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IMPACT OF THE FORMAL SAFETY ASSESSMENT ON SHIPBOARD OPERATIONS

SUMMARY

The paper presents, in broad outlines, the concept of the Formal Safety Assessment, a newly proposed official methodology for the rule-making process in IMO. It examines possible potentials and drawbacks of the proposed methodology and attempts to identify the most important long-term consequences of its application in the international shipping and shipboard operations.

1. INTRODUCTION

According to the IMO-accepted definition, Formal Safety Assessment (FSA) is "a structured and systematic methodology, aimed at enhancing maritime safety, including protection of life, health, the maritime environment and property, by using risk and cost-benefit assessment". The development of the methodology has been initiated by the Lord Carver's 1992 report on safety aspects of ship design and technology. Further development of the methodology has been carried out by the UK Marine Safety Agency upon which UK proposed to the IMO Maritime Safety Committee to apply the formal analytical process to its regulation development. The concept was termed the Formal Safety Assessment and presented to the IMO MSC in 1993. At the 65th MSC Meeting the concept gained strong support from the Committee so that the trial application has been programmed. After the successful trial application, the MSC, at its 68th meeting and the MEPC at its 40th meeting, adopted The Interim Guidelines for the Application of Formal Safety Assessment (FSA) to the IMO Rule-making Process. Consequently, the FSA procedure can be expected to become a routine procedure for the IMO rule-making process within the next few years.

2. FORMAL SAFETY ASSESSMENT - - PRINCIPLES AND PROCEDURES

FSA is a formal analytical procedure developed to improve the rule-making process of the IMO. It strictly follows the top-down approach (from hazard backward to cause) and consists of the following steps:

1. Identification of hazards
2. Assessment of risk associated with identified risks
3. Analysis of various risk control options
4. Cost benefit assessment
5. Decision-making.

Hazard identification is the sub-process in which target physical situation is considered and consequently defined. A particular situation is considered hazardous if there is a reasonable probability or if previous experience proves that such situations can result in human injury or damage to property or to the environment. According to the Interim Guidelines, a coarse analysis of possible causes and consequences can be made using standard techniques already developed in other branches of the industry. This could include Fault and Event Trees Analysis (FTA/ETA), Hazard and Operability Studies (HAZOP), Failure Modes, Effects and Criticality Analysis (FMECA), Cause Consequence Analysis (CCA), Human Error/Reliability Analysis (HE/RA), etc., usually in a simplified form. Applied techniques can be later refined if deemed necessary.

The second step is risk assessment. The risk is defined as frequency (likelihood of incident) multiplied by consequence (severity or impact of the incident). The units representing risk can be different, appropriate to the hazard under consideration. As a result of this step a Risk Contribution Tree has to be made. It is a combination of Fault Tree and Event Tree Analyses and it is aimed to structure direct and underlying causes as well as structure of final outcomes. The Risk Contribution Tree is the basis for the FN curve, i.e., graphical representation of the relation between the frequency of incident (F) and its normalised consequence (N). As the last sub-step, the Regulatory Impact Diagram has to be made.

The Risk Control Measure is a measure inserted somewhere in the causal chain for the particular incident outcome. The Risk Control Measures can be preventive or mitigating, engineering or procedural, passive or active and so on. Various Risk Control Measures are, as might be expected, similar in nature and therefore some of them could be grouped together in several basic control options.

The next step in the FSA procedure is the cost-benefit analysis. Its outcome is the evaluation of economic costs and benefits for each Risk Control Measure or group in financial terms. Costs are estimated for two basic groups: public costs (e.g., administrative costs, inspection, compliance costs etc.) and commercial sector costs. The same procedure is applied for determining the benefits. For each option and its outcome the sensitivity analysis has to be performed. For each risk the Cost of Unit Risk Reduction (CURR) is determined. It is obtained by dividing the net present value of the costs and benefits by the risk benefit as identified within step two, taking into account the risk units.

The last step in the FSA procedure is to collate all information obtained during the steps one to four and to produce the final report. It must include a short comparison between main options with a recommendation for decision-makers. The presentation of results must be according to Interim guidelines and consisting of less than 20 pages.

3. INFLUENCE OF FSA - - DERIVED REGULATION ON GOVERNMENTAL POLICY

The FSA is clearly a newly developed methodology. Except for trial applications, the methodology still has no wider application in shipping. However, the basic ideas and the methods behind the FSA concept are not new. They had been developed first in nuclear industry and were then successfully implemented in many other industries with high inherent risks. The basic feature of all these industries is that they are technologically mature, i.e., they passed the period of intense development and now show steady growth in relatively stable market conditions. Therefore, the application of these methods in shipping can be deemed as the first evidence that shipping is becoming a mature industry at the international level.

However, there is a significant difference between these industries and shipping. The aforesaid industries are, as a rule, technologically highly advanced, without low level operators, significantly more self-regulatory and with substantially fewer competitors on the market than in the shipping industry. Additionally, these methods are first devised and applied by market competitors (in order to increase profit by decreasing accident rate and the resulting exploitation costs) and only afterwards introduced by governmental institutions.

In shipping, these methods will be implemented not by market competitors, but by member state(s) when proposing a new international rule or amending the existing one. It can reasonably be expected that this will ensure a wider promotion of public interests as a whole. Also, such approach will, after some time, result in a much more consistent international maritime regulation system than the existing one, with decreased numbers of overlaps of any kind and with a systematic coverage of all important aspects of maritime safety and environmental protection.

On the other side, a resulting regulatory system (or conclusions derived through FSA methodology) has to be applied (and enforced) in each national shipping by the responsible maritime authority of each member state. This multilevel process will include, on the first level, more than 150 member governments of IMO, on the next level more than several hundred registers and other governmental representatives and maritime institutions, and on the last level several thousand shipowners, ship-managers and other directly involved subjects (i.e. specialised crew-managers, technical managers, shipbuilders and so on). The number of subjects is much higher than in the industries, in which the basic methods are developed, giving rise to much more complex interrelations between them. Additionally, the organisational structure, efficiency, personal and technical support of each subject, from the governmental to operational level, could be very different, ranging from excellent to poor, therefore making co-ordination and co-operation between them very complex.

In essence, member states are using the FSA methodology to justify a proposed new rule or amending an existing one. In a certain case, it means that the member state proposing an amendment or a new rule will apply its own input values. And these values, because of significantly different commercial, cultural, safety and environmental conditions of each or group of states, could be significantly different for different states. Consequently, what is highly justified in one country could be completely unacceptable in the other. In this respect two basics issues arise: the system of priorities and the system of values. Let us consider, for example, a new or an amended rule on environmental protection, proposed by the highly developed state. The rule and the resulting costs are clearly justified using FSA methodology based on the values adopted by the proposing state. How to persuade a member state with a low income per capita, poor social security system and/or poor medical care system to invest in environmental protection and not to invest in the improvement of social security or medical care system? Even if the problem of social priorities is resolved, what values will be used in the cost-benefit analysis if different values cause a significant change in the outcome of each risk control option? For example, what is the cost of a human life[1] or totally exterminated biological species? The problem is additionally complicated by the fact that different countries apply different principles (if any) for determining these values. Therefore, one can ask what value will be appropriate on the international level: minimum, maximum or average?

The experience from the industries where basic FSA methods have been used for a number of years shows that these methods are very well suited for advanced and technologically well defined applications. In shipping, the technological processes are generally well defined but highly diversified. As an example, the term "ship/vessel" is used as a generic term for many technologically different types of ships (e.g., procedures applied on an LNG carrier have nothing in common with procedures applied on a passenger vessel). In order to give full effect to FSA methodology it will be necessary to apply it, in most cases, to particular ship types and, to a lesser extent, to a particular segment of the technological procedure used on that ship type. Therefore, the best results of the FSA methodology will probably be achieved with novel ship types with no precedents[2] or with technologically well defined processes.

Generally, the probable outcome of the extended application of the FSA methodology will be an increased number of specialised rules. This trend can already be noticed, even without the introduction of the FSA. Full implementation of the FSA methodology will force this trend even more. It can be expected that full implementation of the FSA methodology will dictate rewriting the major part of the existing regulatory system, including all major conventions. This could bring about many positive effects, the most important being the much more consistent and harmonised international regulatory system than the existing one.

4. FSA-DERIVED REGULATION AND SHIPBOARD OPERATIONS

The basic difference between shipping and other branches of industry with comparable general level of technological complexity is the proportion of human work involved in the technological process as a whole. In the shipping, as well as in other branches of industry, pure human workforce is reduced as much as possible and replaced by power-driven tools and appliances. However, while automation of control processes has become very high in most industries, in shipping the dominant role of human work in the process control has remained almost unaffected by automation. The beginning, supervision of process execution as well as termination of many shipboard operations is, with a few exceptions, still under full human control. It is a well-known fact that with an increase of system complexity there is also an increase of the sensitivity of the system to human errors. Consequently, human errors are predominant causes of accidents in shipping. Furthermore, beside accidents caused by ordinary human errors (an operator not aware of an error or misconduct), a number of maritime accidents are caused by wilful misconduct of a working procedure (an operator willingly refusing to follow the prescribed procedure hoping that nothing will go wrong). Such professional behaviour is provoked mainly by commercial pressure exerted on masters by shipowners and managers but also because of low safety culture. Consequently, it is estimated that more than 80% of all maritime accidents are caused by human error.

In order to decrease the huge impact of human error on maritime safety and environmental protection, IMO has adopted the International Code for Safety Management and Environment Protection (ISM Code). According to ISM Code, the management responsible for safe operations of the ship has to define, inter alia, appropriate working procedures critical for ship safety and to assure that all persons on board in all circumstances follow these procedures.

So far, administrations, when issuing certificates based on the ISM Code, have generally not performed an in-depth verification of technical correctness and completeness of approved working procedures. In other words, the responsible management has a great deal of freedom in tailoring the working procedures to its needs, provided that they are not, to a great extent, in discrepancy with the customary practice. If FSA methodology is applied, then the government proposing a new or an amended rule has to carry out an in-depth analysis of a particular technological process using appropriate methods (FTA, ETA, RCT, etc.). The most important outcome of these methods will be the definition of the proper working procedure for given working and technical conditions. If IMO adopts the proposed rule then the embedded working procedure is indirectly adopted as well. Consequently, after some time it can be expected that almost all safety or environmentally crucial working procedures will be defined for the given technical conditions. Therefore, all shipboard procedures making part of the approved ISM system and satisfying particular working and technical conditions will have to be adjusted to the newly-adopted procedure. This process will significantly help the harmonisation of working procedures at the international level.

It can be expected that a wider application of FSA methodology will also influence the standardisation of the co-operation between ships and terminals. Up to now the IMO has not tried to strictly define operational procedures concerning port terminals. Informal standardisation and harmonisation of terminal working procedures have been left to interested groups such as Oil Companies International Marine Forum or International Chamber of Shipping. If the shipboard procedures relating to terminal operations are better defined, through FSA methodology as expected, then the IMO will be forced to take a closer look at terminal working procedures. In the early stage, formal standardisation of highly co-operative operations, such as communication procedures between ships and bulk liquids terminals, is expected.

While admitting that FSA methodology, beside its vast potentials, will bring about a number of decisive issues of which some have been discussed herein, IMO member states decided at the last MSC Meeting to adopt a more conservative, rather than pro-active approach. Therefore, it has been decided to postpone the decision about the implementation of the FSA methodology until the full system, including reporting requirements, and consequences of its application are more clearly defined. However, debates in IMO and a number of articles in professional journals are expected to give rise to wider application of FSA underlying methods in shipping, possibly with numerous positive effects.

5. CONCLUSIONS

The FSA methodology, if applied carefully, will in due time increase the harmonisation of different legal instruments maintained by IMO. Also, it will indirectly stimulate the unification of safety critical working procedures, not only on the ship's side but also on the terminal side. Regarding shipboard working operations, FSA methodology will force ship operators to re-examine their working procedures as a part of the approved ISM system whenever a relevant rule (new or amended) is adopted by IMO applying FSA methodology.

Because of a number of socially and commercially sensitive issues, it can be reasonably expected that introduction of the FSA methodology as part of the IMO rule-making process will be gradual and slow. Consequently, the application of FSA methodology should be expected to take off in specialised subject areas characterised by high-level technology and highly critical safety and environmental operations. If application of the FSA methodology in these fields proves to be effective, then its wider application in other areas of the IMO framework can be expected. Should this occur, full potentials and cumulative positive effects of the applied FSA methodology could be expected after a few years only.

SAŽETAK

UTJECAJ FORMALNE PROSUDBE SIGURNOSTI NA BRODSKE DJELATNOSTI

U radu su u osnovnim crtama prikazana načela Formalne sigurnosne prosudbe (Formal Safety Assessment), novopredložene službene metodologije postupka donošenja pravila i propisa Međunarodne pomorske organizacije. U radu se utvrđuju mogućnosti i nedostaci predložene metodologije i nastoji uočiti najvažnije dugoročne posljedice njezine primjene u međunarodnom pomorstvu i postupcima u svezi s brodovima.

REFERENCES

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2. The trial applications (in the United Kingdom on the high-speed craft and in Germany on novel emergency propulsion and steering devices for oil tankers) can be taken as a clear evidence of expressed expectations.

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