PANAMA CANAL´S BANK LIGHTING

by

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Abstract—Operating a recently expanded 24/7 waterway, while maintaining safety standards and addressing new traffic challenges requires the use of reliable aids to navigation systems. These aids to navigation systems include maritime buoyage system, sector lights with oscillating boundaries, ranges, and a bank lighting system. The bank lights installation is similar to lights on an airport runway, these are present on the east and west sides of the banks at the narrowest parts of the navigation channel, at Culebra Cut and at the approaches to the locks. The associated distribution power lines were scaled in order to meet the needs of the Panama Canal expansion and the construction of nearly 9 kilometers of access channels to the new locks on both the Atlantic and Pacific sides.

The first Bank Lighting system on the Panama Canal was installed between 1959 and 1961, and consisted of cool white light fluorescent fixtures. Over the years, the fluorescent fixtures were replaced with amber light low pressure sodium fixtures (LPS). For the Panama Canal expansion the new Bank Lighting project considered a technology migration to LED fixtures, keeping the performance in color and light output of the existing with a higher life expectancy, and lower maintenance costs. Over 10 km of overhead power distribution lines and 6km of underground power distribution lines were built in order to illuminate the east and west banks of the new access channels.

This paper presents the planning, design and construction of the electrical infrastructures and lighting system needed for the new Panama Canal´s bank lighting.

1. INTRODUCTION

One of the components of the expansion program of the third set of locks of the Panama Canal considered the adjustments required to provide navigation assistance systems for the new channels. These adjustments included new maritime buoyage system, sector lights with oscillating boundaries, ranges, and a bank lighting system. The bank lights were installed on the north approach to the Agua Clara locks and the north and south approaches of Cocoli locks. These lights are installed in the narrowest parts of the navigation channel and help to ensure the safety of ships in night transit demarcating the limit between water and land on the banks of the canal.

For the Agua Clara Locks access, over 65 luminaires on the west bank and more than 70 luminaires on the east bank, were installed, as shown schematically in Figure 1.

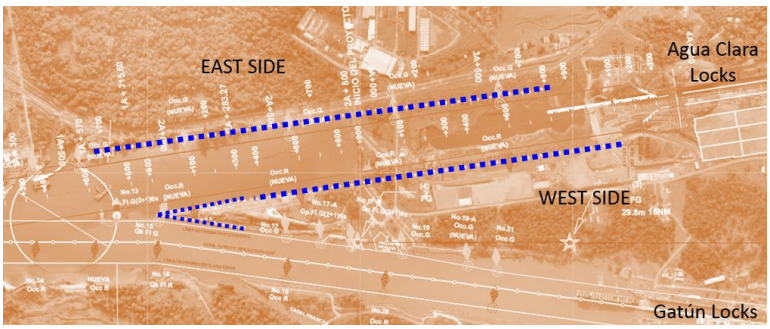

Figure 1: Atlantic Entrance Fixtures Layout

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At the north access of the Pacific Locks, over 170 luminaries were installed on the west bank and more than 165 luminaries on the east bank, spaced at 30 meters. In the bifurcation between the access to Pedro Miguel Locks and the new locks, 5 luminaries spaced every 20 meters were installed.

At the southern access to the Pacific Locks, more than 30 luminaires on the west bank and over 25 luminaires were installed at the bifurcation between the access channel to the Pacific Locks and Miraflores Locks.

2. **PLANNING**

The manufacture of the luminaire supports and their installation had always been executed through internal labor. However, due to the extent of the works for the expanded channel and considering the interaction with the Contractors of the new Locks and of the Approach Channel to the Pacific Locks, it was necessary to elaborate schemes for the supply of luminaires, manufacture of luminaire supports, extension of primary and secondary power lines in access channel to Atlantic Locks and extension of primary and secondary power lines in access channel to Pacific Locks. The luminaires at the southern access of the Pacific Locks were installed by internal force.

3. **DESIGN**

The required designs and specifications included studies for the replacement of Low Pressure Sodium luminaire to LED luminaire technology, designs and specifications for the fabrication of support arms, design and specification for the Atlantic works, design and specification for the North Pacific works and design for the South Pacific east and west banks works.

3.1 FIXTURES

For the development of the procurement specifications of the new luminaires, market studies, software simulations, field tests with measurements and validation by the Panama Canal pilots were carried out. These ensure the availability of heavy industrial proven solutions, with light color similar to the existing technology installed in the Culebra Cut, which would not cause glare to ship pilots, and friendly to the existing wildlife and environment of the area. Figure 2 shows a view of the software model simulation.

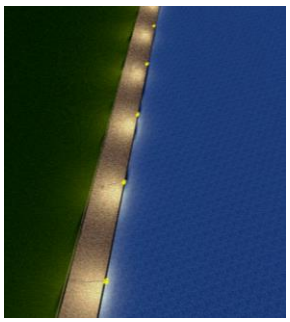

Figure 2: Software model of fixture arrangement

3.2 SUPPORT ARMS

The aluminum arms that support the luminaires have an extension of 6 meters in length and a pivot mechanism that facilitates the maintenance of the luminaires from the ground. To ensure the proper supply and operation of the arms, careful mechanical design drawings were developed, including detailed instructions for their manufacture, painting, delivery and storage.

3.3 ATLANTIC ENTRANCE WORKS

The design process for the works required in the Atlantic area begins with field inspections, surveying existing infrastructures, study of new channel design drawings and new locks. The conceptual design considered for the east bank the extension of about 2.8 kilometers of electrical circuit in medium voltage-12kV from a new electric substation, "Agua Clara", built to ensure reliable power supply to the Atlantic Locks. Due to the restriction in safety distances between the navigation channel, existing street, high-voltage aerial line and railroad tracks, this circuit was extended underground.

For the west bank, restrictions for vegetation and existing water lines required the construction of a section of 650mts of electric line with insulation for 12kV in protected cable. To the north the lines go near a heliport area that imposed restrictions on the use of air space. It was necessary to extend 550mts of the underground line.

Once the primary lines are built, low voltage distribution transformers provide the required voltage for the luminaires. From each distribution center, two secondary circuits, north and south, are derived, for a more reliable arrangement, each luminaire has an individual protection to prevent the failure of one affecting the rest of the circuit.

3.4 NORTH PACIFIC ENTRANCE WORKS

The design process for the works required in the north Pacific sector included field inspections, surveys of existing infrastructures, study of design drawings for the new access channel, dams and new locks. Figure 3 shows the wok area considered.

On the west bank, the extension of two 12kV circuits of 3.5 kilometers each in aerial configuration were built. For reliability, these circuits one north and one south have mooring capacity in a central point.

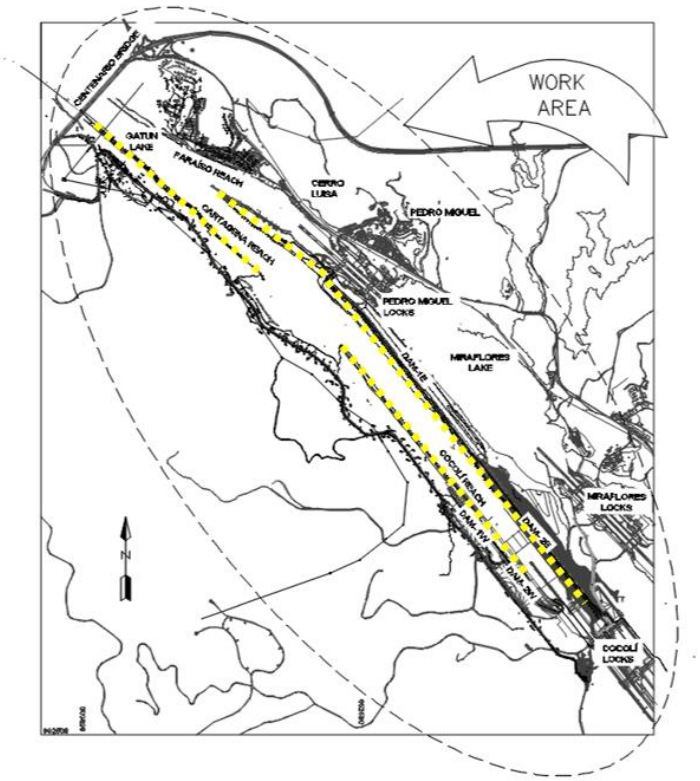

Figure 3: North Pacific Entrance

The east bank of the new north access canal to the Cocoli Locks is on the new island and is defined in most of its extension by the dam that divides Lake Gatun from Lake Miraflores. For this area the construction of an underground electric line of approximately 5 kilometers was considered as the most reliable solution for the electrical supply of the system.

3.5 SOUTH PACIFIC ENTRANCE WORKS

All the works in the South Pacific access to the new locks was executed with internal workforce. On the west bank, approximately 2 kilometers of medium voltage electric lines were extended. This branch that feeds navigation aid systems on the west bank, is provided with a normal power circuit and an alternate backup circuit.

In the eastern area, the bifurcation between the original canal and the new locks was illuminated, extending a secondary underground circuit from the electrical system of the locks. The lock´s electrical systems is highly reliable, with backup systems and redundant systems.

4. CONSTRUCTION

The process to the fixtures procurement was developed along with the Engineering Division of the Panama Canal and the Maritime Signaling Workshop of the Dredging Division, with the of Canal Port Captain and Contracts Division. The Maritime Signaling Workshop was also in charge of the fixtures final wiring and installation of all work areas.

The support arms procurement task was developed by specialists in Machine Design, Maintenance and Specifications. These items were manufactured in Panama with local contractor.

At the Atlantic Entrance the works were executed both with local contractors and internal workforces. The North Pacific Entrance works were executed by local contractor. At the South Pacific Entrance the works were executed by internal workforce alone, these works included tasks executed by floating crane Goliath in water.

The works were executed within the budgeted and without affecting the execution and delivery of the construction of the new locks and main dams. Figure 4 shows the South west Pacific entrance to Cocolí Locks banks lights in service.

Figure 4: South Pacific Entrance: West Victoria Reach bank lights-Photo by Edward Ortiz