



## POP&C: Pollution Prevention & Control Safe Transportation of Hazardous Goods by Tankers

An overview of interim results from the EC funded project POP&C - involving the analysis of all accidents and incidents on Aframax tankers between 1978 to 2003.

by Nikos Mikelis  
POP&C Project Coordinator  
INTERTANKO



### Aim of the project:

The intention of the POP&C project is to develop a **risk-based methodology** and suitable tools, so as to enable the quantification of the oil spill potential of different tanker designs.

Such a methodology would also allow a rational evaluation of proposed regulatory measures.



## Vital statistics:

- POP&C is a three-year project that started in January 2004.
- The project's total budget of 2.2 million Euros is part funded with 1.5 million Euros by the European Commission.
- There are 15 participants/partners.

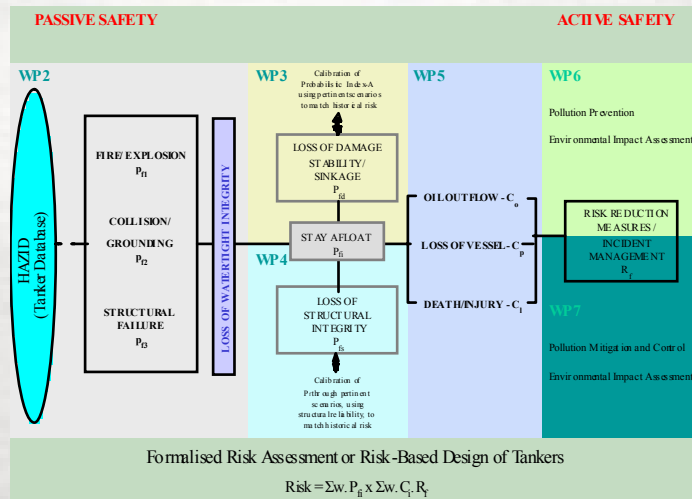


## POP&C Project Partners:

- INTERTANKO, Norway (Project Coordinator)
- Universities of Glasgow and Strathclyde, U.K. (Technical Coordinator)
- National Technical University of Athens, Greece
- Istanbul Technical University, Turkey
- University of Newcastle upon Tyne, U.K.
- Bureau Veritas, France
- Lloyd's Register, U.K.
- SIREHNA, France
- Centre of Maritime Technologies, Germany
- Maritime Simulations Rotterdam, Netherlands
- SSPA Sweden AB, Sweden
- Herbert Software Solutions Europe, U.K.
- Stocznia Gdynia S.A., Poland
- IZAR, Spain
- OSG Ship Management, U.K.
- Also, the IMO Secretariat is participating in the project as an observer/advisor.



## Project Outline



## Period of analysis 1978-2003

During this period the tanker fleet suffered 16,554 incidents.

In order to reduce the magnitude of the analysis, POP&C concentrated on the AFRAMAX Tanker fleet (80-120K DWT) which has suffered 1,311 incidents.

IMIS Incident Type	No. of Incidents
Hull and machinery	616
Collision	363
Grounding	192
Fire/Explosion	118
Miscellaneous	22
<b>Total</b>	<b>1311</b>

Tanker subtypes	No. of Incidents
Oil Tankers	627
Crude Tankers	621
Shuttle Tankers	23
Product Carriers	27
Chemical Oil Tankers	13
<b>Total</b>	<b>1311</b>



## The Six Hazards

POP&C considers hazards that can potentially lead to Loss Of Watertight Integrity (LOWI).

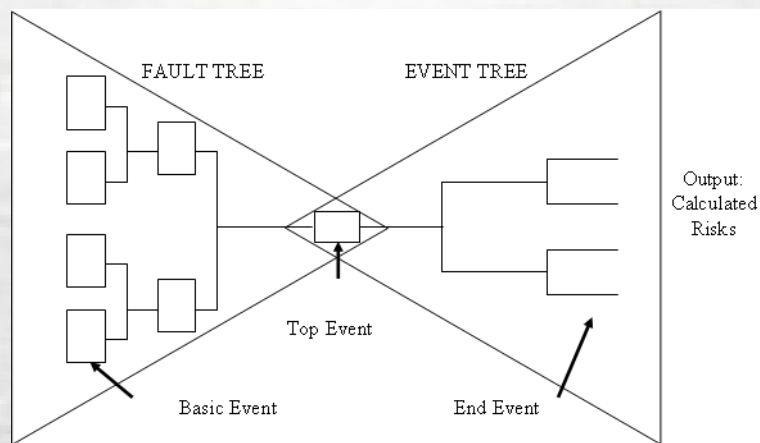
The identified six hazards are the top events of the fault trees developed by WP2.

POP&C Incident Type	No. of Incidents	%
Machinery Failure	337	26%
<b>Collision</b>	<b>233</b>	<b>18%</b>
<b>Grounding</b>	<b>194</b>	<b>15%</b>
Failure of Hull Fittings	137	11%
<b>Contact</b>	<b>126</b>	<b>10%</b>
<b>Structural Failure</b>	<b>121</b>	<b>9%</b>
Fire	79	6%
Explosion	39	3%
Unknown Reasons	26	2%
TOTAL ALL CATEGORIES	1294	100%
TOTAL LOWI CATEGORIES	792	61%

*Note: 17 out of 1311 initial records were finally not analysed at all due to complete lack of source complementary texts*



## WP2: Risk Assessment

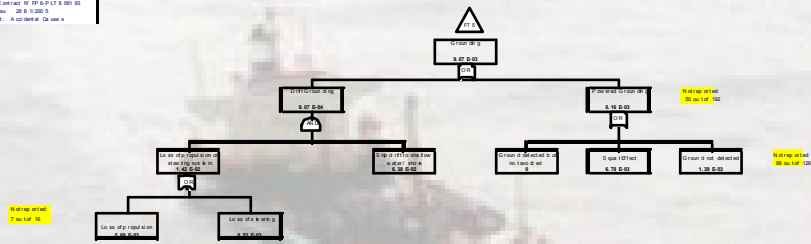






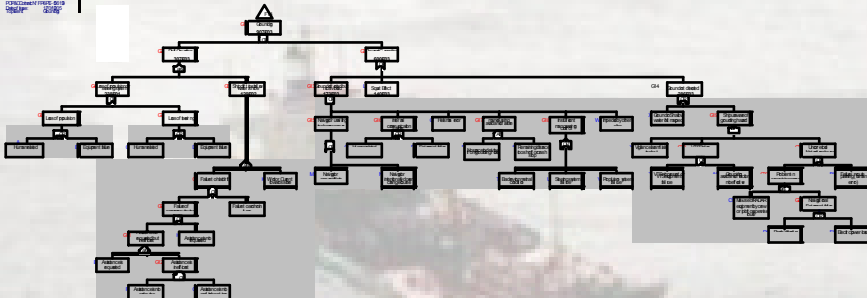
## Fault Tree for Grounding (from Historic Analysis)

POP&C Incident N° 10-0011 & 0012  
Date of issue: 20.05.2015  
Top level: Accident 00.000



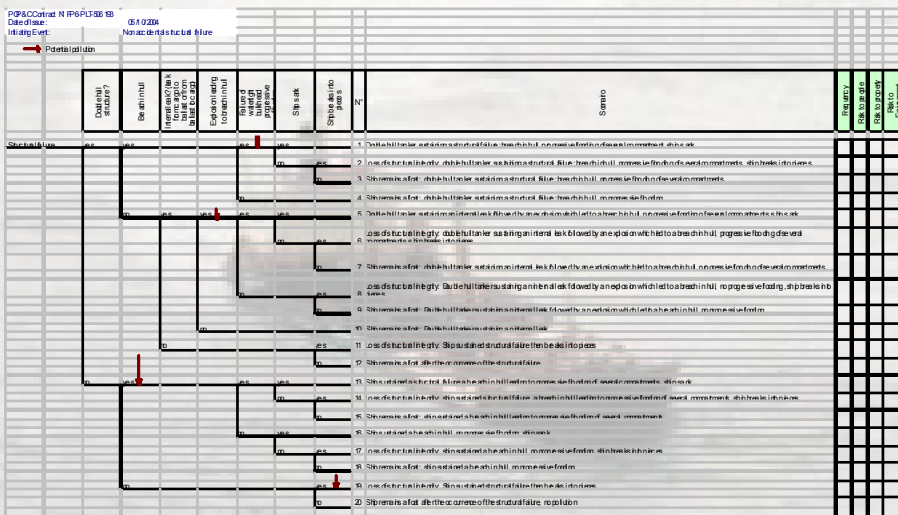
## Fault Tree for Grounding (by Expert Assessment)

POP&C Incident N° 10-0011 & 0012  
Date of issue: 20.05.2015  
Top level: Accident 00.000





## Example of Event Tree for Structural Failure

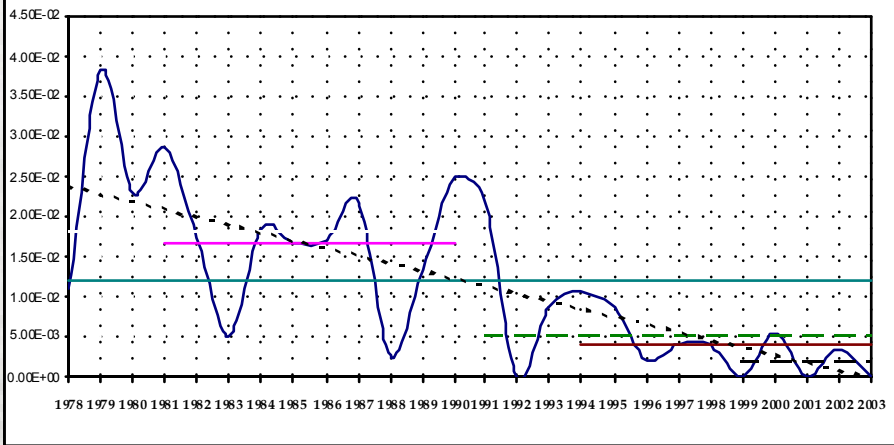


## Summary results for the 6 top events

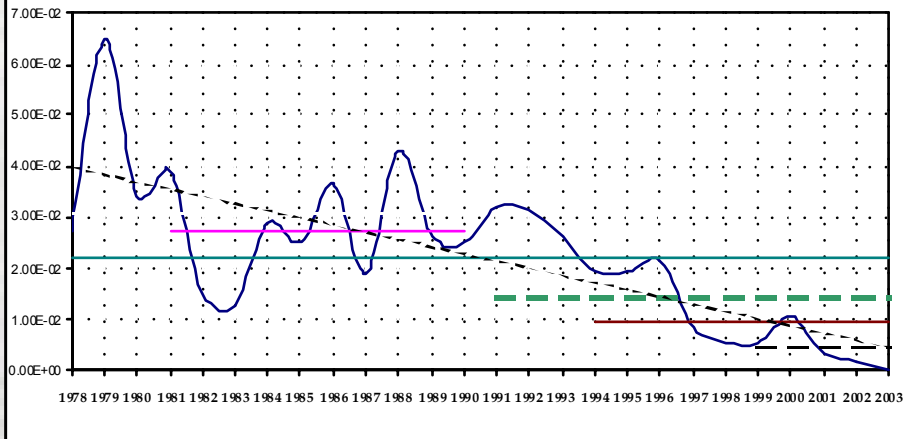
Year	No. of Ship At Risk	789 Incidents No & Rates	Grounding Incidents No & Rates	Fire Incidents No & Rates	Explosion Incidents No & Rates	Contact Incidents No & Rates	Collision Incidents No & Rates	Structural Failure Incidents No & Rates							
1978	364	33	9.07E-02	10	2.75E-02	2	5.495E-03	2	5.495E-03	5	1.37E-02	10	2.75E-02	4	1.10E-02
1979	340	69	2.03E-01	18	5.29E-02	8	2.353E-02	1	2.941E-03	7	2.06E-02	22	6.47E-02	13	3.82E-02
1980	349	43	1.23E-01	14	4.01E-02	3	8.596E-03	1	2.865E-03	5	1.43E-02	12	3.44E-02	8	2.29E-02
1981	383	69	1.80E-01	14	3.66E-02	14	3.655E-02	3	7.833E-03	12	3.13E-02	15	3.92E-02	11	2.87E-02
1982	405	43	1.06E-01	16	3.95E-02	6	1.481E-02	2	4.938E-03	6	1.48E-02	6	1.48E-02	7	1.73E-02
1983	391	33	8.44E-02	8	2.05E-02	4	1.023E-02	4	1.023E-02	10	2.56E-02	5	1.28E-02	2	5.12E-03
1984	380	38	1.00E-01	8	2.11E-02	2	5.263E-03	1	2.632E-03	9	2.37E-02	11	2.89E-02	7	1.84E-02
1985	360	27	7.50E-02	5	1.39E-02	3	8.333E-03	1	2.778E-03	3	8.33E-03	9	2.50E-02	6	1.67E-02
1986	355	38	1.07E-01	8	2.25E-02	4	1.127E-02	4	1.127E-02	3	8.45E-03	15	3.66E-02	6	1.69E-02
1987	366	32	8.74E-02	7	1.91E-02	3	8.197E-03	3	8.197E-03	4	1.09E-02	7	1.91E-02	8	2.19E-02
1988	370	44	1.19E-01	10	2.70E-02	1	2.703E-03	2	5.405E-03	14	3.78E-02	16	4.32E-02	1	2.70E-03
1989	379	42	1.11E-01	10	2.64E-02	4	1.055E-02	3	7.916E-03	10	2.64E-02	10	2.64E-02	5	1.32E-02
1990	402	46	1.14E-01	10	2.49E-02	2	4.975E-03	4	9.950E-03	10	2.49E-02	10	2.49E-02	10	2.49E-02
1991	408	39	9.56E-02	6	1.47E-02	6	1.471E-02	1	2.451E-03	4	9.80E-03	13	3.19E-02	9	2.21E-02
1992	444	29	6.53E-02	10	2.25E-02	1	2.252E-03	1	2.252E-03	3	6.76E-03	14	3.15E-02	0	0.00E+00
1993	457	30	6.56E-02	9	1.97E-02	2	4.376E-03	0	0.00E+00	3	6.56E-03	12	2.63E-02	4	8.75E-03
1994	467	23	4.93E-02	4	8.57E-03	1	2.141E-03	0	0.00E+00	4	8.57E-03	9	1.93E-02	5	1.07E-02
1995	463	22	4.75E-02	4	8.64E-03	2	4.320E-03	0	0.00E+00	3	6.48E-03	9	1.94E-02	4	8.64E-03
1996	469	17	3.62E-02	2	4.26E-03	1	2.132E-03	0	0.00E+00	3	6.40E-03	10	2.13E-02	1	2.13E-03
1997	486	19	3.91E-02	6	1.23E-02	4	8.290E-03	0	0.00E+00	3	6.17E-03	4	8.24E-03	2	4.12E-03
1998	521	12	2.30E-02	5	9.60E-03	1	1.919E-03	1	1.919E-03	0	0.00E+00	3	5.76E-03	2	3.84E-03
1999	555	10	1.80E-02	2	3.60E-03	1	1.802E-03	2	3.604E-03	2	3.60E-03	3	5.41E-03	0	0.00E+00
2000	553	15	2.71E-02	3	5.42E-03	1	1.808E-03	1	1.808E-03	1	1.81E-03	6	1.08E-02	3	5.42E-03
2001	556	6	1.08E-02	0	0.00E+00	1	1.799E-03	2	3.597E-03	1	1.80E-03	2	3.60E-03	0	0.00E+00
2002	560	7	1.25E-02	2	3.57E-03	2	3.571E-03	0	0.00E+00	0	0.00E+00	1	1.79E-03	2	3.57E-03
2003	596	3	5.03E-03	3	5.03E-03	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
<b>Total</b>	<b>11579</b>	<b>789</b>		<b>194</b>		<b>79</b>		<b>39</b>		<b>125</b>		<b>232</b>		<b>120</b>	



**Structural Failure Incidents Rate per Shipyear**

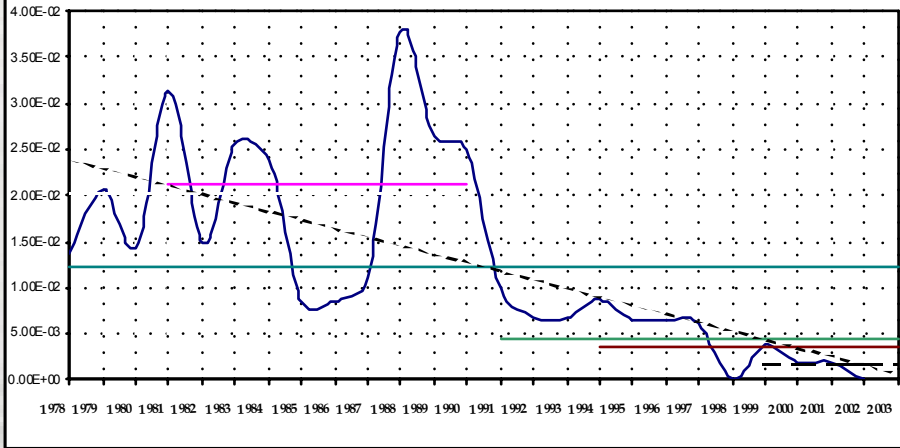


**Collision Incidents Rate per Shipyear**

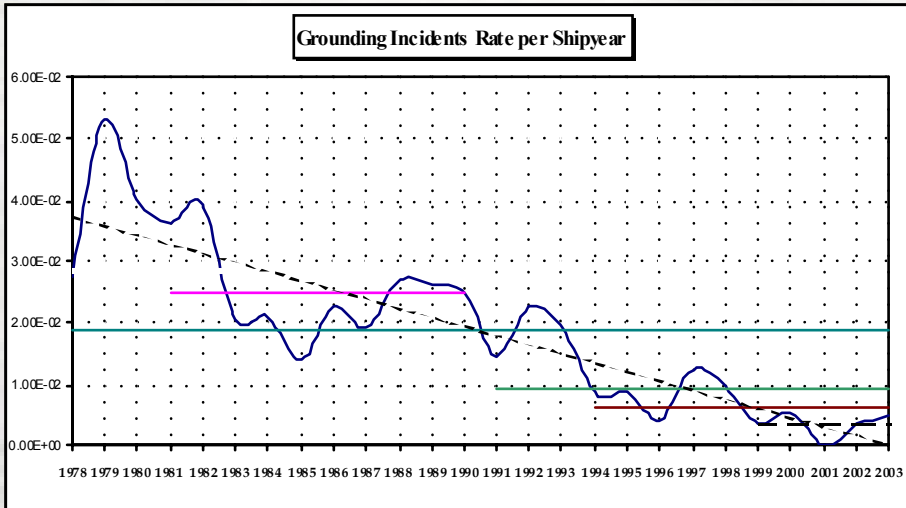




Contact Incidents Rate per Shipyear

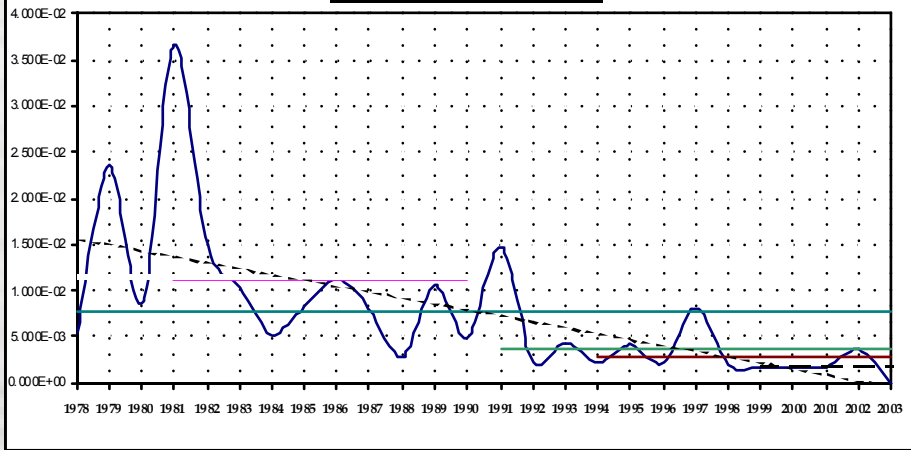


Grounding Incidents Rate per Shipyear

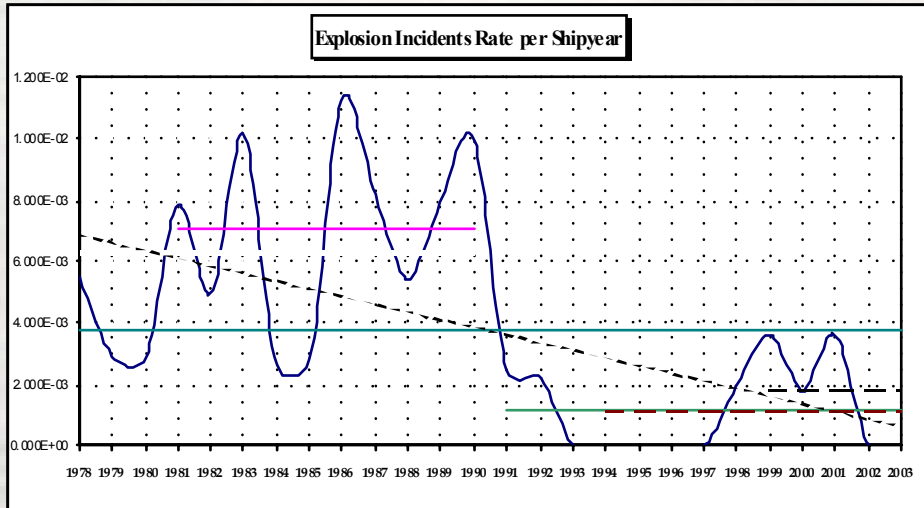




**Fire Incidents Rate per Shipyear**



**Explosion Incidents Rate per Shipyear**







## Example of analysis by Hull Type Fleet at risk 1978-2003

**AFRAMAX FLEET AT RISK (source LR)**

Year	SH	DB	DS	DH	Sum	Year	NON-Double Hull	Double Hull
1978	356	8	0	0	364	1978	364	0
1979	331	9	0	0	340	1979	340	0
1980	340	9	0	0	349	1980	349	0
1981	372	9	2	0	383	1981	383	0
1982	392	9	4	0	405	1982	405	0
1983	377	10	4	0	391	1983	391	0
1984	365	10	5	0	380	1984	380	0
1985	342	10	8	0	360	1985	360	0
1986	321	11	20	3	355	1986	352	3
1987	319	13	28	6	366	1987	360	6
1988	313	13	37	7	370	1988	363	7
1989	314	13	42	10	379	1989	369	10
1990	323	16	52	11	402	1990	391	11
1991	326	16	53	13	408	1991	395	13
1992	328	20	63	33	444	1992	411	33
1993	310	21	65	61	457	1993	396	61
1994	297	20	66	84	467	1994	383	84
1995	283	17	66	97	463	1995	366	97
1996	282	17	66	104	469	1996	366	104
1997	271	16	65	134	486	1997	352	134
1998	268	16	65	172	521	1998	349	172
1999	248	16	67	224	555	1999	331	224
2000	228	16	67	242	553	2000	311	242
2001	220	16	67	253	556	2001	308	253
2002	192	16	67	285	560	2002	275	285
2003	145	16	65	370	596	2003	226	370



## Pollution Frequency by Hull type POP&C Database 1978-2003

All cases of the 6 types of incident by Hull Type	
DH	54
DSS	43
DB	38
Single Skin	657
	792



## Pollution Frequency by Hull type POP&C Database 1978-2003

Oil Spill outcome of the 792 cases of the 6 incident categories by Hull Type

% of ships with NO OIL SPILL		% of ships with OIL SPILL	
DH	92.6	DH	7.4
DSS	93.0	DSS	7.0
DB	92.1	DB	7.9
Single Skin	91.9	Single Skin	8.1



## Pollution Consequence by Hull type POP&C database 1978-2003

Ships involved in the 6 incident categories

Hull Type	Single Skins		DB Ships		DSS Ships		DH Ships	
	# of ships	Pollution Quantity	# of ships	Pollution Quantity	# of ships	Pollution Quantity	# of ships	Pollution Quantity
No Spill	604	0.00	35	0.00	40	0.00	50	0.00
0 < Spill <= 7 t	18	26.19	1	0.01	0	0.00	1	1.00
7 < Spill <= 30 t	3	55.00	0	0.00	0	0.00	0	0.00
Spill > 30 t	30	397,112.17	2	4,377.00	2	8,851.00	3	362.00
	655	397,193	38	4,377	42	8,851	54	363

Number of Ships involved = 789

Total Pollution Quantity = 410,784 t



## Pollution Consequence by Hull type POP&C Database 1978-2003

<b>Incident categories: Non-Accidental Structural Failure, Collision, Contact, Grounding, Fire, Explosion</b>					
	<b>All Ships</b>	<b>SH</b>	<b>DB</b>	<b>DSS</b>	<b>DH</b>
Number of Ship-years	11,379	7,863	363	1,044	2,109
Total Quantity Spilled (in tonnes)	410,784	397,193	4,377	8,851	363
<i>Index (tonnes/Ship-year)</i>	<i>36.1</i>	<i>50.5</i>	<i>12.1</i>	<i>8.5</i>	<i>0.2</i>