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INTERNATIONAL MARITIME ORGANIZATION

SUB-COMMITTEE ON FIRE PROTECTION
53rd session
Agenda item 5

MEASURES TO PREVENT EXPLOSIONS ON OIL AND CHEMICAL TANKERS TRANSPORTING LOW-FLASH POINT CARGOES

Analysis of fire and explosion casualties in cargo areas on oil and chemical tankers

Submitted by Japan

<table>
<thead>
<tr>
<th>SUMMARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive summary: This document provides the result of analysis of fire and explosion casualties in cargo areas on oil and chemical tankers</td>
</tr>
<tr>
<td>Strategic direction: 5.2</td>
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<td>High-level action: 5.2.3</td>
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<td>Action to be taken: Paragraph 5</td>
</tr>
<tr>
<td>Related documents: MSC 81/8/1, MSC 81/INF.8; FP 51/10, FP 51/10/1, FP 51/10/2; FP 52/20, FP 52/20/1, FP 52/20/2, FP 52/20/3, FP 52/20/4, FP 52/INF.2 and FP 52/21, paragraph 20</td>
</tr>
</tbody>
</table>

Background

1 Measures to prevent explosions on oil and chemical tankers have been considered since MSC 81. During the discussion on this issue, Japan provided the results of a preliminary FSA study on the application of requirements for inert gas systems to tankers of less than 20,000 dwt (FP 51/10/1 and FP 52/INF.2).

2 The Sub-Committee, at its last session, decided to establish a working group at this session to progress the matter and urged Member Governments and international organizations to submit the essential data for consideration and action at this session. (FP 52/21, paragraph 20.6).

Analysis of fire and explosion casualties in cargo areas on oil and chemical tankers

3 Japan analysed the casualty data supplied by Lloyd’s Register Fairplay (LRF), focusing on fire and explosion casualties in cargo areas on oil and chemical tankers, to facilitate the consideration by the Sub-Committee. The results of the analysis are set out in the annex to this document.
The results of the analysis indicate the following issues:

.1 the frequency of lives lost by fire and explosion casualties in cargo area on tankers of less than 20,000 dwt was $3.3 \times 10^{-4}$ per ship\textperiodcentered year. On the other hand, the frequency of lives lost by fire and explosion casualties in cargo area on tankers of 20,000 dwt and upwards was $1.4 \times 10^{-3}$ per ship\textperiodcentered year. In this context, safety measures against fire and explosion in cargo areas on tankers should be considered comprehensively and it seems irrational to focus on safety measures for tankers of less than 20,000 dwt only (see paragraph 4.1, in particular table 1, in the annex); and

.2 two hundred and thirty people were killed by fire and explosion in cargo areas on tankers since 1990 until 2007. Roughly speaking, half of the lives lost was caused by casualties occurring during the process of “repairing”. Taking these data into account, safety measures against fire and explosion in cargo areas on tankers should be considered comprehensively and it seems irrational to focus on safety measures under “in service” condition only (see paragraph 4.3, in particular figure 20, in the annex).

**Action requested of the Sub-Committee**

The Sub-Committee is invited to note the information contained in the annex to this document.
ANNEX

ANALYSIS OF FIRE AND EXPLOSION CASUALTIES IN CARGO AREAS ON OIL AND CHEMICAL TANKERS

1 Introduction

The Fire Protection Sub-Committee, at its fifty-second session (14 to 18 January 2008), decided to establish a working group at FP 53, to progress the consideration on “Measures to prevent explosions on oil and chemical tankers transporting low-flashpoint cargoes”, and urged Member Governments and international organizations to submit the essential data for consideration. In response to the decision of the Sub-Committee, Japan provides the results of the analysis of fire and explosion casualties in cargo areas on oil and chemical tankers, based on casualty data and the ship type data supplied by Lloyd’s Register Fairplay (LRF).

Japan already provided the results of the preliminary FSA study, i.e., analysis of the costs and benefits, on the application of requirements for Inert Gas Systems (IGSs) to tankers of less than 20,000 dwt, contained in documents FP 51/10/1 and FP 52/INF.2. In these documents, fire and explosion casualties that occurred in cargo tanks on tankers of 4,000 dwt and upwards were referred to. In this annex, fire and explosion casualties that occurred in cargo areas on tankers of 100 gross tonnage and upwards are referred to.

2 Data analysed

The casualty data fulfilling the following conditions were analysed:

.1 the initial event was categorized as Fire/Explosion (LRF Category Code: 3);
.2 occurred from 1 January 1990 until 31 December 2007;
.3 occurred on the tankers of the following types:
   .3.1 chemical tankers (LRF Ship Type Code: A12);
   .3.2 oil tankers (LRF Ship Type Code: A13); and
   .3.3 bulk dry/oil tankers (LRF Ship Type Code: A22); and
.4 occurred in “cargo area” (LRF Compartment Code: 11XX; “XX” means arbitral figures).

To determine the number of tankers of the above types, the relevant ship type data were also analysed during the mentioned period.

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1 For detailed information, please contact Dr. S. Ota, National Maritime Research Institute (NMRI): ohta@nmri.go.jp.
2 There were no casualty records on ships categorized as “Other liquid tankers (LRF Ship Type Code: A14)”. Most of these ships were “water tankers” and one “alcohol tanker” was categorized as this type. In LRF data, ship type code “Inland waterways tankers (LRF Ship Type Code: W11)” exists. However, no ship was categorized as this type in LRF data.
3 Number of tankers operated during 1990 to 2007

Based on the LRF ship type data, numbers of tankers of respective types operated on 1 January 1990 to 31 December 2007 were investigated. The results of the investigation are shown in figures 1 and 2. It is important to note that the scales of the ordinates of these figures are different.

4 Results of analysis of casualty data

4.1 Number of fire and explosion casualties in cargo area and lives lost in each year

Figure 3 shows the numbers of casualties on tankers of respective types from 1990 to 2007. The total number of casualties in the aforementioned 18 years was 109. The total numbers of casualties from 1990 to 1998 (9 years) and in 1999 to 2007 (9 years) were 74 and 35, respectively. The average numbers of casualties from 1990 to 1998 and from 1999 to 2007 were 8.2 and 3.9, respectively.

Figure 4 shows the numbers of lives lost, i.e. the summation of the numbers of persons killed and missing, caused by the casualties on tankers of respective types from 1990 to 2007. The total number of lives lost in the above mentioned 18 years was 230. The total numbers of lives lost from 1990 to 1998 and from 1999 to 2007 were 147 and 84, respectively. The average numbers of casualties from 1990 to 1998 and from 1999 to 2007 were 16.3 and 9.2, respectively.

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3 LRF ship type data contains 17,437 records for tankers of the types “A12”, “A13” and “A22” built until 2007. In these records, 384 were for tankers used more than 50 years. Therefore, it is supposed that “date” in the column for “DEATH DATE” may be missing and that “number of ships” contains several percents error, while such error is insignificant.
Figures 5 and 6 show the numbers of casualties on tankers of 20,000 dwt and upwards and on tankers of less than 20,000 dwt, respectively. The total numbers of casualties in the above mentioned 18 years on tankers of these sizes were 69 and 40, respectively.

Figures 7 and 8 show the numbers of lives lost on tankers of these sizes, respectively. The total numbers of lives lost on tankers of these sizes in the above mentioned 18 years were 167 and 63, respectively.
Table 1 shows frequencies of casualties in cargo areas and lives lost on tankers of respective types and sizes. This table indicates that the frequency of lives lost is comparatively high on chemical tankers of 20,000 dwt and upwards.

**Table 1 – Frequencies of fire and explosion casualties in cargo areas on tankers and lives lost**

<table>
<thead>
<tr>
<th>Type of ships</th>
<th>Size</th>
<th>Ship-year (1990 to 2007)</th>
<th>No. of casualties</th>
<th>No. of lives lost</th>
<th>Frequency of casualties [1/ship-year]</th>
<th>Frequency of lives lost [P/ship-year]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical tankers</td>
<td>Less than 20,000 dwt</td>
<td>36,524</td>
<td>19</td>
<td>32</td>
<td>5.2x10^-4</td>
<td>8.8x10^-4</td>
</tr>
<tr>
<td>Oil tankers</td>
<td></td>
<td>83,597</td>
<td>21</td>
<td>31</td>
<td>2.5x10^-4</td>
<td>3.7x10^-4</td>
</tr>
<tr>
<td>Bulk/Oil tankers</td>
<td></td>
<td>1,071</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>All tankers (Total)</td>
<td></td>
<td>121,192</td>
<td>40</td>
<td>63</td>
<td>3.3x10^-4</td>
<td>5.2x10^-4</td>
</tr>
<tr>
<td>Chemical tankers</td>
<td>20,000 dwt and upwards</td>
<td>9,544</td>
<td>53</td>
<td>131</td>
<td>5.6x10^-3</td>
<td>1.4x10^-2</td>
</tr>
<tr>
<td>Oil tankers</td>
<td></td>
<td>39,549</td>
<td>10</td>
<td>22</td>
<td>2.5x10^-4</td>
<td>5.6x10^-4</td>
</tr>
<tr>
<td>Bulk/Oil tankers</td>
<td></td>
<td>1,933</td>
<td>6</td>
<td>14</td>
<td>3.1x10^-3</td>
<td>7.2x10^-3</td>
</tr>
<tr>
<td>All tankers (Total)</td>
<td></td>
<td>51,026</td>
<td>69</td>
<td>167</td>
<td>1.4x10^-3</td>
<td>3.3x10^-3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>172,218</td>
<td>109</td>
<td>230</td>
<td>6.3x10^-4</td>
<td>1.3x10^-4</td>
</tr>
</tbody>
</table>

It should be noted that:

1. the frequency of fire and explosion casualties in cargo area on tankers of less than 20,000 dwt (3.3x10^-4 per ship\*year) is smaller than on tankers of 20,000 dwt and upward (1.4x10^-3 per ship\*year); and

2. the frequency of lives lost by fire and explosion casualties in cargo area on tankers of less than 20,000 dwt (5.2x10^-4 person/ship\*year) is smaller than on tankers of 20,000 dwt and upward (3.27x10^-3 person/ship\*year).
4.2 Casualties in cargo tanks

IGSs are basically effective for preventing fire and explosion accidents in cargo tanks while IGSs are, in general, not effective for preventing fire and explosion accidents in cargo areas other than cargo tanks, e.g., cargo pump-rooms. Taking this issue into account, we investigated the number of casualties and lives lost in casualties in cargo tanks and in cargo areas other than cargo tanks. Figures 9 to 11 show the numbers of fire and explosion casualties in cargo tanks on tankers of 20,000 dwt and upwards, tankers of less than 20,000 dwt and tankers of all sizes, respectively. Figures 12 to 14 show the numbers of lives lost by casualties in cargo tanks on tankers of 20,000 dwt and upwards, tankers of less than 20,000 dwt and tankers of all sizes, respectively. Briefly speaking, fire and explosion casualties in cargo tanks represent around 80% of those casualties in cargo areas.

<table>
<thead>
<tr>
<th>Fire/Explosion in other cargo areas</th>
<th>Fire/Explosion in other cargo areas</th>
<th>Fire/Explosion in other cargo areas</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Figure 9" /></td>
<td><img src="image" alt="Figure 10" /></td>
<td><img src="image" alt="Figure 11" /></td>
</tr>
<tr>
<td><strong>Fire/Explosion in cargo tanks</strong></td>
<td><strong>Fire/Explosion in cargo tanks</strong></td>
<td><strong>Fire/Explosion in cargo tanks</strong></td>
</tr>
<tr>
<td><strong>Figure 9 – Number of casualties in cargo tanks on tankers of 20,000 dwt and upwards</strong></td>
<td><strong>Figure 10 – Number of casualties in cargo tanks on tankers of less than 20,000 dwt</strong></td>
<td><strong>Figure 11 – Number of casualties in cargo tanks on tankers of all sizes</strong></td>
</tr>
<tr>
<td><img src="image" alt="Figure 12" /></td>
<td><img src="image" alt="Figure 13" /></td>
<td><img src="image" alt="Figure 14" /></td>
</tr>
<tr>
<td><strong>Fire/Explosion in other cargo areas</strong></td>
<td><strong>Fire/Explosion in other cargo areas</strong></td>
<td><strong>Fire/Explosion in other cargo areas</strong></td>
</tr>
<tr>
<td><strong>Fire/Explosion in cargo tanks</strong></td>
<td><strong>Fire/Explosion in cargo tanks</strong></td>
<td><strong>Fire/Explosion in cargo tanks</strong></td>
</tr>
<tr>
<td><strong>Figure 12 – Number of lives lost by casualties in cargo tanks on tankers of 20,000 dwt and upwards</strong></td>
<td><strong>Figure 13 – Number of lives lost by casualties in cargo tanks on tankers of less than 20,000 dwt</strong></td>
<td><strong>Figure 14 – Number of lives lost by casualties in cargo tanks on tankers of all sizes</strong></td>
</tr>
</tbody>
</table>
4.3 Ship status at casualties

Based on the “ship status code” in the LRF data, numbers of casualties and lives lost were investigated in relation to “ship status”. Figures 15 to 17 show the numbers of fire and explosion casualties in cargo areas at “in service” and “repairing” on tankers of 20,000 dwt and upwards, tankers of less than 20,000 dwt and tankers of all sizes, respectively. Figures 18 to 20 show the numbers of lives lost by fire and explosion casualties in cargo areas at “in service” and “repairing” on tankers of 20,000 dwt and upwards, tankers of less than 20,000 dwt and tankers of all sizes, respectively. One casualty of VLCC with 9 fatalities whilst “converting” and one casualty of VLCC with 5 fatalities whilst “bound for breakers” were categorized as “repairing” in figures 15, 17, 18 and 20.

Figures 15 to 20 clearly indicate that a certain percentage of fire and explosion casualties were occurred during “repairing” (not in service) and around 50% of lives lost were caused by such casualties.
4.4 Cargo status at “in service” casualties

Based on the “precise text” and “complementally text” in the LRF data, numbers of casualties during “in-service” and lives lost caused by these casualties were investigated in relation to operations on-board. The result of the investigation on number of casualties is given in table 2 and the result of the investigation on number of lives lost is given in table 3.

**Table 2 – Numbers of casualties at respective operations during “in-service”**

<table>
<thead>
<tr>
<th>Category of operation</th>
<th>Tank cleaning</th>
<th>Gas freeing</th>
<th>Discharging</th>
<th>Loading</th>
<th>Repairing</th>
<th>Others</th>
<th>Not specified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical tankers of less than 20,000 dwt</td>
<td>6</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Oil tankers of less than 20,000 dwt</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td><strong>Tankers of less than 20,000 dwt (sub-total)</strong></td>
<td><strong>6</strong></td>
<td><strong>1</strong></td>
<td><strong>4</strong></td>
<td><strong>2</strong></td>
<td><strong>4</strong></td>
<td><strong>1</strong></td>
<td><strong>19</strong></td>
<td><strong>37</strong></td>
</tr>
<tr>
<td>Chemical tankers of 20,000 dwt and upwards</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Oil tankers of 20,000 dwt and upwards</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td>Bulk/Oil tankers of 20,000 dwt and upwards</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Tankers of 20,000 dwt and upwards (sub-total)</strong></td>
<td><strong>4</strong></td>
<td><strong>0</strong></td>
<td><strong>1</strong></td>
<td><strong>0</strong></td>
<td><strong>3</strong></td>
<td><strong>0</strong></td>
<td><strong>34</strong></td>
<td><strong>42</strong></td>
</tr>
<tr>
<td><strong>All tankers (Total)</strong></td>
<td><strong>10</strong></td>
<td><strong>1</strong></td>
<td><strong>5</strong></td>
<td><strong>2</strong></td>
<td><strong>7</strong></td>
<td><strong>1</strong></td>
<td><strong>53</strong></td>
<td><strong>79</strong></td>
</tr>
</tbody>
</table>

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4 The LRF casualty data contain “cargo status code”. However, we did not analyse this code for the reason that this code does not represent operation.
Table 3 – Numbers of lives lost at respective operations during “in-service”

<table>
<thead>
<tr>
<th>Category of operation</th>
<th>Tank cleaning</th>
<th>Gas freeing</th>
<th>Discharging&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Loading</th>
<th>Repairing&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Others&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Not specified&lt;sup&gt;4&lt;/sup&gt;</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical tankers of less than 20,000 dwt</td>
<td>11</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>22</td>
</tr>
<tr>
<td>Oil tankers of less than 20,000 dwt</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>29</td>
<td>31</td>
</tr>
<tr>
<td>Tankers of less than 20,000 dwt (sub-total)</td>
<td>11</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>38</td>
<td>53</td>
</tr>
<tr>
<td>Chemical tankers of 20,000 dwt and upwards</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Oil tankers of 20,000 dwt and upwards</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>44</td>
<td>49</td>
<td>58</td>
</tr>
<tr>
<td>Bulk/Oil tankers of 20,000 dwt and upwards</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Tankers of 20,000 dwt and upwards (sub-total)</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>49</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>All tankers (Total)</td>
<td>22</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>87</td>
<td>119</td>
</tr>
</tbody>
</table>

The following notes are common for tables 2 and 3.

*1 This category contains casualties “whilst completing discharge of cargo”, “after discharging” and “while discharging”.

*2 This category contains casualties “undergoing welding”, “whilst repairs being carried out”, “during maintenance work” and similar ones.

*3 This category contains casualty caused by “cargo overheated”.

*4 We categorized casualties in this group in the case that the operation on-board at the casualties could not be specified.

Figure 21 shows the number of casualties during “tank cleaning”, “other operations” and “operations that could not be specified based on the text”. Here, “other operations” include “gas freeing”, “discharging”, “loading”, “repairing” and “others” as specified in tables 2 and 3. Figure 22 shows the number of lives lost caused by these casualties. Figure 23 shows the number of casualties at respective operation categories other than “not specified”. Figure 24 shows the number of lives lost caused by these casualties of respective categories. These figures indicate that “tank cleaning” is the most dangerous operation among specified ones during “in service”. It should, however, be noted that the LRF data are not sufficient to identify dangerous operations in relation to fire and explosion in cargo areas, for the reason that majority of operations at the times of casualties were “not specified”.

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5 Discussion

As mentioned in subsection 4.1, the frequency of lives lost by fire and explosion casualties in cargo area on tankers of less than 20,000 dwt is smaller than on tankers of 20,000 dwt and upwards. In this context, safety measures against fire and explosion in cargo areas on tankers should be considered comprehensively and it seems irrational to focus on safety measures for tankers of less than 20,000 dwt.

As mentioned in subsection 4.2, the majority of fire and explosion casualties in cargo areas occurred in cargo tanks, for which IGSs may be effective. As mentioned in subsection 4.3, about half of lives lost were caused by casualties occurred during “repairing”. Taking these data into account, safety measures against fire and explosion in cargo areas on tankers should be considered comprehensively and it seems irrational to focus on safety measures under “in service” condition only.