



Damage & Capacity Assessment

PORTS OF HODEIDAH, SALIF AND RAS ISSA



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Henk Engelberts and Marc Wormmeester

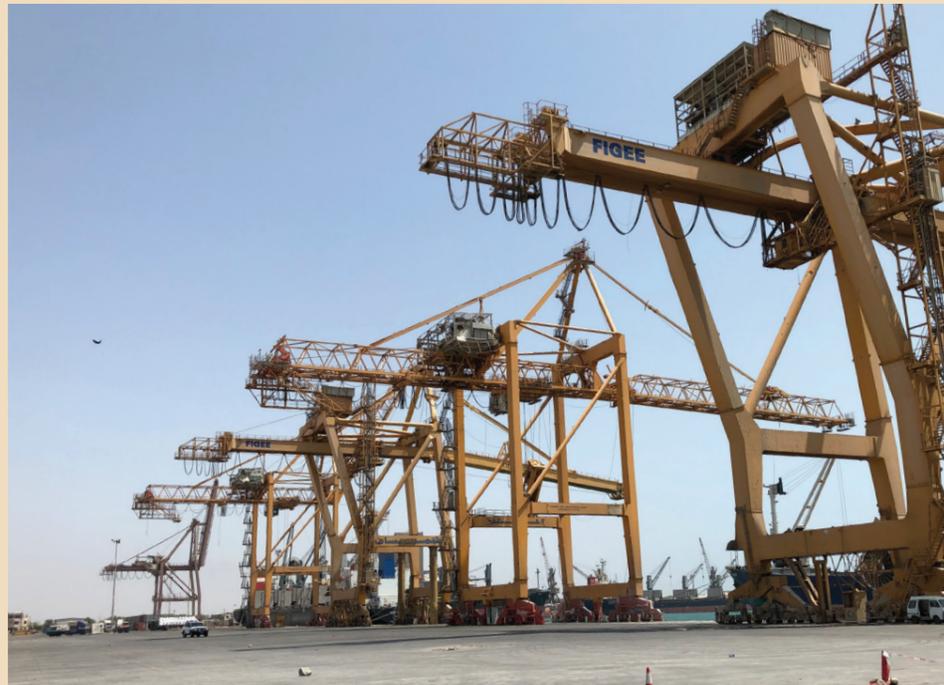


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Executive Summary

Recognizing Hodeidah as critical to the delivery of food and humanitarian assistance, Yemeni parties have agreed on the need for peace in the area. The Stockholm Agreement, brokered by the UN Special Envoy of the Secretary-General for Yemen on 14 December 2018, is seen as a foundation on which to restore peace and rebuild lives.

UN Security Council Resolution (UNSCR) 2541 was issued on 21 December 2018, calling for an immediate cease-fire in the city of Hodeidah, the ports of Hodeidah, Salif and Ras Issa and the governorate of Hodeidah. In addition, it calls for the strengthening of the UN's presence in the city of Hodeidah and the three ports and places the Organization in a leading role to support the Yemen Red Sea Ports Corporation (YRSPC) in the management of, and inspections at, the ports.

The United Nations Development Programme (UNDP) has been tasked to take the lead in providing support to YRSPC in close coordination with relevant authorities, the United Nations Mission to support the Hodeidah Agreement (UNMHA), the United Nations Verification and Inspection Mechanism for Yemen (UNVIM) and the World Food Programme (WFP). UNDP intends to support port restoration and to build operational capacity to help facilitate the entry of vital humanitarian aid and commercial shipments. UNDP's initial support aims to upgrade port facilities including, among other priorities, the replacement of navigational aids at the main port; refurbishing the training center; replacing the berth guards; and, enhancing the perimeter lighting.

In support of these efforts, UNDP organized a port assessment of Hodeidah, Salif and Ras Issa to be executed by experts from the Port of Rotterdam. This assessment was performed from 15 June – 8 July 2019.

The result of the assessment is an investment package with a total value of €46,570,000. The recommended projects are necessary for maintaining the current port operations and restoring operations to pre-war conditions.

The projects are classified based on priority. Priority 1 projects (estimated to be €2,850,000) are necessary for maintaining the current port operations. Priority 2 projects (estimated to be €18,720,000) aim at re-establishing containerized cargo handling at Hodeidah Port. Priority 3 projects (estimated to be €25,000,000) are necessary to restore or improve safety and sustainability of the port's operations and assets.



Assess and rehabilitate vital port infrastructure as soon as possible.

Given the damage to, and condition of, some vital assets in the port, i.e. electrical installations, horizontal transport equipment and tugboats, securing spare parts and rehabilitation of these assets is the most urgent and requires immediate action. Further diminishing of these assets will bring parts of the port to a complete standstill. The implementation of these Priority 1 projects are a prerequisite for maintaining the humanitarian support for the people of Yemen.



Repair ship-to-shore container cranes.

One of the main findings of the assessment is the possibility of repairing at least one but maybe two ship-to-shore cranes instead of buying new cranes. New cranes are not only much more expensive, but also completing specifications, procurement, building and commissioning of the cranes takes a lot more time, at least two years. With repairing the cranes, the re-establishment of containerized cargo can be achieved in about a year.



Perform a detailed inspection of sheet piles.

According to YRSPC, the sheet piles have not been inspected as they were informed that corrosion of submerged steel structures was not possible. Their integrity is unknown.

Given the age of the structures, the salinity and the average water temperature of the Red Sea, the risk of corrosion damage is certainly present as submerged steel sheet piles can indeed corrode. Reduction of wall thickness by corrosion decreases the structural strength of the sheet pile profile. Depending on the amount of reduction, sheet piles can be repaired by costly reinforcements. If the reduction is too much, and reinforcements no longer possible, the construction must be considered a loss. Therefore, a detailed inspection of the sheet piles is mandatory.



Ensure required specialists and parts can enter Yemen.

The recommended projects require specialists and (spare) parts not available in Yemen. Because of the restrictions on the import of prohibited items as per UN Security Council Resolution 2216 (2015), the delivery of the required (spare) parts is an issue. Also, obtaining entry visa can be a challenge. Considering the criticality of the infrastructure of the Ports of Hodeidah, Salif and Ras Issa to commercial and humanitarian activities in Yemen, the authorities must be urged to ensure that the required specialists and parts can enter Yemen in accordance with the Hodeidah Agreement.



Implement a training programme on maintenance, personal safety and working conditions.

The assessment was to include monitoring of the compliance of the port operations and immediate requirements for provision of advisory support and training to strengthen technical and managerial capabilities.

Port management considered that a review of the port's operational capabilities did not form part of the scope of the assessment. Therefore, this report on the assessment does not give an answer in this regard.

The port's assets suffer from little to no maintenance which means higher costs and implies a negative influence on the performance, reliability and safety of the assets. Also, the port is facing issues related to health, safety and environmental conditions for port workers. A general training programme combined with a safety awareness project, can train the staff—ultimately elevating the port to international standards.

1.0 Preface

With nearly 80 per cent of the population in need of humanitarian assistance and protection, the Yemeni crisis is the world's greatest humanitarian disaster. The situation has driven over four million people from their homes with over three million still displaced. Ten million people are on the brink of famine and starvation and 240,000 people are in advanced stages of extreme food deprivation.

With 70 per cent of all imports and 80 per cent of all humanitarian assistance passing through the ports of Hodeidah, Salif and Ras Issa, they are critical and irreplaceable infrastructure to commercial and humanitarian activities in Yemen. The three west coast ports have recently accounted for 85 per cent of wheat grain, 42 per cent of rice imports and nearly half of the wheat flour that entered Yemen. However, the area's recent conflict has made passage of goods difficult, if not impossible. Several key access routes to the city have been blocked, with only one route remaining for civilian, commercial and humanitarian traffic. This has left key humanitarian infrastructure—including milling capacity and warehousing—inaccessible.

With 70% of all imports and 80% of all humanitarian assistance passing through the ports of Hodeidah, Salif and Ras Issa, they are critical and irreplaceable infrastructure to commercial and humanitarian activities in Yemen.

Recognizing Hodeidah as critical to the delivery of food and humanitarian assistance, Yemeni parties have agreed on the need for peace in the area. The Stockholm Agreement, brokered by the United Nations Special Envoy of the Secretary-General for Yemen on 14 December 2018, is seen as a foundation on which to restore peace and rebuild lives.

The undertakings outlined within the Stockholm Agreement include: the Hodeidah Agreement, the Ta'iz Understanding and a prisoner swap agreement. The committed parties to: (a) a ceasefire in the city of Hodeidah and the ports of Hodeidah, Salif and Ras Issa and a mutual redeployment of forces; (b) opening of humanitarian corridors to allow aid to move through the three ports; and, (c) a prisoner swap aiming to

release more than 15,000 prisoners and detainees. It was also agreed that there would be discourse around the creation of a humanitarian corridor allowing aid into the Ta'iz Governorate. The Hodeidah Agreement is the focus of this report.

The United Nations (UN) quickly moved to meet its obligations and to engage with the parties to the conflict to seek consensus on the technical details of the Stockholm Agreement. The Hodeidah-focused UN Security Council Resolution (UNSCR) 2541 was issued on 21 December 2018, calling for an immediate cease-fire in the city of Hodeidah, the ports of Hodeidah, Salif and Ras Issa and the governorate of Hodeidah. In addition, it calls for the strengthening of the UN's presence in the city of Hodeidah and the three ports and places the Organization in a leading role to support the Yemen Red Sea Ports Corporation (YRSPC) in the management of, and inspections at, the ports.

Subsequently, the UN Security Council established a special political mission to support implementation of Hodeidah Agreement reached in Stockholm in December 2018 between the Government of Yemen and Ansar Allah covering the city and port of Hodeidah, as well as the ports of Salif and Ras Issa. Unanimously adopting Resolution 2452 (2019), the Council established the United Nations Mission to support the Hodeidah Agreement (UNMHA).

UNDP has been asked to take the lead in providing support to YRSPC in close coordination with relevant authorities, UNMHA, the United Nations Verification and Inspection Mechanism for Yemen (UNVIM) and the World Food Programme (WFP). UNDP intends to support port restoration and to build operational capacity to help facilitate the entry of vital humanitarian aid and commercial shipments. UNDP's initial support aims to upgrade port facilities including, among other priorities, the replacement of navigational aids at the main port; refurbishing the training center; replacing the berth guards; and, enhancing the perimeter lighting.

In support of these efforts, UNDP organized a port assessment of Hodeidah, Salif and Ras Issa to be executed by experts from the Port of Rotterdam.

2.0 Introduction

Through UNDP, the Port of Rotterdam experts supported YRSPC by undertaking an initial damage and capacity assessment outlining the minimum requirements necessary to sustainably improve the productivity and effective management of the ports. It is expected that these actions will lead to enhanced efficiencies, increased transparency and accountability, and will be in line with the commitments outlined within the Hodeidah Agreement. The assessment includes proposals for training, equipment and rehabilitation of critical infrastructure. The assessment also includes the need for re-establishing containerized cargo and liner shipments to Hodeidah.

The three areas of assessment covered are: (1) Nautical; (2) Infrastructure; and (3) Logistics during which the following were taken into consideration:



Compliance: Monitoring the compliance of port operations as per international port standards, international maritime law, and other internationally recognized standards.



Human resource capacity assessment: Determining the immediate requirements needed for advisory support and training to strengthen technical capacity.



Equipment and infrastructure assessment: Consulting with YRSPC and relevant actors to assess port damage and capacity in order to outline key priorities for limited critical infrastructure rehabilitation.

3.0 Assessment Process

YRSPC has compiled three lists of projects that they think need to be executed as an Emergency Path Card Project (executed now), or as an Intermediate Path Card Project (executed within 1-5 years) and a Strategic Path Card Project (long-term projects). During the assessment these three lists are used as a reference. The project lists are part of this report in Annex 2.

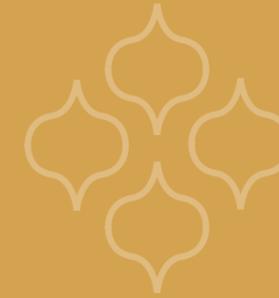
The port processes will only work efficiently if the entire chain of equipment, manpower and supporting systems are ready and capable of performing according to expectations. To help assess the situation in the ports of Hodeidah, Salif and Ras Issa, the following needed to be reviewed and/or checked:

- Training level and readiness of operational management and staff.
- Training level and readiness of technical and maintenance management, as well as staff.
- Requirements as per drawings of maritime infrastructure (e.g. quay walls, buoys, jetties, etc.).
- Visual inspection of maritime infrastructure maintenance conditions.
- Availability and readiness of vessel load and/or discharge equipment (cranes).
- Diesel and electrical power supply to operate equipment.
- Availability and readiness of horizontal transport for cargo between quay and stack and/or warehouses.
- Availability and readiness of yard stacking equipment and related power supply.
- Availability and readiness of supporting equipment (e.g. forklifts, empty handlers, reach stackers (RS), etc.).
- Availability and readiness of Terminal Operating System and Gate Operating System (GOS) required for coordinating terminal operations.
- Availability and readiness of GOS and related processes.
- Availability of Information and Communications Technology (ICT) network and data center supporting operational processes.
- Maintenance facilities, maintenance support systems and availability of spare parts and services combined with possible contracts with local suppliers.
- International Ship and Port Facility Security (ISPS) and security level of the port.
- Customs procedures for quick processing of goods arriving in ports.
- Port procedures to properly handle vessels (e.g. pilots, tug boats, mooring crew, etc.).

Evaluation and a proposed follow-up for minimal and optimal remedial actions for effective and efficient terminal operations is part of this report.

4.0

Maritime Infrastructure



The maritime infrastructure within the ports of Hodeidah, Salif and Ras Issa were established between 1958 and the 1980's. Below is a description of the following maritime assets and their visual inspection, where applicable.

HODEIDAH

Oil Berth 1
Oil Berth 2
Quay wall, Berths 1–5

Quay wall, Berths 6–7
Quay wall, Berth 8
Slipway and maintenance yard

Approach channel and harbor basin
Control tower

RAS ISSA

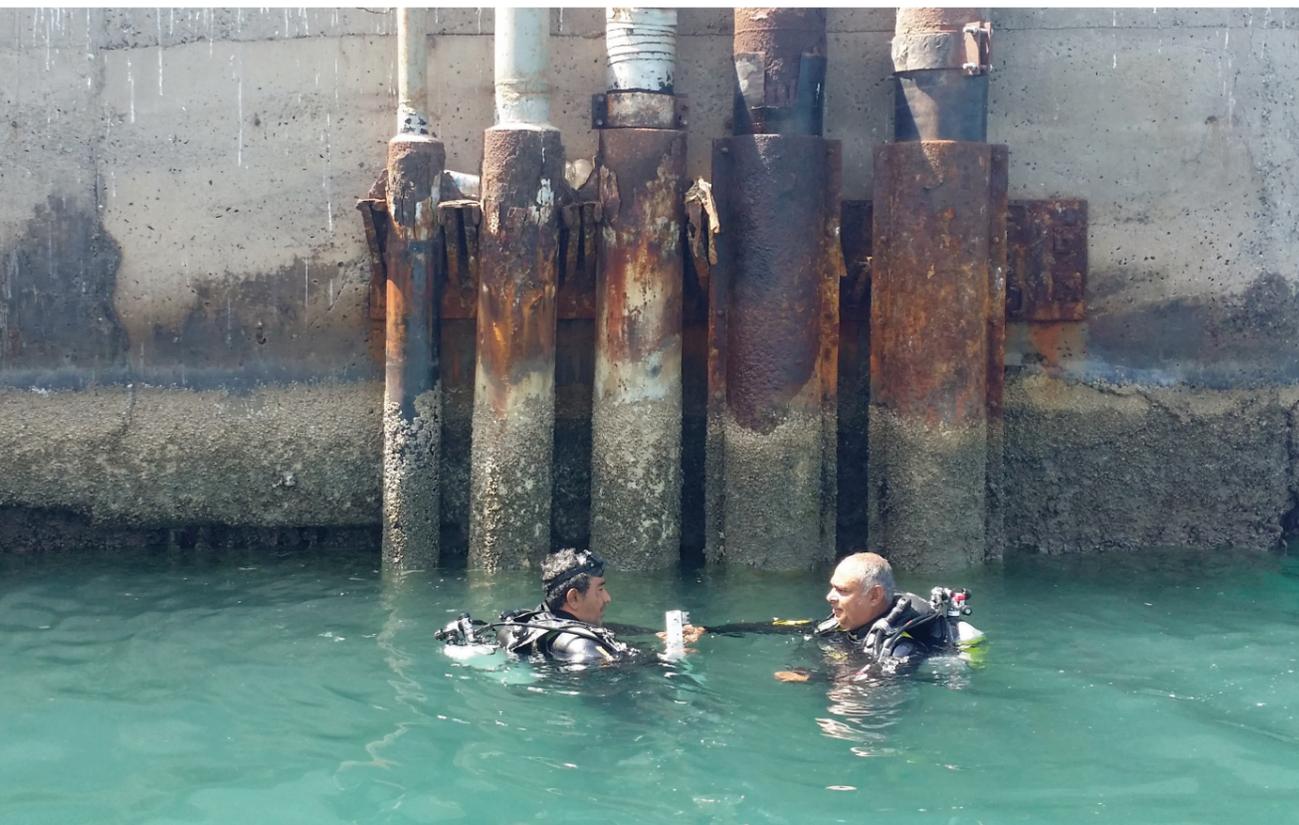
Buoys



View of Port of Hodeidah

4.1

Hodeidah: Oil Berth 1



Oil Berth 1 is located on the edge of the harbor basin and is used to discharge oil tankers up to 6,000 deadweight tonnage (DWT). It consists of a platform and dolphin made from a sheet pile cofferdam with a concrete topside structure and one steel buoy. The platform and dolphin are equipped with two and one bollards, respectively, with a safe working load (SWL) of 60 tons. Fenders are degraded to a large extent and/or are no longer present. Provisional fenders have been installed to keep the berth functional.

Oil pipelines from the Yemen Petroleum Company are present on the platform. From the platform the oil pipelines are placed in the bottom of the harbor in the direction of the Yemen Petroleum Company which is located south of the Hodeidah Port.



Above and left, all images: Hodeidah Oil Berth 1

4.1.1 RESULTS: VISUAL INSPECTION

Concrete structure The concrete structure of both the platform and the dolphin is disintegrating to a large extent. The reinforcement of the concrete structure is corroding and due to the lack or poor execution of maintenance the concrete is broken over the entire structure.

Sheet piles The concrete structure is placed on Larssen V sheet piles¹ and has not been treated with cathodic protection.² According to YRSPC, the sheet piles have not been inspected as they were informed that corrosion of submerged steel structures was not possible.

Bollards Bollards and anchors are corroded.

Fender system Fenders are degraded to a large extent and/or are no longer present. Provisional fenders have been installed to keep the berth functional.

Buoy The buoy is in a bad state of maintenance. It is corroded and leaks.

Pipelines The casing pipes through which the oil pipes pass are filled with concrete. The outside is considerably corroded.

Personal safety Loose materials on the platforms create a tripping hazard. There is no railing on the platform and the risk of falling into the water is great. Should this happen, it is not possible to ascend to the platform or dolphin as no ladders have been installed.



Fenders are degraded to a large extent and/or are no longer present.

4.2

Hodeidah: Oil Berth 2

Oil Berth 2 is located on the edge of the harbor basin and is used to discharge oil tankers up to 15,000 DWT. It consists of a concrete platform placed on steel foundation piles, two sheet pile dolphins with a concrete topside and two buoys.

The dolphins are equipped with a bollard for the spring lines with a SWL of 60 tons and a rubber fender system. Wooden fenders are located at the corners and backside of the dolphins, as well as a ladder. For the ships breast lines, there are two steel buoys in place.

Oil pipelines from the Yemen Petroleum Company are present on the platform. From the platform the oil pipelines are placed in the bottom of the harbor in the direction of the Yemen Petroleum Company which is located south of the Hodeidah Port.



Above and below: Hodeidah Oil Berth 2

4.2.1

RESULTS: VISUAL INSPECTION

Concrete structure The concrete structure of both the platform has largely been degraded. The reinforcement of the concrete structure is corroding and due to the lack or poor execution of maintenance the concrete is broken over the entire structure. Additionally, the platform suffered severe structural damage in 2016 due to a ship's collision. To date, the damage has not been repaired.

The concrete structure of the dolphins appears to be in a reasonable condition.

Sheet and foundation piles The concrete structure of the dolphins is placed on Larssen V sheet piles and are not provided with cathodic protection. The current state of the steel foundation piles under the platform is unknown.

Based on information provided by the YRSPC the sheet piles have not been inspected as YRSPC was informed that corrosion of submerged steel structures was not possible.

Bollards The bollards and anchors are corroded but appear to be in a reasonable condition.

Fender system The dolphin's fender systems are in a reasonable condition.

Buoys The buoys appear to be in reasonable condition with minor defects. The current state of the buoys' steel chains and anchors are unknown.

Personal safety There is loose material on the platform and the walkway around the platform is small with no handrails. There is a provisional ladder installed to ascend to the platform. The ladders installed on the dolphins are in poor condition.

The casing pipes through which the oil pipes pass are filled with concrete and the outside is considerably corroded.



There is loose material on the platform and the walkway around the platform is small with no handrails.



Above and below: Hodeidah quay wall, Berths 1–5



The quay's concrete has largely degraded. Due to poor maintenance—or lack thereof—corrosion of the reinforcement is spreading.



4.3

Hodeidah: Quay Wall Berths 1–5

Berths 1–5 are used for bulk, breakbulk and general cargo transfer. The quay can accommodate ships up to 30,000 DWT and has a maximum draught level of 9.4 meters (approximately 31 feet).

The quay wall was built between 1958 (Berths 1 and 2) and 1975 (Berth 5). It is a Larssen V sheet pile wall attached to an anchor wall that is placed 21 meters (approximately 61 feet) away from the sheet pile wall. The sheet pile wall is capped with a reinforced concrete beam.

The quay wall is equipped with cylindrical fenders and bollards are placed every 20 to 30 meters. The SWL of the bollards is 60 tons.

Directly behind the quay, gantry crane rails have been built on footings. The dredged depth in front of the quay is 8.5 meters (approximately 28 feet) for Berths 1 and 2; 9.25 meters (approximately 30 feet) for Berths 3 and 4; and, 9.70 meters (approximately 32 feet) for Berth 5.

4.3.1

RESULTS: VISUAL INSPECTION

Concrete structure The quay's concrete has largely degraded. Due to poor maintenance—or lack thereof—corrosion of the reinforcement is spreading, and parts of the concrete structure have broken.

Sheet piles The Larssen V sheet piles have not been treated with cathodic protection. The current state of the sheet piles is unknown. According to YRSPC, the sheet piles have not been inspected as they were informed that corrosion of submerged steel structures was not possible. Their integrity is unknown.

Part of the sheet pile wall was damaged as a result of a collision on Berth 4. The sheet pile is torn and soil seeps out; the damaged part has not been repaired.

Fender system The rubber fenders are in a reasonable condition; however, the anchors, booms and chains are heavily corroded. Some fenders have been removed to replace the damaged fenders on Berths 6 and 7.

Bollards The quay has steel bollards filled with concrete. The bollards and its anchors are corroded, and some bollard's concrete foundations are cracked. During the site visit, up to four mooring lines were placed on the bollards.

Harbor bed There is no recent hydrographic survey available; however, a 2016 survey shows that the harbor bed alongside the quays is deeper than the maximum dredging depth of 9.70 meters (approximately 32 feet) in some places.

4.3.2

GENERAL ADVICE: HODEIDAH BERTHS 1-5

Bollards and mooring lines The mooring system contains three main elements: the mooring line, the mooring winch and the bollard. The key property of a mooring line is the minimum breaking load (MBL) and its minimum working load (MWL). The MWL is between 50 per cent and 60 per cent of the MBL, depending on the exact material properties of the used line. The MBL is a certified value.

A ship is classified with an 'Equipment Number'—a parameter associated with the front surface area used to determine the anchoring equipment. The Equipment Number is also used to determine both the MBL and the minimum number of mooring lines needed for a ship.

The winch holds the mooring line and has an 'auto tension' and brake function. Auto tension is used under fair-to-moderate conditions. Should the wind speed increase, winches are placed on the brake increasing the holding capacity. The winch should render³ at 60 per cent of the MBL maximum—the Maximum Holding Capacity (MHC) of a winch. The MHC is not a certified value.

The system's failure process should occur in the following order:

1. Winch renders
2. Mooring line breaks
3. Bollard fails
4. Quay wall fails

Safe mooring equipment and its foundations should be designed for human failure based on the MBL and number of the applied mooring lines. Based upon international guidelines, the following is advised⁴ for the bollard design (see Table 1).

The approach is conservative and guarantees safe mooring points. Nuances are possible but will require more research to avoid miscalculations related to the safety of mooring their vessels at fewer bollards. It is possible, however, to use the Dynamic Mooring Analysis and Finite Element Modelling to prove the safety of a moored vessel at existing infrastructure.

In the ports of Hodeidah, with the MBL of 50-ton mooring lines and the SWL of the 60-ton bollards, it is strongly advised to only allow a maximum of two mooring lines on each bollard.

Harbor bed The 2016 hydrographic survey indicates areas along the quay⁵ that are deeper than the maximum dredging depth of -9.75 meters (approximately -32 feet). To maintain the structural integrity and safety of the quay, the harbor bed must be regularly surveyed.

Table 1

MAXIMUM BOLLARD LOAD

Limit State	Formula	2 lines	3 lines	4 lines
Serviceability Limit State (SLS)	$N \times 0.6 \times \text{MBL}$	1.2 MBL	1.8 MBL	2.4 MBL
Ultimate Limit State (ULS)	$1.5 \times N \times 0.6 \times \text{MBL}$	1.8 MBL	2.7 MBL	3.6 MBL
Accidental Limit State (ALS)	$2 \text{ MBL} + (N-2) \times 0.6 \times \text{MBL}$	2.0 MBL	2.6 MBL	3.2 MBL



Hodeidah quay wall, Berths 6-7

4.4

Hodeidah: Quay Wall Berths 6-8

Berths 6-8 are used for container transfer. The quay can accommodate ships up to 30,000 DWT and has a maximum draught of 9.4 meters (approximately 31 feet).

Berth 6 is constructed as a cellular wall where—with straight web profiles—cylindrical cells form to link to each other. The cells are filled with sand a concrete beam is constructed on top. Cylindrical piles are driven in each cylinder as a foundation of the crane rail of the ship-to-shore cranes.

Berth 7 and 8 are constructed in the same manner as Berths 1-5 and consist of a Larssen V sheet pile wall with anchor rods to an anchor wall. On top of the sheet pile wall a reinforced concrete beam is constructed. Behind Berth 7, cylindrical piles are driven in the ground as a foundation for the crane rails for the ship-to-shore cranes.

The quay wall is equipped with arch type fenders and bollards are placed every 20 to 30 meters. The SWL of the bollards is 75-tons. The dredged depth in front of the quay is 9.75 meters (approximately 32 feet).

4.4.1 RESULTS: VISUAL INSPECTION

Concrete structure The quay's concrete shows damage due to corrosion of the reinforcement and because of irregular maintenance, the concrete structure has broken.

Cylindrical cells and sheet piles The cylindrical cells of Berth 6 and the Larssen V sheet piles of Berth 7 and 8 do not have cathodic protection; their current state is unknown. According to YRSPC, the sheet piles have not been inspected as they were informed that corrosion of submerged steel structures was not possible.

Fender system The quay's fenders have deteriorated to a great extent and are unusable. Cylindrical fenders from Berths 1–4 have been used to replace damaged fenders.

Bollards The quay has steel bollards filled with concrete; however, the bollards and its anchors are corroded, and some bollards have cracks in the concrete foundation.

Service trenches The waterside service trenches alongside the crane rails are filled with sand, water and dirt. Nearly all the concrete trench covers are broken or missing.

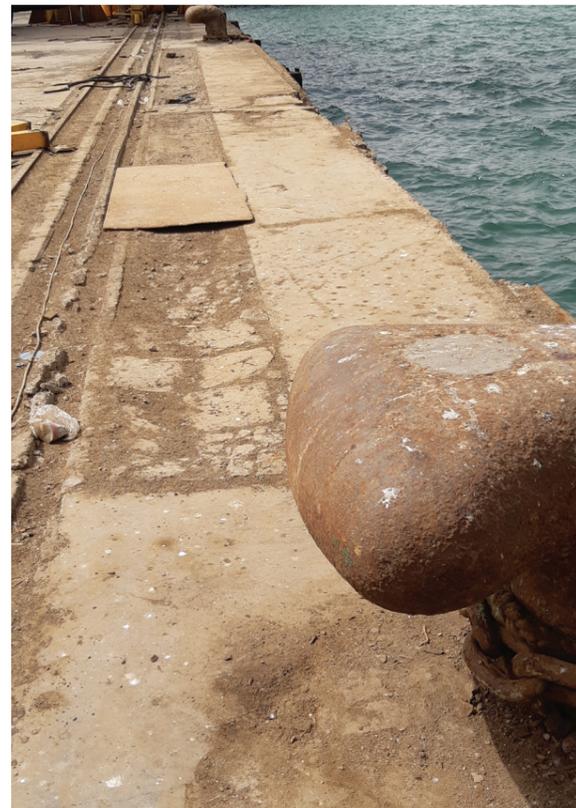
The bollards and its anchors are corroded, and some bollards have cracks in the concrete foundation.



4.4.2 GENERAL ADVICE: BERTHS 6–7

Bollards and mooring lines In the ports of Hodeidah, with the MBL of mooring lines of 50-ton mooring lines and the SWL of the 75-ton bollards, a maximum of two mooring lines on each bollard should be allowed.

Harbor bed The hydrographic survey of 2016 shows areas adjacent to the quay that are deeper than the maximum dredging depth of 10 meters (approximately 33 feet). To maintain the structural integrity and safety of the quay, the harbor bed must be surveyed on a regular basis.



Hodeidah quay wall, Berths 6–7



Above, all images: Slipway



4.5 Slipway and Maintenance Yard

South of Berth 1, two jetties and a slipway are constructed for berthing tugboats and maintenance equipment. The slipway is used to maintain tug and pilot boats. The boats are placed on a mobile steel undercarriage and lifted from the water by steel cables. The slipway slope is constructed from concrete beams upon which rails are mounted. A marine equipment maintenance yard is next to the slipway.

Located at the end of the slope is the building in which the cable drums, electricity supply and electric motor are placed.

4.5.1 RESULTS: VISUAL INSPECTION

Slipway building The slipway building and concrete beams were damaged in the conflict. Provisional repairs were made to the building wall; however, the building is also in need of repair. The ceiling sustained damage, and the assessment found the cable drum drip trays to contain oil and fat and the facility to be dusty. The electric motor is in good condition, but the electrical installation is in need of repair. The steel pulling cables are damaged, but provisional repairs have been made.

Slipway yard The yard next to the slipway can be better maintained, discarding scrap, old equipment and waste to help enable a safer, cleaner and more functional environment.



The yard next to the slipway can be better maintained to help enable a safer, cleaner and more functional environment.

4.6

Approach Channel and Harbor Basin

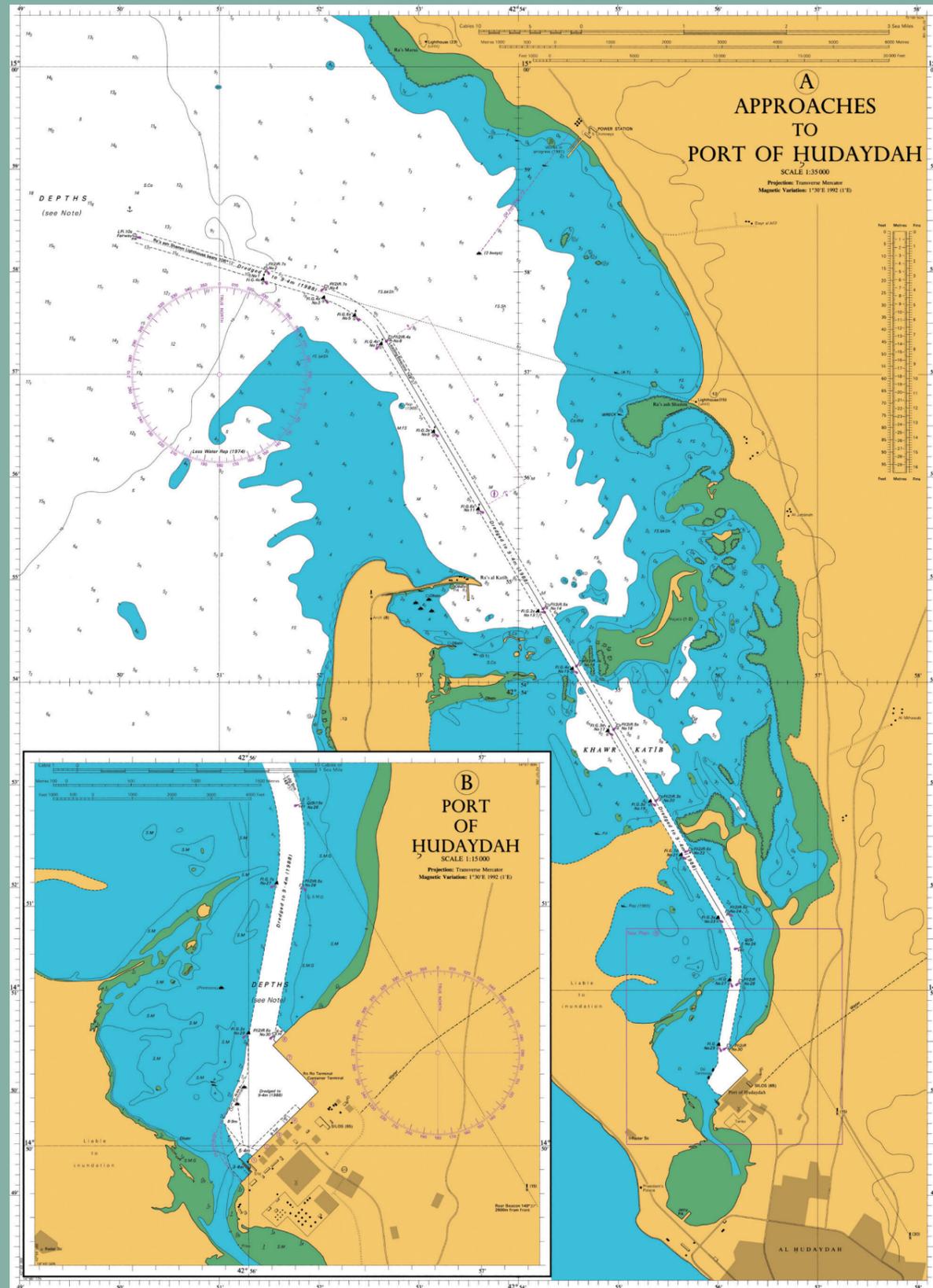
The approach channel from the Red Sea toward the Hodeidah Port basin is long and narrow. The depth is between 9.5 and 10 meters approximately (approximately 31 to 32 feet). At one point, there were 30 buoys that marked the approach channel. However, YRSPC reported that many buoys sank or drifted away, a navigational safety issue.

No visual inspection was done for the buoys and a recent hydrographic survey has not been conducted. The assessment recommends the installation of 27 new navigational buoys that are equipped with radar reflectors and lightning. The last hydrographic survey of the harbor basin was conducted in 2016 and the approach channel in 2008. Regular surveys are recommended to reduce the risk of shoaling of the seabed.

4.7

Hodeidah: Control Tower

The YRSPC has indicated that the current control tower must be raised to have a better overview of port operations and shipping in the approach channel and harbor basin. Current means of communication are insufficient for proper and safe guidance of shipping. The building is largely abandoned and hardly maintained.



Approach channel Hodeidah Port

4.8

Ras Issa: Buoys



The port of Ras Issa has very deep water (greater than 50 meters/ 164 feet). Because of this, there is no restriction on the draft and the largest tankers can visit the port. The port of Ras Issa is used to unload diesel fuel via a pipeline system to existing storage tanks. Tankers moor in a buoy system and unload the diesel fuel to storage tanks via a floating pipeline.

The new buoy system is owned and operated by the YRSPC. Placing the buoys in the water will make the location fully operational; however, an operational timeline is unknown, and the port is currently not functioning due to the conflict.

The pipelines and storage tanks are owned and operated by the Yemen Petroleum Company.



Above, both images: Ras Issa port buoys

5.0

Technical Port Equipment



Damage to machine and electricity house

The port provided a list of available equipment in need of maintenance and spare parts, but not a detailed list of equipment. Some of the numbers below are estimates.

- Berth cranes** Hodeidah port has seven berths. Berths 1–5 are used for general cargo and fuel and Berths 6 and 7 are container berths. Next to these berths, the port has two dolphins for fuel and gas discharge.

On Berths 1–5, there are five Russian-made portal cranes of which two are fully decommissioned. The other three are working but are in urgent need of maintenance. Replacement of the cranes should be considered as quickly as possible.

On Berths 6 and 7, there are five ship-to-shore gantry cranes on the quay side. Three cranes have been demolished—one Mitsubishi-made and two Fige gantry cranes. They have destroyed engines and/or electrical houses and the main frames have been structurally damaged in the conflict.

The two other cranes were built by Liebherr, Germany in 2011 and have a container lifting capacity of 41-tons. Both cranes have sustained damaged from the conflict in the machine house on top of the gantry, behind the rear legs. The machine houses will need to be replaced including the hoisting engines (spreader and boom) and central electronics of the crane.

Both cranes sustained collateral damage when the machine houses were destroyed. Other minor damage is due to contact with shrapnel; both cranes have minor secondary damage to all parts of the crane.

- Crane IR 1801** Crane IR 1801 has secondary damage to the stairs, the festoon cable, the upper rear support beam, the forestage and to the bogies of the rear legs that are positioned next to the rails. The hoisting cables for the boom and the spreader will need to be replaced to ensure operational ability. It is likely that lifting the rear leg of the crane will cause the bogies to be repositioned over the rails (the bogies are all aligned) allowing for immediate operation.

The headblock and spreader are salvageable but need urgent action to move them to a safe location. The most critical is the damage to the crane boom as it currently hangs at an angle of 1 to 2 degrees. This is likely a result of when the engine house sustained damage and the hoist cables broke, causing the forestage to stretch as the boom fell; the forestage must be replaced. The structural damage to the boom's hinge could also be the reason for the hanging of the boom. If this is the case, significant repairs to the crane will be required. *Note:* The structural damage to the hinge was not determined but must be part of a detailed assessment of the crane's structure.

- Crane IR 1800** There is a secondary damage to the stairs of the crane IR1800 on the festoon cable, the upper rear support beam and the hoisting cables for the boom and the spreader. Besides this damage the spreader is damaged beyond repair.



Top: Spreader of crane IR1801; bottom: bogies of rear leg of crane IR1801 next to rail

4. Heavy lifting crane The port has a 75-ton floating crane built on a platform of which the floating capacity is uncertain. It is currently unused for fear of sinking and is unlikely to be operationalized soon. Previously the crane was used for cargo handling and large repairs.

5. Russian (breakbulk) cranes To unload bulk cargo from a vessel to the trucks, the port uses hoppers and Russian cranes on Berths 1–5. In case of breakbulk,⁶ cargo is unloaded to the quay by cranes and nets or other lashing equipment. Of the five cranes, two are fully decommissioned and three are quasi functional; however, the port prefers to use gear from the ships to remove cargo. The cranes were purchased in 1967 and have not been well maintained; replacements are needed soon.

6. Horizontal transport The terminal has an unverified 11 straddle carriers (SC) of different brands (e.g. Terex, Kalmar, and Sizo) that are used for horizontal transport between the quay and the stack, and within the stack as well. Of the 11 SCs, three are non-functioning. The remaining SC are in varying states of operation, but all are in urgent need of maintenance to ensure future usability.

Most of the SCs are diesel-hydraulic and port staff appear to have skills to maintain them. However, the two Diesel Electric Terex SCs have a complicated diesel-electrical propulsion system and are currently unusable because of a software issue related to the SCs electrical power; local engineers have not been trained to solve the problem. Onsite assistance from a Terex certified engineer is required to solve the problem and to train the local engineers on the Terex SC.

Besides the SC, the terminal is using tractors and chassis to transport containers on the terminal. The terminal has an unknown number of tractors, of which 12 tractors made by Terberg (1), Kalmar (2), Molcy (3) and Mafi (6) are operational, but they require extensive maintenance to remain operational.

7. Equipment for stacking refrigerated (reefer) containers in the yard The yard has four stations with 18 plugs each to connect reefers to the power grid. Currently none of the stations have an operational connection to the port's power grid and are unable to store reefers for any period.



Above: Destroyed machine house; below: damaged cable support trolley



All straddle carriers are in urgent need of maintenance to ensure future usability.



Clockwise from top left: a Russian crane at the port; straddle carriers requiring maintenance; tractors requiring maintenance.



8. Supporting equipment The port has an unknown number of supporting equipment such as forklifts, empty handlers, top lifters and reach stackers. It provided a list of equipment they considered to be repairable and/or useable including:

- 4 forklifts
- 8 lift trucks
- 14 tractors

This equipment is in urgent need of corrective maintenance, but there are no maintenance parts currently available.

9. Power supply for the port The port and the cranes receive power from three Caterpillar generators built in 2015 that are in good condition. Currently one of the three generators supply enough power for the port to be operational. The switchgear that controls the generator's power flow to the central power control unit is in very good condition. All generators have run approximately 5,000 hours and are due for major maintenance at 10,000 hours. No spare parts for these generators were requested.

Even though the switchgear of the generators is in good condition, the power supply from the generators to the port is controlled by Russian switchgear installed at the same time the Russian ship-to-shore cranes. This switchgear needs to be urgently replaced to ensure future continuous distribution of power to the entire port.

10. Maintenance facilities The main repair workshop is a steel beam structure with corrugated iron sheets. It has been damaged during the conflict including one of the roof beams and all the corrugated sheets; they all require replacement.

A second, heavily damaged workshop, is not being used for fear of collapse. It has large equipment for repair work such as milling and drilling that appear to be usable, but the port indicated that staff was not trained to use the machinery. All major repairs requiring welding, milling or drilling on parts and machines were outsourced to specialized companies in the city of Hodeidah.

11. Spare parts All the spare equipment parts used in the port have not been replenished or renewed due to difficulties related to imports. The need for spare parts for the horizontal transport equipment and tugboats is significant. Despite the port being unable to purchase parts, commercial companies in the city of Hodeidah can procure them through the port of Aden.

12. ICT network and data center It appears that none of the operational staff have access to internet at the port, but this is unconfirmed. All communication to support the ports operational processes between the shipping agents, the clearing agents and other customers seems to be done by phone or paper. The port confirmed there is not an ICT manager.

13. Gate and related processes Unloaded cargo will be cleared for transportation to the final customer by the consignee's clearing agent. Once port duties are paid, the clearing agent pays any duties at customs.

After customs approval, the clearing agent will arrange for the cargo's transportation. The port loads the cargo on the trucks to be taken to Customs for final inspection where it will either be cleared for import, X-rayed or physically inspected. This process determines the time needed to transport the cargo from the port.

In the port of Hodeidah, these processes are conducted via paper; there is no electronic clearing of cargo.

14. Terminal Operating System and Gate Operating System for coordinating the terminal operations Based solely upon observations, it is reasonable to assume that the port does not have an operational Terminal Operating System (TOS) nor a Gate Operating System (GOS). All processes on the port are governed by paper backup.



A second, heavily damaged workshop is not being used for fear of collapse.



Top to bottom: Reefer connection station; forklift in use by the port; damage to roof of workshop; maintenance workshop



6.0 Human Resource Capacity



Storage of debris for future use

Operational management and staff Further discussions on this issue will be required.

Training level and readiness of technical/ maintenance management and staff Although the maintenance manager assured the capacity of his staff to conduct maintenance of the port equipment, the level of readiness of technical and maintenance management could not be verified as certificates of maintenance training were not received during the assessment.

Customs procedures for quick processing of incoming goods Further discussions on this issue will be required.

Procedures to handle vessels in the port (pilots, tug boats, mooring crew, etc.) Further discussions on this issue will be required.

7.0 Compliance

International Ship and Port Facility Security (ISPS) and port's security level Port management indicated that the port of Hodeidah is ISPS⁷ certified. As ISPS certification is relevant for the security of the port, and disclosure is limited to relevant staff, no additional information was provided. There were, however, some concerns witnessed on site:

- Children playing in port's operational areas
- No CCTV port monitoring
- Non-functional port lighting

A concern with the violations is that the number of vessels entering the port soon may be limited as other ports may refuse a vessel entry after embarking and/or berthing in the port of Hodeidah.

Compliance with Health, Safety and Environmental Standards Health, safety and environmental awareness in the port is unacceptable.

The port contains large areas of debris from the conflict, damaged and unusable equipment and equipment being stored in hopes of future use.

Staff safety awareness must also be improved as general safety measures are not being taken, proper work attire is not being worn and there is no—or limited—use of Personal Protective Equipment (PPE) such as hard hats and safety vest. The latter makes it difficult to be seen by truck drivers and other heavy equipment drivers.

The electricity connection at both Hodeidah and Salif ports also poses a safety issue as open power connections—including up to 11 kilovolt connections—are

visible in multiple locations. In some instances, connections are made and protected by plastic tape. In the port of Salif, this is compounded by the dust that has accumulated in the high voltage transformer room. Should there be an electric spark, it could lead to a massive explosion and casualties.

It is suggested that all electrical connections be covered. However, if it is too hot, then the connections must be under lock and key, accessible only for staff who possess detailed knowledge of the electrical shock risks.

An urgent remedy is needed for these issues.



Staff working on height without securing measurements



Transformer connections in Salif Port



Both images: Electrical connections in Hodeidah Port

8.0 Recommendations

A list of recommendations was compiled and given in Table 2. This list contains projects that are necessary for maintaining the current port operations and restoring port operation to pre-war conditions.

Priority 1 projects are a prerequisite for maintaining the current port operation and require immediate action.

Priority 2 projects aim at re-establishing containerized cargo handling capacity by the port of Hodeidah.

Priority 3 projects are necessary to restore or improve safety and sustainability of the port's operations and assets.

A description and substantiation of the recommended projects is given below the table.

Table 2

RECOMMENDED PROJECTS

#	Priority 1 Projects	Estimated Cost (EUR)	Duration (months)
1	Repair sheet pile damage resulting from collision on Berth 4 (risk of sinkhole)	150,000	1
2	Procurement of spare parts generators and rolling equipment (also Salif)	1,000,000	6
3	Procurement of spare parts for tugboats	500,000	6
4	Procurement of 27 buoys in the channel leading to the port	200,000	8
5	Overhaul Ras Isa Tugboat (Salif)	800,000	8
6	Assessment for all electrical works in the port	100,000	2
7	Assessment of damage of Liebherr cranes by Liebherr Engineer for possible repairs	100,000	1
Total		2,850,000	

PRIORITY 1 PROJECTS

Table 2 (continued)

#	Priority 2 Projects	Estimated Cost (EUR)	Duration (months)
8	Prepare specifications for future expansion of ship to shore cranes	50,000	4
9	Repair of damages Liebherr cranes (€18 million to procure new cranes if not repairable)	9,000,000	12
10	Procurement of two Mobile Harbor Cranes	6,000,000	12
11	Replace Russian switchgear	1,000,000	18
12	Repair of maintenance workshop (sheeting and aircon with solar panels)	750,000	4
13	Installation of roof over generators	120,000	6
14	Detailed inspection of sheet piles and concrete structures of quayside	1,800,000	12
	Total	18,720,000	
#	Priority 3 Projects	Estimated Cost (EUR)	Duration (months)
15	Installation of two buoys at Ras-Isa	-	1
16	Procurement of a pilot boat	1,500,000	12
17	Repair of damage to slipway building and replacement of pulling cables	100,000	8
18	Repair and/or replacement of quay wall concrete structure and fenders	16,700,000	60
19	Repair and/or replacement of Oil Berth 1 and 2 concrete structures and fenders	4,200,000	12
20	Container scanners (two mobile + two fixed later on)	unknown	-
21	Safety and maintenance awareness programme	2,500,000	-
22	New control tower	unknown	-
	Total	25,000,000	
Overarching Total for Priorities 1, 2, and 3		€46,570,000	

1. **The damage to Berth 4's sheet pile** must be urgently repaired to prevent collapse of the structure or the risk of a sinkhole from occurring. The sheet piles may be repaired by welding a steel plate on the sheet pile and fill the hole behind the plate with concrete.

2. **Yemen's public grid power supply** is not capable of supplying enough power to the port. The port, therefore, has several generators to power all the electrical equipment. The three relatively new generators are currently capable of supplying the port with enough power; however, as the ship-to-shore cranes are repaired or replaced, the generators will not be able to provide the power necessary to keep the port operational.

The required extra power must be supplied from generators that are not currently used. The generators are in urgent need of maintenance; however, preventive and corrective maintenance has not been done as there is a lack of spare parts that are difficult to procure. Generators in the port of Salif are also in need of urgent maintenance.

Equipment for horizontal transport includes straddle carriers, tractors and chassis; however, this equipment has not been maintained for an extended period. Failure to service this equipment will result in the lack of capability of transport from the quay to the yard, limiting the port's operational capabilities even further—possibly even leading to a total collapse of port operations.

It is better to procure the spare parts via local reseller agents from original equipment manufacturers (OEM) suppliers. This methodology allows a competitive bidding on the delivery of packages of parts to the port. The list of required spare parts compiled by the port's maintenance department is under review by the onsite UN Technical Specialist. Once the review is done, a final list will be available for procurement purposes. Resellers typically represent multiple suppliers and should be able to supply the spare parts of all cargo handling equipment on the port.

3. **The tugboats in the ports** of Hodeidah and Salif are also in need of repair and currently, the port has no spare parts to maintain them.

The priority is the two tugboats in the port of Hodeidah that are not in use and need maintenance. When these tugboats are operational, they can be sent to Salif Port to temporarily replace the tugboat Ras Issa while that boat receives a master overhaul maintenance (noted below in item 5). When these are operational again, the port should focus on the remaining tugboat maintenance.

Spare parts for all the boats must be taken into consideration.

4. **The channel from the Red Sea to the port of Hodeidah is missing many buoys** making coming into and out of the port a hazardous operation. Many ship captains have complained about this situation and may not return to the port if the situation is not resolved. This can be remedied by installing 27 new buoys which is expected to cost €200,000.

5. **In the Port of Salif, the large tugboat Ras Issa** is being used to tow vessels to a safe location in the port, but the boat needs a mid-life overhaul maintenance.

Due to the size of the tugboat Ras Issa, an independent marine expert must confirm that there is no docking facility available in Yemen for the maintenance. If no dry-dock service is available in Yemen, the port has received a quote for the work from an Oman-based dry-dock company. Sailing the Ras Issa tugboat to Oman will require authority approval.

6. **As mentioned previously, the port's electrical work** must be significantly improved, as well as the port's reefer stations which need to be electrically connected and operational before reefer containers can berth. An independent assessment of the complete electrical installation should be conducted by a certified electrical engineer.

Only the Liebherr company has the original drawings and design calculations of the cranes and have the technical knowledge to determine the consequences of the damages to the cranes. A Liebherr specialist should undertake a detailed assessment of the two Liebherr ship-to-shore gantry cranes to determine their structural integrity and the best way to ensure operational capacity. If a Liebherr specialist is unable to come to Yemen, it may also be possible to undertake the assessment from a distance.

PRIORITY 2 PROJECTS

7. **If the two remaining Liebherr ship-to-shore gantry cranes are not repairable**, new cranes must be procured to give the port enough container handling capacity. The following is an approximate timeline for this process:
- The procurement of custom-made ship-to-shore gantry cranes is a process of approximately two years.
 - Making the detailed specifications will take three to four months.
 - The procurement process will take another two to three months.
 - The building of the crane with delivery and installation will take 1.5 years.

Given the time pressure under which the cranes must be procured, it is advisable to compile the specifications as early in order to reduce the overall process up to four months. Specifications should also be created in case the volume of the port increases to over 200,000 containers per year as extra container lifting capacity will be required.

8. **A ship-to-shore gantry crane** holds its operational integrity for 25–30 years. Given the age of the cranes (8 years)—approximately a quarter to a third of its standard lifetime—the current value of the cranes is approximately USD \$6 million each. Initial cost estimation of repair is between €2.5 million–€4.5 million per crane.

If the cranes cannot be repaired within a reasonable cost, the cranes should be replaced by new ones.

9. **Two Mobile Harbor Cranes (MHC)** can be procured and delivered in a period of 6–7 months after ordering. The port currently has no capability of handling containers other than with available gear on visiting vessels, limiting the number of vessels that can visit the port.

It is possible to procure the MHC's using a limited competition process to request reputable companies to submit a bid. Reputable companies building MHC's are Liebherr, Konecranes/Gottwald and Sennebogen. The procured MHC must include the crane, a 20" and a 40" spreader, a Jibb and rotor with remote control and have a lifting capacity of 25-tons at 33 meters or the center of the crane.

The MHC may be used on the container and general cargo berths. As soon as the two gantry cranes are operational, the MHC should replace the old Russian cranes on Berths 1–5.

The load of the MHC on the quay should not exceed the maximum allowable load of the quay. For the

Berths 6 and 7 the supplier will have to assure that the load of the MHC does not exceed the following values:

- 250 kN/m on the crane rails
- 40 kN/m² between the crane rails (rails are 18 meters apart)
- 60 kN/m² behind the rear crane rails
- 600 kN as a concentrated load on the quay

The supplier must warrant that during normal operations the crane load will not exceed the maximum allowable quay load.

The procurement process of an MHC is off-the-shelf for which the suppliers have standardized and optimized designs; in principle, any structural changes are not possible. Any extra supplies may be ordered.

10. **To secure a safe workspace** for the engineers, the maintenance workshop needs new sheeting (sheets of corrugated iron) and climate control measurements. Climate control can include ceiling fans or optimally, an air-conditioning system to control the temperature in the workshop. If the latter, the power to operate the system must come from solar panels as the port's power supply is currently under too much stress to handle the extra load.

11. **The Port of Hodeidah is relying on old Russian switchgear** for the distribution of electrical power over the Port, but the switchgear needs to be replaced. The specifications provided by the port for its replacement are insufficient to launch a tender process. An electrical engineer certified in handling medium voltage (MV) switchgear must provide acceptable specifications to ensure the correct switchgear is procured.

12. **The port's three operational generators** are currently placed in a power supply area and positioned on concrete foundations with trenches. However, the foundations do not have a cover against direct exposure to sunlight, which accelerates the deterioration of the generators.

A simple roof over the generators will shield them from direct sunlight and preserve the current good condition of the generators for an extended period. The design of such a roof is currently under review by the UN Infrastructure Specialist.

13. **Inspection of sheet piles** Given the age of the structures, the salinity and the average water temperature of the Red Sea, the risk of corrosion damage is certainly present as submerged steel sheet piles can indeed corrode. Additionally, the steel wall of the cylindrical cells of Berth 4 is relatively thin and vulnerable to damage due to a ship collision and corrosion. If further damages occur, loss of the material inside the cells may cause instability of the quay.

Uniform corrosion rates normally vary between 0.05 and 0.25 millimeters per year. Uniform corrosion rates are relatively easy to estimate; however, local corrosion is not.

There are many mechanisms that can cause local corrosion, which may be concentrated in specific places in which its rate may be very high. In saline water such as the Red Sea, Microbiologically Induced Corrosion may be an issue as bacteria present in saline waters locally form slimy bio-films on the steel surface of the quays. Anaerobic conditions can form in the bio-film where acid producing bacteria may develop, causing rapid pitting corrosion. Corrosion rates of many millimeters per year have been recorded in similar conditions.

Reduction of wall thickness by corrosion decreases the structural strength of the sheet pile profile. Depending on the amount of reduction, sheet piles can be repaired by costly reinforcements. If the reduction is too significant, and reinforcements no longer possible, the construction must be considered damaged beyond repair.

Detailed inspection of sheet piles is therefore mandatory and must include:

- Wall thickness measurements on the sheet piles
- Pitting corrosion measurements
- Inspection for hole formation and other deviations
- Measurement of water temperature and conductivity
- Service life calculations

Depending on the results of the inspection, it may be necessary to repair reduced structural strength and/or hole formation in the best-case scenario. In the worst case, part or all the quay must be rebuilt. The Port of Rotterdam can supply an inspection protocol, offer support on the inspections and perform service life calculations on request. To prevent further deterioration in structural safety, as soon as repairs are made to the quay, a system of cathodic protection must be installed on the sheet piles.

Inspection of concrete structures A detailed inspection of all the concrete structures needs to be performed to determine the residual service-life (durability) and evaluate the expected effort and associated costs that will be required to maintain the structures in proper condition.

It is estimated that up to 100 per cent of the concrete surface needs to be serviced. At least 150 millimeters of concrete should to be replaced as to leave no chlorides behind the replaced concrete as a source of renewed corrosion of the reinforcement. Definitive quantities need to be determined through the detailed inspection. In the least, the inspection needs to provide the following:

- **Fieldwork investigation**
 - Visual inspection of the concrete surface with hammer to determine any absence of delamination.
 - Determine concrete cover at different locations using a ground-penetrating radar (GPR).
 - Considering GPR measurements—and to avoid reinforcement damages when possible—determine the core location conditions of the elements and any other relevant observation.
- **Extraction of and laboratory testing on concrete cores**
 - The objective of the laboratory testing programme is to evaluate the quality of concrete in the different structures. Among others, tests to be performed include:
 - Petrographic exam*
 - Chloride content test*
 - Volume of permeable voids*
 - Moisture transport properties*
 - Ion diffusion coefficient*
- **Service-life analysis**
 - The service-life analysis aims to evaluate the remaining lifetime of the structure based upon the chloride-induced corrosion within concrete structures. For the service life analysis, we highly recommend the use of STADIUM® software.
 - STADIUM® is a finite element analysis software which reliably predicts concrete degradation kinetics.⁸ With the help of STADIUM®, the exposure conditions are determined based on experimental data collected during the laboratory testing. The evaluation of the chloride ingress with time is then calculated and the remaining lifetime of the different structures is determined.
- **Evaluation of maintenance options and evaluation of cash flows related to the repairs.**

PRIORITY 3 PROJECTS

14. The oil berth in the port of Ras Issa is operational in principle and ready to receive fuel for storage and transportation into the country. The only activity required is the installation of two buoys that are currently lying on Ras Issa beach next to the mooring point for the oil transporting vessels. This will allow visiting vessels to safely moor at the discharge point.

15. The port currently has no operational pilot boat to help guarantee the pilot's safety. For now, the pilots are transported by the tugboats, which is neither cost effective (higher diesel consumption) nor time effective. It is also less safe for the pilot to transfer from the tugboat to the vessel to be guided compared to the transfer from a pilot boat. A new pilot boat is recommended.

16. The following actions are recommended as part of the rehabilitation of the slipway:

■ **Maintenance on the slipway**

- Clean and grease the wheels of the mobile undercarriage and preserve the steel structure with a NORSOK M-501 system 7B approved paint system.
- Replace all pulling cables.
- A detailed inspection of the structural integrity of the slipway building by a structural engineer is strongly recommended.
- Repair the damage to the slipway building and repair the concrete damage to the slipway.
- Have the electrical installation checked, shielded from unauthorized personnel, cleaned and maintained by a certified electrical engineer.

■ **Clean the slipway building**

- Empty and clean the dip trays, remove all dust, excess grease and accessory materials that is no longer needed.
- Clean the maintenance yard next to the slipway. Remove the scrap, old equipment and accessory materials no longer needed.
- Repair damaged concrete of the jetties.

17. Repair and/or replacement of quay wall concrete structures and fenders.

■ **Concrete structures**

- Based on the results of the detailed inspection and service life calculations, the concrete surface needs to be repaired with an application of cathodic protection (sacrificial anodes) to the reinforcement in the repaired surface to prevent corrosion along the edges of the repair. Quality control supervision of such works is mandatory.

- The concrete structure of Berth 5 degraded to such an extent that this can only be repaired by replacing the entire concrete structure.

■ **Fender systems**

- Anchors, booms and chains of the cylindrical fenders on Berths 1–5 need to be replaced and the fenders placed on the Berths 6 and 7 need to be reinstalled on Berths 1–5. Replacement should take place after the execution of the concrete repairs.
- The fender system of the Berths 6–8 has degraded to a great extent and needs to be fully replaced.

■ **Bollards**

- The bollards on the Berths 1–4 and 6–8 need to be preserved with a NORSOK M-501 system 7A approved paint system. In addition, the concrete work should include the repair of the damages to the bollard foundation.
- The bollards on Berth 4 need to be replaced during the concrete work on this berth.

■ **Personal safety**

- Install ladders on the quay walls. Ensure the lowest step is one meter minimum below low tide.

■ **Service trench**

- The service trench of the Berths 6 and 7 needs to be cleaned and the trench covers replaced.

18. Repair and/or replacement of concrete structures and fenders Oil Berth 1 and 2.

■ **Concrete structure**

- Based on the results of the detailed inspection and service life calculations, the concrete surface needs to be repaired with an application of cathodic protection (sacrificial anodes) to the reinforcement in the repaired surface to prevent its corrosion along the edges of the repair. Quality control supervision is mandatory.

■ **Bollards**

- Preserve the bollards with a NORSOK M-501 system 7A approved paint system.

■ **Fender system**

- Remove provisional fenders and install four cylindrical fenders on the platform and one on the dolphin of Oil Berth 1. Replace two wooden fenders on the back of the platform of Oil Berth 2 and install a ladder in between. Ensure the lowest step is one meter minimum below low tide.

■ **Buoys**

- Cleaning, detailed inspection, repair, welding and preservation of buoy. For the preservation use a NORSOK M-501 system 7B approved paint system.
- Detailed inspection of chains and anchor of buoy at same time of sheet pile inspection.

■ **Personal safety**

- Remove accessory materials from the platforms and dolphins.
- There are electrical equipment and generators on the platforms which can be an explosive hazard. Special shielded equipment (IECEX certified) is mandatory to reduce the risk of explosion, as is Personal Certification for personnel working on the berth.
- Add a ladder on platform and dolphin of Oil Berth 1. Ensure the lowest step is one meter minimum below low tide.
- Install new ladders on the dolphins of Oil Berth 2. Ensure the lowest step is one meter minimum below low tide.
- Place fire extinguishers on the platforms.
- Consider installing a handrail on the sides and back of the platforms.

19. Under the Stockholm Agreement, the port of Hodeidah plays a key role for the movement of goods and humanitarian aid. Mobile and regular X-Ray scanners are required to ensure that prohibited items listed in the UN Security Council Resolution 2216 (2015) are not entering the port.

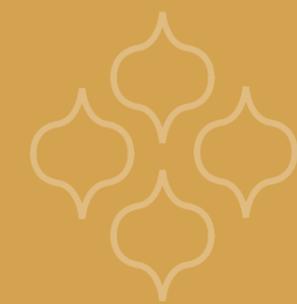
20. The lack of safety awareness in the port—

combined with hazardous situations and activities— can be mitigated through a safety awareness project. This, combined with a general training program, can build capacity of the port staff—ultimately elevating the port to international standards.

21. Given the need for reliable communications

between the port and ships berthing, new VHF, radar and automatic identification system (AIS) equipment will be required; however, the existing control tower is too low and is sited in the wrong place. Additional work is needed to identify a suitable location for the tower and the required height to also cover the anchorage area and near approaches. The site should be clear of interference by moving cranes and have safe access from the head office area. It will require power supply and communication cables.

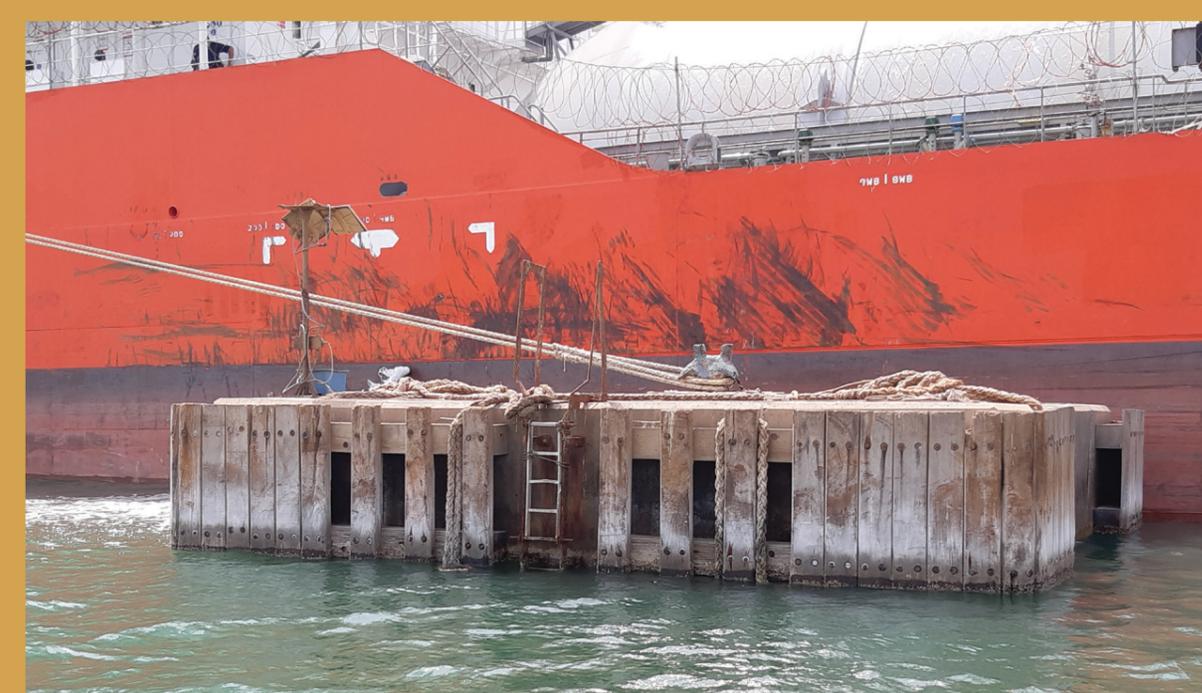
9.0 Conclusion



The assessment found that the port's quays, buildings and all the equipment are in dire need of maintenance. Although some damage has been done during the conflict, there was also a lack of maintenance prior to the conflict. Additionally, the port staff maintains their assets using only corrective maintenance and doesn't either have the means nor the capacity to exercise preventive maintenance.

Given the damage to, and condition of, some vital assets in the port (i.e. electrical installations, horizontal transport equipment and tugboats), it is urgent to secure spare parts and rehabilitation of these assets. Further diminishing of these assets will bring some of the port to a complete standstill.

One of the main findings of the assessment is the possibility of repairing at least one but maybe two ship-to-shore cranes instead of buying new cranes. New cranes are not only much more expensive, but also completing specifications, procurement, building and commissioning of the cranes takes a lot more time, at least two years. Re-establishing containerized cargo can be achieved in approximately a year by repairing the cranes.



Hodeidah Oil Berth 2

The recommended projects require specialists and (spare) parts not available in Yemen. The delivery of the required (spare) parts is difficult and obtaining a visa can also be a challenge. Considering the criticality of the infrastructure of the ports of Hodeidah, Salif and Ras Issa to commercial and humanitarian activities in Yemen, the authorities must be urged to ensure that the required specialists and parts can enter Yemen in accordance with the Hodeidah Agreement.

The authorities must be urged to ensure that the required specialists and parts can enter Yemen in accordance with the Hodeidah Agreement.

Repair of the jetties and quays will be a project with a long lead time; however, solving the problem with the hole in the sheet piles in front of Berth 4 must be done urgently. Due to the time passed since the accident that caused the hole to date, the likeliness of a sinkhole appearing behind the quay wall will rise to an unacceptable risk.

Given the age of the structures, the salinity and the average water temperature of the Red Sea, the risk of corrosion damage is certainly present as submerged steel sheet piles can indeed corrode. Reduction of wall thickness by corrosion decreases the structural strength of the sheet pile profile. Depending on the amount of reduction, sheet piles can be repaired by costly reinforcements. If the reduction is significant, and reinforcements are no longer possible, the construction must be considered damaged beyond repair. Therefore, a detailed inspection of the sheet piles is mandatory.

This report does not give an opinion on the strategic path project card of the YRSPC. The reason for this is twofold.

1. Given the size of these projects, an extensive study must accompany these plans. Detailed information on the projects was not provided. An assessment of these plans based on only the summary is not possible without knowing the background and basis of the plans.

2. A business case must be prepared to justify these plans. In this business case, a prospect of container handling and the related revenues will be presented on which an investment decision can be made. As an example: in general, the following benchmarks⁹ can be used to determine the need for extra equipment:

- 1 ship-to-shore crane for every 100,000 to 120,000 containers handled over the quay per year
- 2.5–3 straddle carriers per crane for the horizontal transport between the quay and the stack
- 5–7 tractors with chassis per crane for the horizontal transport between the quay and the stack

In view of the current situation in Yemen, it is not possible to give any expectation regarding the prospects of container handling and revenues, and it remains to be seen whether and when these plans can be implemented.

The assessment was to include monitoring of the compliance of the port operations and immediate requirements for provision of advisory support and training to strengthen technical and managerial capabilities. This was not possible and further discussions are required.

The port's assets suffer from poor maintenance which means higher maintenance costs and implies a negative influence on the performance, reliability and safety of the assets. Also, the port is facing issues related to health, safety and environmental conditions for port workers. A general training program combined with a safety awareness project, can build the staff's capacity—ultimately elevating the port to international standards.

The port is facing issues related to health, safety and environmental conditions for port workers.



Top: Damaged walkway next to machine house; bottom: damaged spreader

TERMS OF REFERENCE

DAMAGE AND CAPACITY ASSESSMENT
HODEIDAH PORTS YEMEN

21 February 2019

BACKGROUND

Yemen is experiencing one of the world's worst protracted political, humanitarian and development crises. More than 24 million people—80 per cent of the population require some form of humanitarian aid and protection.

The ports of Hodeidah, Salif and Ras al-Isa are critical and irreplaceable infrastructure essential to commercial and humanitarian activities in Yemen. Seventy percent of all imports into Yemen and 80 per cent of all humanitarian assistance pass through these ports. This essential lifeline has been threatened by recent fighting, which has already made key humanitarian infrastructure, including milling capacity and warehousing, inaccessible. Important access routes into the city have been cut, with a single route remaining for all civilian, commercial and humanitarian traffic. Recently, the west coast ports of Hodeidah and Salif have collectively accounted for 85 per cent of wheat grain and 42 per cent of rice imports and almost half of the wheat flour that entered Yemen. The port of Ras Issa remains dysfunctional.

A United Nations (UN) sponsored agreement to address the significant humanitarian impact of the fighting in Hodeidah governorate was endorsed in Stockholm, Sweden on 14 December 2018 (herein referred to as the 'Hodeidah Agreement'). The UN has moved rapidly to meet its obligations and to engage with the parties to the conflict to seek consensus on the technical details of the agreement.

United Nations Security Council Resolution 2541 (UNSCR) on Yemen was issued on 21 December 2018 and calls for an immediate cease-fire in the city of Hodeidah, the ports of Hodeidah, Salif and Ras Issa and the governorate of Hodeidah. The UNSC 2451 (2018) calls for the UN to play a leading role in supporting Yemen Red Sea Ports Corporation (YRSPC) in management of and inspections at the ports of Hodeidah, Salif and Ras Issa; and, strengthening the United Nations' presence in the city of Hodeidah and ports of Hodeidah, Salif and Ras Issa.

The UNSCR provides a vital opportunity for the humanitarian community to enhance and strengthen operations in the port of Hodeidah, which has served as a lifeline for reaching people in need.

Subsequently, the UN Security Council decided to establish a special political mission to support implementation of the ceasefire agreement reached in Stockholm on 13 December 2018 between the parties to the conflict covering the city and port of Hodeidah, as well as the ports of Salif and Ras Issa.

Unanimously adopting resolution 2452 (2019), the Council decided that the United Nations Mission to support the

Hodeidah Agreement (UNMHA)—with an initial mandate of six months—will lead and support the Redeployment Coordination Commission (RCC) tasked with overseeing the ceasefire, redeployment of forces and mine action operations.

It will monitor compliance with the ceasefire, work with the parties to ensure that security is assured by local security forces, in line with Yemeni law, and coordinate United Nations efforts to assist the parties in fully implementing the Agreement.

The mandate of UNMHA is comprised of the following:

1. *Decides* to establish a special political mission, the United Nations Mission to support the Hodeidah Agreement (UNMHA), to support the implementation of the Agreement on the city of Hodeidah and ports of Hodeidah, Salif and Ras Issa as set out in the Stockholm Agreement, circulated as document S/2018/1134, for an initial period of six months from the date of adoption of this resolution.
2. *Decides further* that, to support the parties in implementing their commitments in accordance with the Hodeidah Agreement, UNMHA shall undertake the following mandate:
 - To lead, and support the functioning of, the Redeployment Coordination Committee, assisted by a secretariat staffed by United Nations personnel, to oversee the governorate-wide ceasefire, redeployment of forces, and mine action operations;
 - To monitor the compliance of the parties to the ceasefire in Hodeidah governorate and the mutual redeployment of forces from the city of Hodeidah and the ports of Hodeidah, Salif and Ras Issa;
 - To work with the parties so that the security of the city of Hodeidah and the ports of Hodeidah, Salif, and Ras Issa is assured by local security forces in accordance with Yemeni law; and,
 - To facilitate and coordinate United Nations support to assist the parties to fully implement the Hodeidah Agreement.

UNDP has been requested to take on the lead role in providing support to the YRSPC in close coordination with UNMHA, UNVIM, and WFP.

SCOPE OF WORK

The objective of this engagement is to deploy specific technical expertise to support the YRSPC in doing an initial damage and capacity assessment aimed at establishing the minimum requirements to improve the productivity and effective management of the ports of Hodeidah, Salif and Ras Issa, in a way that enhances efficiencies, increases transparency and accountability, is sustainable, and is in accordance with the Hodeidah Agreement. The assessment will include proposals for needed equipment and rehabilitation of critical infrastructure. The final report will also include a plan of action for development of a longer-term investment plan for the ports of Hodeidah, Salif and Ras Issa that will also identify training needs. The three main areas that will be covered in this initial assessment are: 1) Nautical assessment, 2) Infrastructure assessment, 3) and logistics assessment. The assessment will include the needs for re-establishment of containerized cargo/liner shipments to Hodeidah.

Compliance: Monitoring the compliance of the port operations vis-a-vis international port standards, international maritime law, etc.

Equipment and infrastructure assessment: Damage and capacity assessment with a view to determine the priorities for limited critical infrastructure rehabilitation in consultation with the Red Sea Ports Corporation and UNMHA.

Preliminary human resource capacity assessment: Capacity assessment with a view to determine the immediate requirements for provision of advisory support and training to strengthen technical and managerial capabilities.

Engagement may be required with multiple actors and success will be dependent on close coordination and cohesion with several key stakeholders. Some of the key stakeholders include:

- YRSPC and commercial entities
- UNMHA and relevant UN agencies/entities; i.e. WFP and UNVIM
- Ministry of Transport
- Ministry of Finance
- Local authorities
- Compliance and Standards Authorities
- Chamber of Commerce
- Shipping agents

DELIVERABLES

Inception, assessment methodology and inventory (3 days)

In-depth review of the assessment aspects (6 days)

Consultations on assessment aspects (3 days)

Draft damage and capacity assessment document (2 days)

Stakeholder workshop (1 day)

Final damage and capacity assessment document (5 days, home-based)

EMERGENCY PATH CARD PROJECT

Serial #	Component of the Project	Estimated Cost (USD)
1	Two gantry cranes with 55-ton capacity according to prepared specification	20,500,000
2	The removal of three gantry cranes of the container terminal which was completely damaged (already in progress)	700,000
3	Towing tugboat 3500 HP	8,500,000
4	Pilot boat 800 HP	1,500,000
5	Spare part for floating equipment, electric station, handling containers, general merchandise, etc.	7,500,000
6	Providing navigational aids, constructing lighting towers, safety equipment	6,000,000
7	Rehabilitation of Oil Berth 2 with length of 150 meters	1,200,000
8	Rehabilitation of Oil Berth 1, with length of 80 meters, construction work finders, clean and deepen the ship yard up to six meters	1,500,000
9	Slipway, construction, maintenance	12,000,000
	Total	59,400,000

INTERMEDIATE PATH CARD PROJECT

Serial #	Component of the Project	Estimated Cost (USD)
1	Construction of 2400 m ² warehouse	470,000
2	Metallic cover for generators	200,000
3	Port construction work, civil work for asphalt, etc.	530,000
4	Yard construction work, asphalt, etc.	100,000
5	Computer and accessories plus electronic control	300,000
6	Warehouses, 3,000 m ² rehabilitation	1,000,000
7	Maintenance of berths (7, 6, 4, 3, 2, 1)	1,500,000
8	Repair, construction, rail way lines	1,000,000
9	Lighting towers, high and medium compression cables, electric box and control utters	3,500,000
10	Fens, construction walls, guard towers, etc.	75,000
11	Demolition work of building 5, maintenance of buildings 1, 2 and 6	420,000
	Total	9,095,000

STRATEGIC PATH CARD PROJECT

Serial #	Component of the Project	Estimated Cost (USD)
1	3 gantry cranes (45 tons each), 5 straddle carrier, 12 tractor heads, 4 top lifters, 4 forklift cranes, 2 side lift cranes	40,955,200
2	6 towing tugboats 3500hp, 4 pilot boats 800hp, 2 towing boats 700hp, 2 service boats 700hp	27,742,000
3	4 stable cranes (60 tons each), 6 stable cranes (30 tons each), and 2 stable cranes (20 tons each)	6,598,000
4	5 MW gen set for Hodeidah port , 2 gen set 500kw for Salif and Mokha port	3,335,000
5	One 6-ton car for waste, one 6-ton car for water supply, 6 fire extinguisher cars	3,000,000
6	14 M-16 M Digging and Deeping the port	307,000,000
7	4 gantry cranes, 16 straddles, 24 tractors, 2 tugboats 4500-5000hp, 1 pilot boat 800hp, 1 tow boat 700hp, 1 service boat 700hp	200,000,000
8	200 M sea berth, navigation channels, ship yard extension + deepen, wave barrier extension, etc.	55,000,000
9	New berth 734 M length, 16 meter deep	50,000,000
10	2 tow tugboats 3500hp, pilot and captain buildings, building watch tower, small Salif building	20,000,000
11	Buying 29 POGS for navigation pilots	200,000
	Total	713,830,200

FOOTNOTES

- 1 Larssen sheet piling is a kind of sheet piling retaining wall. Segments with indented profiles (troughs) interlock to form a wall with alternating indents and outdents. The troughs increase resistance to bending. The segments are typically made of steel or another metal.
- 2 Cathodic protection (CP) is a technique used to control the corrosion of a metal surface by making it the cathode of an electrochemical cell.
- 3 The force required to turn the winch in the opposite direction.
- 4 E.J. Broos et al. PIANC-World Congress Panama City, Panama 2018 paper “Bollard loads on new port infrastructure, Port of Rotterdam Authority Policy.”
- 5 A concrete, stone, or metal platform lying alongside or projecting into water for loading and unloading ships.
- 6 Cargo in separate pieces, not in containers.
- 7 The International Code for the Security of Ships and Port Facilities (International Ship and Port Facility Security Code, ISPS Code) is an amendment to the Safety Of Life At Sea (SOLAS) Convention (1974/1988) which sets out the minimum requirements for the security of ships, port facilities and government institutions. For more information reference is made to http://www.imo.org/en/OurWork/Security/Guide_to_Maritime_Security/Pages/SOLAS-XI-2%20ISPS%20Code.aspx
- 8 For more information reference is made to <https://www.simcotechnologies.com/what-we-do/stadium-technology-portfolio/stadium-overview/>
- 9 These are only standard key performance indicator (KPI) numbers to be used as a reference. Each port must develop its own KPI-numbers for their need of port equipment related to the volume handled by the port.

IMAGE CREDITS

All images in this report are courtesy of the Port of Rotterdam unless noted below.

Page 11: Google Maps

Page 24: UNDP



*Empowered lives.
Resilient nations.*