB TO BOLT UP THE SUPPORT BEAMS. INSERT SHIM AS REQUIRED TO CLOSE GAP BETWEEN ANGLES AND WEB.
PCL Civil Constructors, Inc.
1 North Dale Mabry Hwy. Suite 1050, Tampa Florida 33609
Phone: (813)-425-1440
PHASE 4 - ALIGN PINION GEAR
REV01 | Name | Date
Drawn By | JLD | 06/22/23
CSX Transportation
Drawing Title
SPAN DRIVE INSTALL PROCEDURE
PCL Project / Job No.
5521011 Marley Neck Rehabilitation
Sheet No.
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Span Drive Turnover Sequence Risks and Mitigation

Action No.	Action Scope	Action Description	Action Duration	Bridge Position	Risks	Risk Rating	Mitigation
1	Mechanical	Install differential chock torque arm and remove bevel gear assembly.	3 Hours	Open	Delay train due to bridge not closing due to : 1. Welds not being completed 2. Gear not removed in time 3. Mechanical issue with existing span drive	A	1. Schedule train traffic with CSX 2. Begin work earlier that day, 5-6A 3. Test bridge on 1 motor prior to train arriving 4. Tighten all existing bearing and inspection machinery days prior to beginning work 5. Keep bridge in low speed when testin
2	Electrical	Disconnect motor power from VFD. Reduce to existing VFD to 1/2 speed. Manually disengage motor brake on span drive with differential chock.	1 Hour	Open	Delay train due to bridge not closing due to: 1. VFD fault and speed issues 2. Motor brake interlock	A	1. CWE controls/programmer to be on-site during testing 2. Keep VFD that runs demoed system, on, to avoid comms fault 3. Jump out brake LS feedback
Bridge should be 100% operable on 1 span drive system before continuing to next action.							
3	Electrical	Relocate existing motor conduit/wiring	1 Hour	Open	1. Potential to damage of existing wires to be reused	C	1. Properly protect conduit and wires from torch slag and impact damage from demoed materials 2. After demo is complete, have CWE recheck wiring
4	Mechanical	Remove existing span drive motor, relocate in vicnity of other span drive motor. Run bridge on single motor and cut main shaft.	4 Hours	Open or Closed	Delays to marine or rail traffic due to: 1. Failure of single motor operating span 2. Failure of existing mechanical equipment	A	1. Keep rigging in place to easily swap motors out in event of motor failure 2. Tighten, grease, and inspect span drive machinery prior to beginning demo work. Replace bolts where needed. 3. Means to manually operate bridge?
5	Mechanical	Remove existing rack gear shaft assembly	1 Hour	Closed	Delay of marine traffic due to: 1. Taking too long to demo shaft assembly	B	1. Utilize 2 Hour Notice to open deviation 2. Check with for shceduled openings and USCG traffic prior to beginning task 3. Set up all rigging day prior to removal
6	Mechanical	Remove all existing span drive machinery	5 Days	Open and Closed	1. Damage of center wedge gearing below 2. Damage to eixsting electrical components in demo vicinity	B	1. Protect center wedge gearing from slag/sparks 2. It is critical to not drop demoed materials onto gearing. Set up proper rigging and protection of existing equipment prior to beginning work 3. Cover all limit switch wiring, cables, and conduit to protect from slag. Mark/record position of limit switches in the area if bumped 4. Test open bridge at end of each day 5. Avoid bridge operations as much as possible
7	Mechanical	Set new machinery supports in place	3 Days	Open and Closed	No high risk to marine or rail traffic, or existing equipment.	C	
8	Mechanical	Set new machinery skid in place	1 Day	Closed	Delay of marine traffic due to: 1. Bridge being in closed position Delay of train traffic due to: 1. Track panel being removed too long	B	1. Schedule train traffic with CSX 2. Begin work earlier that day, 5-6A 3. Check for shcedule openings 3. Set up all rigging day prior to removal 4. Complete track panel modifications prior to skid install
9	Mechanical	Set new pinion shaft assembly in place	1 Day	Closed	Delay of marine traffic due to: 1. Bridge being in closed position	C	1. Utilize 2 hour notice to open deviation 2. Check with for scheduled openings and USCG traffic prior to beginning task 3. Set up all rigging day prior to install
10	Mechanical	Align Machinery	3 Days	Open and Closed	Delay of marine traffic and train traffic due to: 1. Gear binding 2. Damage of new machinery	B	1. Check for binding between rack and pinion gear prior to aligning machinery skid to bull gear. 2. Check for binding between bull and pinion gears prior to train traffic arriving 3. Ensure motor brake is relased at all times. Install lock out device to keep brake disengaged 4. Ensure bridge clamps are well secured or bolt up skid with undersized holes prior to running machinery 5. Ensure oil is in reducer and components are greased
11	Electrical	Terminate motor leads	1/2 Day	Open	1. Existing wiring damaged 2. Existing wiring too short 3. Wrong phase direction	C	1. Verify wiring length and condition as soon as machinery skid is set. Megger wires 2. Run new cable prior to termination of motor 3. Bump motor prior to connectiong falk coupling
12	Electrical	Terminate brake leads	1/2 Day	Open	1. Existing wiring damaged 2. Existing wiring too short	C	1. Verify wiring length and condition as soon as machinery skid is set. Megger wires. 2. Run new cable prior to termination of motor
13	Electrical	Test new motor on existing VFD	1 Day	Open & Closed	1. Delay of marine and rail traffic due to VFD issues 2. Control system faults due to brake interlocks 3. New motor not operating on existing VFD 4. Motor running wrong direction 5. New system not synced with existing system	B	1. Ensure CWE controls/programmer on-site for VFD modifications 2. Test new motor on existing VFD prior to machinery demo? 3. Install new VFD into existing system, have manual drive system prepared. 4. Bump motor to test direction prior to connecting falk coupling 5. Release brake of existing system prior to testing new system. 6. Unhook old motor on opposite side prior to testing new system
14	Electrical/Mechanical	Turnover resolver feedback	1 Day	Open	Unable to tie in new resolver to existing system Bridge not operational due to loss of resolver feedback	B	1. CWE programmer to provide support when installing RCLS 2. On-site to jump out resolver feedback in existing program 3. Reinstall existing resolver onto new span drive system
15	Electrical/Mechanical	Test new span drive system	1 Week	Open and Closed	Delay of marine traffic or trains due to: 1. Mechanical failure 2.	A	Continuously check conditions