The Contribution of Stability-Related Research to IMO Regulations

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ABSTRACT

From its inception in 1948, the Convention establishing IMO has specified that the first of the three main purposes of the Organization includes "to encourage the general adoption of the highest practicable standards in matters concerning maritime safety and efficiency of navigation". As Chairman of SLF, I see this as meaning that my Sub-Committee is responsible for encouraging research into stability and load line matters and ensuring that, where practicable, the outcomes of that research are reflected in the relevant IMO regulations.

The practicality aspect cannot be over-emphasised with regard to successful regulatory measures based on research outcomes. Clearly, these issues are best addressed, and optimum outcomes achieved, through the cooperative efforts of not only researchers and regulators, but also the industry groups to whom the responsibility for implementation of measures ultimately falls.

But the resulting regulations must be sufficiently robust to provide for uniform safety outcomes, irrespective of who is using the regulations and the tools applied in their implementation.

The procedures adopted by IMO require regulatory results to be produced within a finite time. Accordingly, finalisation of regulations cannot be delayed to await conclusive outcomes from research work, other than in exceptional circumstances.

In order to learn from previous work, I will provide some examples are given of the success or otherwise of the translation of previous research work into IMO regulations.

I will also provide my assessment of the current items on the SLF work programme for which stability-related research is a necessary basis for the resulting IMO regulations.

The key to success in these endeavours is cooperation between researchers, regulators and industry throughout the process of identifying areas of compelling need for action, setting and translating achievable goals, through research, into meaningful improvements to maritime safety.

1. INTRODUCTION

At the outset I would like to thank the organisers for inviting me to this Conference and providing the opportunity to address you at this early stage in the proceedings.

In preparing for the Conference, I scanned the list of committee members and found many familiar names and faces from SLF sessions over the years, so I trust that what I have to say is not too repetitive of views that have been expressed before in relation to IMO and to my

Sub-Committee in particular.

As many of you will know, IMO was founded following a conference held by the

United Nations in Geneva in March 1948 that adopted of the *Convention on the Inter-Governmental Maritime Consultative Organization*. The names of the Convention and the Organization were subsequently changed in 1982.

Notwithstanding amendments over the years reflecting the rise of IMO's roles in relation to environmental protection and maritime security among other things, the first of its main purposes as stated in paragraph (a) of Article 1 of the Convention still includes the words "to encourage and facilitate the general adoption of the highest practicable standards in matters concerning maritime safety and efficiency of navigation".

Is there anything more fundamental to maritime safety than ship stability and subdivision?

As Chairman of SLF, I see the role of the Sub-Committee according to the quoted provision of the Convention as being responsible for encouraging research into stability and load line matters and ensuring that, where practicable, the outcomes of that research are reflected in the relevant IMO regulations. The practicality aspect cannot be over-emphasised if regulatory measures based on research outcomes are to be successful in improving maritime safety.

Clearly, these issues are best addressed, and optimum outcomes achieved, through the cooperative efforts of not only researchers and regulators, but also the industry groups to whom responsibility for the implementation of measures ultimately falls. However IMO, the shipping industry and dare-I-say the communities of our respective countries cannot afford the luxury of the resulting regulations being anything less than sufficiently robust to provide for uniform safety outcomes, irrespective of who is using the regulations and the tools applied in their implementation.

Before attempting to provide something of a report card as to how successful our collective endeavours have been to date, I should provide those of you in the research community who are less familiar with IMO and its processes with some background information.

2. THE IMO REGULATION-MAKING PROCESS

Before looking at the process itself, it is informative to look into actions that follow when IMO makes a regulation. The regulation invariably constitutes an amendment to SOLAS or other convention, so countries who are parties to that convention are required to give legal effect to the amendment through their national law. As most conventions have a "no more favoured treatment" clause, each country's law has to ensure that the convention is applied equally to all ships, regardless of flag and whether or not the flag State is itself a party to the relevant convention.

The government lawyers in many countries, do not generally allow national laws to give effect to conventions "as may be amended" so deliberate legislative action is often required by each country to give effect to a new or amended regulation. This process may include preparation and scrutiny of a "regulatory impact statement" or similar. Given the significant workload for Governments in giving effect to individual technical regulations from a significant number of IMO conventions, and keeping those regulations up-to-date with the latest amendments, it is not surprising that a "compelling need" test is applied to the development of new and amended regulations.

IMO applies such a test to its approval of work programme items through its Guidelines on the organization and method of work of the Maritime Safety Committee and the Marine Environment Protection Committee and their subsidiary bodies, as amended, which I will refer to as "the Guidelines". To gain approval of a work programme item under the

Guidelines, a compelling need must be established, as well as the scope of the work, the potential impact on industry, other affected IMO committees/sub-committees and target completion date identified. Work can only commence following such approval.

I should say that, noting the time required for many stability-related research projects, I do not envisage the Maritime Safety Committee agreeing to a work programme item lasting longer than five years. That is not to say that an item could not be on the work programme for a period while research is being carried out before it is promoted to the agenda, but five years of substantive consideration should be sufficient to bring any item to regulatory conclusion.

In outlining the process I have concentrated on convention regulations, but the same process and the necessity of compelling need apply to development of lower level and non-mandatory instruments such as recommendations and guidelines. In many cases, for example, non-mandatory guidelines are necessary for the uniform international implementation of a regulation. It is only to reduce the complexity of the regulation that this separate explanatory material is developed.

Since the resources of IMO are finite, and are primarily to facilitate achievement of international agreement on standards for mutual acceptance purposes, I must emphasis the target date. If insufficient preparatory work has been completed to facilitate agreement or if there is not enough compelling need for an item to be pressed to conclusion, then that item will take agenda space and "air time" that could be better utilised on other subjects in terms of safety outcomes.

To complete a project by the target date without getting ahead of incomplete underpinning research, it may be necessary to have that research completed and to pre-determine options for regulatory action before the relevant new work programme item is requested, let alone commenced. But such planning may be upset when consideration of the matter commences on the floor at IMO and possible competing views come into play.

As for who in IMO needs to be convinced of the compelling need to work on particular subjects, being a naval architect and long-time regulator I'm probably fairly typical of an IMO delegate working in this area. The regulatory background provides a balance between what is possible in both technical and legal terms and what is practicably achievable from those perspectives. But people like yourselves are the technical experts and of course there's always a lawyer willing to tell a naval architect which end of a ship is which! So my colleagues and I need your technical advice to put into the regulatory mix and in doing so you may need to educate me on some detailed aspects of naval architecture that have evaded me in attempting to cover a broad sweep of subjects at IMO under various sub-committees. I look forward to being educated at this Conference – you will need to take account of the need to demonstrate the relevance of your research outcomes to people like me.

The working arrangements I have outlined have been shown to be effective, in that IMO has responded quickly and positively to emerging priority areas such as bulk carriers, passenger ships and following the casualties to *HERALD OF FREE ENTERPRISE*, *ESTONIA* and, on non-stability matters, *PRESTIGE* and *ERIKA*. It has a reputation as one of the more responsive United Nations agencies, despite occasional public criticism of its bureaucracy.

I should point out that IMO, as an agency of the United Nations, works on a similar funding basis to other UN agencies and the UN itself. Apart from the funds required to maintain the fabric of the Organization, there are no funds available for what might be described as discretionary spending, such as peace-keeping missions or stability-related research projects. For these, the UN and IMO are dependent on the voluntary contributions of

Member Governments and other interested organisations.

To carry out its charter as I outlined earlier, IMO is therefore very much dependent upon voluntary research contributions.

Having laid out the basis of IMO's workload management process, let's examine some examples of research-based regulatory outcomes to give an indication of how we are progressing.

3. IMO BASIC INTACT STABILITY CRITERIA

The basic "Rahola" criteria were adopted by IMO's Assembly as resolution A.167(ES.IV) at its fourth extraordinary session in November 1968. Although expressed to apply only to vessels of up to 100 metres in length, they were from the outset applied to larger vessels by many Administrations and, it must be said, that application has been rather successful in view of the relatively small number of intact stability casualties in subsequent years.

In signing-off on this initial set of criteria, the seventh session of the STAB Sub-Committee (SLF's predecessor) in early 1968 foresaw the need for further investigations of the effect of wind and waves and therefore established an expert group on "external forces" together with an associated research programme dealing with not only wind and wave characteristics but also ship responses through model tests. Although the USSR proposed the first formulation of a weather criterion in 1973, it was not until 1979 that the Sub-Committee papers show a first "agreed" draft in a working paper. Comparative calculations were then carried out as the criterion was refined, firstly using a Japanese proposal and then through a combination of the USSR and Japanese methods. In 1983, at its first session following amalgamation with the Fishing Vessel Panel and subsequent re-naming, SLF agreed to a criterion which was subsequently published as MSC/Circ.346 (with a corrigendum) for further evaluation before being finally adopted by the Assembly as resolution A.562(14). So it took 17 years to get develop and finalise this criterion. However, that wasn't the end of the story.

4. EXPERIENCE WITH THE WEATHER CRITERION

Although the criterion was a recommendation adopted by the Assembly and had been subjected to extensive evaluation, and was subsequently incorporated into the Intact Stability Code resolution A.749(18), it has faced some problems in implementation.

According to some whispers I have heard, these problems have included the criterion being met by ships with negative GM values. Indeed, the comparison document SLF 30/4/3 by the United Kingdom concedes this and, consistent with res. A.167(ES.IV), uses a minimum GM value of 0.15 metres in such cases. While the setting of such a minimum value is entirely logical, it has never been embodied directly within the weather criterion but has subsequently been given effect in the Intact Stability Code through removal of the 100 metre length limit to the application of the basic (Rahola-type) criteria.

Nonetheless, it is my understanding that the proposed mandatory implementation of the weather criterion throughout Europe gave rise to some concern about the standard itself. Accordingly, in 2001 SLF raised to "high" the priority of its work on revision of the weather criterion and the remainder of the *Intact Stability Code*. Given the time and research effort expended in the initial development of the criterion, it is perhaps not surprising that the only significant change that has resulted is the development of guidelines for experimental determination of coefficients applicable to a particular design in place of the standard coefficients. I understand that this alternative

may be particularly useful for passenger ships, where the costs of models and experiments is relatively low in relation to the total cost of the ship.

So, despite the slowness of its birth and the subsequent "bad press" that has acted as something of a barrier to its implementation, it is my assessment that the weather criterion together with the earlier Rahola-type criteria have to be seen as successful regulatory outcomes from research work.

5. HIGH-SPEED CRAFT INTACT STABILITY CRITERIA

Some of you will know that I have since the start of the 1990s been closely involved with the development and implementation of IMO's *Code of Safety for High-Speed Craft (HSC Code)*.

Putting on my Australian hat, particularly in relation to the application of that Code to large high-speed catamarans, I have to say that our concerns related more to the ability of these craft to comply with the Load Line Convention than to intact stability. Nevertheless, the United Kingdom conducted a research project in the early 1990s that resulted in the current *HSC Code*'s intact stability criteria for multihull craft. A further but unsuccessful research project on the same subject was initiated by the United Kingdom in 2001 as part of the just-completed review of that Code. The fact that they saw the need to for further research is perhaps an indication that the present criteria need to be improved.

However, in my opinion the *HSC Code*'s continued use of the IMO weather criterion in respect of monohull craft is of greater concern, as the tabulated coefficients of the criterion

were not developed with this type of craft or anything other than "conventional" dimensional ratios in mind. Nor have the tabulated values subsequently been verified for such craft. To date I am not aware of any problems resulting from using this "stock criterion" approach, but would welcome research that either proves or disproves its validity or validates an alternative approach.

Before leaving this particular topic, I should point out the intact stability standard-setting problems associated with the emergence of trimarans as a significant type of HSC. Trimarans could be renamed "design-your-own-GZ-curve" craft. Accordingly, some may have intact stability characteristics similar to monohulls, while others may be similar to multihulls. Since the distinction between these two categories is blurred in terms of the *HSC Code* stability criteria, this factor may need to be taken into account in further research work.

Concluding this item, I have to say that this is an area in which regulatory and research interests have failed to adequately engage. But the *HSC Code* is scheduled for routine revision in about five years, so the situation I have outlined may represent an opportunity for a research project during the intervening period to feed into that review.

6. OTHER HIGH-SPEED CRAFT ISSUES

When the *HSC Code* was written over a decade ago, there seemed to be no realistic alternative to practical tests to determine operating limitations on those craft, particularly in relation to dynamic behaviours such as directional instability, roll/pitch instability, broaching, bow-diving, coupled pitch and heave (porpoising), reduced transverse stability at speed, chine tripping, ACV skirt-tripping and plough-in, reduced roll stiffness of SES in high-speed turns and resonant rolling in beam seas.

While I do not pretend to be up with the state-of-the-art in CFD, it seems to me from seakeeping simulations I've seen that numerical simulation of these behaviours may

soon be possible as a means of determining whether a craft will experience problems in these areas. If and when this is verifiably so, the relevant software is likely to substantially reduce the cost of model or full-scale tests – in the full-scale case it should also reduce the costs associated with waiting for or seeking sea conditions that corresponding to the worst intended conditions.

Of more immediate interest is the related subject, to be considered for the first time by SLF at its next session, of "guidelines for uniform operating limitations on high-speed craft." These guidelines are intended to secure as far as practicable the same operating limitations for a high-speed craft irrespective of by whom the assessment is conducted. The two-year time-frame of this item represents an opportunity for researchers to contribute to this work.

7. PERFORMANCE-BASED INTACT STABILITY CRITERIA

When the review of the *Intact Stability Code* was commenced in 2002, with an anticipated project life of 5 years, it was intended that development performance- or probability-based stability criteria would be included in the review. However, the time has been consumed with such issues as re-examining the weather criterion and transforming the existing *Intact Stability Code* into a format suitable for giving mandatory effect to the most important provisions, but we are not much closer to describing a performance-based criterion.

Although Germany made a substantial proposal on this subject (SLF 49/5/2) to SLF's session two months ago, there were other competing views expressed. It seems that much more research is required before we can firm-up on the principles for such a criterion, let alone codify those principles into regulations that will produce uniform outcomes irrespective of the person or tools used in their implementation. Nonetheless, I am hopeful that as with the present weather criterion we will eventually achieve a robust regulatory outcome.

8. HARMONISATION OF DAMAGE STABILITY BASED ON PROBABILISTIC PRINCIPLES

Opening this subject reminds me of a conversation with Tom Allan after one of my early SLF sessions, having just been exposed to IMO's work in this area, in which I expressed the hope that the probabilistic damage stability concept would soon enable the old-style floodable length calculation to be deleted from SOLAS.

Having completed work related to the SOLAS'90 provisions at its previous session, in January 1993 SLF 37 commenced work on development of harmonised probabilistic damage stability requirements covering both passenger and cargo ships, which had lain dormant on the work programme for a number of years. Although progress on the project within IMO was slow, it was conducted in parallel with the cooperative research project HARDER which was outside IMO's control but of which SLF was informed in 1994.

I won't go into the details of how either, or indeed both, projects progressed but suffice it to say that funding arrangements for HARDER permitted much greater resources to be applied than to the IMO work. It is fair to say that the robustness of the SOLAS Chapter II-1 amendments that will enter force on 1 January 2009 owes much to the research input from the HARDER project. The floodable length calculation is indeed being phased out in favour of a more flexible and realistic assessment of the effectiveness of sub-division. I am confident that these amendments will stand the test of time notwithstanding the comment I occasionally hear that some of the underlying assumptions have not been borne out.

9. PASSENGER SHIP SAFETY

It was perhaps fortuitous that the damage stability harmonisation project was approaching completion before commencement of the IMO initiative on this subject, concentrating at least initially on "large" passenger ships, since it provided a rational and technologically advanced way of dealing with subdivision and damage stability on coming generations of passenger ships.

Arising from this project has been a work programme item for SLF, to be commenced at our next session, on "time dependent survivability of passenger ships in damaged condition". Whilst the outcomes of calculations of this type already reported to IMO have been useful as tools in determining the adequacy of our damage stability standards for such ships, I will be interested to hear any views you might have on the likely regulatory outputs from SLF's future work on this item.

10. AMENDMENTS TO TECHNICAL PROVISIONS OF THE 1988 LOAD LINE PROTOCOL

SLF started looking at "basic principles for a future revision of the 1966 Load Line Convention" at its 30th session in February 1985. From this first discussion emerged a view that justification existed for revisitation of the basic principles of the Convention itself, with studies of ship motions and deck wetness as a first step, but with studies of the relevance of the 1966 Convention to new ship types also necessary. By 1987 it was agreed that the studies "to modernise the freeboard tables" did not need to provide accurate long-term prediction of deck wetness but that deck wetness was important to evaluation of the effectiveness of conditions of assignment.

Of course, 1988 saw adoption of the Load Lines Protocol, which made only minor amendments to the basis for calculation of assigned freeboards except in relation to the reduced freeboard provisions of regulation 27.

However, by the time the resulting amendments to the 1988 Protocol were finalised by SLF 45 in 2002 (subsequently adopted by MSC in 2003), they did not make any fundamental changes to the method of assignment of Load Lines, but rather were put forward with the comment that "future revision efforts could include" among other subjects "freeboard assignment on the basis of deck wetness for conventional an novel hull forms". So, despite 17 years of effort, attempts to consider this fundamental aspect of freeboard assignment had not brought any result.

The story does not end there. Notwithstanding the agreement at its previous session that revision of the freeboard tables remained a priority in relation to load lines, by it's 48th session in September 2005 SLF had completely lost its appetite for revision of the technical requirements of the Convention/Protocol and discontinued further work in this area.

I would suggest that this outcome might on the one hand represent a failure by both regulators and researchers to collaborate in achieving an appropriate outcome, but on the other it could simply be that the provisions of the 1966 Convention and 1988 Protocol are adequate. I prefer the former in view of technological improvements over the past 40 years and more. However, in the vein of "every cloud has a silver lining" perhaps a researcher proposing to develop a "first principles" approach to ship design could do well to develop appropriate methodology and software to fill the void resulting from this failure.

11. EFFECT OF TONNAGE MEASUREMENT ON SHIP DESIGN AND STABILITY

Those involved in the 1969 Conference tell

me that the potential effect of the *1969 Tonnage Measurement Convention* on ship design, freeboard and stability was pointed out when the Convention was being finalised. Perhaps this knock-on effect was lost in the relief of having a single international tonnage measurement system after so many years of convoluted and competing systems. But it has been brought to the fore again in recent years through consideration of tonnages of open-top containerships and proposals for what I call the "maritime real estate" approach to tonnage measurement.

At its session two months ago, SLF was advised of a long-term voyage simulation conducted by the Netherlands into the loss of the containership *DONGERDIJK*, which demonstrated the effect of the Tonnage Convention in reducing the levels of stability reserves and thus of safety.

It is somewhat disappointing that the trigger for IMO to commence work in this area has not come from the research sector and that we do not have more research reports on which to base development of options to overcome these safety problems. We have to hope that perhaps some delegations will contribute their research when SLF commences work on developing options at its next session in April-May 2007.

12. IMPACT OF OPEN WATERTIGHT DOORS UPON SURVIVABILITY

Another item on which discussion is proposed and can hopefully be concluded at the next session of SLF is the development of guidelines on the impact of open watertight doors on survivability under regulation 22.4 of the revised SOLAS Chapter II-1. This item will have two parts, namely the conditions under which watertight sub-division doors may remain open during navigation and the survivability aspect.

I expect that researchers may be able to assist the Sub-Committee by submitting calculations that quantify the effect on the attained index of leaving individual doors open.

13. CONCLUSIONS

Most of the examples of completed work that I have outlined took much longer to complete than initially expected, or failed to deliver fully on the expected outcomes when the time came to bring the subjects' consideration to a close.

While some of the outcomes have been, or are expected to be, technical successes, too many have started off with high expectations only to fall short of the mark in terms of a suitable research basis for development of regulations or simply through exhaustion from attempting an unattainable goal. Maybe SLF's initial expectations were unrealistically high, or maybe between researchers and regulators we were collectively over-optimistic as to what might be achieved.

Perhaps what is required is more consultation between researchers and regulators at an early stage of each research/regulatory project. This Conference provides a perfect stage on which to progress such discussions and consultations. But, to avoid excessive expectations, it is most important that those discussions should be free and frank so that we can collectively develop a realistic picture of the likely outcomes and that the resulting regulatory outcomes achieve the required standard of robustness.

I have identified areas in which researchers can provide meaningful contributions to forthcoming items on the Sub-Committee's agenda and look forward to any contributions that you make being submitted through your respective Administrations and/or accredited observer organizations.

It is important to recognise that IMO cannot provide funding for research, which must be

contributed on a voluntary basis.

While IMO's established procedures might at times appear overly bureaucratic, they are necessary for establishment of priorities, workload management and avoiding unjustified regulatory burden on Member Governments and the shipping industry.

The key to success in our endeavours is cooperation between researchers, regulators and industry throughout the process of identifying areas of compelling need for action, setting achievable goals and translating those goals, through research, into meaningful improvements to maritime safety.

I would like to thank the organisers once again for inviting me to give this address and look forward to participating in your discussions with a view to promoting the necessary research input into SLF's work.