HEAVY MOVABLE STRUCTURES, INC.

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"Team Tackles Complex BNSF Span Rehab"

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TEAM TACKLES COMPLEX BNSF SWING SPAN REHABILITATION

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INTRODUCTION

HDR Engineering, Inc. in partnership with the Burlington Northern Santa Fe Railroad (BNSF) are performing a complete rehabilitation of the mechanical and electrical equipment on this 92-year-old, 462-foot long, rim bearing through truss swing span. This portion of the project was the third phase of this five-year rehabilitation project. This project is a combination of detailed design and complex planning using multiple contractors, design build techniques, owner-supplied equipment to contractors, and BNSF personnel providing portions of the labor. The BNSF will spend nearly $5,000,000 rehabilitating this swing span, but are limited to spend under $950,000 per year. This particular phase was highlighted by the in-place field installation of two new main drive turning machinery enclosed gear reducers complete with new main drives, auxiliary drives and a state of the art control system.

BNSF BRIDGE 9.6 HISTORY

Several years ago the BNSF started to experience operational difficulties with the movable span. The movable span occasionally would not re-align with the rest piers and failed to line up the rails for passage of rail traffic. In 1991, a segmental gear on the Vancouver end lift operating mechanism fractured and consequently halted vessel navigation through Bridge 9.6 for 4 days. The segment gear had to be field welded back together in order to restore span operation. Several other less severe mechanical and electrical equipment problems have also occurred prompting additional concern about the continued reliability of the swing span. The original equipment was designed for 600 Volts AC. The Power Company can no longer furnish this voltage to the bridge, so the current line is feeding the bridge at approximately 535 Volts. Over the years, this voltage difference combined with the wiring problems from the shore to the span has decreased the reliability of the electrical system.

Since the power was becoming less and less reliable, the equipment was becoming or had become obsolete. The BNSF decided to include modern electrical equipment as part of the rehabilitation. This decision effected every electrical operating system on the bridge. This swing span has electric motors that operate the end lift mechanisms, the easer bar rail joints, the air horn compressor, and the main drive turning machinery. The drive control system and signal system is also effected by the change to modern electrical equipment.

Before any replacement of the end lift equipment could begin, new power and control systems have to be in place to operate the new equipment. The existing control and power equipment would have to remain operational until all of the new equipment had been install and the existing equipment was no longer needed.

One of the more noticeable problems was that the electric slip ring at the center of the bridge was not always making contact. The slip ring allows the electric power from the shore onto the swing span without using an aerial cable or dragging a loop cable on the center pivot pier. The power on this span comes from an underground submarine cable rather than from an overhead aerial cable. This allows vessels of nearly any height to pass through the navigation opening. The slip ring was known to be in fair condition, however, closer examination indicated that there were other concerns.

The rim bearing swing span is guided by a bearing located in the center of the bridge and is partially buried in the center pivot pier concrete. This bearing was worn to the point that the span could move nearly 2 inches out of round. This was sufficient to cause the slip ring to lose contact with one or more of its power conductors. The worn center bearing also attributed to some of the rail locking difficulties. The center bearing wear has caused the span opening and closing failures to quadruple in less than six months time. It was determined that a worn center bearing pin was the cause of the out of round movement. A new center bearing pin was installed in March 1999. This additional immediate work was unplanned for in the rehabilitation sequence and therefore a new adjusted work sequence was made.

The study of upgrading and rehabilitating the span continued to grow. The rail joints on each end of the swing span were old and in poor condition. These old joints limited operation of rail traffic across the movable span to 25 MPH. The electric motors for the main drive turning machinery were not of current design and discussion of upgrading these motors also ensued. As the cost estimates were developed, the project quickly neared $5,000,000. The BNSF is unable to easily fund such a large project in a single budget year. This would have been nearly 20 percent of the total capital budget for bridges in 1999. Therefore, a staged year by year rehabilitation sequence was agreed upon.

SOLUTION

BNSF Bridge 9.6 was originally constructed in 1908 and is a 462-foot rim bearing through truss swing span that holds double mainline tracks which carry nearly 80 BNSF and Union Pacific Railroad (UPRR) freight trains plus 8 Amtrak trains per day. This span is located between Portland, Oregon and Vancouver, Washington crossing the Columbia River. The bridge is over one half mile long and provides a major link for the BNSF and UPRR West coast operations. The swing span is also operated approximately 15 to 25 times per day to allow for passage of navigation vessels. This crossing is a major transit point on the Columbia and Snake Rivers for barge traffic coming into port or going out to sea.

Since the electrical power was becoming less and less reliable and the mechanical operating equipment was obsolete, the BNSF decided to update the mechanical operating systems and electrical control systems to modern equipment. The trick was that the existing control and power equipment must remain operational until all of the new equipment has been installed and the existing equipment is no longer needed. This meant a dual control system would be used for a period of time when the new equipment was being installed.

The rehabilitation will include replacement of the entire electrical power and control systems on the swing span while maintaining rail traffic and river navigation. Replacement of the bridges end lift operating machinery was performed during a navigation closure in March 2000. The turning machinery first primary reduction gearing, drive motor and brake assemblies is being replaced under rail traffic currently. A new span lock will be installed during a March 2001 closure. The span lock is designed to align the bridge before the new three-piece joints are installed. The existing easer bar rail joint mechanisms and machinery will be replaced with new three-piece manganese rail joints in October 2001. The rail joints and the steel tie supports under the joints will be replaced during 6-hour track windows and river navigation windows.

This type of staged bridge rehabilitation is a continuing program by the BNSF to update the movable bridges on their system. The BNSF and HDR obtained navigation closure in March 2000 to install the machinery necessary to operate the end lifts. During the end lift installation portions of structural steel ties necessary to support the rail joints at the ends of the swing span and the ends of the adjacent approach spans will be replaced. HDR has finished designing the rail joint machinery phase to this rehabilitation project so the BNSF could order equipment this year. The equipment will take nearly 8 months to arrive on site for installation in March 2001. The new three-piece rail joints have been ordered to allow for the joints to arrive early 2001 for installation in October 2001.

CURRENT CONSTRUCTION ISSUES

The BNSF and HDR have developed a plan of design using design build techniques and owner construction crew to rehabilitate this bridge over a five-year period. This plan is shaped by a number of issues that are listed below, however, for this discussion all issues are not discussed in detail:

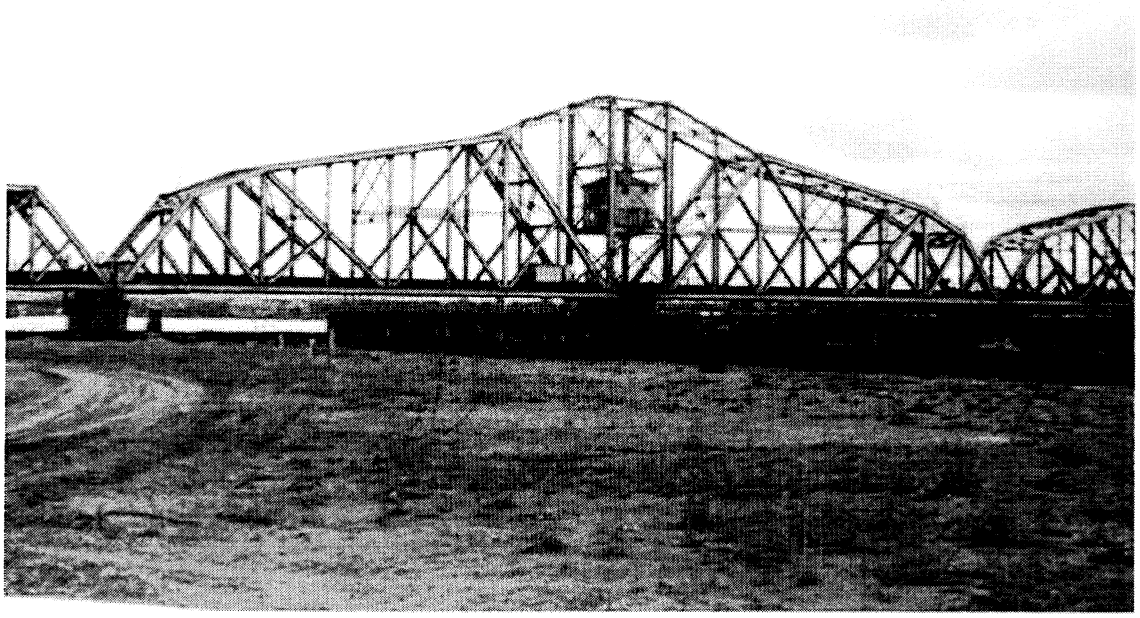
- The Bridge can only be closed to navigation for a maximum of 10 days in March of each year with an opening after 5 days for a minimum of 12 hours.
- Construction work has to be completed by November of each year due to high traffic volumes during the holiday periods of each year.
- All dollars allocated each calendar year have to be spent prior to the end of the calendar year or that funding is lost.
- Long lead items will have to be ordered in advance and arrive between January and February to allow for payment and for preparation for installation in March.
- The swing span has to remain operational except during navigation closures.

- The swing span is to remain operational in both the clockwise and counterclockwise directions during and after construction.
- The 115 RE on the bridge and the approaches will remain for the immediate future. The new rail joints will be 136RE joints.
- The maximum rail closure for one track will be 12 hours at night or 6 hours during daylight hours on a weekend. The majority of river traffic is at night; therefore the closure will likely occur during the two- week navigation closure in March.

PROJECT SCHEDULE

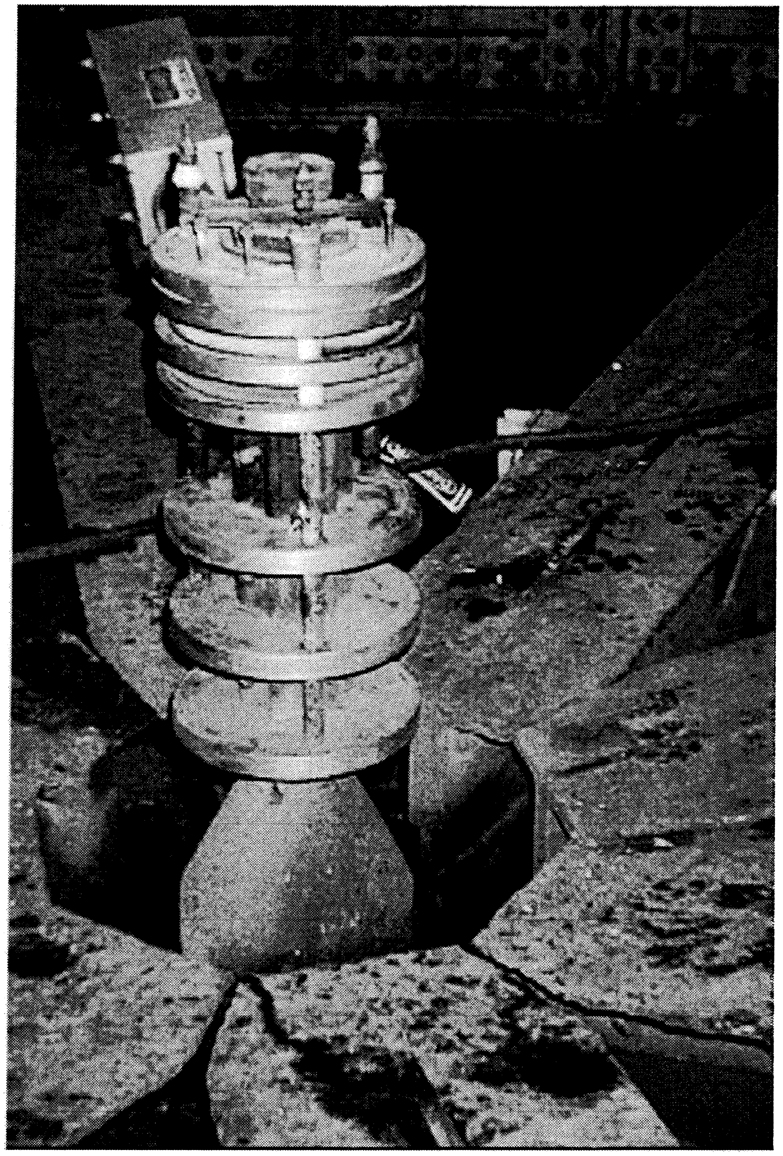
The current design, procurement, construction and equipment changeout is as follows:

- March 1999 – Replaced the Center Bearing Pin. Delayed installation of the end lift machinery until March 2000.
- July 1999 – Finished Phase I of the new electrical control and power distribution center.
- Designed the supports for the new 3-piece rail joints. Part of this design effort included the development of a standard high-speed three-piece rail joint for use on any BNSF movable bridge.
- Designed new computerized bridge operation and control systems for procurement in late 1999 and installation in spring 2000.
- Designed the new turning machinery and supports for procurement in fall 2000 and installation in March 2001.
- February 2000 – Complete testing of the new end lift control system. This will include operating the new endlift machinery without the machinery being engaged to the endlift push rods. The new machinery is located in each quadrant of the movable span and controlled electrically. The existing control was per end and controlled mechanically.
- March 2000 – Install end lift machinery. During installation of the end lift machinery, remove the existing rail joint assemblies and replace the steel supporting ties with new ties modified to accommodate the existing rail joints and the new 3 piece rail joints planned for installation in March 2001.
- Designed new span lock, supports and operating machinery for procurement in February 2001.
- Summer 2000 – Procure supports for the turning machinery. BNSF personnel will install equipment in October 2000.
- March 2001 – Install new span locks.
- Spring 2000 – Procure the three-piece rail joints and machinery for delivery in January 2001.
- October 2001 – Install new three-piece rail joints and operating machinery.

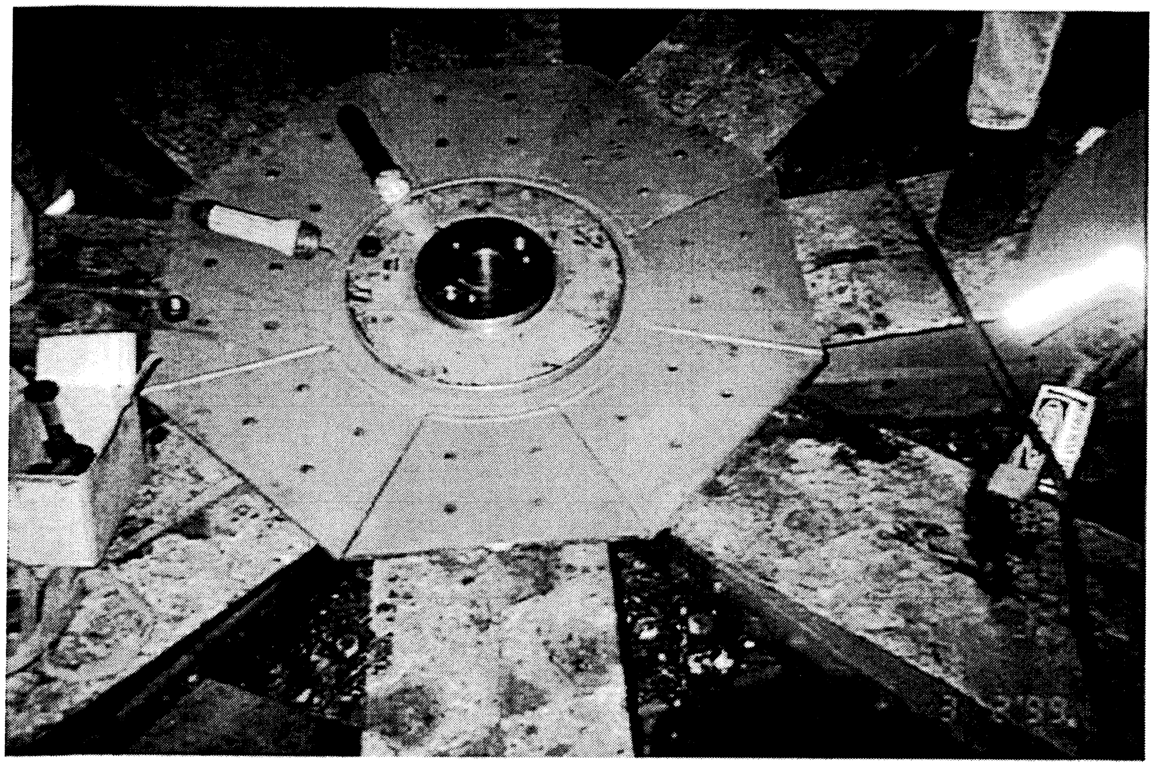


Photograph 1: Elevation View Looking East

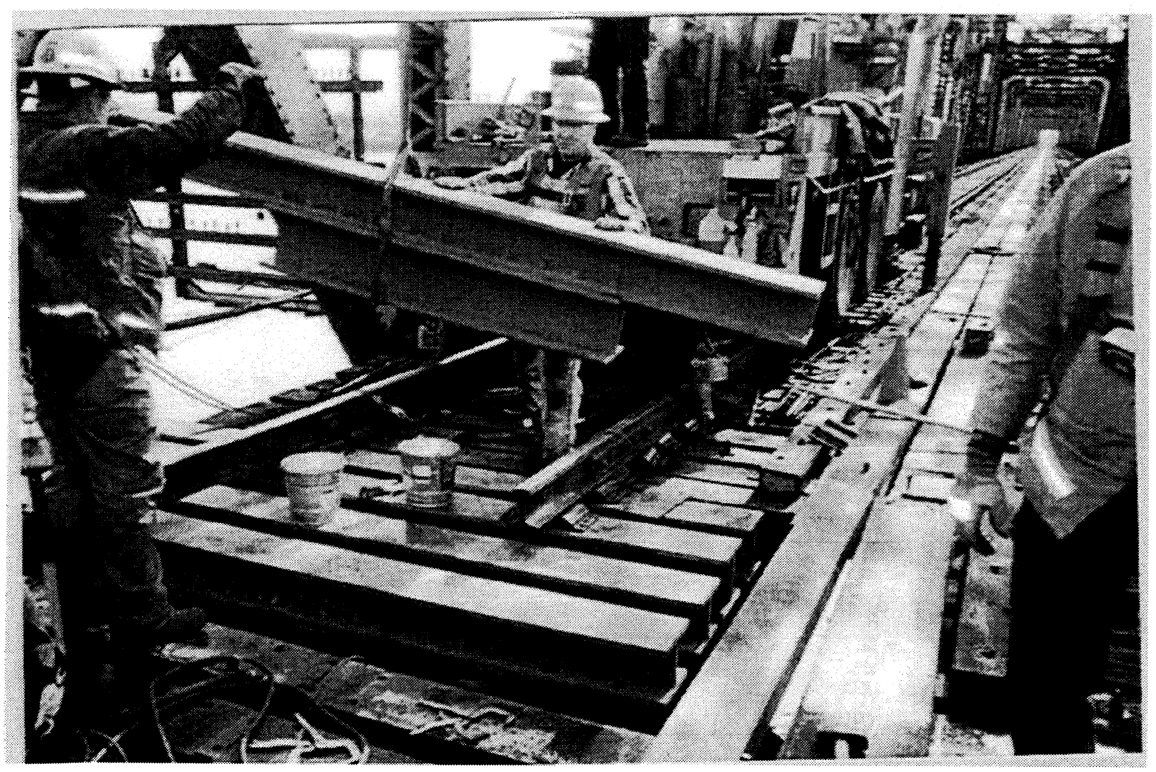
Photograph 2: Elevation View Looking Southwest



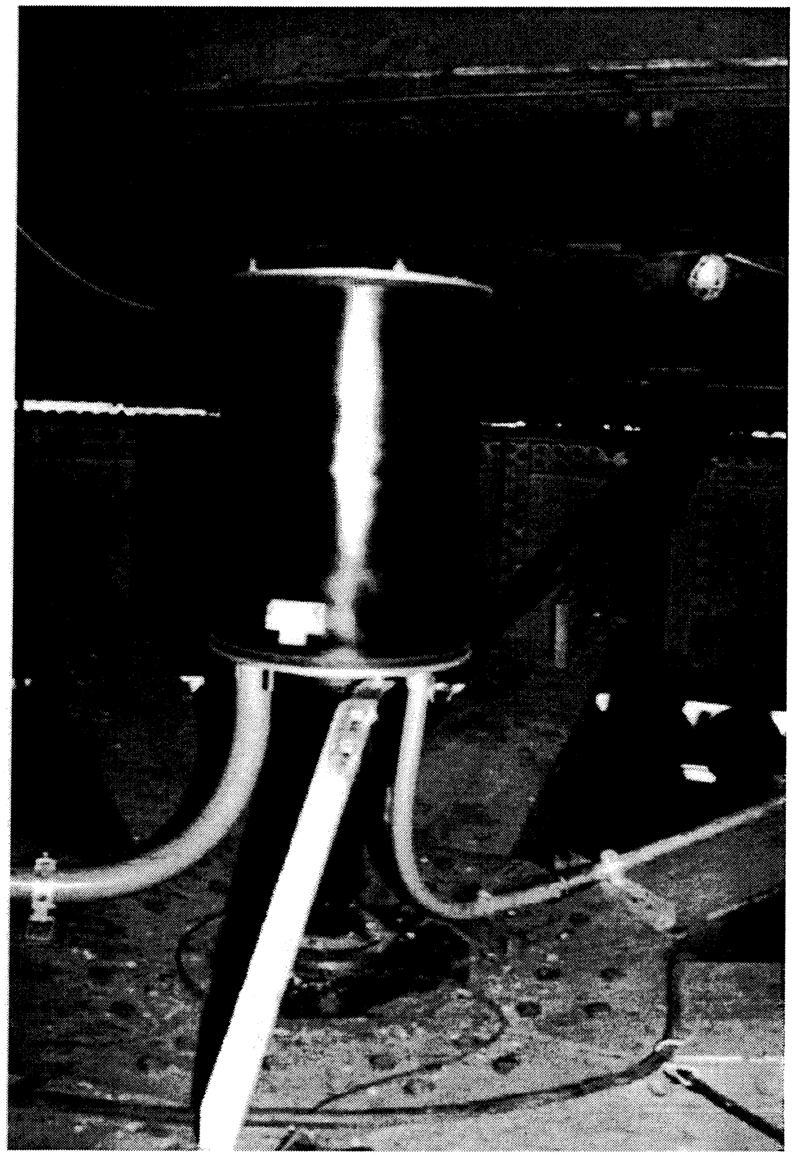
Photograph 3: Old Slip Ring Located at Center of Bridge



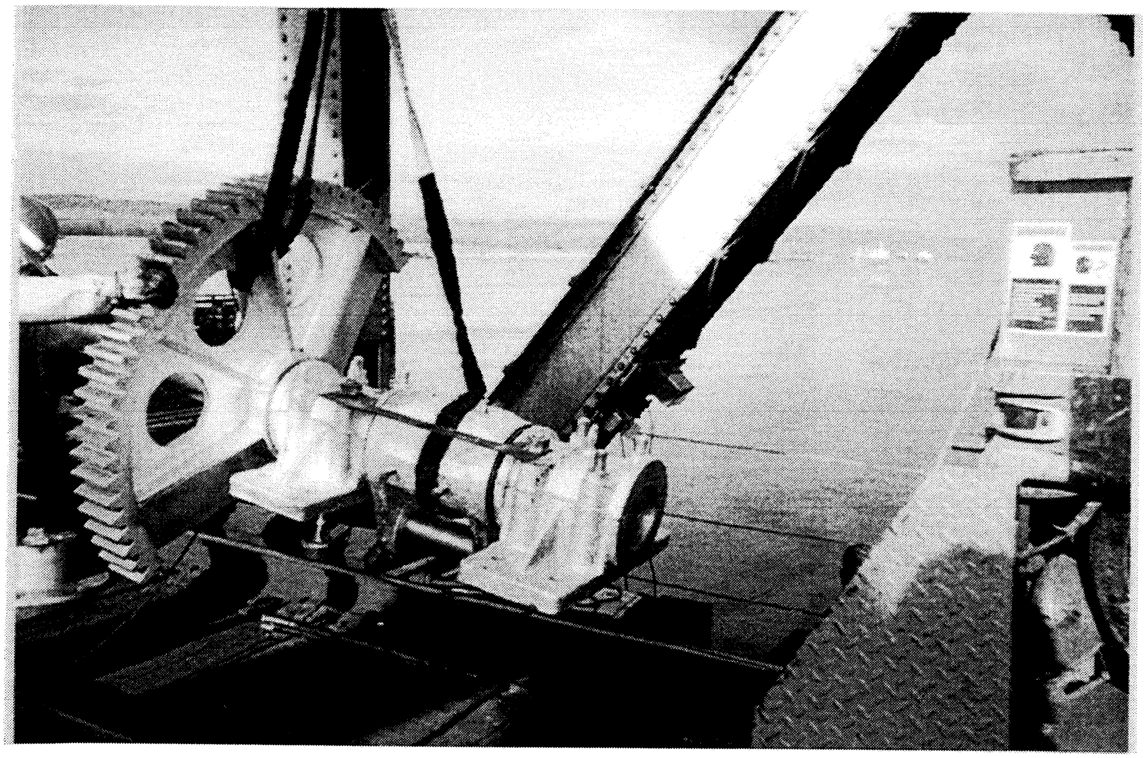
Photograph 4: New Center Bearing Repairs



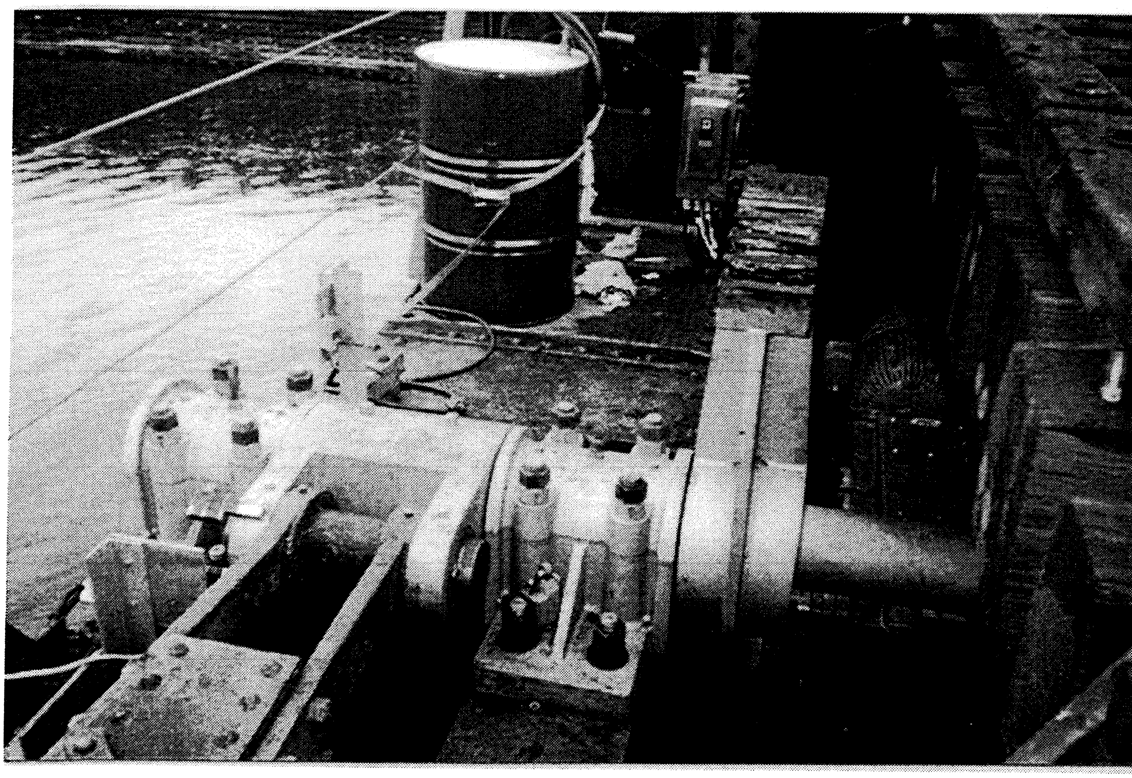
Photograph 5: Installation of New Steel Belly Beam Ties



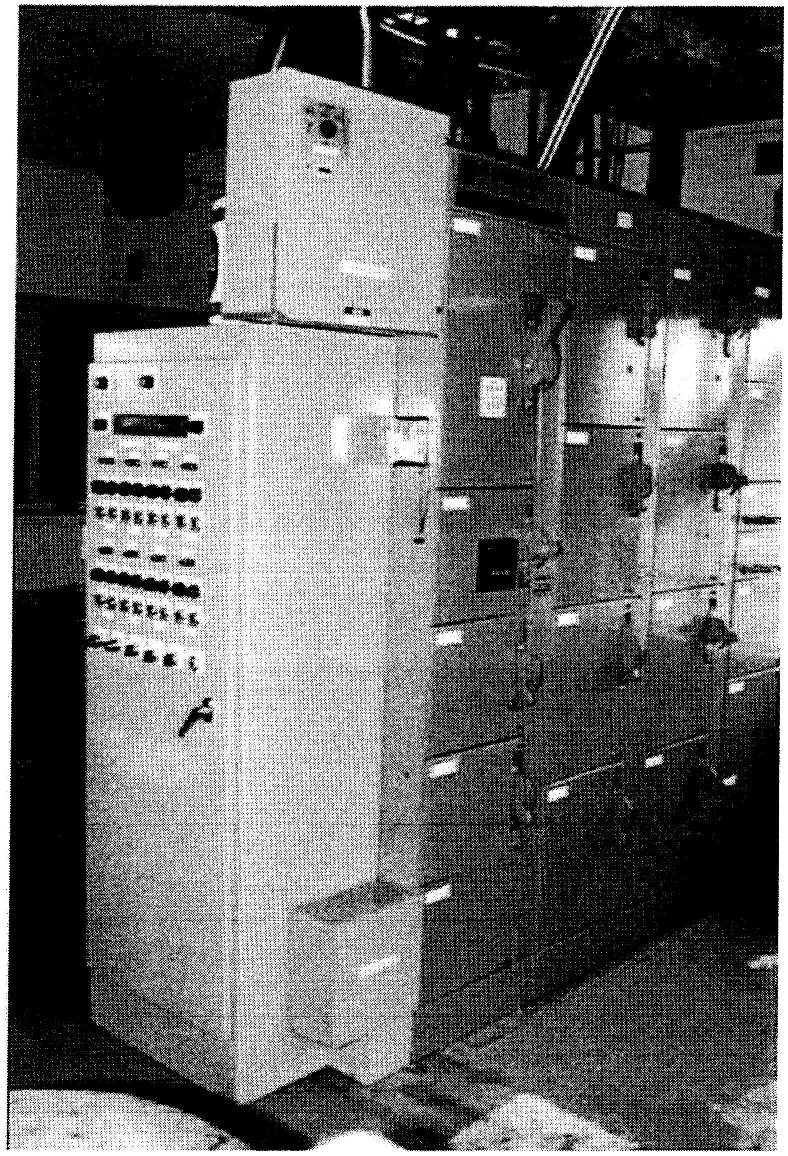
Photograph 6: New Slip Ring Placed on Top of New Center Bearing Pin



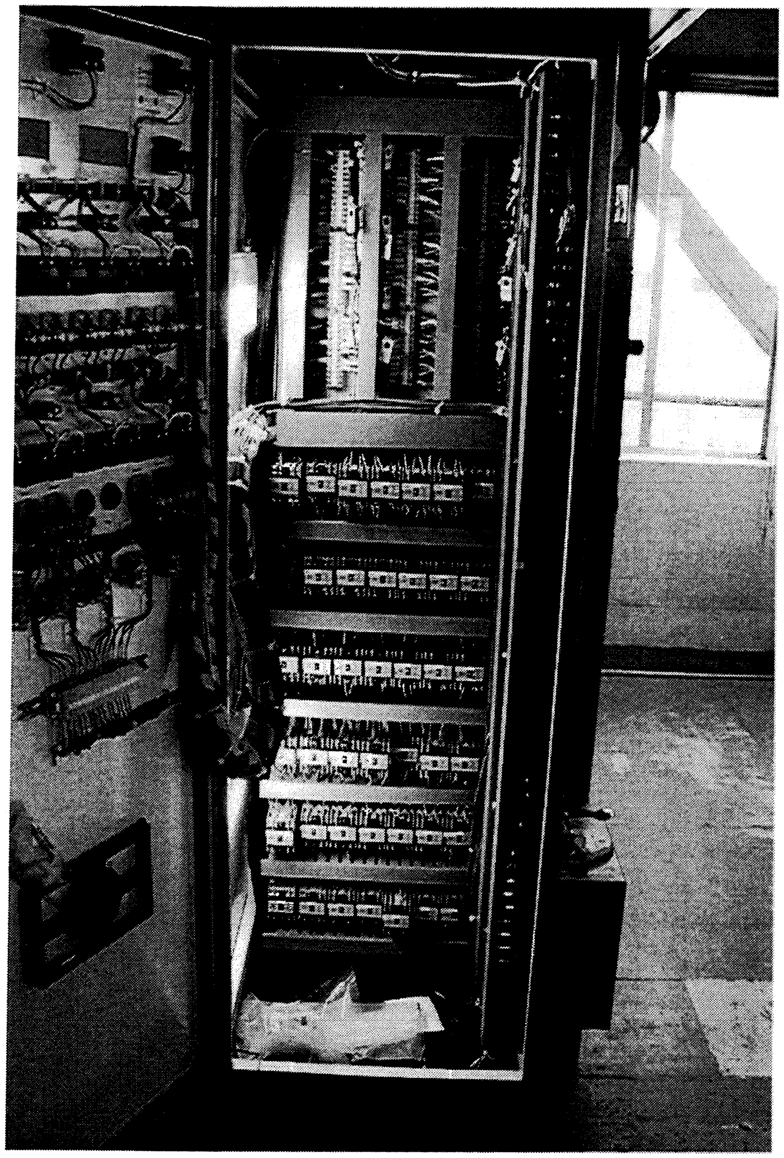
Photograph 7: New Quadrant Gear for End Lift



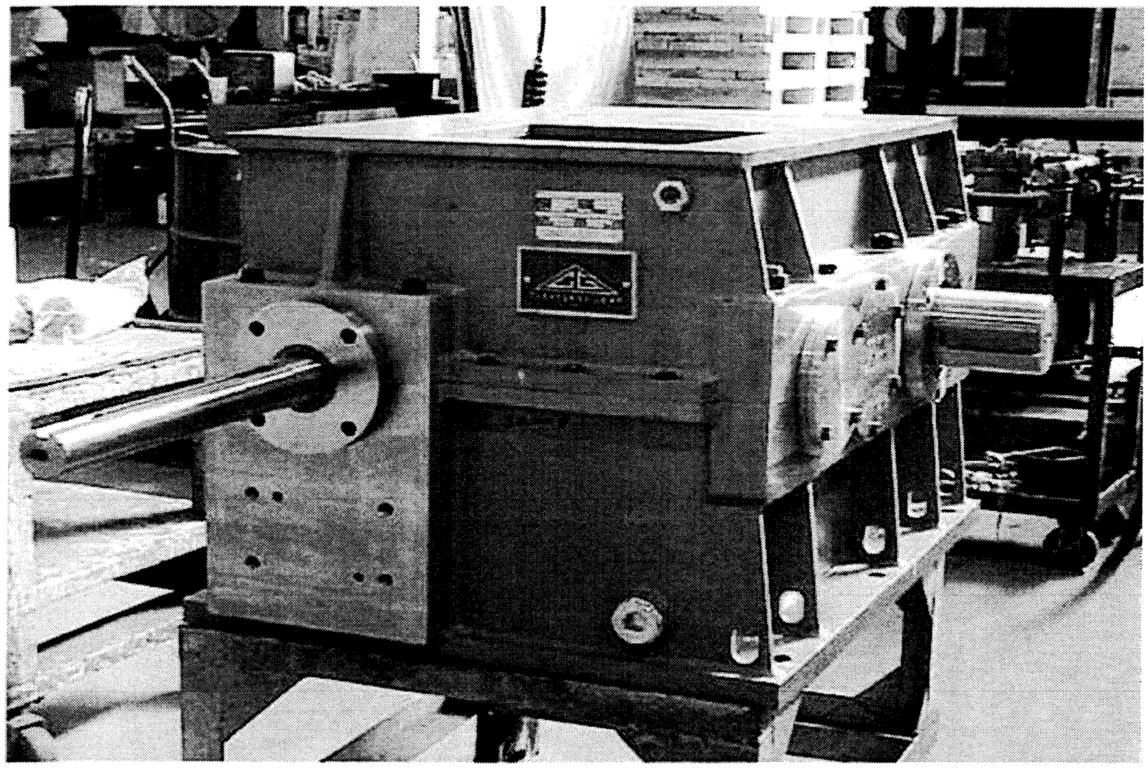
Photograph 8: New End Lift Machinery Installed



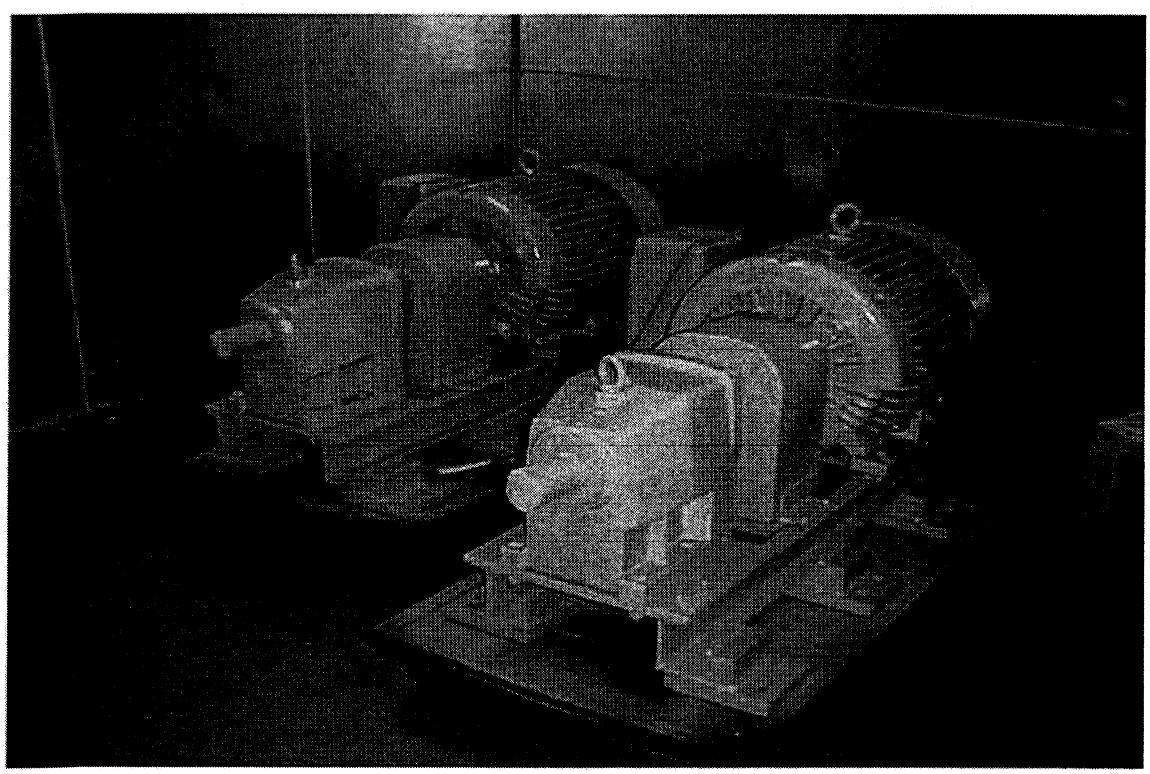
Photograph 9: New Control System PLC Cabinets



Photograph 10: New Control System PLC Cabinet



Photograph 11: New Main Drive Enclosed Gear Box



Photograph 12: New Auxiliary Drive Equipment