APPENDIX III

AUSTRALIAN OIL SPILL DATA

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Contents

III.1 INTRODUCTION

III.1.1 Objective

This appendix provides an analysis of the oil spill data that has been supplied by AMSA. In the present assessment of marine oil spill risks, it serves the following purposes:

- Provides an indication, based on historical data, of the main sources of oil spill risk.
- Allows estimates of risks from oil spill sources that are difficult to estimate from generic data (e.g. onshore sources).
- Provides data for approximate validation of the overall study results.

III.1.2 Data Source

AMSA supplied a database consisting of 8463 records of oil spills, or reports of oil spills in Australian ports and waters between 3 March 1970 and 7 February 2011. AMSA cautioned that the data includes spills that come to their attention by various routes, but may not be complete, particularly for onshore and offshore spills.

The National Offshore Petroleum Safety Authority (NOPSA) receives reports on dangerous occurrences at or near offshore installations, including any uncontrolled release of petroleum liquids exceeding 80 litres (NOPSA 2010). However, NOPSA did not release this data for the present study. Equivalent information, including that prior to 2005 when NOPSA started operations) is held by the various State-based authorities. The following information of this type was made available:

- Fluid spills over 80 litres during offshore drilling in Western Australia during 1989-2009.
- Environmental incidents, including uncontrolled escape of petroleum or chemicals, on offshore installations in Victoria during January 2006 to July 2009.

To date, no comprehensive information has been received for offshore spills in:

- States other than Victoria/WA - although these would be relatively few.
- Victoria before 2006.
- Production and other non-drilling activities in Western Australia.

III.1.3 Data Selection

The present analysis is based on the AMSA database of 8463 oil spills, with data selected as described below, and supplemented as described in Section III.2.

Incidents during 2011 were excluded, as this dataset was still growing at the time of the analysis. The data includes 8418 incidents during 1970-2010.

AMSA identified 546 events that appear to be duplicate reports of the same incident, recorded with the same incident date. There are other cases of similar reports on successive days that may also be duplicates, but these cannot be eliminated systematically. In general, the duplicates refer to unknown oil spill quantities, and so do not affect the results below.

The pollution sources in the database include not only oil but also chemicals, garbage, harmful packaged substances, and other substances (including sludge, foam, brine and discoloured water). DNV eliminated these 409 events from the analysis.

This leaves 7462 oil pollution events in the AMSA dataset from 1970-2010 that are consistent with the scope of the study.

The spill quantity is recorded in 1297 of these events. This is increased to 1317 after data validation (see Section III.2). After consideration of data trends and completeness (see Section III.3), a subset of 1258 events from 1982-2010 is used for the analysis.

III.2 DATA VALIDATION

III.2.1 Comparison with AMSA Website

DNV attempted to validate the database by comparing it to information on major oil spills provided on the AMSA website (AMSA 2011). The results are shown in Table III.1. The oil spill quantity in the database has no units given, although AMSA indicated it is intended to refer to litres. The comparison below suggests that it may not have been consistently applied.

Table III.1 Comparison of Major Spill Quantities

DATE	VESSEL	LOCATION	QUANTITY ON WEBSITE	QUANTITY IN DATABASE (1000 litres)	RATIO
03/03/1970	Oceanic Grandeur	Torres Strait QLD	1,100 tonnes	1067	1.03
26/05/1974	Sygna	Newcastle, NSW	700 tonnes	407	1.72
14/07/1975	Princess Anne Marie	Offshore, WA	14,800 tonnes	Missing	
10/09/1979	World Encouragement	Botany Bay NSW	95 tonnes	110	0.86
29/10/1981	Anro Asia	Bribie Island QLD	100 tonnes	No quantity	
22/01/1982	Esso Gippsland	Port Stanvac SA	unknown	180	
03/12/1987	Nella Dan	Macquarie Island	125 tonnes	No quantity	
06/02/1988	Sir Alexander Glen	Port Walcott, WA	450 tonnes	30	15
20/05/1988	Korean Star	Cape Cuvier WA	600 tonnes	800	0.75
28/07/1988	Al Qurain	Portland VIC	184 tonnes	184	1
21/05/1990	Arthur Phillip	Cape Otway VIC	unknown	18.8	
14/02/1991	Sanko Harvest	Esperance WA	700 tonnes	No quantity	
21/07/1991	Kirki	WA	17,280 tonnes	17000	1.02
30/08/1992	Era	Port Bonython SA	300 tonnes	296	1.01
10/07/1995	Iron Baron	Hebe Reef TAS	325 tonnes	325	1
28/06/1999	Mobil Refinery	Port Stanvac SA	230 tonnes	260	0.88
26/07/1999	MV Torungen	Varanus Island, WA	25 tonnes	25	1
03/08/1999	Laura D'Amato	Sydney NSW	250 tonnes	250	1
18/12/1999	Sylvan Arrow	Wilson's Promontory VIC	<2 tonnes	No quantity	
02/09/2001	Pax Phoenix	Holbourne Island, QLD	<1000 litres	No quantity	
25/12/2002	Pacific Quest	Border Island , QLD	>70 km slick	9	
24/01/2006	Global Peace	Gladstone, QLD	25 tonnes	25	1
11/03/2009	Pacific Adventurer	Cape Moreton, QLD	270 tonnes	0.27	1000
21/08/2009	Montara Wellhead	NW Australian coast	approx 64 te/day	Missing	
03/04/2010	Shen Neng1	Great Keppel Island QLD	4 tonnes	No quantity	

DNV's interpretation of the data provided and cross-checks against other sources suggests that in general the information on the website is more accurate than the database.

The conclusions from this comparison are as follows:

- 2 events are missing from the database - these are among the largest experienced:
    - Princess Anne Marie, 14 Jul 75, was 300nm offshore and so outside the EEZ
    - Montara wellhead, 21 Aug 09, is missing for no known reason.
- 6 events have no oil spill quantity recorded in the database.

- 1 event has the quantity in error by 3 orders of magnitude - entered as tonnes instead of litres.
- 2 events have the quantity in error by factors of 15 and 1.8 - possibly based on preliminary reports and not updated.
- 5 events have the quantities matching exactly - implying the quantity was entered as kg instead of litres.
- 3 events have the quantities matching within 1-3% - also implying the quantity was entered as kg instead of litres.
- 3 events with the quantities differing by 15-25% - implying the quantity was entered correctly as litres, because this is consistent with realistic oil densities.

DNV concludes that the database is of variable quality, even for major events with readily available information. It is unlikely that the data quality is much better for the other events.

In order to use the data in the present study, DNV has made the following adjustments:

- Corrected quantities to match the AMSA website, interpreting the field as a quantity in litres.
- Inserted the missing 2 events.
- Inserted quantities for 6 events where tonne quantities are mentioned in the description but the field is not filled in.

This gives a total of 1312 events with spill quantity recorded.

III.2.2 Comparison with Offshore Data

DNV attempted to improve the database by comparing it to the available information on offshore oil spills (see Section III.1.2). The available information from Western Australia and Victoria was in different formats; only the Victoria information gave the full date, quantity, cause and location that is required for the present analysis, and this was not available in database format. Therefore DNV extracted 4 incidents involving oil spills over 1 tonne, and used these to compare with the AMSA database. Because WA requested confidentiality, the individual incidents cannot be stated here. There were also 38 cases of spills of over 1 tonne of “non-water based mud”, which may have included an oil component, but these are outside the scope of the present study.

The conclusions from this comparison are as follows:

- None of the 4 incidents involving oil spills over 1 tonne in the Victoria/WA data are in the AMSA database. This is presumed to be because they were not reported to AMSA at the time.
- There are a further 6 oil spills over 1 tonne reported from offshore sources in the AMSA database that do not appear in the WA data. This is presumed to be because they were not in the drilling activities covered by the WA data.

- The time period of the WA data ended just before the Montara wellhead blowout in August 2009.

DNV concludes that the offshore spill data cannot be validated because neither source provides a comprehensive collection of offshore spills matching the scope of the study. It is likely that the Victoria/WA datasets are comprehensive in their stated areas of coverage. They confirm the expectation that the AMSA data is incomplete, but do not provide enough data to fill the gaps.

In order to proceed with the present study, DNV has inserted the 4 incidents involving oil spills over 1 tonne into the AMSA database. This includes all offshore spills over 1 tonne that have been identified in this study, but it remains likely that others are missing.

III.2.3 Comparison with Previous Studies

In a previous risk assessment (DNV 2004), AMSA provided a database of oil pollution cases. Data was extracted for the period 1990 to 2003. The events are compared to the present dataset in Table III.2. It appears that the previous study received only a subset of the current data. This may be because the AMSA database has been made more comprehensive since 2004, or because different inclusion criteria were used in the two studies.

Table III.2 Comparison of Oil Spill Events, 1990-2003

	DNV 2004	PRESENT STUDY
Total oil spills	1000	3975
Spills with size recorded		612
Spills over 1 tonne	60	123
Spills over 10 tonnes	11	23

In the previous risk assessment (DNV 1999), AMSA provided a database of oil spills. Data was extracted for the period 1982 to 1998. The events are compared to the present dataset in Table III.3. The two datasets are broadly but not exactly consistent. The difference may in part result from the elimination of duplicate records and the use of spill sizes recorded in the descriptive text in this study (see above).

Table III.3 Comparison of Oil Spill Events, 1982-1998

	DNV 1999	PRESENT STUDY
Total oil spills	4382	4053
Spills with size recorded	830	795
Spills over 1 tonne		169
Spills over 10 tonnes	36	41

It is concluded that, despite the data quality problems noted above, the present dataset is broadly consistent with those used in previous studies, and may in fact be more reliable.

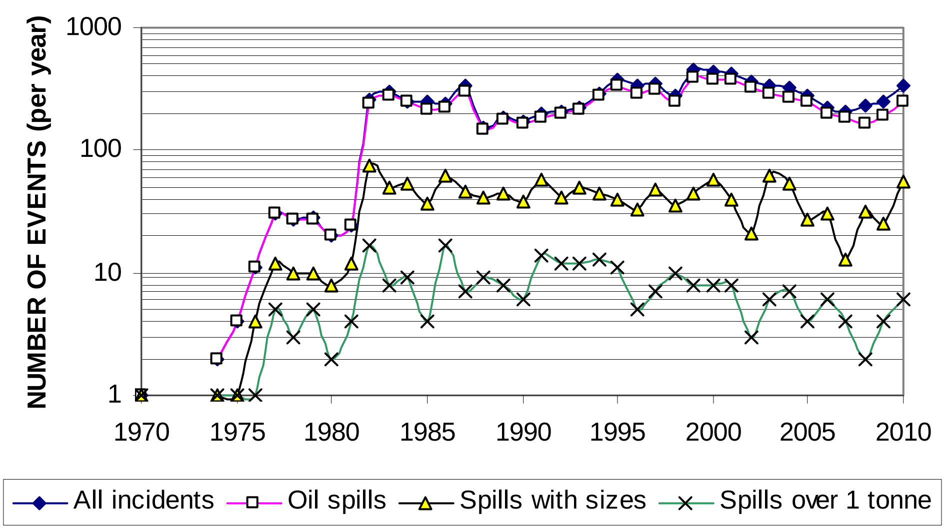
III.3 DATA TRENDS

The number of events in each year gives an indication of data completeness as well as trends. Figure III.1 shows the numbers of:

- All incidents included in the database
- All oil spills
- Oil spills with sizes recorded, including additional events added by DNV (see above)
- Oil spills with sizes over 1 tonne, after correction of quantities by DNV (see above)

A log scale is used on the plot to make the trend clearer for the small numbers of spills over 1 tonne.

Figure III.1 Trends of Oil Spill Reports



It is evident that the reporting standards changed in 1982, and that the data is not reliable before this date. Since then, there have been variations in the numbers of incidents and the numbers of spills with sizes reported, but no significant trends. The number of spills over 1 tonne has also fluctuated, as expected since the overall numbers are low, but there is a slight downward trend. This trend is likely to result from improvements in oil spill prevention practices in the industry. However, given the data quality problems identified above, there is also a possibility that it results from a decline in efforts by AMSA to populate the quantity field in the database.

For the present study, it appears that the whole dataset from 1982 to 2010 is suitable for inclusion. In this period, there were 1258 events with spill quantity recorded. These are used as the dataset for the analysis below.

III.4 OVERALL RESULTS

III.4.1 Spill Risk

The total spill quantity over the period 1982-2010 is 29,300 tonnes. This is an average of 1010 tonnes per year during the 29 year period of the data.

However, 60% of the total was spilled in the single largest event, and 77% in the largest two events. This makes it impossible to obtain any reliable indication of risks by analysing the total spill quantities. This would imply that the risks arose almost entirely from the major events that have already happened. In reality, there is an element of ill-fortune that these events have given large spills while others have not occurred. The impact of this on the usability of the spill risk metric is discussed in Section 2.8 of the main report.

III.4.2 Spill Size Distribution

The size distribution is less affected by the few large events, and so may be a better indication of the underlying risk. Figure III.2 shows the size distribution, plotted as a complementary cumulative frequency distribution, known as an FQ curve, since it shows the frequency (F) of spills exceeding given quantities (Q). The frequencies are calculated as average numbers of events per year during the period 1982-2010, which is justified by the fact that the overall frequencies are roughly constant over this 29 year period.

Figure III.2 FQ Curve for Oil Spills, 1982-2010

This FQ curve gives an approximate indication of the overall risks of oil spills in Australian ports and waters, based on the AMSA data.

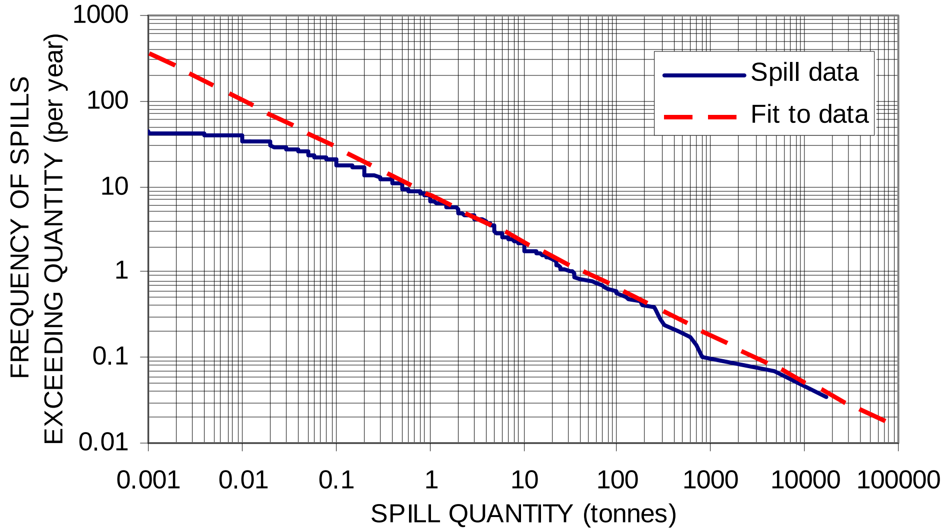
The fluctuations in the plot for quantities of 200 tonnes or more result from the small numbers of events, so the frequencies are uncertain. However, better estimates can be made by fitting a straight line to the log-log plot, as shown in Figure III.3. This allows an estimate to be made of the frequencies of large spills. The equation of this line is:

$$F = 6.6\ Q^{0.55}$$

where:

F = frequency (per year) of spills exceeding size Q
Q = quantity of oil spilled (tonnes)

Figure III.3 Fitted FQ Curve for Oil Spills, 1982-2010



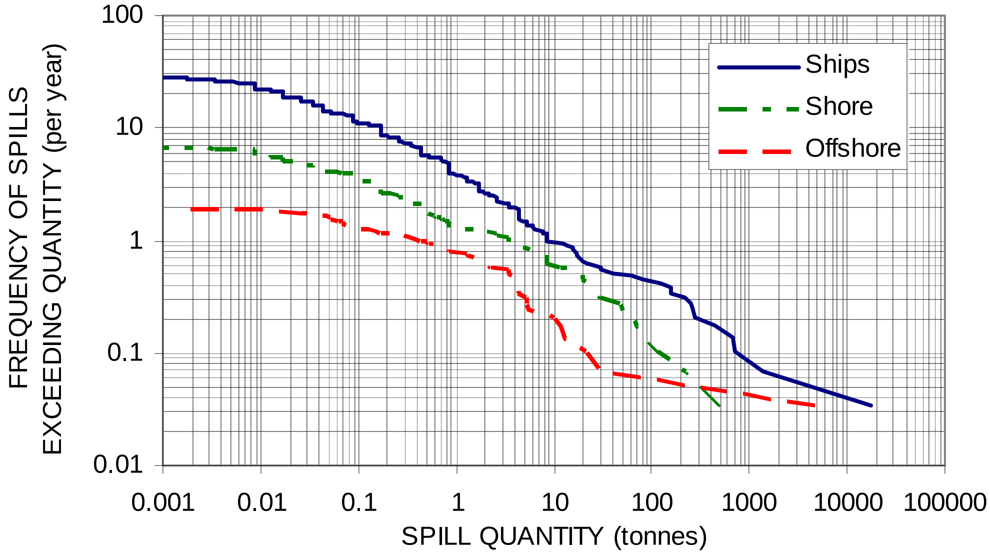
The curvature for spills less than 0.1 tonnes indicates incomplete reporting. It is noted that the complete dataset of 7315 oil spills during 1982-2010 is equivalent to 252 spills per year. If they were assumed to have a spill quantity of 2kg or more, this would align almost exactly with the fitted line.

The AMSA data has been split into three source types:

- Ships, including ship-shore transfer
- Offshore, including pipelines
- Shore-based sources

DNV has reassigned the category “other” used by AMSA, and eliminated the group “unknown”, where the source has not been determined. Figure III.4 shows the size distributions for the three remaining spill causes. This shows that ships comprise the majority of the spills, but offshore becomes a significant contributor for spills over 1000 tonnes. This strongly reflects the Montara blowout.

Figure III.4 FQ Curves for Oil Spill Sources, 1982-2010



III.5 SHORE-BASED SPILLS

The historical spill data provides the best available method of estimating the frequency of spills from onshore sources that enter the marine environment. In using the data, it is first assumed that:

- The data is complete for spills exceeding 1 tonne.
- The spill frequency has been broadly constant during 1982-2010.

There are only 37 shore-based spills over 1 tonne in the database during 1982-2010. This is not enough to give a spill size distribution for each of the 40 near-shore regions in the study. Therefore, the following additional assumptions are made:

- The frequency of spills over 1 tonne in each region is proportional to the frequency of shore-based spills of any size recorded in the data. There are in total 192 events with size and location recorded in the data, covering 20 of the 40 regions. Of these, 18.2% involved spills over 1 tonne. The same ratio is applied to each region.
- Regions of the mainland, Tasmania and the Australian Antarctic Territory (AAT) that have no shore-based spills of any size recorded in the data during 1982-2010 are treated as "70%" of the way to their first spill.
- Offshore Territories, none of which have shore-based spills of any size recorded in the data during 1982-2010 are treated as "10%" of the way to their first spill.

Table III.4 shows the resulting frequencies of spills exceeding 1 tonne in each region, and the equivalent number of spills during the period 1982-2010. The overall national frequency is 1.3 per year.

The size distribution for shore-based spills (given a spill over 1 tonne) is assumed to be the same for all regions, as in Table III.5. It is taken direct from the data, except that the probability of spills exceeding 1000 tonnes is extrapolated from the distribution in Figure III.4.

Table III.5 Size Distribution of Shore-Based Spill Frequencies

SPILL SIZE	PROBABILITY (per spill)
1-10 tonnes	0.514
10-100 tonnes	0.400
100-1000 tonnes	0.080
>1000 tonnes	0.006

The average size for shore-based spills (given a spill over 1 tonne) is calculated by assuming an average spill size of 1.8 x the lowest size in the band (as appropriate for the logarithmic decay shown in Figure III.4). The average estimated from this distribution is then:

$$Q_m = 0.514 \times 1.8 + 0.4 \times 18 + 0.08 \times 180 + 0.006 \times 1800 = 33 \text{ tonnes}$$

The information on spill source in the AMSA database is insufficient to provide a useful analysis, but the events include spills from tanks, pipes, pipelines and road tankers.

Table III.4 Shore-Based Spill Frequencies for Calculation Sub-Regions

REGION	SPILLS 1982-2010	FREQUENCY (per year)
QLD-1-N	12	0.075
QLD-2-N	0.7	0.004
QLD-3-N	3	0.019
QLD-4-N	8	0.050
QLD-5-N	5	0.031
QLD-6-N	13	0.082
NSW-1-N	1	0.006
NSW-2-N	45	0.283
NSW-3-N	8	0.050
VIC-1-N	2	0.013
VIC-2-N	48	0.302
VIC-3-N	0.7	0.004
TAS-1-N	6	0.038
TAS-2-N	0.7	0.004
TAS-3-N	6	0.038
SA-1-N	6	0.038
SA-2-N	1	0.006
SA-3-N	0.7	0.004
WA-1-N	0.7	0.004
WA-2-N	1	0.006
WA-3-N	1	0.006
WA-4-N	14	0.088
WA-5-N	0.7	0.004
WA-6-N	0.7	0.004
WA-7-N	6	0.038
WA-8-N	0.7	0.004
WA-9-N	0.7	0.004
WA-10-N	0.7	0.004
NT-1-N	4	0.025
NT-2-N	0.7	0.004
NT-3-N	2	0.013
AAT-1-N	0.7	0.004
AAT-2-N	0.7	0.004
AAT-3-N	0.7	0.004
MDH-N	0.1	0.001
COC-N	0.1	0.001
CH-N	0.1	0.001
NOR-N	0.1	0.001
LHW-N	0.1	0.001
MAC-N	0.1	0.001
TOTAL		1.272

III.6 SPILLS FROM SHIPS

The historical spill data is suitable to validate the frequencies of oil spills from ships that are estimated from world-wide maritime data. In using the data, it is first assumed that:

- The data is complete for spills exceeding 1 tonne.
- The spill frequency has been broadly constant during 1982-2010.
- Where the ship type is unknown, it is not one of the main trading ship types.

There are 111 spills over 1 tonne from ships in the database during 1982-2010. Table III.6 shows the breakdown by ship type (defined in Appendix IV.1.5) and accident category (defined in Appendix IV.1.6).

Table III.6 Spills Over 1 Tonne from Ships, 1982-2010

SHIP TYPE	CN	CT	FX	HD	TS	UD	WS	UNK	TOTAL
Oil tanker	3	0	0	3	13	6	0	3	28
Chemical tanker	0	0	0	0	1	0	0	0	1
Bulk carrier	1	0	0	0	1	0	3	6	11
General cargo	0	1	0	2	3	1	2	3	12
Container ship	0	0	0	0	0	1	0	1	2
Barge	0	0	0	1	0	0	1	0	2
Dredger	1	0	0	0	0	0	0	0	1
Fishing	1	0	2	7	0	0	4	3	17
Navy	0	0	0	0	4	2	0	1	7
Offshore	0	0	0	0	0	0	0	1	1
Tug	0	0	0	0	0	0	0	1	1
Other	0	1	0	3	3	3	4	0	14
Small	0	0	0	1	0	1	1	0	3
Unknown	0	0	0	2	2	0	0	7	11
Total	6	2	2	19	27	14	15	26	111

Table III.7 shows the annual spill frequencies from the same data.

Table III.7 Frequencies (per ship year) of Spills Over 1 Tonne from Ships

SHIP TYPE	CN	CT	FX	HD	TS	UD	WS
Oil tanker	0.10			0.10	0.45	0.21	
Chemical tanker					0.03		
Bulk carrier	0.03				0.03		0.10
General cargo		0.03		0.07	0.10	0.03	0.07
Container ship						0.03	
Other	0.07	0.03	0.07	0.48	0.31	0.21	0.34
Total	0.21	0.07	0.07	0.66	0.93	0.48	0.52

III.7 UNCERTAINTIES

The AMSA spill database provides a large dataset that is potentially very useful for the present study. It provides an approximate estimate of the overall risk, and a breakdown by size and source of the spills, which is very useful for validation of the present risk estimates.

However, there are some concerns about the quality of this data. The validation exercise in Section III.2.1 shows that the spill quantity field, which is most useful for the present study, is incomplete, inconsistently interpreted and sometimes inaccurate, even in well-reported spill events. The comparison with available offshore data in Section III.2.2 shows that its coverage of offshore spills is incomplete. The available offshore data, although comprehensive within the area reported by the individual State authorities, is insufficient to assemble a comprehensive picture of offshore spill experience. No suitable source is available for validation of the onshore sources of spills, but it is expected that the database may be incomplete in this area too.

For the present study, DNV has made use of the available data, together with corrections and additions from the other sources identified. The analysis has made use of 1258 events with known oil spill quantity during 1982-2010. Although it may be expected that these larger events would be more reliably recorded, the validation exercise casts doubt on this. Given that 8 out of 25 major spills in Table III.1 did not have quantities recorded in the AMSA data, and 2 others had quantities that were under-estimated by more than a factor of 10, this suggests the quantity data for ships may be under-estimated by a factor of 25/15, i.e. 1.67. Allowing for other uncertainties in the data, this is rounded to a factor of 2.

In the analysis of the oil spill data, DNV has assumed, with reference to Figure III.1, that risks have been roughly constant during 1992-2010. However, Figure III.1 suggests that the annual frequency of spills over 1 tonne has declined during this period, possibly by as much as a factor of 2. This could be due to further data quality problems, or it could reflect a reduction in oil spill risk.

Overall, it is concluded that the analysis of oil spill quantities above could over-estimate or under-estimate the current risk by a factor of 2.

For the future, DNV recommends that AMSA improves the quality of its database by cross-checking against other sources, so that the data is sufficiently reliable to support future risk analyses and monitor trends in oil spill risks.

III.8 REFERENCES

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