LARGE PASSENGER VESSEL SAFETY STUDY

Report on the Analysis of Safety Influences

Presented to:

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FINAL REPORT
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FOR

THE INTERNATIONAL COUNCIL OF CRUISE LINES

EXECUTIVE SUMMARY

The International Council of Cruise Lines (ICCL) contracted the M. Rosenblatt and Son Group, of AMSEC LLC to perform a holistic study of large passenger vessel safety, reinforced by the extensive experience of ICCL ship operators. This study is an initiative to take a comprehensive look at large passenger vessel safety by examining a substantial number of influences on the safe operation of a large passenger vessel, and the rules and regulations that govern them, in an effort to identify areas that may need additional emphasis. The findings of this study will be presented to the International Maritime Organization at their Maritime Safety Committee meeting in May 2001, for the active review by the international community.

To accomplish this, the spectrum of influences, as defined by an expert panel of large passenger vessel operators and safety personnel, was divided into Influence Centers. Within those centers the spectrum of influences was further divided into Influence Factors. Influence Centers are major groupings of Influence Factors. Influence Factors are items that prevent, detect, constrain, resolve or in some other way influence a Safety Driver. Safety Drivers are the external events that create a safety-related incident. These incidents are such things as groundings, collisions, etc. Each safety-related incident requires some level of response to resolve it. For purposes of the study, the response was divided into four levels; prevention, containment, recovery and evacuation.

The large passenger vessel safety evaluation process began by identifying the Safety Influence Centers. Each Influence Center was then broken into as many Influence Factors as could be derived from several iterations of brainstorming by panels of experts. As the panels examined the Influence Factors, the numbers of Influence Centers and the groupings changed until a mutually agreeable Master Diagram depicting all the Influence Centers, Influence Factors, and Safety Drivers was achieved. These Influence Factors were then ranked to identify their degree of impact on a particular Safety Driver during each level of response. This ranking was performed in a two-day off-site meeting of “experts”. Finally, overlays of operating procedures and rules/regulations were applied to the applicable Influence Factors to determine the extent to which Influence Factors appear to be or appear not to be adequately addressed. This approached considered both the safety impacts and regulatory coverage to highlight areas where there may be opportunities to further consider large passenger vessel safety.

The regulatory overlay considered the following regulations, rules and, guidelines:

1. The International Convention for the Safety of Life at Sea (SOLAS)

2. International Safety Management Code (ISM Code)

3. International Convention for Standards of Training, Certification and Watchkeeping (STCW)

4. Measures to Prevent Unlawful Acts Against Passengers and Crews on Board Ships
5. International Convention for the Prevention of Pollution from Ships (MARPOL)
6. International Load Lines Convention (LLC)
7. International Life Saving Appliance Code (LSA Code)
8. Det Norske Veritas (DNV) Rules for Classification of Ships
9. International Council of Cruise Lines Guidelines

The results are presented in two distinct manners, diagrammatically and in a spreadsheet. There are 51 diagrams; 4 for each of the Safety Divers (Incidents), and one for each response level, except for the Man Overboard Safety driver, where there are only 3 diagrams since there is no Evacuation response level to consider. For each diagram, the Influence Factors were assigned one of three levels based on the following criteria:

- Level I Directly effects or prevents a particular Safety Driver
- Level II Significant contributor
- Level III Minor contributor

The ranking is conveyed on the influence diagrams by the type of line connecting it to the Safety Driver. Factors with no contribution were not assigned a level and no connectivity was shown on the influence diagram.

Color-coding and numbering were used on the incident diagrams and descriptions to indicate how well the rules and regulations address the Influence Factors. The same lines (or type of line) showing the Influence Factors' level of significance are color coded on the diagrams as follows:

Color Code	**Coverage Level**	**Description**
Red	1	No or minimal coverage
Yellow	2	Some coverage
Green	3	Extensive coverage

Additionally, the data is presented in spreadsheet form, using much the same scheme, except the level of significance is depicted using Roman Numerals I, II, and II as previously discussed, and the color of the cell is the same as the line color used for the influence diagrams.

The areas that would most likely benefit from further study would be those Influence Factors that are ranked as having a direct effect on the Safety Drivers (significance level I) and having minimal or no regulatory coverage. The final report lists these areas and a methodology for further analysis.

1.0 Introduction

The large passenger vessel trade has increased dramatically in recent years and projections are for even greater increases in the future. This increase in business has been accompanied by an increase in vessel size and attendant public exposure. These factors have made the safety of large passenger vessels a growing area of public concern, not only nationally, but internationally as well. Ship safety, including large passenger vessels, has been covered in the past by a myriad of international, national and classification society rules and regulations. The ICCL has contracted with the M. Rosenblatt and Son Group, of AMSEC LLC to perform a holistic study of large passenger vessel safety, reinforced by the vast experience of ICCL ship operators.

This study examines a large number of influences on the safe operation of a large passenger vessel, and the regulations that govern them, in an effort to identify areas that may need additional emphasis. In order to do this the spectrum of influences, as defined by an expert panel of large passenger vessel operators and safety personnel, was divided into Influence Centers, and within those centers, Influence Factors.

Influence Centers are major groupings of elements that are defined as Influence Factors. Influence Factors are items that prevent, detect, constrain, resolve or in some other way influence a Safety Driver. Safety Drivers are the external events that create a safety-related incident. These incidents are such things as groundings, collisions, etc. Each safety-related incident requires some level of response to resolve it.

The level of response was broken into four parts. The first level of response is Prevention. For this level, the intent is to see what influence factors come into play so that for instance, collisions may be avoided all together. The second level of response is defined as Containment. Containment, in this study, basically means stopping the consequences of a Safety Driver (incident) very quickly, before its spreads or creates a larger problem. This may typically be viewed as first response. An example would be putting out a fire out with a portable fire extinguisher before any real damage has been done. The third level of response is defined as Recovery. Recovery would be the response to a Safety Driver that has escalated beyond the effectiveness of initial response and other resources, such as firefighting teams, repair teams, fixed fire-fighting systems etc. had to be employed to get control of the situation. Finally, the last level of response is defined as Evacuation. Here the incident cannot be contained or managed at the whole ship level or within an area of the ship, so that either a portion of the ship has to be evacuated, or in the worst case, the vessel must be abandoned.

The concept of Influence Centers was chosen to capture and analyze the safety information because it is especially useful for grouping information and depicting interactions among Safety Drivers and their related Influence Factors. An overlay of regulations and operating procedures is then applied to the influence framework to demonstrate how each influence link is currently addressed and highlight areas where there may be opportunities to consider large passenger vessel safety.

2.0 Objective

The objectives of this study are to:

1. Support the ICCL initiative to address the expressed concern over the safety of large passenger vessels by determining the areas where to best enhance passenger safety. Take a comprehensive look at the issues and opportunities, as a basis for an ICCL presentation delivered to the International Maritime Organization at their Maritime Safety Committee meeting in May 2001.

2. Analyze the total ship in its environment, including its operations and management, to capture the most significant passenger vessel Safety Drivers, i.e. incidents such as fire, collision and unlawful acts, and their interactions with influence factors.

3. Develop a well-balanced, non-redundant methodology to determine areas where there is extensive regulatory coverage of influence factors and other areas of less coverage where there may be opportunities to further enhance safety. Present this information in a clear and useful manner.

4. Benefit from the participation of industry ship operators, to provide input, review and validation, throughout the process.

3.0 Scope

This study addresses the major safety influences onboard large passenger vessels from the regulatory and the ship operations perspective. The study is limited to passenger, crew and inherent ship safety. The study examines passenger ship safety from the operator's standpoint. The examination of regulations is cursory at this stage, at a level sufficient to identify broad coverage, in order to identify influences that merit more detailed analysis.

4.0 Approach

The process to evaluate large passenger vessel safety starts by identifying the Safety Influence Centers. Each Influence Center is then broken into as many Influence Factors as can be derived from several iterations of brainstorming by panels of experts. As the panels examine the Influence Factors, the numbers of Influence Centers, the groupings change until a mutually agreeable Master Diagram depicting all the Influence Centers, Influence Factors, and Safety Drivers is achieved. These Influence Factors are then ranked to identify the degree of impact on a particular Safety Driver. This ranking was performed in a two-day off-site meeting of "experts". Finally, overlays of operating procedures and rules/regulations on the applicable Influence Factors are made to determine the extent to which Influence Factors appear to be adequately addressed and which are not.

In an effort to assure validity, the evaluation of the Safety Influences is an iterative process which takes advantage of exchanges between the contractor performing the primary analysis and ship operators and

safety experts. The intent is to get a realistic perspective, involving the people who are ultimately responsible for ship safety; those who develop the operating procedures, and most importantly, those who apply the procedures and regulations that correspond to those safety issues. The study process steps are as follows:

1. Identify the Influence Centers. These centers consist of groupings of safety Influence Factors and the list of Safety Drivers that impact large passenger vessel safety.

2. Identify the regulations, rules, and guidelines that impact large passenger vessel safety. This step runs concurrently with the remaining steps.

3. Iteratively derive a Master Diagram depicting all the Influence Centers, Influence Factors and Safety Drivers.

4. Develop Influence Diagrams for each Safety Driver showing the interactions of individual Influence Factors within the Influence Centers for a given response level of a Safety Driver. This provided a mapping of the influence relationships. For example, for the Safety Driver, Collision, there would be four influence diagrams, one each for prevention, containment, recovery, and evacuation.

5. Rank the Influence Factors in each influence diagram. This is done by experienced ship operators and safety experts, taking into account the Influence Factors' possible impact on the associated Safety Driver. Ship operators and safety experts also review the Master Diagram during this step to see if there were any additional Influence factors to be added or deleted.

6. Compile the final Influence Diagrams. This is done by tabulating all of the ranking data from the ship operators and safety experts.

7. Overlay existing regulations, rules, and guidelines, and operating procedures on the influence diagrams.

8. Organize the results of the overlays on the diagrams and in spreadsheets; identify apparent gaps and shortfalls in the coverage of regulations, rules, guidelines and operating procedures.

5.0 Process Details:

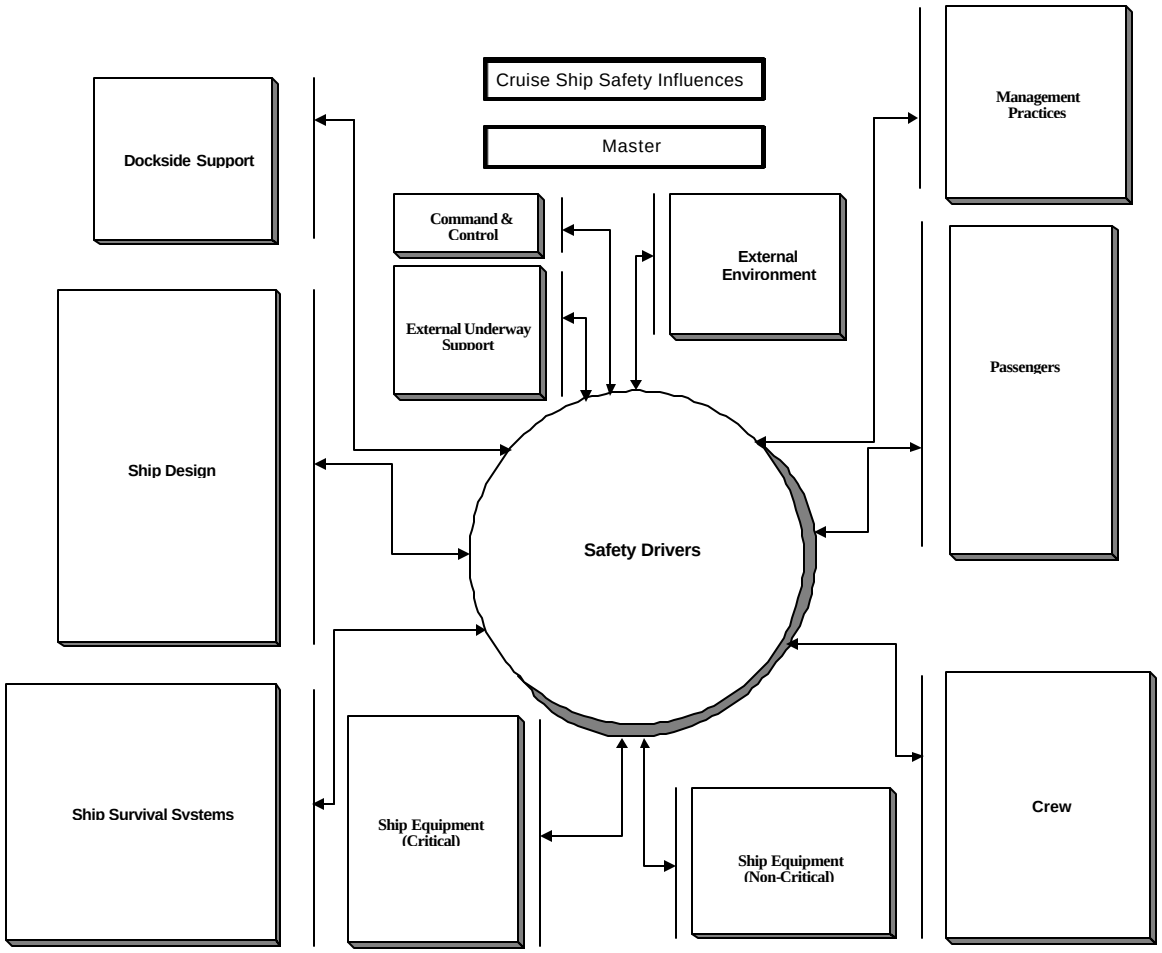
This section addresses specific details of each of the process steps identified in the previous section and how it was actually performed.

5.1 Identify Influence Centers

Influence Centers, as used in this assessment, refer to groupings of Influence Factors that have an effect on passenger vessel safety by interacting with the drivers at the different levels of incident response.

The Influence Centers were developed based on initial input from ICCL. This input was combined with the results of brainstorming sessions using the contractor's own experts. The resulting combination was then grouped into a set of Influence Centers. The Influence Centers went through several revisions before being presented to a panel of experts for review and input, and later revised by a second panel. This study has identified eleven Influence Centers and a set of Safety Drivers. The influence centers are shown in the master diagram outline below:

The actual complete master diagram depicts all the Influence Factors in the Influence Centers. Safety Drivers are external events that create a safety problem and require a response. An Influence



Factor is anything that influences a driver or is a response to a driver. Influence Factors may also include elements that prevent or detect drivers. The Safety Drivers (incidents) are shown below. A listing of all the drivers and their definitions is provided in Appendix A.

5.2 Identify Safety Regulations

The study concentrates on those safety-related regulations and rules that apply to large passenger vessels. The regulations and rules are organized into three groups based on who enforces them:

1. Flag States
2. Port States
3. Classification Societies

Many regulations and rules overlap more than one group, although efforts have been made toward commonality and consistency between flag states and classification societies.

Most large passenger vessels, and all ICCL members' vessels, are flagged in countries that are IMO

members and have adopted all IMO maritime safety Resolutions and Conventions. Therefore, the regulatory focus of this study will be on IMO regulations, vice regulations of individual flag states. Specifically the review focuses on the following:

1. The International Convention for the Safety of Life at Sea (SOLAS)
2. International Safety Management Code (ISM Code)
3. International Convention for Standards of Training, Certification and Watchkeeping (STCW)
4. Measures to Prevent Unlawful Acts Against Passengers and Crews on Board Ships
5. International Convention for the Prevention of Pollution from Ships (MARPOL)
6. International Load Lines Convention (LLC)
7. International Life Saving Appliance Code (LSA Code)

United States regulations were used for the Port State entity. Specifically, the study concentrates on United States Coast Guard (USCG) and United States Public Health Service Center for Disease Control Vessel Sanitation Program (CDC VSP) guidelines, practices and procedures.

The third enforcement entity is the classification societies. Large passenger vessels are built and maintained to the rules of classification societies. While all classifications societies publish their own rules, all of the societies are working together through the International Association of Classification Societies to develop consistent regulations between them. The current rules from Det Norske Veritas (DNV) were used for this study.

In addition, the study included ICCL industry guidelines and statements will be noted where applicable.

5.3 Derive a Master Diagram

The master diagram has been created through numerous iterations and changes all through the process. An initial master diagram was presented to the ICCL thirty two technical committee members at a meeting in Miami on 31 Oct 2000. The master diagram was reviewed and comments and suggestions were taken during the meeting and have been incorporated. The revised master diagram was sent on 13 Nov 2000 for review of the incorporated comments and finalized at that point. However, during the two day offsite, on 18 and 19 January 2001, to finish the creation of the influence diagrams described in Section 5.4, changes were again made, based on a survey process depicted by Appendix B. This revealed new Influence Factors to be considered. The revised master diagram and the definitions which go with each Influence Factor in the context of this project are included in Appendix C.

5.4 Develop Influence Diagrams

Four Individual influence diagrams were developed for each Safety Driver, except the Man Overboard Safety Driver, since there is no evacuation in that case. The first diagram starts with step1, prevention, successively to step 4, escape (when all other measures have failed). The four response steps, as previously discussed, are as follows:

- Step 1 Prevention
- Step 2 Containment
- Step 3 Recovery
- Step 4 Escape

An influence diagram is composed of the Influence Factors and interactions at each response step that applies to a given Safety Driver (incident), as determined by the panel of experts. An example of a specific influence diagram would be flooding; at the step 2 response level (containment). All the Influence Factors that apply to containment of flooding are shown as connected from the Safety Driver Circle to the applicable Safety Factor. This same evaluation is then repeated for each successive response step. It should be noted that:

- Some Influence Factors within an Influence Center will not apply to a given Safety Driver / response combination.
- An entire Influence Center might not be applicable to a certain Safety Driver/ response level combination.
- Some response steps will not apply to some incidents.

However some Safety Drivers can generate secondary incidents that are Safety Drivers themselves, and therefore require their own response. An example would be a collision, which might well have flooding as a secondary Safety Driver. To account for this, each diagram will denote potential secondary Safety Drivers.

The individual influence diagrams for each Safety Driver and the accompanying influence lists and descriptions are found in Appendix D.

5.5 Rank Influence Factors

As part of Step 5.3, each Influence Factor was rated on the degree of impact that it exerts for the indicated response step. This review was performed by the panel of experts. This panel included: a Master and current Director of Fleet Safety; an active ship Captain, a Director of Fleet Safety Programs; a Manager of marine Safety; a Manager of Loss Prevention; a Director and Superintendent Nautical Operations; a Director of Quality Assurance; A Safety Assurance Manager for Safety and Environment; A Marine Superintendent Navigation and Safety; A Director of Safety and Environment; A Director of Safety and Environmental Management, Designated Person, an Executive Vice President, and a Manager, Marine Safety and Regulatory Training. Influence Factors were assigned one of three

levels based on the following criteria:

- Level I Directly effects or prevents a particular Safety Driver
- Level II Significant contributor
- Level III Minor contributor

Factors with no contribution were left blank and no connectivity on the influence diagram was made. The ranking is conveyed on the influence diagrams by the type of line connecting it to the Safety Driver . On the influence diagrams in Appendix D the small arrows pointing out the Influence Factor will denote ranking. A Level I influence will have a solid arrow, a Level II influence will have a dashed arrow, and a Level III influence will have a dotted arrow. Influence significance level ranking is also included in the influence lists and descriptions that accompany the diagrams in Appendix D.

5.6 Compile Final Influence Diagrams and Expert Data

After the two day off-site meeting, the team of experts went through each Safety Driver and associated response level and ranked the applicable Influence factors. This data was tabulated and numerical ranges were selected to determine the final rankings for Level I, II, and III.

5.7 Overlay Regulations, Rules, Guidelines, and Operating Procedures

The regulatory overlay is based on a survey of several sets of regulations. The results of the survey are listed in Appendix E. That information, excepting the ICCL statements and guidelines, was then used to judge the regulatory coverage for each influence factor. Color-coding was then used on the incident diagrams (Appendix D) and on the summary spreadsheet, Appendix F, to indicate how sufficiently the rules and regulations address the Influence Factors. In Appendix D the small arrows pointing out the Influence factors in the diagrams are color coded and the accompanying influence lists and descriptions have numbers indicating Regulation Coverage Level, as follows:

Color Code	Coverage Level	Description
Red	1	No or minimal coverage
Yellow	2	Some coverage
Green	3	Extensive coverage

Regulation coverage level is also included in the influence lists and descriptions that accompany the diagrams in Appendix D.

5.8 Organize the Results and Identify Gaps and Shortfalls in Regulatory Coverage

The Results are presented in two formats.

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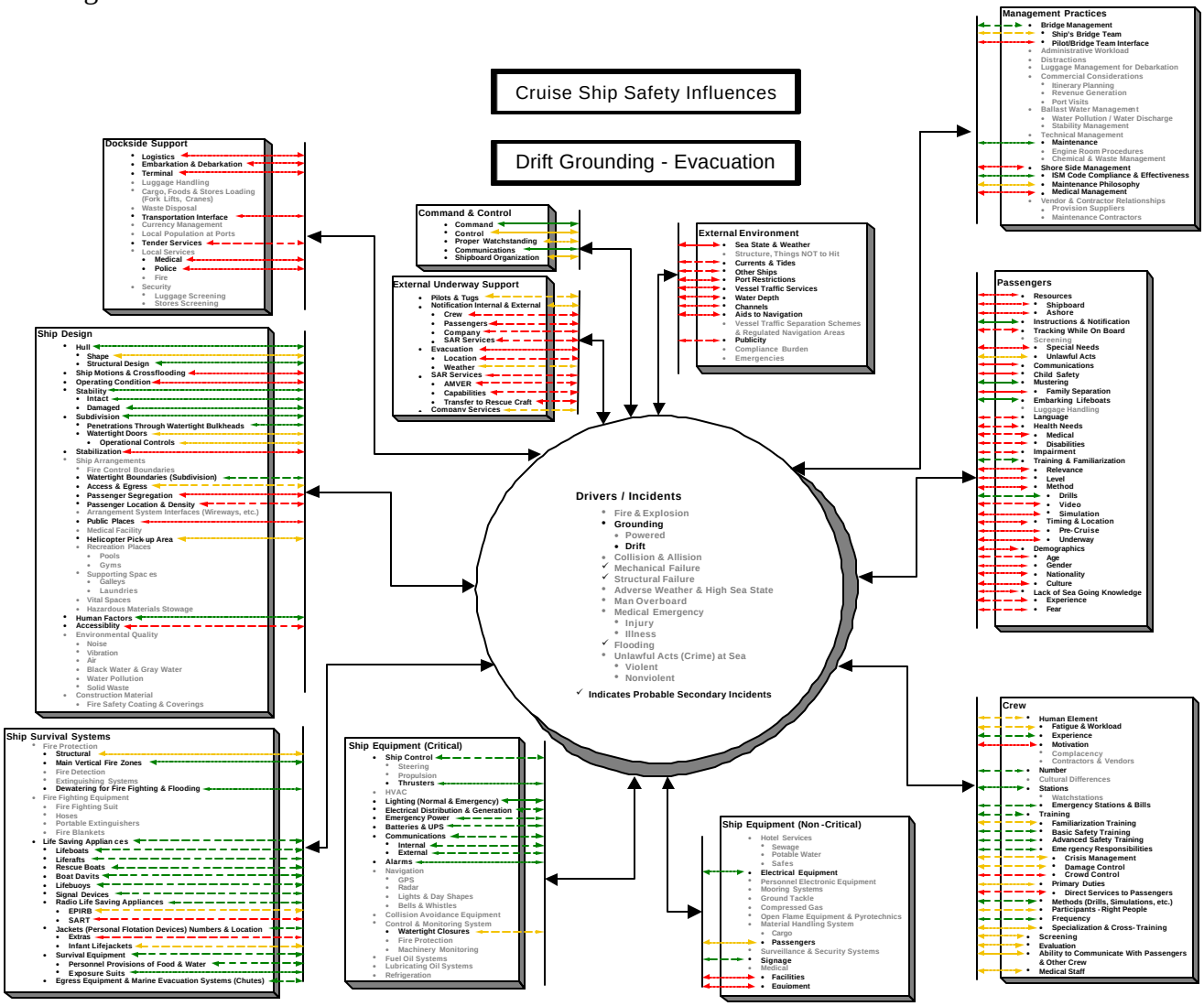
First the influence diagrams (four for each Safety Driver, except Man Overboard) depict each applicable safety factor by the line type as previously discussed in Section 5.5 and by the color code detailed in Section 5.7. The final influence diagrams in full size are in Appendix D, with tabular sheets showing the same data.



For illustrative purposes only – Full size influence diagrams are in Appendix D.

Second, the results are presented in spreadsheet form in Appendix F. A small portion of the spreadsheet is shown below. Note that the Roman Numerals in the cells represent the significance ranking of the Influence factor shown at the right side. Across the top of the spreadsheet are the Safety Drivers and the level of response. For example under Collision/Prevention, the cell for the Influence Factor, Pilot to Bridge Team Interface, has a Roman Numeral I, meaning that it was found to have a direct effect on the Safety Driver. That particular cell is colored red, meaning there are few if any rules or regulations controlling this Influence Factor.

Influence	Fire & Explosion				Powered Grounding			
	Prevention	Containment	Recovery	Evacuation	Prevention	Containment	Recovery	Evacuation
External Environment								
• Sea State & Weather		III	II	I	II	II	I	I
• Structure, Things NOT to Hit					II	III		
• Currents & Tides				III	II	II	II	II
• Other Ships			III	II	III		III	II
• Port Restrictions				III	III			III
• Vessel Traffic Services			III	III	II			II
• Water Depth				III	I	III	III	III
• Channels				III	II	III		III
• Aids to Navigation				III	I	III		III
• Vessel Traffic Separation Schemes & Regulated Navigation Areas					II	III		III
• Publicity				III				II
• Compliance Burden	III				III			
• Emergencies				III	III			III
Management Practices								
• Bridge Management	III	II	II	II	I	II	II	II
• Ship's Bridge Team		III	II	II	I	III	II	II
• Pilot to Bridge Team Interface			III	III	I	III	III	III
• Administrative Workload	III				II			
• Distractions	II	III	III	III	I			
• Luggage Management for Debarkation				III				
• Commercial Considerations								
• Itinerary Planning				III	II			
• Revenue Generation								
• Port Visits					III			
• Ballast Water Management				III				
• Water Pollution & Water Discharge								
• Stability Management			III	III		II	II	
• Technical Management	II	II	II	III	III	III	III	
• Maintenance	I	II	II	II	II	III	III	III
• Engine Room Procedures	I	II	II	III	II	III	II	
• Chemical & Waste Management	II	III	II	III				
• Shore Side Management	II	III	III	II	III			III
• ISM Code Compliance & Effectiveness	I	II	II	III	II	III	III	III
• Maintenance Philosophy	II	III	III	III	III			
• Medical Management				III				
• Vendor & Contractor Relationships								
• Provision Suppliers								
• Maintenance Contractors	II	III			III			

6.0 Results

The purpose of the study was to identify areas that might merit further investigation by IMO in the future. Those areas that would be most likely benefit from further study would be those Influence Factors that are ranked as having a direct effect on the Safety Drivers and having minimal regulatory coverage. On the Spreadsheet in Appendix F that would be those Influence factors that have a Roman numeral I, and a red cell. The order in which to more closely examine the specific Influence factors that would be most worthwhile is shown in the Table below.

Order of Investigation			
	Level of Regulation Coverage		
Influence factor Ranking	None/Minimal	Some	Extensive
I	1st	2nd	3rd
II	2nd	3rd	4th
III	3rd	4th	Last

As discussed in Section 5.8, all the information is presented in graphical and spreadsheet form.

Looking first at those Influence Factors with a Roman numeral I and little of no regulatory coverage (1st level of investigation from the chart above) you find:

- Sea State and Weather – While it is obvious that there can be no regulation of weather, it shows up as a very significant Influence Factor more than any other. Since it appears to be a major concern, it would seem reasonable to take a look as at what actions can be taken to mitigate the effects of weather.
- The most number of I's under a particular response level fall under Evacuation. The Influence Factors that appear to be the most significant with the low regulation are:
    - Communications with Passengers
    - Child Safety
    - Family Separation
    - Language Differences
- In The Powered Grounding Safety Driver, three Influence Factors fall into the 1st review category:
    - Water Depth
    - Aids to Navigation
    - Pilot to Bridge Team Interface

  Actual regulation/rules for the above three Influence Factors would vary from port to port. Most ports would seem to have excellent Aids to Navigation, but perhaps not sufficient rules defining acceptable water under the keel when entering port. The issues of the Pilot to Bridge Team Interface has been discussed at length in recent years, but still appears as a significant

Influence Factor.

- For Fire and Explosion, External underway Support appears to be a major area of concern. In particular the Safety Drivers that fit the 1st level of investigation are:
    - Notification Internal and External of:
        - Crew
        - Passengers
        - SAR Services
    - SAR Services
        - Transfer to Rescue Craft

These Influence Factors also rate high for other Safety Drivers, just not quite at the level of concern for fire and explosion.

This would be just the 1st Level (as defined in the chart above) of Influence Factors to investigate using this rationale. The same review can then be performed for the 2nd level, etc.

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