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To : All Inspectors in OSD 3, OSD 5 and CD 4C

Unit Managers in OSD 1, OSD 2, OSD 3, OSD 4 and OSD 5

ACCIDENT/INCIDENT DATA

PURPOSE

This document provides guidance for assessment of failure rate data used in the risk analyses in Offshore Safety Cases.

BACKGROUND

1. The guidance in this SPC is in addition to, but does not conflict with, the guidance given in the Guidance for the Assessment of Safety Cases – Engineering Topics (GASCET) or in the Assessment Principles for Offshore Safety Cases (APOSC).

2. There is a need for accident/incident data and other failure rate data (e.g. release frequencies) in risk assessment in order to evaluate risks to persons and to demonstrate that these risks are as low as reasonably practical (ALARP). The amount and type of data required will depend on the initiating events being studied in the risk evaluation, and on the techniques being used.

3. The quantitative assessment of risk, in terms of the probability of occurrence and the severity of the consequences, depends greatly on both the availability and the quantity of the accident/incident data, failure rate data and the probability figures being used.

4. This SPC categorises those sources of accident/incident and other related data likely to be used in Offshore Safety Cases, and in Quantified Risk Assessment (QRA) in particular.

5. The main sources of generic data are identified, and are linked with the various data categories to show what type of data is available from which source.

6. Value ranges for frequencies and/or probabilities for certain events are tabulated, and preferred values are stated where available.

7. The legal requirements for the data provision are discussed, and key assessment points are listed including areas where specialist advice should be sought.

8. Methods of using the data are described in Appendix 1, which also includes discussion on the various data sources.

FURTHER INFORMATION

For further information please contact: OSD 3.1 (VPN 523 3135) or CD 4C (VPN 523 3113)

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DATA CATEGORIES

1. Accident/Incident data or Failure Rate data can be divided into a number of categories, depending on the risks being quantified [11]

2. The three main categories associated with the typical Offshore risk are:

Category 'A'

- The probability of occurrence of an unwanted event (i.e. **initiating event**), for example:

External Events: Vessel Collision, Helicopter Crash, Dropped Objects

Internal Events: Blowout, Process Release, Pipeline/Riser Leak

Category 'B'

- The **conditional probability** of occurrence of the effects on the initiating event, for example:

Effects: Immediate/Delayed Ignition, Accumulation, Dispersion

Safety Systems: Fire and Gas Detection, ESD, Blowdown

Category 'C'

- The probability of occurrence of **insult/damage** given an effect, for example:

Consequences: Jet Fire, Pool Fire, Loss of Life, Capital Loss

3. Figure 1 below illustrates the relationship between the main data categories.

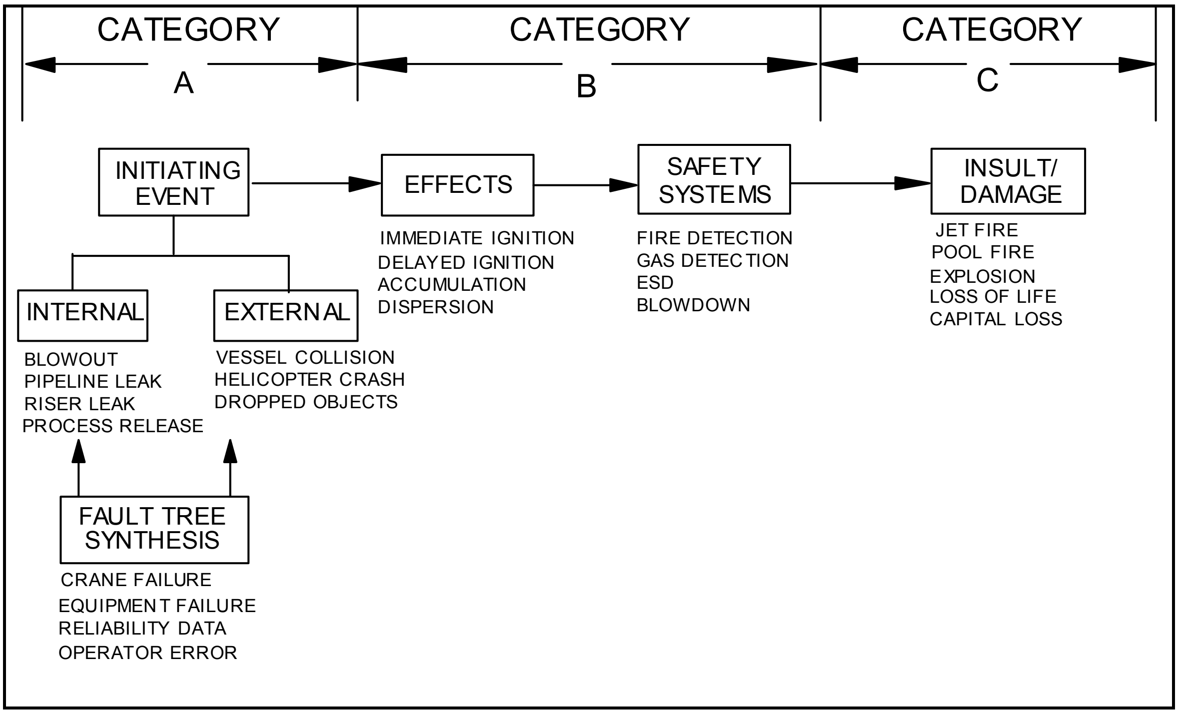

Figure 1: Categories of Data

4. Failure rates, accident/incident frequencies and probabilities can be derived either from generic sources such as published data, the main sources of which are discussed in detail later, or from installation specific sources such as maintenance and other records held by the organisation concerned.

5. The kind of data to be used depends on the events being studied. Discussion of the main data sources and the event types associated with each of the three main categories are outlined in the Data Sources and Indicative Data Sections of this SPC.

LEGAL REQUIREMENTS

6. A requirement of the Offshore Installations (Safety Case) Regulations 1992 SI 1992 No.2885 (also known as SCR) is 'A demonstration, by reference to **the results of** suitable and sufficient **quantitative risk assessment**, that the measures taken in relation to the hazards referred to…, will reduce risks to the health and safety of persons to the lowest level that is reasonably practicable' (the ALARP principle). [Regulation 4 (Schedule 1 Para 12, and Schedule 2 Para 11), and Regulation 5 (Schedule 3 Para 9) of SCR refer].

7. Under 'Interpretation', Regulation 2 (1) of SCR states that **'quantitative risk assessment'** means the identification of hazards and the **evaluation** of the extent of risk arising there from incorporating calculations **based upon the frequency and magnitude of hazardous events**.

8. Guidance on SCR also states 'QRA allows the various components of risk, and possibly the overall risk, to be quantified **where input data are available on failure rates and consequences**'. This and other references to data, either direct or indirect, are made under Paras 85,92 and 93 of the SCR Guidance.

9. In addition, the Prevention of Fire and Explosion, and Emergency Response Regulations, 1995, SI1995 No.743 (also know as PFEER) require in Regulation 5 that: 'The duty holder shall perform…. an assessment [which] shall consist of…. the identification of the various events [and]…. the **evaluation of the likelihood and consequences of such events**'.

10. The above extracts from SCR, PFEER and guidance demonstrate the need for relevant failure rate data in Offshore Safety Cases, and in the respective assessments on prevention of fires/explosions and emergency response.

CODES AND STANDARDS

11. 'Risk Management' BS8444, Part 3, 1996, refers to the use of data in section 5.4.3 'Risk Calculations' and 7.2.3.1 'Frequency Analysis'. This British Standard also contains detailed discussion on the various methods of risk analysis.

12. 'Collection of Reliability and Maintenance Data for Equipment' ISO/CD14 224 rev.1 (CLEAN) deals with the collection of data but not with its use. As the title suggests, it deals exclusively with reliability data.

13. 'Reliability of (constructed or manufactured products) Systems, Equipments and Components' BS5760 parts 1 to 7 (various years) contain many references to data, both on the collection and use of it, but this is centred on reliability rather than on risk analysis. This British Standard however, has many areas in common with BS 8444 (see 11. above) since it also deals with analysis techniques such as Fault Tree analysis, FMEA, etc.

14. Apart from the above standards, there are those relating to quality e.g. BS5750, ISO9000, etc. which do not deal directly with the use of data.

DATA SOURCES

15. There are a number of existing data sources suitable for use in Offshore QRA studies. The main sources of generic data considered in this section are listed below. It is stressed that the list is far from exhaustive, since there are many other relevant data sources not in the public domain.

- Statistics from the Hydrocarbon Releases (HCR) database, also contained in annual HSD-OSD reports

- Statistics from HID 'ORION' database

- Offshore Reliability Data (OREDA) 2002

- Cox, Lees and Ang, 'Classification of Hazardous Locations' (1993), I Chem. E

- Offshore Blowouts Causes and Control (1997), by Per Holand

- Accident Statistics for Fixed Offshore Units on the UK Continental Shelf 1980-2001

- Accident Statistics for Floating Offshore Units on the UK Continental Shelf 1980-2001

- Ship/Platform Collision Incident Database (2001)

- An Appraisal of Existing Seismic Hazard Estimates for the UK Continental Shelf (2003)

16. Figure 2 below illustrates how these main sources of data relate to the data categories discussed in Data Categories above.

17. Other sources of data for pre-cursor events in Fault Tree Analysis may be found in the operator's own in-house maintenance/inspection and other operational records.

18. Descriptions of the main data sources, and comment on the use of each are contained in Appendix 1.

MAIN SOURCE DATA	A			B		C
	INITIATING EVENTS			COND. PROBS.		
	EXTERNAL HAZARDS	INT. HAZARDS		EFFECTS	SAFETY SYSTEMS	CONSEQUENCES
		HYDROCARBON	NON HYDROCARBON			
HSE-OSD Hydrocarbon Release Database		X		X	X	X
HID ‘ORION’ Database	X	X	X	X	X	X
Offshore Reliability Data (OREDA)					X	
Classification of Hazardous Locations		X		X	X	
Offshore Blowouts Causes and Control		X	X	X	X	X
Accident Statistics for Fixed Offshore Units on the UK Continental Shelf	X		X			X
Accident Statistics for Floating Offshore Units on the UK Continental Shelf	X		X			X
Ship/Platform Collision Incident Database	X					X
UK Offshore Public Transport Helicopter Safety Record	X					X
An Appraisal of Existing Seismic Hazard Estimates for the UK Continental Shelf	X					X

Figure 2 – Main Data Sources

INDICATIVE DATA

Category 'A'

External Events

19. Each of the frequencies given in Data Table (1) below are generic averages, based on historical accident/incident data averaged over a wide variety of locations and Installation types. These are indicative figures only and therefore should be used with caution, particularly in an Installation specific analysis.

20. It should also be noted that collision data on general shipping may be generated by computer models such as 'CRASH' or 'COLLIDE'. This data is not included in the table and further details of these codes and their limited applicability may be found in separate guidance.

DATA TABLE (1) – EXTERNAL EVENTS

Event Type	Description/Frequency Range	Indicative Value
Dropped and Swinging Loads	Installation Impacts Drops into the Sea	7.3×10^{-2} /platform yr 3.2×10^{-2} /platform yr
Helicopter Accidents	Fatal Accident Rate*: Flight Hours Sectors ***based on 1,000,000 flight hours/ sectors**	1.36×10^{-5} /flight hrs 5.78×10^{-6} /sector
Seismic Activity	For peak ground Accelerations: Value range of 0.09g to 0.119g Value range of 0.197g to 0.239g	Exceedance probabilities are: 10^{-3} /per yr 10^{-4} /per yr

Mean Incident Frequency 1975 to 31/10/2001 – All Vessel Types		
Installation Type	**All Reported Incidents /Year**	**Incidents Resulting in Moderate or Severe Damage /Year**
All Installations	9.87×10^{-2}	1.52×10^{-2}
Fixed Installations	6.30×10^{-2}	9.50×10^{-3}
Semisubmersibles	2.38×10^{-1}	4.87×10^{-2}
Jack-Ups	1.41×10^{-1}	5.40×10^{-3}
Mean Incident Frequency 1975 to 31/10/2001 – Passing Vessels		
Installation Type	**All Reported Incidents /Year**	**Incidents Resulting in Moderate or Severe Damage /Year**
All Installations	1.40×10^{-3}	4.00×10^{-4}
Fixed Installations	1.20×10^{-3}	2.00×10^{-3}
Semisubmersibles	0.0	0.0
Jack-Ups	5.40×10^{-3}	1.80×10^{-3}

Internal Events

21. Each of the frequencies given in the following Data Table (2), are generic averages for the UK Continental Shelf (UKCS), based on historical accident/incident data averaged over a wide variety of UKCS locations, installation types, system and equipment types.

22. The data are split into 'Hydrocarbon Events' and 'Non-Hydrocarbon Events'.

23. The main use of such data in an assessment is to cross check that synthesised frequencies are not wholly at odds with past experience. The best approach is to synthesise accident frequencies using Fault Tree Analysis methods, and incorporating Installation specific failure rate data.

24. It is important to note that generic leak frequencies do not generally give an indication of the leak sizes involved. In practice, analysis should be carried out for a range of hole sizes, since these can have a significant bearing on the effects (e.g. ignition probability) and on the consequences of the leak. It is usual to consider pin hole, 50 mm diameter, and full bore/rupture as a minimum range of hole sizes when analysing a particular initiating event.

25. The probability of distribution of hole size for a particular leak should be stated in the assessment, and this is also usually linked to the leak rate. For example, a typical statement would be that 'a pin hole leak has a 90% probability of occurrence within the leak frequency, and is assumed to have a leak rate of 0.1 kg/s'.

26. Details of the probable hole size distribution for hydrocarbon releases from the main types of hydrocarbon carrying systems and equipment items may be found in the HSE-OSD annual Hydrocarbon Release Statistics[1].

27. On blowouts, the location of the leak (at Wellhead, Xmas Tree or Drill Floor level) must also be examined and allocated a probability to gain a more accurate estimate of the effects and consequences of the release, should it occur at one or other of these levels. Details of the probable hole size distribution for hydrocarbon releases from Drilling/Well Operations may also be found in the HSE-OSD annual Hydrocarbon Release Statistics reports.

28. It should be noted also that the vulnerability of equipment to damage, e.g. from impact, fire, explosion etc. is covered in separate guidance.

DATA TABLE (2) – INTERNAL EVENTS

(a) **HYDROCARBON EVENTS**		
Event Type	**Description/Frequency Range**	**Indicative Value**
Blowouts* (Recommended frequencies) *** These frequencies may be factored by application of a positional and/or hole size probability**	Exploration Drilling: Shallow Gas Deep Gas Development Drilling: Shallow Gas Deep Gas Workover Production Wireline Completion	3.79×10^{-3} /wells drilled 2.51×10^{-3} /wells drilled 1.90×10^{-3} /wells drilled 9.20×10^{-4} /wells drilled 9.30×10^{-4} /well workover* 1.20×10^{-4} /well yr 5.00×10^{-5} /wells yr 3.00×10^{-6} /wireline run** 8.00×10^{-6} /wireline job** 1.40×10^{-5} /well yr 2.10×10^{-4} /completion*** *** 1 workover every 8 well yrs** **** 4.2 wireline runs /well yr, 1.7 wireline jobs /well yr** ***** Based on trend analysis**
Process Releases* Systems: ***Each of these frequencies may be factored by applying a hole size probability**	Blowdown Drains, Closed Drains, Open Drilling, Equipment Export, Oil Export, Gas Export, Condensate Flare, HP Flare, LP Flowlines, Oil Flowlines, Gas Flowlines, Other (Condensate) Gas Compression Import, Oil Import, Gas Import, Condensate	4.49×10^{-3} /system yr 2.57×10^{-2} /system yr 2.43×10^{-2} /system yr 8.76×10^{-3} /system yr 1.72×10^{-1} /system yr 3.12×10^{-2} /system yr 1.35×10^{-1} /system yr 3.31×10^{-2} /system yr 1.85×10^{-2} /system yr 1.14×10^{-2} /system yr 9.27×10^{-3} /system yr 9.41×10^{-4} /system yr 3.06×10^{-1} /system yr 2.13×10^{-2} /system yr 1.20×10^{-2} /system yr 2.22×10^{-2} /system yr

(Systems Continued)	Manifold, Oil Manifold, Gas Manifold, Other (Condensate) Metering, Oil Metering, Gas Metering, Condensate Processing, Oil, Oil Treatment Processing, Oil, Prod Water Treatment Processing, Oil, Methanol (Injection) Processing, Oil, Chemical Injection Processing, Gas, Dehydration Processing, Gas, Prod Water Treatment Processing, Gas, Methanol (Injection) Processing, Gas, Chemical Injection Processing, Gas, LPG/Condensate Processing, Gas, Sour (H2S/C02) Treat. Separation, Oil Test Separation, Oil Production Separation, Gas Test Separation, Gas Production Utilities, Oil, Heli Fuel/Jet Fuel Utilities, Oil, Diesel Utilities, Oil, Heat Transfer Oil Utilities, Oil, Power Gen Turbine Utilities, Gas, Fuel Gas Utilities, Gas, Power Gen Turbine Vent, HP Vent, LP Well, Oil Production, Surface Well, Oil Production, Subsea Well, Gas Production, Surface Well, Gas Production, Subsea Well, Gas Injection, Surface Well, Gas Injection, Subsea	1.73×10^{-2} /system yr 1.11×10^{-2} /system yr 7.45×10^{-4} /system yr 4.08×10^{-2} /system yr 3.12×10^{-2} /system yr 3.75×10^{-2} /system yr 7.00×10^{-2} /system yr 8.18×10^{-2} /system yr 2.14×10^{-2} /system yr 1.67×10^{-3} /system yr 7.85×10^{-2} /system yr 1.11×10^{-2} /system yr 1.27×10^{-2} /system yr 3.54×10^{-3} /system yr 5.73×10^{-2} /system yr 4.49×10^{-2} /system yr 5.52×10^{-2} /system yr 8.26×10^{-2} /system yr 1.58×10^{-2} /system yr 2.06×10^{-2} /system yr 5.55×10^{-3} /system yr 3.48×10^{-2} /system yr 3.23×10^{-2} /system yr 3.33×10^{-3} /system yr 1.42×10^{-1} /system yr 1.90×10^{-2} /system yr 1.63×10^{-2} /system yr 9.16×10^{-3} /system yr 8.12×10^{-3} /system yr 8.96×10^{-3} /system yr 5.44×10^{-3} /system yr 6.64×10^{-3} /system yr 1.50×10^{-2} /system yr 2.00×10^{-1} /system yr

Process Releases* Pipelines:	Pig Launchers (by diameter):		
(Radius to 500m**)		D<=8”	1.44 x 10^{-2} /equipment yr
***Each of these frequencies may be factored by applying a hole size probability**		8”<D<=12”	3.53 x 10^{-3} /equipment yr
****Radius over 500m consult PARLOC**		12”<D<=16”	No data available
		D>16”	6.77 x 10^{-3} /equipment yr
	Pig Receivers (by diameter):		
		D<=8”	1.01 x 10^{-2} /equipment yr
		8”<D<=12”	4.76 x 10^{-3} /equipment yr
		12”<D<=16”	7.63 x 10^{-3} /equipment yr
		D>16”	6.70 x 10^{-3} /equipment yr
	Pipelines (by diameter):		
	Steel:	D<=4”	1.26 x 10^{-5} /metre yr
		4”<D<=8”	2.69 x 10^{-6} /metre yr
		8”<D<=12”	1.92 x 10^{-6} /metre yr
		12”<D<=16”	3.21 x 10^{-6} /metre yr
		D>16”	1.07 x 10^{-6} /metre yr
	Flexible:	D<=4”	1.76 x 10^{-5} /meter yr
		4”<D<=8”	4.40 x 10^{-6} /metre yr
		8”<D<=12”	No data available
		12”<D<=16”	4.00 x 10^{-4} /metre yr
		D>16”	No data available
	Valve Actuated (by diameter):		
	P/L ESDV	D<=4”	1.16 x 10^{-3} /valve yr
		4”<D<=8”	1.87 x 10^{-3} /valve yr
		8”<D<=12”	8.85 x 10^{-4} /valve yr
		12”<D<=16”	1.37 x 10^{-3} /valve yr
		D>16”	1.18 x 10^{-3} /valve yr
	P/L SSIV Assembly	D<=4”	No data available
		4”<D<=8”	No data available
		8”<D<=12”	No data available
		12”<D<=16”	6.25 x 10^{-3} /valve yr
		D>16”	No data available
	Risers (by diameter):		
	Steel:	D<=4”	No data available
		4”<D<=8”	2.58 x 10^{-6} /riser yr
		8”<D<=12”	No data available
		12”<D<=16”	1.37 x 10^{-5} /riser yr
		D>16”	1.15 x 10^{-5} /riser yr
	Flexible:	D<=4”	3.20 x 10^{-5} /riser yr
		4”<D<=8”	1.17 x 10^{-5} /riser yr
		8”<D<=12”	No data available
		12”<D<=16”	No data available
		D>16”	No data available

Process Releases* Equipment:	BOP Stacks, Surface		8.30×10^{-4} /stack yr
***Each of these frequencies may be factored by applying a hole size probability**	Compressors:	Centrifugal	1.11×10^{-2} /compressor yr
		Reciprocating	6.53×10^{-2} /compressor yr
	Degassers		4.83×10^{-4} /degasser yr
	Expander		1.83×10^{-2} /expander yr
	Flanges (by diameter (D)):		
		D<=3”	4.11×10^{-5} /flange yr
		3”<D<=11”	5.81×10^{-5} /flange yr
		D>11”	1.09×10^{-4} /flange yr
	Filters		3.77×10^{-3} /filter yr
	Fin Fan Coolers		2.51×10^{-3} /cooler yr
	Heat Exchangers:	HC in Shell	5.68×10^{-3} /exchanger yr
		HC in Tube	4.01×10^{-3} /exchanger yr
		Plate	1.12×10^{-2} /exchanger yr
	Instruments		6.82×10^{-4} /instrument yr
	Mud/Shale:	Pumps	5.03×10^{-4} /pump yr
		Shakers	1.01×10^{-3} /shaker yr
	Piping (by diameter):		
	Steel:	D<=3”	2.20×10^{-4} /metre yr
		3”<D<11”	6.64×10^{-5} /metre yr
		D>11”	5.92×10^{-5} /metre yr
	Flexible:	D<=3”	9.39×10^{-4} /metre yr
		3”<D<11”	2.12×10^{-4} /metre yr
		D>11”	No data available
	Pressure Vessels (all types):		
	Upper Limit – 7.38×10^{-3}		9.41×10^{-3} /vessel yr
	Lower Limit – 1.50×10^{-2}		
	Pumps (all types):		
	Upper Limit – 9.69×10^{-2}		7.22×10^{-3} /pump yr
	Lower Limit – 3.73×10^{-3}		
	Storage Tanks		3.86×10^{-3} /tank yr
	Turbines:	Gas	2.89×10^{-2} /turbine yr
		Dual Fuel	7.89×10^{-2} /turbine yr

(Equipment continued)	Valve Actuated (by diameter):	
(Excluding Pipelines)	D<=3”: Upper Limit: 1.34×10^{-3}	6.54×10^{-4} /valve yr
	Lower Limit: 8.97×10^{-5}	
	3<D<11”: Upper Limit: 1.34×10^{-3}	7.57×10^{-4} /valve yr
	Lower Limit: 3.00×10^{-4}	
	D>11”: Upper Limit: 1.42×10^{-3}	8.86×10^{-4} /valve yr
	Lower Limit: 4.26×10^{-4}	
	Valve Manual (by diameter):	
	D<=3”: Upper Limit: 3.32×10^{-4}	1.59×10^{-4} /valve yr
	Lower Limit: 8.08×10^{-5}	
	3<D<11”: Upper Limit: 4.41×10^{-4}	2.29×10^{-4} /valve yr
	Lower Limit: 1.17×10^{-4}	
	D>11”: Upper Limit: 1.28×10^{-3}	8.65×10^{-4} /valve yr
	Lower Limit: 4.49×10^{-4}	
	Xmas Trees:	
	P<=5000 psi (345 bar)	4.55×10^{-3} /well yr
Note: Well systems comprise xmas tree and wellhead only. Down hole is covered under Drilling/Well Operations activities.	5000 psi<P<=10000	4.63×10^{-3} /well yr
	P>10000 psi	1.59×10^{-2} /well yr
	Wellheads:	
	P<=5000 psi (345 bar)	2.61×10^{-3} /well yr
	5000 psi<P<=10000	1.45×10^{-3} /well yr
Mechanical Failure	Pumps: Reciprocating	4.70×10^{-3} /pump yr
	Centrifugal	1.30×10^{-3} /pump yr
	Compressors: Reciprocating	1.90×10^{-4} /compressor yr
	Centrifugal	5.60×10^{-3} /compressor yr

(b) **NON HYDROCARBON EVENTS**

Event Type	Description/Frequency Range	Indicative Value
Missile Generation	Creation of a few large missiles	1.00×10^{-3} /machine yr
	Creation of many large missiles	1.00×10^{-4} /machine yr
Structural Failures	Fixed units, all failures, North Sea	4.30×10^{-3} /platform yr
	Fixed units, total losses, North Sea	4.20×10^{-4} /platform yr
	Mobile units, all failures, North Sea	5.20×10^{-2} /rig yr
	Mobile units, total losses, North Sea	3.75×10^{-3} /rig yr
Towing	Mobile units, Jackups, North Sea	1.80×10^{-2} /rig yr
	Mobile units, Semisubmersibles, North Sea	2.40×10^{-2} /rig yr
Mooring/Anchoring (Grounding and Off-Position)	Mobile units, Jackups, North Sea	1.80×10^{-2} /rig yr
	Mobile units, Semisubmersibles, North Sea	3.87×10^{-2} /rig yr
Loss of Stability (Capsize, Foundering, Leakage, List)	Mobile units, Jackups, North Sea	2.40×10^{-2} /rig yr
	Mobile units, Submersibles, North Sea	3.44×10^{-2} /rig yr

Category ‘B’ Data

29. This type of data includes the probable **Effects** of initiating events (e.g. Gas dispersion/accumulation, ignition probability) and the probability of failure (unavailability) of the various **Safety Systems** (ESD, Blowdown, F & G Detection).

30. Data Table (3) below contains indicative values for various conditional possibilities. These values were derived from a range of generic sources.

DATA TABLE (3) - CONDITIONAL PROBABILITIES

Event Type	Description/Probability Range	Indicative Value
(a) Effects		
Ignitions	Blowouts: 0.08 to 0.3 Gas Leaks: Small 0.005 to 0.01 Large 0.3 to 0.8 Oil Leaks: Small 0.01 to 0.03 Large 0.07 to 0.1	0.3 0.01 0.3 0.03 0.1
Explosions	Probability of explosion given ignition: Small Leak (<1kg/s) Major Leak (up to 50 kg/s) Massive Leak (>50 kg/s)	 0.04 0.1 0.3
(b) Emergency Systems		
Emergency Shutdown (ESD) System	Dependant on system complexity, but range of failure on demand values between 0.0015 & 0.1	0.02
Blowdown System	Range of failure on demand values between 0.01 & 0.2	0.1
Fire Detector	Maximum unavailability per detector	0.12*
Gas Detector	Maximum unavailability per detector	0.12*
***Probability of failure to detect is dependant on number of detectors in area and number of detectors needed to cause alarm/shutdown. Usually calculated using appropriate formulae**		

31. The main use of such data in an assessment is to cross check that platform specific probability values are not wholly at odds with past experience.

32. Details on hydrocarbon release ignition rates, means of detection, emergency actions, causation etc. may be found in the HSE-OSD annual Hydrocarbon Release Statistics report[1].

Category ‘C’ Data

33. This comprises of the probabilities of **damage and/or loss** due to the effects of initiating events, which are generally derived by **consequence** modelling. Data on generic incidence rates for fatalities, major injuries and dangerous occurrences are available, and these are shown in Data Table (4) below.

DATA TABLE (4) – GENERAL OCCUPATION HAZARDS

Work Year		1980-1989 (average) Per Year***	1990-1999 (average) Per Year***	99/00	00/01	01/02	02/03 (p)****
Estimated Workforce Levels*		27,300	29,566	19,000	23,330	23,206	22,264
Fatalities	Total	7.3 (24.0)**	4.7	2	3	3	0
	Incidence per 100,000 Employees	26.7 (87.9)**	14.96	10.5	12.9	12.9	0
Serious Injuries	Total	68.2	63.9	53	53	47	64
	Incidence per 100,000 Employees	250	218.9	278.9	227.2	202.5	287.5
Over 3-day Injuries	Total	-	372.1	193	177	187	118
	Incidence per 100,000 Employees	-	1233.1	1015.8	758.7	805.8	530.0
Dangerous Occurrences	Total	187.2	525.3	647	764	661	636

Notes:

HSE took over responsibility for offshore safety from the UK Department of Energy (D.En) from April 1991

* Based on Inland Revenue survey held in August/September each year

** Figures in brackets include Piper Alpha

*** Figures averaged over 10-year period

**** Figures for 2002/03 are provisional

34. Further breakdown of this data may be found in the latest version of the annual Offshore Accident/Incident Statistics report.[2]

35. However, it is not possible to provide generic values, for example, for damage by impact, fire, or explosion. Separate guidance should be consulted for these criteria.

36. Similarly, separate guidance should be consulted for criteria associated with the loss of life (e.g. FAR, PLL, IR, F-N curves, etc.).

ASSESSMENT

Key Questions

37. Topic assessment guidance on accident/incident data is provided in APOSC and in GASCET.

38. To supplement the assessment principles contained in both, key questions to be asked by assessors during assessment failure rate data are tabulated below together with the reasoning behind each.

Question	Reason
Are the sources of data properly identified?	Identification of data sources is essential in order to check their validity. Actual data used must be fully referenced. Data should be available for audit if required, although this should not normally be necessary.
Is the data relevant to the UK Continental Shelf Oil and Gas Industry?	Ideally, all data used should be Installation specific. However, if generic data sources are used then these should preferably cover related offshore activities at (in order of preference): local level (i.e. similar Installation in the area), UKCS, Overall North Sea, Gulf of Mexico (where relevant) or at worldwide level.
Is the data sufficiently specified in terms of the type of failure being analysed, and its frequency or probability?	The data should be on an appropriate basis for the event being analysed, e.g. per drilling equipment year, per demand, per well drilled, per helicopter flight etc.
Is the data the most recent available?	The most recent, but relevant data should be used, and the age and period of operation of Installation should also be taken into account.
How accurate is the data?	Where this is shown to be sensitive and where the risk levels are significant, the accuracy of the data should be discussed and account taken of the sample size etc. including justification of confidence levels.
Has experience and/or expert judgement been used to adjust generic frequencies?	It may be necessary to consider how the individual situation being addressed is likely to differ from the ‘typical’ situation, and what effect this could have on accident frequency or severity and hence on the risks. Experience and/or expert judgement may have to be applied to adjust the figures to suit, thus introducing further uncertainties.
Does the frequency used compare favourably with HSE-OSD indicative values?	In general, unless full justification is given the frequency should approximate to the HSE-OSD indicative value (where stated). Frequencies for event types not quoted in the table (or not dealt with within the Technical Reference Manual discussions) should be selected to give conservative outcomes in terms of risk levels.
Do release frequency analyses include hole size distribution?	Although generic frequency data does not always give a breakdown of leak size within overall frequency figure, in practice the analyses should be carried out for a range of leak sizes. Leak size has a considerable bearing on the magnitude of any effects of the leak (e.g. ignition probability) and could also result in significantly different consequences. A minimum range of hole sizes to be considered would comprise: Pin hole, 50mm diameter, full bore/rupture. These should each be given a probability of occurrence, together with a leak rate in kgs/s.
Has a sensitivity analysis been carried out?	Where there are large uncertainties in the data used and where the associated risk levels are of particular significance, then the sensitivity of the data should be examined. If the uncertainty and significance remain after the sensitivity analysis, then efforts should be made to obtain more accurate data. 90% confidence band or higher is preferable.
Are the calculation methods for producing estimated data (e.g. release rates, ignition	The applicability and accuracy of such methods (formulae, parameter, etc.) should be discussed. It is

probabilities) appropriate, and are they being applied property?	recommended that, if possible, a check be done by the assessor to confirm the proper use of the methods employed.
Have HAZOP and/or Human Factors been taken into account to justify using generic average data	The use of generic frequency data assumes that the operations (i.e. Installation and its personnel) meet the average requirements for the location covered by the data. Direct use of such data should not be considered acceptable unless fully justified. One way to justify its use is to apply HAZOP and human factors studies, to demonstrate that the operation is close to average, thereby also justifying the use of generic data without adjustment.
Has failure frequency data been adjusted down due to a system or equipment either being new, or near to the end of its design life?	Claims may be made that a new Installation and/or its systems and equipment are better than average by virtue of the latest technology etc. or that an old Installation is not being exposed to the same operating parameters, e.g. significantly reduced reservoir pressure. Such claims need to be fully justified, especially since there is a counter argument that failure frequencies may tend to be biased upwards, either by enhanced infant mortality (new) or by wear out (old age). This is amply demonstrated by the bathtub curve.

Possible Areas Requiring Specialist Assessment

39. The following situations may require the assessor to refer to the topic specialist for advice or for secondary assessment. The topic specialists for accident/Incident data are CD4C.

    a. Where data sources are not clearly identified and referenced in the Safety Case, and no further (or unsatisfactory) clarification has been received from the duty holder.

    b. Where the use of the data is dubious i.e. not relevant to the situation being analysed in the Safety Case.

    c. Where the manipulation of data (e.g. adjustment by experience etc.) is dubious, for instance the justification for factorising generic data is unsatisfactory or not given.

    d. Where there is significant disparity between the HSE-OSD indicative value and that used in Safety Case, without clear justification.

    e. Inaccurate data is being used (i.e. with unacceptable confidence levels or unconservative outcomes in terms of risks), especially in situations with significant risk attached.

    f. No sensitivity analysis has been carried out where the data has associated uncertainties and particular significance in terms of consequence/risk.

g. Where uncertainty remains and risk remains significant due to the use of certain failure data values, even after a sensitivity analysis has been carried out.

h. Where calculation/estimation methods are questionable, are not clearly justified, or are not being applied properly.

REFERENCES

1. Statistics from the HSE-OSD Hydrocarbon Release (HCR) database, based on Offshore Incident Reporting (OIR/12) Scheme, and contained in annual HSE-OSD Statistics reports (HSR Series)

2. Statistics from HID 'ORION' database, based on RIDDOR (OIR/9B). Contained in HSE-OSD Statistics reports (HSR Series)

3. Offshore Reliability Data (OREDA) 2002 - SINTEF Industrial Management.

4. Cox, Lees and Ang, 'Classification of Hazardous Locations', I.CHEM.E., 1993

5. Offshore Blowouts Cases and Control – Per Holand 1997

6. Accident Statistics for Fixed Offshore Units on the UK Continental Shelf 1980-2001, Research Report 096 (2003), by Det Norkse Veritas for HSE

7. Accident Statistics for Floating Offshore Units on the UK Continental Shelf 1980-2001, Research Report 095 (2003), by Det Norkse Veritas for HSE

8. Ship/Platform Collision Incident Database (2001), Research Report 053 (2003), by Serco Assurance for HSE

9. UK Offshore Public Transport Helicopter Safety Record (1973 - 2000), by BOMEL Consortium for HSE/Civil Aviation Authority (CAA)

10. An Appraisal of Existing Seismic Hazard Estimates for the UK Continental Shelf, Research Report 166 (2003), by The Mallard Partnership for HSE

11. Reliability Data for use in Offshore FSA studies - Verwoerd, M.

12. World Offshore Accident Databank (WOAD) 1998 - Det Norske Veritas

13. 'Pipeline and Riser Loss of Containment Data for Offshore Pipelines' (PARLOC) 2001, prepared for UKOOA and HSE by Advanced Mechanics & Engineering Ltd (AME)

14. Review of the Risk Assessment of Buoyancy Loss (RABL), Research Report 143 (2003), by BMT Fluid Mechanics Ltd for HSE

APPENDIX 1 – DATA SOURCES

EXISTING DATA SOURCES

i. There are a number of existing data sources suitable for use in Offshore QRA studies. The main sources of generic data considered in this section are listed below. It is stressed that the list is far from exhaustive, since there are many more data sources not in the public domain.

– Statistics from Hydrocarbon Release (HCR) Database

– Statistics from 'ORION' database

– Offshore Reliability Data (OREDA)

– Classification of Hazardous Locations

– Offshore Blowouts Causes and Control

– Accident Statistics for Fixed Offshore Units on the UK Continental Shelf 1980-2001

– Accident Statistics for Floating Offshore Units on the UK Continental Shelf 1980-2001

– Ship/Platform Collision Incident Database (2001)

– UK Offshore Public Transport Helicopter Safety Record (1973 - 2000)

– An Appraisal of Existing Seismic Hazard Estimates for the UK Continental Shelf

j. Sources of data for pre-cursor events Fault Tree Analysis may be found either in the operator's own in-house maintenance/inspection and other operational records, or generic sources such as OREDA data.

SOURCE DESCRIPTIONS

In the following sections, a summary is given of each of the above listed main data sources, followed by brief discussion of their uses and limitations.

Hydrocarbon Release (HCR) Database

When a loss of containment incident is reported via RIDDOR on form OIR9/9B, the operator is requested to supply supplementary data on a voluntary basis for all leaks involving hydrocarbons. The data is supplied on form OIR/12 and entered into the HCR database. (**Note:** This data is now submitted via the on-line HCR system)

The two main contributions from the database to this report are Leak Frequencies for Systems and Equipment (both in Data Table 2), and Hole Size distribution. The data produced is available to contributors on-line. There is also an annual report provided to Industry in full accordance with the Cullen report.

Under 'Process Releases Equipment' some of the figures produced show an upper & a lower limit. Where this is the case the indicative value is based on the average of the total values. This applies to the following: Pressure Vessels, Pumps, Valve Actuated and Valve Manual.

HID 'ORION' Database

This is the HID data recording system for accidents/incidents reported under RIDDOR by the Offshore Industry. It records the five main categories of incidents, i.e. fatalities, major and minor injuries, dangerous occurrences, and ill health. Accident/incident statistical reports are produced annually and are considered the prime source of data for the Offshore Industry.

The figures for accident/incident data shown in Data Table (4) have been extracted from ORION. The figures for the estimated workforces are provided from a survey carried out by the Inland Revenue.

Offshore Reliability Data (OREDA)

The OREDA handbook contains reliability data for offshore equipment, derived from maintenance records kept by the members of the OREDA group for their offshore installations in the North Sea. The data are divided into five main categories as follows:

- Machinery
- Electrical Equipment
- Mechanical Equipment
- Control and Safety Equipment
- Subsea Equipment

Each of these categories is then subdivided into Taxonomies for each different type of system within the category, and for each type of component within the system. Each component has dedicated pages allotted, with the last page (in comments box) of the Taxonomy providing details of the probability of failure on demand.

Mechanical Failure data for Pumps/Compressors have been extracted from OREDA and can be found in Data Table (2).

Classification of Hazardous Locations

This is essentially an investigation of the feasibility of putting hazardous area classification on a more quantitative basis. It is not a definitive guide to classifications, but is an overall type of approach to classification, which includes models and risk criteria, and might form the basis for further work aimed at producing guidelines.

Ignition and explosion probability data for blowouts and leaks have been extracted from the publication are shown in Data Table (3).

Offshore Blowouts Causes and Control

This publication is based on the SINTEF Offshore Blowout Database, but is limited to the 124 blowouts that occurred on the Outer Continental Shelf of the US Gulf of Mexico and the Norwegian and UK waters in the period January 1980 to January 1994.

The publication covers blowout frequencies and associated trends for the various phases of operation, contribution from blowouts to the fatal accident rate, pollution caused by blowouts. Also included are important factors when evaluating offshore risk, i.e. ignition probability, time to ignition, ignition trends, blowout duration, and blow path.

The data extracted from the report have been used to provide recommended blowout frequencies in Data Table (2).

Accident Statistics for Fixed Offshore Units on the UK Continental Shelf (UKCS) (Research Report 096)

This research report can be viewed through the HSE Website. It is a subsidiary of the World Offshore Accident Databank (WOAD) and provides the latest statistics for accidents/incidents that have occurred on fixed units engaged in the oil and gas exploration and exploitation on the UKCS in the period 1980-2001.

To provide comprehensive statistics the following databases have been interrogated: ORION, WOAD, and Offshore Blowout Database. By combining the results from ORION and WOAD databases, the accident frequencies for fixed units in the UKCS are estimated.

Figures for structural failure have been extracted from the report. They can be found in Data Table (2), under Non Hydrocarbon Events.

Accident Statistics for Floating Offshore Units on the UK Continental Shelf (UKCS) (Research Report 095)

This research report can be viewed through the HSE Website. It is a subsidiary of the World Offshore Accident Databank (WOAD) and provides the latest statistics for accidents/incidents that have occurred on floating units engaged in oil and gas activities on the UKCS in the period 1980-2001.

To provide comprehensive statistics the following databases have been interrogated: ORION, WOAD, FOCUS, Marine Accident Investigation Bureau (MAIB) accident database and the Offshore Blowout Database. By combining the results from ORION, WOAD and MAIB databases, the accident frequencies for floating units in the UKCS are estimated.

Figures for structural failure, towing, mooring/anchoring and loss of stability have been extracted from the report. They can be found in Data Table (2), under Non-Hydrocarbon Events.

Ship/Platform Collision Incident Database (Research Report 053)

This research report can be viewed through the HSE Website. The data has been collected from a number of collision incident record sources and provides an update to the database on the UKCS. By combining data of collision incidents with installation operating experience, it has been possible to establish the variation of incident frequency with time, and the likely confidence limits that may be placed on them.

The data extracted from the report shows the probability of a collision incident per installation year for all incidents. The figures can be found in Data Table (1) for all types of vessels and for passing vessels only.

UK Offshore Public Transport Helicopter Safety Record (1973 - 2000)

This document makes statistical comparisons within the UK aviation sector to establish how the offshore public transport helicopter safety record compares with other aviation public groups. Also within the offshore public transport helicopter group, analysis has been done to establish what fatal and reportable accident rates exist collectively and for the different groups of helicopter.

Only accidents/incidents that relate to offshore helicopter carrying passengers (e.g. offshore workforce) are included in this document and not accidents/incidents involving personnel on an offshore installation, SAR, freight or other offshore flight activity. Flight crew fatal accidents are also excluded as the CAA identifies them as an integral part of the airborne transport system.

The figures extracted from the report show the passenger fatal accident rates between 1990 and 1999, based on 1,000,000 flight hours/sectors, and can be viewed in Data Table (1).

An Appraisal of Existing Seismic Hazard Estimates for the UK Continental Shelf (Research Report 166)

This research report can be viewed through the HSE Website. It is an appraisal of the four most significant and recent hazard assessments which deal with offshore areas, presented solely in the form of peak ground acceleration contour maps for certain annual probabilities of exceedance. The objective was to see how best the results from the four studies could now be used in the light of current and developing engineering practices.

The results are combined to generate a set of hybrid seismic hazard maps and for seismic hazard at the 10^{-4} p.a. probability of exceedance, the hybrid contour map of offshore peak ground acceleration (pga) is compared with corresponding pga hazard levels determined in site-specific studies.

The figures extracted from the report are generic examples of the dependence of pga hazard on earthquake catalogue completeness thresholds and based on the expected 10^{-4} p.a. & 10^{-3} p.a. pga hazard. These are shown in Data Table (1).