TERMPOL 3.8 – CASUALTY DATA SURVEY

Trans Mountain Expansion Project

Prepared for:

TRANS MOUNTAIN

Prepared by:

Det Norske Veritas (U.S.A.), Inc.
1400 Ravello Drive
77449 Katy Texas
United States

DET NORSKE VERITAS™

REPORT

TRANS MOUNTAIN PIPELINE EXPANSION PROJECT

TERMPOL 3.8 CASUALTY DATA SURVEY

TRANSMOUNTAIN

REPORT NO./DNV REG NO.: 167ITKV-10 / PP061115
REV 0, SEPTEMBER 2013

MANAGING RISK

Trans Mountain Pipeline Expansion Project - TERMPOL 3.8

Det Norske Veritas (USA) Inc
1400 Ravello Dr
Katy, TX 77449
Tel: (281) 396-1000
http://www.dnv.com

For:
Trans Mountain
300 Fifth Avenue SW - Suite 2700
T2P 5J2 Calgary
Canada

Account Ref.:
Bikramjit Kanjilal

Date of Current Issue:	September 2013	Project No.:	PP061115
Revision No.:	0	Organization Unit:	Energy Solutions
DNV Reg. No.:	167ITKV-10/PP061115	Report No.:	167ITKV-10

Summary:

This report describes the casualty data survey performed as part of the TERMPOL Review for the Trans Mountain Pipeline Project. The casualty data survey has been completed through a review of:

- Worldwide casualty data from the IHS Fairplay database (IHS) (Ref. /1/), considered to be one of the world's most comprehensive casualty database for the marine industry;
- Oil spills recorded by the International Tanker Owners Pollution Federation Limited (ITOPF) (Ref. /2/);
- Incidents in Canadian waters summarized in Marine Statistics, published by the Transportation Safety Board of Canada (TSB) (Ref. /3/).
- Incidents in British Columbia summarized in Pacific Pilotage Authorities (PPA) incident database.
- Incidents in US waters summarized in Marine Statistics (Marine Casualty and Pollution Data) from the US Coast Guards published by Homeport - US Department of Homeland Security (Ref. /4/).

The casualty data survey shows that there has been a decline in the number of incidents both internationally and in Canadian waters for 2002 - 2011. The most relevant spill frequency to be used for validation/evaluation of the risk modeling result in TERMPOL 3.15 is the results from the ITOPF database. Based on the last ten years of data it is estimated that tank vessels have 1.6 accidents every 1,000 shipyears with oil spill over 7 tons.

Prepared by:	*Name and Position* Vincent Demay Consultant	*Signature*
Verified by:	*Name and Position* Ole Oystein Aspholm Senior Principal Consultant	*Signature*
Approved by:	*Name and Position* Nick Roper Regional Manager Canada	*Signature*

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

Keywords

Incident data
Marine
Oil spill

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
0	11/7/13	First issue signed and verified	Demay	Aspholm	Roper

Table of Contents

1 INTRODUCTION

1.1 Objective

This report describes the casualty data survey performed as part of the TERMPOL Review for the Trans Mountain Pipeline Project.

In addition to collision and grounding (wrecking/stranding), the casualty data survey also includes fire/explosion, foundering and contact incidents.

The report examines available incident data at five levels of detail, including:

- Global incident data for bulk (liquid and dry) carriers
- Global accidental oil spill data for oil tankers
- National and regional incident data for oil tankers in the USA
- National incident data for Canadian waters
- Local incident data for Canadian waters of British Columbia

The risk assessment that is conducted under TERMPOL 3.15 utilizes an advanced numerical risk model that incorporates casualty data over time and accounts for relevant risk controls for the project. The incident frequency data that is derived from the casualty databases discussed in this document do not have a proportional relationship with the accident frequencies estimated in TERMPOL 3.15. One of the reasons that these are not proportionally related is because casualty data lacks corresponding exposure data. One exception for this is the global data where the IHS Fairplay database also gives overview of number of vessels in operation. Another reason is that the model applied in TERMPOL 3.15 accounts for locally implemented risk controls and local weather and navigational conditions.

This casualty study uses several databases to produce estimates of incident frequencies per ship year and/or per year for the study area. Based on the analysis of these available accident data, a comparison will be made in TERMPOL 3.15 between the casualty results and the risk modeling results of the QRA.

1.2 Abbreviations

BC	British Columbia
DNV	Det Norske Veritas
IHS	IHS Fairplay (in the context of this document refers to the IHS Fairplay incident database published annually)
ITOPF	International Tanker Owners Pollution Federation LTD
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
OBO	Oil Bulk Ore
PPA	Pacific Pilotage Authority
QRA	Quantitative Risk Assessment
TERMPOL	Technical Review Process of Marine Terminal Systems and Transshipment Sites (in the context of this document refers specifically to TERMPOL Review Process summarized in Transport Canada publication TP 743E).
TSB	Transportation Safety Board of Canada

2 METHODOLOGY

The casualty data survey has been completed through a review of:

- Worldwide casualty data from the IHS Fairplay database (IHS) (Ref. /1/), considered to be one of the world's most comprehensive casualty database for the marine industry;
- Oil spills recorded by the International Tanker Owners Pollution Federation Limited (ITOPF) (Ref. /2/);
- Incidents in Canadian waters summarized in Marine Statistics, published by the Transportation Safety Board of Canada (TSB) (Ref. /3/).
- Incidents in British Columbia summarized in Pacific Pilotage Authorities (PPA) incident database.
- Incidents in US waters summarized in Marine Statistics (Marine Casualty and Pollution Data) from the US Coast Guards published by Homeport - US Department of Homeland Security (Ref. /4/).

Produced annually, the IHS Fairplay database lists all vessels removed from the propelled sea-going merchant fleet as losses or disposals. Losses are analyzed and disposals are categorized. Details in the database include the ship name, flag, gross tonnage, year built, location and a summary of the casualty incident suffered, including the fate of the vessel and crew.

The Marine Casualty and Pollution Data files provide details about marine casualty and pollution incidents investigated by U.S. Coast Guard Offices throughout the United States. The database can be used to analyze marine incidents and pollution incidents by a variety of factors including vessel or facility type, injuries, fatalities, pollutant details, location, and date.

The Transportation Safety Board of Canada (TSB) is an independent agency, separate from other government agencies and departments, which reports to Parliament through the President of the Queen's Privy Council for Canada. The TSB has a mandate to identify safety deficiencies, as evidenced by transportation incidents. The TSB is the most definitive source of marine incidents in Canadian waters.

This report summarizes the information from the noted data sources in the following chapters:

- Chapter 3: Global Trend in Maritime Shipping Safety
- Chapter 4: Review of Global Oil Tanker Incidents
- Chapter 5: Review of Incidents in Canadian waters
- Chapter 6: Review of Incidents in US waters

A common challenge with casualty databases is that there are seldom sufficient available data about the traffic density (exposure data) directly related to the area of study. Although global data is good, it cannot be directly applied to a specific location where local traffic could be quite different.

This casualty study will aim to give an estimate of incident frequencies per shipyear or per year for an area. These data will be used for comparison with and evaluation of the risk modeling results in TERMPOL 3.15.

3 GLOBAL TREND IN MARITIME SHIPPING SAFETY

The safety record in the marine industry has improved continuously in the last four decades. Regulatory improvements and lessons learned from past incidents have led to improved safety procedures and increased commercial and regulatory emphasis on safety.

The number of total ship losses is generally considered the best indicator of the improved navigational safety record of the shipping industry. The definition of a total loss is when the ship sinks (actual loss) or is scrapped due to damage repair cost that will exceed insurance value (constructive loss). The following ship types, similar to those operating to and from the Westridge Marine Terminal, were selected to illustrate the decrease in total losses:

- Oil Tankers (including product tankers)
- Liquid Natural Gas (LNG) Tankers
- Liquid Petroleum Gas (LPG) Tankers
- Chemical Tankers
- Dry Bulk Carriers

The following total loss incident and fatality numbers are provided just as an indicator of improved navigational safety.

Figure 3-1 illustrates the trend of total loss incidents for the selected ship types for the period 2002-2011. Because the number of vessels has increased over the same period, the total loss incident number has been plotted per 1,000 shipyears (a shipyear is defined as one ship operating for one year). Over this period, the average number of total losses per 1,000 shipyears was 1.0.

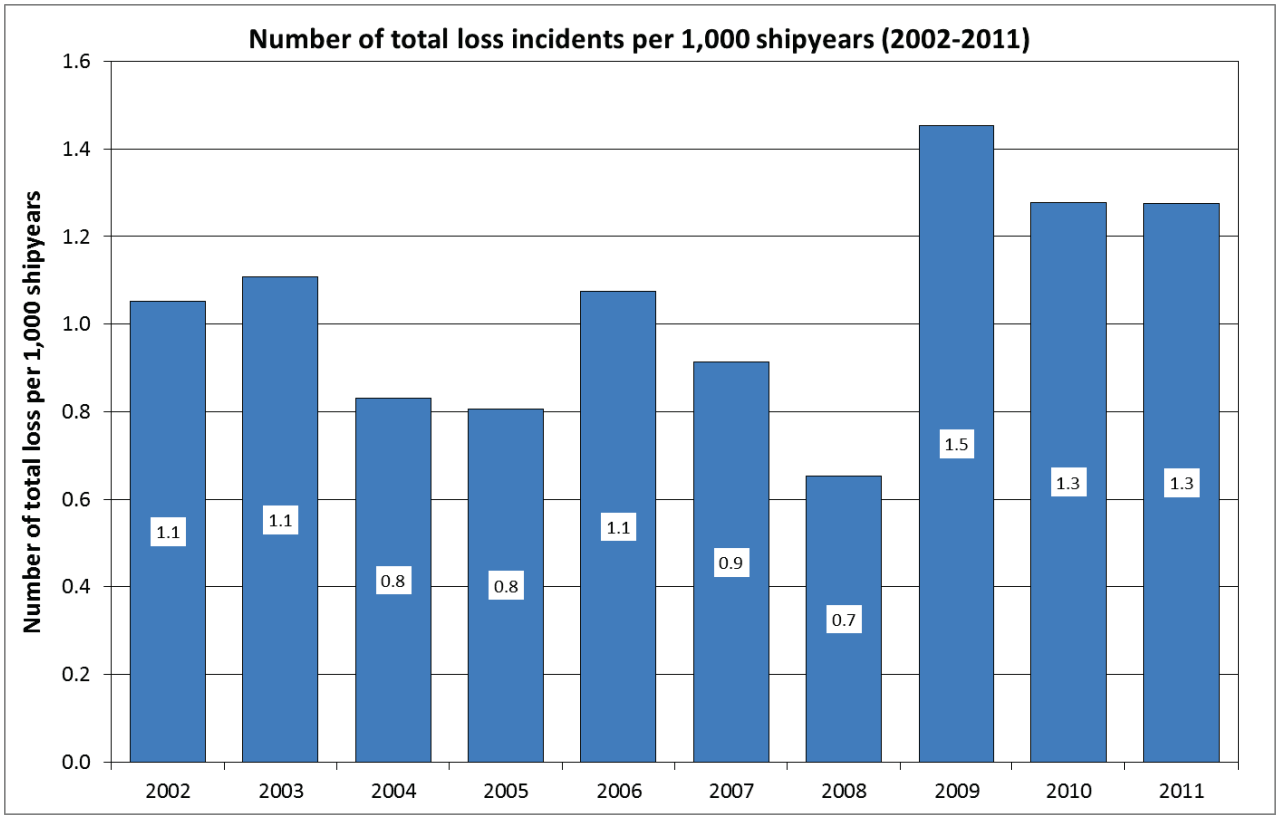

Figure 3-1 Annual worldwide total loss incidents (actual and constructive losses) per 1000 shipyears for the oil, gas, chemical tankers and bulk carriers for 2002-2011 (Ref. /1/)

Figure 3-2 shows the annual worldwide fatalities per 1,000 shipyears from 2002 – 2011. The average over this period is 2.1 fatalities per 1,000 shipyears.

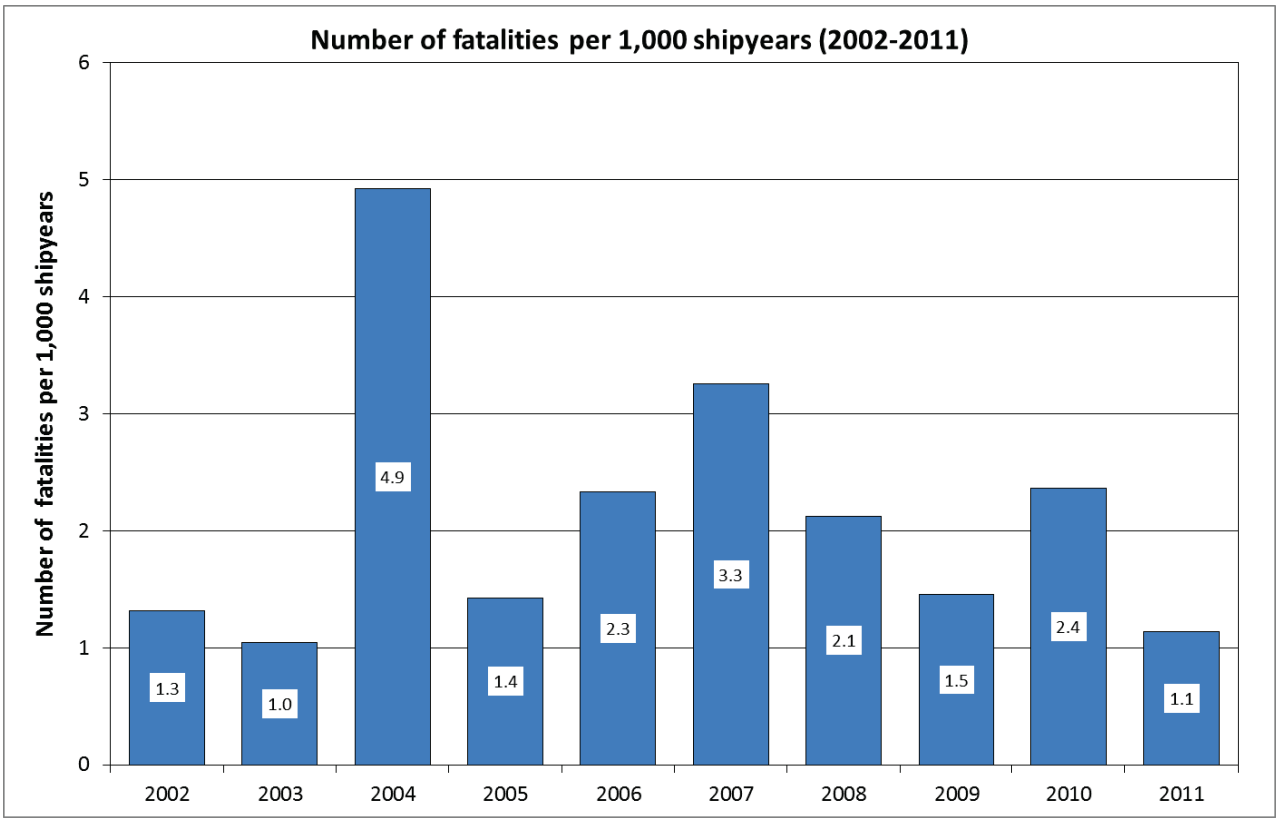

Figure 3-2: Annual worldwide fatalities per 1000 shipyears for the selected ship types 2002-2011 (Ref. /1/)

4 REVIEW OF GLOBAL OIL TANKER INCIDENTS

The following chapter reviews global oil tanker incidents and oil spills that have occurred. The information and data presented is based on statistics from 2002 - 2011 obtained from the IHS Fairplay Incident database (Ref. /1/) and the International Tanker Owners Pollution Federation Ltd (ITOPF) (Ref. /2/).

4.1 Overall Global Tanker Incidents

As the overall global safety record for the maritime industry has improved, so has the record for oil tankers. Figure 4-1 shows that the incident frequency for oil tankers was among the lowest of all dry and wet bulk carriers for the period 2002-2011. It should be noted that only a fraction of the total incidents led to oil spills. The incident data includes a variety of incidents categories. Incidents in this section are divided into 3 categories:

1. **Not serious** - any event reported to IHS database and included in the database, not being categorized as serious or total loss (defined below).
2. **Serious** - breakdown resulting in the ship being towed or requiring assistance from ashore; flooding of any compartment; or structural, mechanical or electrical damage requiring repairs before the ship can continue trading. In this context, serious incident does not result in total loss.
3. **Total loss** - where the ship sinks after an incident and the ship is irrecoverable (actual total loss) or where the ship is declared constructive total loss when repair cost exceeds insurance value.

The sum of all incident categories for oil tankers based on statistics for 2002 - 2011 is 15.7 per 1,000 vessels operating per year (often expressed as $1.6x10^{-2}$) or an expected incident every 64 years per tanker (see below Figure 4-1 and Figure 4-2).

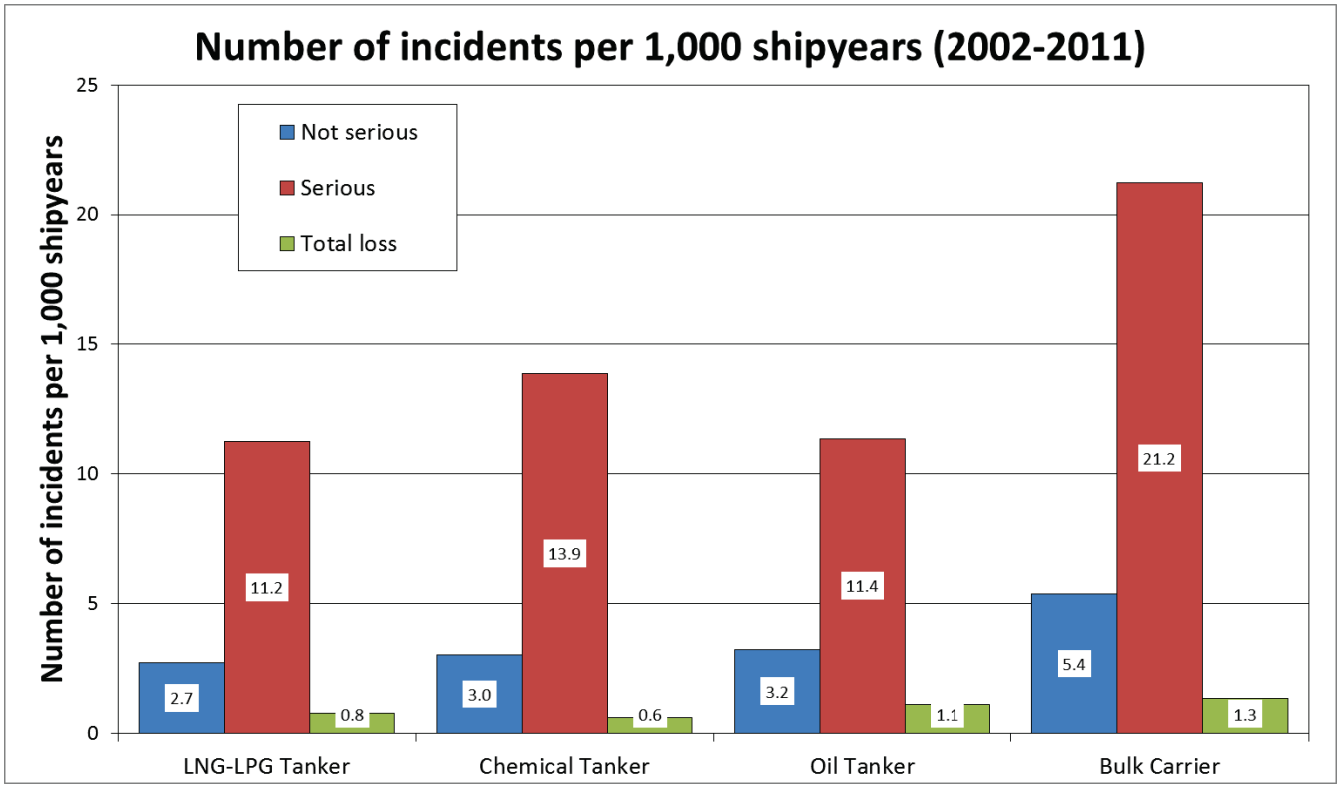

Figure 4-1: Worldwide number of incidents for 2002-2011 (Ref. /1/)

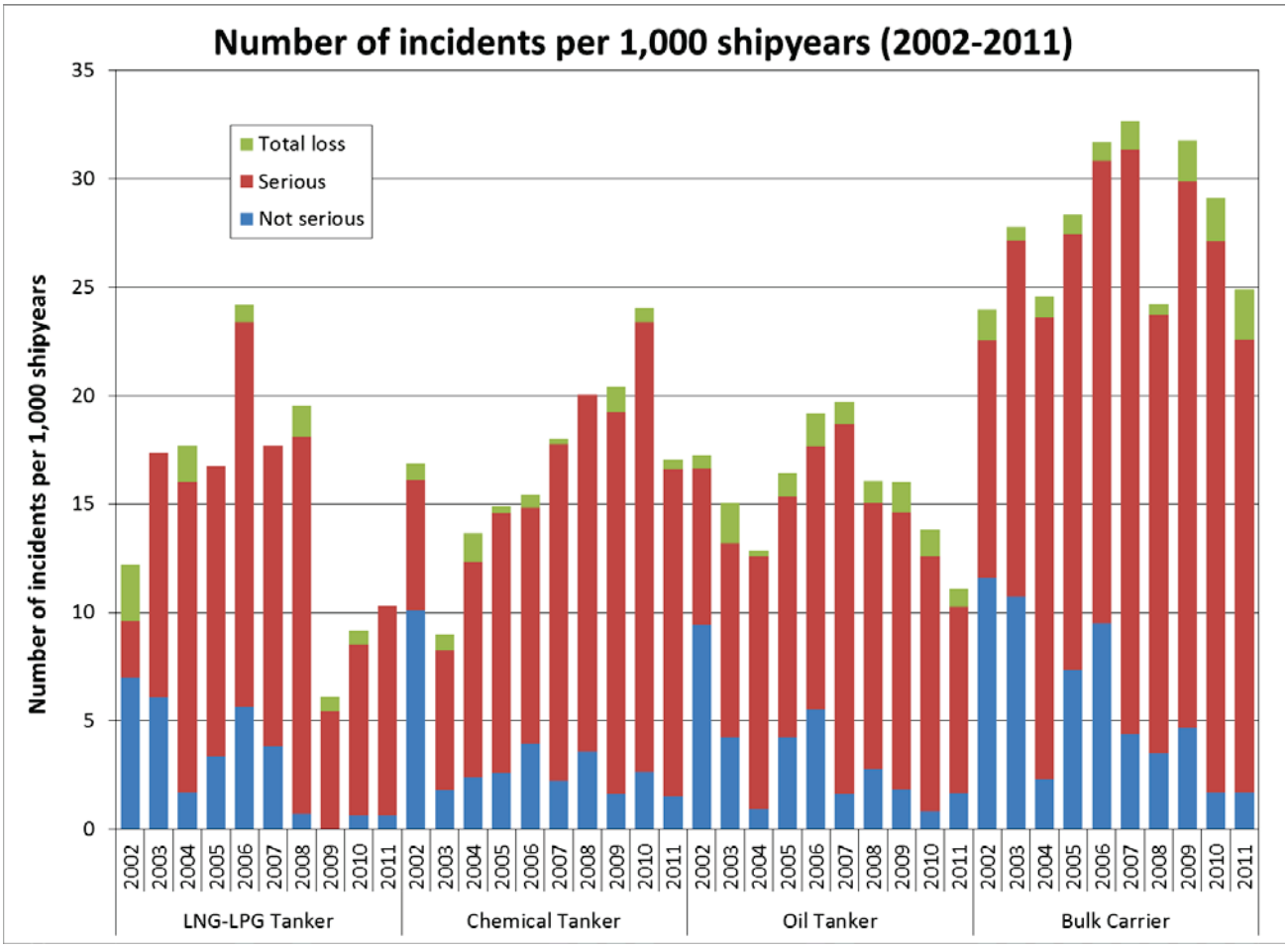

Figure 4-2: Worldwide yearly number of incidents for 2002-2011 (Ref. /1/)

As can be seen from Figure 4-3, the majority of incidents for oil tankers are categorized as serious (72%), 21% are not serious and 7 % resulted in a total loss.

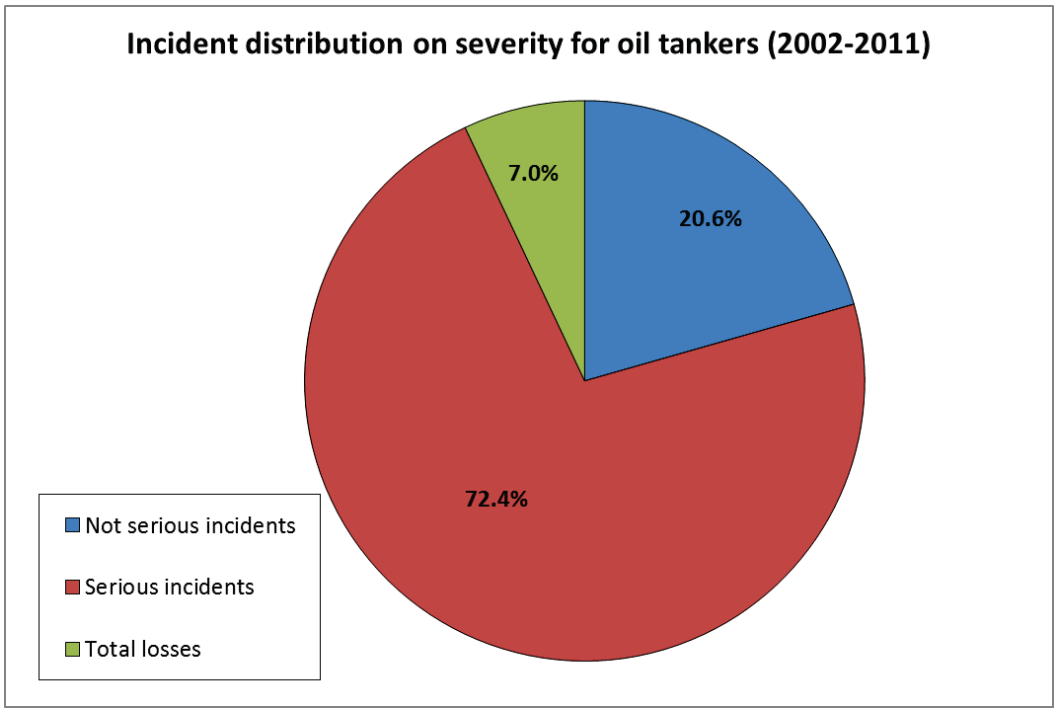

Figure 4-3: Worldwide incident distribution for oil tankers by IHS incident category for 2002-2011 (Ref. /1/)

DNV believes that the reason for that the number of "not serious incidents" is lower than the number of "serious incidents" is that the "not serious incidents" are underreported in the database.

In Figure 4-4, the total incident frequency is broken down by the type of incident.

- Collision – Collision with another vessel
- Contact – Collision with the pier / jetty
- Fire / explosion
- Foundering – Sinking due to other causes (mainly structural failures)
- Grounding (Wrecking/Stranding).

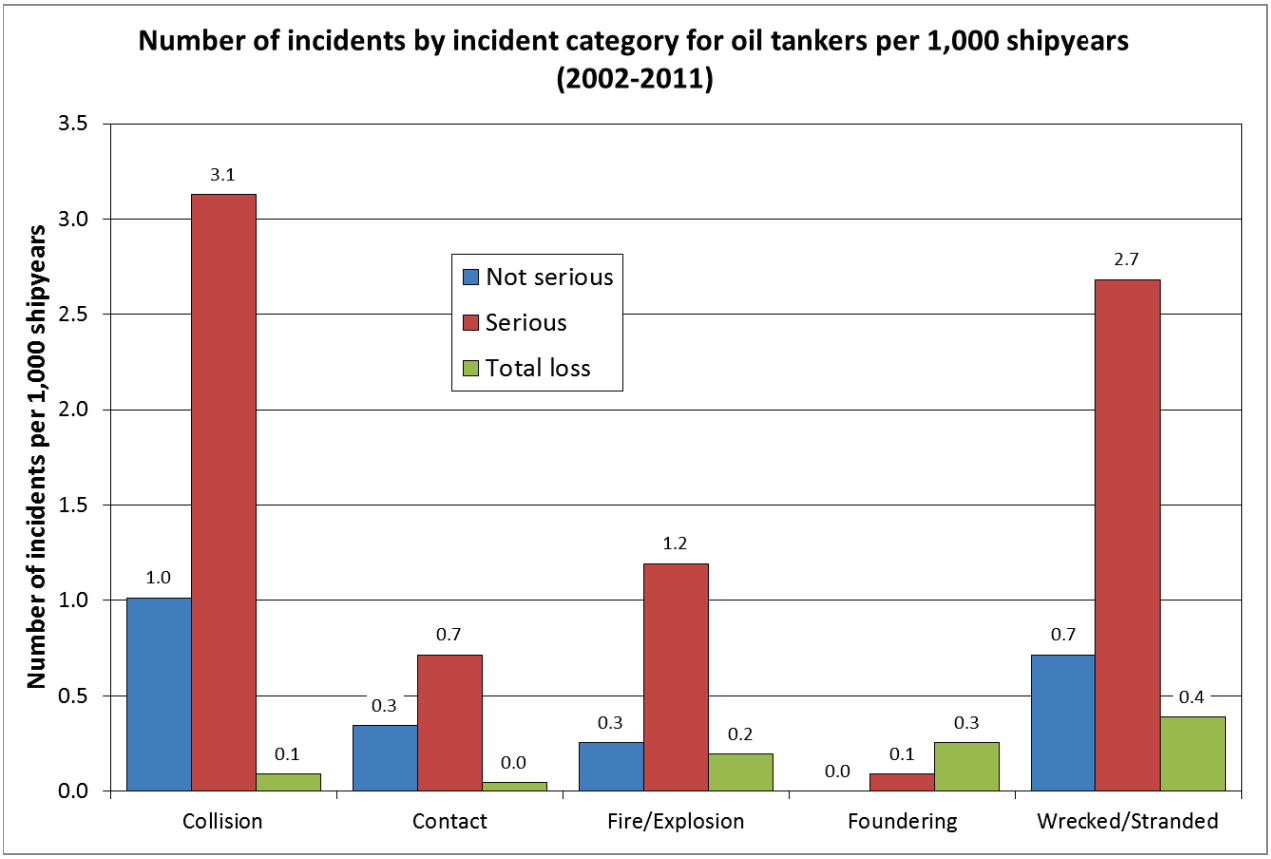

Figure 4-4: Worldwide number of incidents by incident category for oil tankers for 2002-2011 (Ref. /1/)

The Wrecked/Stranded category from the IHS Fairplay database is assumed to be the same as the Grounding category used elsewhere in this data survey report. The Contact category is assumed to be the same as the Allision category. Allison is defined as a collision with a non-moving object, either a docked vessel or a fixed object as a terminal platform. DNV has chosen to use the category labels as used in the database.

From the data it is clear that collision and allision categories infrequently result in a total loss of an oil tanker. Collision and grounding (Wrecked/Stranded) were the most frequent incidents for *not serious* and *serious* incidents. The total losses were mainly the resulted from fire/explosion, foundering and grounding incident types.

The incident data for the global oil tanker fleet shown in this section is not directly comparable to the study area for the risk assessment in TERMPOL 3.15. Consider that the exposure data for global oil tankers includes all the sailing of the tankers, also in high seas while the likelihood for an incident at high seas is much lower than in coastal waters. In addition, the part of a shipyear where oil tankers are exposed to grounding and collision risks is lower than the full shipyear. Local weather conditions and the navigability of the sailing route will also affect the likelihood for an incident. Further, the study area has several local risk controls implemented that will reduce the likelihood for an incident.

4.2 Accidental Oil Spills

A good indicator of the improvements seen in terms of oil tanker operation is the number of oil spills recorded by the International Tanker Owners Pollution Federation Ltd (ITOPF (Ref. /2/). There has been a significant reduction in incidental oil spills larger than 7 tons since ITOPF started recording such data in the early 1970s. Figure 4-5 shows that the average number of spills has declined substantially since 1970.

Spikes in the number of incidental oil spills in Figure 4-5 can be partially explained by increases in seaborne shipment of oil and number of oil tankers. This has usually led to an increase in the total number of oil spills recorded. However, periods of increased incidents have also lead to an increased focus on oil tanker operations and new regulations. In spite of the steady increase in the volume of oil being transported over the period shown below, the number of oil spills has decreased as shown in Figure 4-6.

ITOPF classifies spills up to 7 tons as small, spills between 7 tons and 700 tons as medium, while spills exceeding 700 tons are classified as large.

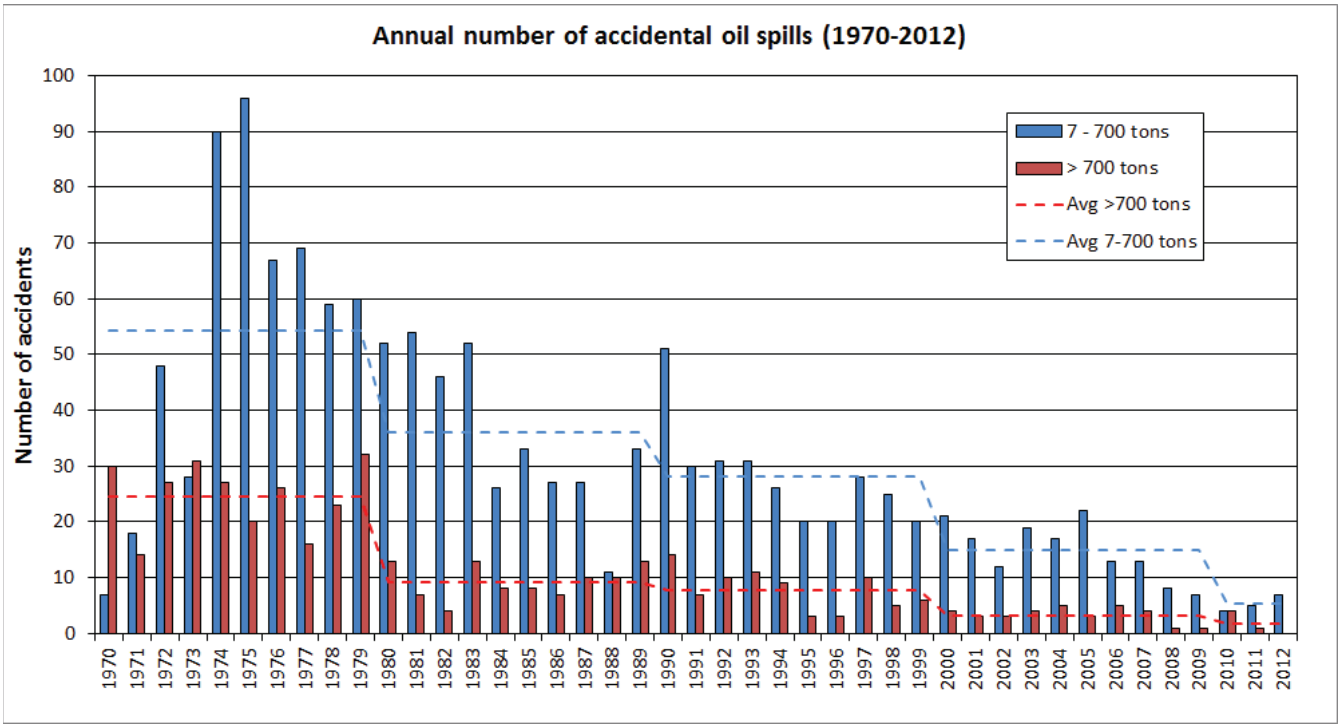

Figure 4-5: Annual number of accidental oil spills worldwide for 1970-2012. The dashed lines show the average for each decade (Ref./2/)

As shown in Figure 4-5 the number of spills recorded over the last 4 decades has declined significantly. The average number of medium spills (7-700 tons) per year has declined from an average of 28 for 1990 - 1999 to an average of 15 for 2000 - 2009. The average number of large spills (>700 tons) has also declined from an average of 8 for 1990 - 1999 to an average of 3 for 2000 - 2009.

The substitution of single hull tankers with double hull tankers with more segregated oil tanks, improved reliability of machinery, improved navigational aids and improved risk management are expected to be the main reasons for this reduction in oil spill incidents. The effect of double hull tankers is discussed in section 7.

The number of incidental oil spill per 1,000 shipyears for 2002 to 2012 are shown in Figure 4-6. The number of medium size oil spills (7-700 tons) exceeded 2 per 1,000 shipyears at the beginning of the decade but has been below 0.7 since 2010. The number of large oil spills (>700 tons) has also decreased over the last decade with 0.4 - 0.6 spills per 1000 shipyears in the first half of the decade till 0 - 0.4 spills per 1000 shipyears in the last half of the decade.

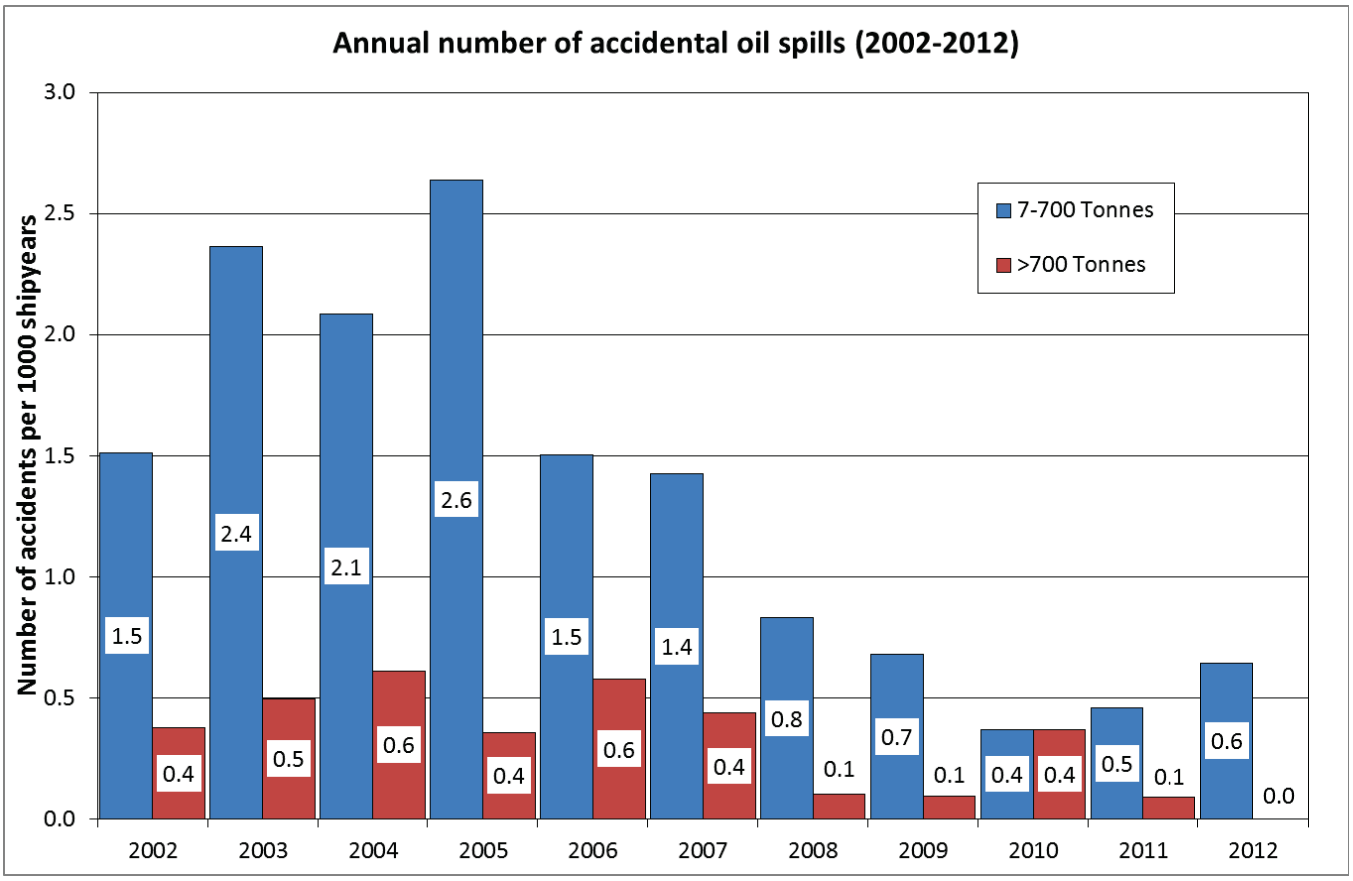

Figure 4-6: Number of accidental oil spills per 1,000 shipyears for 2002-2012, based on global data (Ref./2/)

Based on the last ten years of global data it is estimated that tanker vessels have a frequency of 1.6 accidents per 1,000 shipyears with oil spill exceeding 7 tons. This frequency would vary by regions depending on the risk reducing measures in place, weather and current conditions as well as the navigability of the sailing route. For such information related to the study area for Trans Mountain traffic, please refer to TERMPOL 3.15.

5 REVIEW OF INCIDENTS IN CANADIAN WATERS

The following chapter reviews incidents that have occurred in Canadian waters. The information and data presented is based on statistics obtained from the Transportation Safety Board of Canada (TSB) (Ref. /3/) and from Pacific Pilotage Authority.

5.1 Overall Number of Shipping Incidents

The incident data for Canadian waters from the TSB is categorized by Region (Western, Central, Laurentian, Maritimes, Newfoundland, Arctic and Foreign). For each incident the causes and consequences, the affected vessels (type, size) and the geographical location are provided.

In 2011, 322 marine incidents were reported to the Transportation Safety Board of Canada (TSB), which was lower than the 2010 total of 354 by 9% and lower than the 2006-2010 average of 420 by 23%. Over the last decade, 88% of Canadian marine incidents have been shipping incidents resulting in vessel damage, while the remaining incidents were onboard incidents that lead to personnel injuries.

Shipping incidents totaled 285 in 2011, which represents a decline of 5% from the 2010 total of 299 and a 22% reduction from the 2006-2010 average of 364. This is in line with international trends in maritime safety. Figure 5-1 shows that there has been a downward trend in the number of shipping incidents in Canadian waters since 2002.

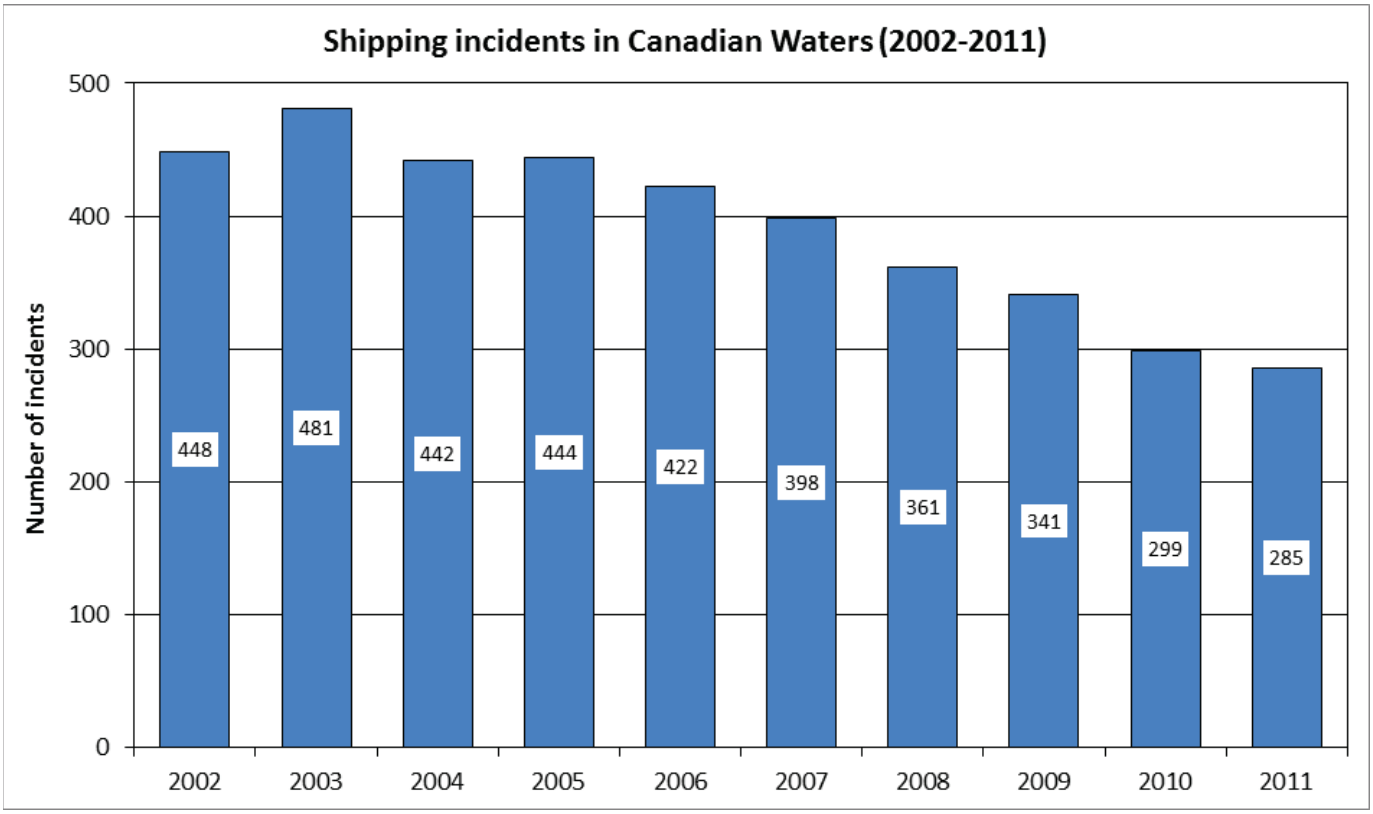

Figure 5-1: Annual number of shipping incidents in Canadian Waters for 2002-2011 (Ref./3/)

In 2011, there were 23,560 fishing vessels in Canada, representing 55% of all registered vessels excluding pleasure crafts (Ref. /3/). Since 2002, approximately 45% of the vessels involved in shipping incidents were fishing vessels (see Figure 5-2). In 2011, there were 121 fishing vessels involved in shipping incidents, which represent a 28% reduction from the 2006-2010 average of 169.

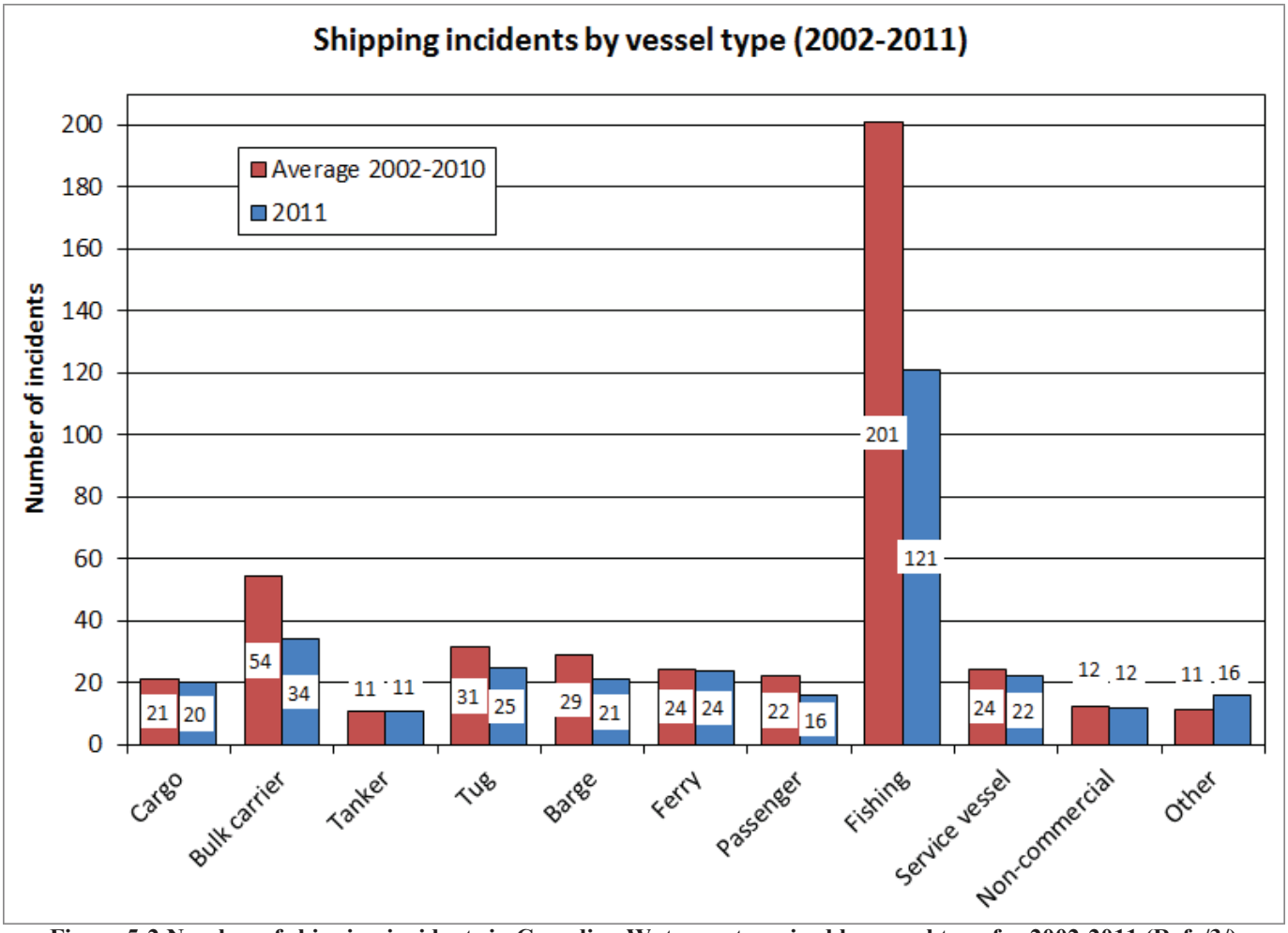

Figure 5-2 Number of shipping incidents in Canadian Waters categorized by vessel type for 2002-2011 (Ref. /3/)

After fishing vessels, tugs/barges (14%) and bulk carriers (11%) were most often involved in shipping incidents in 2011. The bulk carrier data also includes dry/wet bulk (OBO) vessels. Although the use of OBO vessels has decreased since the 1980s it cannot be excluded that these vessel types are also used as oil carriers. However, Trans Mountain will only use tankers for oil transport. As a result, the incident data for oil tankers is most relevant for this study. In 2011 there were 11 tankers involved in incidents all over Canada (less than 3.5% of the incidents), matching the 10-year average. This is the lowest number of all vessel categories.

5.2 Shipping Incidents by Incident Type

As illustrated in Figure 5-3, the most frequent types of shipping incidents in 2011 were grounding (25%), striking (19%) and fire/explosion (18%).

Compared to the 10-year average, all incident types saw a decrease in frequency: 31% for grounding, 17% for striking, 9% for fire/explosion, 43% for foundering/sinking and 19% for collision.

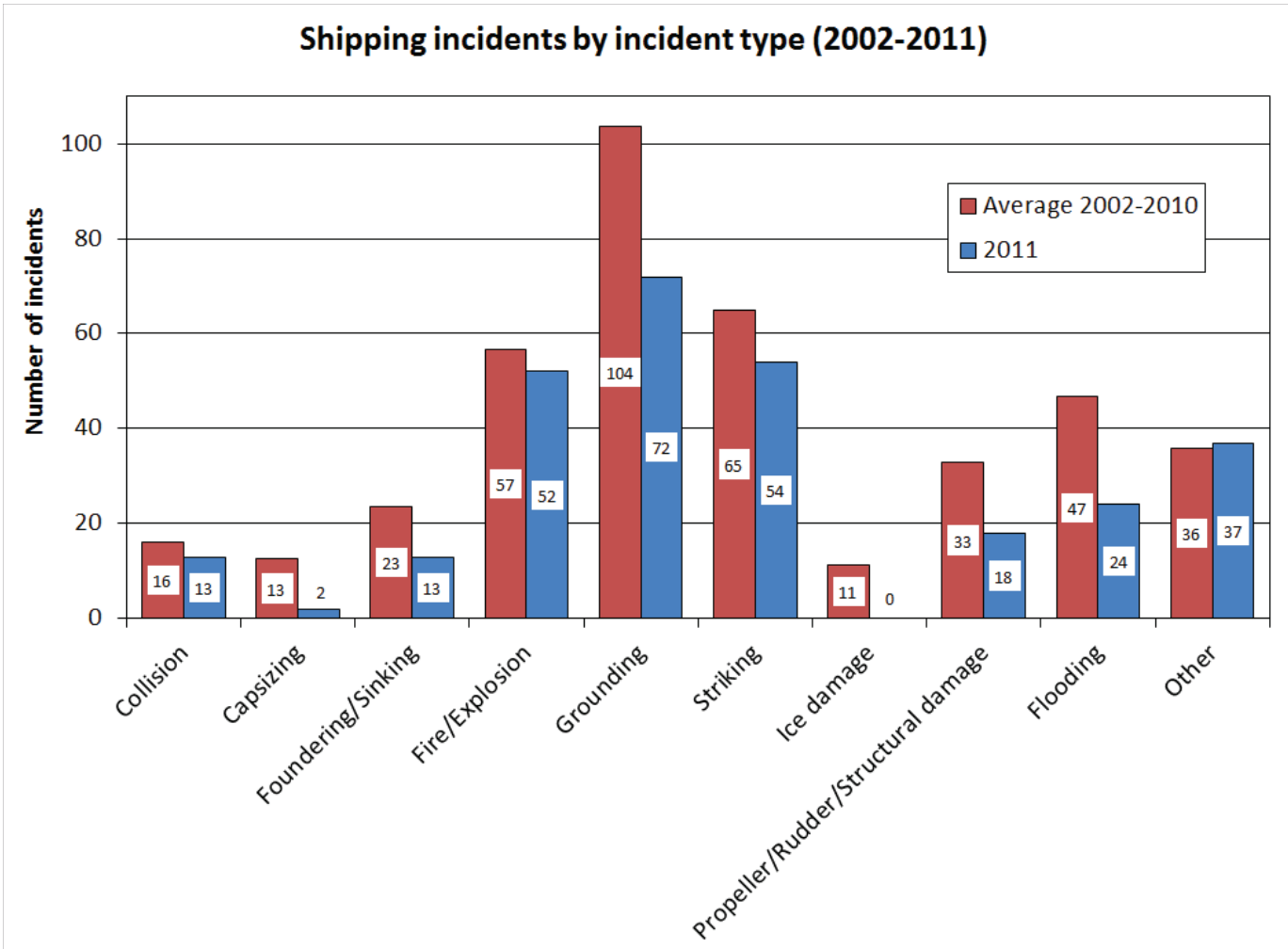

Figure 5-3 Number of shipping incidents in Canadian Waters categorized by incident type for 2002-2011 (Ref. /3/)

5.3 Shipping Incidents by Geographical Region

In 2011, 31% of shipping incidents occurred in the Western Region (see Figure 5-4). Fishing vessel incidents were the most common in these waters. All regions saw a drop in the number of incidents in 2011 compared to the 2002-2010 average. The Western Region had the highest number of incidents, which is due to the size of region and number of vessels compared to the other regions. The average number of incidents from 2002-2010 is 119, compared to 89 in 2011. The majority of these incidents are related to fishing vessels.

The Laurentian, Central, Maritimes and Newfoundland Regions accounted from 9% to 23% of the total number of shipping incidents in Canadian waters in 2011. The remaining 3% of shipping incidents took place in foreign (non-Canadian) waters or in the Arctic Region.

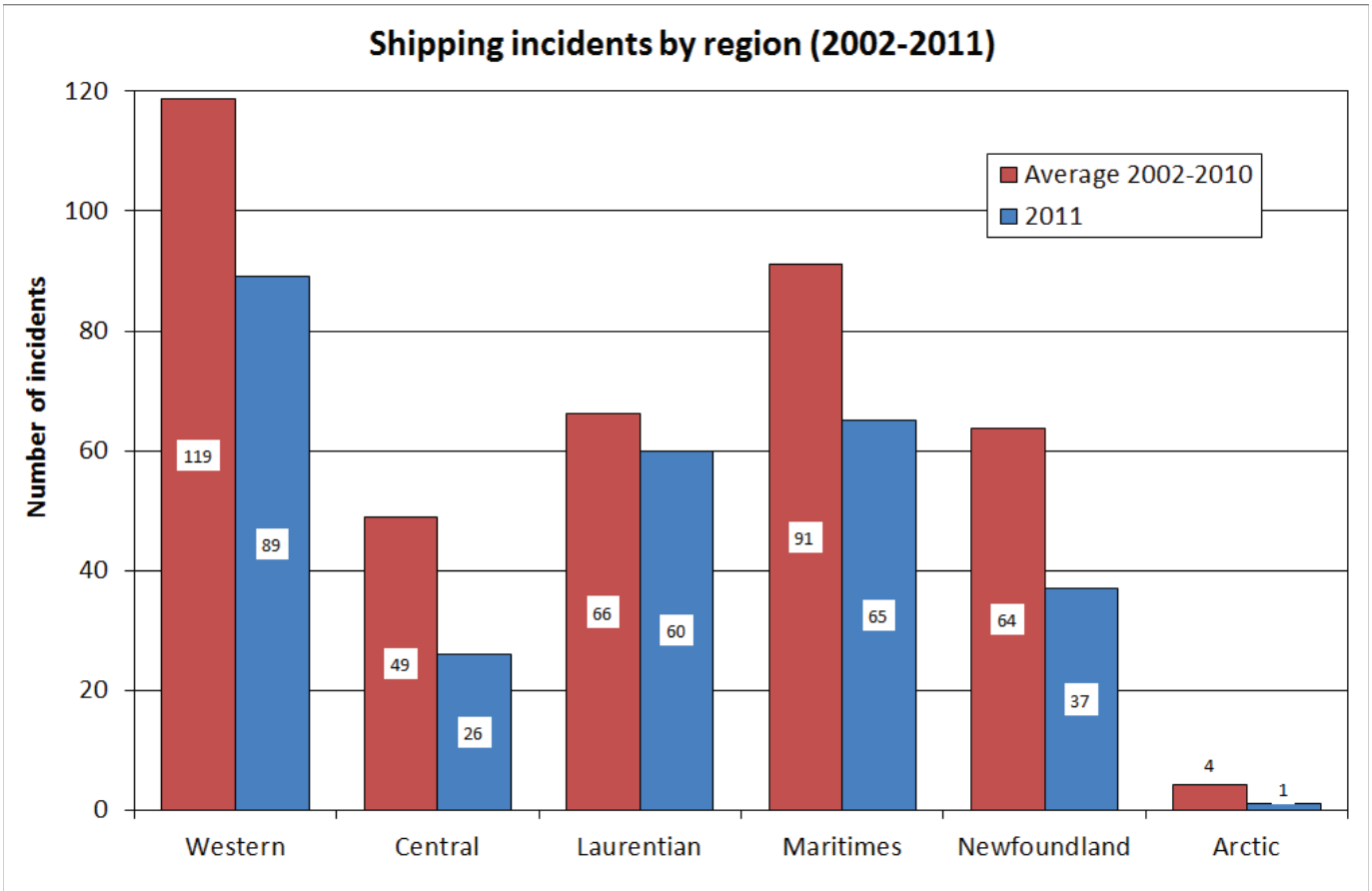

Figure 5-4 Number of shipping incidents in Canadian Waters categorized by TSB region for 2002-2011 (Ref. /3/)

5.4 Shipping incidents in the Western Region - British Columbia

Figure 5-5 shows the average number of incidents in the Western Region, which represents the coast of British Columbia, for 2002-2010 and for 2011.

The majority of incidents are related to fishing vessel and tug and barges. There is only one incident involving a tanker vessel during the period from 2002-2011. That incident did not lead to damage of the hull or oil spill.

There is no traffic density data correlated to the TSB data so it is not possible to derive incident frequencies based in terms of number of ship years or sailed nautical miles. The data gives a good indication of the low number of vessel incidents in the region, especially for the tanker vessels.

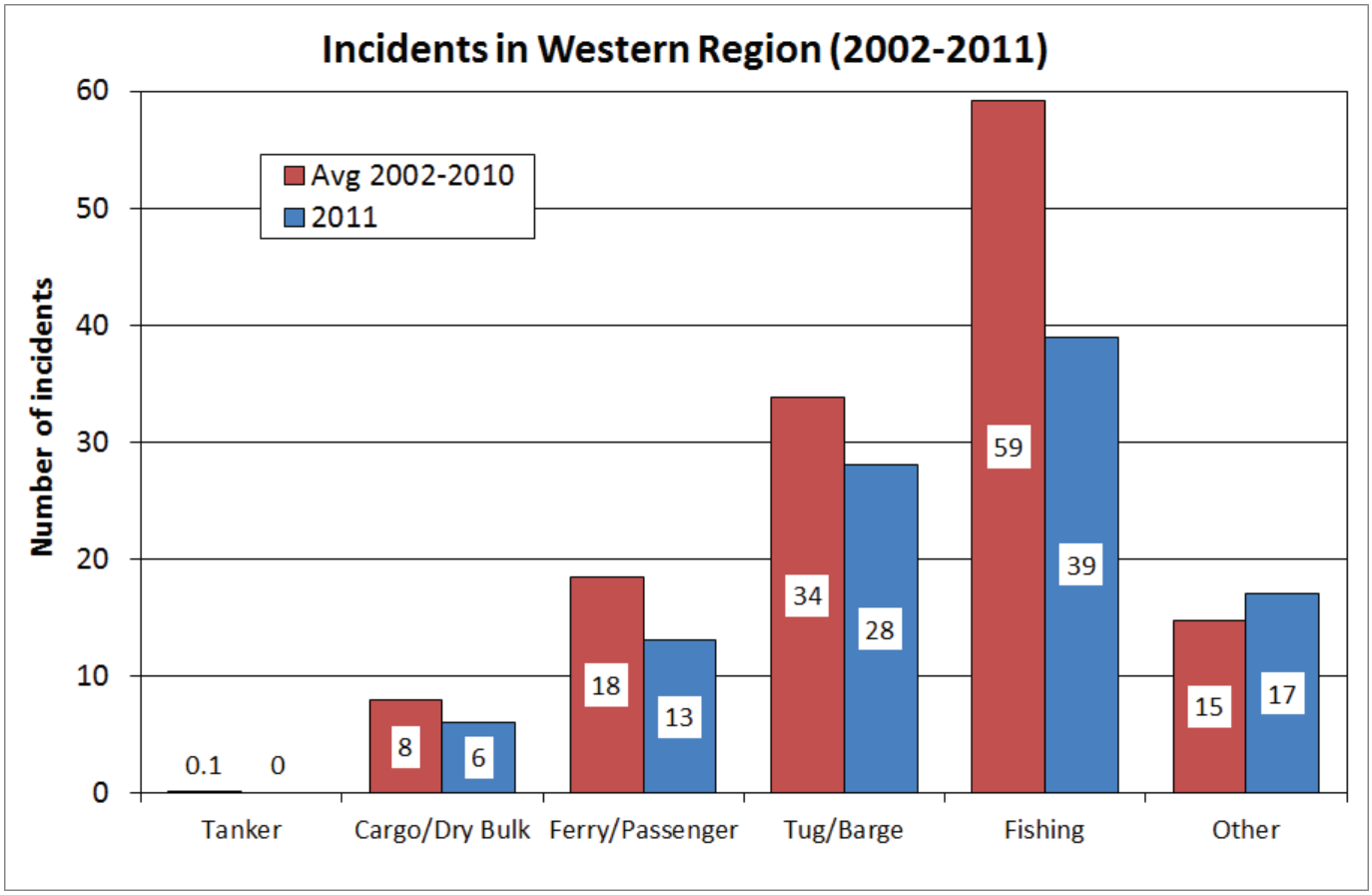

Figure 5-5 Number of incidents in the TSB Western Region for 2002-2011 (Ref. /3/)

The Pacific Pilotage Authorities has incident data for the vessel types they are piloting, which include large vessels in international traffic. This includes all oil tankers. Table 5-1 shows the number of vessel incidents for vessels under pilotage by PPA and the number of pilotage assignments per year. The number of assignments per year is assumed to be the same as the number of transits per year. The PPA data averages 0.6 incidents per 1,000 transits in the region from 2002-2012. The table also shows the number of incidents related to tanker vessels for the period from 1993-2012. There have been 6 incidents with tanker vessels in the last 20 years, with an average of 0.3 incidents per year for the region. It has to be emphasized that the type of incidents varies from minor incidents (e.g. breaking a fender) to more serious incidents (e.g. collision and grounding).

The majority of the incidents for all vessels and also for the tankers are contact damage. On average, over the 20 years, more than 60 % of the incidents are contact damage or other dock related incidents. There is no information on the number of assignment/transits of tanker vessels, so it is not possible to calculate an incident frequency per tanker vessel transit.

Table 5-1 Number of incidents for vessels under service by Pacific Pilotage Authority in British Columbia coast and the annual number of pilot assignments

Year	Number of Assignments	Number of Incidents	Incidents per 1,000 transits	Number of Tanker vessel incidents
2012	11,865	7	0.59	0
2011	11,416	5	0.44	0
2010	11,446	1	0.09	0
2009	11,055	6	0.54	0
2008	10,398	4	0.38	1
2007	11,821	6	0.51	0
2006	11,673	8	0.69	0
2005	11,832	6	0.51	0
2004	12,291	11	0.89	0
2003	11,891	12	1.01	0
2002	11,326	9	0.79	0
2001	12,037	9	0.75	0
2000	13,104	12	0.92	0
1999	12,908	12	0.93	1
1998	12,366	16	1.29	0
1997	13,465	30	2.23	3
1996	12,812	20	1.56	0
1995	12,497	15	1.20	0
1994	13,177	11	0.83	1
1993	11,980	23	1.92	0

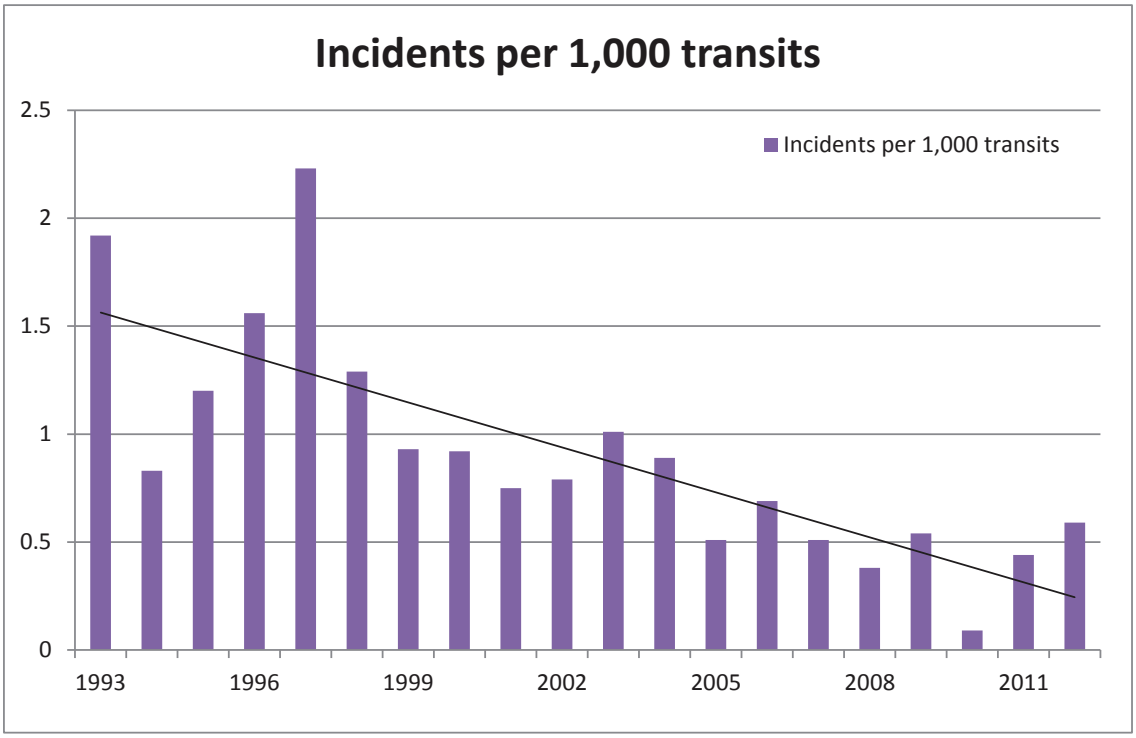

Figure 5-6 Number of incidents per 1,000 transits for vessels under service by Pacific Pilotage Authority

The incident data from the PPA does not include any consequence resulting from the incidents. The portion of them leading to an oil spill is then unknown.

5.4.1 Oil Spills in Western Region

All pollution or threats of pollution in the marine environment in Canadian Waters must be reported to the Canadian Coast Guard (CCG). Statistics provided by CCG (CCG 2001-2009) include more than 6,000 records of incidents in the Western Region from 2001 to 2009. Approximately one of ten of these was related to spills of 10 liters or more of petroleum products, and 163 are related to spills (of any size) from vessels above 15 meters.

As can be seen from Figure 5-8, 6 incidents, representing approximately 4 % of all incidents, have caused spills of more than 5 m^3, while 140, or 86 %, of the incidental spills are less than 1 m^3, and 21 % less than 10 liters. There have been no incidental spills from oil tankers in the period. The project has not been able to get updated oil spill data for the period of 2010-2012. However, there is available data that shows that there have been no oil spill accidents from tanker vessels in the 9 year period.

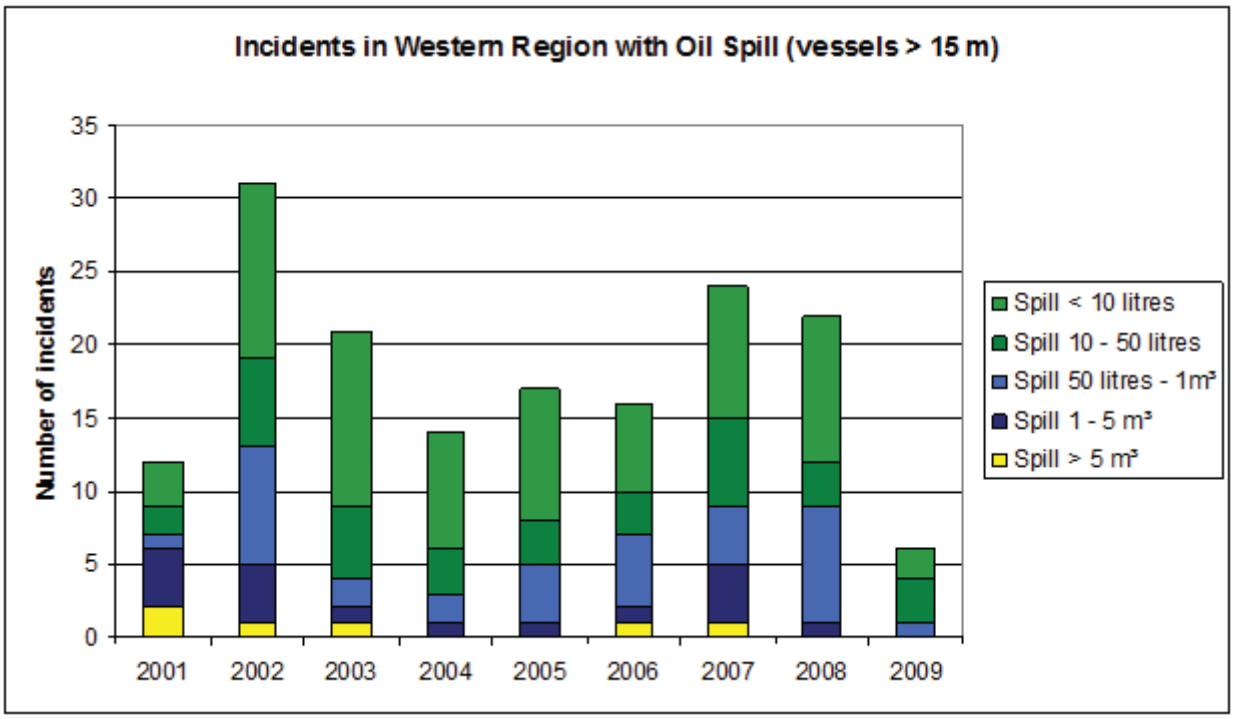

Figure 5-7 Number of shipping incidents with vessels above 15 m causing oil spill accidents in Western Region for 2001-2009 (Source: CCG 2001-2009)

Filtering the incident statistics indicates 63 spills have occurred at oil handling facilities during these years. Of these, 6 incidents, or slightly below 10 % resulted in spills exceeding 1 m^3. This is illustrated in Figure 5-8 below.

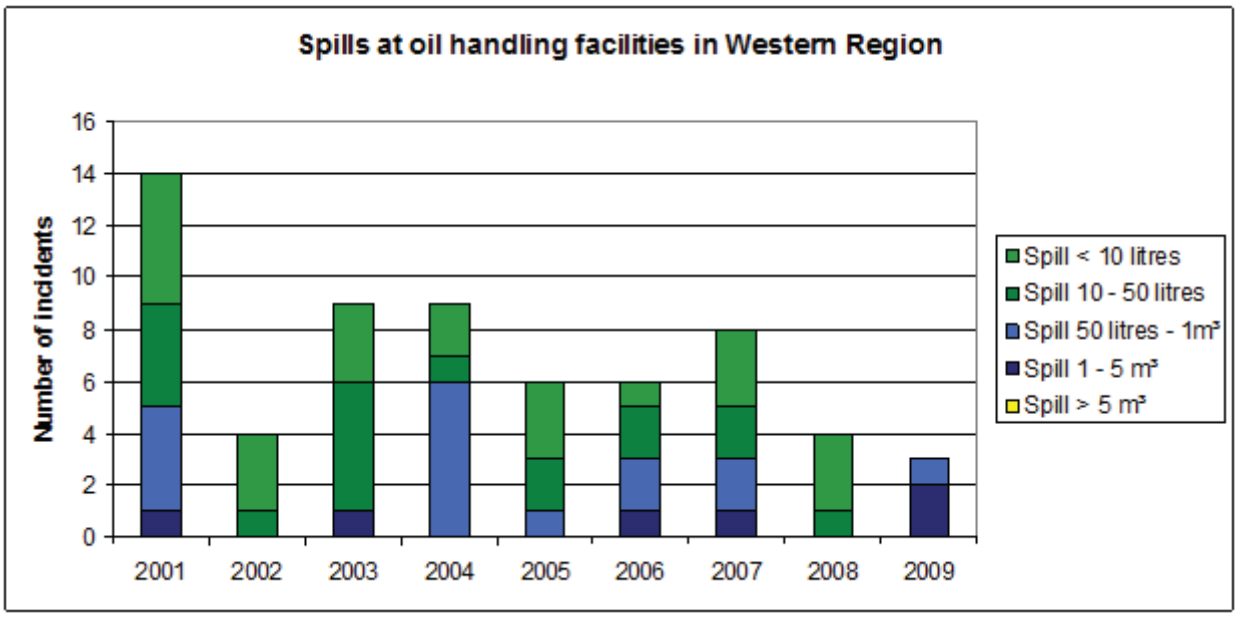

Figure 5-8 Number of spills at oil handling facilities in Western Region for 2001-2009 (Source: CCG 2001-2009)

6 REVIEW OF INCIDENTS IN US WATERS

The US casualty database from Homeport primarily contains incidents for North America. It is reliable for the period 2006 - 2010. Before that, some data appears to be missing so the casualty trend is not trustworthy. Also, there are a number of incident cases after 2010 that are still under investigation and therefore not included in the database at the moment.

6.1 Shipping incidents in US casualty database

Figure 6-1 shows the incidents registered in this database between 2006 and 2010. These incidents happened mainly in North America. The data also includes some incidents from other territorial waters.

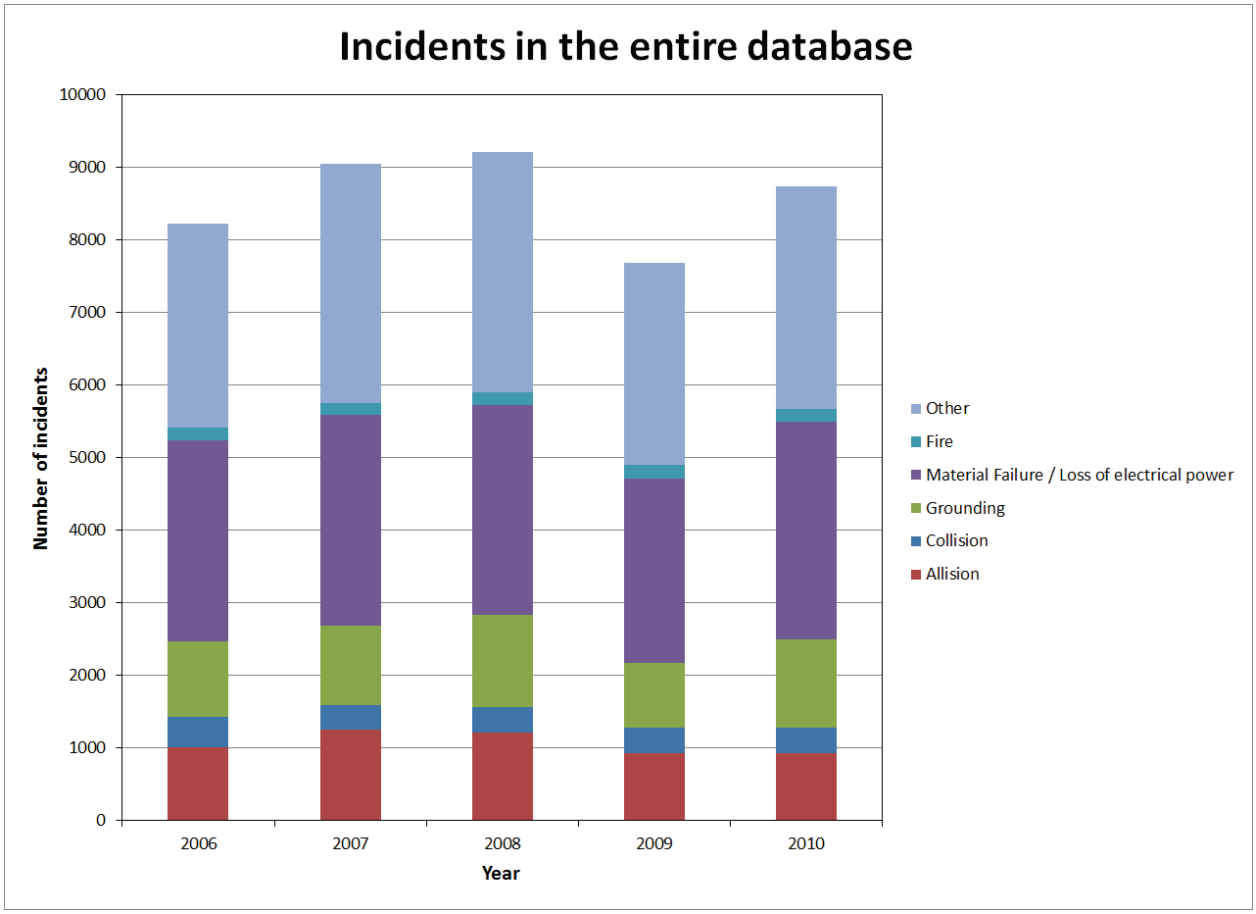

Figure 6-1 Number of incidents in the USCG database for 2006-2010 (Ref. /4/)

Figure 6-2 focuses on the incidents that occurred in the US West Coast. The trend indicates an increase in incidents, which is probably due to an increase in the traffic. However, it is hard to rely on a trend based on only 5 years. The annual number of incidents in this area is between 600 and 1100.

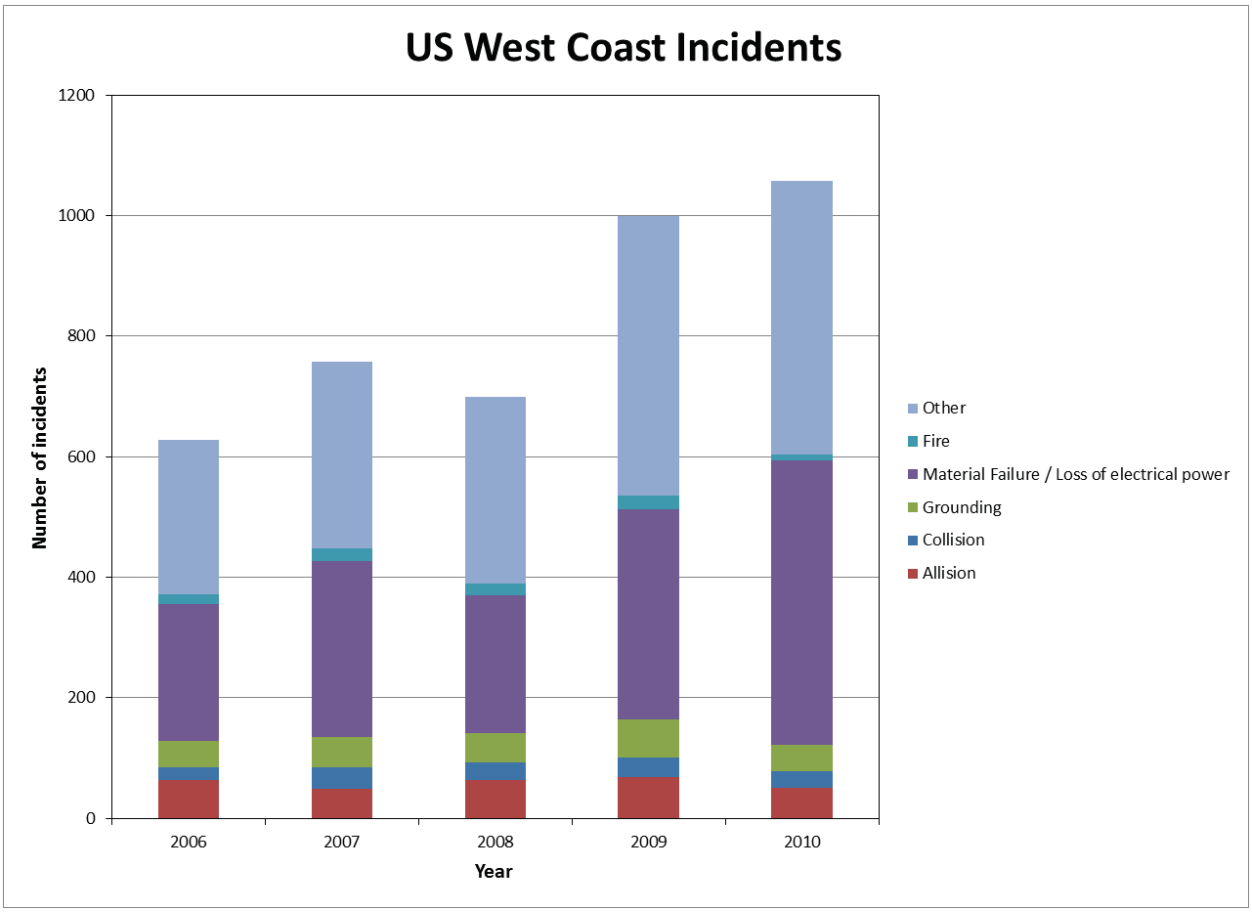

Figure 6-2 Number of incidents in the US West Coast for 2006-2010 (Ref. /4/)

6.2 Shipping incidents for tank vessel in all of U.S. and the West Coast

The analysis of the Homeport database in this section is focused on tanker vessels.

In the U.S. there are approximately 350 - 400 incidents related to tank vessels annually (Figure 6-3). The main cause of incident is “Material Failure / Loss of electrical power”.

The number of groundings is around 40 per year, and is approximately the same as the number of collisions and allisions combined. These incidents, in addition to fire incidents, are the incidents that could potentially lead to an oil spill accident.

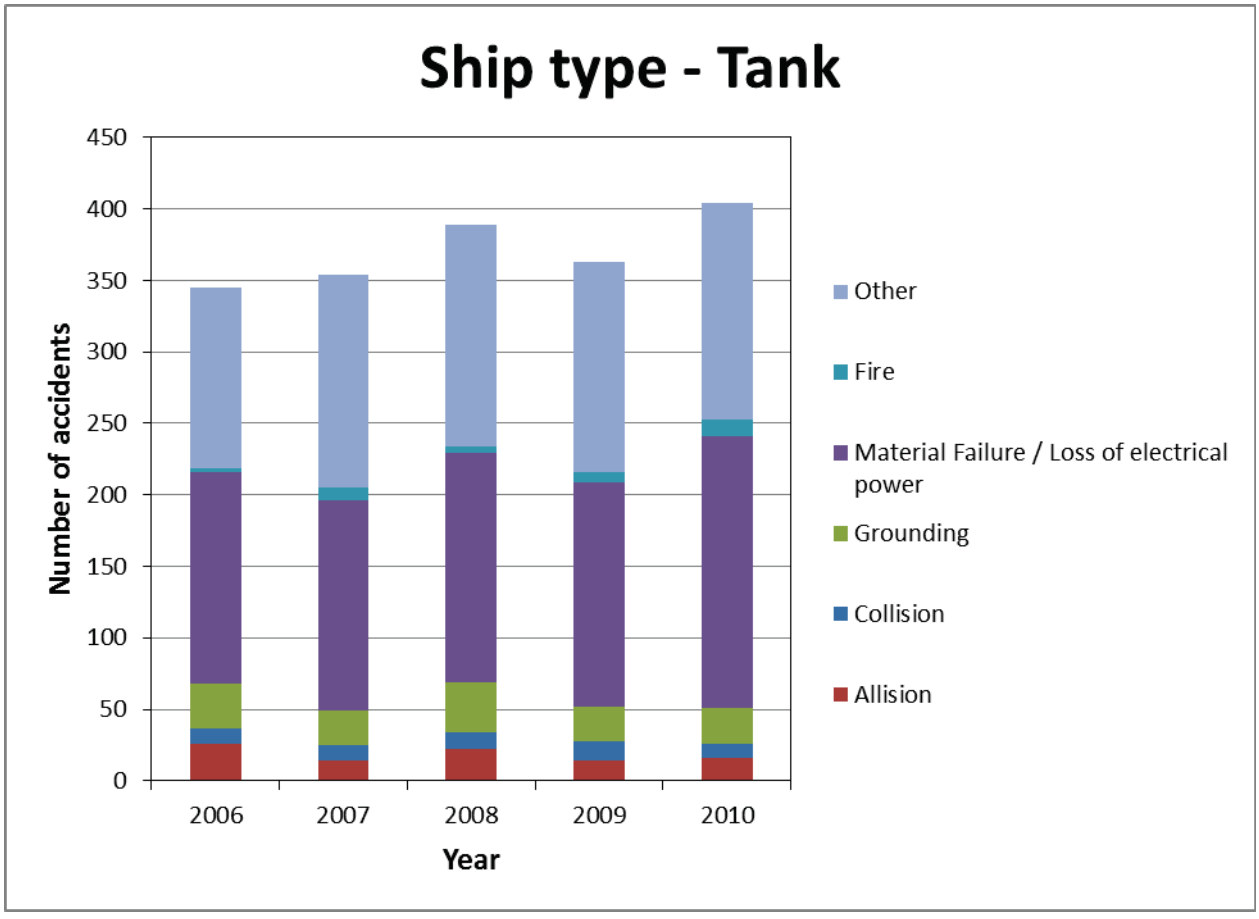

Figure 6-3 Number of tank ship type incidents in the database for 2006-2010 (Ref. /4/)

The majority of incidents for the U.S. West Coast fall into the incident categories "material failure/loss of electricity" and "other" (Figure 6-4). There have been 5 groundings, 5 allisions and one collision incident involving tanker vessels in the U.S West Coast in 2006-2010, which gives an annual frequency of one grounding and allision per year and 0.2 collisions per year.

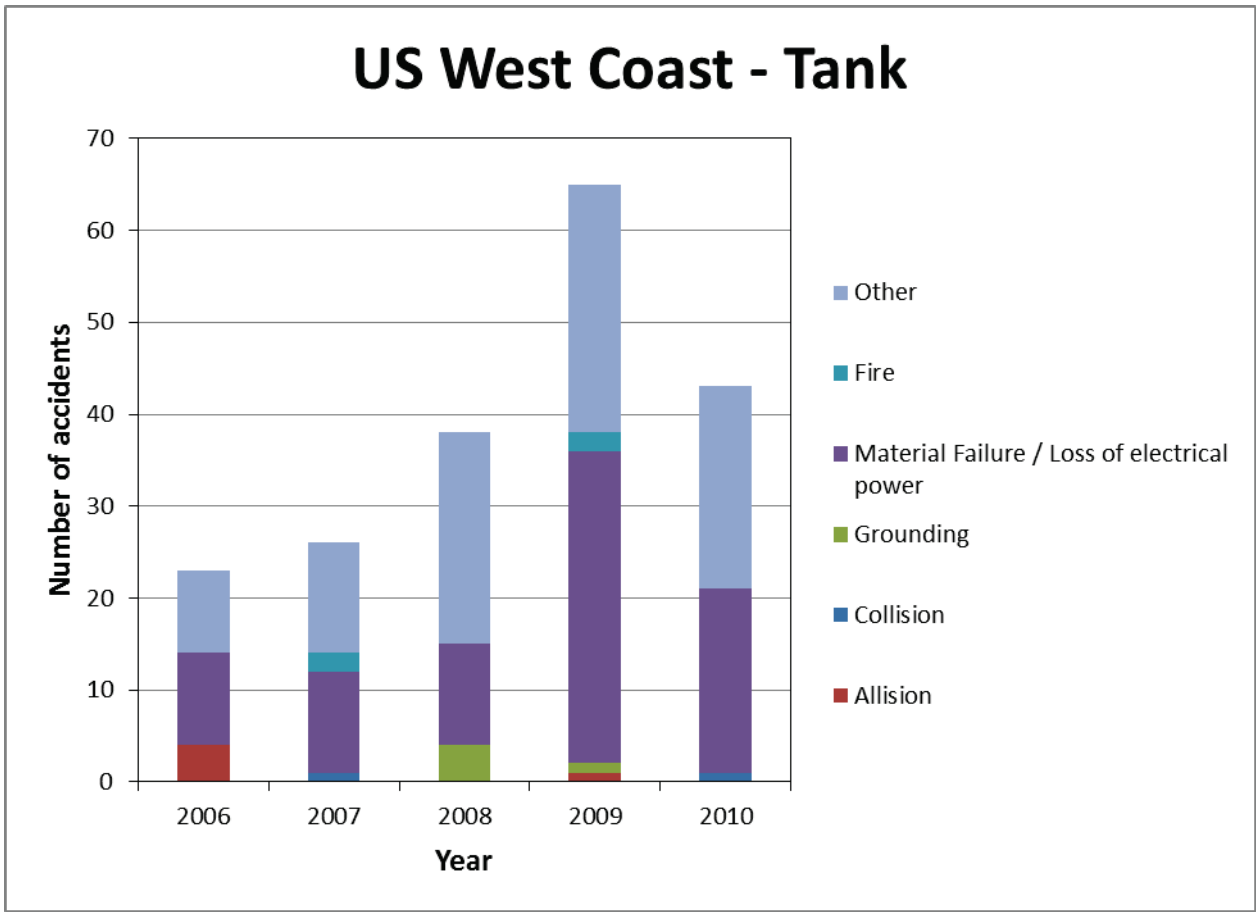

Figure 6-4 Number of tank vessel incidents in the US West Coast for 2006-2010 (Ref. /4/)

6.3 Shipping incidents for tank vessels in the US part of the Salish Sea

Figure 6-5 presents the casualty for the tank vessels in the Salish Sea, excluding the tank barges. The annual number of incidents ranges from 3 (2007 & 2008) to 8 incidents (2006). There was one allision in 2006, but no collision or grounding incidents in the five year time period. This gives an annual frequency of 0.2 for allision. Since the data only covers 5 years and the number of vessels is relatively low in this area, the validity of the frequency estimates is relatively low. However, it gives an indication of what impact a high level of navigational risk controls can have on the level of navigational safety in the area, because of the low or non-existing number of allision, collision and grounding. These accident types are the ones directly related to the effectiveness of the navigational risk controls implemented in the area.

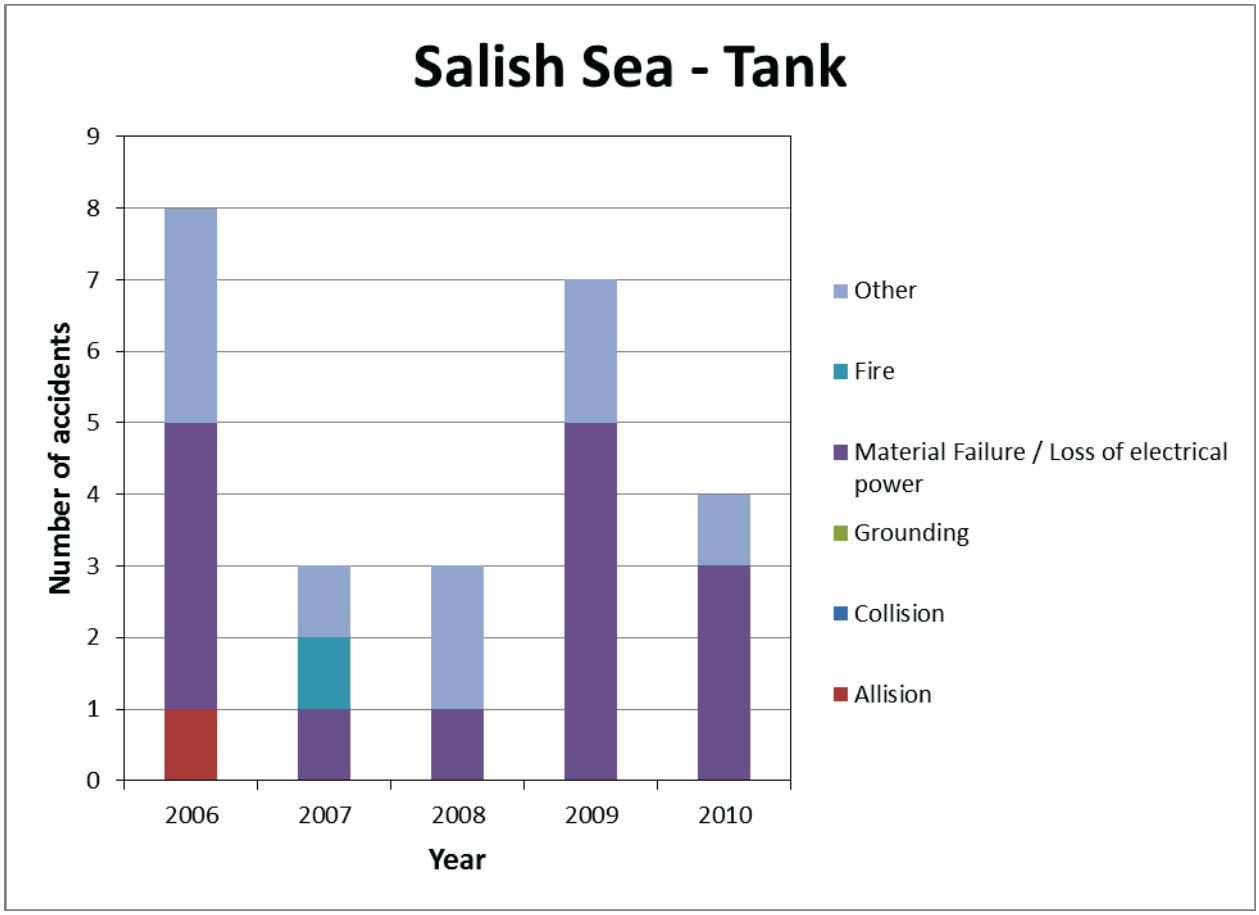

Figure 6-5 Number of tank shiptype incidents in the Salish Sea for 2006-2010 (Ref. /4/)

Figure 6-7 identifies the location of different incidents for tank vessels in U.S. waters of the Salish Sea over the period 2006 - 2010. Most of the incidents happened in the vicinity of the terminals at Cherry Point and Anacortes.

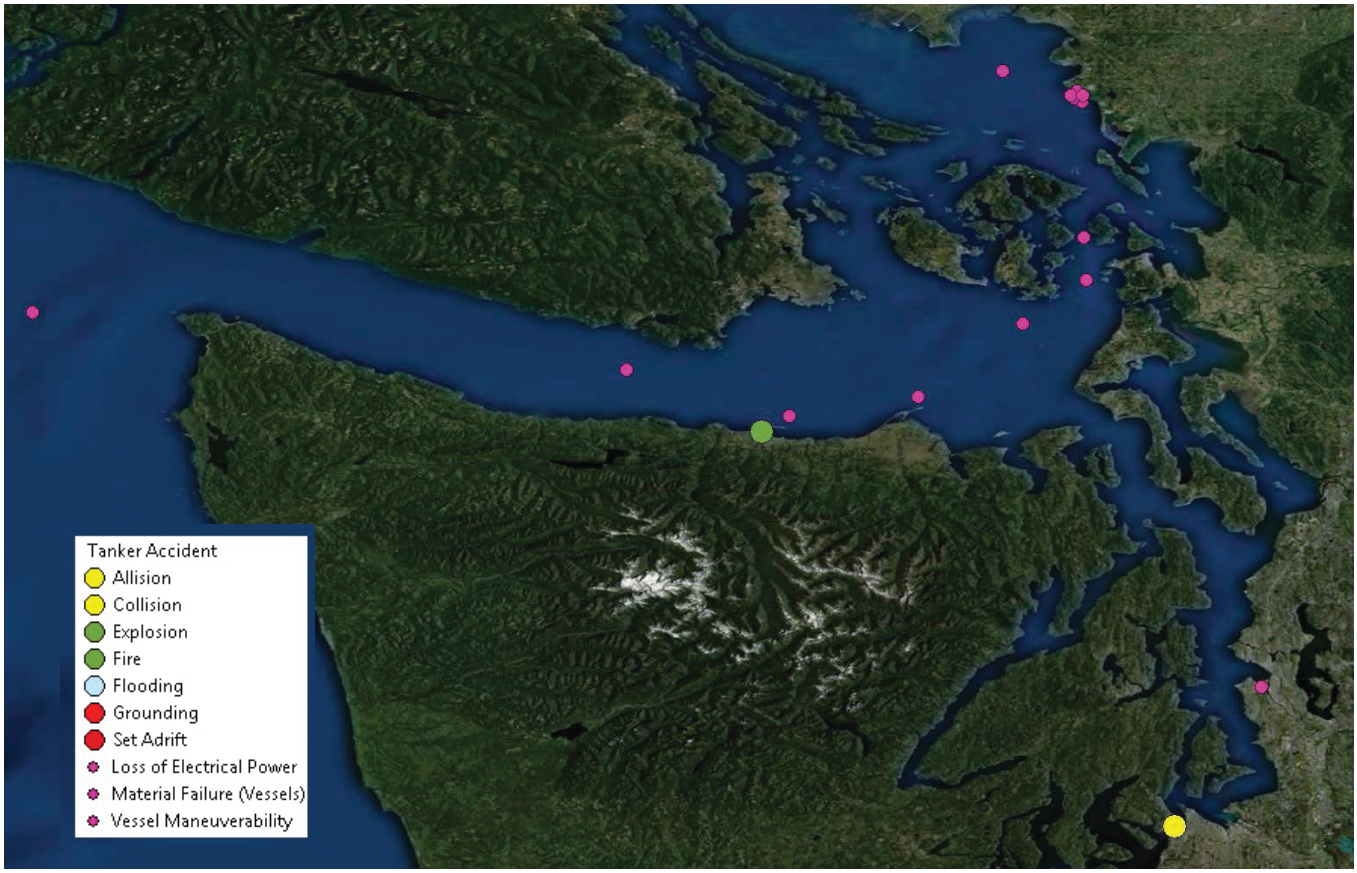

Figure 6-6 Locations of the incidents and incident types for tank vessel in the US part of Salish Sea for 2006-2010 (Ref. /4/)

The map in Figure 6-7 shows the location and size categories of oil spill accidents with tanker vessels.

Figure 6-7 Locations of the oil spill accidents and oil spill volumes for tank vessel in the US part of Salish Sea for 2006-2010 (Ref. /4/)

7 EFFECT OF DOUBLE HULL TANKERS VERSUS SINGLE HULL

After the OPA 90 and IMO regulation on phase out of non-double hull vessels by 2015 there have been some studies on the oil spill reduction effect of the double hull tankers compared to single hull tankers. All studies show a reduction of the number of oil spill accidents and spill volumes. The most recent study in "The effectiveness of double hulls in reducing vessel-accident oil spillage" by Yip *et al* (ref/5/) all U.S. related oil tanker and oil barge incidents from 2002-2008 were included. The conclusion from this study was that double hull structure lead to more than 60 % reduction of oil spill volume compared to single hull structure. An expert group evaluated the effectiveness of the OPA 90 double hull rules (ref/6/). The estimated effectiveness in terms of reduction in number of oil spill accidents due to double hull vessels were 79 and 84 % for low energy collision and grounding, respectively. The number of spill accidents from high energy collision and grounding were estimated to be reduced by approximately 20 %. The study estimated a reduction in spill volumes for low and high energy grounding accidents with spills to be 33 and 50 %, respectively. The expert group concluded that in case of a collision that leads to an oil spill from a double hull tanker, it is expected to be the same spill volume as for a single hull tanker, given the same cargo tank volume and oil type. However, as mentioned above; the number of oil spills from a collision was determined to be significantly reduced.

The consequences of an accident depend on the surrounding conditions and various factors, and therefore the influence of one factor cannot be easily compared between two different accidents. However, the effect of the double hull versus single hull can be illustrated by the groundings of Exxon Valdez in 1989 and HS Elektra in 2009. Indeed, the single hull Exxon Valdez vessel spilled 37,000 tons of oil in Prince William Sound, due to a hard grounding on Bligh Reef. On the contrary, when the double hull HS Elektra vessel hit an uncharted rock close to the Chilean coast, the vessel did not spill any of the cargo oil.

8 CONCLUSION

The casualty data survey shows that there has been a decline in the number of incidents both internationally and in Canadian waters for 2002 - 2011.

Oil tankers have seen a similar improvement in safety performance and have the lowest incident frequency of all bulk carriers (liquid and dry bulk). Public and regulatory scrutiny in both tanker design and operations continue to contribute to improvements in the safety for oil tanker operations. This assertion is supported by the average number of oil spills over 7 tons recorded by ITOPF, which has declined from an average of 79 for 1970 - 1979, to an average of 18 for 2000 - 2009. In 2011 only 6 oil spills above 7 tons were recorded, and 7 in 2012.

The most relevant spill frequency to be used for validation/evaluation of the risk modeling result in TERMPOL 3.15 is the results from the ITOPF database. Based on the last ten years of data it is estimated that tank vessels have 1.6 accidents every 1000 shipyears with oil spill over 7 tons. In other words, 1000 tank vessels have the likelihood of 1.6 accidents with oil spill within a year of operation.

9 REFERENCES

/1/ IHS Fairplay Incident database

/2/ International Tanker Owners Pollution Federation Limited website, Data & Statistics webpage: http://www.itopf.com/information-services/data-and-statistics/statistics/

/3/ Transportation Safety Board of Canada website , Marine Statistics webpage:

http://www.tsb.gc.ca/eng/stats/marine/index.asp

/4/ Statistics based on “Marine Casualty and Vessel Data for Researchers” issued by Homeport - US Department of Homeland Security - United States Coast Guard

/5/ Tsz Leung Yip, Wayne K. Talley, Di Jin. 2011. The effectiveness of double hulls in reducing vessel-incident oil spillage. Marine Pollution Bulletin 62 (2011) 2427–2432

/6/ OPA 90 Programmatic Regulatory Assessment (PRA) BENEFIT, COST, AND COST EFFECTIVENESS OF ELEVEN MAJOR RULEMAKINGS OF THE OIL POLLUTION ACT OF 1990 May 2001

Det Norske Veritas:

DNV is a global provider of knowledge for managing risk. Today, safe and responsible business conduct is both a license to operate and a competitive advantage. Our core competence is to identify, assess, and advise on risk management, and so turn risks into rewards for our customers. From our leading position in certification, classification, verification, and training, we develop and apply standards and best practices. This helps our customers to safely and responsibly improve their business performance.

Our technology expertise, industry knowledge, and risk management approach, has been used to successfully manage numerous high-profile projects around the world.

DNV is an independent organisation with dedicated risk professionals in more than 100 countries. Our purpose is to safeguard life, property and the environment. DNV serves a range of industries, with a special focus on the maritime and energy sectors. Since 1864, DNV has balanced the needs of business and society based on our independence and integrity. Today, we have a global presence with a network of 300 offices in 100 countries, with headquarters in Oslo, Norway.

Global impact for a safe and sustainable future:

Learn more on www.dnv.com