1 Abstract

In this report the results of the evaluation of historical data for *General Cargo Ships* are summarised. This is a preparative step for a Formal Safety Assessment (FSA) for this ship type. The objectives of the analysis and evaluation are the determination of frequencies for different consequences of accidents and the identification of items that should be a focus of the subsequent analysis. The historical data used in the present analysis are taken from the databases for casualties and ship register provided by Lloyds Register FairPlay (LRFP) for ship sub-categories specified with different StatCode5v. The dataset is restricted to vessels which are classed as general cargo ship, with a gross tonnage greater than 499 and with a due or delivered date specified by LRFP later than 1981-12-31. In the final calculation of accident frequencies only IACS ships are considered, as these ships are considered representative for the world fleet, and due to indications of under-reporting of accidents for groups of ships that are not classified by an IACS society.

2 Introduction

The issue of general cargo ship safety was noted at IMO in 2006 in the submission by Russia (MSC 82/21/19, 2006). This submission highlights the disparity between the fraction of general cargo ships of the world fleet (17 % in number of ships) and the share of this ship type of all total losses (42 %) and of all fatalities (27 %) for the period 1999 to 2004. It was further explained that approximately 73 general cargo ships were lost each year in this period. Additionally, it was stated that in 2004, based on Paris MoU statistics, general cargo ships had the second highest rate of port State control inspections with deficiencies (60% of inspections of general cargo ships compared with an average of 54% for all types of ships) and detentions (8% of inspections of general cargo ships compared with an average of 6% for all types of ships).

At MSC 83 several additional papers that focus on general cargo ship safety were submitted. In these submissions the safety with respect to other ship types (MSC 83/20/1, 2007; MSC 83/20/5, 2007), the causes of total losses of general cargo ships and the causes of fatalities on general cargo ships (MSC 83/20/3, 2007) are further highlighted. According to the cited submissions, occupational risk contributes with 63 % (MSC 83/20/3, 2007) of the total risk.

To bring forward the discussion of general cargo ship safety, IACS started a project on the statistical analysis of general cargo ship safety. This report summarises the results of the initial review of accident data and fleet data which provide the basis for further analyses within a FSA.

For this analysis the LRFP PC-ship register of 2007 and the LRFP casualty database of 2007 are used. Both provide one of the most extensive databases in their fields. However, in the present analysis some issues regarding the use of databases for the determination of statistical parameters are identified, most notably

- underreporting
- unrecorded change of certain properties over time (e.g. class, ship type).

It should be noted that these issues are considered general problems of databases in this area of industry, and are not believed to be unique for LRFP databases.

The focus of a statistical evaluation of historical data is to provide a snapshot for a specific period. The consistency between statistics and reality is mainly influenced by the completeness of the data used. Incomplete casualties records, e.g. caused by underreporting, yields lower accident frequencies than in reality and thus results in a more optimistic evaluation. In order to reach a complete consideration of casualty reports comprehensive capturing of accident information is required. With respect to the world wide operation of ships the acquisition of accident data inclusive their causes and their consequences require a sophisticated system. For unknown reasons, the analysis of casualty reports performed within the scope of this project indicates that presently no consistent acquisition of data with respect to flag or class can be achieved. It is also concluded that the present casualty databases are affected by underreporting. For instance, one group of ships with a strong indication of underreporting in the database used is the ships operating in national waters and without assignment to one of the major classification societies.

Additionally, the correct determination of ship-years also influences the accident frequency. For the calculation of accident frequencies the number of ship-years is required. For this report the calculation of ship-years is based on the dates of "due or delivered" and "scrapped or lost" considering the operating date (and not only the year). The presently available data permit the accurate calculation of ship-years and thus the frequencies, for instance, for a ship type. However, focussing on smaller groups, e.g. for single societies, this is not possible because the database reflect only the present class assignment, and does not keep the track of class changes. Such discrepancies were detected when IACS member societies compared LRFP data to own records.

The first analyses give strong indications of underreporting for ships of non IACS societies. Consequently, to minimize the effect of under-reporting for this analysis only the data for IACS ships are considered to be representative for general cargo ships. For ships larger than 20,000 GT this assumption has no or limited effects as nearly 100 % of these ships are classified by IACS member societies. The results of the first analyses lead to the following definition of scope:

- ships "due or delivered" after 1981-12-31 and before 2007-01-01 (corresponding to a maximum ship age of 25 at the end of the investigation period);
- a gross tonnage greater than 499;
- classed by IACS society (based on the assignment in LRFP 2007);
- casualty reports for IACS classed ships and classified as "severe" accident.

The statistical data in terms of accident frequency are produced for:

- the size categories:
    - $500 \leq GT < 1{,}000$;
    - $1{,}000 \leq GT < 20{,}000$;
    - $20{,}000 \leq GT$.
- the accident categories:
    - all severe;
    - total loss;
    - killed and missing.

As mentioned above occupational risk is the main risk category with respect to safety (MSC 83/20/3, 2007). This aspect is further investigated and the results summarised in this report. Occupational risk data provided by the Norwegian Maritime Directorate (NMD) is considered. For the ship-years, the abovementioned scope still holds but with the additional restrictions that only ships registered to Norway (NOR) or in the Norwegian International Register (NIS) are considered. Furthermore, in these analyses only personal accidents, i.e. only accidents involving individuals and not the ship itself is considered.

3 General Cargo Ship and the Database

The focus of this analysis is the ship type "General Cargo Ship". LRFP provides definitions of all ship types in the LRFP database by means of "StatCode5v". An overview of the ship type classification by LRFP is shown in Figure 3-1. For the analysis of the ship type "General Cargo Ship" the sub-types "General Cargo" (A31A), "Palletised Cargo Ship" (A31B) and "Deck Cargo Ship" (A31C) are considered. For these sub-types further sub-categories are defined within LRFP (Figure 3-1). Based on this classification the following ship sub-types are considered in the analysis for "General Cargo Ship":

- General cargo ship (with RoRo facilities) A31A2GA
- Open hatch cargo ship A31A2GO
- General cargo/tanker (Container/oil/bulk – COB ship) A31A2GS
- General cargo/tanker A31A2GT
- General cargo ship A31A2GX
- Palletised cargo ship A31B2GP
- Deck cargo ship A31C2GD

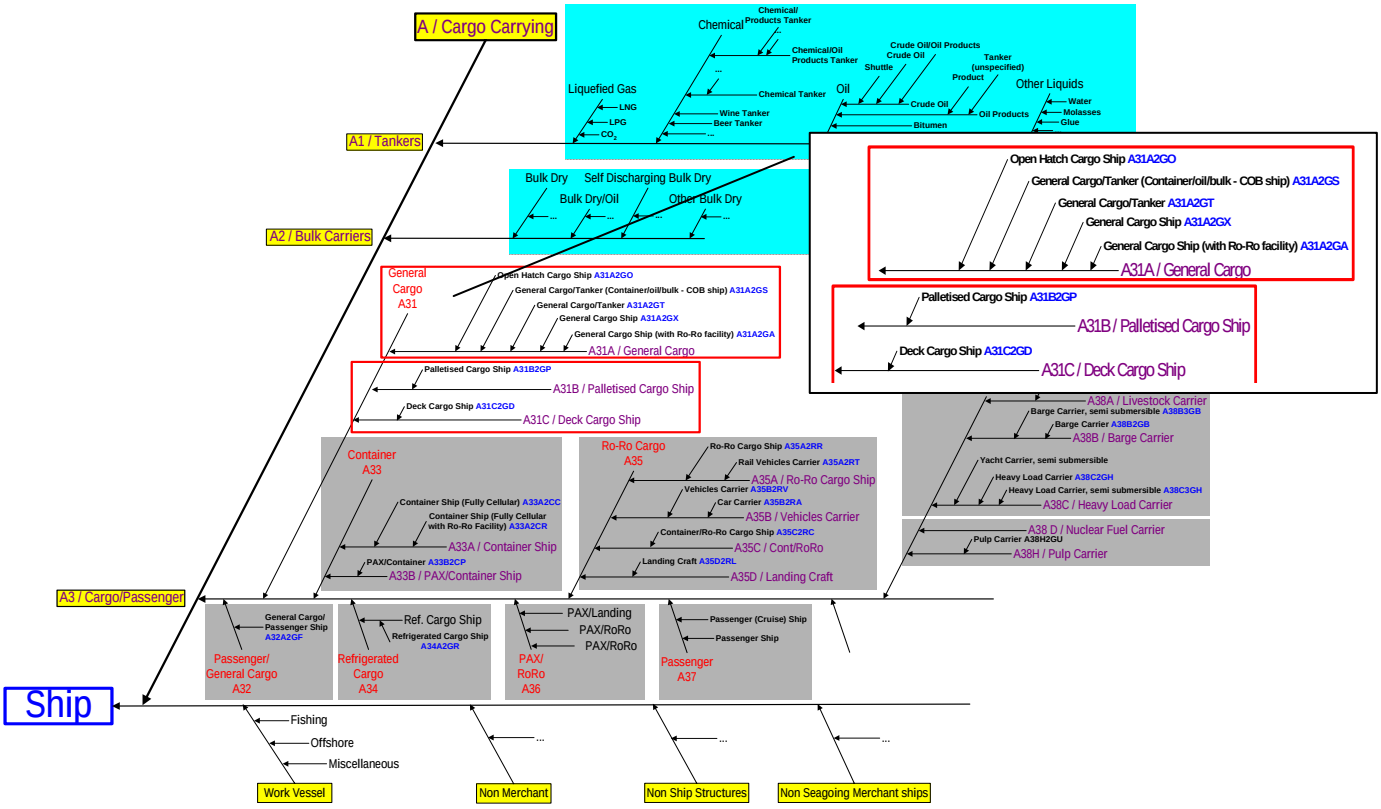

Figure 3-1: Classification of ship types using StaCode5v of LRFP.

For these ship sub-types LRFP provides the following definitions summarised in Table 3-1.

Table 3-1: Definition of sub-types of general cargo ships corresponding to StatCode5v (LRFP)

StatCode5v	Name	Description / Definition
A31A2GA	General Cargo Ship (with Ro-Ro facility)	A general cargo ship with the additional capability to be loaded and unloaded by ro-ro access to a limited portion of the cargo space
A31A2GO	Open Hatch Cargo Ship	A large single deck cargo vessel with full width hatches and boxed holds for the carriage of unitised dry cargo such as forest products and containers. Many are fitted with a gantry crane
A31A2GS	General Cargo/Tanker (Container/oil/bulk - COB ship)	A general cargo ship with reversible hatch covers; one side is flush and the other is fitted with baffles for use with liquid cargoes. Containers can be carried on the hatch covers in dry cargo mode
A31A2GT	General Cargo/Tanker	A general cargo ship fitted with tanks for the additional carriage of liquid cargo
A31A2GX	General Cargo Ship	A single or multi deck cargo vessel for the carriage of various types of dry cargo. Single deck vessels will typically have box shaped holds. Cargo is loaded and unloaded through weather deck hatches
A31B2GP	Palletised Cargo Ship	A single or multi deck cargo ship loaded and unloaded by way of pallets lift(s). There are no weather deck hatches
A31C2GD	Deck Cargo Ship	A vessel arranged for carrying unitised cargo on deck only. Access may be by use of a ro-ro ramp

The selection of all ships without size limitation and using the above mentioned sub-type criteria yield 21,995 ships. This group does *not* contain:

- all ships scrapped or lost before 1997-01-01;
- all ships coming into service (due or delivered) after 2006-12-31;
- all ships on order;
- all ships cancelled, pending, input errors.

The break down of the ship sub-types of these reports is summarised in Table 3-2. It can be seen that 97 % of all general cargo ships that were active between 1996 and 2007 belong to the category A31A2GX. It is believed that all ships which cannot be assigned to another sub-type are found in this category. For the ship type A31A2GS no active ships are listed in LRFP.

Table 3-2: Number of ships per StatCode5v category and active between 1996 and 2007							
Sub-type	A31A2GA	A31A2GO	A31A2GS	A31A2GT	A31A2GX	A31B2GP	A31C2GD
No. of ships	130	235	0	15	21351	70	194

LRFP provide a variety of data for the ships e.g. IMO number, class, ship size etc. In the data field "Classed By" the present classification is specified. A classification society is defined by LRFP as an organisation that publishes and overseas rules for the construction and maintenance of ships. Twenty-four classification societies were found in LRFP, which are in alphabetic order:

American Bureau of Shipping
Biro Klass Indonesia
Bulgarski Koraben Registar
Bureau Veritas
China Class Society
China Corp Register
Croation Register
Det Norske Veritas
Germanischer Lloyd/East German Register
Hellenic Register
Indian Register
Jugoslavia Register
Korea Class Society
Lloyds Register
Nippon Kaiji
Polish Register
Registro Cubano
Registro Italiano
Rinave Portugesa
Romanian Register
Russian Register
Korean Register of Shipping
Turk Loydu
Vietnamese Register

(The ships of the former East German Register are still in the LRFP database. Due to the handling during the unification process of Germany these ships are considered Germanischer Lloyd ships.)

Several of the ships covered by Table 3-2 are believed to operate in national waters only, and almost no accidents to these ships are recorded in LRFP. These ships are not equally distributed over the flags. For instance, of the 1,079 ships built after 1981, with a gross tonnage greater than 499 GT and with "Class Unknown", 559 ships are assigned to only five flags. In order to include these ships in the data analyzed, the accident statistics must be reported to different channels.

It is worth noting that the LRFP database contains no data concerning the classification society for a significant amount of ships (12,202 of 21,995). In the following investigation this group is designated as "Class Unknown". The distribution of the ships "Class Unknown" with respect to year built and ship size (gross tonnage) was further analysed. An overview with respect to the size categories specified for this analysis is summarised in Table 3-3. This overview shows that the size category of ships smaller than 500 GT in particular is affected by the missing information of class. 87 % of all ships with no class was assigned belong in

this group. However, also for 70 % of the ships between 500 GT and 1,000 GT and for 38 % of the ships between 1,000 GT and 20,000 GT had no class assigned in the database.

Table 3-3: Proportion of ship reports for "Class Known" and "Class Unknown" classified into ship size categories

	100 ≤ GT ≤500	500 ≤ GT < 1000	1000 ≤ GT < 20000	20000 ≤ GT	Σ
Class Known	877	679	7932	305	9793
Class Unknown	5782	1584	4824	12	12202

3.1 Investigation of database

To investigate if some characteristics could be identified for the class assignment the number of ships built per year is determined (Figure 3-2). This figure shows that a significant number of general cargo ships are built before 1980 (11,765), where some of them are built in the first decade of the last century. These ships mainly belong to the group "Class Unknown". The maximum commissioning of general cargo ships in this group is observed for the year 1970 with 434 ships delivered in this year and is then declining until today to about 60 to 70 ships per year. The group "Class Known" mainly consist of "younger" ships with a maximum of annual commissioning in 1977. Further, Figure 3-2 shows that after year 2000 about 80 % of all ships commissioned are classed by one of the 24 societies listed above.

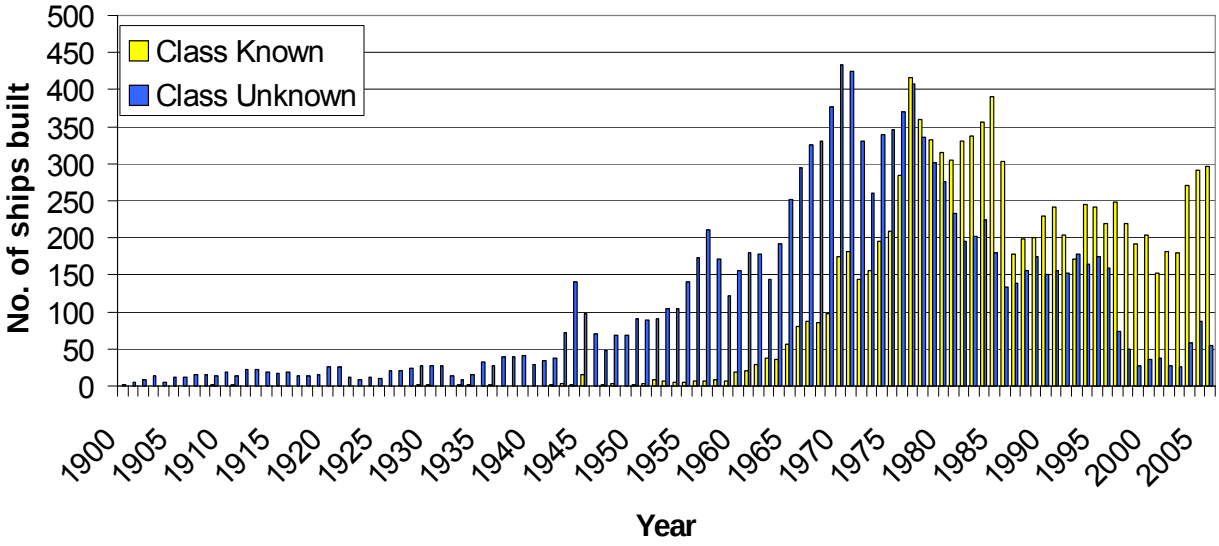

Figure 3-2: Number of ships built per year for the groups "Class Known" and "Class Unknown". All general cargo ships selected in LRFP considered.

Given that until the beginning of the 80's ship owners of general cargo ships had no preference for class societies not listed above, the distribution of "Class Known" and "Class Unknown" indicates a general trend to transfer older ships from the group "Class Known" to "Class Unknown".

It becomes obvious that the database for general cargo ships contains a significant number of ships that are built before 1980 (Figure 3-2). IMO regulations as well as class rules are subject to continuous improvement, for instance requirement of damage stability calculation for dry cargo vessels entering into force in 1992.

The focus of this analysis is to provide a basis for a Formal Safety Assessment. The intention of FSA is to identify safety deficits and to propose cost-efficient risk control options to reduce the risk as low as reasonably practicable. To reach this goal a mostly homogenous group of ships is essential.

Thus and due to the limited available information concerning the ships of the group "Class Unknown" with respect to survey and building rules, all ships built before 1982 are excluded from further analysis. Additionally, also ships smaller than 500 GT are excluded from the next steps of the analysis, because the complete SOLAS is only required for ships greater than or equal to 500 GT. After the exclusion of all ships built before 1982 and smaller than 500 GT 6,602 ships remain.

Furthermore, because of the possible access to additional information provided by the class societies involved in this analysis and for minimizing the effects of under reporting on the analysis results, only ships classified by an IACS society in 2007 and all casualty reports for ships belonging to an IACS society at the date of incident are considered in this investigation. This group consist of 4596 ships that were active between 1997-01-01 and 2006-12-31. Of these about 95 % belongs to the ship type A31A2GX. Due the small number of ships in the ship type categories A31A2GA, A31A2GO, A31A2GT, A31B2GP and A31C2GD the StatCode5v categories are not further considered in this analysis.

Figure 3-3 shows the number of ships with respect to the age determined for the specified period. The age of a ship is calculated from the 31st December of each year. This figure shows a homogenous distribution up to 15 years of age. Thereafter the number of ships decreases continuously with increasing age. This observation can be explained by scrapping of older ships, change of class to a non-IACS society or another organisation and/or the specified selection criterion (from 1982 on). More detailed results with respect to the development of the fleet age are broken down into the three size categories are shown in Figure 3-4 to Figure 3-6.

These results show that the mean age of the general cargo fleet is higher than 15 years (because all size categories show an increase of the mean age over the investigated time period), and thus the selection is not homogenous. However, this should only affect incidents caused by time dependent processes, for instance fatigue.