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

At Appendix B, page B-14, section 3.2.1, please provide a copy of the 1988 Shawmont Letter Report referred to by Hatch.

A. A copy of the Shawmont Letter Report is attached.

File: ~~028-70.00~~

ShawMont Newfoundland Limited

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1988 02 26

File: NLH 8382-9

File 102

81.54/8.03

Mr. John Carnell, P. Eng.,
Senior Civil Engineer
Newfoundland & Labrador Hydro
P.O. Box 9100
St. John's, Nfld.
A1A 2X8

HOLYROOD MARINE TERMINAL
DESIGN REVIEW

Dear Mr. Carnell:

Subsequent to our meeting of February 12, 1988, at which we discussed the findings of our design review of the Holyrood Marine Terminal, I requested our designer, Mr. Eugene Komorowski, to provide a brief explanation of the reasoning used in arriving at the conclusion that the terminal can accomodate tankers up to 65,000 dwt. A copy of his reply is attached and is self explanatory.

As this work is now concluded, we would like to thank you for having placed the assignment with us. Should you deem it necessary to carry out a further assessment of the structural integrity of the terminal, or the implementation of additional berthing or mooring facilities as discussed, we would be pleased to provide you with an offer of further services in this regard.

Yours very truly,

A.D. Peach

A.D. Peach, P. Eng.,
Vice-President and
General Manager

ADP/ral

Attachment

Eugene S. Komorowski
c/o 350 - 10333 Southport Rd. SW
Calgary, Alberta
T2W 3X6

February 25, 1988

ShawMont Newfoundland Limited
P.O. Box 9600
St. John's, Newfoundland
A1A 3C1

Attention: Mr. A.D. Peach, P. Eng
Vice-President and General Manager

Dear Mr. Peach:

RE: FILE NLH 8382-9
HOLYROOD MARINE TERMINAL

In response to your request, the notes below explain the procedure and reasoning used in arriving at the conclusion regarding the structure's ability to take impacts and energies likely to arise from somewhat larger ships than from the size designed for.

1. The fendering system at each end of the Holyrood Marine Terminal comprises four concrete blocks, each weighing an estimated 142 kips, hanging from 5.5 foot radius links and retracted 12 inches. In plan, they are placed 3° 40' apart on a circular arc of 172 foot radius, which is equivalent to an 11 foot spacing relating to the concrete faces at the front. Such an arrangement allows the fenders to receive impacts when the tanker's side is at an angle of up to 11° (nearly 1 in 5) with the berthing line.

2. Depending on the approach angle, at least one fender unit comes in contact with the vessel's side and, as it retracts under the impact other units become involved in resisting the ship's movement. It has been estimated that

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depending on the retraction distance of the first unit engaged, the total amount of kinetic energy absorbed by the group of gravity units and the corresponding impact can range as follows:

(1) 3.85 foot retraction of the first unit hit - the total kinetic energy absorbed varies from 1140 to 1305 ft kips; the total resulting impact varies from 780 to 855 kips.

(2) 4 foot retraction - k.e. absorbed varies from 1265 to 1440 ft kips; resulting impact varies from 880 to 970 kips.

(3) 4.1 foot retraction (considered to be a practical maximum) - k.e. absorbed varies from 1360 to 1540 ft. kips; resulting impact varies from 980 to 1080 kips.

3. For the size of tanker considered, berthing against relatively soft fenders such as the gravity type used at Holyrood, it is quite probable they would absorb at least 90 percent of the actual energy imparted by the ship. The remaining 10 percent would be taken by the ship.

4. Based on a statistical approach, developed from the study of many recorded impacts of a similar class of tankers berthing at a number of terminals of varying types and exposure, the design criteria for a berth of average exposure are:

(1) Fender capacity to absorb energy is 17 ft. kips for each 1000 long tons deadweight up to yield point in the fenders.

(2) Fender impact reaction is not more than 1120 kips (500 long tons).

Accordingly, for tankers of 60,000 and 65,000 dwt, the required capacity of each fender group should be 1020 and 1105 ft. kips, respectively. These do not exceed the estimated energy absorbing capacities of a fender group retracting 3.85 feet as quoted in section 2 above. Actually, it can be estimated that the required retraction may be as low as 3.6 feet, resulting in a total reaction of 720 kips, on the assumption that the vessel will strike at nearly 7^{o} to the berthing line (ie. the two internal units will be struck first followed by the two outer units).

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5. Another approach in designing berthing structures is to choose a certain velocity of approach normal to the fender plane. It is assumed that this velocity will not be exceeded. If it is exceeded, then the resulting effect can be classified as an accident. Among factors to be considered when selecting the impact velocity are: conditions of approach and exposure of the berth to wind; magnitude and direction of waves and currents; local conditions including particular procedures for manoeuvreing the vessel and the skill of local shore gangs. For guidance, the typical velocities of a berthing ship of over 30,000 long tons displacement, under the various conditions indicated, would be as listed below:

(i)	Difficult approach, strong wind and swell:	1.5 ft/sec.
(ii)	Favourable approach, strong wind and swell:	1.0 ft/sec.
(iii)	Moderate approach, moderate wind and swell:	0.8 ft/sec.
(iv)	Difficult approach, protected from wind and swell:	0.6 ft/sec.
(v)	Favourable approach, protected from wind and swell:	0.4 ft/sec.

6. Assuming the conditions prevailing at the Holyrood Marine Terminal lie somewhere between (iii) and (iv), the impact velocity adopted will lie somewhere between 0.6 and 0.8 ft/sec., say, 0.7 ft/sec (nearly 8 1/2 inches/sec). Assuming the displacement of a 65,000 dwt tanker is 82,500 long tons and its approach velocity is 0.7 ft/sec, the kinetic energy of the approaching vessel will be:

$$= 82{,}500 \times 2.24 \times (0.7)^2/(2 \times 32.2)$$
$$= 1406 \text{ ft. kips.}$$

To allow for hydrodynamic mass, the above kinetic energy must be multiplied by the following factor:

$$\left(1 + 2 \times \frac{\text{draught}}{\text{beam}}\right)$$

$$= \left(1 + 2 \times \frac{42 \text{ feet}}{112 \text{ feet}}\right) = 1.75$$

Thus, the virtual kinetic energy of the berthing ship would be = 1406 x 1.75 - 2460 ft. kips. Depending on the manner in which the ship makes its first contact with the fenders, only a fraction of this energy would be absorbed by the fenders. This energy factor can be adopted as 0.5. Therefore, the energy to be absorbed = 1230 ft. kips. It can be seen from the summary of berthing impacts in section 2 that the retraction of a fender unit and the resultant force under the impact would not exceed 4 feet and 880 kips, respectively. These lie within limits of the structure.

7. The impact of an estimated 880 kips, transmitted through the fender system into the supporting piles at one end of the jetty head, would be primarily resisted by a system of eight 1 in 2.5 batter piles and fourteen vertical ones. The total axial compressive force induced into the 1 in 2.5 batter piles would equal 2370 kips or about 296 kips/pile. The vertical piles would be subjected to a tension of some 2200 kips, equivalent to 157 kips/pile on average.

8. The minimum driving resistance of piles is given as:
   - 500 kips for vertical piles, and
   - 600 kips for 1 in 2.5 batter piles.

   The batter piles have sufficient capacity to withstand impacts of the estimated magnitude. The vertical piles carry all the deadload of the jetty head. Their normal compressive load would be higher than the expected tensile counter reaction due to the expected impacts. They can also tolerate nominal reversal from compression to tension.

9. For comparision, the kinetic energy of 1105 ft. kips estimated in section 4 is equivalent to a berthing velocity of 0.66 feet/sec (8 inches/sec) assuming the same conditions as outlined in section 6.

I hope you find the above notes satisfactory. Should you find it necessary, I will be pleased to expand on them and provide additional information.

Yours very truly,

ORIGINAL signed by

E.S. Komorowski, P. Eng.,

ESK:dm