OSD hydrocarbon release reduction campaign
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EXECUTIVE SUMMARY

This document reports the initial findings of an OSD initiative in 2000-2001 to investigate all reported offshore hydrocarbon releases. The main objective was to analyse the size, type and causes of the releases, to provide information useful to industry and OSD regarding ways of reducing the number of releases. The project forms part of an ongoing OSD initiative aimed at reducing the number of “major” and “significant” releases by 50% by April 2004.

The results for the year to 31 March 2001 showed a 10% reduction in the total number of major and significant releases, but a 50% increase in the number of minor releases. This increase may however be the result of increased awareness of the need to report minor releases, and a better understanding of the reporting criteria, as a result of the publicity generated by the campaign. The number of major releases declined 33% - a considerable improvement.

Comparisons on the relatively crude “per manned installation” basis show a wide variation of release frequencies, such that a significant improvement would be achieved if the worst operators in this respect came up the standard of the best.

The releases were analysed by hydrocarbon type, operating mode, release site, release mechanism, immediate and underlying causes, and failed safeguarding systems. Potential additional safeguarding systems were also identified in some cases. The majority of releases involved gas, and occurred during normal production. Pipework was the main release site, with small-bore piping a significant contributor.

The most frequent immediate cause of all releases, by some margin, was degradation of material properties of the containment envelope. For the major releases however, operator error and procedural violation became important, rather than hardware failures. Operator error and procedural problems accounted for half of the releases from pipes or valves opened to the atmosphere. Nearly two-thirds of all releases had hardware-related immediate causes, the remainder being "software" or human factor-related.

Inadequate design featured strongly in the underlying causes, as did inadequate inspection/condition monitoring.

The main failed safeguard identified was inspection/condition monitoring, suggesting that effective plant and operating status checks, along with good personnel supervision, are significant factors in preventing releases.
# CONTENTS

<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>iii</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Release Severity Classification</td>
<td>2</td>
</tr>
<tr>
<td>Overall Hydrocarbon Release Numbers and Severity Distribution</td>
<td>2</td>
</tr>
<tr>
<td>Benchmarking</td>
<td>3</td>
</tr>
<tr>
<td>Size Distributions</td>
<td>4</td>
</tr>
<tr>
<td>Analytical Taxonomy</td>
<td>4</td>
</tr>
<tr>
<td>Next Steps</td>
<td>8</td>
</tr>
<tr>
<td>Table 1 Numerical severity classification criteria</td>
<td>10</td>
</tr>
<tr>
<td>Table 2 Offshore hydrocarbon releases 1/4/00 – 31/3/01</td>
<td>11</td>
</tr>
<tr>
<td>Table 3 Offshore hydrocarbon releases 1993 - 2001</td>
<td>11</td>
</tr>
<tr>
<td>Table 4 Major/significant release rates per manned installation</td>
<td>12</td>
</tr>
<tr>
<td>Table 5 Release analysis taxonomy</td>
<td>13</td>
</tr>
<tr>
<td>Fig. 1 Minor liquid releases – size distribution</td>
<td>14</td>
</tr>
<tr>
<td>Fig. 2 Significant liquid releases – size distribution</td>
<td>15</td>
</tr>
<tr>
<td>Fig. 3 All releases by operating mode</td>
<td>16</td>
</tr>
<tr>
<td>Fig. 4 All releases by hydrocarbon type</td>
<td>17</td>
</tr>
<tr>
<td>Fig. 5 All releases by release site</td>
<td>18</td>
</tr>
<tr>
<td>Fig. 6 Immediate causes - all releases</td>
<td>19</td>
</tr>
<tr>
<td>Fig. 7 Underlying causes - all releases</td>
<td>20</td>
</tr>
<tr>
<td>Annex 1 Summary of major releases</td>
<td>21</td>
</tr>
</tbody>
</table>
INTRODUCTION

1. In April 2000 OSD launched an Offshore Hydrocarbon Release Reduction Campaign. This was targeted at obtaining a 50% reduction in the annual number of RIDDOR-reportable offshore hydrocarbon releases in the major and significant categories (see para. 5 below) by April 2004, compared with the comparable baseline figures in 1999/2000.

2. The campaign consisted of two parallel projects:
   a) one based on the mandatory investigation of all RIDDOR-reportable incidents involving hydrocarbon release on offshore installations,
   b) the second involving a programme of planned process integrity inspections for all normally attended production platforms.

3. The purpose of this report is to:
   a) provide the offshore industry with the results on hydrocarbon release numbers for year one of the campaign. Updates will be provided for future years,
   b) provide the offshore industry and OSD inspectors with analysis data from the incident investigation reports. In this context, the document should be seen as an initial report as there are many additional factors which time and data processing constraints have currently excluded from the analysis. See para. 34 for proposed next steps,
   c) highlight broad problem areas which during the life of the project have led to release of hydrocarbon, as a means of prioritising those areas where further work on formulating and sharing good practice within the industry would be most beneficial.

4. The investigation project ran for a 12 month period from 1 April 2000 to 31 March 2001. During this period OSD inspectors were required to investigate all offshore RIDDOR-reportable hydrocarbon releases, the extent of the investigation varying with the size of the release. To concentrate on the more serious releases, the main offshore effort was directed at the investigation of gas and 2-phase releases greater than 25kg and liquid releases greater than 250kg (this broadly equates to releases in the ‘major’ category and upper quartile ‘significant’ releases as described below). Smaller releases were investigated by gathering information through the dutyholder’s own investigations, to describe the release scenario and identify the root causes and proposed remedial measures, with some onshore follow-up as necessary to produce the report.
RELEASE SEVERITY CLASSIFICATION

5. All hydrocarbon releases reported to OSD under RIDDOR are classified in terms of three severity categories: major, significant and minor. The definitions of the categories are as follows:

Major – those with the potential to quickly impact outwith the local area for example affect the Temporary Refuge, escape routes, or escalate to other areas of the installation causing serious injury or fatalities.

Significant – those with the potential to cause serious injury or fatality to personnel within the local area and to escalate within that local area, for example by causing structural damage, secondary leaks or damage to safety systems.

Minor – those with the potential to cause serious injury to personnel in the immediate vicinity, but no potential to escalate or cause multiple fatalities.

6. Classification of releases is achieved through the use of numerical severity criteria (in terms of release size, release rate and duration). The criteria used were agreed with the offshore industry some years ago in conjunction with the development of the Hydrocarbon Release Database, and are given in Table 1. The same system of classification has been employed throughout the investigation project.

OVERALL HYDROCARBON NUMBERS AND SEVERITY DISTRIBUTION

7. The number of offshore hydrocarbon releases reported to OSD for 2000/2001 under RIDDOR are shown in Table 2, together with the respective severity classifications. Comparative figures for the seven previous years are shown in Table 3.

8. In terms of major and significant releases, the figures indicate:

a) A reduction in the number of major releases to eight in 2000/2001, from twelve in 1999/2000. This is the first time that the number of major releases has been in single figures and reflects a 33% reduction against the baseline figure. Given that it is the major releases which have the greatest potential for rapid escalation, this is an encouraging improvement, particularly when compared to the long-term average of 15 to 20 major releases per year.

b) The number of significant releases fell from 127 in 1999/2000 to 117 in 2000/2001, representing a 7.8% reduction against baseline.
c) The number of major and significant releases combined fell from 139 in 1999/2000 to 125 in 2000/2001, a 10% overall reduction against baseline. This represents useful initial progress toward the 50% reduction target, though clearly much more remains to be done if the target is to be met.

9. The number of minor releases reported in 2000/2001 rose to 145, from 99 the previous year. However it is believed that the result mainly represents an increase in reporting activity as a result of greater awareness and scrutiny of the reporting process, rather than an increase in the number of such incidents actually taking place. The OSD hydrocarbon release reduction campaign has been supplemented by campaigns from a number of individual companies and this has undoubtedly increased awareness of reporting requirements across the industry.

10. There have also been doubts in the past as to the completeness and reliability of the reporting of minor releases. For example, minor releases have shown by far the greatest year-to-year variability, with swings of up to 50% being recorded. This uncertainty was one of the reasons that the release reduction target was formulated in terms of major and significant releases.

11. There is undoubtedly a degree of judgement required in deciding whether smaller releases are reportable under RIDDOR and perhaps in the past there have been instances where the judgement process has been inconsistent. For example, during the course of the campaign a number of additional minor releases have been identified which had not been reported under RIDDOR but it is now believed were probably reportable. Conversely, scrutiny of the minor releases reported during the year has also identified some which it is considered are strictly outside RIDDOR reporting requirements. A joint HSE-industry research project is planned to examine current industry understanding of reporting requirements together with aspects of the numerical severity criteria, which may not fully reflect advances made in areas such as gas dispersion and fire and explosion modelling.

BENCHMARKING

12. Table 4 indicates major and significant hydrocarbon release rates on a “per manned installation” basis for a number of different dutyholders. For this comparison the few releases on not-normally-manned installations have been disregarded. The rates derived are clearly only a fairly crude measure of safety performance in that:

a) they relate only to the 12-month timeframe of the project.

b) they treat all normally manned platforms as having an equal number of potential leak sources, whereas in reality the installations will vary in size and complexity and hence in the number of potential leak sources.
13. Nevertheless the data indicates a wide range in performance between
dutyholders, the worst having a release rate more than 6 times that of the
best. 50% of these dutyholders had a release rate of 1 or below, 35% a rate
of 2 or above. On the basis of the available information, significant reductions
in overall hydrocarbon release numbers could be secured if the performance
of the worst dutyholders could be brought up to that of the best, through
methods such as inter-company benchmarking, sharing of good practice etc.

SIZE DISTRIBUTIONS

14. The three different severity categories (major, significant and minor) into
which the hydrocarbon releases are classified have quite wide size bands
(see Table 1). For example, the “significant liquid release” category ranges
from 60 to 9000kg of liquid. In practice, the release sizes reporting during the
project have been heavily skewed toward the bottom end of the relevant
ranges.

15. The effect for minor and significant liquid releases can be seen in Figs. 1 and
2. For minor releases, 86% of releases were smaller than half the upper limit
for the category (60kg), and 58% of releases were smaller than one sixth the
upper limit. For significant liquid releases, 96% of releases were less than
half the upper limit (9000kg), and 80% were less than one sixth the upper
limit.

16. A similar pattern was found for significant gas and two-phase releases,
although for minor gas and two-phase releases the distribution was more
even across the size range.

17. The largest gas or two-phase release on a manned installation was around
3350kg of hydrocarbon. There was also a release of 9600kg of gas from a
normally unmanned installation. The largest liquid release was around
6000kg, from a manned installation.

ANALYTICAL TAXONOMY

18. To try to make maximum use of the information from the incident investigation
reports, the data in the reports has been classified in terms of causal factors
relating to:

a) operating mode,
b) release site,
c) release mechanism,
d) immediate cause(s),
e) underlying cause(s),

f) failed safeguarding system,

g) potential new or additional safeguarding systems that could have prevented the incident.

19. Each of these primary factors has then been developed in terms of secondary factors. For example, the following secondary factors have been associated with the primary factor “operating mode”:

a) normal production,

b) start-up/re-instatement,

c) maintenance,

d) well operations/drilling,

e) abnormal production,

f) shutdown/shutting down,

g) construction,

h) testing/sampling,

i) pigging.

20. The complete taxonomy employed is given in Table 5. Where relevant, an attempt has been made to harmonise the taxonomy with that used in the current OIR 12 reporting system. Nevertheless it is recognised that there are many different taxonomies (in terms of primary and secondary factors) that could be used, and that the current system may be modified for the purposes of further analysis - see para 3(b).

21. Annex 1 contains a summary of each of the eight major releases.

Operating mode

22. As might be expected, incidents occurring during normal production were in the majority, at 57% of the total number of incidents - see Fig. 3. The next largest category was start-up/re-instatement (13%) followed by maintenance (11%) and well operations/drilling (8%). This last figure excluded releases of formation fluids from the well bore during drilling, as these were considered to
be outside the scope of the project. Releases during topsides well operations, for example during well testing, were included.

**Hydrocarbon type**

23. The distribution of incidents by hydrocarbon type is shown in Fig. 4. 55% of incidents were gas releases and 23% oil releases. The proportion of oil releases is somewhat higher than for earlier years as a result of a significant increase in the number of minor oil releases reported. As discussed in para. 9, this may be the result of increased awareness/scrutiny rather than a increase in the number of incidents taking place. Releases of other hydrocarbon types were much less frequent, the most common being diesel (6%), condensate (6%) and two-phase fluids (3%). All of the eight major releases reported were either gas (seven) or two-phase (one). Three-quarters of the significant releases also involved gas or two-phase fluids. The minor release category contained a significant proportion (almost a third) of oil releases.

**Release sites**

24. The incidents were analysed for the site of each release, differentiating between major components such as vessels, pipework and valves, and between generic site types such as flanges, seals and open ends. The results are shown in Fig. 5. Pipework was the largest contributor, being involved in 61% of all releases. Within that category small bore piping was associated with 18% of releases. Valves were involved in 12% of releases and vessels in 8%.

25. The detailed findings also indicate the following:

a) 47% of all releases were from cracks, splits or holes in the containment envelope.

b) 21% of releases were from the body of a pipe, vessel or valve, mostly caused by mechanical degradation including, for example, from corrosion or erosion.

c) Of the 18% of releases associated with small bore piping, just over half were from connections and the rest from the pipe body. 36% were classed as significant, the rest as minor.

d) 15% of all releases were from flanges.

e) 14% of all releases were from seals or packing.

f) 4% of releases were from hoses.
26. Analysis of the immediate causes of releases is shown in Fig 6. The biggest single immediate cause was degradation of material properties (26%), followed by corrosion/erosion (19%), fatigue/vibration (11%), incorrect installation (11%), operator error (11%) and inadequate procedures (8%). In this context “degradation of material properties” means loss of integrity by failure of equipment which was originally fit for purpose and was operated correctly. This category includes causes such as loss of flexibility in flange gaskets and valve stem packing, and general “wear and tear”. It excludes the specific causes of corrosion, erosion, fatigue and vibration, which are recorded as separate categories.

27. However for major releases, operator error and failure to follow procedures assume greater importance, accounting for half the releases between them. This reflects the increased role of individual and system failures in the larger releases, as opposed to hardware or equipment failures.

28. In terms of some of the principal release sites:

   a) The immediate cause of 29% of flange releases was incorrect installation, with degradation of material properties contributing a further 24%.

   b) The immediate cause of 28% of releases from small bore tubing was fatigue/vibration, with a further contribution of 24% from degradation of material properties.

   c) 27% of releases from open ends were due to inadequate procedures and 25% to operator error.

29. The immediate causes can be divided into hardware-related and software related issues:

   **Hardware**
   - Degradation of material properties
   - Fatigue/vibration
   - External corrosion
   - Erosion
   - Inadequate equipment
   - Internal corrosion
   - Line blockage

   **Software**
   - Inadequate installation
   - Operator error
   - Inadequate procedures
   - Procedural violation
   - Inadequate isolation

Nearly two-thirds of the releases had hardware-related immediate causes. Their biggest single underlying cause was inadequate design, contributing to 40% of these incidents. Inadequate inspection/condition monitoring was the next biggest underlying cause at 38%, followed by inadequate material specification (10%) and inadequate installation (10%).
30. For the remaining releases with software-related immediate causes, the associate underlying causes were more scattered, with seven between 22% and 15%. In decreasing order these were inadequate installation, compliance monitoring, risk assessment, competence, design, procedures and supervision. The two management monitoring causes combined (compliance monitoring and supervision) contributed to 37% of the software-related incidents.

31. Of the underlying causes for all releases, irrespective of immediate cause, (Fig. 7), the largest category was inadequate design (29%), followed by inadequate inspection/condition monitoring (28%), inadequate competency (11%), inadequate compliance monitoring (10%), inadequate procedures (9%), and inadequate risk assessment (8%). For the major releases, inadequate design was implicated in half of the incidents, with a half also resulting from inadequate monitoring, either of compliance with procedures or of the condition of the plant.

Failed safeguards

32. An attempt was made in each case to identify a safeguard which, if it operated correctly, might have prevented the release. Of these, inspection/condition monitoring was identified in nearly a third of all incidents, suggesting that checking and maintaining the condition of the plant was one of the most important ways of preventing leaks. One in six incidents had design review as a failed safeguard, one in ten corrosion/erosion monitoring and another one in ten competency assurance. For three of the eight major releases, the failed safeguard involved breakdown of the control system of isolations or of locked valves. This indicates that failure of such systems can readily lead to serious releases of hydrocarbon.

Additional safeguards

33. In some cases additional safeguards were suggested which might help prevent future incidents. The main safeguards identified were improved implementation of the UKOOA guide on small-bore pipeline (12% of incidents) and use of some form of flange integrity verification scheme (7% of incidents), such as that currently under development by UKOOA.

NEXT STEPS

34. In the light of information available from this report OSD will:

   (a) work with the industry to develop appropriate industry guidance detailing good practice in the particular problem areas identified. For example industry guidance is already at different stages of development on both small bore tubing and bolted flanges,
(b) identify (with the industry) areas where further analysis of the data may lead to the development of specific remedial measures to reduce release numbers further,

(c) use the data to develop specific Strategic Inspection Plans for individual dutyholders.
TABLE 1
NUMERICAL SEVERITY CLASSIFICATION CRITERIA

MAJOR RELEASES

(i) Gas releases
   EITHER (Quantity released > 300 kg)  
   OR  (Mass release rate > 1kg/s AND Duration > 5 min.)

(ii) Liquid releases (Oil/Condensate/Non-process)
   EITHER Quantity released > 9000kg  
   OR Mass release rate > 10kg/s AND Duration > 15 min.

(iii) 2-Phase releases
   EITHER Quantity of liquids released > 300kg  
   OR Liquids mass release rate > 1kg AND Duration > 5 min.

MINOR RELEASES

(i) Gas release
   EITHER Quantity released < 1kg  
   OR Mass release rate <0.1kg/s AND Duration < 2 min.

(ii) Liquid releases (Oil/Condensate/Non-process)
   EITHER Quantity released < 60kg  
   OR Mass release rate <0.2 kg/s AND Duration < 5 min.

(iii) 2-Phase releases
   EITHER Quantity released < 1kg  
   OR Liquid release rate < 0.1 kg/s AND Duration < 2 min.

SIGNIFICANT RELEASES

Those releases lying between the limits for major and minor releases.
**TABLE 2**

Offshore hydrocarbon releases reported under RIDDOR from 1st April 2000 to 31st March 2001
By Process Type and Severity Type

<table>
<thead>
<tr>
<th>Release Type</th>
<th>Severity</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Major</td>
<td>Significant</td>
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<tr>
<td>Non Process</td>
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<td>27</td>
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<td>Oil</td>
<td>17</td>
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<td>Condensate</td>
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<tr>
<td>Gas</td>
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<td>74</td>
</tr>
<tr>
<td>2-Phase</td>
<td>1</td>
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<tr>
<td><strong>GRAND TOTAL</strong></td>
<td><strong>8</strong></td>
<td><strong>117</strong></td>
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**TABLE 3**

Annual number of major, significant and minor hydrocarbon releases reported under RIDDOR from 1993/94 to 2000/01

<table>
<thead>
<tr>
<th>SEVERITY</th>
<th>YEAR</th>
<th>93/94</th>
<th>94/95</th>
<th>95/96</th>
<th>96/97</th>
<th>97/98</th>
<th>98/99</th>
<th>99/00</th>
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<tbody>
<tr>
<td>Major</td>
<td></td>
<td>24</td>
<td>20</td>
<td>20</td>
<td>19</td>
<td>13</td>
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<tr>
<td>Significant</td>
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<td>151</td>
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<td>134</td>
<td>129</td>
<td>139</td>
<td>134</td>
<td>127</td>
<td>117</td>
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<tr>
<td>Total (major/significant)</td>
<td></td>
<td>175</td>
<td>214</td>
<td>154</td>
<td>148</td>
<td>152</td>
<td>149</td>
<td>139</td>
<td>125</td>
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<tr>
<td>Minor</td>
<td></td>
<td>96</td>
<td>111</td>
<td>58</td>
<td>78</td>
<td>66</td>
<td>85</td>
<td>99</td>
<td>145</td>
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<tr>
<td>Total (all releases)</td>
<td></td>
<td>271</td>
<td>325</td>
<td>212</td>
<td>226</td>
<td>218</td>
<td>234</td>
<td>238</td>
<td>270</td>
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### TABLE 4

MAJOR/SIGNIFICANT RELEASE RATES PER MANNED PRODUCTION INSTALLATION

<table>
<thead>
<tr>
<th>OPERATOR</th>
<th>RELEASE RATE PER INSTN. YR</th>
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<tbody>
<tr>
<td>A</td>
<td>2.50</td>
</tr>
<tr>
<td>B</td>
<td>2.50</td>
</tr>
<tr>
<td>C</td>
<td>2.33</td>
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<tr>
<td>D</td>
<td>2.25</td>
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<tr>
<td>E</td>
<td>2.00</td>
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<tr>
<td>F</td>
<td>2.00</td>
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<tr>
<td>G</td>
<td>2.00</td>
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<td>H</td>
<td>1.57</td>
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<td>I</td>
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<td>J</td>
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<tr>
<td>K</td>
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<tr>
<td>L</td>
<td>1.00</td>
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<tr>
<td>M</td>
<td>1.00</td>
</tr>
<tr>
<td>N</td>
<td>1.00</td>
</tr>
<tr>
<td>O</td>
<td>1.00</td>
</tr>
<tr>
<td>P</td>
<td>1.00</td>
</tr>
<tr>
<td>Q</td>
<td>0.82</td>
</tr>
<tr>
<td>R</td>
<td>0.50</td>
</tr>
<tr>
<td>S</td>
<td>0.50</td>
</tr>
<tr>
<td>T</td>
<td>0.43</td>
</tr>
</tbody>
</table>

Excludes small operators typically with less than two installations.
<table>
<thead>
<tr>
<th>OPERATING MODE*</th>
<th>RELEASE SITE(1)</th>
<th>RELEASE SITE (2)</th>
<th>RELEASE MECHANISM</th>
<th>IMMEDIATE CAUSES</th>
<th>UNDERLYING CAUSES</th>
<th>FAILED SAFEGUARDING SYSTEM</th>
<th>POTENTIAL NEW/ADDITIONAL SAFEGUARDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Start-up/ reinstatement</td>
<td>1) Pipe flange</td>
<td>1) Crack</td>
<td>1) Internal explosion</td>
<td>1) Inadequate compliance monitoring</td>
<td>1) Locked valve</td>
<td>1) UKOOA/IP small-bore piping guide</td>
<td></td>
</tr>
<tr>
<td>2) Normal production</td>
<td>2) Pipe weld</td>
<td>2) Split</td>
<td>2) Overpressurisation</td>
<td>2) Inadequate risk assessment</td>
<td>2) Permit to work</td>
<td>2) Flange verification scheme</td>
<td></td>
</tr>
<tr>
<td>3) Maintenance</td>
<td>3) Pipe body</td>
<td>3) Hole</td>
<td>3) Under-pressurisation</td>
<td>3) Inadequate design</td>
<td>3) Isolation</td>
<td>3) Regular drawing upgrades</td>
<td></td>
</tr>
<tr>
<td>4) Shutdown/ shutting down</td>
<td>4) Pipe open end</td>
<td>4) Pinhole</td>
<td>4) Open pathway</td>
<td>4) Inadequate procedures</td>
<td>4) Change control</td>
<td>4) HAZOP</td>
<td></td>
</tr>
<tr>
<td>5) Construction</td>
<td>5) Valve stem</td>
<td></td>
<td>5) Corrosion/internal containment envelope</td>
<td>5) Inadequate supervision</td>
<td>5) Procedural review</td>
<td>4) Inadequate design</td>
<td></td>
</tr>
<tr>
<td>6) Well operations/drilling</td>
<td>6) Valve body</td>
<td></td>
<td>6) Fatigue/ vibration</td>
<td>6) Inadequate procedures</td>
<td>6) Design review (incl. HAZOP)</td>
<td>6) Inadequate procedures</td>
<td></td>
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<tr>
<td>7) Testing/sampling</td>
<td>7) Valve flange</td>
<td></td>
<td>7) Incorrect installation</td>
<td>7) Inadequate competency</td>
<td>7) Competency assurance</td>
<td>7) Incorrect procedures</td>
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<tr>
<td>8) Pigging</td>
<td>8) Valve open end</td>
<td></td>
<td>8) Degradation of material properties</td>
<td>8) Inadequate supervision</td>
<td>8) Inspection/condition monitoring</td>
<td>7) Inadequate design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9) Vessel body</td>
<td></td>
<td>9) Operator error</td>
<td>9) Incorrect material specification/ usage</td>
<td>9) Corrosion/erosion monitoring</td>
<td>7) Inadequate tasks specification</td>
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<td>10) Vessel flange</td>
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<td>10) Degradation of material properties</td>
<td>10) Inadequate task specification</td>
<td>10) Construction/commissioning review</td>
<td>8) Inadequate task specification</td>
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<td>11) Vessel open end</td>
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<td>11) Inadequate procedures</td>
<td>11) Excessive workload</td>
<td>11) Operational review (older installations)</td>
<td>9) Inadequate task specification</td>
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<td>12) Small bore piping</td>
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<td>12) Inadequate procedures</td>
<td>12) Outdated information/ data</td>
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<td>10) Construction/commissioning review</td>
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<td>13) Small bore connection</td>
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<td>13) Incorrect installation</td>
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<td>17) Hose body</td>
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<td>18) Swivel stack</td>
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<td>19) Other equipment seal</td>
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</table>

*For the system where the release occurred

TABLE 5

RELEASE ANALYSIS TAXONOMY
FIG. 2 SIGNIFICANT LIQUID RELEASES – SIZE DISTRIBUTION
FIG. 3  ALL RELEASES BY OPERATING MODE

- Normal production: 60%
- Start-up: 20%
- Maintenance: 20%
- Well operations: 10%
- Abnormal production: 5%
- Shutdown: 5%
- Pigging: 5%
- Testing/sampling: 5%
- Construction: 5%
FIG. 4  ALL RELEASES BY HYDROCARBON TYPE

Percentage of releases

- Gas
- Oil
- Diesel
- Condensate
- Two-phase
- Methanol
- Lube oil
- Hydraulic oil
- Helifuel
FIG. 5 ALL RELEASES BY RELEASE SITE

Percentage of releases

Pipe open end
Pipe body
Pipe flange
Pipe weld
Small bore piping
Small bore connection
Instrument connection
Valve body
Valve stem
Valve open end
Valve flange
Vessel body
Vessel flange
Vessel open end
Pump/compressor seal
Pump/compressor flange
Hose body
Other equipment seal
Swivel seal
FIG. 6 IMMEDIATE CAUSES – ALL RELEASES

- Internal corrosion
- External corrosion
- Inadequate procedures
- Degradation of properties
- Erosion
- Fatigue/vibration
- Inadequate equipment
- Inadequate isolation
- Inadequate installation
- Line blockage
- Operator error
- Procedural violation

Percentage of total incidents
FIG. 7 UNDERLYING CAUSES - ALL RELEASES

- Excessive workload
- Inadequate communication
- Inadequate competency
- Inadequate compliance monitoring
- Inadequate design
- Inadequate inspection/condition monitoring
- Inadequate installation
- Inadequate procedures
- Inadequate risk assessment
- Inadequate supervision
- Inadequate task specification
- Incorrect material specification
- Incorrect materials usage
- Outdated information

Percentage of total incidents
ANNEX 1

SUMMARY OF MAJOR RELEASES

There were eight major releases, with a size range between 375 and 9625kg of hydrocarbon. Three were on installations operated by one company, the other five were on installations with different operators. Four were on manned production installations, one on an unmanned installation, one on an FPSO and two were subsea releases. Seven were gas releases and one a two-phase release, indicating that the biggest releases were also of the most dangerous type, in terms of their ability to form flammable vapour clouds. Three included operator error as an immediate cause and one procedural violation, suggesting that for major releases human factors tended to be a more significant cause than mechanical breakdown.

Outline summaries of each incident are as follows:

1) While preparing to flow a well to the production header, operator error led to gas being inadvertently routed to the kill system, and thence overboard via a burner boom. With no measurable wind, gas drifted back onto the installation. Gas heads were triggered and the General Alarm and deluge were activated.

2) Gas was released from a flange on a vent line which was overpressured when a compressor relief valve vented. A block valve in the vent line was found to be closed. The valve had been left shut by mistake following maintenance two weeks previously.

3) Two-phase fluids were released into the sea over a subsea satellite of a production platform. A flowline had failed at a flexible jumper connection, most likely due to corrosion or other degradation of material properties.

4) A gas leak occurred during service testing of a production train. The leak was traced to an open valve on a drain line, had had been left open in error.

5) Gas leaked from a vent valve on a subsea well template, on a line between the manifold and a pressure transducer. It was detected by a ROV during pipeline inspection. The valve had erroneously been left partially open and the vent plug was also leaking.

6) A low level gas alarm came up near the intake of a generator operating on diesel. This occurred twice. The gas fuel blowdown line to flare for the engine was iced, and the control panel indicated “High Crankcase Pressure” and “Low Seal Oil DP” alarms. The "closed" main fuel gas feed valve to the generator was found to be partly open. In the absence of the HP oil seal (not present whilst on diesel) the feed gas had found a path via small bore pipework into the crankcase and to flare via the blowdown line. The spindle of the fuel valve was of the wrong type for the duty, with inadequate yield strength, and had twisted and only allowed the valve to partially close.
7) During well operations on a production installation the BOPs were about to be tested on a well. The well was isolated by the swab valve and upper master gate valve. An operator noticed what appeared to be trapped pressure being vented on the drill floor. Intending to close the BOPs, in error he opened the upper master gate valve. As another operator was already cracking open the swab valve, to allow water in for the pressure test, well gas vented up the riser onto the drill floor. The installation alarm was triggered by gas detectors, alerting the operators to the release.

8) Workers on a nearby installation heard an unusual noise on an unmanned platform. A standby vessel reported seeing a large mist cloud. The installation was closed in and depressurised and a team sent to investigate. It was found that sand had eroded an elliptical hole 18mm x 16mm in a 50mm drain line on the gas export line.