FRASER SURREY DOCKS RISK ASSESSMENT UPDATE

Risk Assessment Update for Coal Operation

Fraser Surrey Docks

Report No.: 2014-9443, Rev. 3
Date: 2015-05-26

Project name:	Fraser Surrey Docks Risk Assessment Update	Det Norske Veritas (U.S.A.), Inc
Report title:	Risk Assessment Update for Coal Operation	Oil & Gas
Customer:	Fraser Surrey Docks, 11060 Elevator Rd.	Risk Advisory Services
	V3V 2R7 Surrey	1400 Ravello Dr
	Canada	Katy, TX 77449
Contact person:		United States
Date of issue:	2015-05-26	Tel: +1 281 396 1000
Project No.:	PP131963	
Organization unit:	Risk Advisory Services	
Report No.:	2014-9443, Rev. 3	

Task and objective:

Prepared by:	Verified by:	Approved by:
Mia Matuszak Consultant	Danielle Holden Consultant	Cheryl Stahl Senior Principal Consultant

☒ Unrestricted distribution (internal and external)
☐ Unrestricted distribution within DNV GL
☐ Limited distribution within DNV GL after 3 years
☐ No distribution (confidential)
☐ Secret

Keywords:
Fraser River, Risk Assessment, Coal Operation

Reference to part of this report which may lead to misinterpretation is not permissible.

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
0	2014-10-21	First issue	MMATU	TGF	ASPH
1	2014-12-09	Comment Revision	MMATU	TGF	ASPH
2	2015-04-10	Additional Analysis Performed	MMATU	DHOLD	ASPH
3	2015-05-26	Comment Revision	MMATU	DHOLD	CSTAHL

Table of Contents

1 INTRODUCTION

DNV GL has been contracted by Fraser Surrey Docks (FSD) to perform an update to the risk results of a previous navigational risk assessment conducted for FSD in the Fraser River. In 2012, Det Norske Veritas (Canada) Limited (DNV) was hired by FSD to perform a risk assessment of proposed coal barge operations to assess possible navigational risks associated with the increased coal barge traffic (Ref. /1/). The marine navigation risks were assessed from kilometer marker -1.0 (mouth of the river) to FSD at kilometer marker +34.0. Currently, FSD is considering eliminating the potential of 640 barge transits and replacing with 80 transits of Panamax class dry bulk vessels. DNV GL provides an update to the results of the original risk assessment for the year 2016 based on the projected traffic of 80 Panamax transits. A vessel transit is defined in this document as the inbound and outbound movements of a vessel.

2 METHODOLOGY AND APPROACH

DNV GL's MARCS (Marine Accident Risk Calculation System) risk model was used in the 2012 FSD study to assess the accident risk of vessel transits in the Fraser River. The MARCS model uses the study vessel routes, local traffic (current and projected), environmental parameters, and operating procedures to produce various accident frequencies. The data and assumptions used in the original risk assessment were deemed appropriate and sufficient to complete the risk assessment update (Ref. /1/).

This study updates the risk results for the year 2016. The original FSD study modelled the study area for 2014, 2016, and 2018. Year 2016 has been chosen for this update because it is the first year modelled that the proposed change from barges to Panamax class vessels may be applied. A complete re-model of the study area is considered unnecessary for the year 2016 due to the fact that the only parameter that would be altered is the number of study vessels transiting the Fraser River. DNV GL considers that a linear adjustment of the MARCS results for the year 2016 (based on a projection of 80 Panamax class vessels) is appropriate to accurately depict the risk level for the following reasons:

- The traffic data utilized in the original assessment for 2016 remains the same for this study (Ref. /2/). A complete description of the traffic data can be found in Table 2 in Section 4 of the 2012 FSD Risk Assessment Study for Coal Barge Operation (Ref. /1/). A discussion of the projection for future traffic follows Table 2.
- The environmental data and assumptions remain appropriate for the update.
- It is assumed that FSD will implement the same operational procedures and risk controls for the year 2016.
- Due to a lack of available data for barges, the MARCS model used generic cargo ship data to represent barges. This assumption makes the loss of containment and total loss results appropriate to determine the risk results for Panamax class vessels. The generic cargo ships modelled are assumed to be compartmentalized (similarly to a Panamax class vessel), with the main difference between the generic vessels and a Panamax class vessel being the smaller cargo capacity of the generic vessel.

The frequency of accidents for the year 2016 was linearly adjusted using the projected activity summarized in Table 2-1. The frequency results are presented in Section 3.1.

Table 2-1 Summary of Projected Traffic Update

Original Activity	Updated Activity
640 barge tows per year inbound and 640 barge tows per year outbound	80 Panamax class dry bulk carriers per year inbound and 80 Panamax class dry bulk carriers per year outbound

Once a linear adjustment of the accident frequency results was completed, the frequency was combined with a qualitative consequence assessment (Section 3.2) in the form of a risk matrix (Section 3.3). The risk matrix yields the risk results of each accident type and assigns a risk value to each. Conclusions based on the risk results are presented in Section 4.

Note that the update of the risk assessment in this study has only been conducted for the accident frequencies, assuming there is a linear relation between number of vessel transits and the accident frequency. There is a limitation to this approach; there is a lack of differentiation between the likelihood for breaching the cargo containment in a Panamax vessel versus a cargo barge. Further, the assessment of the consequence of a containment loss has not been updated from the original risk assessment, as the export cargo is unchanged (Ref. /1/). Thus, the incident frequency is the only changing risk contributor in this analysis.

3 RISK ASSESSMENT RESULTS FOR PROPOSED OPERATIONS

This section describes the estimated frequency, consequence and risk associated with 80 Panamax vessel calls in the Fraser River for the year 2016. Each vessel call counts as one vessel transit, which is then both the inbound and outbound movements of a Panamax vessel.

3.1 Accident Frequency Results

The following numerical frequency results have been calculated for 80 Panamax vessel transits:

- The total incident frequency (incidents per year) with or without loss of cargo or damage to the vessel (e.g. if the vessel grounds on mud).
- The loss of containment frequency (accidents per year). This result characterizes accidents that result in a release of cargo.

As previously mentioned, the loss of containment frequency and the total loss frequency were calculated using probabilities derived from an analysis of spills from tanker accidents worldwide.

The year 2016 incident frequency results for FSD, with 80 Panamax vessel transits, are presented in Table 3-1 below.

Table 3-1 Annual incident Frequency (Incidents per Year) Results for 80 Panamax Vessel Transits

Incident Type	Incident Frequency	Loss of Containment Frequency
Collision	3.4×10^{-2}	4.5×10^{-3}
Structural Failure/ Foundering	8.8×10^{-5}	2.5×10^{-5}
Fire/ Explosion	1.5×10^{-4}	6.3×10^{-5}
Powered Grounding	1.6×10^{-1}	2.8×10^{-3}
Drift Grounding	7.5×10^{-2}	1.6×10^{-3}
Impact at Fraser Surrey Docks	3.0×10^{-2}	1.0×10^{-3}
Striking at Fraser Surrey Docks	2.1×10^{-3}	1.1×10^{-5}
Total Frequency	3.0×10^{-1}	1.0×10^{-2}

The results in Table 3-1 should be interpreted as the number of incidents and accidents that are estimated to occur per year. For example, 2.8×10^{-3} total loss accidents due to a collision are estimated to occur per year, which is equal to 2.8 total loss accidents in a 1,000 year period, due to collision.

Table 3-2 presents the sum of all incident types for incident frequency, loss of containment frequency, and total loss frequency. The table also shows the return period (in years) for each of the total frequencies. The return period is defined as the mathematical inverse of the frequency of an event occurring. In this context, the return period is the average number of years between each time one defined incident is estimated to occur.

The total frequency reported includes:

- Collision
- Structural Failure/Foundering
- Fire/Explosion
- Powered Grounding
- Drift Grounding
- Impact at Fraser Surrey Docks
- Striking at Fraser Surrey Docks

Table 3-2 Total Incident Frequency and Return Period for 80 Panamax Vessel Transits

	Incident Frequency	Loss of Containment Frequency
Total Frequency (per year)	0.30	0.010
Return Period (years)	3.3	100.3

3.2 Consequence Assessment

In the 2012 study, the focus of the qualitative consequence assessment was the consequence to the environment. The qualitative consequence metric used in the original study is from Transport Canada Pilotage Risk Management Methodology (PRMM) (Ref. /3/). The same metric used in the original FSD assessment is used in this update to maintain comparability of the results. Sub-bituminous coal is expected to be transported during normal operations of FSD. The interpretation of the consequence level from the original risk assessment is maintained, as the export cargo is unchanged (Ref. /1/). The consequence to the environment has been assigned the consequence "D-Medium" based on the consequence definitions presented in Table 3-3.

Table 3-3 PRMM Levels of Consequence to the Environment (Ref. /3/)

Consequence to the Environment				
A-Extreme	**B-Very High**	**C-High**	**D-Medium**	**E-Low**
Sustained long term harm (i.e. damage lasts longer than a month)	Sustained medium term harm (i.e. damage lasts up to one month)	Medium term harm (i.e. damage lasts up to two weeks)	Short term harm (i.e. damage lasts no longer than a week)	Minimal harm (i.e. damage lasts no longer than a day)

3.3 Risk Assessment

Risk is a function of both accident frequency and accident consequence. The risk acceptance criteria and risk matrix used for this study are from PRMM (Ref. /3/). The risk matrix, provided in Table 3-4, is used to determine the level of risk.

The color of each frequency-consequence pair on the matrix indicates the level of risk:

- Green: Risk is acceptable, though low cost risk reduction measures should still be considered for implementation.
- Yellow: Risk is tolerable and must be reduced to As Low as Reasonably Practicable (ALARP) by the implementation of all justified risk reduction measures.
- Red: Risk is unacceptable and the proposed operation should be re-considered, or addition risk mitigating measures introduced to lower the risk (by lowering the consequence and/ or the frequency) and bring the risk down to an acceptable level (Yellow or Green).

Table 3-4 PRMM Risk Acceptance Criteria Matrix (Ref. /3/)

Consequence Metric		Consequence				
		A-Extreme	B-Very High	C-High	D-Medium	E-Low
	Environment	Sustained long term harm (i.e. damage lasts longer than a month)	Sustained medium term harm (i.e. damage lasts up to one month)	Medium term harm (i.e. damage lasts up to two weeks)	Short term harm (i.e. damage lasts no longer than a week)	Minimal harm (i.e. damage lasts no longer than a day)
Frequency Metric		Risk Ranking				
	1-Highly Probable	1A	1B	1C	1D	1E
	2-Probable	2A	2B	2C	2D	2E
	3-Possible	3A	3B	3C	3D	3E
	4-Unlikely	4A	4B	4C	4D	4E
	5-Improbable	5A	5B	5C	5D	5E

Frequency Definitions	Definition	Accident Return Period (interpretation)
Highly Probable	Almost certain the event will occur OR at least once over a period of one year.	Less than or equal to 1 year
Probable	Expected that the event will occur OR at least once over a period of three years	Between 1 and 3 years
Possible	The event could occur over a period of 10 years	Between 3 and 10 years
Unlikely	It is not expected that the event will could occur during a period of 10 years	Between 10 and 25 years
Improbable	It is not expected that the event will occur during any defined period.	Assume greater than 25 years

The risk results, based on the definition in the risk matrix, are provided in Table 3-5.

Table 3-5 Risk Results

Incident Type	Year 2016 – 80 Panamax Transits		
	Incident Frequency	Loss of Containment Frequency	Total Loss Frequency
Collision	5D	5D	5D
Structural Failure / Foundering	5D	5D	5D
Fire / Explosion	5D	5D	5D
Powered Grounding	**3D**	5D	5D
Drift Grounding	**4D**	5D	5D
Impact at Fraser Surrey Docks	5D	5D	5D
Striking at Fraser Surrey Docks	5D	5D	5D
Total Frequency (per year)	5D	5D	5D

Table 3-5 shows that all the risks assessed are in the 'green' category (i.e. risk is acceptable, though low cost risk reduction measures should still be considered for implementation).

Table 3-6 describes possible risk reduction measures based on the risk results for FSD, some of which may already be in place.

Table 3-6 Possible Risk Management Options

Category	Risk Management Options
Equipment Selection and Inspection	• All operational vessels will be inspected at regular intervals to ensure they meet Transport Canada regulations.
Operational Aspects	• Operations will not be conducted in high wind conditions in order to lessen the chances of an accident. The criteria will be defined in broad terms leaving room for taking into account operator experience. • All night time operations will follow mandatory lighting and manning requirements. • Require tankers to conduct pre-arrival tests and inspections on critical systems before entering or operating in more restrictive waters in the study area • Pilotage for FSD vessels
Management	• Strong safety culture with management system support

4 CONCLUSIONS

Marine incidents are expected to occur most frequently when all barges are used in transit and least frequency when all Panamax class vessels are used in transit. This directly correlates to the number of vessels that travel the Fraser River in each of the cases, due to the nature of the linear frequency adjustment.

Based on the risk results, this study update concludes that the proposed coal export operations (year 2016, with 80 transits of Panamax class vessels) are acceptable according to the risk acceptance criteria in the applied risk matrix. The highest risks are associated with powered and drift grounding. The risk results show that although grounding occurs at a higher incident frequency than other incident types, the frequency of a loss of containment remains in the lowest defined frequency category in the risk matrix. For this frequency category, risk is acceptable with the estimated consequences for a coal discharge. However, low cost risk reduction measures should still be considered for implementation if deemed cost efficient. The recommended risk mitigations based on the results of the study update for all Panamax class vessels are outlined in Table 3-6.

5 REFERENCES

/1/	Det Norske Veritas, Risk Assessment Study for Coal Barge Operation, prepared for Fraser Surrey Docks, Rev. 2A. September 26, 2012.
/2/	Det Norske Veritas, Fraser River Tanker Traffic Study, prepared for Port Metro Vancouver, Rev. 1 June 6, 2012.
/3/	Transport Canada Pilotage Risk Management Methodology (PRMM) Publication No.TP 13741E. May 2010.

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.