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1 Introduction

The analysis of processes concerning the emergency response phase of the basic emergency repair scenario (see specification in document No 1-00-W-1999-01-x) was achieved using the information provided by the ERS-experts of GL and through analysis of casualty reports occurred in the past. The processes and events are described at a high level of abstraction, in order to simplify their analysis. Some processes or activities actually occur simultaneously, so that a chronological order is not very relevant for their descriptions.

Another important aspect that must be taken into consideration is the possibility that different roles during the emergency phase may be played by several parties or by one and the same company. The Emergency Response Service, for instance, may be integrated in the managing company's in-house staff or be contracted by an external provider, which may in turn be a party involved in other activities of the whole process, like the Salvage Company (tug service provider) or the Classification Society.

The emergency response phase comprises the time period from the occurrence of the casualty until the emergency situation has been brought under control. For a grounding casualty this is usually the case, when the vessel has been re-floated and no further risk for damage or pollution is expected from the stability/strength condition of the vessel or other factors influencing the situation.

2 Definitions

Following definitions apply for the purpose of this document and the scope of the basic emergency response scenario:

<u>Marine Casualty:</u> Article 221/2 of the United Nations Convention on the Law of the Sea (UNCLOS) defines a marine casualty as: "a collision of vessels, stranding or other incident of navigation, or other occurrence on board a vessel or external to it resulting in material damage or imminent threat of material damage to a vessel or cargo."

<u>Emergency Response Service</u>: Service provided by a qualified company to technically assist a vessel in case of casualty or emergency at sea. According to different regulations the designation of an ERS may be mandatory for a vessel. The OPA90 Regulations for instance requires that "For vessels carrying oil in bulk as cargo and operating in US waters, *shore based arrangements* have to be provided on 24-hours basis enabling rapid information to be obtained on salvage, damage stability and hull stress assessments".

<u>Grounding</u>: A none free floating condition of a ship, where the ship's bottom is in direct contact with the sea floor, and where its weight is partly supported by the surrounding water and partly by the ground.

<u>Marine Salvage</u>: A service provided to ship and cargo owners with the object of preserving a significant portion of the value of the ship, its cargo, or both. As a pre-requisite, remedial actions are performed to achieve a safe condition of a damaged ship, under consideration of stability, buoyancy, trim and strength of the vessel's structure (e.g. re-floating a grounded vessel).

3 Description of current processes

After occurrence of the casualty the master of the ship must immediately inform the nearest Maritime Rescue Co-ordination Centre (MRCC) or the nearest coastal radio station, according to the position of the vessel at sea. This reporting is mandatory and regulated by different regulations such as the Ship Oil Pollution Emergency Plan (SOPEP), the Oil Pollution Act from 1990 (OPA90) and the International Safety Management Code (ISM).

The communication between vessel and the contacted rescue site is realized through a Global Maritime Distress and Safety System (GMDSS) as specified by the convention of Safety of Life at Sea (SOLAS) through its amendment from 1988. This GMDSS-regulation entered into force on 1 February 1999 for all ships subjected to the SOLAS convention (see appendix A). The GMDSS is based on modern satellite and radio communication technology.

Even, if there is no risk of pollution due to a probable discharge of oil or other chemical substances, the master usually must notify the corresponding port and coastal state authorities immediately after the addressing of resultant safety concerns.

The master contacts also the owner (shipping company, operator) or its nearest representative (marine superintendent) about the casualty. In order to avoid duplication of reports and to co-ordinate the vessel response plan and the company's shore-side emergency plan, the owner is usually in charge of reporting the casualty to the ship interest contacts, such as the P&I Club, the cargo owner and the insurance company.

For long-term response co-ordination, the owner may designate a so-called On-Scene Commander (OSC), which is responsible for the decisions and measures to be taken on scene during the salvage of the vessel.

The Emergency Response Company is informed either by the MRCC, by the owner and in some cases by the master of the ship directly. After the first contact with the vessel the ER-Company requests detailed information about the casualty. This communication process is usually carried out through special telephone and fax lines.

The casualty information is provided by the master in form of so-called data sheets, which are onboard of the vessel for use in emergency cases. Usually they contain information about cargo and tank load condition prior to and after the casualty, type and extension of damage and specification of breached compartments, if any. In case of a grounding casualty some additional data concerning the type of sea bottom, the position of the ship aground and environmental circumstances like local tidal information and wind force/direction are also specified in the data sheets.

After filling in the required data sheets, the master sends them via fax to the ER-Company, where in the mean time the relevant ship data files have been activated on the computing system. The current casualty data is fed into the calculation program to perform the required response analysis.

Usually following calculations are performed for rapid response and damage assessment in case of grounding:

- Verification of vessel's condition prior to casualty
- Verification of vessel's condition after the casualty
- Intact and damage stability

- Longitudinal strength investigations
- Bending and shear stresses resulting from grounding induced loads
- Estimation of oil spill and sea water ingress (if required)
- Grounding reaction, force to free the vessel

When the calculations are performed, the results are analyzed and the corresponding recommendations are provided to the master and other involved parties on scene. This is currently done by means of special telephone and telex connections to the vessel via satellite.

Depending on several circumstances and factors influencing the operations some of the following measures may be applicable to a certain situation, in order to take control over the emergency by reducing hull girder stress and ground-force reaction and improving the residual stability:

- Cargo transfer/discharge
- Ballasting/Deballasting
- Internally transfer of bunker
- Towing the vessel
- Whether it is recommendable to wait improvements in weather or tide

Any changes in the conditions on scene are provided by the master to the ER-Company by filling in and faxing the relevant data sheets (e.g. change of tide, weather conditions, wind direction as well as extend of damage, loading and ballast water distribution, etc.). Additional or complementing information may also be provided via fax, e.g. load master output lists. By comparing the results of calculations to measured data on-scene the engineers of the ER-Company can make an evaluation of the course of actions. This procedure may be repeated several times, until the situation is under control.

In case of damage of the steel structure the ER-Company may request additional information on the vessel from the Classification Society, like steel drawings and results/data from previously performed strength analysis. The Classification Society in some cases also takes actively part in the response and salvage efforts during the emergency phase providing assessment concerning the strength of damaged steel structure.

In many grounding cases it is not possible to free the vessel by own means and therefore the services of a tug company (salvor) are required to re-float the vessel and tow it out of the grounding area. The owner of the vessel is usually in charge of the negotiation and contract of the salvage service.

When the Salvage Company is contracted and becomes part of the scenario, there is also a communication and information process between the ER-Company and the Salvage Company, in order to co-ordinate the salvage efforts. These processes may also involve the transfer of information, such as results of calculations and ship specific data. Currently this data transfer is realized via fax or e-mail.

After the vessel has been re-floated, it is usually escorted by the tugs to a safe anchorage place, where further surveys and underwater inspections are carried out to determine the extension of the damage resulting from the grounding. A surveyor of the Classification

Society carries out the survey of the damaged ship structures. For the underwater inspections usually the owner contracts services of a diving company.

The repair phase begins with the estimation of the whole damage and the negotiations with a shipyard, where the vessel may eventually be dry-docked.

3.1 Strength and weakness of current processes

The actual communication between the damaged vessel and the ER-Company during the operation is realized through telephone conversations. The transmission of the data required by the calculation programs on the ER-Company's site is carried out via fax lines and satellite communication technology.

The use of fax has the advantages, that it is an easy to use, reliable and fast mean of communication. Through the telephone communication it is possible to discuss directly special matters concerning the emergency situation and to clarify specific questions related to the data transmitted via fax. The human communication plays here also an important role.

Among the disadvantages of the telephone and fax communication are the bad legibility of some transferred information like sounding tables, sketches, etc. and the lack of a possibility to directly input the transferred data into calculation programs without manual data entry at the receiving site.

4 Specification of data required by current processes

The data required for the rapid response calculations are actually divided into permanent and variable data. The permanent data concerns all general ship data, which are usually not subjected to frequent changes, such as:

- General Dimensions and characteristics
- Contact addresses (Owner, shipping company)
- Hull form (lines drawing, computer model of hull surface)
- Bulkhead arrangement (watertight subdivision)
- General Arrangement (Compartments)
- Tank arrangement and sounding tables
- Stowage arrangement (e.g. container vessel, ro-ro ship)
- Lightship weight distribution
- Permissible values for bending moment and shear forces

This set of data is provided to the ER-Company when the vessel is registered to the ER-Service. Based on this information the corresponding basic input data for calculation software, such as computer models and software-specific files, are prepared by the ER-Company and stored in a database. The availability of these data files at the ER-Company's site is a pre-requisite for the realization and effectiveness of the rapid response operations and for this reason the permanent data do not actually form part of the information being transferred during the emergency process.

On the other hand the variable data concerns the information that varies depending on cargo type, ship route, crew and load conditions, as well as the information concerning the casualty and its consequences. Following variable data are required by the processes concerning the response and salvage phase of the emergency scenario and are usually transferred from the vessel to the ER-Company.

- Persons of contact onboard (Master, Pilot, On-Scene Commander)
- Geographic Position of the vessel
- Cargo condition
- Amount Ballast and consumables
- Floating condition prior to casualty (draft, heel, trim etc.)
- Position of vessel aground (draft, heel, trim, etc.) and type of sea bottom (sand, mud, coral reef)
- Specification of damaged and flooded compartments
- Extension of structural damage (shell bottom, propeller, rudder, etc)
- Weather and environmental data (waves/wind force and direction, tidal influence)

Additional data of the ship might be required during the response phase by the ER-Company. These data are usually provided by the owner or the Classification Society, and could be for instance:

- Steel and Class drawings
- Specifications and certificates of machinery
- Reports of previously performed strength analysis

4.1 Analysis and evaluation of the required data

A more detailed description of the data required to perform the calculations for rapid response and casualty assessment is necessary for analyzing and identifying the information objects, which will form part of the data model. The data marked with "*" is already contained in existing data models of emerging standards.

4.1.1 Contact person(s) on board:

Master, pilot or member of the crew responsible for the operations onboard

- Name
- Range or function (e.g. Captain, Pilot)
- Telephone number
- Fax number
- E-mail

4.1.2 Geographic position*

Geographic position of the vessel provided for instance by a Global Positioning System (GPS).

- Latitude*
- Longitude*
- Nearest coast (country)

4.1.3 Cargo condition*

The specification of cargo condition depends on the type of vessel and the type of cargo.

- Current stowage arrangement (container ship, ro-ro ship, general cargo vessel)
- Current cargo distribution (Bulk carrier, Tanker)
- Type of load (dangerous goods, chemical products, inflammable substances)

4.1.4 Amount of ballast and consumables

These concerns all bunker tanks (Heavy Oil, Marine Diesel Oil, Marine Gas Oil, Lubricating Oil) fresh water tanks, ballast tanks and others tanks on the vessel (e.g. bilge tanks). For each tank on the vessel the following data are required (soundings):

- Tank identification (e.g. Bunkering number*)
- Density of substance [t/m^3]
- Weight [t]
- Filling stage [%]

4.1.5 Floating condition prior to casualty

The following information is required:

- Draft aft on port side* [m]
- Draft aft on starboard side* [m]
- Draft midship on port side* [m]
- Draft midship on starboard side* [m]
- Draft fore on port side * [m]
- Draft fore on starboard side * [m]
- Type of draft specifications (measured, estimated)

4.1.6 Grounding specification

- Draft aft on port side * [m]
- Draft aft on starboard side* [m]
- Draft midship on port side* [m]

- Draft midship on starboard side* [m]
- Draft fore on port side * [m]
- Draft fore on starboard side * [m]
- Type of draft specifications (measured, estimated)
- Heeling angle [degrees]
- Heeling direction (port, starboard)
- Type of grounding (Pinnacle, Shelve)
- Longitudinal position of aft grounding location [m]
- Longitudinal position of forward grounding location [m]
- Water depth around the ship (soundings) [m]
- Sea floor composition (silt, mud, sand, coral, rock)
- Vessel moving or fixed on the ground [Yes/No]

4.1.7 Damaged and flooded compartments

For every damaged compartment following specifications are required:

- Compartment Identification (Name, Number)
  - Compartment open to sea? (yes/no)
  - Remaining cargo weight [t]
  - Estimated water ingress [t]
  - Sounding [m]
  - Ullage [m]
  - Over/Underpressure [bar]

Additionally the data sheets usually contains:

- Sketch of the general arrangement of the vessel, highlighting the damaged compartments and the extent and location of grounding contact
- Sketch of the vessel (top view) showing graphically the soundings of water depth around the vessel.

4.1.8 Extension of structural damage

The specification of damage extension in transverse, longitudinal and vertical direction.

- Affected long hull girder.
- Affected watertight bulkheads.

4.1.9 Weather and environmental data

- Wave direction*
- Wave direction relative to bow*

- Wave height* [m]
- Wind direction*
- Wind force* [beaufort]
- Tidal range [m]
- Tidal height [m] (above/below tidal datum)
- Whole tidal cycle for the given area.

4.1.10 Operational data

Following information about operational data is additionally provided through the data sheets or other means:

- Is the main engine working?
- Are auxiliary engines working?
- Available pump capacity
- Available manoeuvring winch capacity
- Available compressed air capacity (e.g. to overpressure flooded compartments)
- Is lightening tonnage available? (for transfer of cargo)
- Possibilities and restrictions for remedial actions
- Which measures have been taken so far?

5 Requirements for future processes (web based integration tool)

For the development of a web based integration tool to achieve the tasks of transferring casualty data in a fast, safe and reliable way from the vessel to the ER-Company or between other involved parties, the following aspects should be considered:

1. The vessel specific data sheets should be implemented electronically (e.g. webforms).
2. Only the actual data should be transmitted, since the corresponding data sheets (forms) will be available at the sender's and receiver's respective sites.
3. An Interface between the web tool and the ERS calculation system should be implemented to translate the received data into the required format.
4. Sketches and drawings should be provided in a vector graphic format for a high quality of the transferred information. Possible candidates are:
   - DXF – Drawing Exchange Format.
   - DWF – Drawing Web Format.
   - VML – Vector Markup Language.
   - PGML – Precision Graphics Markup Language.

– SVG – Scalable Vector Graphics.

5 Other information not contained in the data sheets (descriptions, specifications, comments, etc.) should be also provided electronically and supported by the integration tool (e.g. by means of electronic forum for discussions or virtual conferences).

6 The integration tool should provide links to other conventional communication means (Fax, Telex, SMS, pagers etc.)

Annex A: Description of SOLAS Amendment conerning GMDSS

The 1988 (GMDSS) amendments

Adoption: 11 November 1988
Entry into force: 1 February 1992

IMO began work on the Global Maritime Distress and Safety System in the 1970s and its introduction will mark the biggest change to maritime communications since the invention of radio.

It is being introduced in stages between 1993 and 1999. The basic concept of the system is that search and rescue authorities ashore, as well as ships in the vicinity, will be rapidly alerted in the event of an emergency.

The GMDSS makes great use of the satellite communications provided by INMARSAT but also uses terrestrial radio.

The equipment required by ships varies according to the area in which they operate. In addition to distress communications, the GMDSS will also provide for the dissemination of general maritime safety information (such as navigational and meteorological warnings and urgent information to ships).