HATCH™

Newfoundland and Labrador Hydro

Holyrood, NL

Final Report

Holyrood Marine Terminal 10 Year Life Extension Study

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Holyrood Marine Terminal 10 Year Life Extension Study

Final Report

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Newfoundland and Labrador Hydro

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1. Introduction

1.1 General

The purpose of this study was driven by Newfoundland and Labrador Hydro (Hydro) as a result of the following:

- The noted increase in vessel size since the Jetty was originally designed including:
  - vessels up to 55,000 deadweight tonnes (DWT), docking at the facility designed for 35,000 deadweight tonnes (DWT); and
  - double hull vessels which have a greater freeboard range than the facility's original design for single hull vessels.
- A 70 tonne concrete gravity fender had fallen off the Jetty structure in 2008.
- The remaining gravity fenders had deficiencies such as worn rotation support arms and pins.
- Two of the fenders, have been for some time, slightly retracted and seized in place.
- In the last number of years, there have been a number of protest letters from the incoming vessels on the condition of structure and the fuel offloading system.

Based on the above, Hydro requested Hatch complete an assessment for the Marine Terminal based on a 10 year life expectancy and provide recommendations for upgrades to the Holyrood Marine Terminal.

This work is performed in accordance with the proposal letter presented by Hatch dated December 23, 2010. As outlined in the proposal, the scope included:

1. Review the requirements for making the inside four (4) gravity, fenders No's. 3, 4, 5 and 6, functional and safe. The work will also include the preparation of a cost estimate and timeline for design and construction.
2. Review the expected vessel sizes that will be available to service the generating plant over the next 10-year period. Review the loading arm requirements and make recommendations for modification or replacement. The work will also include the preparation of a cost estimate and timeline for design and construction.
3. Prepare a methodology for inspection of steel pile and anodes.
4. Review life safety issues, in consultation with NLH, to determine minimum requirements for the life extension period. The work will also include the preparation of a cost estimate and timeline for design and construction.

While the existing marine terminal layout/location is unusual as per today's standards, it is not unique. Industry experience will not be a problem for this site.

1.2 Contacts and Resources Assisting with the Study

Hatch acknowledges and thanks the following Hydro personnel for providing information for input into the study.

- Terry LeDrew, P.Eng., Holyrood Plant Manager
- Gerard Piercy, P.Eng., Manager, Civil Engineering
- Jabe Hunter, P.Eng., Project Manager
- Mike Manual, Asset Manager
- Mike Flynn, Operations Manager
- Ron LeDrew, Emergency Response Coordinator
- Matthew Leonard, P.Eng, Civil Engineer

1.3 Documentation Available for Review

Information provided by Hydro for this study included:

- Letter dated December 11, 2009 from Atlantic Pilotage Authority RE: Mooring Equipment Guidelines.
- Newfoundland and Labrador Power Commission, Holyrood Generating Station, Specifications, Construction of Marine Landing Facility, April 1969.
- Newfoundland and Labrador Contract for Diving Services for Holyrood Marine Terminal, May 1984.
- Generation Operations Engineering Services (Mech). Holyrood Marine Terminal Anode and Pipe Inspection, September 1991.
- Report on Investigation of Damage and Proposed Repairs to Shore Arm, May 1983.
- Newfoundland and Labrador Power Commission, Holyrood Generating Station, Specifications, Marine Terminal Civil Works, October 1969.
- Engineering Report 1, Holyrood Newfoundland Marine Terminal, Damage of August 31, 1972. During currency of wharf repairs Contract and various internal memos from NL Hydro dated 1982-1983.
- Memo from Newfoundland and Labrador Hydro RE: Corrosion Survey of Pilings on the Offloading Dock dated, 1981.
- Memo from Wayne Rice dated 1988-11-25, RE: Inspection of Anodes on Holyrood Marine Terminal.
- Various Photos and Drawings: Dwg. Holyrood Generating Station, Plan 7 Profile of 18" diameter Fuel Oil Delivering & Trace Heating, 1970. Dwg: Holyrood Generating Station, Stage 1 – Fuel Handling Facility, Pipeline Grade from Dock to Tank 1987, Dwg: Pile Repairs details, 1972.

- Dwg: Existing Concrete Details, 1972. Dwg: Investigation of Wharf Damage at Holyrood\ Generating Station, 1971.
- Letter dated February 1988, Shaw Mont NL Limited RE: Holyrood Marine Terminal.
- Information from Owner, Internal memo from Kevin Skebo to Greg Saunders, March 15, 2010.
- Proposal to Hydro, Holyrood Dock, January 29, 2010.
- Request for Quotation of Loading Arms, 1969.
- Jetty Survey, 1972.
- Photos Tanker Collision Jetty 1 and 2, 1972.
- Jetty Questions from Atlantic Pilotage Authority, April 2008.
- Continental-Emsco Medium range Loading Arm Maintenance Manual.
- Continental-Emsco Loading Arm Drawings, 1970.
- ERM-08 Rescue - Confined Space/High Angle/Difficult, 2010.
- Intertanko's Standard Tanker Chartering Questionnaire 88 (Q88).
- Temporary Fender Repairs Hatch Drawings H331421-M-D-001/002, 2008.
- Pile and Anode Inspection Report, Crotty Diving Services, October 2004.
- Crotty Video Fender Inspection, October 2008.

1.4 Published Standards and Guidelines

Published Standards and Guidelines used for this study are from the following sources:

- Port Designer's Handbook; Carl A. Thoresen
- Design of Marine Facilities for Berthing, Mooring, and Repair of Vessels; John W. Gaythwaite
- US Army Corp of Engineers Marine Design Manual
- Transport Canada – Termpol Review Process – TP743E
- Oil Companies International Marine Forum – (Standard acknowledged by Atlantic Pilotage Authority)
- Permanent International Association of Navigational Congress

1.5 Acts and Regulations

Acts and Regulations that define requirements for constructing components similar to those at the Holyrood Marine Terminal include:

- Navigation Waters protection Act – Transport Canada.
- Canadian Environmental Assessment Act.
- The Fisheries Act.
- Species at Risk Act.
- Transportation of Dangerous Goods Act.
- Canadian Shipping Act.
- Pilotage Act – (Atlantic Pilotage Authority).

2. General Description of the Existing Harbour and Facility

A general description of the Holyrood Marine Facility and the location is described as follows and is demonstrated in Figure No.'s 1, 2 and 3.

- The facility is located at the south end and along the eastern shore of Conception Bay.
- The facility is unprotected from the strong north winds and the rough seas created by the winds.
- The harbour is generally considered ice free. However, on rare occasions, a combination of constant northerly winds and arctic pack ice from the Labrador Sea ice has filled the bay.
- The Marine Facility was constructed in 1969 and consisted of a concrete deck supported on circular steel piles. The components of the Marine Facility include:
  - bridge support on piled bents;
  - combination two breasting dolphins and offloading platform;
  - an underdeck swinging gravity fenders system consisting of 8 - 70 tonne concrete fenders;
  - two fuel offloading arms; and
  - one 18 inch diameter offloading pipeline.
- The harbour shore consists of exposed granite bedrock.
- The harbour bottom consists of a till overlay on top of the granite.

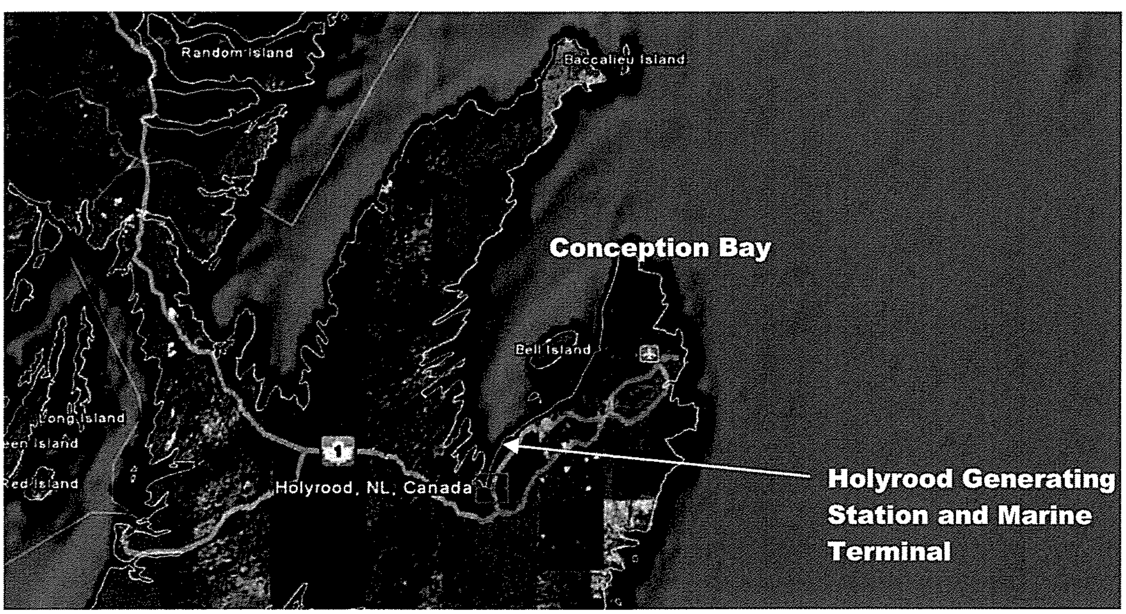


Figure No. 1

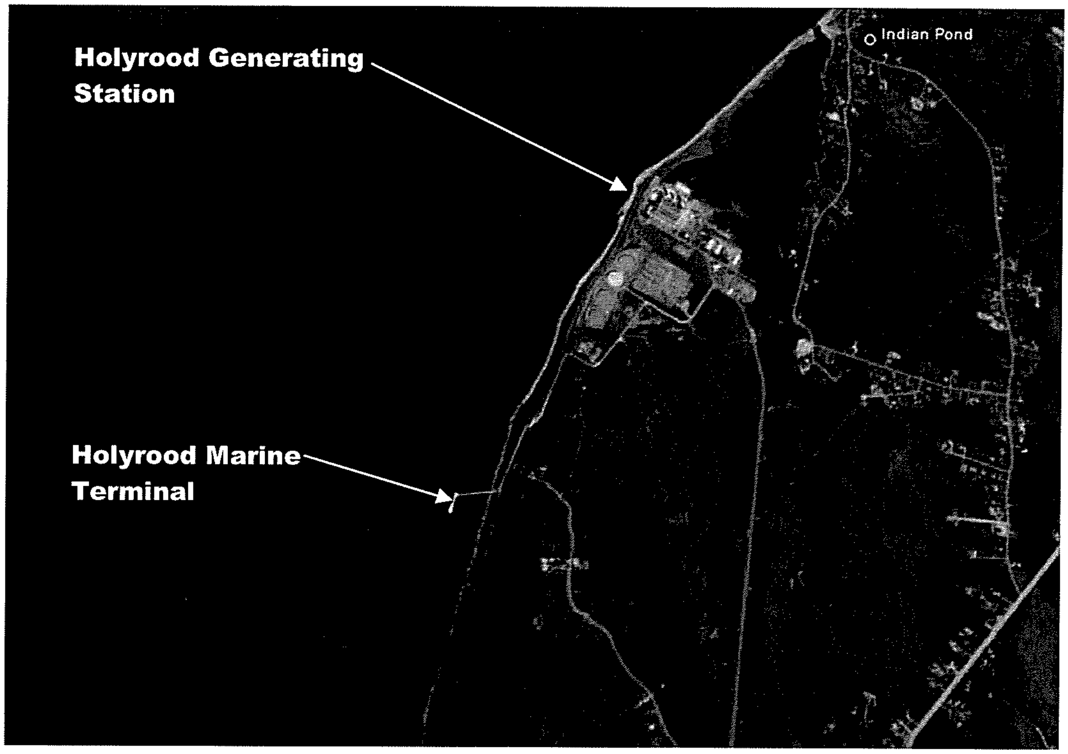


Figure No. 2

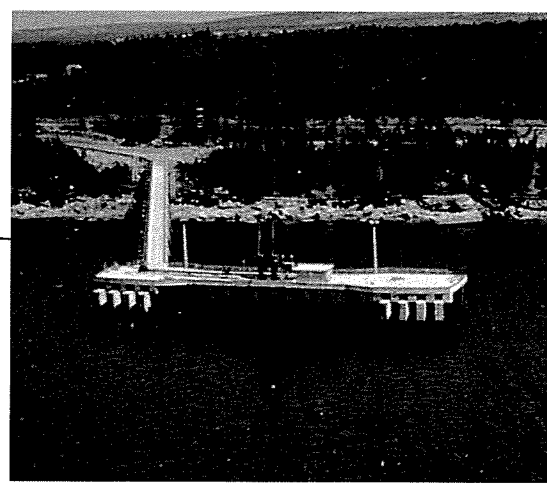


Figure No. 3

3. Jetty Condition Review and Recommendations

3.1 General

The Holyrood Marine Terminal was designed and constructed in 1969 to meet the standard practices and sizes of vessels of that time. Its purpose is the offloading of No. 6 fuel oil from incoming tankers for the Holyrood Generating Station.

The Marine Facility is a "L" shaped configured structure comprised of:

- A shore link access bridge of approximately 410 ft in length and a 20.6 ft wide concrete deck.
- A 241.7 ft long by 39.4 ft wide Jetty structure for ship berthing, breasting and mooring.
- A system of four shore mooring dolphins each equipped with two bollards and one capstan.

The layout of the facility can be found in Appendix A.

Major incidents requiring repairs to the bridge and Jetty have included:

- The north dolphin portion of the Jetty structure required a major repair in 1972 as a result of a vessel impact.
- Several of the bridge piled support bents required a major repair in 1983 as a result of heavy ice flow damage.
- In 2008, Gravity Fender No. 4 became disengaged from the supporting deck structure and fell to the bottom of the harbour. An investigation into the condition of the other three fender supports required immediate temporary repairs.

3.2 Berthing Structure

The existing Jetty structure was designed to accommodate the 35,000 DWT tanker vessels and the structure consists of a 241.7 ft long by 39.4 ft wide, 2 to 3.5 ft thick, concrete deck supported on eighty-two 600 mm diameter concreted filled steel piles.

The north and south quartiles of the Jetty project out beyond the centre portion of the structure and act as the breasting and mooring façade for the vessels. Each of these breasting points engages 25 of the piles and four 70 tonne swinging concrete gravity fenders. These structural components absorb the forces from the vessels impact.

The four gravity fenders at each end of the Jetty are aligned on a circular arc to ensure a least one of the fenders is engaged by the ships hull as it approaches and makes contact on an 11° angle with the Jetty.

The centre fifty percent of the Jetty structure, which supports the fuel offloading system, is set back approximately 6.5 ft from the breasting face. Although this section is set back, so not to take any impact forces from a berthing ship, the 30 supporting piles are designed to accommodate longitudinal berthing loads. In our opinion, this arrangement is contrary to current practice as piled structures used for loading platforms should be free from normal berthing forces (Port Designers Handbook – Carl A. Thoresen).

Based on observations from the deck surface, the overall physical condition of the 42-year old Jetty structure is in good condition and piles appear well maintained. The gravity fenders are in poor condition, with one fender missing having fallen to the harbour bottom and two of the remaining seven fenders seized in a retracted position. See Section 4 for fender assessment.

3.2.1 Capacity of Existing Structure

Hatch completed a review of the "1988 Shawmont Letter Report" and reviewed their methodology regarding their calculation of the Jetty's structural ability to take impacts from 65,000 DWT tankers.

Hatch subsequently completed a review of the Jetty structure to confirm the conclusions identified in the "1988 Shawmont Letter Report". The structural review was completed using modern computer and analysis techniques of the energy absorption capacity of the gravity fenders, an analysis of the pile loading and capacity and tension capacity of the support arms. Appendix B contains the report findings and recommendations of the analytical model that encompasses the following:

- The absorption and transfer of forces into the structure from a properly functioning gravity fender system (50 percent transfer of energy to deck in 1988).
- The absorption and transfer of forces into the structure from a seized functioning gravity fender system (possibly 100 percent transfer of energy to deck due to seized gravity fenders).
- The number of piles under compression and load under impact.
- The number of piles under tension and the load under impact (1988 letter report identifies 14 piles under tension; Hatch's review indicates this could be as low as 11 piles).
- Identifies piles that take deck loading instead of assuming only piles in tension that take full weight of the concrete deck.
- Evaluated the impact velocities noting:
  - An increase of velocity impact from 0.7 ft/sec to 0.9 ft/sec increases the energy to the structure by 65 percent.
  - A decrease to the velocity impact from 0.7 ft/sec to 0.5 ft/sec decreases the energy to the structure by 50 percent.

Due to the condition of the Jetty's gravity fenders, the Jetty structure is incapable to take a design impact load from any vessel that is docking at the facility today.

Currently, vessels of less than 55,000 DWT and shorter than 656 ft long are able to dock at the Jetty, as docking is being performed in a controlled manner with a very low impact velocity.

Therefore, until reinstatement of the fendering system is completed, the docking of ships should be completed under very controlled parameters such as moderate to low wind speeds and the use of tractor tug(s).

A detailed structural analysis of the concrete deck was not considered necessary as the thinnest part is approximately 3.3 ft. A manual calculation of the deck's punching shear capacity was completed and it was found to be satisfactory.

3.2.2 Approach Velocity of Docking Vessels

The analysis of the Jetty structure determined vessels larger that those used in the original design of 35,000 DWT can be safely docked at the facility but the approach velocity has to be controlled. For vessels of 55,000 DWT the recommended approach velocity is 0.410 ft/s.

There are no records at the Marine Terminal of the required approach velocity or any means of measuring and recording this velocity. Any velocity records are currently the property of the vessel operators.

To assist Hydro control and record vessel velocities, we recommend the installation of a laser sensor, display and recording system be installed. A typical laser docking system can be found in Appendix K.

3.3 Breasting Fender Spacing

The breasting system was designed and constructed to accommodate 35,000 DWT tankers that would engage four of the eight gravity fenders.

Once the gravity fenders neutralize the impact of the vessel and the vessel is stabilized at the Jetty face, the vessel centres itself about the loading arms and the vessel breasts against the inner two gravity fenders on the north and south mooring face. The vessels generally do not breast against the outer four fenders as they are on an arc which falls away from the tangent.

This operation of centering the vessel on the breasting dolphins and tying up to equal positions on both bow and stern ends gives the vessel the most stability during offloading operations at the Jetty face.

The vessels are designed with flat parallel faces to accommodate the breasting position and these sections are located in the centre 40 percent of the vessel at light ship conditions.

The range for the distance between breasting points, for a stabile vessel at the Jetty face, is between 0.25 LOA (overall length) and 0.4 LOA with the ideal breasting position being 0.3 LOA.

Given the distance between breasting gravity fenders that the vessel may contact is 178.4 ft (see Appendix A), the length of ships using the Holyrood Marine Facility should be as follows.

Minimum Length - 439.5 ft

Ideal Length - 595.3 ft

Maximum Length - 715.0 ft

Based on records provided (Appendix C), it is noted that all ships docking at the facility in 2009 and 2010 were near the ideal length for the existing Jetty.

To meet the requirements of stabilizing vessels at the Jetty face, it is recommended Hydro adopt measures restricting the docking tankers to a minimum length of 525 ft and a maximum length of 656 ft.

3.3.1 *Vessels Docking at the Holyrood Marine Terminal*

A review of the data presented in Appendix C of this report, Intertanko's Standard Tanker Chartering Questionnaire 88 (Q88) Summary, indicates the following range of vessel size's that are safely docking at the facility since 2009 (questionnaires reported in metric):

Typical Smallest – Kandilousa – 600 ft LOA (overall length) – 105.6 ft Beam – 40,000 Maximum Assigned DWT.

Typical Largest – Aris – 611.5 ft LOA (overall length) – 105.6 ft Beam – 53,000 Maximum Assigned DWT.

3.4 Mooring System

3.4.1 *Bollard Capacity*

According to the original drawings, the mooring system was designed to accommodate 35,000 DWT vessels using a combination of four shore and four berth 70 tonne mooring bollard systems.

The original 1969 specification did not require a pull test on these bollards and there is no evidence that a pull test was ever completed to certify their capacity. There is no evidence that the capacity of the bollards was ever issued to the Masters of vessels before docking at the facility.

It is noted there are additional 15 tonne capacity bollards on the Jetty but their purpose is undefined. In our opinion, their purpose is excluded from mooring vessels.

After 42 plus years service, due to environmental deterioration, the bollards could have a reduced capacity. In particular, there is a risk of bollard failure either from the use of high capacity vessel winches or from a vessel using several mooring lines on the same bollard.

3.4.1.1 *Bollard Capacity Investigation*

Ships of approximately 50,000 displacement tonnes would generally expect a bollard capacity in the order of 90 tonnes (according to Port Designers Handbook – Carl A. Thoresen).

It is recommended Hydro design a procedure and complete a pull test on all bollards to certify the bollards for a specific rating. Upon preliminary review, our recommendation would be certification for a rated capacity of 70 tonnes. Further investigation into the required bollard rated capacity based on vessels that are safely docking at the facility today should be validated prior to certification.

The rated capacity of the bollards should be visibly posted for docking vessels.

3.4.2 *Bollard / Mooring Line spacing*

The mooring system was designed and constructed to accommodate 35,000 DWT vessels using four shore dolphins complete with two bollards each and four bollards on the Jetty.

The Marine Terminal uses a variety of vessels under charter services and the Masters and Pilots guiding the ships have different preferences for mooring configurations. We would like to point out, however, OCIMF recommends the bow and stern mooring lines to be located 15 degrees off the perpendicular of the vessel.

During meetings held with the APA, we have been given varying opinions of the required mooring arrangements. These conflicting preferences are outlined below:

- In addition to meeting the OCIMF guidelines, consideration should be given to the addition of separate bow and stern lines set at 45 degrees off the perpendicular (May 2010).
- The only requirement is having the bow and stern line arrangement conform to the OCIMF guidelines as stated above, located 15 degrees of the perpendicular (October 2010).

Hydro representatives noted the long mooring lines from the ship to the shore presented a number of challenges and hazards and they are listed as follows.

1. The mooring lines on some ships are not long enough to reach the shoreline bollards. This means there are challenges tying up the vessels as the mooring lines must be extended by tying to shore tender lines.
2. The mooring lines sometimes get stuck on the rocks along the shore and on the harbour bottom and there are safety concerns when trying to untangle the lines.
3. It was noted the walkways along the shoreline are embedded into a steep slope and there have been periodic landslides damaging the walkway. These incidents affect the tying of mooring lines and safety of the workers.

The current mooring arrangement does not meet either the OCIMF standards or the APA's preference for berthing a vessel. The possibility exists that a Master of a vessel could refuse berthing if the mooring configuration is not updated to meet today's industry standards.

Hydro to correspond with vessel owner's to obtain their acceptance for docking under the existing mooring arrangement. If a new mooring arrangement is required, a complete mooring system design and installation program is recommended based on the requirements of today's standards. The new design should comply with the requirements of OCIMF and wherever possible meet the requirements of the Atlantic Pilot Association.

Appendix J shows a new mooring configuration (not priced in the estimate) that will meet OCIMF standards for 600 ft long tanker vessels (vessels near the ideal length for the existing Jetty) with capacities of 55,000 DWT. The mooring configuration gives consideration to local tide and wind conditions.

4. Fender Refurbishment and Replacement

4.1 Description of Existing Fenders

As described above, the Jetty was originally constructed with four gravity fenders at each end of the Jetty aligned on a circular arc to ensure at least one of the fenders is engaged by the ships hull as it approaches and makes contact with the Jetty.

Based on the following, it has been determined that only gravity fenders No. 3, 4, 5 and 6 (see Appendix H for fender numbering) are utilized during docking given:

- The current size of the vessels (Appendix C);
- The current docking procedure with the assistance of tractor tugs and the requirement to dock parallel to the Jetty façade, and;
- The recommended approach velocity.

4.2 Fender Deficiencies

Gravity fender No. 4 fell off the super structure in 2008 from a failure in the support arm. Due to this failure, temporary work has taken place over the past few years to keep the remaining fenders operational.

The impact to the structure of another gravity fender falling from the superstructure could be catastrophic as a fender could fall against a pile and cause a portion of the supporting pile structure to collapse or it could fall against a ship and cause a puncture in the vessel. A further detailed investigation of the fenders existing condition is required to assess the required remedial work.

Two of the fenders, have been for some time, slightly retracted and seized in place. These fenders are not critical and will not be looked at in the scope.

4.3 Proposed Inspection, Modifications and Replacement

4.3.1 Fender Inspection

The proposed work involves a complete review of the fenders functionality with key aspects of the inspection to include:

- The integrity of the timbers: look for pieces of timber cracked or split off, ensure HDPE rubbing strips are intact against the timbers.
- Suspension / Retraction brackets: visually inspect all embedded connections and supports for noticeable wear, NDE inspection on critical components or parts that have wear.
- Support pins: the support trunnion pins have been gouged severely and analysis of a case by case is required to determine if they are still suitable.
- Support Arms: the clevis and linkage arms that support the pins in the front and back of the fender have been worn considerably. Tolerance and thickness checks will be required.

As part of the inspection, scaffolding will be required around the perimeter of each fender to allow for a proper inspection of the fender from all sides.

4.3.2 Fender Modifications

Prior to completing any fender modifications, all critical supports and components shall be water blast cleaned before performing NDE thickness readings. The required work will require extensive scaffolding to be erected.

A complete list of recommended repairs will be generated as a result of the inspections listed in 4.3.1. Based on current knowledge, the following will be required as a minimum.

4.3.2.1 Fender No. 3

The front support suspension arms were replaced in 2008. Inspect, and repair as necessary, the support arms for the back suspension as well as all the pins and associated nuts. Replace all chains.

4.3.2.2 Fender No. 5 & 6

Replace support suspension arms at the front of fenders No. 5 and 6. These components are known to be quite worn and are currently using a temporary support to hold them in place. Inspect and repair the back support brackets and all support pins and associated nuts. Replace all chains.

4.3.3 Fender Replacement

Fender No. 4 detached and broke free from the Marine Terminal. This is one of the critical fenders required for safely mooring the vessel alongside the Jetty. Video analysis by divers show the fender lying on the ocean floor with severe structural damage to the supports and the back of the fender.

From the videos we know that the fallen fenders are not near the piles and are in deep water. There is no harm in leaving them where they fell as they pose no risk to the jetty piles or the docking vessels. These fenders are quite heavy and it could pose a risk in trying to lift the large odd shape concrete fender onto a barge and bring to shore for repair. Based on past experience, the cost to recover, clean, inspect and repair the damaged fender, would be significantly higher than the price to replace it.

We anticipate the following steps to replace the lost fender.

- A scaffold will have to be setup to inspect the area around the missing fender and verify the integrity of the embedded support components.
- If the existing components are structurally sound they can be reused. If not then the supports will have to be replaced. New stabilizing and retraction chains will be required.
- To replace the fender a steel box frame, in the shape of the fender, is prepared and brought to the Jetty on a flat bed. A crane with a minimum capacity of 20 tonnes will be required to lift the fender frame. The crane then lowers the frame vertically over the side of the Jetty, where chains are attached to the retraction bracket with chain falls. This permits the chain fall to pull the fender frame into the horizontal position while simultaneously lowering the frame with the crane. The fender frame is then secured in its final position with the suspension brackets and

support pins. Concrete is then poured into the frame to form the fender. Four (4) timbers are then attached to the front side as the point of contact with the vessels.

5. Loading Arm Modification or Replacement

5.1 General

As part of the 10 year life extension study of the Marine Terminal, Hatch has completed a detailed review of the existing loading arm operating envelope and recommended least cost modifications to meet the design requirements of vessels that are docking at the facility today.

5.2 Description of Existing Fuel Offloading System

The existing marine facilities two fuel loading arms were manufactured by Continental-Emsco and classified as medium range load arms and are original to the facility. The load arm size specifications were based on single hull ships of 35,000 DWT and an off loading rate of approximately 5000 BBL/h, per arm, for a total design rate into the pipeline of 10,000 BBL/h.

The loading arms are summarized as follows:

- A 12 inch flange connection which accommodated the original 35,000 DWT tankers;
- Stripping capabilities for the Jetty side portion of the arm;
- Gravity drainage to the tanker for the vessel portion of the arm, and;
- The arms are not insulated nor heat traced.

The offloading arms are connected to an existing 18 inch diameter pipeline which transfers the No. 6 fuel oil to a four tank fuel storage field. The furthest tank is located approximately 4000 ft from the Jetty.

During the site visit, there was no offloading activity and the load arms were secured in the storage position. The load arms appeared to be in good repair as a result of a preventative maintenance program.

5.3 Design Considerations

The design conditions outlined below were assumed to remain unchanged from the original construction of the Marine Terminal:

- Jetty deck is 22.5 feet above the low water level;
- Fore and aft drift is 30 feet total;
- Fluid Characteristics: No. 6 fuel oil with a viscosity 500 S.S.F. @ 122°F and specific gravity 0.96;
- Product temperature is 120°F minimum;
- Tanker discharge pressure is 100 psig with maximum pressure drop through loading arm at 10 psi;
- Ambient temperature variation -21 to 93°F;

- Design wind velocity 100 mph in stored position;
- Distance between loading arm support columns C/L and edge of Jetty is 4.5 feet;
- Maximum tidal variation is 5.25 feet, and;
- Distance between Jetty and tanker at rest (ie. Berthing line) is 12 feet.

Tidal information as published by the Department of Fisheries and Oceans for St. John's during the year of 2010 was reviewed and compared against tidal data during the original design (Appendix D). The original design information of 5.25 feet between low and high water level is accurate today.

The following original design considerations are documented for a comparison basis of the operating envelopes below:

- Tanker freeboard when loaded is 11 feet;
- Tanker freeboard when unloaded is 35 feet, and;
- Tanker manifold location: 4-5 feet above freeboard and 15-20 feet inboard from side.

5.4 Loading Arm Deficiencies

5.4.1 Review of Expected Vessel Sizes

A review of the freeboard data for vessels that have frequented the facility in the last couple of years is presented in Appendix C of this report, Intertanko's Standard Tanker Chartering Questionnaire 88 (Q88) Summary.

The operating envelope is defined from the data presented for 40,000-55,000 DWT vessels as follows:

- Smallest tanker freeboard when loaded is 25.4 feet (including height from ship deck to manifold centerline);
- Largest tanker freeboard when unloaded is 60.2 feet (including height from ship deck to manifold centerline);
- Average tanker freeboard at normal ballast is 45.1 feet (including height from ship deck to manifold centerline), and;
- Tanker manifold location ranges: 5.4-7.2 feet above ship deck and 15–17 feet inboard from ships side.

Based on the information presented in the manufactures "Marine Loading Arm Description" drawing and the vessel questionnaires, Hatch Drawing. No. 337965-M-A3-001 "Holyrood Marine Terminal Loading Arm Layout" (Appendix E) provides a comparison of the existing loading arm operating envelope and the required operating envelope (Appendix C). This illustration indentifies the limits of the loading arms can be severely exceeded during offloading operations if the ship is not ballasted properly.

For simplicity, the following is provided as a summary of the existing and required operating envelopes:

- The existing loading arm operates between 7.5 feet below to 22.75 feet above the Jetty deck;
- The required safe operating envelope is 2.9 to 43 feet above the Jetty deck (based on Appendix C);
- During normal ballast condition the ships manifold flange connection is located 27.9 feet above the Jetty deck (Appendix C), and;
- The location of the ships manifold flange connection inboard from the ships side (based on Appendix C) is within the existing loading arms operating envelope of 15 to 20 feet.

When the unloaded (lightship) occurs at high tide, the range of the loading arm is exceeded by approximately 20 feet requiring vessels to bring onboard ballast to prevent the loading arms from being over extended.

When the vessels are at normal ballast freeboard, the loading arms range limit is exceeded by approximately 5 feet. When the normal loading arm range is exceeded there is difficulty in disconnecting the lines from the ship which could lead to a spill.

Both above noted situations can and are being dealt with by taking on ballast water. It should be noted however, taking on cold ballast water for certain vessel tank configurations can be problematic because of the cooling effect and the consequential increasing of the viscosity of the fuel being transferred.

Due to the flanged connections at the ship, it takes several hours to complete a fuel line disconnection. This creates a potential for severe consequences in the following emergency situations:

- a fire and the ship must leave the Jetty;
- rapid deterioration in weather;
- the ship breaks away from its mooring position, and;
- or the ship extends its freeboard past it's reach.

In all cases there is a possibility of damaging the existing loading arms and causing a hydrocarbon spill.

The loading arms present a significant hydrocarbon spill risk. The current environmental response, as a preventative measure, is to install a boom around the vessel during the offloading process. This can only be employed during favourable weather conditions and is stored a considerable distance away in the town of Holyrood.

Any other hydrocarbon spill response is sub-contracted and located off site. Hydro should review the risks, their procedures and response times for potential environmental spills.

5.5 Proposed Modifications or Replacement

5.5.1 *Investigation*

To meet the operating envelope of vessels frequenting the facility today, Hatch reviewed the possibilities of:

a) Providing a structural foundation to raise the loading arm base to match the new low point reach (smallest tanker freeboard) of 2.9 feet above the Jetty deck, and;

b) Providing arm extensions to the existing loading arms to match the new high point reach (largest tanker freeboard) of 43 feet above the Jetty deck.

A requisition was forwarded to the loading arm manufacture, presently known as Emco Wheaton, for permissible modifications to the existing loading arms. The basis of the request outlined: the loading arm original design with its operating envelope, the condition of the loading arms, the change in vessel size docking at the facility with the updated safe operating envelope, the plans to raise the base support to meet the new low point reach and the request for budgetary pricing for arm extensions to meet the new high point reach.

Upon review of the design, the manufacturer's representative responded with their concern of the age of the loading arms coupled with such factors as unforeseen stresses that may have been applied to the arm, corrosion in the piping and the fact that these arms were originally not designed for this length of service. Adding additional length to the arms would result in more counterweights and thus additional loading on the base swivels. The general consensus appears that modifications to the loading arm is not advised, however the manufacture does not oppose raising the load arm base with a structural support.

Based on the manufacturer's recommendations, Hatch is proposing to raise the loading arms as outlined below and advise Hydro to ballast, as required, with water to prevent the loading arms from being over extended. Raising the base support 10 feet to meet the new low point reach requirements will bring the new operating envelope to approximately 2.5 to 32.75 feet above the Jetty deck. Ballasting would commence only after the ships manifold connection is beyond 32.75 feet above the Jetty deck. The questionnaires indicated that all vessels docking at the facility today have ballasting capabilities.

The existing loading arms are equipped with 12 inch flange connectors which require an adapter to couple to the ships manifold connection. A review of the data presented in the vessel questionnaires indicates the ships manifold connections are 12/14/16 inch with on-board reducer's capable of mating to the loading arm flanges.

5.5.2 *Loading Arm Modifications*

As discussed above, in order to raise the loading arms the required height of approximately 10 feet, it is proposed to install a new column pedestal, which could be anchored to the main deck using the existing anchor bolt arrangement. Preliminarily, it is proposed to use a 24" STD pipe for the pedestal, with gusset plates at the top and bottom for stiffening (see sketch located in Appendix F). Design loadings at the base will need to be confirmed prior to final design and drawing preparation.

The proposed modifications assume the load arms are in good repair as a result of a preventative maintenance program.

The modifications to the loading arm base will require minimal changes to the existing piping configuration. A flanged spool piece will be added from the base of the loading arm to the Jetty piping tie point and supported mid-way from the new pedestal foundation. It is assumed the ship's cargo pumps have the additional capacity for the change in elevation head and the pipe friction losses approximated at less than 1 foot.

Hatch will perform an investigation of installing a quick coupler release to the exiting loading arms. An analysis and physical simulation will be required to determine the suitability of adding the additional weight to the existing 42 year old loading arms. If the loading arms are deemed structurally adequate for this modification, it will reduce the time to connect / disconnect to the ships flange and provide a better method of spill prevention.

Market research has been conducted for a commercially available quick coupler release product(s) to connect to the existing loading arm flanges. An acceptable coupler has not been sourced to date.

5.5.3 Loading Arm Replacement

To meet the requirements for the proper reach of the loading arms for the largest 55,000 DWT tankers and to simplify the draining of the loading arms after each use, we recommend Hydro budget for the replacement of the existing systems with two new long range loading arms capable of 15,000 BBL/hr (2400 m3/hr) each. The loading arms would be equipped with the following features:

- 16 inch (400 mm) coupler connection;
- Isolation flange;
- Hydraulic operation;
- Quick coupler release;
- Nitrogen purge line;
- Vacuum breaker;
- Emergency release system;
- Drain connections;
- Heat traced and insulated; and
- Control systems.

The over capacity offloading arms would be beneficial on a life cycle basis should it be decided in the near future to upgrade or twin the existing 18 inch (450 mm) diameter transfer main to the storage tanks.

Should the facility upgrade the loading arms, we recommend determining if the existing 18 inch transfer line can operate at an increased pressure and thus increase the overall transfer rate of the product. A full investigation of the existing piping and valve sizing and functionality with the new loading arms will need to be completed as part of the new installation.

5.5.4 Loading Arm Cleanout System

Currently after the vessel has offloaded the fuel oil, the loading arms remain full. Over time the oil can harden causing problems to occur during the next operation. At present there is no way to expunge the left over oil to the storage tanks or return it to the ship. An investigation will be performed to determine a method of removing the oil from the loading arms after the system is shut down. Any new system will require upgrades to the electrical system including the existing MCC's in the marine terminal enclosure.

6. Pile Inspection & Anode Replacement

6.1 General

The existing Jetty structure was designed to accommodate the 35,000 DWT tanker vessels; the concrete deck is supported on eighty-two 600 mm diameter concreted filled steel piles. The breasting points engages 25 of the piles and four 70 tonne swinging concrete gravity fenders; these structural components absorb the forces from the vessels impact.

6.2 Condition Review

As mentioned previously, the overall physical condition of the 42-year old Jetty structure is good and piles appear well maintained.

Even though the Jetty's structural piles appear well maintained, a visual inspection from the deck noted that the splash zone coating system is starting to degrade. This will lead to surface pitting corrosion. The last thickness survey of the piles was performed in 1980. We understand that in 1983 anodes were installed to the piles to reduce their corrosion rate and the anodes are inspected on a periodic basis with the last inspection completed in 2004.

6.3 Proposed Inspection and Replacement

6.3.1 Inspection

Based on the information presented above, it is recommended to complete a site inspection and perform a steel measurement program on the Jetty piles.

Hatch recommends to complete a detailed inspection of the metal thickness of the piles and a visual inspection of the underside of the deck. Hatch has prepared and issued, under a separate cover, a specification for a complete metal thickness measurement program for the Jetty piles and a complete inspection of the underside of concrete deck (Appendix I). These inspections will provide a representative view of the integrity of the structure.

6.3.2 Anode Replacement

In 2004, Crotty Diving Services performed a complete visual inspection of each pile and anode on both the Jetty head and shore arm from seabed to splashzone and recorded the amount of deterioration on each. The results are in Appendix G.

From Appendix G, assuming no anodes were replaced following the 2004 inspection, we can conclude that 107 anodes either need immediate replacement or will need to be replaced within 10 years. It is anticipated, the remaining 125 anodes will surpass the expected life of 10 years for the Marine Terminal and replacement is not required.

It is recommended that an underwater video and visual inspection of each anode and all attachment brackets on each pile be performed to confirm / verify the conclusions stated above. The inspection, using methodologies outlined in Appendix I, will provide a representative view of the current integrity of the anodes, confirm the number of anodes to be replaced and help plan the required work. The plan and methodology shall be developed in conjunction with a certified diving contractor in strict accordance with all Newfoundland and Labrador Hydro, Provincial and Federal diving regulations. As noted above, thickness measurements of the steel piles shall be recorded at time of inspection.

During the inspection, review the requirement of painting exposed piles on a case by case basis to reduce the corrosion rate to meet the expected life of the Marine Terminal. Painting of the piles shall only be considered if the associated pile anode is not being replaced.

7. Safety Upgrades

7.1 Emergency Evacuation

Presently if an incident or accident occurs at the offloading arm location, due to fire for example, there is no adequate method of emergency evacuation from the south end of the Jetty. Currently the only method of evacuation is the using the Jetty ladders to evacuate to the water.

Risk No.1

There is the possibility of personnel injury or death if a person was trapped at the south end of the Jetty due to a major fire at the offloading arms.

Mitigation of Risk No.1

No. 1: Install 2 fixed platforms at separate ends of the Jetty, facing the shore. The platform system will also allow access to the Jetty from a docking and undocking support vessel. The approximately 8 ft x 12 ft platform will be located 6.5 feet above the high tide water line with a set of stairs up to the top of the Jetty. Hatch will further investigate other requirements with Hydro including final location and method of support. A hinged gangway with a float at the bottom will be used to bring the walkway down to the water level. Lighting will be provided along with manual winch, to secure the gangway up to the platform height when not in use. See Appendix H for schematic (Drawing No. H337965-M-A1-002).

No. 2: Install an Ovatek (or approved equivalent) 4 persons rigid fibreglass life raft complete with mounting cradle that is secured to the Jetty at the south end. Individuals who would be trapped from the main egress would get into the life raft, pull the internal lever and drop safely into the bay where they would be picked by another vessel.

7.2 Man Overboard

Ongoing maintenance, periodic inspections and fuel offloading all require personnel to be located in the Jetty area. This activity can lead to the potential of someone falling into the water. Man overboard scenarios include:

Risk No. 1
Vessel offloading

In the event a vessel is on route, moored or departing the Jetty, personnel will be present at the Marine Terminal.

Mitigation of Risk No.1

Should an individual fall overboard, Hydro's Emergency Response team does have a procedure in place to facilitate a rescue.

- Shout "Man Overboard" three (3) times and immediately deploy the site life rings and Mustang Rescue Sticks located on dock. One person will maintain visual contact and physically point at the person in the water.
- If tanker is approaching the dock, contact the pilot to cease approach to the dock. If already alongside, instruct tanker captain to cease transfer of fuel if pumping operations are in effect.
- Instruct tanker captain to assist by deploying additional life-saving equipment and drop vessel's cargo netting down the outboard side of the dock.
- Contact Shift Supervisor to declare Man Overboard. Give location, number of persons in the water and general situation (i.e.; conscious/responsive).
- Shift Supervisor immediately contacts ER Technicians, 911, Canadian Coast Guard and RCMP informing them of the man overboard situation.
- Alert the boom deployment support vessel, if available.
- ER Techs will deploy the HTGS boom deployment craft only if marine weather conditions are determined safe by the OSC-1.
- Apply First Aid.
- Call for medical assistance as required.

Risk No. 2
Jetty Construction Maintenance

When ongoing maintenance/repairs are being made at the Marine Terminal there is the risk of a worker falling into the water.

Mitigation of Risk No.2

The Marine Terminal is treated as a confined space and workers must be wearing life jackets and tied off when near the edge of the Jetty.

Hydro's emergency response team will have 2 members of their team fully set up in survival gear for the duration of the work. The emergency response deployment support vessel is prepared and placed in the water for immediate assistance. Radio communication is required to call for help in the event someone falls overboard.

Risk No. 3
Maintenance Inspection

When travelling to the Jetty for general inspection, a minimum of two (2) workers are required. Life jackets again are mandatory as well as a radio to call for help.

This scenario presents the highest risk as the sole means to call for help, in the event that someone falls overboard, is the radio. There are a couple chain ladders on the Jetty to allow a responsive victim a chance to get out of the water, however they do not extend all the way into the water at low tide. In the event the victim is unconscious, the partner would have little chance to get the victim out of the water by themselves. There is an inflatable boat inside a locked building on the Jetty, but there is no adequate method to place the boat in the water with rescuers aboard. Besides calling for help the individual would keep an eye on the victim as the normal current in the area tends to flow down the bay towards the town of Holyrood.

Mitigation of Risk No.3

No. 1: Install a fall restraint system in critical areas near the edge of the Jetty. This would require personnel working in high risk locations to be tied-off to prevent anyone from going over. Recessed connect plates will be installed on the bay side of the Jetty. In the event of a trip or strong wind near the Jetty edge, the individual would be held back by their lanyard and prevent them from falling into the ocean. A review of Hydro's practice and procedures at the Marine Terminal will be required.

No.2: A rescue winch to be located on top of the Jetty near each of the 2 existing hand ladders to aid rescuers in recovering any injured personnel who have fallen overboard.

No. 3: Provide staff members with water activated locator beacons to alert the emergency response team in the event someone falls overboard.

7.3 Lighting upgrades

The existing light fixtures on the jetty are extremely high, making replacement of the bulbs difficult in good weather, let alone in nasty conditions. A new style of fixture with improved maintenance accessibility is recommended to ease in the replacement of the bulbs, but still provide adequate lighting for the workers on the jetty.

8. Regulatory Approvals

8.1 General

As detailed in previous sections, the scope of work of the project could include the following proposed modifications:

- installation of structures along the shoreline;
- Modification/repair to piled structures in the harbour bottom; and/or
- demolition over and in the harbour.

The undertaking will trigger the provincial and federal environmental assessment process. Several departments will be involved to address the potential effects of the project. The following sections describe the triggers and the anticipated departments and agencies that will be involved.

8.2 NL Department of Environment and Conservation

A project that must be registered for the provincial environmental assessment process is referred to as an undertaking. As per the *NL Environmental Protection Act* an undertaking is defined as:

> "an enterprise, activity, project, structure, work or proposal and a modification, abandonment, demolition, decommissioning, rehabilitation and an extension of them that may, in the opinion of the minister, have a significant environmental effect".
> *Section 2 (mm)*

The purpose of the environmental assessment process is to: (a) protect the environment and quality of life of the people of the province; and (b) facilitate the wise management of the natural resources of the province (*NL Environmental Protection Act, Section 46*).

The provincial assessment process is triggered by the Environmental Assessment Regulations (*NL Regulation 54/03*), Section 35(a) which states the following:

> "An undertaking that will be engaged in the construction of a breakwater structure where the breakwater will be more than 100 m in length."

8.3 Transport Canada

Transport Canada will be involved in the approval process under *The Navigable Waters Protection Act* and as a Responsible Authority under the *Canadian Environmental Assessment Act.*

<u>Navigable Waters Protection Act</u>

Section 5 of the NWPA states the following:

> "No work shall be built or placed in, on, over, under, through or across any navigable water without the Minister's prior approval of the work, its site and the plans for it."

Section 16 of the NWPA states the following:

"The Minister may cause any wreck, vessel or part of a vessel resulting from the wrecking, sinking, partial sinking, lying ashore or grounding of a vessel, or may cause any other thing, to be secured, removed or destroyed in the manner that the Minister considers appropriate if, in the Minister's opinion,

a. the navigation of any navigable water over which Parliament has jurisdiction is obstructed, impeded or rendered more difficult or dangerous for more than 24 hours by the wreck, vessel, part of a vessel or thing;

b. the wreck, vessel, part of a vessel or thing has been in a position for more than 24 hours that is likely to obstruct, impede or render more difficult or dangerous the navigation of any such navigable water; or

c. the wreck, vessel, part of a vessel or thing is cast ashore, stranded or left on any property belonging to Her Majesty in right of Canada and has been an obstruction or obstacle, for more than 24 hours, to the use of that property as may be required for the public purposes of Canada."

Historical knowledge indicates that there may be shipwrecks present at or near the proposed work location. During preliminary discussions with regional Transport Canada representatives, it was confirmed that the provincial archaeologist must be consulted prior to any proposed dredging operations.

The application process and required documentation is determined by the regional Navigable Waters Protection Program (NWPP) office. The application will include at a minimum:

1. Details of work:
   a. clearly identify the proponent; this must be a single body, company, etc.
   b. proposed construction schedule
   c. description of work
   d. status of work (existing, proposed or both)
   e. name of waterway, including width and depth
   f. chart and topographic map number
   g. latitude and longitude of the work site
   h. legal description (section, lot number, concession etc)
   i. identification of upland property owners
   j. method of construction (i.e. equipment to be used etc)

2. Plans:
   a. drawings completed to scale with all dimensions
   b. indicate if any plans have been registered/deposited at your local land registry; if so, include registration number
   c. identify which government regulatory agencies have been forwarded copies of the plans

3. Additional information:
   a. history of the waterway, including all navigational uses
   b. characteristics of the waterway
   c. pictures of the work location, as well as upstream and downstream views

The above is intended to provide an overview of information that may be required for the application; again, the specific application requirements must be confirmed with the regional NWPP office.

Canadian Environmental Assessment Act

Part V of the Inclusion List Regulations (SOR/94-637), Transportation, Section 36 states the following:

> "Dredge or fill operations in a navigation channel of a historic canal or other navigable water for the purpose of ensuring the navigability of the historic canal or other navigable water."

This will trigger the federal EA process and include Transport Canada as a Responsible Authority.

8.4 Fisheries and Oceans Canada

The Department of Fisheries and Oceans (DFO) will be involved in the approval process under *The Fisheries Act* and as a Responsible Authority under the *Canadian Environmental Assessment Act*. DFO will also be included under the *Species at Risk Act*; this is discussed further in Section 5.5.

The Fisheries Act

Section 35 of the Fisheries Act addresses the harmful alteration, disruption or destruction of fish habitat, Subsections (1) and (2) state the following:

1) No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat.

2) No person contravenes subsection (1) by causing the alteration, disruption or destruction of fish habitat by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council under this Act.

While all efforts and best practices will be incorporated into the project planning phase to minimize any impact on fish or fish habitat, some disturbance may be unavoidable. As per the requirements of DFO, and in accordance with the *Proponent's Guide to Information Requirements for Review under the Fish Habitat Protection Provisions of the Fisheries Act (April 2009)*, the proponent will prepare a Development Proposal. The document will include the following:

1. Contact information for proponent, contractor and consultants
2. location of the proposed development:
    a. nearest community
    b. name of watercourse likely to be impacted
    c. coordinates of the proposed development
    d. map to show how to access the proposed development
    e. illustrate location on a nautical chart if requested
3. description of the aquatic environment:
    a. type of watercourse, water body
    b. biophysical characteristics of the site:
        - channel width

- type of flow
- tides
- water depth
- substrate type and density
- aquatic vegetation type and density
- other aquatic organisms
- presence of fish species

c. drawings and/or photos of the aquatic environment

4. description of the proposed development:
   a. components (permanent and temporary structures, project activities)
   b. methods, materials and equipment
   c. affected area
   d. plans, maps and/or drawings
   e. fish and fish habitat protection measures
   f. implementation schedule
   g. life expectancy

The submission of the Development Proposal will allow the DFO to assess the undertaking and the impact on fish and fish habitat.

<u>Canadian Environmental Assessment Act</u>

Part VII of the Inclusion List Regulations (SOR/94-637), Fisheries, Sections 42, 43 and 45 state the following:

> (42) The destruction of fish by any means other than fishing, where the destruction requires the authorization of the Minister of Fisheries and Oceans under section 32 of the Fisheries Act or authorization under regulations made by the Governor in Council under that Act.
>
> (43) The harmful alteration, disruption or destruction of fish habitat by means of physical activities carried out in a water body, including dredge or fill operations, that require the authorization of the Minister of Fisheries and Oceans under subsection 35(2) of the Fisheries Act or authorization under regulations made by the Governor in Council under that Act.
>
> (45) The harmful alteration, disruption or destruction of fish habitat by means of erosion control measures adjacent to a water body that require the authorization of the Minister of Fisheries and Oceans under subsection 35(2) of the Fisheries Act or authorization under regulations made by the Governor in Council under that Act.

The proposed undertaking may involve one or all of the above and will trigger the federal environmental assessment process and include the Department of Fisheries and Oceans as a Responsible Authority.

It is expected that there will be some overlap between the *Fisheries Act* requirements and the Environmental Assessment document. Specifically, regarding mitigation measures with respect to the protection of fish habitat. The Department of Fisheries and Oceans strives to achieve no net loss, this is intended to balance unavoidable habitat losses with habitat replacement on a project-specific basis.

8.5 Environment Canada

Environment Canada will be involved in the approval process under *The Canadian Environmental Protection Act* and *The Species at Risk Act*.

Species at Risk Act

Under Sections 32 and 33 the Species at Risk Act (SARA—2002, c. 29), it is an offence to:

- kill, harm, harass, capture or take an individual of a listed species that is extirpated, endangered or threatened;
- possess, collect, buy, sell or trade an individual of a listed species that is extirpated, endangered or threatened, or its part or derivative;
- damage or destroy the residence of one or more individuals of a listed endangered or threatened species or of a listed extirpated species if a recovery strategy has recommended its reintroduction into the wild in Canada.

The Act allows the issuance of a permit or agreement authorizing a person to affect a listed species so long as certain conditions are first met. Under Section 73 of SARA, the Minister of Fisheries and Oceans may enter into an agreement with a person, or issue a permit to a person, authorizing the person to engage in an activity affecting a listed aquatic species, any part of its critical habitat, or the residences of its individuals.

Under section 73(2) of SARA, the agreement may be entered into, or the permit issued, only if the Minister is of the opinion that:

- the activity is scientific research relating to the conservation of the species and conducted by qualified persons;
- the activity benefits the species or is required to enhance its chance of survival in the wild; or
- affecting the species is incidental to the carrying out of the activity.

http://www.dfo-mpo.gc.ca/species-especes/permits-permis/guidelines-directives-eng.htm

The above refers to all species at risk, not just aquatic. It is understood that all potential species at risk will be considered in the review (mammals, birds, aquatic etc). This will involve both DFO and Environment Canada as Responsible Authorities. All requirements under the Species at Risk Act will be incorporated into the EA document.

8.6 Summary

Transport Canada, the Department of Fisheries and Oceans, the NL Department of Environment and Conservation and Environment Canada are anticipated to be the primary contributors to the approval and permitting processes required for the proposed undertaking. It is recognized that through the Federal Coordination Regulations, other departments/ agencies will potentially be involved in the review process. It is also recognized that there may be overlap in submission requirements, the proponent will maintain continuous contact with regulators, and the Lead Responsible Authority, to minimize duplication of effort and facilitate streamlining the process. Based on the various permit applications, surveys and environmental assessment documentation, it is estimated that the process will take approximately 6 months from initiation to final approval.

9. Cost Estimates for Jetty Upgrades

9.1 General

To assist Hydro with their assessment of risk mitigation at the Holyrood Marine Terminal, we have completed an order of magnitude cost estimate for the upgrading of individual components.

The order of magnitude construction cost estimates are based on similar types of work completed in Atlantic Canada and on costs supplied by contractors who are familiar with this type of work.

Fender Replacement/Repairs	**$1,874,300**
• Fender No. 4 complete replacement	$633,500
• Repairs to Fenders No. 3,5&6	$1,139,500
• Engineering	$101,300
Vessel Approach/Loading Arms	**$711,800**
• Modify existing loading arms.	$211,500
• Radar System	$110,000
• Loading Arm Drainage System	$280,000
• Engineering	$110,300
Anode Inspection/Replacement	**$504,800**
• Inspect all anodes and replace as required	$473,400
• Engineering	$31,400
Life Safety Issues	**$832,225**
• Install a 4 persons evacuation life raft. Install 2 fixed platforms below deck to allow access to vessels	$592,000
• Lighting Upgrades	$65,000
• Engineering	$175,225
General	**$1,624,506**
• Mobilization/Demobilization	$50,000
• On-Site Facilities	$581,225
• Contingency	$595,968
• Overhead and Profit	$397,313
Total	**$5,547,631**

A detailed breakdown of the estimated construction cost is attached in Appendix L.

10. Schedule

10.1 General

From the cost estimate Hatch approximates two (2) to three (3) months of engineering from design to tendering.

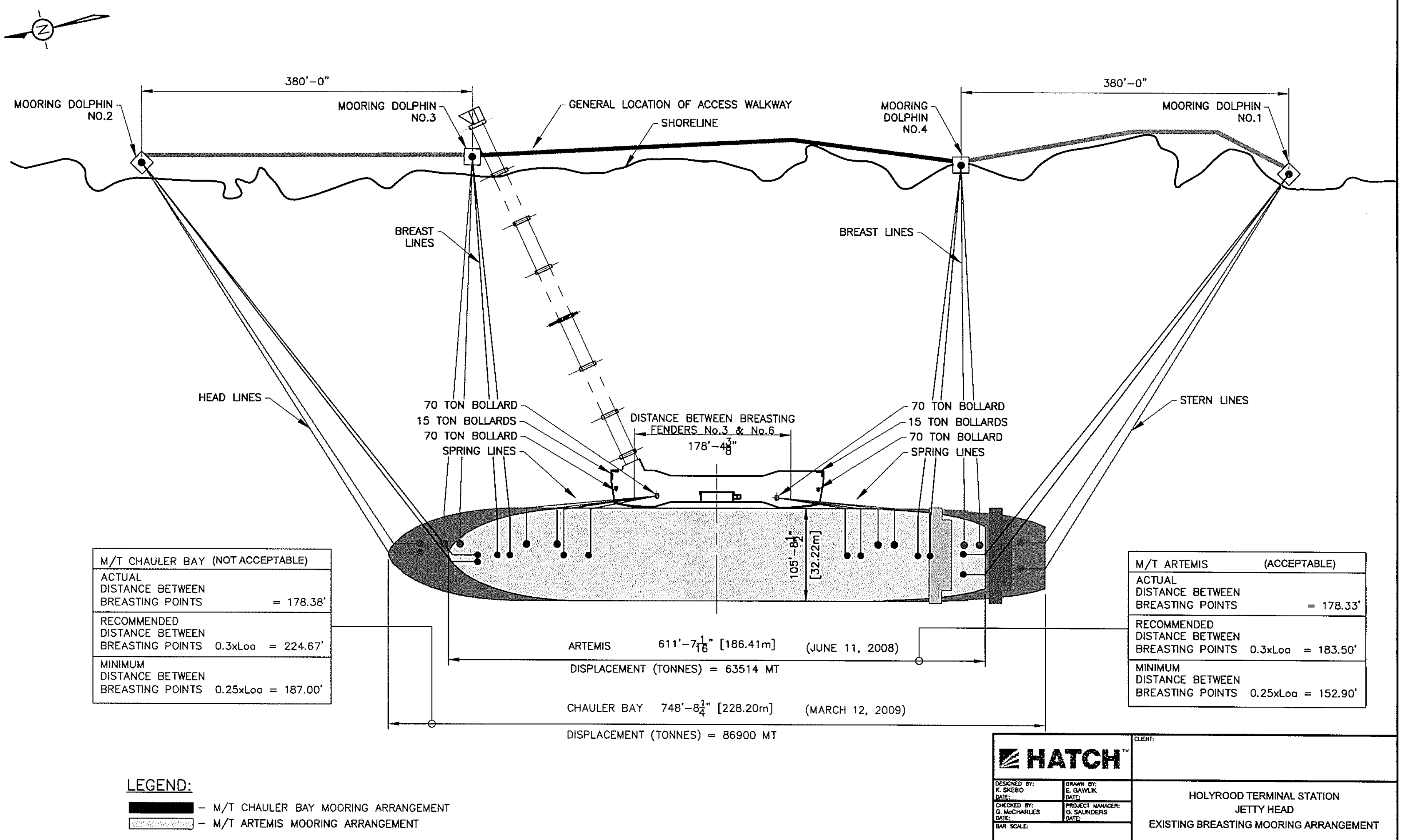
Based on Hatch's preliminary assessment of the existing structures and previous experience, we anticipate approximately four (4) months to complete the construction phase. This work will take place during Hydro's construction season, May to October.

The final schedule will require the delivery times for long lead items that may delay or prolong the construction stage.

Depending on climate conditions, construction may commence earlier than May given that engineering is completed one month after the start of construction.

Appendix A

Holyrood Terminal Station Jetty Head Existing Breasting Mooring Arrangement



M/T CHAULER BAY (NOT ACCEPTABLE)		
ACTUAL DISTANCE BETWEEN BREASTING POINTS		= 178.38'
RECOMMENDED DISTANCE BETWEEN BREASTING POINTS	0.3xLoa	= 224.67'
MINIMUM DISTANCE BETWEEN BREASTING POINTS	0.25xLoa	= 187.00'

M/T ARTEMIS (ACCEPTABLE)		
ACTUAL DISTANCE BETWEEN BREASTING POINTS		= 178.33'
RECOMMENDED DISTANCE BETWEEN BREASTING POINTS	0.3xLoa	= 183.50'
MINIMUM DISTANCE BETWEEN BREASTING POINTS	0.25xLoa	= 152.90'

HATCH™

CLIENT:

DESIGNED BY: K. SKEBO | DRAWN BY: E. GAWLIK
CHECKED BY: G. McCHARLES | PROJECT MANAGER: G. SAUNDERS
BAR SCALE:

HOLYROOD TERMINAL STATION
JETTY HEAD
EXISTING BREASTING MOORING ARRANGEMENT

H&M PROJECT No: 272249 | DWG SCALE(FULL SIZE): 1"=100'-0" | DWG No: FIGURE 4 | SHT No | REV No: A

Dec 15, 2010 – 10:53am
P:\272249 Holyrood (H335093)\90 Drawings\FIGURE 4-NEW.dwg

Appendix B

Design Check of Structural Capacity of Piles and Calculation of Recommended Vessel Approach Velocity

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List of Tables

Number Title

1. Introduction

At the request of Newfoundland and Labrador Hydro, Hatch has carried out structural analyses of the jetty structure at the Holyrood Marine Terminal for the purpose of determining acceptable vessel berthing practices, specifically as it relates to 55,000 DWT tanker vessels. The following report summarizes the details of the analyses along with the conclusions derived from them. The capacity of the jetty when vessels are in a moored condition was not part of the scope of work.

2. Description of Work

To perform these analyses, several assumptions were required and are listed below:

- The gravity fenders and their support mechanisms are in good working order;
- The driving resistances of the piles, as noted on the original design drawings, are valid. A factor of safety of 2.0 was used to derive an allowable bearing load from these driving resistances;
- The point of pile base fixity was determined to be approximately 10' (3.0m) below the seabed. The average depth to the seabed below the underside of concrete deck was assumed to be approximately 65' (20m) based on original borehole survey data;
- The mass of each gravity fender is 66 tonnes (calculated);
- The berthing energy of a vessel will be absorbed by a minimum of two (2) concrete gravity fenders and these fenders will deflect the same amount during berthing;
- In accordance with established practice, an eccentricity (berthing) coefficient of 0.5 and a safety factor for abnormal berthing of 2.0 were applied to the calculated berthing energies;
- The lateral movement of the fenders is only significant in the direction perpendicular to the fender's berthing face; i.e. there is no appreciable side to side movement during vessel berthing;
- A deck live loading of 12.5 kPa (250 psf).

A 3-dimensional STAAD model of the jetty deck and pile structure was created for the structural analyses. Capacities were then checked manually using limit states design in accordance with CSA S16.1.

Analyses were run for 45,000 and 55,000 DWT vessels with berthing velocities of 0.10 m/s, 0.15 m/s, and 0.20 m/s perpendicular to the face of the jetty. For the purpose of creating a baseline for the results, an analysis was run for a 35,000 DWT vessel, the original design vessel displacement, berthing at 0.10 m/s and 0.15 m/s. An equivalent static force was determined based on the required energy absorption for each case. This force was divided into two (2) equal parts for both fenders and applied directly to the concrete deck.

The following procedure was carried out for each berthing (loading) condition:

- The allowable energy absorption of two (2) fenders was compared with the berthing energy for each vessel at each berthing velocity. The allowable energy absorption was determined based on the potential energy of each fender rising up to the level of the underside of the jetty deck.
- The maximum tension and compression loads in the piles were determined from the results of the STAAD model. The pile compression capacity was calculated as the minimum of either the

structural capacity of the pile or the final driving resistance indicated on the drawings. Punching shear through the concrete deck was also calculated and it was found not to govern the design. The driven tensile capacity of the piles is not indicated on the original drawings, nor is there any construction detail showing a tensile resistance connection of the pile and deck. It was decided to determine the maximum pile tension based on the original design condition of 35,000 DWT at 0.15 m/s and limit the allowable tensile forces for the other analyses to this value.

- The axial load in each of the fender support arms was determined based on static equilibrium at the point of maximum fender deflection. This axial load was then compared with the tensile and shear capacities of the support arms. The clevis plates' capacities were not checked as they are thicker than the support arms and each plate only carries approximately half the load of the support arms. The concrete embedment capacity of the clevis plates was not checked.

3. Results

3.1 Energy Absorption Capacity of Fenders

It was found that at 0.10 m/s and 0.15 m/s, two fenders were capable of absorbing the energy of all three vessel sizes analyzed. At 0.20 m/s, however, the fenders would rotate far enough under 45,000DWT and 55,000 DWT vessel berthing that they could strike the underside of the concrete deck. As this was considered the limiting case, this berthing velocity was not considered as an option. Table 3.1 shows the raised heights of the fenders required to fully dissipate the berthing energies.

Table 3.1: Raised Height Required for Energy Dissipation

DWT	Displaced Tonnage	Velocity	Required Height	Allowable Height	Energy U/R
t	t	m/s	mm	mm	
55000	65000	0.100	454	1362	0.33
		0.125	709	1362	0.52
		0.150	1021	1362	0.75
		0.200	1815	1362	1.33
45000	55000	0.100	371	1362	0.27
		0.150	834	1362	0.61
		0.200	1483	1362	1.09
35000	46000	0.100	315	1362	0.23
		0.150	709	1362	0.52
		0.200	1261	1362	0.93

Note: Highlighted regions indicate cases that exceed the allowable limits

3.2 Tension/Compression Capacity of Piles

The 55,000 DWT vessel at 0.15 m/s was found to produce compression loads in the piles that overloaded the allowable driving resistance with a utilization ratio of approximately 1.07. The 0.10 m/s berthing velocity was found to produce acceptable compression loads with a utilization ratio of 1.0.

Using the tension loads from the baseline analysis of the 35,000 DWT vessel, a velocity was determined for the 55,000 DWT vessel that would produce similar tensile pile loads in the jetty. This velocity was determined to be 0.125 m/s, which produces berthing loads that are nearly identical to the baseline analysis. Tables 3.2 and 3.3 show the compression and tension utilization ratios of the piles, respectively.

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Holyrood Thermal Generating Station Marine Terminal - Jetty Structural Analysis - June 16, 2010

Table 3.2: Compression Capacity of Piles

DWT t	Displaced Tonnage t	Velocity m/s	Critical Compression Load Case	Critical Pile Type	Max Comp. in Piles kN	Comp. Capacity (driving) kN	Comp. Capacity (piles) kN	Comp. U/R (driving)	Comp. U/R (piles)
55000	65000	0.100	DL + LL	Vert	1117	1112	1919	1.00	0.58
		0.125	DL + LL	Vert	1117	1112	1919	1.00	0.58
		0.150	DL + FBL + LL	1 to 2.5	1190	1112	2094	1.07	0.57
		0.200	-	-	-	-	-	-	-
45000	55000	0.100	DL + LL	Vert	1117	1112	1919	1.00	0.58
		0.150	DL + LL	Vert	1117	1112	1919	1.00	0.58
		0.200	-	-	-	-	-	-	-
35000	46000	0.100	DL + LL	Vert	1117	1112	1919	1.00	0.58
		0.150	DL + LL	Vert	1117	1112	1919	1.00	0.58
		0.200	-	-	-	-	-	-	-

Note: Highlighted regions indicate cases that exceed allowable limits

Table 3.3: Tension Capacity of Piles

DWT t	Displaced Tonnage t	Velocity m/s	Critical Tension Load Case	Critical Pile Type	Max Tens. in Piles kN	Tens. Capacity kN	Tension U/R
55000	65000	0.100	DL + FBL	1 to 2.5	115	334	0.34
		0.125	DL + FBL	1 to 2.5	118	334	0.35
		0.150	DL + FBL	1 to 6	315	334	0.94
		0.200	-	-	-	-	-
45000	55000	0.100	DL + FBL	1 to 2.5	113	334	0.34
		0.150	DL + FBL	1 to 6	147	334	0.44
		0.200	-	-	-	-	-
35000	46000	0.100	DL + FBL	1 to 2.5	113	334	0.34
		0.150	DL + FBL	1 to 2.5	118	334	0.35
		0.200	-	-	-	-	-

Note: Highlighted regions indicate cases that exceed the baseline results

3.3 Fender Support Arms

The loading in each of the fender support arms was compared with their tensile and shear capacities and in all cases the loading was below the calculated safe operating capacity. The results are summarized in Table 3.4.

Table 3.4: Support Arm Utilization Ratios

DWT t	Displaced Tonnage t	Velocity m/s	Max Tens. in Arms kN	Resistance Factor	Tensile Capacity kN	Arm U/R
55000	65000	0.100	393	2.0	2204	0.36
		0.125	503	2.0	2204	0.46
		0.150	755	2.0	2204	0.69
		0.200	-	-	-	-
45000	55000	0.100	366	2.0	2204	0.33
		0.150	581	2.0	2204	0.53
		0.200	-	-	-	-
35000	46000	0.100	351	2.0	2204	0.32
		0.150	503	2.0	2204	0.46
		0.200	-	-	-	-

4. Conclusions

Based on the structural analysis of the jetty, it was determined that the jetty is capable of withstanding the berthing forces from a 55,000 DWT vessel at a maximum berthing velocity of 0.125 m/s without exceeding the capacity of the piles, support arms, or available potential energy in two simultaneously displaced fenders. The 55,000 DWT vessel at 0.125 m/s produces very similar results to the assumed original design criteria of a 35,000 DWT vessel at 0.15 m/s. This determination includes a safety factor to account for abnormal berthing energy due to the occurrence of docking problems caused by human error, malfunctions, exceptional weather conditions, or a combination of these factors.

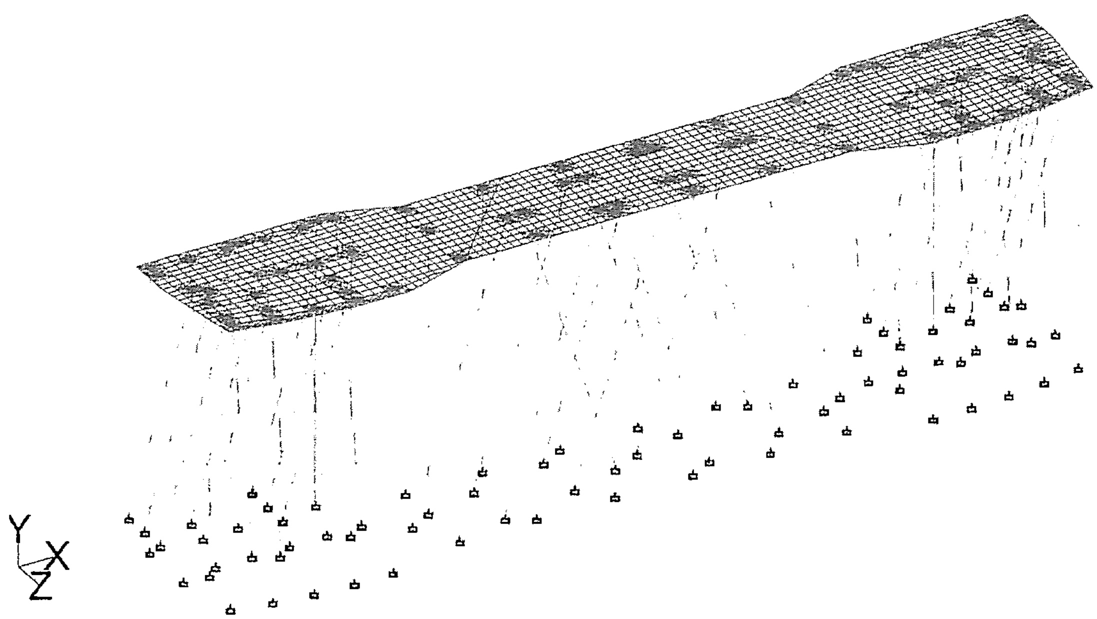
As mentioned in the description of work, the results of these analyses are dependent on the fenders and their support mechanisms being in good working order. If any of these components are not in good working order, these less than ideal conditions will increase the loads on the jetty, which could cause it to be overloaded for a 55,000 DWT vessel berthing at 0.125 m/s.

An analysis while the vessel is in a moored condition may also be required to determine the capacities of mooring aids such as bollards and capstans.

Appendix A

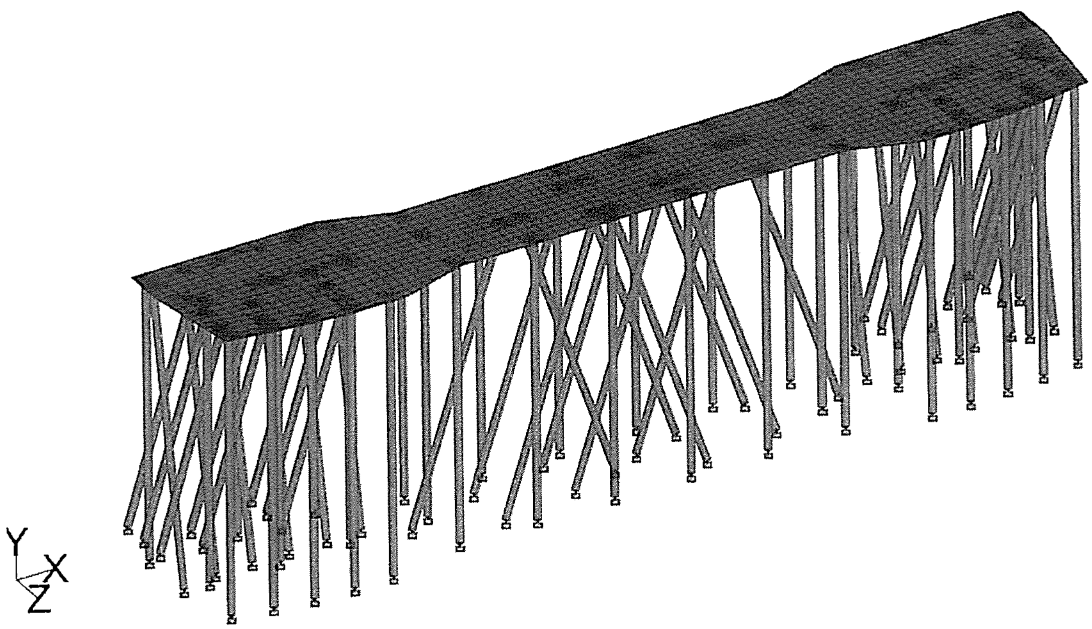
STAAD Model Printouts

Software licensed to Hatch	Job No H335093	Sheet No 1	Rev 08e
	Part		
Job Title Holyrood Jetty	Ref Metric		
	By SWR	Date 14-May-10	Chd
Client NL Hydro	File Jetty - 65000 DT - 125 mr	Date/Time 15-Jun-2010 09:32	

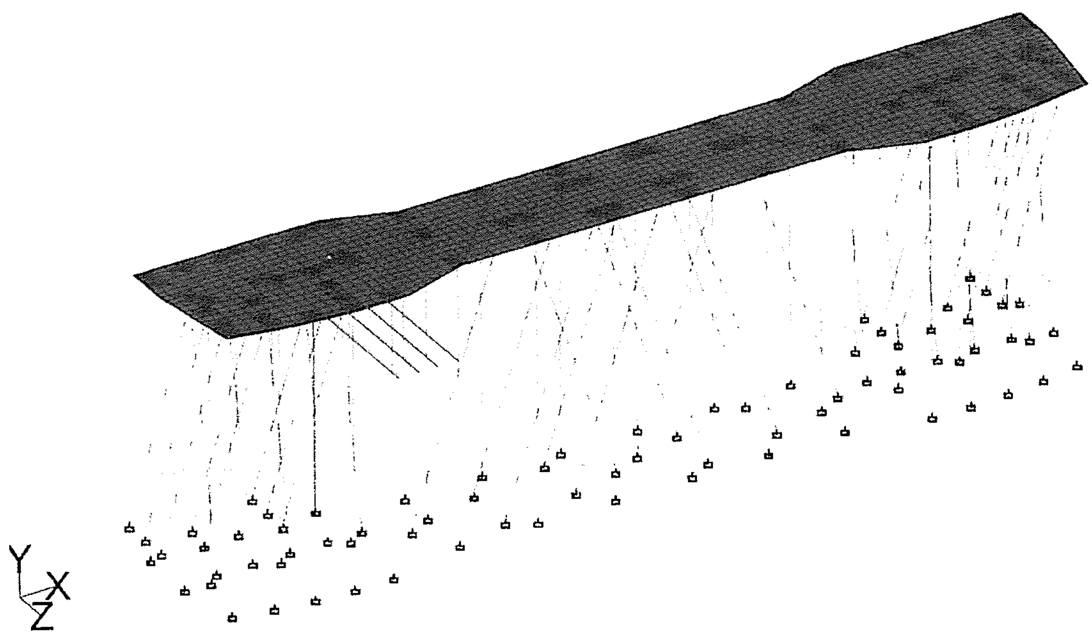


Software licensed to Hatch

Job No	H3350[illegible]
Sheet No	1
Rev	[illegible]
Part	
Job Title	Holyrood Jetty
Ref	Metric
By	SWR
Date	14-May-10
Chd	
Client	NL Hydro
File	Jetty - 65000 DT - 125 mr
Date/Time	15-Jun-2010 09:32



Software licensed to Hatch	Job No H3350[illegible]	Sheet No 1	Rev 08a
	Part		
Job Title Holyrood Jetty	Ref Metric		
	By SWR	Date 14-May-10	Chd
Client NL Hydro	File Jetty - 65000 DT - 125 mr	Date/Time 15-Jun-2010 09:32	



Software licensed to Hatch	Job No H335090	Sheet No	Rev
	Part		
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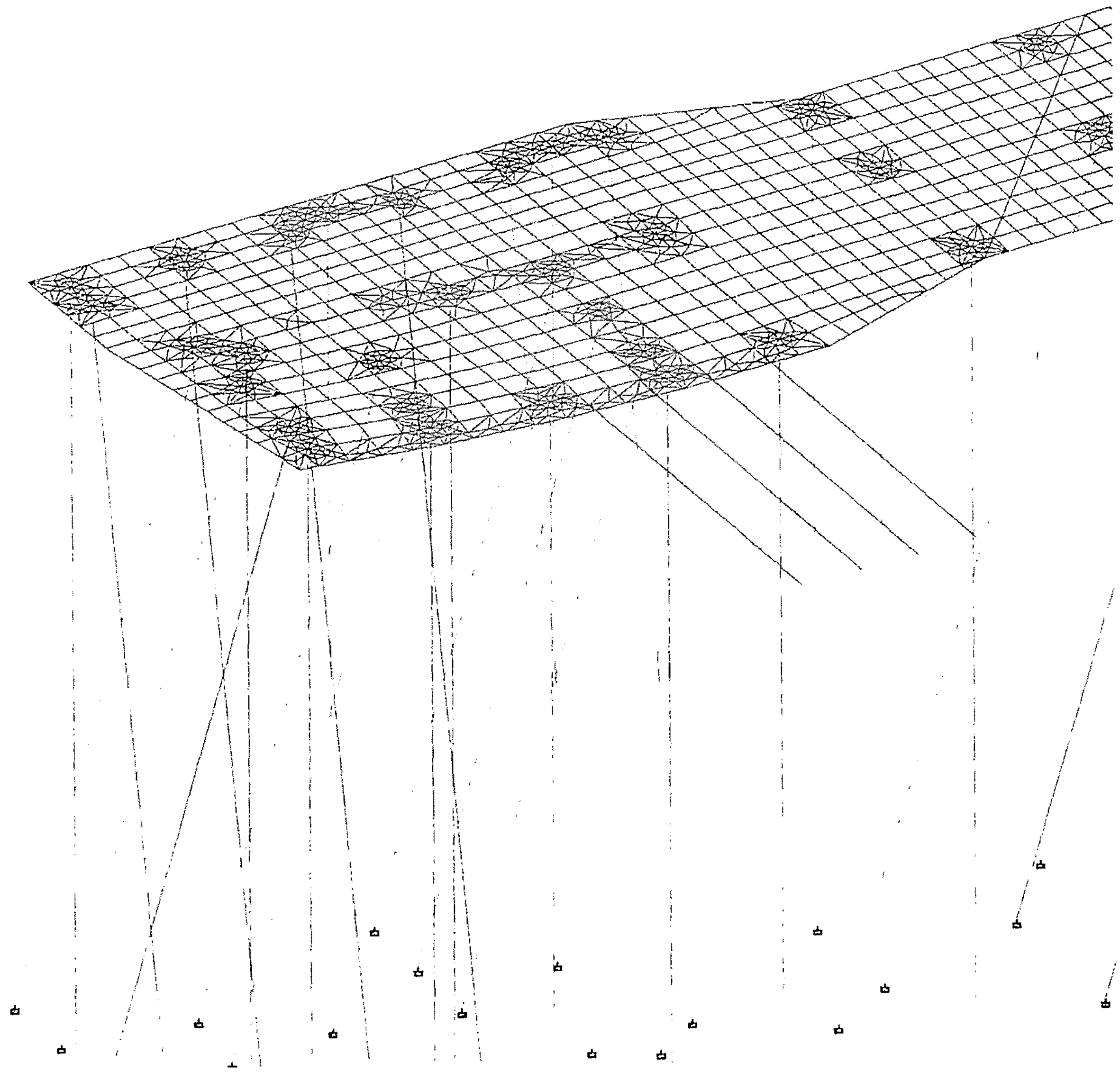
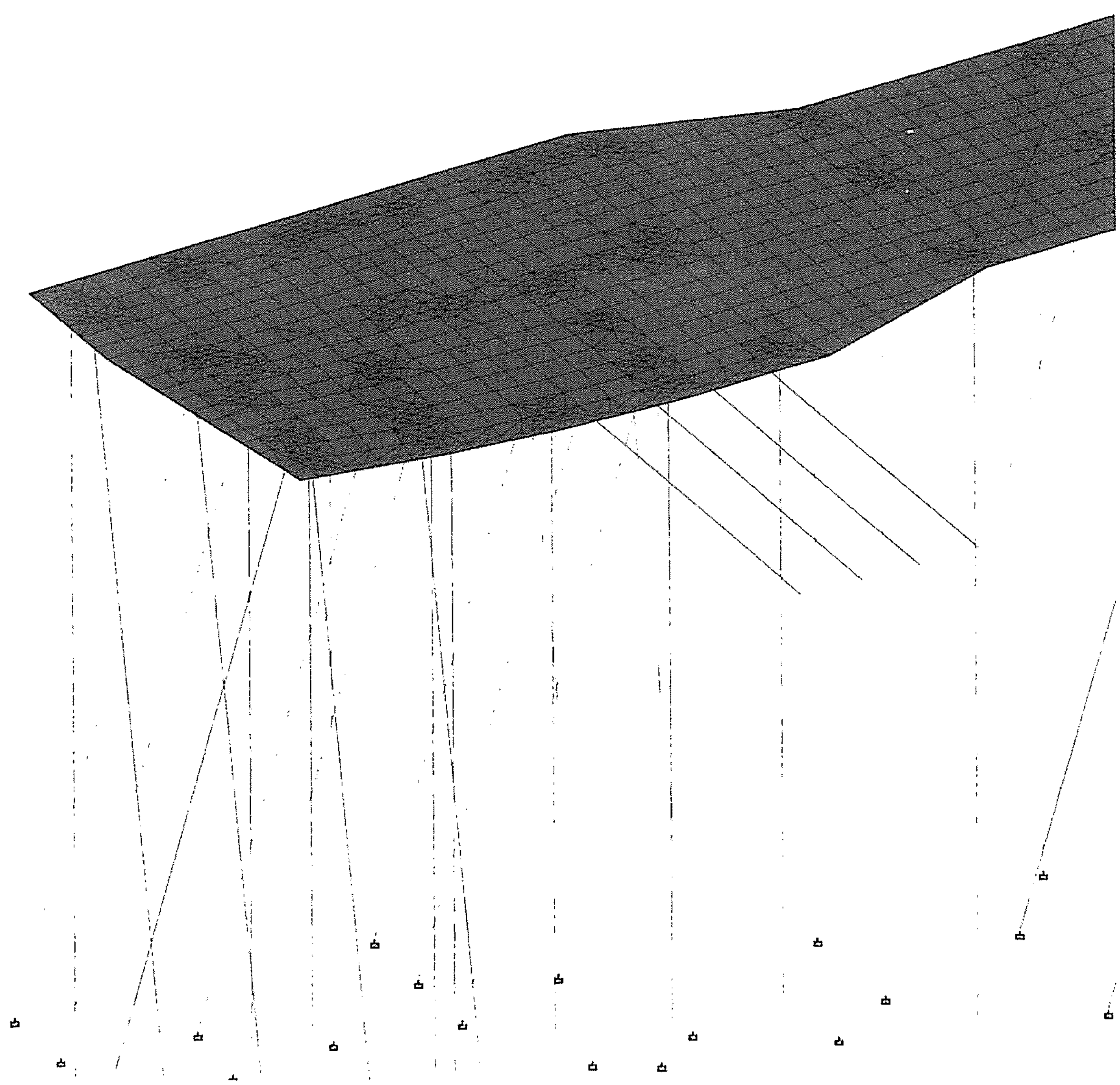
Client NL Hydro	File Jetty - 65000 DT - 125 mr	Date/Time 15-Jun-2010 09:32	



Software licensed to Hatch

Job Title: Holyrood Jetty	Job No: H335	Sheet No: 1	Rev
	Part		
	Ref: Metric		
	By: SWR	Date: 14-May-10	Chd
Client: NL Hydro	File: Jetty - 65000 DT - 125 mr	Date/Time: 15-Jun-2010 09:32	



Appendix B

Fender Berthing Loads Calculation

ENERGY CALCULATIONS FOR BERTHING OF SHIP

1.0 - Vessel Details

$m_v := 65000\text{tonne}$	*Displaced tonnage of vessel*
$v_v := 0.125\frac{m}{s}$	*Velocity of vessel*
$Draft := 13.0m$	*Max draft of vessel*
$Beam := 32.2m$	*Beam of vessel*
$L_v := 200m$	*Length of vessel*

2.0 - Fender Details

$n_f := 2$		*Number of fenders activated in resisting vessel impact*
$m_c := 66\text{tonne}$		*Mass of one concrete fender*
$W_c := m_c \cdot g$	$W_c = 647.24\,kN$	*Weight of one concrete fender*
$L_{arm} := 5.5ft$		*Length of steel arms (c/c of pins)*

3.0 - Energy Calculations

$C_B := 0.5$		*Berthing factor*
$F_s := 2.0$		*Safety factor for abnormal berthings (as recommended in Trelleborg book - p.12-12)*
$\phi_{hmf} := 1 + 2\cdot\frac{Draft}{Beam}$	$\phi_{hmf} = 1.81$	*Hydraulic mass factor*
$K_{ev} := \frac{1}{2}\cdot m_v \cdot v_v^{\,2}$	$K_{ev} = 507.81\,kN\cdot m$	*Kinetic energy of vessel*
$K_e := F_s \cdot C_B \cdot \phi_{hmf} \cdot K_{ev}$	$K_e = 917.85\,kN\cdot m$	*Total kinetic energy*
$P_e := K_e$	$P_e = 917.85\,kN\cdot m$	*Required potential energy (potential must equal kinetic energy assuming no other energy losses in the system)*
$y_{c\_max} := 4ft + 5\frac{5}{8}in$	$y_{c\_max} = 1362.08\,mm$	*Maximum vertical distance fender can travel before impacting underside of jetty*
$P_{e\_max} := n_f \cdot W_c \cdot y_{c\_max}$	$P_{e\_max} = 1763.18\,kN\cdot m$	*Maximum potential energy available before activated fenders impact underside of jetty*

Energy_Check := | "Activated fenders can resist the load" if $P_e \le P_{e\_max}$
| "Activated fenders are impacting the jetty!!!" otherwise

Energy_Check = "Activated fenders can resist the load"

4.0 - Displacement Calculations

$y_c := \frac{P_e}{n_f \cdot W_c}$ $\quad y_c = 709.05\,\text{mm}$ *Total required vertical rise of activated fenders from equilibrium (when arms are vertical)*

$\theta := \text{acos}\left(1 - \frac{y_c}{L_{arm}}\right)$ $\quad \theta = 54.76 \cdot \text{deg}$ *Total required arm rotation from vertical*

$x_c := L_{arm} \cdot \sin(\theta)$ $\quad x_c = 1369.14\,\text{mm}$ *Total required horizontal displacement of fender*

$x_{ci} := 7\text{in}$ $\quad x_{ci} = 177.8\,\text{mm}$ *Initial horizontal displacement of fender due to retraction chains*

$\Delta_x := x_c - x_{ci}$ $\quad \Delta_x = 1191.34\,\text{mm}$ *Relative horizontal displacement of fender*

5.0 - Static Force Calculations

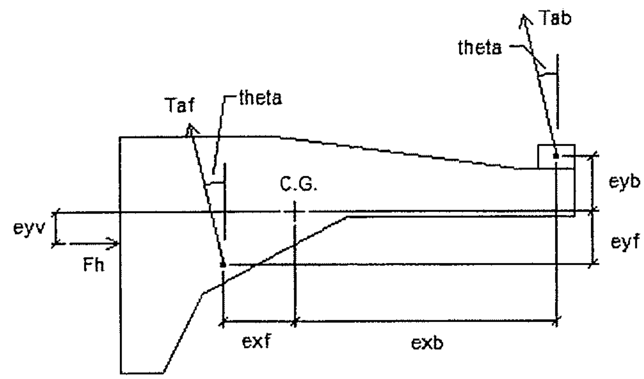
$e_{xf} := 3\text{ft} + 4\frac{5}{8}\text{in}$ $\quad e_{xf} = 1031.88\,\text{mm}$

$e_{yf} := 2\text{ft} + 7\frac{5}{8}\text{in}$ $\quad e_{yf} = 803.27\,\text{mm}$

$e_{xb} := 20\text{ft} + 0\frac{3}{8}\text{in}$ $\quad e_{xb} = 6105.52\,\text{mm}$

$e_{yb} := 3\text{ft} + 10\frac{3}{8}\text{in}$ $\quad e_{yb} = 1177.93\,\text{mm}$

$e_{yv} := 2\text{ft} + 7\frac{5}{8}\text{in}$ $\quad e_{yv} = 803.27\,\text{mm}$



5.1 - Summation of moments about front support hinge

$$T_{ab} := \frac{W_c \cdot e_{xf}}{(e_{xf} + e_{xb}) \cdot \cos(\theta) + (e_{yf} + e_{yb}) \cdot \sin(\theta)}$$

<--- $e_{yv} = e_{yf}$, therefore F_h has no component in the summation of moments calculation

$T_{ab} = 116.42\,\text{kN}$ *Axial force in rear arm*

5.2 - Summation of forces in Y-axis

$$T_{af} := \frac{\frac{W_c}{\cos(\theta)} - T_{ab}}{2}$$

$T_{af} = 502.61\,\text{kN}$ *Axial force in each front arm*

5.3 - Summation of forces in X-axis

$$F_h := 2 \cdot T_{af} \cdot \sin(\theta) + T_{ab} \cdot \sin(\theta)$$

$F_h = 916.07\,\text{kN}$ *Horizontal force on each fender at max displacement*

6.0 - Fender Arm Capacity

$t := 1\frac{3}{8}in$	*Thickness of arm*
$b := 18in$	*Width of arm*
$d := 6in$	*Diameter of pin*
$d_h := 6\frac{1}{16}in$	*Diameter of hole for pin*
$e_p := 10in$	*Distance from centre of pin to end of arm*
$F_y := 230MPa$	*Yield strength of arm*
$F_u := 400MPa$	*Ultimate strength of arm*
$\phi_s := 0.9$	*Steel resistance factor*
$\phi_{br} := 0.67$	*Bearing resistance factor*

6.1 - Gross Tension

$A_{tg} := t \cdot b$	$A_{tg} = 15967.71\ mm^2$	*Gross tensile area*
$T_{tg} := \phi_s \cdot A_{tg} \cdot F_y$	$T_{tg} = 3305.32\ kN$	*Gross tensile capacity*

6.2 - Net Tension

$A_{tn} := t \cdot (b - d_h)$	$A_{tn} = 10589.7\ mm^2$	*Net tensile area*
$T_{tn} := 0.85 \cdot \phi_s \cdot A_{tn} \cdot F_u$	$T_{tn} = 3240.45\ kN$	*Net tensile capacity*

6.3 - Shear/Tension

$A_{tn} := t \cdot \frac{(b - d_h)}{2}$	$A_{tn} = 5294.85\ mm^2$	*Net tensile area*
$A_{vg} := t \cdot e_p$	$A_{vg} = 8870.95\ mm^2$	*Gross shear area*
$A_{vn} := t \cdot \left(e_p - \frac{d_h}{2}\right)$	$A_{vn} = 6181.94\ mm^2$	*Net shear area*
$T_{tvg} := \phi_s \cdot A_{tn} \cdot F_u + 0.6 \cdot \phi_s \cdot A_{vg} \cdot F_y$	$T_{tvg} = 3007.92\ kN$	*Net tensile / gross shear tear-out capacity*
$T_{tvn} := \phi_s \cdot A_{tn} \cdot F_u + 0.6 \cdot \phi_s \cdot A_{vn} \cdot F_u$	$T_{tvn} = 3241.45\ kN$	*Net tensile / net shear tear-out capacity*

6.4 - Shear

$A_{vg} := 2 \cdot t \cdot e_p$ | $A_{vg} = 17741.9\ mm^2$ | *Gross shear area*

$A_{vn} := 2 \cdot t \cdot \left(e_p - \frac{d_h}{2}\right)$ | $A_{vn} = 12363.89\ mm^2$ | *Net shear area*

$T_{vg} := 0.6 \cdot \phi_s \cdot A_{vg} \cdot F_y$ | $T_{vg} = 2203.54\ kN$ | *Gross shear capacity*

$T_{vn} := 0.6 \cdot \phi_s \cdot A_{vn} \cdot F_u$ | $T_{vn} = 2670.6\ kN$ | *Net shear capacity*

6.5 - Bearing

$B_r := 3 \cdot \phi_{br} \cdot t \cdot d \cdot F_u$ | $B_r = 4279.35\ kN$ | *Bearing capacity*

6.6 - Governing Capacity

$T_r := \min(T_{tg}, T_{tn}, T_{tvg}, T_{tvn}, T_{vg}, T_{vn}, B_r)$

$T_r = 2203.54\ kN$ | *Governing tear-out capacity of arm*

$\phi_r := 2.0$ | *Resistance factor of arm*

$T_a := \max(T_{af}, T_{ab})$ | $T_a = 502.61\ kN$ | *Maximum force in any arm*

$\frac{\phi_r \cdot T_a}{T_r} = 0.46$ | *Max utilization of arm*

Appendix C

Pile Capacity Calculation

CAPACITY OF CONCRETE FILLED CIRCULAR HSS COLUMN

1.0 - Input Variables

$k := 1.0$		*Effective length factor*
$L_n := 22.9\text{m}$		*Column length*
$D_s := 24\text{in}$	$D_s = 609.6\ \text{mm}$	*OD of steel*
$t_s := \frac{7}{16}\text{in}$	$t_s = 11.11\ \text{mm}$	*Thickness of steel*
$D_c := D_s - 2 \cdot t_s$	$D_c = 23.12 \cdot \text{in}$	*OD of concrete (ID of steel)*
$\phi_s := 0.9$		*Steel resistance factor (S16.1 - Cl. 13.1)*
$F_y := 230\text{MPa}$		*Steel yield strength (assumed)*
$E_s := 200\text{GPa}$		*Steel modulus of elasticity (S16.1 - Cl. 2.2)*
$A_s := \frac{\pi}{4} \cdot \left(D_s^{\,2} - D_c^{\,2}\right)$	$A_s = 20893.77\ \text{mm}^2$	*Steel area*
$I_s := \frac{\pi \cdot \left(D_s^{\,4} - D_c^{\,4}\right)}{64}$	$I_s = 935.81 \times 10^6\ \text{mm}^4$	*Steel moment of inertia*
$\phi_c := 0.6$		*Concrete resistance factor (S16.1 - Cl. 13.1)*
$f_c := 20\text{MPa}$		*Concrete compressive strength*
$E_c := 4500 \cdot \sqrt{\frac{f_c}{\text{MPa}}} \cdot \text{MPa}$	$E_c = 20.12 \cdot \text{GPa}$	*Concrete modulus of elasticity (S16.1 - Cl. 2.1)*
$A_c := \frac{\pi}{4} \cdot D_c^{\,2}$	$A_c = 270969.74\ \text{mm}^2$	*Concrete area*
$I_c := \frac{\pi \cdot D_c^{\,4}}{64}$	$I_c = 5.84 \times 10^9\ \text{mm}^4$	*Concrete moment of inertia*
$n := 1.80$		*Compression factor*

$$\text{Slenderness\_Check} := \begin{cases} \text{"Calculations are applicable"} & \text{if } \frac{D_s}{t_s} \le \frac{28000}{\left(\frac{F_y}{\text{MPa}}\right)} \\ \text{"COLUMN TOO SLENDER FOR VALID CALCULATION!"} & \text{otherwise} \end{cases}$$

Slenderness_Check = "Calculations are applicable"

2.0 - Calculate Compressive Resistance (S16.1 - Cl. 18.2.2)

2.1 - Computed Variables

$\rho := 0.02 \cdot \left(25 - \frac{L_n}{D_s}\right)$ $\rho = -0.25$ *Compression factor*

$$\tau := \begin{cases} \left(\frac{1}{\sqrt{1 + \rho + \rho^2}}\right) & \text{if } \frac{L_n}{D_s} < 25 \\ 1.0 & \text{otherwise} \end{cases}$$

Compression factor for steel

$\tau = 1$

$$\tau' := \begin{cases} \left[1 + \left[\frac{25 \cdot \rho^2 \cdot \tau}{\left(\frac{D_s}{t_s}\right)}\right] \cdot \left(\frac{F_y}{0.85 f_c}\right)\right] & \text{if } \frac{L_n}{D_s} < 25 \\ 1.0 & \text{otherwise} \end{cases}$$

Compression factor for concrete

$\tau' = 1$

$$C_p := \left[\tau \cdot (1.0) \cdot A_s \cdot F_y + \tau' \cdot 0.85 \cdot (1.0) \cdot A_c \cdot f_c\right] \cdot \left[1 + (0)^{2 \cdot n}\right]^{-\frac{1}{n}}$$

$C_p = 9412.05\ \text{kN}$ *Idealized compression resistance*

$\%DL_f := \frac{2}{3}$ *Ratio of sustained (dead) load to total load (assumed)*

$EI_e := E_s \cdot I_s + \frac{0.6 \cdot E_c \cdot I_c}{1 + \%DL_f}$ $EI_e = 229.49 \times 10^{12} \cdot N \cdot mm^2$ *Effective inertia for column*

$C_{ec} := \frac{\pi^2 \cdot EI_e}{(k \cdot L_n)^2}$ $C_{ec} = 4319.15\ \text{kN}$ *Euler compression resistance*

$\lambda := \sqrt{\frac{C_p}{C_{ec}}}$ $\lambda = 1.48$ *Compression factor*

2.2 - Compression Resistance

$$C_{rc} := \left(\tau \cdot \phi_s \cdot A_s \cdot F_y + \tau' \cdot 0.85 \cdot \phi_c \cdot A_c \cdot f_c\right) \cdot \left(1 + \lambda^{2 \cdot n}\right)^{-\frac{1}{n}}$$

$C_{rc} = 2878.79\ \text{kN}$ *Compression resistance of composite column*

$\phi_r := 1.5$ *Overall compression resistance factor*

$C_d := 500\text{kip}$ $\quad C_d = 2224.11\ \text{kN}$ — *Minimum driving resistance of pile into soil (from drawings)*

$\phi_d := 2.0$ — *Factor for driving resistance*

$C_{rp} := \min\left(\frac{C_{rc}}{\phi_r}, \frac{C_d}{\phi_d}\right)$ $\quad C_{rp} = 1112.06\ \text{kN}$ — *Governing compression resistance of piles (allowable)*

3.0 - Calculate Flexural Resistance (S16.1 - Cl. 18.2.3)

$$h_n := \frac{\phi_c \cdot A_c \cdot f_c}{2 \cdot D_c \cdot \phi_c \cdot f_c + 4 \cdot t_s \cdot \left(2 \cdot \phi_s \cdot F_y - \phi_c \cdot f_c\right)}$$

$$Z_s := \frac{1}{6} \cdot \left(D_s^{\,3} - D_c^{\,3}\right)$$ *Plastic section modulus of steel section*

$$M_{rc} := \left(Z_s - 2 \cdot t_s \cdot h_n^{\,2}\right) \cdot \phi_s \cdot F_y + \left[\frac{2}{3} \cdot \left(0.5 \cdot D_s - t_s\right)^3 - \left(0.5 \cdot D_s - t_s\right) \cdot h_n^{\,2}\right] \cdot \phi_c \cdot f_c$$

$M_{rc} = 942.61\ \text{kN} \cdot \text{m}$ — *Moment capacity of piles*

$M_{rp} := \frac{M_{rc}}{\phi_r}$ $\quad M_{rp} = 628.41\ \text{kN} \cdot \text{m}$

4.0 - Calculate Tensile Resistance (S16.1 - Cl. 13.2)

*** *Assume steel section is the only component resisting tensile loads* ***

$T_{rs} := \phi_s \cdot A_s \cdot F_y$ $\quad T_{rs} = 4325.01\ \text{kN}$ — *Tensile capacity of pile*

$T_d := (30\%) \cdot C_d$ $\quad T_d = 667.23\ \text{kN}$ — *Tensile capacity of embedment (based on past experience)*

$T_{rp} := \min\left(\frac{T_{rs}}{\phi_r}, \frac{T_d}{\phi_d}\right)$ $\quad T_{rp} = 333.62\ \text{kN}$ — *Governing tensile resistance of piles*

5.0 - Check Axial Capacities

$C_a := 918\text{kN}$ — *Max allowable compression in piles (STAAD)*

$T_a := 50\text{kN}$ — *Max allowable tension in piles (STAAD)*

$\frac{C_a}{C_{rp}} = 0.83$ — *Utilization ratio for compression loads*

$\frac{T_a}{T_{rp}} = 0.15$ — *Utilization ratio for tension loads*

Appendix C

Intertanko's Standard Tanker Chartering Questionnaire 88 (Q88) Summary

HATCH™

Vessel Questionnaire Summary - Appendix A

Tanker	ARIS JAN/2010	CHANG HANG TAN SUO DEC/2009	INDIAN POINT NOV/2009	KANDILOUSA OCT/2009	NORTH POINT FEB/2009	AJAX FEB/2009	MINERVA VASO DEC/2009
Overall Length (LOA)	186.41 Metres	184.95 Meters	183 Metres	182.76 Metres	183 M	186.41 M	183 Metres
Maximum Assigned Deadweight	53,000 DWT	47,000 DWT	51,000 DWT	40,000 DWT	51,000 DWT	53,000 DWT	51,000 DWT
Bow to Center Manifold (BCM) / Stern to Center Manifold (SCM)	93.22 Metres/93.19 Metres	92.15 Metres/92.8 Metres	91.31 Metres/91.69 Metres	90.2 Metres/92.56 Metres	91.31 M/91.69M	93.22 M/93.19M	91.618 Metres/91.382 Metres
Loadline							
Winter (Freeboard) - Metres	5.784	6.465	-	6.668	-	5.784	5.842
Lightship (Freeboard) - Metres	15.960	15.425	16.140	16.259	16.000	15.960	16.368
Normal Ballast (Freeboard) - Metres	11.650	11.715	12.100	11.790	12.000	11.570	11.678
Pumping Systems							
Cargo Pumps (No./Capacity - Type)	12/600 & 2/300 Cu. Metres/Hour - Framo	6/600 Cu. Metres/Hour - Framo	122/600&300 Cu. Metres/Hour - Framo	3/1500 M3/HR - Centrifugal	12/600 Cu. Metres/Hour - Framo	12/600 & 2/300 Cu. Metres/Hour - Centrifugal	12/600 & 2/300 Cu. Metres/Hour - Framo
Stripping				1/300 Cu. Metres/Hour - Screw			
Eductors			2/80 Cu. Metres/Hour	1/400 Cu. Metres/Hour			
Ballast	2/750 Cu. Metres/Hour - Centrifugal	2/1300 Cu. Metres/Hour - Framo	2/750 Cu. Metres/Hour - Framo	2/1,000 Cu. Metres/Hour - Centrifugal	2 - Centrifugal	2/750 Cu. Metres/Hour - Centrifugal	2/750 Cu. Metres/Hour
How many cargo pumps can be run simultaneously at full capacity	6	6	6	3			6
Cargo Manifolds							
What is the number of cargo connections per side	6	6	7	3	7	7	7
What is the size of cargo connections	300 Millimetres	350 Millimetres	350 Millimetres	400 Millimetres	400 Millimetres	300 Millimetres	400 Millimetres
Manifold Arrangement							
Distance between cargo manifold centers (Metres)	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Distance manifold to ships side (Metres)	4.600	4.600	4.600	4.600	5.200	4.600	4.563
Distance main deck to center of manifold (Metres)	2.057	2.200	1.650	2.100	1.900	2.050	1.898
Manifold height above the waterline in normal ballast (Metres)	13.552	8.2 Metres	13.39 Metres	13.89 Metres	13.39 Metres	13.552 M	13.77 Metres
Number / size reducers	6 x 300/200mm (12/8") 6 x 300/250mm (12/10") 6 x 300/300mm (12/12") 1 x 200/200mm (8/8") 1 x 200/250mm (8/10")	350 to 400 mm ×4 350 to 350 mm ×4 350 to 300 mm ×4 350 to 250 mm ×4 350 to 200 mm ×4	2 x 400/200mm (16/8") 12 x 400/350mm (16/14") 6 x 200/350mm (8/14") 6 x 250/350mm (10/14") 6 x 300/350mm (12/14")	6 x 400/400mm (16/16") 3 x 400/300mm (16/12") 3 x 400/250mm (16/10") 3 x 400/200mm (16/8")	2 x 400/200mm (16/8") 12 x 400/355mm (16/14") 6 x 200/355mm (8/14") 6 x 250/355mm (10/14") 6 x 300/355mm (12/14")	6 x 300/200mm (12/8") 6 x 300/250mm (12/10") 6 x 300/300mm (12/12") 1 x 200/200mm (8/8") 1 x 200/250mm (8/10")	6 x 200/350mm (8/14") 6 x 250/350mm (10/14") 6 x 300/350mm (12/14") 1 x 200/250mm (8/10") 1 x 200/300mm (8/12")
SUMMARY							
Loadline + Ship Deck to C/L Manifold							
Winter - Metres	7.841	8.665	-	8.768	-	7.834	7.740
Lightship - Metres	18.017	17.625	17.790	18.359	17.900	18.010	18.266
Normal Ballast - Metres	13.707	13.915	13.750	13.890	13.900	13.620	13.576
Vessel Safe Operating Envelope							
Winter - Metres	7.740						
Lightship - Metres	18.359						
Normal Ballast (Average) - Metres	13.765						
Distance from Jetty Fender to Ship Manifold - Metres	4.563 - 5.2						
Cargo Connection Sizes	2 -300 Millimetres (12") 2 -350 Millimetres (14") 3 - 400 Millimetres (16")						

Notes:
Heavy Ship with LWL will give the low point reach requirement
Light Ship with HWL will give the high point reach requirement

Appendix D

Holyrood Tide Information

ST JOHN'S NST Z+3.5 — 2010 — TIDE TABLES

January-janvier

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0107	**1.3**	0.4	16	0158	**1.3**	0.4
	0743	**5.2**	1.6		0813	**4.6**	1.4
FR	1423	**0.7**	0.2	SA	1448	**1.3**	0.4
VE	2013	**3.9**	1.2	SA	2050	**3.6**	1.1
2	0203	**1.3**	0.4	17	0232	**1.3**	0.4
	0832	**5.2**	1.6		0840	**4.6**	1.4
SA	1510	**0.7**	0.2	SU	1514	**1.3**	0.4
SA	2106	**3.9**	1.2	DI	2121	**3.9**	1.2
3	0259	**1.3**	0.4	18	0303	**1.3**	0.4
	0919	**5.2**	1.6		0906	**4.6**	1.4
SU	1557	**0.7**	0.2	MO	1539	**1.3**	0.4
DI	2155	**4.3**	1.3	LU	2150	**3.9**	1.2
4	0353	**1.3**	0.4	19	0336	**1.6**	0.5
	1006	**4.9**	1.5		0934	**4.6**	1.4
MO	1645	**1.0**	0.3	TU	1605	**1.3**	0.4
LU	2242	**4.3**	1.3	MA	2217	**3.9**	1.2
5	0447	**1.3**	0.4	20	0410	**1.6**	0.5
	1051	**4.6**	1.4		1005	**4.3**	1.3
TU	1732	**1.0**	0.3	WE	1633	**1.6**	0.5
MA	2326	**4.3**	1.3	ME	2246	**3.9**	1.2
6	0540	**1.6**	0.5	21	0448	**1.6**	0.5
	1137	**4.3**	1.3		1039	**4.3**	1.3
WE	1819	**1.3**	0.4	TH	1704	**1.6**	0.5
ME				JE	2317	**3.9**	1.2
7	0011	**3.9**	1.2	22	0532	**1.6**	0.5
	0633	**1.6**	0.5		1118	**3.9**	1.2
TH	1226	**3.9**	1.2	FR	1739	**1.6**	0.5
JE	1906	**1.6**	0.5	VE	2354	**3.6**	1.1
8	0057	**3.9**	1.2	23	0629	**2.0**	0.6
	0733	**2.0**	0.6		1203	**3.6**	1.1
FR	1323	**3.3**	1.0	SA	1822	**2.0**	0.6
VE	1952	**1.6**	0.5	SA			
9	0151	**3.9**	1.2	24	0042	**3.6**	1.1
	0846	**2.0**	0.6		0743	**2.0**	0.6
SA	1440	**3.0**	0.9	SU	1301	**3.3**	1.0
SA	2041	**2.0**	0.6	DI	1916	**2.0**	0.6
10	0255	**3.9**	1.2	25	0150	**3.6**	1.1
	1013	**2.0**	0.6		0909	**2.0**	0.6
SU	1611	**3.0**	0.9	MO	1421	**3.0**	0.9
DI	2136	**2.0**	0.6	LU	2020	**2.0**	0.6
11	0406	**3.9**	1.2	26	0315	**3.9**	1.2
	1129	**1.6**	0.5		1030	**2.0**	0.6
MO	1722	**3.0**	0.9	TU	1556	**3.0**	0.9
LU	2239	**2.0**	0.6	MA	2133	**2.0**	0.6
12	0515	**3.9**	1.2	27	0438	**3.9**	1.2
	1226	**1.6**	0.5		1135	**1.6**	0.5
TU	1815	**3.0**	0.9	WE	1714	**3.3**	1.0
MA	2343	**1.6**	0.5	ME	2251	**1.6**	0.5
13	0614	**4.3**	1.3	28	0546	**4.6**	1.4
	1310	**1.3**	0.4		1230	**1.3**	0.4
WE	1859	**3.3**	1.0	TH	1816	**3.6**	1.1
ME				JE			
14	0037	**1.6**	0.5	29	0004	**1.6**	0.5
	0702	**4.3**	1.3		0644	**4.9**	1.5
TH	1347	**1.3**	0.4	FR	1319	**1.0**	0.3
JE	1939	**3.3**	1.0	VE	1911	**3.9**	1.2
15	0121	**1.6**	0.5	30	0106	**1.3**	0.4
	0741	**4.6**	1.4		0735	**5.2**	1.6
FR	1419	**1.3**	0.4	SA	1406	**0.7**	0.2
VE	2016	**3.6**	1.1	SA	2003	**4.3**	1.3
				31	0202	**1.0**	0.3
					0822	**5.2**	1.6
				SU	1451	**0.7**	0.2
				DI	2052	**4.3**	1.3

February-février

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0253	**1.0**	0.3	16	0247	**1.3**	0.4
	0907	**5.2**	1.6		0843	**4.6**	1.4
MO	1535	**0.7**	0.2	TU	1503	**1.3**	0.4
LU	2137	**4.6**	1.4	MA	2119	**3.9**	1.2
2	0343	**1.0**	0.3	17	0319	**1.3**	0.4
	0951	**4.9**	1.5		0911	**4.6**	1.4
TU	1618	**0.7**	0.2	WE	1526	**1.3**	0.4
MA	2219	**4.6**	1.4	ME	2145	**4.3**	1.3
3	0431	**1.0**	0.3	18	0352	**1.3**	0.4
	1032	**4.6**	1.4		0942	**4.3**	1.3
WE	1659	**1.0**	0.3	TH	1550	**1.3**	0.4
ME	2258	**4.6**	1.4	JE	2213	**4.3**	1.3
4	0518	**1.3**	0.4	19	0429	**1.3**	0.4
	1112	**4.3**	1.3		1015	**3.9**	1.2
TH	1740	**1.3**	0.4	FR	1614	**1.6**	0.5
JE	2336	**4.3**	1.3	VE	2243	**3.9**	1.2
5	0607	**1.6**	0.5	20	0511	**1.6**	0.5
	1151	**3.6**	1.1		1050	**3.6**	1.1
FR	1821	**1.6**	0.5	SA	1639	**1.6**	0.5
VE				SA	2317	**3.9**	1.2
6	0014	**4.3**	1.3	21	0606	**2.0**	0.6
	0702	**2.0**	0.6		1130	**3.3**	1.0
SA	1235	**3.3**	1.0	SU	1715	**2.0**	0.6
SA	1904	**2.0**	0.6	DI			
7	0058	**3.9**	1.2	22	0001	**3.9**	1.2
	0814	**2.0**	0.6		0720	**2.0**	0.6
SU	1340	**3.0**	0.9	MO	1223	**3.3**	1.0
DI	1953	**2.0**	0.6	LU	1820	**2.0**	0.6
8	0201	**3.6**	1.1	23	0106	**3.9**	1.2
	0952	**2.0**	0.6		0846	**2.0**	0.6
MO	1550	**2.6**	0.8	TU	1345	**3.0**	0.9
LU	2057	**2.3**	0.7	MA	1949	**2.0**	0.6
9	0338	**3.6**	1.1	24	0245	**3.6**	1.1
	1121	**2.0**	0.6		1007	**2.0**	0.6
TU	1716	**3.0**	0.9	WE	1541	**3.0**	0.9
MA	2218	**2.0**	0.6	ME	2121	**2.0**	0.6
10	0510	**3.9**	1.2	25	0428	**3.9**	1.2
	1217	**1.6**	0.5		1113	**1.6**	0.5
WE	1806	**3.0**	0.9	TH	1707	**3.3**	1.0
ME	2335	**2.0**	0.6	JE	2250	**2.0**	0.6
11	0609	**4.3**	1.3	26	0539	**4.3**	1.3
	1257	**1.6**	0.5		1208	**1.3**	0.4
TH	1846	**3.3**	1.0	FR	1805	**3.6**	1.1
JE				VE			
12	0029	**1.6**	0.5	27	0004	**1.6**	0.5
	0651	**4.3**	1.3		0634	**4.6**	1.4
FR	1328	**1.3**	0.4	SA	1257	**1.0**	0.3
VE	1922	**3.6**	1.1	SA	1856	**3.9**	1.2
13	0110	**1.3**	0.4	28	0103	**1.0**	0.3
	0724	**4.6**	1.4		0721	**4.9**	1.5
SA	1355	**1.3**	0.4	SU	1342	**0.7**	0.2
SA	1955	**3.6**	1.1	DI	1944	**4.3**	1.3
14	0145	**1.3**	0.4				
	0752	**4.6**	1.4				
SU	1418	**1.3**	0.4				
DI	2026	**3.9**	1.2				
15	0216	**1.3**	0.4				
	0817	**4.6**	1.4				
MO	1440	**1.3**	0.4				
LU	2053	**3.9**	1.2				

March-mars

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0154	**1.0**	0.3	16	0157	**1.0**	0.3
	0806	**4.9**	1.5		0750	**4.3**	1.3
MO	1425	**0.7**	0.2	TU	1359	**1.0**	0.3
LU	2029	**4.6**	1.4	MA	2018	**4.3**	1.3
2	0241	**0.7**	0.2	17	0229	**1.0**	0.3
	0849	**4.9**	1.5		0818	**4.3**	1.3
TU	1506	**0.7**	0.2	WE	1423	**1.0**	0.3
MA	2112	**4.6**	1.4	ME	2045	**4.3**	1.3
3	0327	**0.7**	0.2	18	0302	**1.0**	0.3
	0930	**4.9**	1.5		0848	**4.3**	1.3
WE	1545	**0.7**	0.2	TH	1448	**1.3**	0.4
ME	2150	**4.9**	1.5	JE	2114	**4.3**	1.3
4	0411	**1.0**	0.3	19	0337	**1.0**	0.3
	1009	**4.3**	1.3		0921	**3.9**	1.2
TH	1622	**1.0**	0.3	FR	1513	**1.3**	0.4
JE	2226	**4.6**	1.4	VE	2145	**4.3**	1.3
5	0455	**1.3**	0.4	20	0417	**1.3**	0.4
	1046	**3.9**	1.2		0955	**3.9**	1.2
FR	1658	**1.3**	0.4	SA	1537	**1.3**	0.4
VE	2259	**4.6**	1.4	SA	2218	**4.3**	1.3
6	0541	**1.6**	0.5	21	0502	**1.6**	0.5
	1121	**3.6**	1.1		1032	**3.6**	1.1
SA	1734	**1.6**	0.5	SU	1604	**1.6**	0.5
SA	2333	**4.3**	1.3	DI	2255	**4.3**	1.3
7	0633	**2.0**	0.6	22	0558	**1.6**	0.5
	1159	**3.3**	1.0		1115	**3.3**	1.0
SU	1815	**2.0**	0.6	MO	1646	**2.0**	0.6
DI				LU	2339	**3.9**	1.2
8	0013	**3.9**	1.2	23	0708	**2.0**	0.6
	0742	**2.3**	0.7		1212	**3.3**	1.0
MO	1253	**3.0**	0.9	TU	1811	**2.0**	0.6
LU	1910	**2.3**	0.7	MA			
9	0111	**3.6**	1.1	24	0044	**3.9**	1.2
	0923	**2.3**	0.7		0827	**2.0**	0.6
TU	1532	**3.0**	0.9	WE	1339	**3.0**	0.9
MA	2024	**2.3**	0.7	ME	1948	**2.3**	0.7
10	0307	**3.6**	1.1	25	0230	**3.6**	1.1
	1058	**2.3**	0.7		0941	**2.0**	0.6
WE	1700	**3.0**	0.9	TH	1535	**3.3**	1.0
ME	2158	**2.3**	0.7	JE	2121	**2.0**	0.6
11	0458	**3.6**	1.1	26	0420	**3.9**	1.2
	1152	**2.0**	0.6		1045	**1.6**	0.5
TH	1744	**3.3**	1.0	FR	1651	**3.6**	1.1
JE	2321	**2.0**	0.6	VE	2250	**1.6**	0.5
12	0550	**3.9**	1.2	27	0526	**4.3**	1.3
	1227	**1.6**	0.5		1139	**1.3**	0.4
FR	1820	**3.6**	1.1	SA	1744	**3.9**	1.2
VE				SA	2358	**1.3**	0.4
13	0013	**1.6**	0.5	28	0616	**4.6**	1.4
	0626	**4.3**	1.3		1228	**1.0**	0.3
SA	1254	**1.6**	0.5	SU	1832	**4.3**	1.3
SA	1853	**3.6**	1.1	DI			
14	0052	**1.3**	0.4	29	0052	**1.0**	0.3
	0656	**4.3**	1.3		0702	**4.6**	1.4
SU	1316	**1.3**	0.4	MO	1312	**0.7**	0.2
DI	1923	**3.9**	1.2	LU	1918	**4.6**	1.4
15	0125	**1.3**	0.4	30	0140	**0.7**	0.2
	0723	**4.3**	1.3		0745	**4.6**	1.4
MO	1338	**1.3**	0.4	TU	1354	**0.7**	0.2
LU	1951	**3.9**	1.2	MA	2001	**4.6**	1.4
				31	0225	**0.7**	0.2
					0827	**4.6**	1.4
				WE	1432	**0.7**	0.2
				ME	2042	**4.9**	1.5

TABLE DES MARÉES **2010** **ST JOHN'S** HNTN Z+3.5

April-avril

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0308	0.7	0.2	16	0245	0.7	0.2
	0907	4.3	1.3		0826	3.9	1.2
TH	1509	1.0	0.3	FR	1415	1.0	0.3
JE	2120	4.9	1.5	VE	2048	4.6	1.4
2	0351	1.0	0.3	17	0325	1.0	0.3
	0946	3.9	1.2		0903	3.9	1.2
FR	1543	1.3	0.4	SA	1446	1.3	0.4
VE	2154	4.9	1.5	SA	2125	4.6	1.4
3	0433	1.3	0.4	18	0408	1.0	0.3
	1022	3.6	1.1		0943	3.6	1.1
SA	1617	1.6	0.5	SU	1519	1.3	0.4
SA	2227	4.6	1.4	DI	2203	4.6	1.4
4	0516	1.6	0.5	19	0456	1.3	0.4
	1058	3.6	1.1		1026	3.6	1.1
SU	1652	2.0	0.6	MO	1601	1.6	0.5
DI	2259	4.3	1.3	LU	2243	4.3	1.3
5	0604	2.0	0.6	20	0552	1.6	0.5
	1135	3.3	1.0		1116	3.3	1.0
MO	1736	2.0	0.6	TU	1707	2.0	0.6
LU	2338	3.9	1.2	MA	2331	4.3	1.3
6	0708	2.3	0.7	21	0657	1.6	0.5
	1227	3.0	0.9		1218	3.3	1.0
TU	1836	2.3	0.7	WE	1828	2.0	0.6
MA				ME			
7	0030	3.6	1.1	22	0036	3.9	1.2
	0834	2.3	0.7		0805	2.0	0.6
WE	1438	3.0	0.9	TH	1341	3.3	1.0
ME	1950	2.3	0.7	JE	1951	2.0	0.6
8	0203	3.6	1.1	23	0218	3.6	1.1
	1001	2.3	0.7		0911	1.6	0.5
TH	1620	3.0	0.9	FR	1515	3.3	1.0
JE	2120	2.3	0.7	VE	2117	2.0	0.6
9	0414	3.6	1.1	24	0358	3.6	1.1
	1057	2.0	0.6		1011	1.3	0.4
FR	1706	3.3	1.0	SA	1623	3.6	1.1
VE	2247	2.0	0.6	SA	2238	1.6	0.5
10	0510	3.6	1.1	25	0502	3.9	1.2
	1133	1.6	0.5		1105	1.3	0.4
SA	1742	3.6	1.1	SU	1715	3.9	1.2
SA	2343	1.6	0.5	DI	2343	1.3	0.4
11	0548	3.9	1.2	26	0553	3.9	1.2
	1200	1.6	0.5		1154	1.0	0.3
SU	1813	3.6	1.1	MO	1803	4.3	1.3
DI				LU			
12	0025	1.3	0.4	27	0037	1.0	0.3
	0620	3.9	1.2		0639	4.3	1.3
MO	1225	1.3	0.4	TU	1239	1.0	0.3
LU	1842	3.9	1.2	MA	1848	4.6	1.4
13	0100	1.0	0.3	28	0124	0.7	0.2
	0650	3.9	1.2		0723	4.3	1.3
TU	1250	1.3	0.4	WE	1321	1.0	0.3
MA	1911	4.3	1.3	ME	1932	4.6	1.4
14	0134	1.0	0.3	29	0208	0.7	0.2
	0720	3.9	1.2		0805	3.9	1.2
WE	1317	1.0	0.3	TH	1359	1.0	0.3
ME	1941	4.3	1.3	JE	2013	4.9	1.5
15	0209	0.7	0.2	30	0251	0.7	0.2
	0752	3.9	1.2		0847	3.9	1.2
TH	1346	1.0	0.3	FR	1436	1.3	0.4
JE	2014	4.6	1.4	VE	2052	4.9	1.5

May-mai

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0332	1.0	0.3	16	0313	1.0	0.3
	0926	3.6	1.1		0852	3.6	1.1
SA	1512	1.3	0.4	SU	1434	1.3	0.4
SA	2127	4.9	1.5	DI	2112	4.9	1.5
2	0412	1.3	0.4	17	0359	1.0	0.3
	1004	3.6	1.1		0939	3.6	1.1
SU	1547	1.6	0.5	MO	1521	1.3	0.4
DI	2200	4.6	1.4	LU	2154	4.9	1.5
3	0452	1.6	0.5	18	0448	1.3	0.4
	1041	3.6	1.1		1028	3.6	1.1
MO	1625	2.0	0.6	TU	1618	1.6	0.5
LU	2234	4.3	1.3	MA	2239	4.6	1.4
4	0537	2.0	0.6	19	0542	1.3	0.4
	1119	3.3	1.0		1120	3.6	1.1
TU	1710	2.0	0.6	WE	1724	1.6	0.5
MA	2310	4.3	1.3	ME	2329	4.3	1.3
5	0630	2.0	0.6	20	0640	1.6	0.5
	1206	3.3	1.0		1218	3.6	1.1
WE	1804	2.3	0.7	TH	1832	2.0	0.6
ME	2355	3.9	1.2	JE			
6	0733	2.3	0.7	21	0031	3.9	1.2
	1322	3.0	0.9		0740	1.6	0.5
TH	1909	2.3	0.7	FR	1327	3.6	1.1
JE				VE	1943	2.0	0.6
7	0059	3.6	1.1	22	0156	3.6	1.1
	0838	2.3	0.7		0838	1.6	0.5
FR	1507	3.3	1.0	SA	1441	3.6	1.1
VE	2025	2.3	0.7	SA	2059	2.0	0.6
8	0238	3.6	1.1	23	0324	3.6	1.1
	0931	2.0	0.6		0933	1.3	0.4
SA	1608	3.3	1.0	SU	1546	3.9	1.2
SA	2150	2.0	0.6	DI	2218	1.6	0.5
9	0406	3.6	1.1	24	0432	3.6	1.1
	1014	2.0	0.6		1026	1.3	0.4
SU	1648	3.6	1.1	MO	1642	3.9	1.2
DI	2259	1.6	0.5	LU	2326	1.3	0.4
10	0458	3.6	1.1	25	0528	3.6	1.1
	1051	1.6	0.5		1117	1.3	0.4
MO	1723	3.6	1.1	TU	1733	4.3	1.3
LU	2350	1.3	0.4	MA			
11	0538	3.6	1.1	26	0021	1.0	0.3
	1127	1.6	0.5		0618	3.6	1.1
TU	1756	3.9	1.2	WE	1206	1.3	0.4
MA				ME	1821	4.6	1.4
12	0031	1.0	0.3	27	0110	1.0	0.3
	0615	3.6	1.1		0704	3.6	1.1
WE	1202	1.3	0.4	TH	1251	1.3	0.4
ME	1831	4.3	1.3	JE	1908	4.6	1.4
13	0110	1.0	0.3	28	0154	1.0	0.3
	0651	3.6	1.1		0749	3.6	1.1
TH	1237	1.3	0.4	FR	1334	1.3	0.4
JE	1909	4.6	1.4	VE	1951	4.9	1.5
14	0149	0.7	0.2	29	0236	1.0	0.3
	0728	3.6	1.1		0831	3.6	1.1
FR	1314	1.3	0.4	SA	1414	1.3	0.4
VE	1949	4.6	1.4	SA	2031	4.9	1.5
15	0230	0.7	0.2	30	0315	1.0	0.3
	0808	3.6	1.1		0912	3.6	1.1
SA	1352	1.3	0.4	SU	1452	1.6	0.5
SA	2030	4.9	1.5	DI	2108	4.9	1.5
				31	0353	1.3	0.4
					0949	3.6	1.1
				MO	1529	1.6	0.5
				LU	2140	4.6	1.4

June-juin

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0429	1.6	0.5	16	0435	1.0	0.3
	1025	3.6	1.1		1026	3.9	1.2
TU	1606	2.0	0.6	WE	1625	1.3	0.4
MA	2211	4.6	1.4	ME	2235	4.6	1.4
2	0506	2.0	0.6	17	0525	1.3	0.4
	1101	3.6	1.1		1115	3.9	1.2
WE	1646	2.0	0.6	TH	1723	1.6	0.5
ME	2244	4.3	1.3	JE	2323	4.3	1.3
3	0547	2.0	0.6	18	0617	1.3	0.4
	1140	3.3	1.0		1205	3.9	1.2
TH	1732	2.0	0.6	FR	1822	1.6	0.5
JE	2322	3.9	1.2	VE			
4	0633	2.0	0.6	19	0017	3.9	1.2
	1228	3.3	1.0		0709	1.3	0.4
FR	1826	2.3	0.7	SA	1259	3.9	1.2
VE				SA	1924	1.6	0.5
5	0010	3.6	1.1	20	0122	3.6	1.1
	0723	2.0	0.6		0801	1.6	0.5
SA	1328	3.3	1.0	SU	1400	3.9	1.2
SA	1930	2.3	0.7	DI	2035	2.0	0.6
6	0115	3.6	1.1	21	0240	3.3	1.0
	0811	2.0	0.6		0853	1.6	0.5
SU	1437	3.3	1.0	MO	1505	3.9	1.2
DI	2046	2.0	0.6	LU	2155	1.6	0.5
7	0237	3.3	1.0	22	0359	3.3	1.0
	0858	2.0	0.6		0946	1.6	0.5
MO	1536	3.6	1.1	TU	1607	3.9	1.2
LU	2205	2.0	0.6	MA	2310	1.6	0.5
8	0354	3.3	1.0	23	0507	3.3	1.0
	0944	2.0	0.6		1042	1.6	0.5
TU	1626	3.6	1.1	WE	1707	4.3	1.3
MA	2311	1.6	0.5	ME			
9	0452	3.3	1.0	24	0010	1.3	0.4
	1030	1.6	0.5		0603	3.3	1.0
WE	1713	3.9	1.2	TH	1139	1.6	0.5
ME				JE	1803	4.3	1.3
10	0003	1.3	0.4	25	0100	1.3	0.4
	0540	3.3	1.0		0653	3.3	1.0
TH	1117	1.6	0.5	FR	1232	1.6	0.5
JE	1759	4.3	1.3	VE	1854	4.6	1.4
11	0048	1.0	0.3	26	0144	1.0	0.3
	0624	3.3	1.0		0737	3.6	1.1
FR	1204	1.3	0.4	SA	1319	1.3	0.4
VE	1846	4.6	1.4	SA	1939	4.6	1.4
12	0132	1.0	0.3	27	0223	1.3	0.4
	0709	3.6	1.1		0819	3.6	1.1
SA	1253	1.3	0.4	SU	1401	1.3	0.4
SA	1932	4.9	1.5	DI	2019	4.6	1.4
13	0216	1.0	0.3	28	0259	1.3	0.4
	0756	3.6	1.1		0858	3.6	1.1
SU	1342	1.3	0.4	MO	1439	1.3	0.4
DI	2018	4.9	1.5	LU	2052	4.6	1.4
14	0301	1.0	0.3	29	0332	1.3	0.4
	0846	3.9	1.2		0934	3.6	1.1
MO	1433	1.3	0.4	TU	1515	1.6	0.5
LU	2103	4.9	1.5	MA	2121	4.6	1.4
15	0347	1.0	0.3	30	0402	1.6	0.5
	0936	3.9	1.2		1007	3.6	1.1
TU	1527	1.3	0.4	WE	1548	1.6	0.5
MA	2149	4.9	1.5	ME	2149	4.6	1.4

July-juillet

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0431	1.6	0.5	16	0501	1.0	0.3
	1037	3.6	1.1		1058	4.3	1.3
TH	1622	1.6	0.5	FR	1712	1.3	0.4
JE	2218	4.3	1.3	VE	2309	4.6	1.4
2	0501	1.6	0.5	17	0548	1.3	0.4
	1108	3.6	1.1		1142	4.3	1.3
FR	1700	2.0	0.6	SA	1804	1.6	0.5
VE	2252	4.3	1.3	SA	2355	3.9	1.2
3	0536	1.6	0.5	18	0635	1.3	0.4
	1141	3.6	1.1		1227	4.3	1.3
SA	1745	2.0	0.6	SU	1901	1.6	0.5
SA	2332	3.9	1.2	DI			
4	0616	2.0	0.6	19	0046	3.6	1.1
	1221	3.6	1.1		0722	1.6	0.5
SU	1841	2.0	0.6	MO	1317	3.9	1.2
DI				LU	2009	2.0	0.6
5	0021	3.6	1.1	20	0153	3.3	1.0
	0701	2.0	0.6		0812	1.6	0.5
MO	1312	3.6	1.1	TU	1418	3.9	1.2
LU	1952	2.0	0.6	MA	2133	2.0	0.6
6	0125	3.3	1.0	21	0329	3.0	0.9
	0750	2.0	0.6		0908	2.0	0.6
TU	1417	3.6	1.1	WE	1534	3.9	1.2
MA	2115	2.0	0.6	ME	2259	2.0	0.6
7	0243	3.0	0.9	22	0457	3.0	0.9
	0842	2.0	0.6		1014	2.0	0.6
WE	1529	3.6	1.1	TH	1652	3.9	1.2
ME	2234	2.0	0.6	JE			
8	0403	3.0	0.9	23	0004	1.6	0.5
	0939	2.0	0.6		0557	3.0	0.9
TH	1636	3.9	1.2	FR	1124	2.0	0.6
JE	2337	1.6	0.5	VE	1757	4.3	1.3
9	0509	3.0	0.9	24	0053	1.3	0.4
	1041	1.6	0.5		0644	3.3	1.0
FR	1736	4.3	1.3	SA	1224	1.6	0.5
VE				SA	1848	4.3	1.3
10	0028	1.3	0.4	25	0133	1.3	0.4
	0604	3.3	1.0		0726	3.6	1.1
SA	1144	1.6	0.5	SU	1311	1.6	0.5
SA	1831	4.6	1.4	DI	1930	4.6	1.4
11	0115	1.0	0.3	26	0208	1.3	0.4
	0656	3.6	1.1		0805	3.6	1.1
SU	1243	1.3	0.4	MO	1351	1.3	0.4
DI	1921	4.9	1.5	LU	2005	4.6	1.4
12	0200	1.0	0.3	27	0238	1.3	0.4
	0748	3.9	1.2		0840	3.9	1.2
MO	1339	1.3	0.4	TU	1427	1.3	0.4
LU	2009	5.2	1.6	MA	2034	4.6	1.4
13	0245	0.7	0.2	28	0304	1.3	0.4
	0839	3.9	1.2		0912	3.9	1.2
TU	1433	1.0	0.3	WE	1459	1.3	0.4
MA	2055	5.2	1.6	ME	2059	4.6	1.4
14	0330	0.7	0.2	29	0328	1.3	0.4
	0927	4.3	1.3		0941	3.9	1.2
WE	1526	1.0	0.3	TH	1529	1.3	0.4
ME	2140	4.9	1.5	JE	2124	4.6	1.4
15	0415	1.0	0.3	30	0351	1.3	0.4
	1014	4.3	1.3		1006	3.9	1.2
TH	1619	1.3	0.4	FR	1559	1.6	0.5
JE	2225	4.9	1.5	VE	2152	4.3	1.3
				31	0415	1.6	0.5
					1032	3.9	1.2
				SA	1633	1.6	0.5
				SA	2223	4.3	1.3

August-août

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0441	1.6	0.5	16	0556	1.6	0.5
	1059	3.9	1.2		1152	4.3	1.3
SU	1712	1.6	0.5	MO	1837	1.6	0.5
DI	2259	3.9	1.2	LU			
2	0511	1.6	0.5	17	0014	3.3	1.0
	1132	3.9	1.2		0641	1.6	0.5
MO	1802	2.0	0.6	TU	1234	3.9	1.2
LU	2340	3.6	1.1	MA	1944	2.0	0.6
3	0549	2.0	0.6	18	0111	3.0	0.9
	1213	3.6	1.1		0731	2.0	0.6
TU	1911	2.0	0.6	WE	1331	3.9	1.2
MA				ME	2112	2.0	0.6
4	0031	3.3	1.0	19	0305	3.0	0.9
	0641	2.0	0.6		0834	2.3	0.7
WE	1313	3.6	1.1	TH	1503	3.6	1.1
ME	2036	2.0	0.6	JE	2249	2.0	0.6
5	0143	3.0	0.9	20	0453	3.0	0.9
	0746	2.0	0.6		0955	2.3	0.7
TH	1437	3.6	1.1	FR	1648	3.9	1.2
JE	2202	2.0	0.6	VE	2355	2.0	0.6
6	0320	3.0	0.9	21	0548	3.3	1.0
	0900	2.0	0.6		1118	2.0	0.6
FR	1609	3.9	1.2	SA	1753	3.9	1.2
VE	2311	1.6	0.5	SA			
7	0448	3.0	0.9	22	0038	1.6	0.5
	1020	2.0	0.6		0629	3.3	1.0
SA	1722	4.3	1.3	SU	1216	1.6	0.5
SA				DI	1837	4.3	1.3
8	0006	1.3	0.4	23	0113	1.3	0.4
	0551	3.3	1.0		0706	3.6	1.1
SU	1136	1.6	0.5	MO	1300	1.3	0.4
DI	1820	4.6	1.4	LU	1913	4.6	1.4
9	0054	1.0	0.3	24	0142	1.3	0.4
	0644	3.6	1.1		0741	3.9	1.2
MO	1240	1.3	0.4	TU	1337	1.3	0.4
LU	1910	4.9	1.5	MA	1943	4.6	1.4
10	0139	0.7	0.2	25	0206	1.3	0.4
	0735	3.9	1.2		0813	3.9	1.2
TU	1336	1.0	0.3	WE	1410	1.3	0.4
MA	1957	5.2	1.6	ME	2008	4.6	1.4
11	0223	0.7	0.2	26	0228	1.3	0.4
	0823	4.3	1.3		0842	3.9	1.2
WE	1428	1.0	0.3	TH	1440	1.0	0.3
ME	2042	5.2	1.6	JE	2033	4.6	1.4
12	0306	0.7	0.2	27	0249	1.3	0.4
	0910	4.6	1.4		0907	4.3	1.3
TH	1518	0.7	0.2	FR	1509	1.3	0.4
JE	2126	4.9	1.5	VE	2058	4.3	1.3
13	0349	0.7	0.2	28	0310	1.3	0.4
	0953	4.6	1.4		0932	4.3	1.3
FR	1606	1.0	0.3	SA	1539	1.3	0.4
VE	2208	4.6	1.4	SA	2127	4.3	1.3
14	0432	1.0	0.3	29	0332	1.3	0.4
	1034	4.6	1.4		0957	4.3	1.3
SA	1654	1.0	0.3	SU	1612	1.3	0.4
SA	2250	4.3	1.3	DI	2158	3.9	1.2
15	0514	1.3	0.4	30	0354	1.6	0.5
	1113	4.6	1.4		1025	4.3	1.3
SU	1744	1.3	0.4	MO	1650	1.6	0.5
DI	2330	3.9	1.2	LU	2233	3.9	1.2
				31	0418	1.6	0.5
					1056	3.9	1.2
				TU	1740	1.6	0.5
				MA	2310	3.6	1.1

September-septembre

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0447	2.0	0.6	16	0042	3.0	0.9
	1135	3.9	1.2		0656	2.3	0.7
WE	1848	2.0	0.6	TH	1249	3.9	1.2
ME	2357	3.3	1.0	JE	2046	2.3	0.7
2	0538	2.0	0.6	17	0242	3.0	0.9
	1229	3.9	1.2		0806	2.3	0.7
TH	2010	2.0	0.6	FR	1428	3.6	1.1
JE				VE	2222	2.3	0.7
3	0107	3.0	0.9	18	0433	3.0	0.9
	0709	2.0	0.6		0936	2.3	0.7
FR	1357	3.6	1.1	SA	1633	3.6	1.1
VE	2133	2.0	0.6	SA	2325	2.0	0.6
4	0255	3.0	0.9	19	0523	3.3	1.0
	0842	2.0	0.6		1102	2.0	0.6
SA	1549	3.9	1.2	SU	1732	3.9	1.2
SA	2241	1.6	0.5	DI			
5	0433	3.3	1.0	20	0006	1.6	0.5
	1013	2.0	0.6		0601	3.6	1.1
SU	1709	4.3	1.3	MO	1159	1.6	0.5
DI	2337	1.3	0.4	LU	1812	3.9	1.2
6	0535	3.6	1.1	21	0037	1.6	0.5
	1132	1.6	0.5		0636	3.6	1.1
MO	1806	4.6	1.4	TU	1241	1.3	0.4
LU				MA	1844	4.3	1.3
7	0026	1.0	0.3	22	0102	1.3	0.4
	0626	3.9	1.2		0708	3.9	1.2
TU	1234	1.3	0.4	WE	1316	1.3	0.4
MA	1854	4.9	1.5	ME	1912	4.3	1.3
8	0112	0.7	0.2	23	0124	1.3	0.4
	0714	4.3	1.3		0738	3.9	1.2
WE	1327	1.0	0.3	TH	1348	1.0	0.3
ME	1940	4.9	1.5	JE	1938	4.3	1.3
9	0156	0.7	0.2	24	0145	1.0	0.3
	0801	4.6	1.4		0805	4.3	1.3
TH	1416	0.7	0.2	FR	1418	1.0	0.3
JE	2024	4.9	1.5	VE	2005	4.3	1.3
10	0238	0.7	0.2	25	0207	1.0	0.3
	0845	4.9	1.5		0831	4.3	1.3
FR	1503	0.7	0.2	SA	1449	1.0	0.3
VE	2106	4.9	1.5	SA	2033	4.3	1.3
11	0319	0.7	0.2	26	0231	1.3	0.4
	0927	4.9	1.5		0858	4.3	1.3
SA	1550	0.7	0.2	SU	1522	1.0	0.3
SA	2148	4.6	1.4	DI	2105	3.9	1.2
12	0359	1.0	0.3	27	0255	1.3	0.4
	1006	4.9	1.5		0928	4.3	1.3
SU	1636	1.0	0.3	MO	1558	1.3	0.4
DI	2229	3.9	1.2	LU	2138	3.9	1.2
13	0438	1.3	0.4	28	0319	1.3	0.4
	1042	4.6	1.4		0959	4.3	1.3
MO	1723	1.3	0.4	TU	1640	1.3	0.4
LU	2308	3.6	1.1	MA	2214	3.6	1.1
14	0518	1.6	0.5	29	0346	1.6	0.5
	1118	4.3	1.3		1033	4.3	1.3
TU	1814	1.6	0.5	WE	1731	1.6	0.5
MA	2349	3.3	1.0	ME	2255	3.6	1.1
15	0602	2.0	0.6	30	0421	2.0	0.6
	1157	4.3	1.3		1113	4.3	1.3
WE	1919	2.0	0.6	TH	1835	2.0	0.6
ME				JE	2346	3.3	1.0

TABLE DES MARÉES

2010

ST JOHN'S HNTN Z+3.5

October-octobre

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0528	2.0	0.6	16	0156	3.0	0.9
	1207	3.9	1.2		0735	2.3	0.7
FR	1949	2.0	0.6	SA	1334	3.6	1.1
VE				SA	2125	2.3	0.7
2	0058	3.0	0.9	17	0346	3.3	1.0
	0706	2.3	0.7		0859	2.3	0.7
SA	1332	3.6	1.1	SU	1543	3.6	1.1
SA	2102	2.0	0.6	DI	2226	2.0	0.6
3	0242	3.3	1.0	18	0441	3.3	1.0
	0837	2.0	0.6		1026	2.0	0.6
SU	1529	3.6	1.1	MO	1650	3.6	1.1
DI	2207	1.6	0.5	LU	2309	2.0	0.6
4	0411	3.3	1.0	19	0521	3.6	1.1
	1007	2.0	0.6		1129	1.6	0.5
MO	1650	3.9	1.2	TU	1732	3.6	1.1
LU	2303	1.3	0.4	MA	2342	1.6	0.5
5	0510	3.9	1.2	20	0556	3.6	1.1
	1123	1.3	0.4		1213	1.3	0.4
TU	1745	4.3	1.3	WE	1807	3.9	1.2
MA	2354	1.0	0.3	ME			
6	0559	4.3	1.3	21	0009	1.3	0.4
	1222	1.0	0.3		0627	3.9	1.2
WE	1833	4.6	1.4	TH	1250	1.3	0.4
ME				JE	1837	3.9	1.2
7	0041	0.7	0.2	22	0034	1.3	0.4
	0647	4.6	1.4		0657	4.3	1.3
TH	1314	0.7	0.2	FR	1323	1.0	0.3
JE	1918	4.6	1.4	VE	1907	3.9	1.2
8	0125	0.7	0.2	23	0100	1.3	0.4
	0734	4.6	1.4		0727	4.3	1.3
FR	1401	0.7	0.2	SA	1356	1.0	0.3
VE	2003	4.6	1.4	SA	1938	3.9	1.2
9	0207	0.7	0.2	24	0128	1.3	0.4
	0818	4.9	1.5		0758	4.6	1.4
SA	1447	0.7	0.2	SU	1431	1.0	0.3
SA	2046	4.3	1.3	DI	2010	3.9	1.2
10	0247	1.0	0.3	25	0158	1.3	0.4
	0859	4.9	1.5		0831	4.6	1.4
SU	1532	0.7	0.2	MO	1508	1.0	0.3
DI	2129	3.9	1.2	LU	2046	3.9	1.2
11	0326	1.0	0.3	26	0228	1.3	0.4
	0938	4.9	1.5		0906	4.6	1.4
MO	1617	1.0	0.3	TU	1548	1.0	0.3
LU	2210	3.9	1.2	MA	2124	3.6	1.1
12	0404	1.3	0.4	27	0301	1.3	0.4
	1014	4.9	1.5		0943	4.6	1.4
TU	1702	1.3	0.4	WE	1633	1.3	0.4
MA	2251	3.6	1.1	ME	2206	3.6	1.1
13	0445	1.6	0.5	28	0340	1.6	0.5
	1049	4.6	1.4		1021	4.6	1.4
WE	1752	1.6	0.5	TH	1724	1.6	0.5
ME	2332	3.3	1.0	JE	2253	3.6	1.1
14	0531	2.0	0.6	29	0434	2.0	0.6
	1127	4.3	1.3		1104	4.3	1.3
TH	1851	2.0	0.6	FR	1823	1.6	0.5
JE				VE	2347	3.3	1.0
15	0023	3.3	1.0	30	0550	2.0	0.6
	0627	2.3	0.7		1158	3.9	1.2
FR	1215	3.9	1.2	SA	1927	2.0	0.6
VE	2005	2.3	0.7	SA			
				31	0055	3.3	1.0
					0709	2.0	0.6
				SU	1317	3.6	1.1
				DI	2031	1.6	0.5

November-novembre

Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0221	3.3	1.0	16	0338	3.3	1.0
	0830	2.0	0.6		0928	2.3	0.7
MO	1502	3.6	1.1	TU	1537	3.3	1.0
LU	2131	1.6	0.5	MA	2149	2.0	0.6
2	0339	3.6	1.1	17	0427	3.6	1.1
	0953	1.6	0.5		1043	2.0	0.6
TU	1621	3.6	1.1	WE	1639	3.3	1.0
MA	2226	1.3	0.4	ME	2229	1.6	0.5
3	0439	3.9	1.2	18	0506	3.6	1.1
	1107	1.3	0.4		1137	1.6	0.5
WE	1719	3.9	1.2	TH	1723	3.3	1.0
ME	2318	1.0	0.3	JE	2306	1.6	0.5
4	0531	4.3	1.3	19	0542	3.9	1.2
	1207	1.0	0.3		1220	1.3	0.4
TH	1810	3.9	1.2	FR	1801	3.6	1.1
JE				VE	2343	1.6	0.5
5	0008	1.0	0.3	20	0617	4.3	1.3
	0620	4.6	1.4		1258	1.0	0.3
FR	1259	0.7	0.2	SA	1836	3.6	1.1
VE	1857	3.9	1.2	SA			
6	0054	1.0	0.3	21	0019	1.3	0.4
	0707	4.6	1.4		0654	4.3	1.3
SA	1347	0.7	0.2	SU	1335	1.0	0.3
SA	1944	3.9	1.2	DI	1913	3.6	1.1
7	0138	1.0	0.3	22	0056	1.3	0.4
	0752	4.9	1.5		0733	4.6	1.4
SU	1432	0.7	0.2	MO	1414	1.0	0.3
DI	2029	3.9	1.2	LU	1951	3.6	1.1
8	0219	1.0	0.3	23	0135	1.3	0.4
	0835	4.9	1.5		0812	4.9	1.5
MO	1516	1.0	0.3	TU	1454	1.0	0.3
LU	2113	3.9	1.2	MA	2033	3.6	1.1
9	0259	1.3	0.4	24	0215	1.3	0.4
	0914	4.9	1.5		0852	4.9	1.5
TU	1559	1.0	0.3	WE	1537	1.0	0.3
MA	2155	3.6	1.1	ME	2117	3.6	1.1
10	0340	1.6	0.5	25	0259	1.3	0.4
	0951	4.9	1.5		0933	4.9	1.5
WE	1642	1.3	0.4	TH	1623	1.3	0.4
ME	2236	3.6	1.1	JE	2204	3.6	1.1
11	0421	1.6	0.5	26	0351	1.6	0.5
	1026	4.6	1.4		1015	4.6	1.4
TH	1727	1.6	0.5	FR	1712	1.3	0.4
JE	2316	3.3	1.0	VE	2253	3.6	1.1
12	0507	2.0	0.6	27	0451	1.6	0.5
	1102	4.3	1.3		1059	4.3	1.3
FR	1817	2.0	0.6	SA	1805	1.6	0.5
VE				SA	2345	3.6	1.1
13	0001	3.3	1.0	28	0555	1.6	0.5
	0558	2.3	0.7		1153	3.9	1.2
SA	1144	3.9	1.2	SU	1902	1.6	0.5
SA	1913	2.0	0.6	DI			
14	0102	3.3	1.0	29	0044	3.6	1.1
	0656	2.3	0.7		0702	2.0	0.6
SU	1239	3.6	1.1	MO	1300	3.6	1.1
DI	2011	2.3	0.7	LU	1959	1.6	0.5
15	0228	3.3	1.0	30	0152	3.6	1.1
	0806	2.3	0.7		0814	2.0	0.6
MO	1403	3.6	1.1	TU	1426	3.6	1.1
LU	2104	2.0	0.6	MA	2054	1.6	0.5

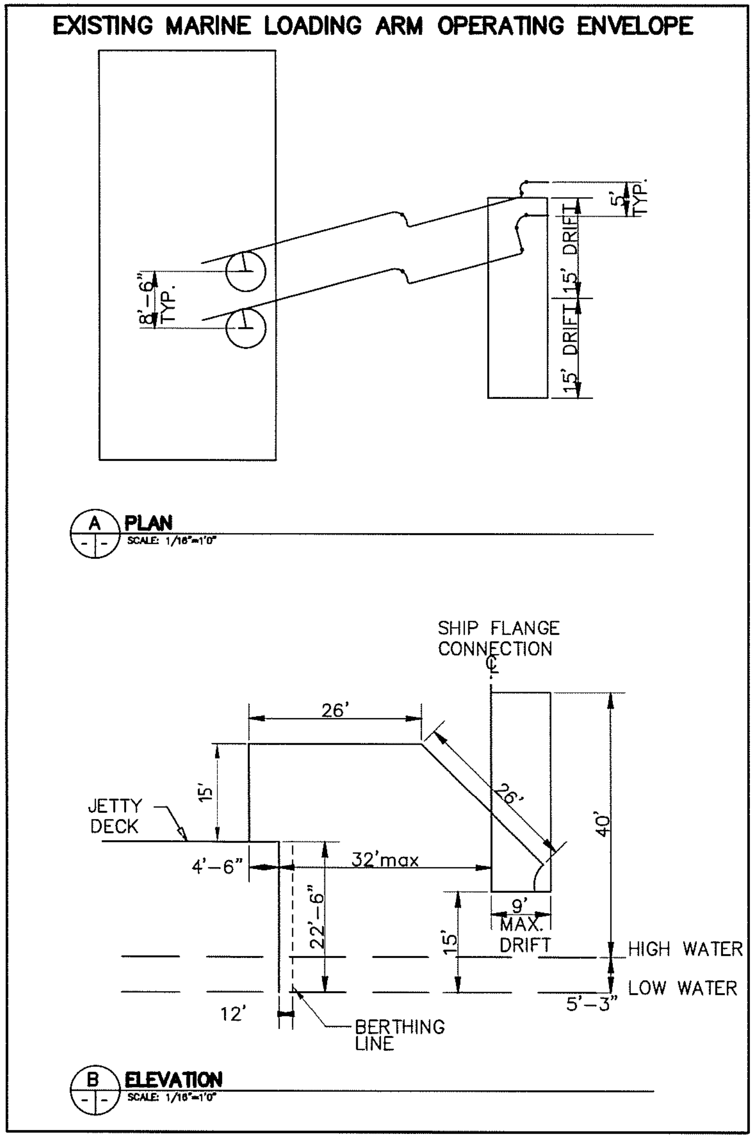
December-décembre

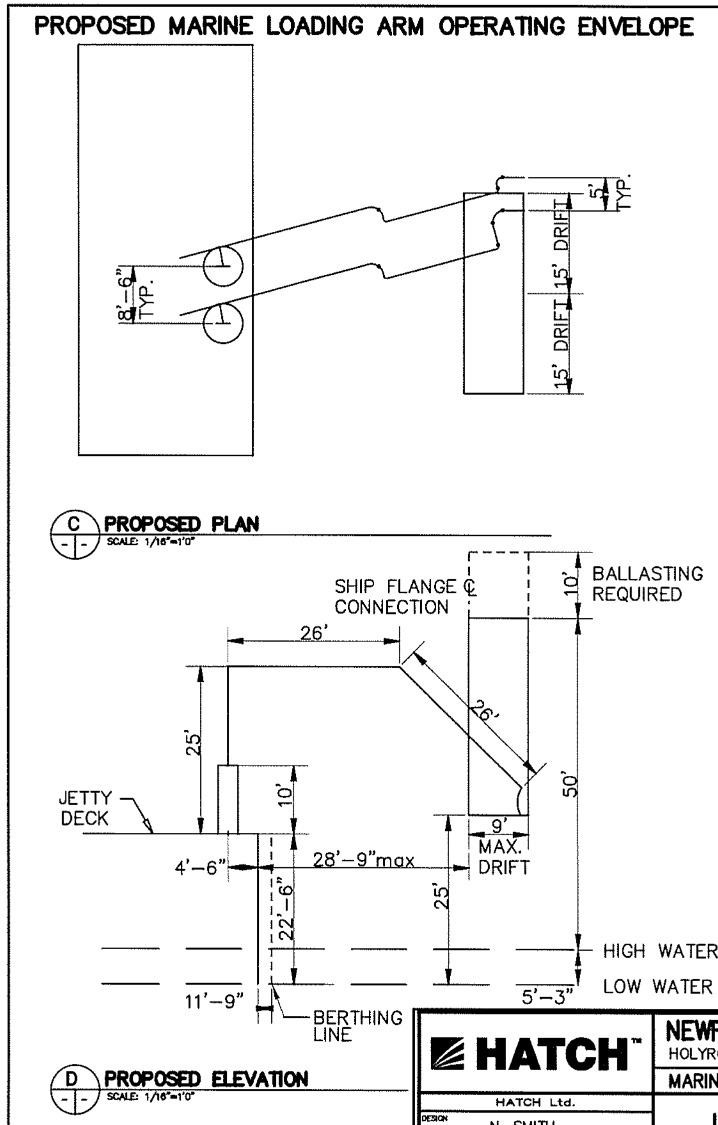
Day	Time	Feet	Metres	jour	heure	pieds	mètres
1	0302	3.9	1.2	16	0309	3.6	1.1
	0933	1.6	0.5		0943	2.0	0.6
WE	1547	3.6	1.1	TH	1524	3.3	1.0
ME	2149	1.3	0.4	JE	2118	2.0	0.6
2	0405	3.9	1.2	17	0406	3.6	1.1
	1048	1.6	0.5		1054	1.6	0.5
TH	1653	3.6	1.1	FR	1632	3.3	1.0
JE	2243	1.3	0.4	VE	2206	2.0	0.6
3	0502	4.3	1.3	18	0457	3.9	1.2
	1152	1.3	0.4		1149	1.6	0.5
FR	1750	3.6	1.1	SA	1724	3.3	1.0
VE	2337	1.3	0.4	SA	2256	1.6	0.5
4	0555	4.3	1.3	19	0544	4.3	1.3
	1246	1.0	0.3		1234	1.3	0.4
SA	1841	3.6	1.1	SU	1809	3.3	1.0
SA				DI	2345	1.6	0.5
5	0028	1.3	0.4	20	0630	4.6	1.4
	0646	4.6	1.4		1316	1.0	0.3
SU	1335	1.0	0.3	MO	1852	3.3	1.0
DI	1930	3.6	1.1	LU			
6	0116	1.3	0.4	21	0034	1.3	0.4
	0734	4.9	1.5		0715	4.6	1.4
MO	1420	1.0	0.3	TU	1358	1.0	0.3
LU	2017	3.6	1.1	MA	1937	3.6	1.1
7	0201	1.3	0.4	22	0122	1.3	0.4
	0818	4.9	1.5		0759	4.9	1.5
TU	1502	1.0	0.3	WE	1440	1.0	0.3
MA	2101	3.6	1.1	ME	2024	3.6	1.1
8	0243	1.3	0.4	23	0211	1.3	0.4
	0857	4.9	1.5		0842	4.9	1.5
WE	1542	1.3	0.4	TH	1523	1.0	0.3
ME	2142	3.6	1.1	JE	2112	3.9	1.2
9	0323	1.6	0.5	24	0302	1.3	0.4
	0933	4.9	1.5		0925	4.9	1.5
TH	1620	1.3	0.4	FR	1608	1.0	0.3
JE	2220	3.6	1.1	VE	2159	3.9	1.2
10	0403	1.6	0.5	25	0356	1.3	0.4
	1006	4.6	1.4		1009	4.9	1.5
FR	1658	1.6	0.5	SA	1654	1.0	0.3
VE	2256	3.6	1.1	SA	2246	3.9	1.2
11	0443	2.0	0.6	26	0452	1.3	0.4
	1037	4.3	1.3		1054	4.6	1.4
SA	1736	2.0	0.6	SU	1743	1.3	0.4
SA	2333	3.6	1.1	DI	2333	3.9	1.2
12	0525	2.0	0.6	27	0548	1.6	0.5
	1112	4.3	1.3		1142	4.3	1.3
SU	1816	2.0	0.6	MO	1834	1.3	0.4
DI				LU			
13	0013	3.6	1.1	28	0023	3.9	1.2
	0613	2.0	0.6		0648	1.6	0.5
MO	1153	3.9	1.2	TU	1238	3.6	1.1
LU	1859	2.0	0.6	MA	1925	1.3	0.4
14	0103	3.3	1.0	29	0119	3.9	1.2
	0711	2.3	0.7		0754	1.6	0.5
TU	1248	3.6	1.1	WE	1347	3.3	1.0
MA	1945	2.0	0.6	ME	2018	1.6	0.5
15	0204	3.3	1.0	30	0222	3.9	1.2
	0822	2.3	0.7		0911	2.0	0.6
WE	1401	3.3	1.0	TH	1511	3.3	1.0
ME	2031	2.0	0.6	JE	2112	1.6	0.5
				31	0330	3.9	1.2
					1033	1.6	0.5
				FR	1633	3.3	1.0
				VE	2211	1.6	0.5

Appendix E

Holyrood Marine Terminal Loading Arm Layout

H337965-M-A3-001





PLOT SCALE 1=1

DATE	NO.	REVISIONS	DRF.	DRF. CHK.	DES. CHK.	P.M. APP.
MAR.22,2011	A	ISSUED FOR INFORMATION	V.C.	N.S.	A.C.	D.F.

HATCH™

HATCH Ltd.

DESIGN — PREPARED: N. SMITH; CHECKED: A. CAREEN

DRAWING — PREPARED: V. CASE; CHECKED: N. SMITH

PROJECT MANAGER: D. FRENCH

SCALE: AS SHOWN

HATCH Ltd. PROJECT NO.: H337965

NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD, NL

MARINE TERMINAL 10 YEAR LIFE EXTENSION STUDY

HOLYROOD MARINE TERMINAL LOADING ARM LAYOUT

DRAWING NO.: H337965-M-A3-001 — SHEET 1 OF 1 — REVISION: A

DRAWING No. 337965-M-A3-001 REV. A

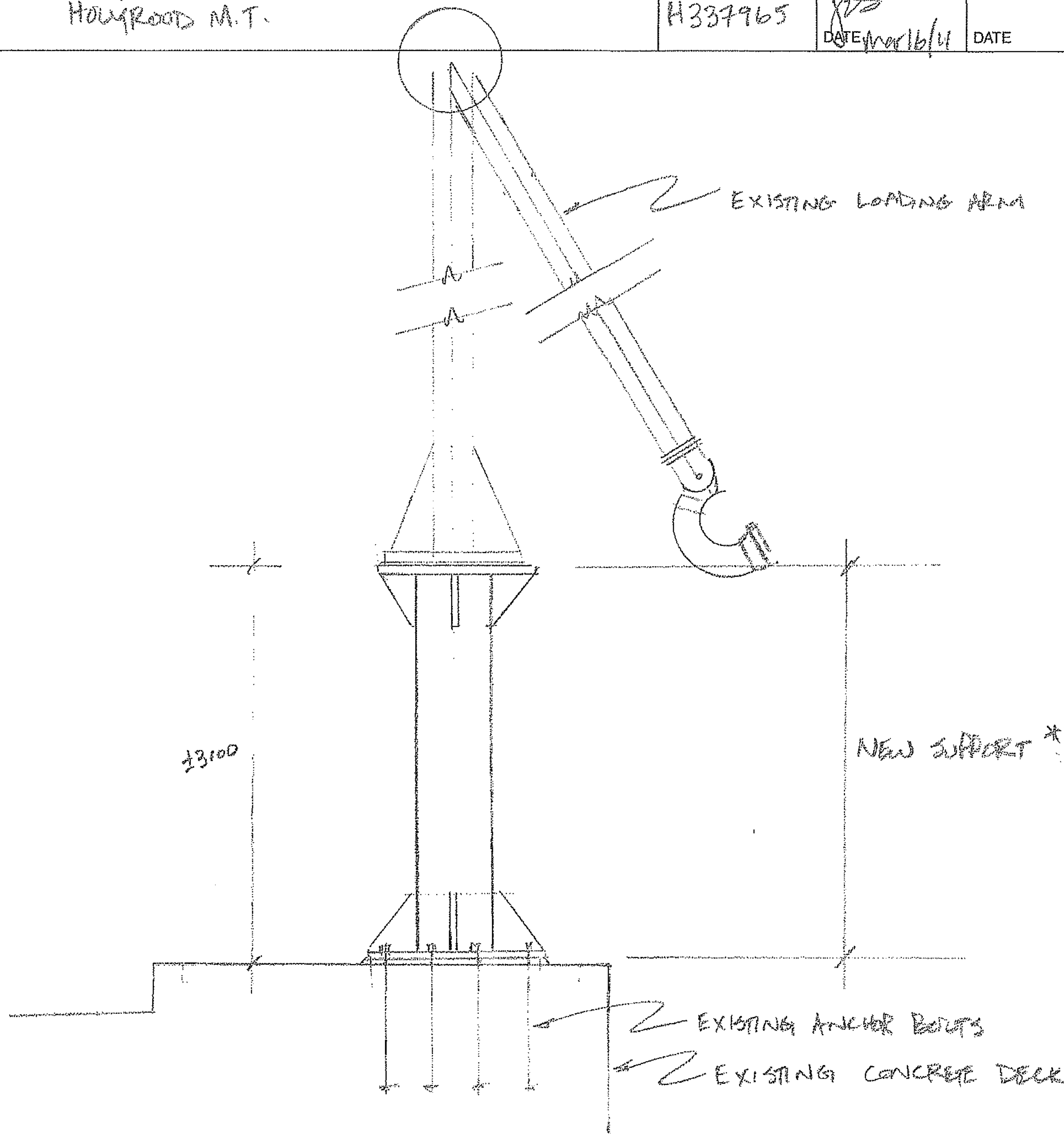
Appendix F

Proposed Loading Arm Extension Sketch

HATCH™

CALCULATION SHEET

SHEET NO.	1 OF 1
DESCRIPTION	10 YEAR LIFE EXTENSION STUDY HOLYROOD M.T.
PROJECT NO	H337965
MADE BY	DATE Mar 16/11
CHECKED BY	DATE



LOADING ARM SUPPORT
1:50
A

* 24" PIPE SHOWN. FINAL SIZE T.B.D.

Appendix G

Summary of Pile and Anode Inspection Report (Crotty Diving Services, October 2004)

In 2004, Crotty Diving Services performed a complete visual inspection of each pile and anode (including attachment brackets) on both the Jetty head and shore arm from seabed to splashzone and recorded the amount of deterioration on each.

The following tables summarize the results of the inspection for both the Jetty head anodes and the shore arm anodes and attempts to identify the current condition of each anode and estimate its remaining life.

Table 6-1: Jetty Head Anodes (213 in total)

Quantity of Anodes	Amount of Anode Remaining in 2004 (%)	Year of Anode Installation	Estimated Deterioration per year* (%)	Remaining Life* (from 2004)	Remaining Life* (from 2011)
8	80%	1994	2%	40 Years	33 Years
1	75%	1994	2.5%	30 Years	23 Years
110	70%	1994	3%	23 Years	16 Years
57	60%	1994	4%	15 Years	8 Years
32	50%	1994	5%	10 Years	3 Years
4	40%	1994	6%	6.7 Years	-0.3 Years
1	30%	1994	7%	4.3 Years	-2.7 Years

* Assuming that anode deterioration rate is linear.

Table 6-2: Shore Arm Anodes (19 in total)

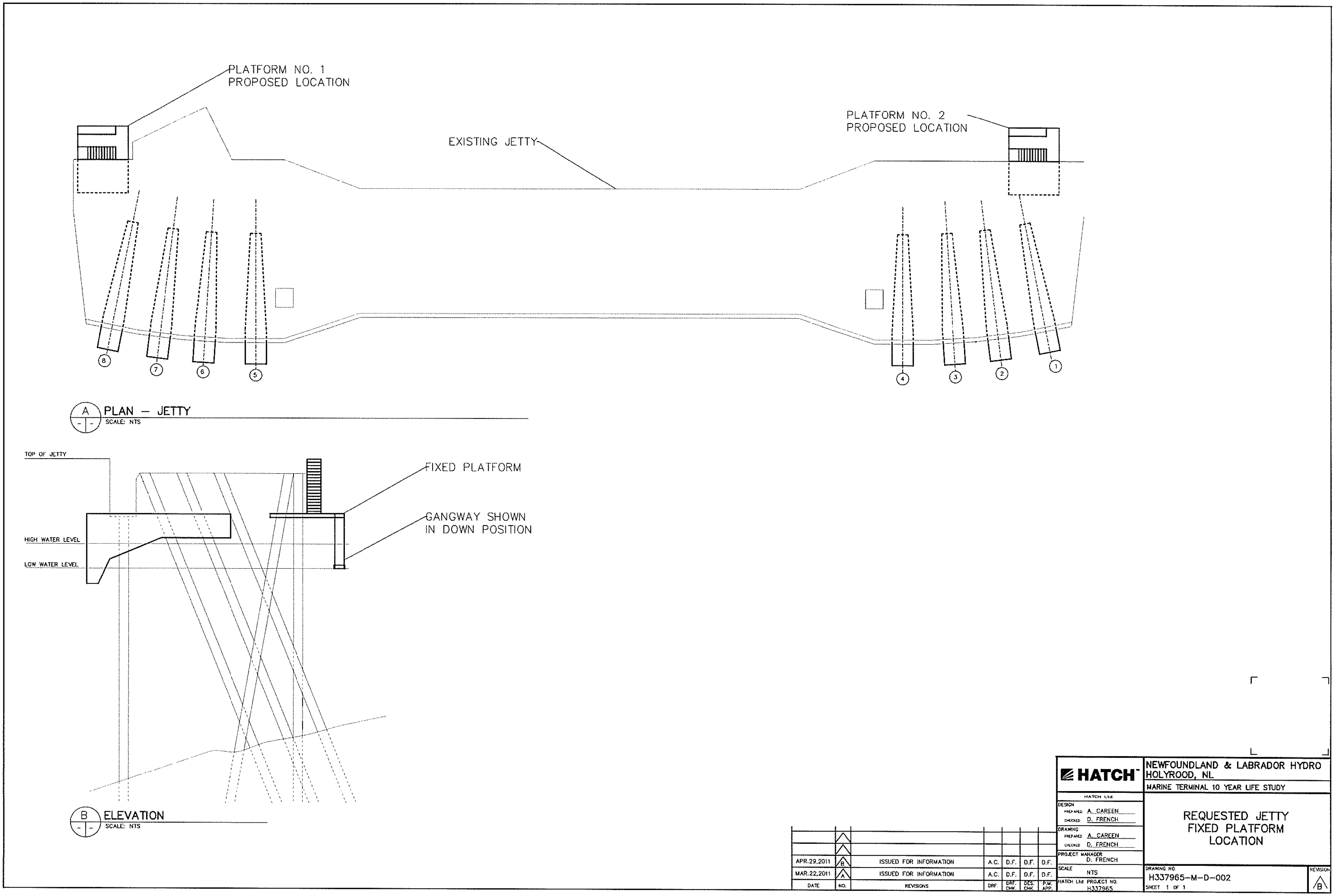
Quantity of Anodes	Amount of Anode Remaining in 2004 (%)	Year of Anode Installation	Estimated Deterioration per year* (%)	Remaining Life* (from 2004)	Remaining Life* (from 2011)
5	95%	2003	5%	19 Years	12 Years
3	90%	2003	10%	9 Years	2 Years
1	70%	1994	3%	23 years	16 Years
3	50%	1994	5%	10 Years	3 Years
2	40%	1994	6%	6.7 years	-0.3 Years
1	30%	1994	7%	4.3 years	-2.7 Years
1	10%	1994	9%	1.1 years	-5.9 Years
3	0%	1994	≥10%	0 Years	-10 Years

* Assuming that anode deterioration rate is linear.

Appendix H

Requested Jetty Platform Location Schematic

H337965-M-A1-002


PLATFORM NO. 1
PROPOSED LOCATION
EXISTING JETTY
PLATFORM NO. 2
PROPOSED LOCATION
8
7
6
5
4
3
2
1
A PLAN – JETTY
SCALE: NTS
TOP OF JETTY
HIGH WATER LEVEL
LOW WATER LEVEL
FIXED PLATFORM
GANGWAY SHOWN
IN DOWN POSITION
B ELEVATION
SCALE: NTS
HATCH
NEWFOUNDLAND & LABRADOR HYDRO
HOLYROOD, NL
MARINE TERMINAL 10 YEAR LIFE STUDY
HATCH Ltd.
DESIGN
PREPARED A. CAREEN
CHECKED D. FRENCH
DRAWING
PREPARED A. CAREEN
CHECKED D. FRENCH
PROJECT MANAGER
D. FRENCH
SCALE
NTS
HATCH Ltd PROJECT NO.
H337965
REQUESTED JETTY
FIXED PLATFORM
LOCATION
DRAWING NO.
H337965-M-D-002
SHEET 1 OF 1
REVISION
B
APR.29,2011 B ISSUED FOR INFORMATION A.C. D.F. D.F. D.F.
MAR.22,2011 A ISSUED FOR INFORMATION A.C. D.F. D.F. D.F.
DATE NO. REVISIONS DRF. DRF. CHK. DES. CHK. P.M. APP.

Appendix I

Holyrood Terminal Station Marine Terminal Field Inspection Program

Underside of Concrete Deck and Spiral Steel Piles Inspection Program

Holyrood Terminal Station
Marine Terminal
Field Inspection Program
Underside of Concrete Deck
and
Spiral Steel Piles.

Inspection Program

Diving and boat operation is required to carry out the inspection.

Safety procedures shall be as required by Newfoundland and Labrador Hydro and applicable standards CAN/CSA-275.2-04, Occupational Safety Code for Diving Operations.

All underwater and above water inspection to be carried out during daylight hours and scheduled for predicted high and low tides.

Pile Inspection

The inspection steel of the piles includes the following:

No.1
Verification of drawings numbers and positioning with dimensions of positioning relative to a longitudinal and transverse axe or datum line or lows for the dock.

All piles an identification numbers according to drawing A1-238-05-4004-005 and AD 239-05-4004-25. – Pile Inspection report shall reference pile Numbers

No. 2
Complete an above and below water level visual inspection of all steel piles.

For the visual inspection of the piles the total length of the pile can be divided into 4 sections.

- Underside of the concrete deck down to 3' above high water.
- Between 3' above and below high water level.
- Between 3' above and below low water level.
- Between 3' below low water and harbour bottom.

No. 3
Complete an ultrasonic steel thickness measurement on representative piles at dock – 14 piles .

Ultrasonic inspection of steel piles shall include;

- Measure the residual thickness of selected steel piles using a watertight ultrasonic testing unit with direct readout, calibrate accordingly. Steel surface to be cleaned of marine growth and pile coating or rust. Any coating removed is to be repaired by touch up recoating once the readings are completed. Inspection spots are selected based on typical corrosion pattern of piles. Three test readings at each location identified.

Proposed location of test points on specified piles are as follows:

- 12.5' below top of deck slabat elevation (+) 8.8;.
- 18' below top of deck slab at elevation (+) 3.3.
- 21.3 below top of deck slab at elevation 0.0
- 25' below top of deck slab at elevation (-) 3.67'.
- 45' below the top of deck, slab at elevation (-) 23.67'.
- Mudline or harbour bottom.

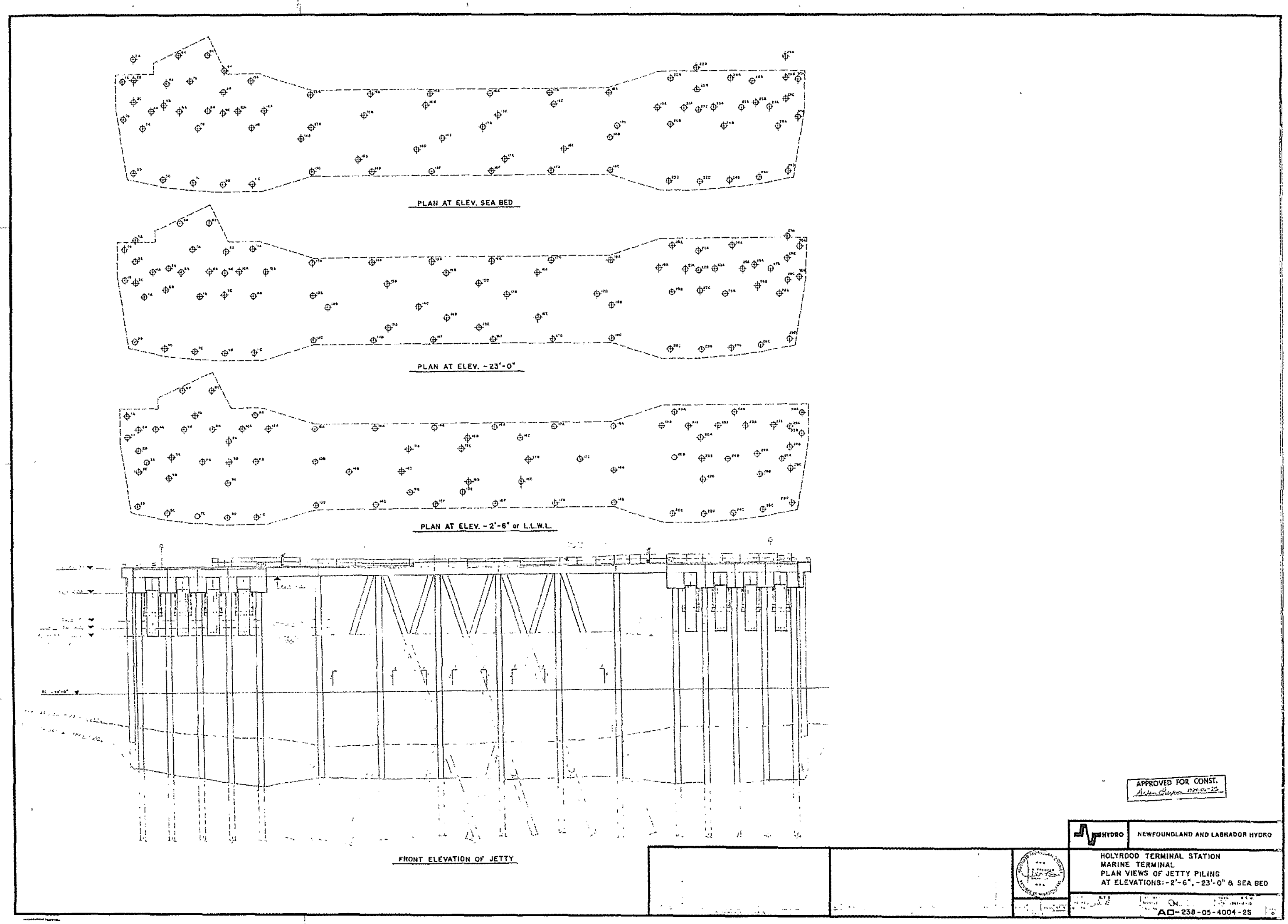
No. 4

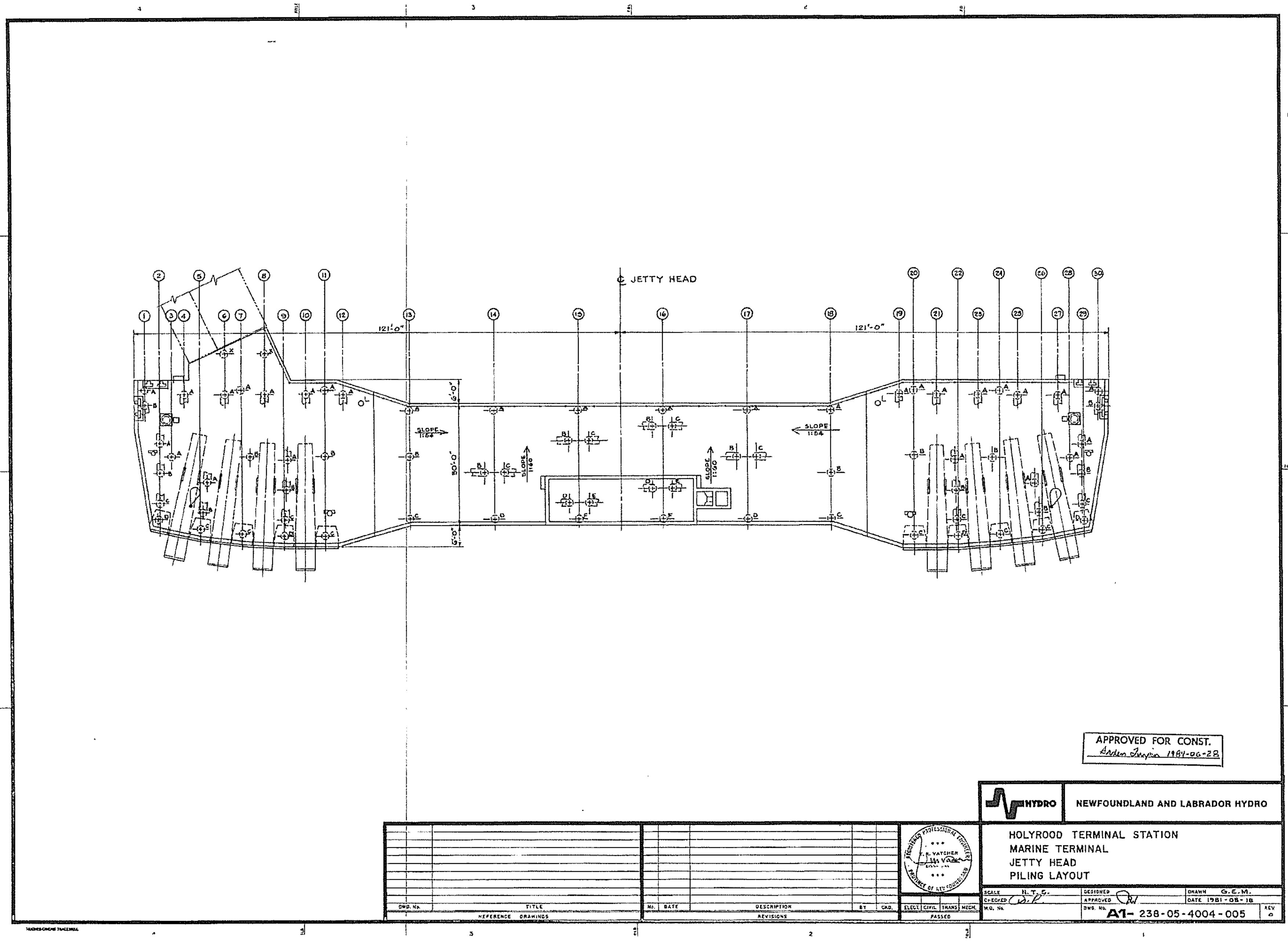
Inspected the condition of the anodes on the piles that have ultrasonic inspection specified.

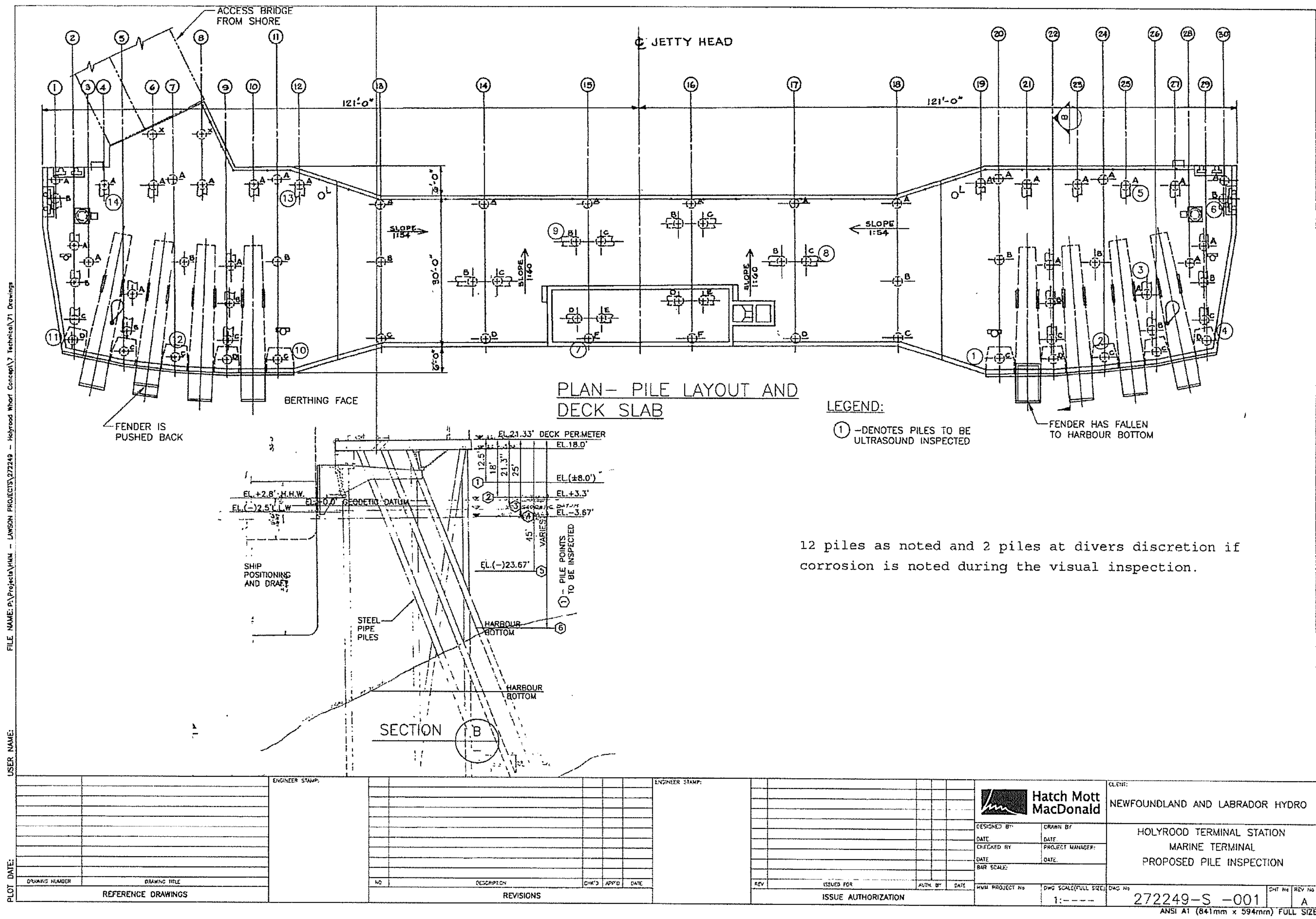
Underside of Concrete Deck Inspection

Visual inspection and comment on the condition of the undersize of the concrete deck along with the expanded concrete deck shoreline at the fenders. Complete a visual inspection of other appurtenances on the dock below deck level.

Photo record of dock from water level


PLAN AT ELEV. SEA BED
PLAN AT ELEV. -23'-0"
PLAN AT ELEV. -2'-6" or L.L.W.L.
FRONT ELEVATION OF JETTY
APPROVED FOR CONST.
HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD TERMINAL STATION
MARINE TERMINAL
PLAN VIEWS OF JETTY PILING
AT ELEVATIONS: -2'-6", -23'-0" & SEA BED
AD-238-05-4004-25

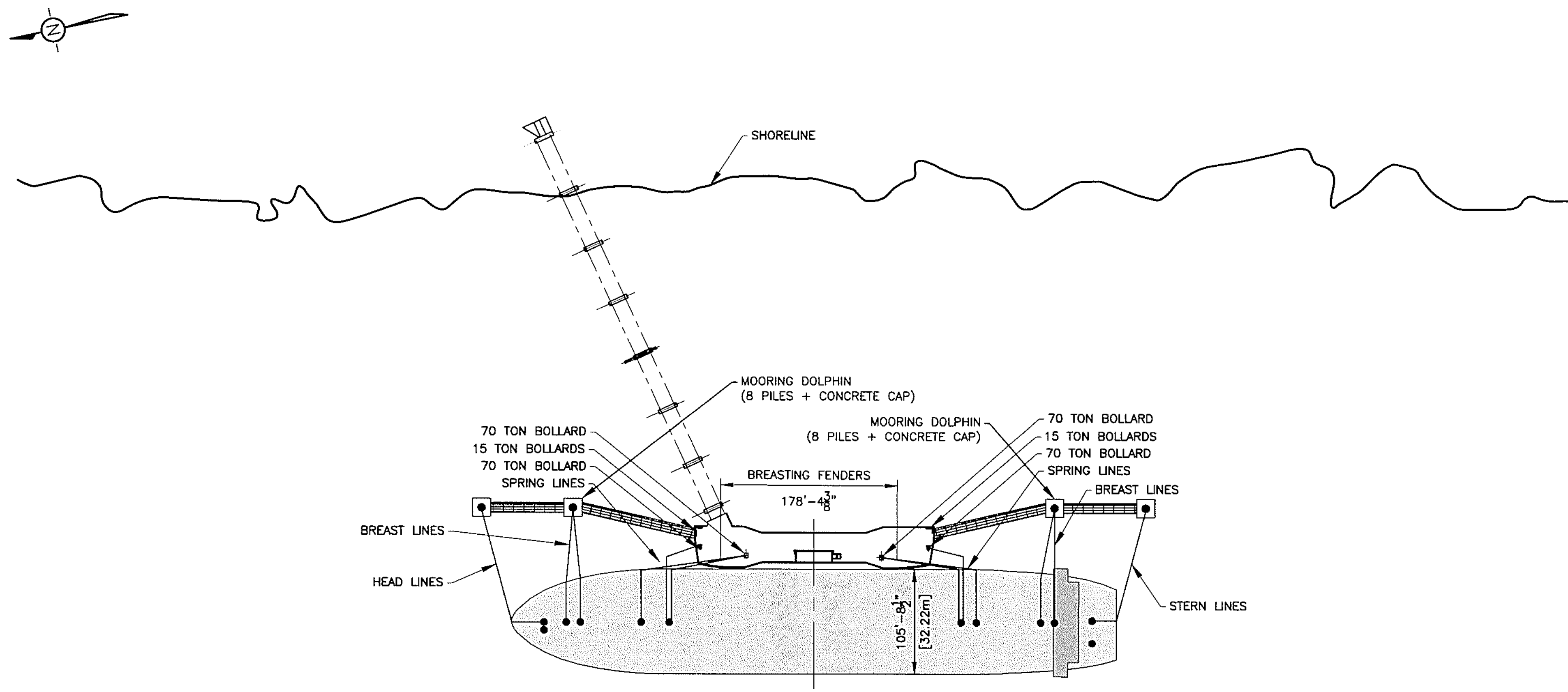

℄ JETTY HEAD
121'-0"
121'-0"
SLOPE 1:64
SLOPE 1:64
SLOPE 1:60
SLOPE 1:60
6'-0"
30'-0"
6'-0"
APPROVED FOR CONST.
1984-06-28
HYDRO
NEWFOUNDLAND AND LABRADOR HYDRO
HOLYROOD TERMINAL STATION
MARINE TERMINAL
JETTY HEAD
PILING LAYOUT
SCALE N.T.S.
DRAWN G.E.M.
DATE 1981-08-18
DWG. No.
A1- 238-05-4004-005
REV 0
DWG. No.
TITLE
REFERENCE DRAWINGS
No.
DATE
DESCRIPTION
REVISIONS
BY
CKD.
ELECT.
CIVIL
TRANS
MECH.
PASSED
CHECKED
DESIGNED
APPROVED
W.O. No.



12 piles as noted and 2 piles at divers discretion if corrosion is noted during the visual inspection.

Appendix J

Holyrood Terminal Station Proposed Jetty Head Proposed Mooring Upgrades to Existing Facility



HATCH™		CLIENT:
DESIGNED BY: K. SKEBO DATE:	DRAWN BY: E. GAWLIK DATE:	HOLYROOD TERMINAL STATION PROPOSED JETTY HEAD PROPOSED MOORING UPGRADES TO EXISTING FACILITY
CHECKED BY: G. McCHARLES DATE:	PROJECT MANAGER: G. SAUNDERS DATE:	
BAR SCALE:		
HMM PROJECT No: 272249	DWG SCALE(FULL SIZE) 1"=100'-0"	DWG No: FIGURE 5 — SHT No — REV No A

Dec 15, 2010 - 10:58am P:\272249 Holyrood (H335093)\90 Drawings\FIGURE 5-NEW.dwg

Appendix K

Laser Vessel Docking System

STRAINSTALL UK LIMITED

DockAlert

Laser Vessel Docking System

Document Ref: #8306

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STRAINSTALL UK LIMITED.
DockAlert – LASER VESSEL DOCKING SYSTEM
Technical Description

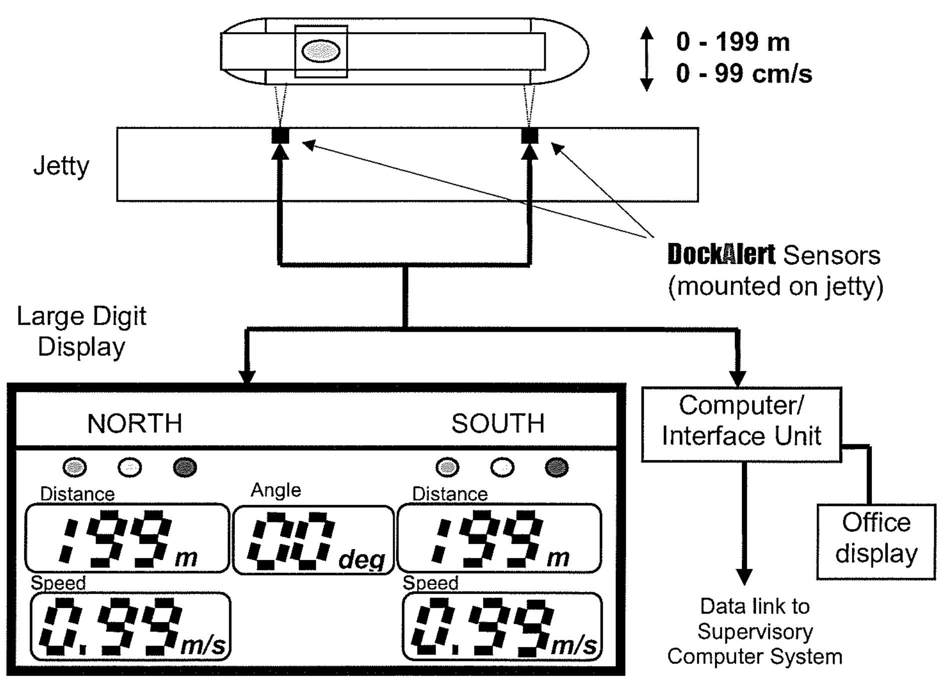
1. SYSTEM DESCRIPTION

The Strainstall **DockAlert** system is designed to give Harbour Authorities and Jetty Operators a clear and accurate reading of the speed and distance of a vessel as it approaches its berth, together with indication and alarm status of drift-off from the jetty once berthed.

DockAlert is a Dual Sensor system installed on the jetty, which transmits laser beams towards an incoming vessel, receiving reflections back from the Bow and Stern. The signals enable digital display of the vessel's approaching speed (Zero to ±99cm/s) and distance (-1 to 199m) from the berth.

A wide range of outputs is provided to maximise the system's flexibility - the **DockAlert** may be used in any configuration, from a simple high-visibility jetty display to a comprehensive data logging system integral with existing terminal control networks.

Optionally a small portable display (similar to a pager) can be provided. This is linked via radio to the main **DockAlert** system and provides a remote (e.g. on ship) display of the vessel's approach speed and distance. This unit may be supplied in an intrinsically safe version, enabling its use in a hazardous area.



Key features of **DockAlert** include:

- Real-time display of approach speed and distance during berthing and drift-off when berthed.
- High accuracy, increasing during critical approach.
- Simple above-surface installation.
- Operation unaffected by weather conditions.
- Reliable low maintenance design.
- Explosion proof construction. EEx'd' II BT5, IP65.
- Small portable unit option for on ship display.

2. SYSTEM SPECIFICATION

System	Laser transmission, 1.5 n sec. width pulse
Peak Power	High peak power Sensor (100W), Pulsed 10^5 times per sec
Safety	Eye safety, FDA Class 1 Laser.
Certification	Explosion proof construction to EEx'd' II BT5
Sealing	IP65
Distance Range Accuracy Minimum increment Measuring Interval	0 -199m Better than 1cm 1.0m (distances >10m) 0.1m (distances <10m) 1s to 9s
Speed Range Resolution	±99cm/s (Approach/leaving) 1cm/s
Angle range Resolution	±15° 1°
Sensor size max. (mm)	W300×H450×D700 mm (one sensor each end of berth)
Operating temperature	-10 to 50°C
Data output	Analogue and digital selectable
Displays	a) VDU graphic display for Control Room b) Large Digit Display for jetty c) Optional 'carry-on' portable display

The precision of the system increases with decreasing target distance, providing the highest accuracy when it is most needed.

The system measures speed and distance simultaneously, with no delays or interpolation errors.

Displays, outputs and peripherals can be configured to suit Customer requirements. Alarms can be 'zoned' so that a speed warning will be triggered by lower speeds at closer ranges.

Because the system is mounted above the waterline, it requires little maintenance and can be easily calibrated. The sensor unit is relatively small and can be mounted directly on a berth or fender dolphin..

DockAlert is unaffected by environmental conditions, including fog, rain and snow. It is packaged in a rugged weatherproof housing, and has no moving parts.

3. SUPPLY SCOPE

No.	Item	Q'ty	Remarks
1.	Laser Sensor	2	Explosion-proof (EEx'd' II BT5)
2.	Interface Unit	1 set	Non explosion-proof 800 x 800 x 2100mm panel
3.	Cable for Power Supply	1	3 core cable (10m length)
4.	Large Digit Display	1	Explosion-proof (Ex 'p')
5.	Accessories	1	
6.	Optional Portable Display (including base station transmitter antennae, software etc.)	1	Display may be EEx'ia' certified.

4. BRIEF DESCRIPTION OF EACH COMPONENT

4.1. LASER SENSOR

- Radiates ultra sharp laser pulse (1.5ns) with high peak power (100W), and receives reflection pulse easily from ship. Eye Safe, FDA Class 1 Laser.
- Self-supporting type and explosion proof construction. (EEx'd').
- Installed on the jetty for BOW and STERN, respectively.
- Easy maintenance as installed on dolphin platform. (above sea).

4.2. INTERFACE UNIT

- Enclosed in 800 x 800 x 2100mm panel and non-hazardous area use construction.
- Installed in the control room.
- Consist of Display Unit (VDU), Control Unit, Computer with keyboard and Power Unit.
- Process the input signals from LASER SENSOR and output the processed data.
- Measured data is saved in HD or FD. (3½")
- Optional Ethernet output for LAN connection.
- Optional serial and relay outputs for connection to site DCS etc.

4.3. LARGE DIGIT DISPLAY

- Installed on the jetty where captain can observe from ship's bridge.
- Self-supporting type, weather-proof and air pressurised hazardous protection.
- Display the distance BOW and STERN, ship approaching speed respectively.
- LED lamp digit display which can control light intensity.
- LED lamp alters the colour for three approaching speed levels.
  RED in dangerous speed.
  AMBER in cautionary speed.
  GREEN in safety speed.

4.4. PORTABLE DISPLAY

- Small and lightweight (similar to a pager).
- Provides numerical display of approach speed and distance.
- Provides internal alarm to warn of danger levels.
- Multiple displays may be used with a single base station transmitter.
- Intrinsically Safe (EEx'ia') version available for use in hazardous areas.

4.5. CABLES

4.5.1. Purchaser Supply

- 3 pair twist cable individual screen 1.5mm^2, (use for Laser Sensor).
- 6 pair twist cable individual screen 1.5mm^2, (use for Large Digit Display).
- The recommended cable specification shall be provided at the detailed Contract planning stage.

4.5.2. Strainstall Supply

- 3 core cable, (used for power supply to Interface Unit).

5. DETAILED SPECIFICATION

5.1. GENERAL

Measuring distance	-1 to 199m
Measuring speed	0 to ±99cm/s (+:Approaching, -: Leaving)
Tilt of ship to the berthing line	within ±15°. Against berthing line
Increment of measurement (resolution of digit)	Distance : 1m at distance more than 10m 0.1m at distance less 9.9m
Speed:	1cm/s
Angle:	1°
Power consumption	AC 230V ±10% 50Hz 300VA (excluding LIGHT BOARD DISPLAY)

5.2. LASER SENSOR

5.2.1. Construction

Protection	EEx'd' II BT5 JIS : Explosion proof, IP65
Materials	Anti corrosive aluminium & SUS
Painting (Colour)	Epoxy (Manufacturer standard)
Dimension	W250 × H403 × D650mm
Weight	~ 30Kg

5.2.2. Laser Light

Wave length	~ 850nm
Peak power	100W peak
Pulse width	1.5ns
Pulse repeating	100,000 times/s
Eye safe class	FDA Class 1
Detective distance	More than 200m
Beam angle	±0.13°
Distance accuracy	Less 1cm

5.2.3. Operating Conditions

Ambient temperature	-10 to 50°C
Storage temperature	-10 to 70°C
Ambient humidity	10 to 95% RH (non condensation)

5.3. INTERFACE UNIT

An SVGA VDU (14" colour), computer, keyboard, power unit, control unit. Interface circuits are enclosed in a 800 x 800 x 2100mm panel and printer is on disk. I built diagnostics provide a maintenance function. Typical display screen layouts are provided in Appendix A.

5.3.1. Distance measurement

Measuring range	-1 to 199m
Number of digits	3 digits
Minimum increment	1m more than 10m distance (approach) 0.1m less than 9.9m distance (drift-off)
Measuring interval	1s to 9s selectable
Indicating method	SVGA Colour VDU 14"
Zero reference offset	0 to 9.99m

5.3.2. Speed measurement

Measuring range	0 to ±99cm/s
Number of digits	2 digits
Minimum increment	1cm/s
Measuring interval	1s to 9s selectable
Indicating method	SVGA Colour VDU 14"
Symbol indication	+: when approaching -: when leaving

5.3.3. Angle measurement

Measuring range	15°
Number of digits	2 digits
Minimum increment	1°
Measuring interval	1s
Indicating method	SVGA Colour VDU 14"

5.3.4. Alarms

Speed alarm range	0 to 99cm/s
Off berthing alarm range	0 to 9.99m
Angle alarm range	0 to 15°

5.3.5. Printer

An A4 colour InkJet printer is provided to provide an alarm/event log.

5.3.6. Operating Conditions

Ambient temperature	0 to 45°C (main computer unit)
Storage temperature	-5 to 60°C
Ambient humidity	10 to 80% RH (non condensation)

5.4. LARGE DIGIT DISPLAY

5.4.1. Construction

Protection	Inner pressurised hazardous protection (Ex ‘p’)
Materials	Stainless Steel plate
Finish	Natural, unpainted
Dimension	W2800 × H1800 × D500mm
Weight	~1040kg

5.4.2. Indication

Range (Distance)	0 to 199m
Range (Speed)	0 to ±99cm/s
Number of digits (Distance)	3 digits
Number of digits (Speed)	2 digits
Min. increment distance	1m at distance more than 10m 0.1m at distance less than 9.9m
Min. increment speed	1cm/s
Lamp	LED lamp controlled light intensity

5.4.3. General

Power consumption	AC 110V ±10%, 50Hz
Design wind velocity	Within 50m/s
Air consumption	250l/m minimum
Name plate	[BOW] [STERN]
Turn swivel	±45° remote controlled from MCR
Visible Range	200m in clear weather
Visible Range	±45° (horizontal) ±45° (vertical)

5.4.4. Operating Conditions

Ambient temperature	-10 to 50°C
Storage temperature	-10 to 70°C
Ambient humidity	10 to 85% RH (non condensation)

5.5. PORTABLE DISPLAY

5.5.1. Construction

Hazardous Area Certification	EEx 'ia' (option)
Dimensions	W57 × H82 × D17.5mm
Weight	~90g

5.5.2. Indication

Display Type	Supertwist LCD
Visible display screen	4 rows x 24 characters
Range (Distance)	0 to 199m
Range (Speed)	0 to ±99cm/s
Number of digits (Distance)	3 digits
Number of digits (Speed)	2 digits
Backlight	Electroluminescent backlight
Alarm	a) Internal vibrator motor, 80dB at 30cm b) Red LED indicator

5.5.3. Power Supply

Battery life	800 hours
Battery Type	Single AAA cell

5.5.4. Operating Conditions

Ambient temperature	-10 to 50°C
Storage temperature	-10 to 70°C
Ambient humidity	10 to 85% RH (non condensation)

Note. The portable Display requires a base station transmitter. This is incorporated into the Interface Unit.

APPENDIX A

VDU Screen Displays

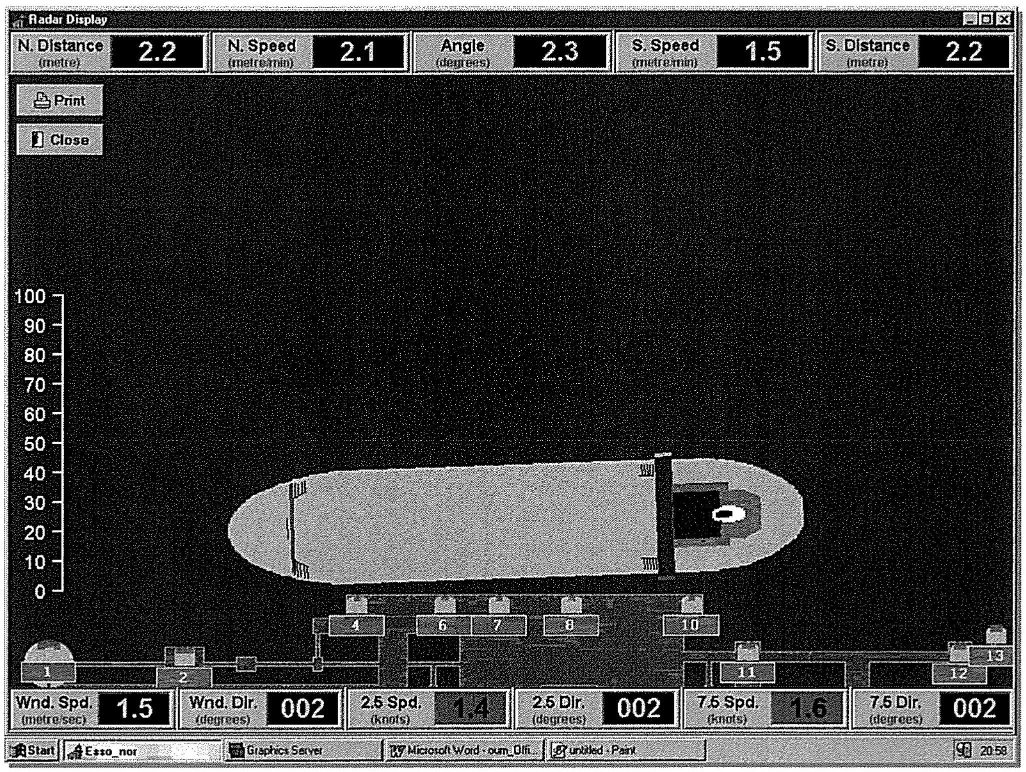


Figure 1 – Vessel Approach Screen Graphic

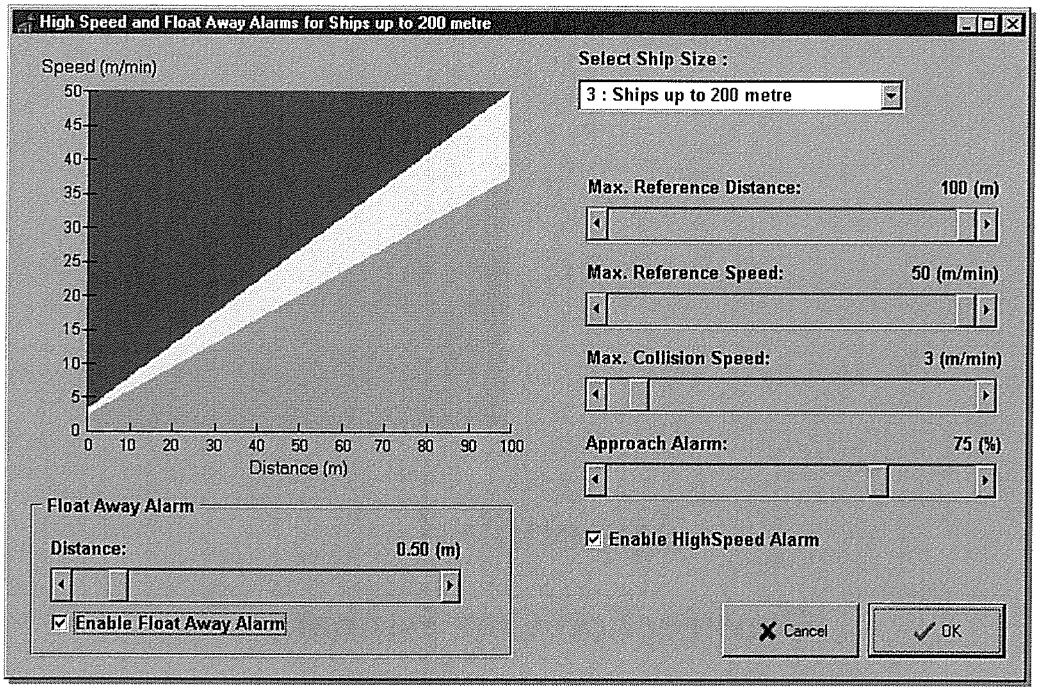
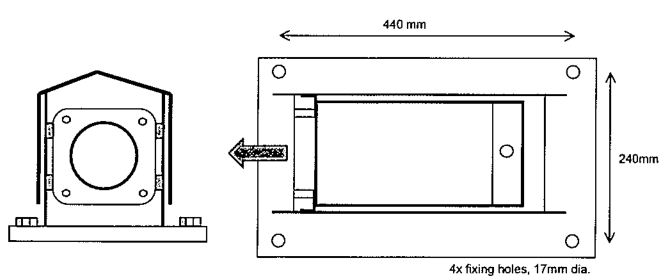


Figure 2 – Alarm Setting VDU Screen



ASDOC laser sensor

Figure 3 – Laser Sensor Details

Appendix L

Construction Cost Estimate

Estimate Description:	Holyrood Marine Terminal 10 Year Life Construction Estimate	Date: Revision:	29-Apr-11 0
Estimate Order:	Unit Rate +/-20%		
References:			

Item	Description	Quantity	Units	Materials/Equipment		Sub-Con		Sub-Total	Total
				Unit Price	Amount	Unit Price	Amount		
1	Mobilization/Demobilization	1	ea		$0.00	50000	$50,000.00	$50,000	$50,000
2	**Fender Replacement/Repairs**								
	Fender Replacement								
	Concrete	50	cu.m	500	$25,000.00	$500.00	$25,000.00	$50,000	
	Structural Steel	12.5	T	6000	$75,000.00	$3,000.00	$37,500.00	$112,500	
	Rebar	4	T	3000	$12,000.00	$3,000.00	$12,000.00	$24,000	
	Crane	200	hrs	40	$8,000.00	$130.00	$26,000.00	$34,000	
	Misc. Steel/Anchors/Pins/etc.	1	lot	25000	$25,000.00	$0.00	$0.00	$25,000	
	Contractor Labour	2400	hrs	0	$0.00	$75.00	$180,000.00	$180,000	
	Scaffolding	1	lot	12000	$12,000.00	$120,000.00	$120,000.00	$132,000	
	Temporary Support Beams	1	lot	35000	$35,000.00	$5,000.00	$5,000.00	$40,000	
	Safety Vessel	200	hrs	0	$0.00	$80.00	$16,000.00	$16,000	
	Safety Watch	200	hrs	0	$0.00	$100.00	$20,000.00	$20,000	
	Sub-Total								$633,500
	Fender Repair (x3)								
	Demolition	1000	hrs	0	$0.00	$75.00	$75,000.00	$75,000	
	Structural Steel	6	T	6000	$36,000.00	$3,000.00	$18,000.00	$54,000	
	Misc. Steel/Anchors/etc.	3	lot	25000	$75,000.00	$0.00	$0.00	$75,000	
	Contactor Labour	5700	hrs	0	$0.00	$75.00	$427,500.00	$427,500	
	Scaffolding	3	lot	12000	$36,000.00	$120,000.00	$360,000.00	$396,000	
	Temporary Support Beams	1	lot	35000	$35,000.00	$5,000.00	$5,000.00	$40,000	
	Safety Vessel	400	hrs	0	$0.00	$80.00	$32,000.00	$32,000	
	Safety Watch	400	hrs	0	$0.00	$100.00	$40,000.00	$40,000	
	Sub-Total								$1,139,500
	Engineering								
	Detailed Design	300	hrs	0	$0.00	$135.00	$40,500.00	$40,500	
	Tender Support	80	hrs	0	$0.00	$135.00	$10,800.00	$10,800	
	Construction Support	400	hrs	0	$0.00	$125.00	$50,000.00	$50,000	
	Sub-Total								$101,300
3	**Loading Arms/Vessel Approach**								
	Piping/Valves/fittings	1	lot	24000	$24,000.00	$8,000.00	$8,000.00	$32,000	
	Structural Steel	3	T	6000	$18,000.00	$3,000.00	$9,000.00	$27,000	
	Misc. Steel/Anchors/etc.	1	lot	10000	$10,000.00	$0.00	$0.00	$10,000	
	Contractor Labour	1000	hrs	0	$0.00	$75.00	$75,000.00	$75,000	
	Scaffolding	1	lot	0	$0.00	$8,000.00	$8,000.00	$8,000	
	Safety Vessel	100	hrs	0	$0.00	$80.00	$8,000.00	$8,000	
	Safety Watch	100	hrs	0	$0.00	$100.00	$10,000.00	$10,000	
	Coupler	2	ea	8000	$16,000.00	$0.00	$0.00	$16,000	
	Coupler	300	hrs	0	$0.00	$85.00	$25,500.00	$25,500	
	Sub-Total								$211,500
	Radar System	1	lot	100000	$100,000.00	$10,000.00	$10,000.00	$110,000	
	Loading Arm Drainage System	1	lot	50000	$50,000.00	$10,000.00	$10,000.00	$60,000	
	Loading Arm Drainage Electrical Upgrades	1	lot	200000	$200,000.00	$20,000.00	$20,000.00	$220,000	
	Sub-Total								$390,000
	Engineering								
	Detailed Design	300	hrs	0	$0.00	$135.00	$40,500.00	$40,500	
	Tender Support	230	hrs	0	$0.00	$135.00	$31,050.00	$31,050	
	Construction Support	310	hrs	0	$0.00	$125.00	$38,750.00	$38,750	
	Sub-Total								$110,300
4	**Anode Inspection/Replacement**								
	Anode Inspection	180	hrs	0	$0.00	$400.00	$72,000.00	$72,000	
	Pile Inspection	180	hrs	0	$0.00	$400.00	$72,000.00	$72,000	
	Anode Replacement	110	ea	500	$55,000.00	$2,200.00	$242,000.00	$297,000	
	Safety Vessel	180	hrs	0	$0.00	$80.00	$14,400.00	$14,400	
	Safety Watch	180	hrs	0	$0.00	$100.00	$18,000.00	$18,000	
	Sub-Total								$473,400
	Engineering								
	Detailed Design	60	hrs	0	$0.00	$135.00	$8,100.00	$8,100	
	Tender Support	80	hrs	0	$0.00	$135.00	$10,800.00	$10,800	
	Construction Support	100	hrs	0	$0.00	$125.00	$12,500.00	$12,500	
	Sub-Total								$31,400
5	**Life Safety Issues**								
	Fall Arrest System(s)	1	lot	50000	$50,000.00	$50,000.00	$50,000.00	$100,000	
	Emergency Evacuation Vessel	2	ea	10000	$20,000.00	$10,000.00	$20,000.00	$40,000	
	Fixed Platforms (s)	2	ea	50000	$100,000.00	$140,000.00	$280,000.00	$380,000	
	Lighting Upgrades	1	lot	50000	$50,000.00	$15,000.00	$15,000.00	$65,000	
	Safety Vessel	400	hrs	0	$0.00	$80.00	$32,000.00	$32,000	
	Safety Watch	400	hrs	0	$0.00	$100.00	$40,000.00	$40,000	
	Sub-Total								$657,000
	Engineering								
	Practises and Procedures	275	hrs	0	$0.00	$135.00	$37,125.00	$37,125	
	Detailed Design	400	hrs	0	$0.00	$135.00	$54,000.00	$54,000	
	Tender Support	160	hrs	0	$0.00	$135.00	$21,600.00	$21,600	
	Construction Support	500	hrs	0	$0.00	$125.00	$62,500.00	$62,500	
	Sub-Total								$175,225
	Sub-Total				$1,067,000.00		$2,906,125.00	$3,973,125.00	$3,973,125
	Contractor - Onsite Facilites	20%			$0.00		$581,225.00	$581,225.00	$581,225
	Contingency	15%			$160,050.00		$435,918.75	$595,968.75	$595,969
	Overhead and Profit	10%			$106,700.00		$290,612.50	$397,312.50	$397,313
	Total				$1,333,750.00		$3,632,656.25	$4,966,406.25	$5,547,631

HATCH™

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