Q. **Re: Refurbishment of Marine Terminal at the Holyrood Thermal Generating Station (Tab 3)**

At page 12, reference is made to an engineering consultant looking for the cause of a 70 ton concrete gravity fender falling from the Marine Terminal superstructure. Please provide a copy of this report.

A. A copy of the materials test report - Cambridge Materials Testing Report, pertaining to the 70 ton concrete gravity fender failure, is attached (Attachment 1).

Given the sudden occurrence of the fender failure and the urgent requirement to complete the repair work prior to the arrival of the next fuel supply vessel, a formal summary into the findings of the Cambridge report was not provided by Hatch.

The attached e-mail (Attachment 2), from Hatch on December 19, 2008, summarizes the findings of the Cambridge report and confirms that the support arm failure originated in the vicinity of the six inch hardened support pins. The failure was caused by a reduction in cross-sectional area, as a result of wear action created by forty years of movement due to wind and wave action, in conjunction with corrosion of the unprotected surface.

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Report For:	Hatch Ltd. 280 Torbay Road Bally Rou Place, Suite E200 St. John's, Newfoundland A1A 3W8 Phone: 1-709-754-6933 Fax: 1-709-754-2717	**Laboratory #:**	**498237-08**
		Report Date:	December 19, 2008
		Received Date:	November 5, 2008
Attention:	Greg Saunders		
Specimen:	Marine Fender Support Arm		

TEST REPORT

A section of a failed support arm for a marine fender was submitted for evaluation (refer to Figure 1). The purpose of the evaluation was to document the condition of the marine fender support arm remains, approximate the cross sectional area of the fracture surface and determine the tensile properties of the main plate of the support arm. Hatch has indicated that the support arm was manufactured from an 18" wide x 1.375" thick plate and had 0.688" thick support plates welded on either side. A 6.0625" hole in the support arm was used to hold a 6" hardened pin that was attached to a 65 ton concrete fender. The marine fender had been in service for 30+ years prior to the failure. A dimensional drawing of the support arm was also provided by Hatch (refer to Figure 2).

Visual Examination

With the exception of two flame cut edges all of the surfaces of the specimen were heavily corroded. Examination of the marine fender support arm section suggests that the submitted section represents only half of the original width. The submitted section of the marine fender support arm was approximately 9" wide and 31" long. The main plate had an approximate thickness of 1⅜" and the support plates were approximately $^{9}/_{16}$" thick. The corrosion product was observed between the main plate and supports plates and the support plates appeared to be separating from the main plates as a gap was observed between the plates (refer to Figure 3). The fracture of the main plate appears to have occurred along the bottom of the hole in an area of minimal cross section, with support plates each fracturing in different locations above the main plate fracture location (refer to Figure 4). The two support plates were welded to the main plate around their outside edges. Between the support plate fracture locations and the main plate fracture location there does appear to be some remnant weld metal still on the main plate (refer to Figure 5).

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Per Jill Cook
Quality Assurance

Per
Technician

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Visual Examination (cont'd)

Examination of the main plate around the fracture location showed a slight curve to the material indicating some deformation (bending) of the material at this location during fracture when compared to the dimensional drawing (refer to Figure 2 and Figure 5). Examination of the main plate fracture surface revealed no fine detail was visible due to the corrosion of the fracture surface, however a chevron pattern observed on the surface indicates the fracture originated along the inside diameter of the hole (refer to Figure 6). Examination of the hole showed that it appeared to be severely elongated due to wear. The hole surface revealed evidence of material deformation as the main plate appeared to be 'mushrooming' at both edges of the hole (refer to Figure 7).

At the fracture location dimensions of the remaining material of the main plate were approximately 1⅜" thick x 1⅞" long (refer to Figure 8). Based on these measured dimensions an approximate cross section area of the main plate at the fracture location was calculated to be 2.578 in^2. Also, based on the dimensions of the support arm indicated in the supplied drawing and the measured 1⅞" length on main plate material remaining along the bottom of the hole at the time of fracture it was estimated that $5^3/_{32}$" of material were worn away along the bottom of the hole. A full-scale cardboard pattern was constructed using the supplied dimensions of the support arm and the submitted section of the support arm was placed on top of the pattern by aligning the outer edges to help convey the amount of wear experienced by the hole in the support arm (refer to Figure 9).

Tensile Testing

A tensile test specimen was machined from the main plate of the marine fender support arm and tested according to ASTM A370-08a (refer to Table 1).

Table 1: Tensile Test Results

Property	Marine Fender Support Arm Main Plate
Yield Strength (0.2% offset)	33,800 psi
Ultimate Tensile Strength	68,000 psi
Elongation in 2 inches	28%
Reduction of Area	51%

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Figure 1: Photograph of the as received section of the marine fender support arm. Top scale on scale marker is in inches and the bottom scale is in centimetres.

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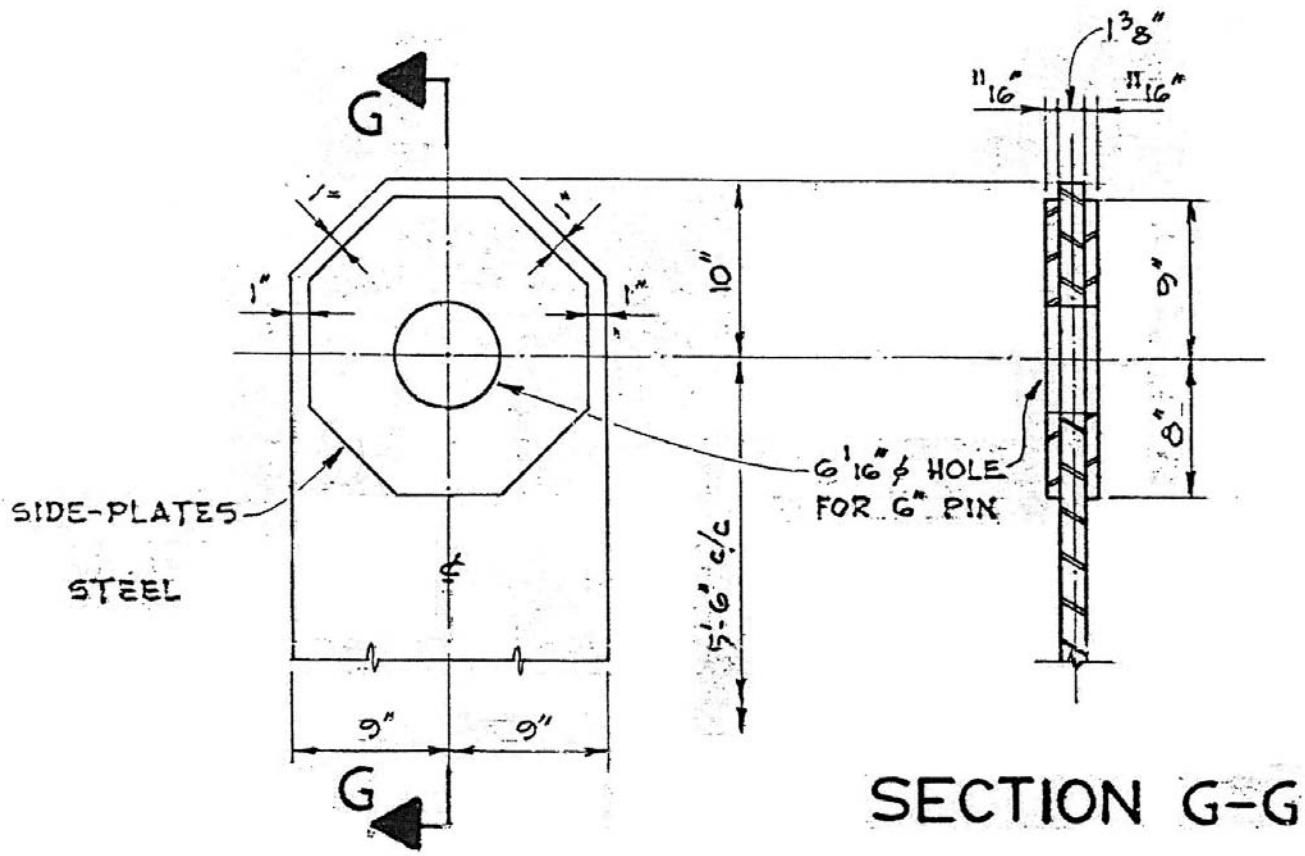

Figure 2: Copy of the Hatch submitted drawing showing the dimensions of the marine fender support arm.

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Figure 3: Photograph showing the corrosion between the support plates and the main plate (refer to the arrows) and the gaps that were present between the main plate and the support plates. Scale is in inches.

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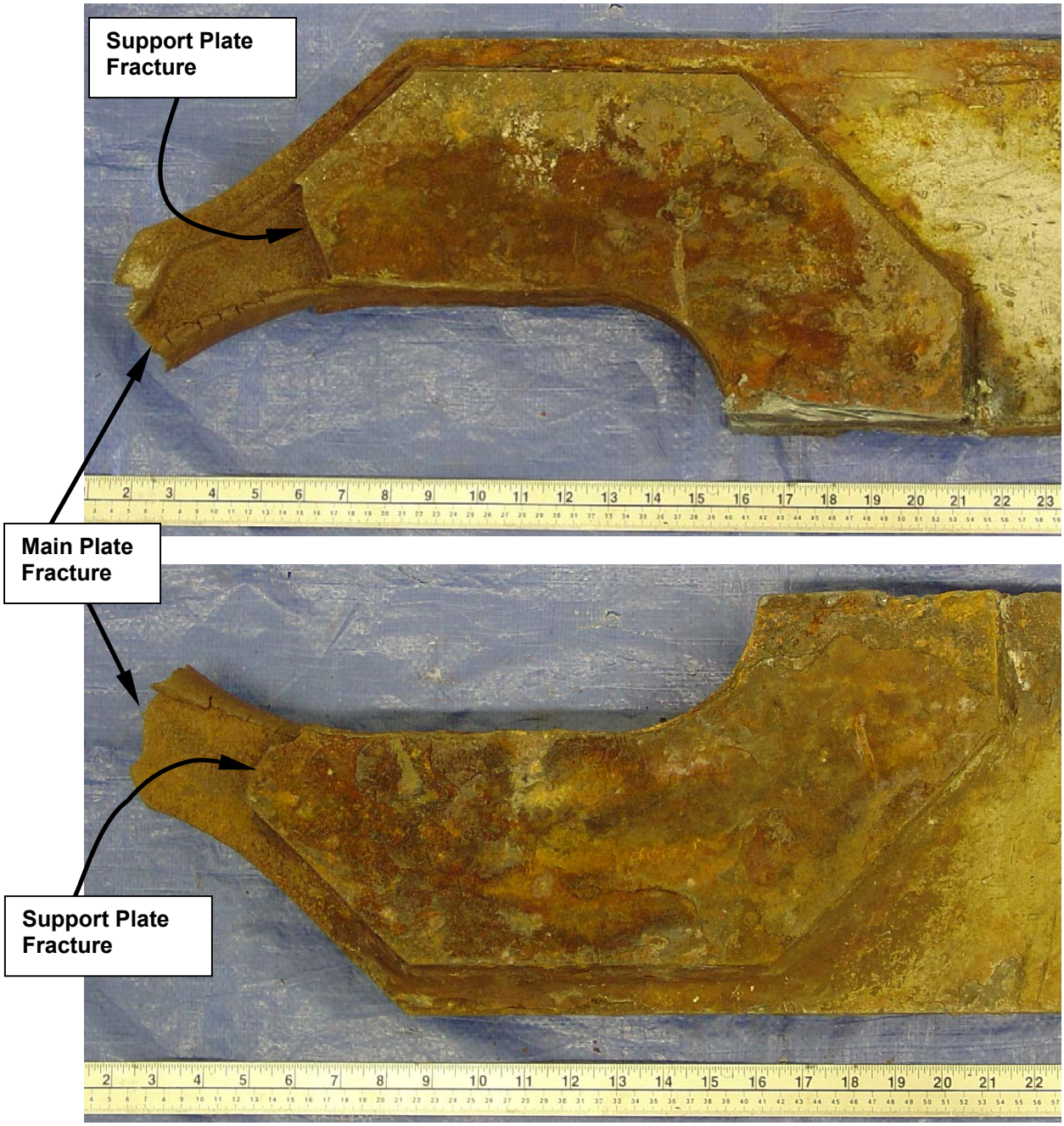

Figure 4: Photographs of each side of the submitted specimen showing the fracture location of the main plate and of both support plates. Top scale on scale marker is in inches and the bottom scale is in centimetres.

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Figure 5: Photograph showing the remnant weld metal on the surface of the main plate (refer to the arrows). Also visible in the photograph is the slight curvature to the diagonal edge of the support arm. Scale is in inches.

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Figure 6: Photograph of the main plate fracture surface. The arrow indicates the likely origin location of the fracture. Scale is in inches.

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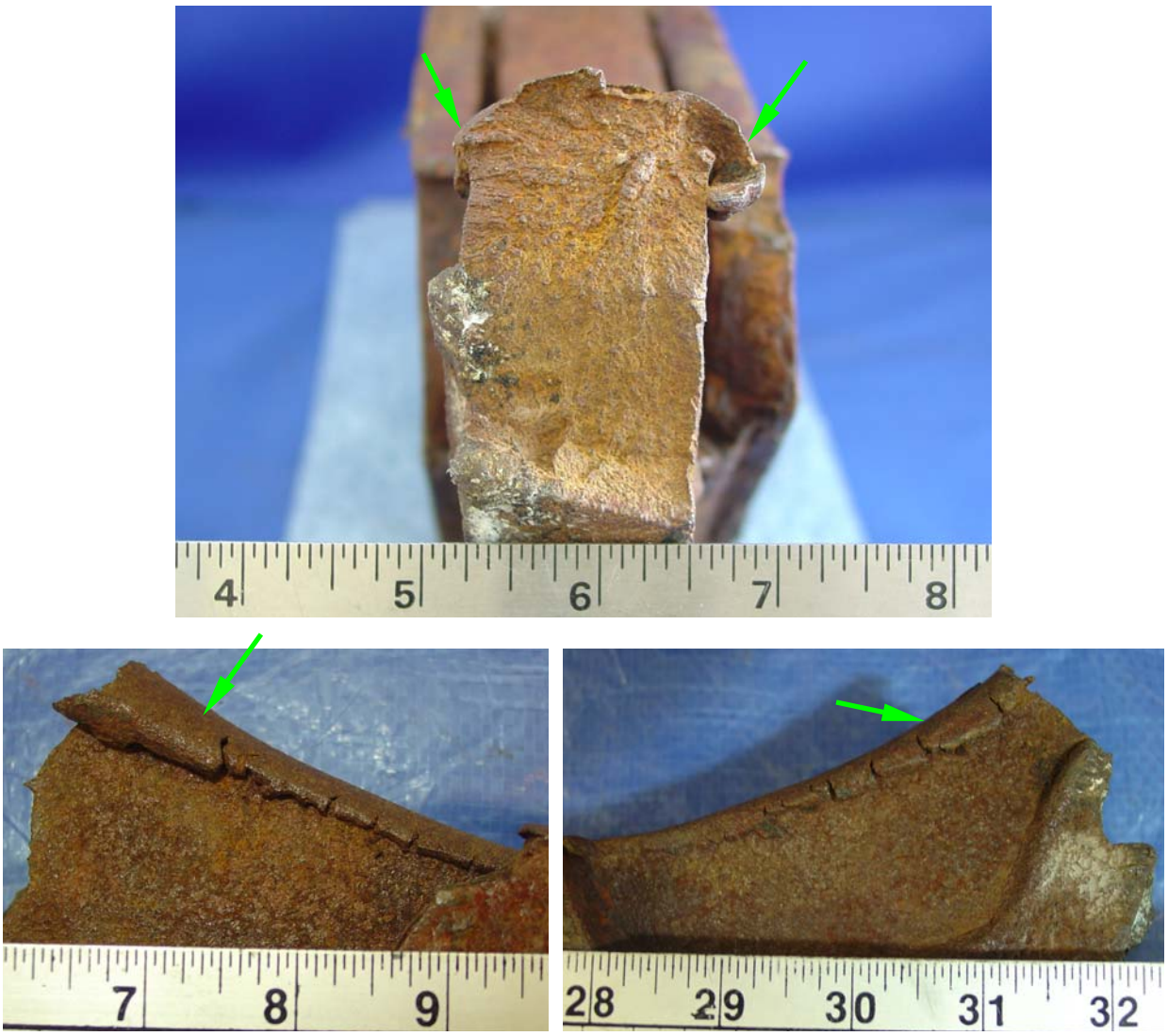

Figure 7: Photographs showing the 'mushroomed' material that was observed along the bottom half of the hole (refer to the arrows). Scale is in inches.

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Figure 8: Photograph showing the bottom potion of the hole with dimension lines to indicate how the length of the remaining material was approximated. Scale is in inches.

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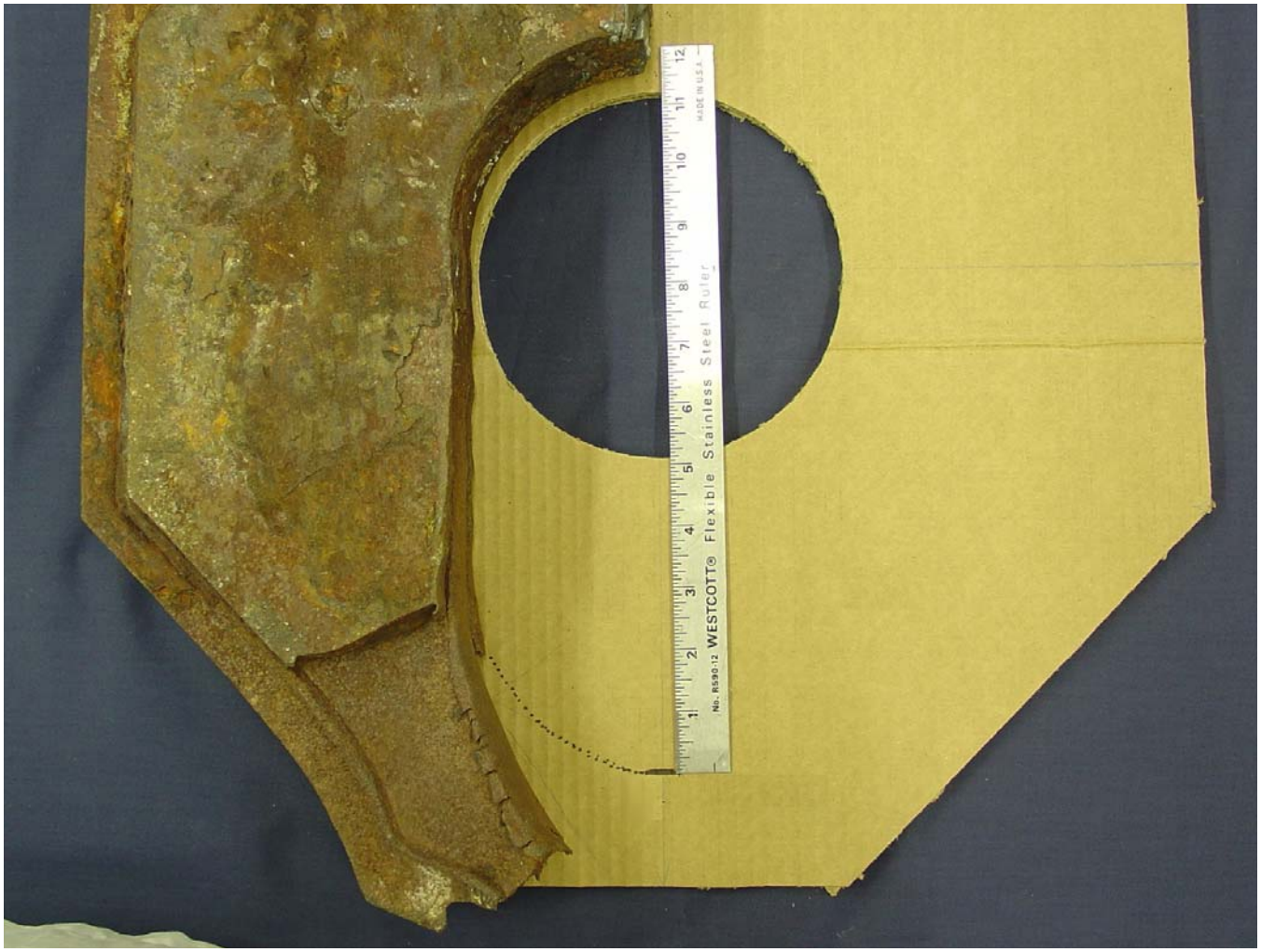

Figure 9: Photograph showing the lower section of the submitted support arm placed on a full-scale cardboard constructed using the supplied dimensions of the support arm. The black line on the pattern indicates the suspected location of the main plate prior to fracture. Scale is in inches.

FW: Newfoundland and Labrador Hydro - Holyrood Thermal Generating Station Marine Terminal Gravity Fenders Proposal 08-2232

Saunders, Greg to: MatthewLeonard 09/27/2011 04:28 PM

2 attachments

Holyrood Proposal 08-2232.pdf 498237.pdf

Hi Matthew

This is the only information I could find. I will check with the admin staff to see if there are any reports I don't have a copy of on my laptop.

Regards,

Greg Saunders P.Eng.
Hatch St. John's, General Manager
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From: Saunders, Greg
Sent: Monday, October 20, 2008 9:09 AM
To: 'GPoole@nlh.nl.ca'
Subject: FW: Newfoundland and Labrador Hydro - Holyrood Thermal Generating Station Marine Terminal Gravity Fenders Proposal 08-2232

Garry

Please find attached Hatch's formal proposal. Note the T&Cs are the same as discussed with the modifications to Hatch's standard T&Cs shown in yellow.

I have spoken with Geoff Wells this morning and from his discussion with Brian Friday we can only get a single axle boom truck out on the deck. Geoff suggested I contacted DCH this morning as their cranes are certified and they have certified personnel lift baskets. I spoke with Dwayne Murphy at DCH and they do not have any single axle boom trucks. Also all their RT cranes are working and unavailable until later in the month.

I will try other companies.

Regards

Greg Saunders P.Eng.
Senior Mechanical Engineer
Hatch Limited
St. John's, NL
Phone (709) 754 6933 Ext. 259
Cell (709) 690 1932

From: Kerkhof, Dianne
Sent: Friday, October 17, 2008 5:57 PM
To: Saunders, Greg
Cc: Hynes, Rory; Rayman, Mirza; Brown, Rob N.
Subject: Newfoundland and Labrador Hydro - Holyrood Thermal Generating Station Marine Terminal Gravity Fenders Proposal 08-2232

Greg,
As per your discussion with Rory, please find enclosed the Holyrood proposal for your distribution.
If you would like the Word version I will send under a separate email.

Regards,

Dianne Kerkhof
Hatch Ltd.
1235 North Service Road West
Oakville, Ontario Canada L6M 2W2
Tel. 905-465-4927, ext. 4933
Email: dkerkhof@hatchenergy.com

----- Message from "Saunders, Greg" <GSaunders@hatch.ca> on Fri, 19 Dec 2008 10:57:24 -0400 -----

To: <GPiercy@nlh.nl.ca>, <GPoole@nlh.nl.ca>
Subject: FW: Holyrood Fenders - CMTL Lab Report

Gentlemen

See attached the failure analysis report from Cambridge Materials Testing.

The cross sectional area at fracture was calculated as approximately 2.578 sq in. and the material yield at 33,800 psi. Load at yield would have been 87136 lbs or 43.5 tons. This does not account for the load intensification due to a circular hole in the plate. For a perfect circle the stress concentration at the bottom of the hole is 3 times the applied tensile load. At the measured UTS of the material, 68,000 psi, the ultimate load for the cross section is 175,304 lbs or 87.6 tons. If you divide by 3 the actual capacity is approximately 29 tons. Assuming both arms are similar in remaining cross section and tensile strength then we would have an approximate capacity of 58 tons. The fender weight is 65 tons and the majority of this is supported on the front two arms.

Based on this quick review of the report we can reasonable assume the failure was caused by the reduction in cross sectional area due to wear caused by nearly 40 years of small movements due to wind and wave action and some corrosion of the unprotected surfaces.

Regards,

Greg Saunders P.Eng.
Senior Mechanical Engineer

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From: Cambridge Materials Testing [mailto:FrontOffice@CambridgeMaterials.com]
Sent: Friday, December 19, 2008 10:28 AM
To: Saunders, Greg
Subject: CMTL Lab Report

Hi Greg

Attached is Lab Report 498237.

Regards

Pauline Holloway

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