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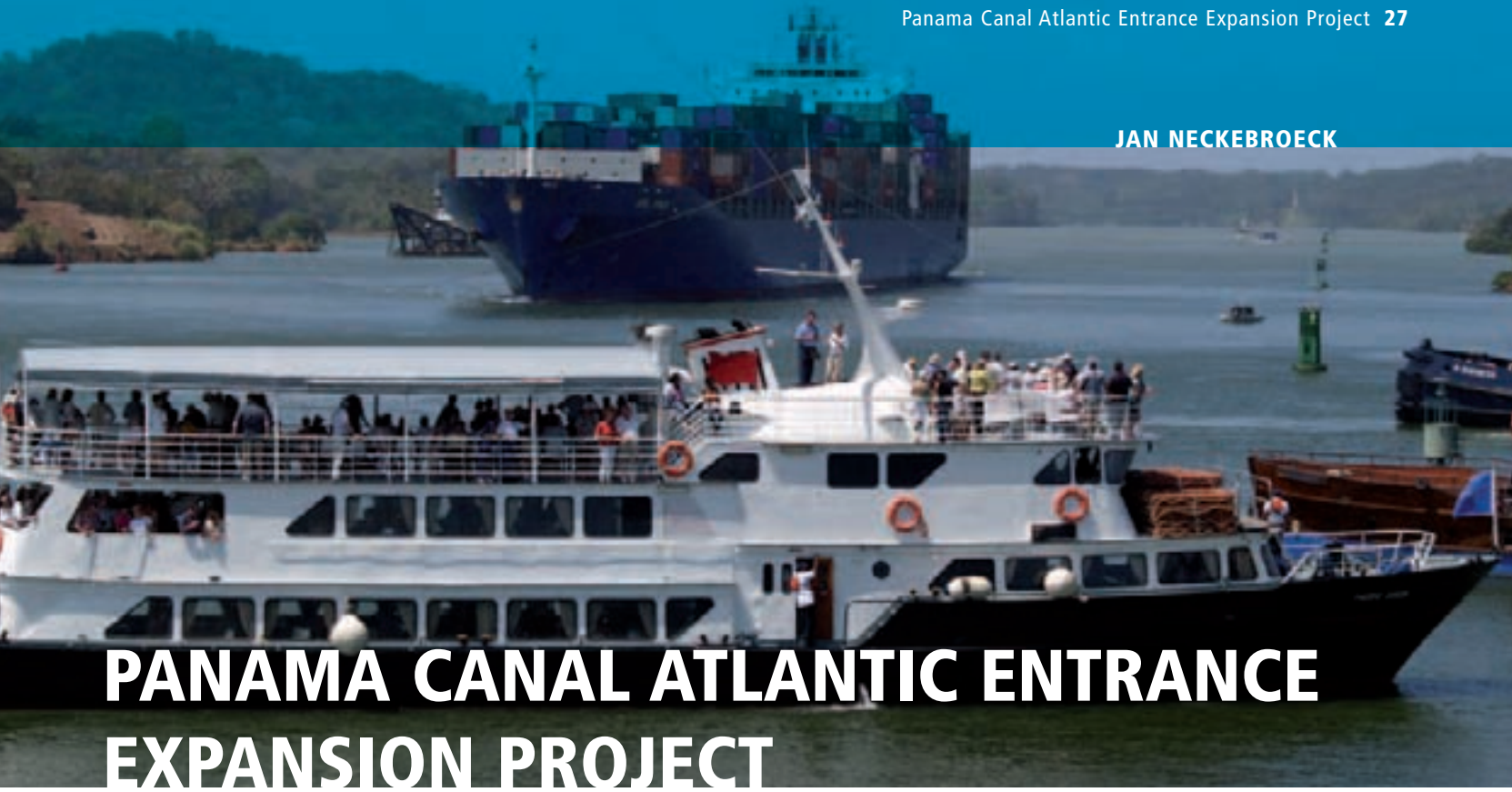

PANAMA CANAL ATLANTIC ENTRANCE EXPANSION PROJECT

ABSTRACT

The commercial importance of the Panama Canal for over some 90 years cannot be overstated. Vessels transiting through the Canal between the Atlantic to Pacific Oceans save an enormous amount of time bringing goods to market. However, given the increasing size of cargo vessels, known as post-Panamax, and the longer wait times for slots to transit the Canal, the need for widening and deepening the Canal became obvious. The Autoridad del Canal de Panama (Panama Canal Authority; ACP) is responsible for all dredging operations in the Canal and at the Atlantic and Pacific Entrance Channels. Usually dredging activities are carried out by its own fleet of dredgers, including the hydraulic dredger *Mindi* and dipper dredger *Rialto M. Christensen* for deepening and maintaining the waterway.

However, considering the scope of the work, the ACP decided to offer an international tender for deepening and widening the Entrance Channels. This proved to be a good choice as one of the most serious challenges to any dredging operation in the Canal is that vessels transiting the Canal must always have priority. In fact during the execution of this project, at least half of the channel width had to remain available for transiting vessels at all times. With these requirements in mind, the ACP opted to employ international state-of-the-art dredging equipment to facilitate the dredging operations necessary to keep the Canal functioning efficiently. The large capacity of these dredging ships plus their self-propelling capability allowed them to avoid obstructing transiting vessels and to expedite the work.

INTRODUCTION

The Panama Canal, which first opened in 1915, is an 80 km long waterway between the Atlantic and Pacific Oceans. The Canal was cut through the narrowest part of the isthmus in Central America that connects North and South America eliminating the long and treacherous voyage around South America. The importance of the Panama Canal for the world economy cannot be emphasised enough. Every year more than 13.000 ships are transiting the Canal, ranging from private yachts to luxury cruisers to Panamax cargo vessels. The commercial transportation activities via the Canal represent approximately 5% of the world's trade and this figure continues to rise. Currently waiting times to find a slot (a confirmed time to transit the Canal) can take several days. Given the Canal's economic importance this situation is unacceptable and therefore plans have been adopted to widen and deepen the Canal.

Above, Dredging operations in the Panama Canal must always yield to the ongoing traffic of vessels transiting the Canal. Under no circumstances may the transiting vessels be obstructed.

The Panama Canal consists in total of three sets of locks; the Gatún locks at the Atlantic coast and the Pedro Miguel and Miraflores Locks at the Pacific coast (Figure 1). The entity of the Government of the Republic of Panama in charge of the operation, administration, management, maintenance and modernisation of the Canal is the Autoridad del Canal de Panamá (Panama Canal Authority; ACP). All operations within the boundaries of the Panama Canal are managed by the ACP. The entrance channel approaching the outer locks (Gatún Locks at the Atlantic side and Miraflores Locks at the Pacific side) also are part of the jurisdiction of ACP.

Given the scope of the work, on November 11, 2003, the ACP launched international tenders for "Deepening of the

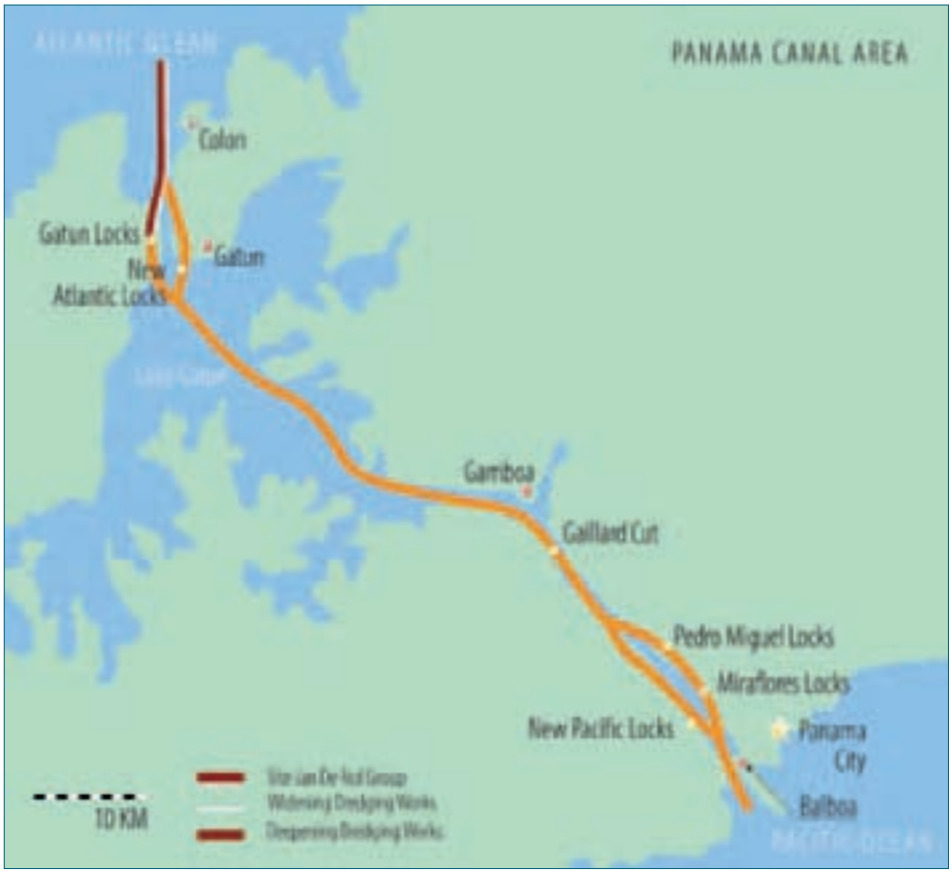

Figure 1. Location map of the Panama Canal and the area to be dredged.

Pacific Entrance" and the "Deepening and Widening of the Atlantic Entrance" of the Panama Canal. On the 22 July 2004 Jan De Nul NV received the Notice of Award for the Deepening and Widening of the Atlantic Entrance.

The contract works included the dredging at the Atlantic Entrance Reach station –1K + 036 m up to the Gatún Locks North Approach Reach station 10K + 250 m. The navigation channel of the Atlantic Entrance, as from the outer breakwater till the locks, over a length of 11.286 km had to be dredged till –14.2 m and the eastern side of the Entrance Channel had to be widened with 22.86 m up to 99.6 m. After the dredging, the total width of the Entrance Channel would become 198.12 m with a slope 1V : 3H from –1K + 036 till 5K + 000 and a slope 1 V : 1 H from 5K + 010 to 10K + 250. In total a volume of some 2.360.000 m^3 had to be removed and placed at the designated disposal areas.

CHALLENGES

Several boundaries were contractually applicable that presented significant challenges to the dredging operation. For instance, the Contract stipulated that the dredging works were to be completed within a period of 24 months as from the Notice to Proceed. In addition, under no circumstances could the transit of vessels be obstructed and strict limitations both in place and time were imposed upon the Contractor for the duration of the Contract.

Traffic in transit

Everyday a convoy of southbound ships (primarily Panamax vessels) starts its voyage to transit the Panama Canal, leaving the anchor areas around 6 in the morning at the Atlantic side. As from 6.00 am until approximately noontime vessels sail continuously through the dredging area towards the Gatún Locks. At the same time the northbound ships (also Panamax vessels) start transiting the Miraflores Locks at the Pacific Side. These convoys cross each other within the Gatún Lake. Around 1 pm (13.00) the first northbound vessels start to transit the Gatún Locks and sail towards the Atlantic Ocean. Normally around 8 pm (20.00) the northbound convoy has transited the Canal.

Traffic, however, does not stop at 8 pm. During the night is the time for the smaller ships (small bulk carriers, tugboats, yachts and such) to transit the Canal. In view of the daily schedule of the convoys in transit, ACP ruled out the presence of dredging equipment in the areas 10K + 250 to 8K + 400 (the narrowest part of the Atlantic Entrance, close to the Gatún Locks) from 5.00 am to 8.00 pm. Additionally, during the execution of the dredging works, at least half of the channel width had to remain available for transiting vessels at all times.

Communications

In order to optimise communications between the dredging vessels and the transiting vessels, ACP ordered the presence of an ACP pilot onboard the main dredging units (trailing hopper dredgers and a cutter suction dredger) and a first mate of ACP onboard of all of the auxiliary equipment such as multicast and tugboats.

Close coordination with all involved departments within ACP was crucial for the smooth execution of the project. The Port captains at Cristobal Port, the Pilot department, the Survey department and the Safety and Environmental departments were involved at each stage of the project and had to be informed about the progress and the interfaces of the dredging project on regular basis.

Soil conditions

A particular challenge for the successful execution of any project in the Panama Canal is the ever- changing soil conditions. In order to define the soil conditions of this particular section to be deepened and widened, an extensive soil investigation was carried out. This included geo-electrical

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graduated in 1998 as a MSc in Constructional Engineering at the Ghent University (Belgium) and joined the Jan De Nul Group the same year. For the last 9 years, he has been employed in the Operational Department on projects in the Philippines, India, United Arab Emirates, Singapore, Brazil, Argentina, Honduras, Nicaragua and El Salvador. For the Panama Project, he was the Project Manager for execution of the dredging works at the Atlantic Entrance. Presently he is working as Deputy Area Manager for the Americas at the head office in Aalst, Belgium.

Figure 2. The *Rialto M. Christensen* has been at work in the Canal for 30 years.

surveys, side-scan sonar surveys, a resistivity study and a bore-hole campaign. All of these were performed during the tender period by the interested Contractors. In the end, the diversity of material to be dredged at the Atlantic side ranged from silt, clay and fine sand to medium and hard rock (siltstone type Gatún).

The contracts for the dredging of the Atlantic and Pacific Approaches were the first major dredging contracts, other than a sporadic maintenance contract, for which ACP had issued an international tender. Up to then, ACP had performed maintenance and capital dredging works within the Canal utilising its own equipment, mainly the 64 year old cutter suction dredger *Mindi* and the 30 year old mechanical dipper dredger *Rialto M. Christensen* (Figure 2).

EXECUTION OF THE DEEPENING AND WIDENING OF THE ATLANTIC ENTRANCE

After submission of the insurance certificates, the Quality Control Plan, the Method Statements, the Work Schedule and the Dredging Execution Plan and their approval, ACP issued the Order to Proceed on October 2 2004.

The first phase

The execution of the works started immediately with the trailing suction hopper dredger *Francesco di Giorgio*, a dredger with a 4400 m^3 hopper capacity and a total installed power of 6330 kW (Figure 3). The TSHD *Francesco di Giorgio* was constructed at the Astillero de Gijon – IZAR in 2003 and is equipped with 2 electric-hydraulic Schottel rudder propellers of 2150 kW and a Schottel transverse bow-thruster system of 550 kW. These latter installations ensure a very high maneuverability of the dredging vessel, which was very important during the operations in the Canal, particularly near the locks, because of the almost continuous traffic.

During the first phase of operations, the dredger removed the soft material at the northern end of the Canal (between –1K + 036 and 4K + 000). This material, mainly silt and fine sand, was deposited at the Northwest Breakwater Disposal Area (offshore from the Northern breakwater). Some soft material was also removed between stations 4K + 000 and 8K + 400. However, the steep slopes and hard material required further use of a cutter suction dredger in that area.

During this phase a total volume of approximately 1.000.000 m^3 was dredged after which the *Francesco di Giorgio* was temporarily demobilised from the site. As was expected, because of the high manoeuverability of this dredger, no problems with the transiting vessels were encountered during the execution of the first phase.

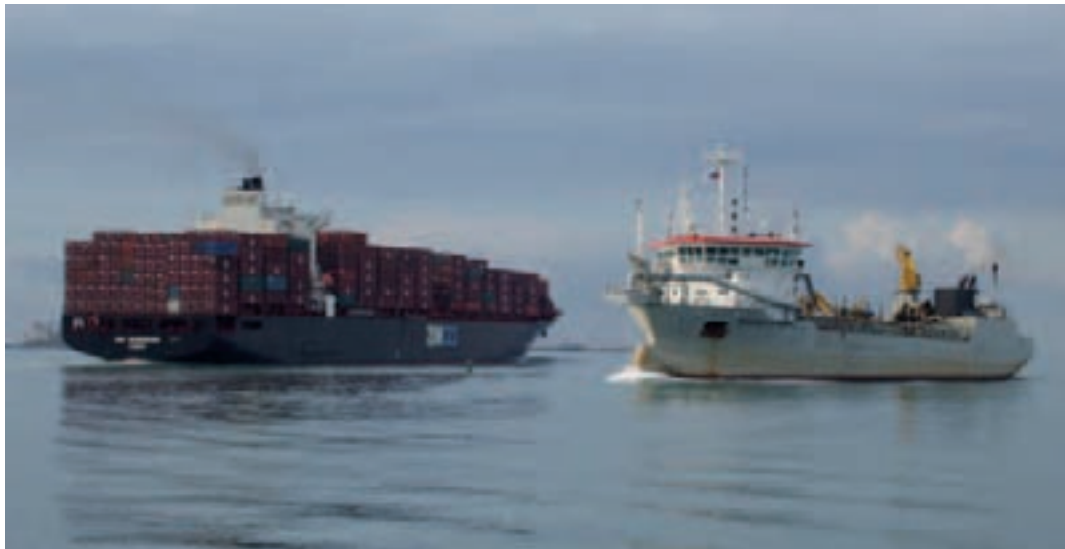

Figure 3. TSHD *Francesco di Giorgio* working at Atlantic Entrance with continuous freight traffic.

Figure 4. Arrival CSD *JFJ De Nul,* transiting through Miraflores Locks.

The second phase

While the dredging operations with the hopper dredger were going on, preparation for the second phase of the works was started. A cutter suction dredger (CSD) had to be used to remove the medium to hard Gatún rock in the Entrance Channel and to dredge the steep slopes. The hard material to be removed was mainly situated in the southern part of the Entrance Channel (8K + 400 to 10K + 250) and at the eastern side. Additionally some hard spots between 3K + 500 and 4K + 000 were encountered in the middle of the canal.

In total three inland disposal areas for the materials of the CSD were prepared: Davis Landing Disposal Area, Sherman Center Disposal Area and Telfers Inland Disposal Area. Davis Landing Disposal Area is situated at the eastern side of the Canal between 9K + 100 and 9K + 500.

The distance between the middle of the Canal and Davis is approx. 250 m. The disposal capacity of this area was approx. 150.000 m^3. Telfers Inland Disposal Area, also situated at the eastern side of the Canal between 5K + 000 and 5K + 800, is situated at a distance of approximately 500 m from the Canal axis. Sherman Center, with a disposal capacity of approximately 650.000 m^3, is situated at the western side of the Canal at a distance of 200 m from the Canal axis.

To accomplish the task, the self-propelled CSD *JFJ De Nul* was mobilised and came over from Russia (Figure 4). This vessel, with a total installed diesel power of 27,240 kW, was built by IHC Holland in 2003. The fact that the cutter is self-propelled proved to be an invaluable asset for the successful execution of the Project. Time lost because of continuous vessel traffic could be substantially compensated for because of the efficient shifting of the CSD back to her position.

The *JFJ De Nul* arrived at the Port of Cristobal, Panama in mid January 2005. The challenge of the rigorous restrictions of ACP regarding working hours at the southern part of the Entrance Channel (from 8.00 pm till 5.00 am between 8K + 400 and 10K + 250) quickly became obvious. As stated earlier, the self-manoeuvering capability of the CSD proved to be an asset. In addition, the good communication and interaction between the ACP pilots (both onboard the *JFJ De Nul* and onboard the transiting vessels) and the crew, meant that the effective operation time could be improved considerably, even though the restrictions of the minimum availability of half the Canal for traffic and the priority for the transiting vessels was always observed (Figure 5).

Dredging at the eastern side commenced and the material was pumped via 500 m floating pipes and shore pipes to the Davis Disposal Area and the Telfers Inland Disposal Area. Because of the limited size of the Davis Disposal Area and the location of the Telfers Inland Disposal Area, part of the material from the eastern side had to be pumped towards the Sherman Center Disposal Area on the opposite bank as well.

For this purpose a sinker pipeline was placed on the bed of the Panama Canal in an area that was previously dredged, which ensured that it would avoid being a hindrance to the transiting vessels. The installation of the

Figure 5. CSD *JFJ De Nul* working at Atlantic Entrance simultaneously with transiting vessels.

sinker pipeline was carefully prepared and ultimately done during a traffic window (2-3 hours at noontime) without disruption of traffic (Figure 6).

After the widening of the eastern side the CSD *JFJ De Nul* was sent to deepen the western side of the Canal. Most of the material collected there was pumped into Sherman Center Disposal Area. In the centre of the canal some hard material was precut for later removal by a trailing hopper dredger.

Owing to the presence of siltstone (Gatún formation), the contract specifications prescribed a slope of 1V : 1H at the eastern side of the Canal between 8K + 400 and 10K + 250. Nevertheless between 9K + 800 and 10K + 250 soft plastic clay was encountered and the 1V : 1H slope proved unstable. In this section additional shore protection was placed in order to achieve a stable slope. In total a volume of 590 m^3 of revetment material "Matacan 12-24 inch" was placed by dry equipment to protect the slope.

The cutter operations took in total around two months with a total volume of approximately 1.300.000 m^3 being dredged. During the whole execution period everything was done to minimise interference with the traffic. As a result none of the transiting vessels ran into delays because of the ongoing dredging operations.

For the final clean up and for the removal of the material that had been precut, the *Francesco di Giorgio* was remobilised to the job by mid March 2005. At the same time a sweeping operation was performed in order to remove the last high spots.

At the end of the Original Contract, taking advantage of the presence of this TSHD and convinced of the possibilities of the vessel to work in confined areas, ACP decided to issue a Variation Order to carry out some maintenance dredging in front of the Gatún Locks (10K + 250 – 10K + 750).

After the official out-survey was carried out and further approval of all involved departments (Port Captain, ACP Contracting Division, ACP Survey Department, ACP Pilots and so on) had been obtained, the Final Acceptance of the Contract on May 12, 2005 was received. The execution period took only slightly over 7 months instead of the 24 months as foreseen in the tender documents. The decision to work with modern state-of-the-art vessels proved to be correct choice for both Client and Contractor.

CONCLUSIONS

Working in such a dynamic environment as the Panama Canal, where the first and only priority is to get the transiting vessels swiftly and safely to the other end of the Canal, proved to be a major challenge for the Contractor. The fact that under no circumstances could the transit of vessels be obstructed meant that strict limitations both in place and time were imposed upon the Contractor for the duration of the Contract.

This challenge could only be converted into a successful project by applying the highest quality standards and utilising modern state-of-the-art vessels. As a result none of the transiting vessels ran into delays because of the ongoing dredging operations nor were the dredging operations hindered by the transiting vessels. In the end, because of this, the execution period for widening and deepening the Canal took only slightly over 7 months, far less than the 24 months allowed for in the tender documents.

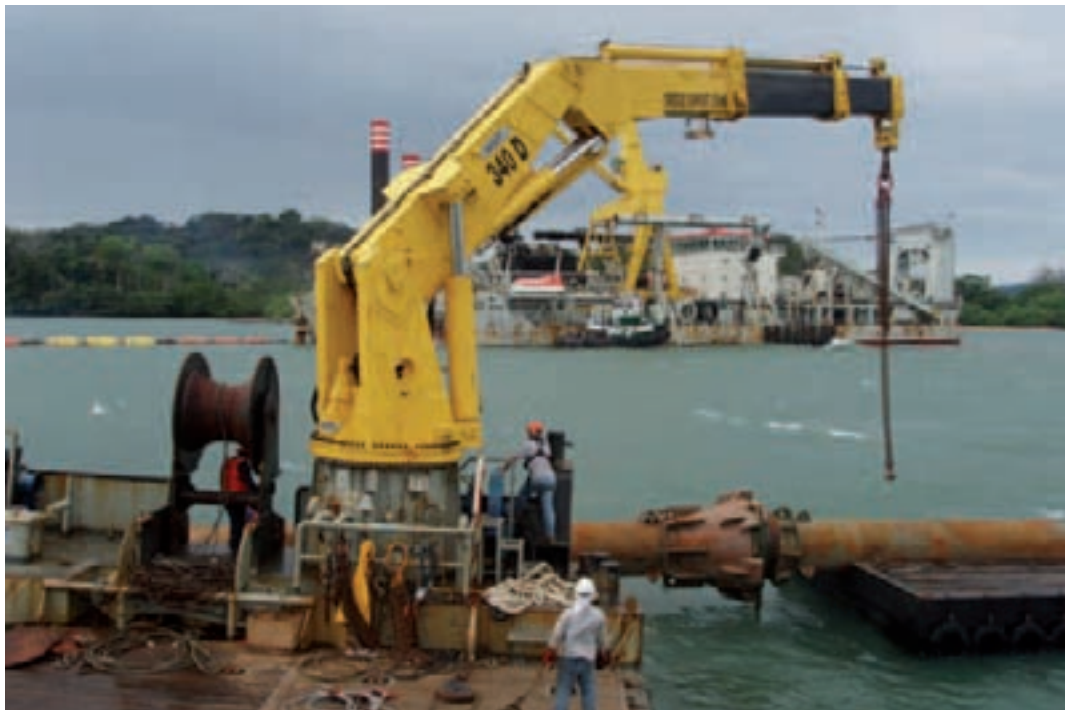

Figure 6. Sinker operations by means of a Multicat.