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COVER NOTE

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to:	Mr Uwe CORSEPIUS, Secretary-General of the Council of the European Union
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Subject:	COMMISSION STAFF WORKING DOCUMENT For the Council Shipping Working party IMO – Joint EU submission and related Commission submission concerning proposals to improve the SOLAS 2009 damage stability regulations for ro-ro passenger ships, to the 55th session of the Stability and Load Lines and Fishing Vessels Safety (SLF 55) meeting in London from 18-22 February 2013

Delegations will find attached Commission document SWD(2012) 378 final II.

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II

COMMISSION STAFF WORKING DOCUMENT

For the Council Shipping Working party

IMO - Joint EU submission and related Commission submission concerning proposals to improve the SOLAS 2009 damage stability regulations for ro-ro passenger ships, to the 55th session of the Stability and Load Lines and Fishing Vessels Safety (SLF 55) meeting in London from 18-22 February 2013

SUB-COMMITTEE ON STABILITY AND LOAD LINES AND ON FISHING VESSELS SAFETY
55th session
Agenda item 7

SLF 55/7/xx
date
Original: ENGLISH

REVISION OF THE DAMAGE STABILITY REGULATIONS FOR RO-RO PASSENGER SHIPS

Changes to the s_i formulation

Submitted by Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, the United Kingdom and the European Commission

SUMMARY

Executive summary:	This document proposes changes to the s_i formulation to estimate the effect of water on deck when it occurs on ro-ro passenger ships.
Strategic direction:	5.1
High-level action:	5.1.1
Planned output:	5.1.1.2
Action to be taken:	Paragraph 25
Related documents:	SLF 55/INF.??; SLF 55/INF.??; SLF 45/3/3; SLF 46/INF.6; SLF 52/11/1; MSC 84/22/12; SLF 52/WP.3; MSC 91/7/2

Introduction

1. This document proposes changes to the s_i formulation to estimate the effect of water on deck when it occurs on ro-ro passenger ships. The proposals are based on extensive research projects that have been performed in the EU and specific design experience to contribute to this agenda item of the SLF Sub-Committee.

Background

2. Following a proposal in (MSC 84/22/12), MSC 84 agreed to include a high priority item on "Damage stability regulations for ro-ro passenger ships" in the Sub-Committee's work programme.

3. The Sub-Committee, at its 52nd session, noted the general view of the SDS Working Group that more research and evaluation of further studies were important and necessary

before considering any possible additional measures. Following a request by the Sub-Committee, MSC 89 agreed to extend the target completion for this item to 2013.

4. The Sub-Committee at its 53rd session, instructed the SDS Correspondence Group to further consider the impact of the SOLAS 2009 amendments on ro-ro passenger ships, as compared to the SOLAS 1990 regulations in association with the Stockholm Agreement, taking into account document SLF 52/WP.3, and any research results in the matter as they become available.

5. The Sub-Committee at its 54th session instructed the SDS Correspondence Group to further consider potential damage stability deficiencies on ro-ro passenger ships under SOLAS 2009 requirements and develop amendments as considered necessary.

First study commissioned by EMSA

6. In July 2009 the final report of the first study, commissioned by the European Maritime Safety Agency (EMSA), on ro-ro passenger vessels[1] was published. This study was carried out by the Hamburgische Schiffbau-Versuchsanstalt GmbH (HSVA) and inter alia concluded that "*The results computed by HSVA for the ships EMSA1 and EMSA2 designed according to SOLAS 2009 […] further confirm the discrepancy between the model test data for RoRo or RoPax -ships and the formulation for s_i used in SOLAS 2009 corresponding to conventional ships. In view of the significant difference between the mainly closed vehicle decks of RoRo ships and open decks in conventional ships, from which water can easier escape, the difference in the survivability is certainly expected.*"

7. As a result of the above mentioned results, HSVA said that "*An elementary but perhaps a premature way to improve the situation would be to elevate the TGZ_{max} value for RoPax ships from the present 0.12 to the more proper value of at least 0.25.*"

8. In the final report the HSVA Consortium proposed to leave the damage stability rules in SOLAS 2009 in their present form and to develop an additional, separate Water-on-Deck (WOD) criterion for ro-ro passenger ships. Further information can be found in the final report which was made available to the members of the SDS Correspondence Group during SLF 52.

Second study commissioned by EMSA - s_{UoS}

9. In December 2011 the final report of the second study, commissioned by EMSA, on ro-ro passenger ships was published[2]. The objective of the second study, which was led by the Ship Stability Research Centre (SSRC) of the University of Strathclyde (UoS), was to propose possible amendments of the SOLAS 2009 damage stability requirements such that the WOD problem of ro-ro passenger ships is taken into account and to identify potential damage stability issues.

10. The results of the UoS study were presented in the margins of SLF 53. With regards to the WOD issue, UoS concluded inter alia that "*it would appear that all the conceptual elements of the construct (1) [referring to the s_i formulation] are robust and accommodative*

[1] HSVA – Seakeeping and Manoeuvring Final Report Part I (Nº 1669) – Research for the Parameters of the Damage Stability Rules including the Calculation of Water on Deck of Ro-Ro Passenger Vessels, for the amendment of the Directives 2003/25/EC and 98/18/EC. The report may be downloaded from http://www.emsa.europa.eu/news-a-press-centre/external-news/weblink/21/1457/1.html

[2] UoS – Study of the specific damage stability parameters of Ro-Ro passenger vessels according to SOLAS 2009 including water on deck calculation – Project no EMSA/OP/08/2009. The report and its annexes may be downloaded from http://emsa.europa.eu/implementation-tasks/ship-safety-standards/items/id/1457.html?cid=92

for the purpose of assigning probability s for survival for some 10 hours in any sea conditions that might be encountered in a collision incident, even though achieved by various degrees of mutually cancelling approximations."

11. Based also on the findings of the HARDER project[3], the UoS specifically proposed "*to adopt a conservative margin in assessing H_{crit} by modifying parameters […] to GZ_{max} = 0.25m and Range = 25deg, which would result in some 90% of all existing data to have been satisfactorily predicted".*

12. In order to demonstrate the above statement, UoS provided the following figures. In these figures the theoretical critical wave height, as calculated by the two formulas (current SOLAS 2009 and proposed), is compared against the critical wave height measured in model tests.

$$Hs = 4 \cdot \frac{GZ_{\max}}{0.12m} \cdot \frac{RANGE}{16\deg}$$

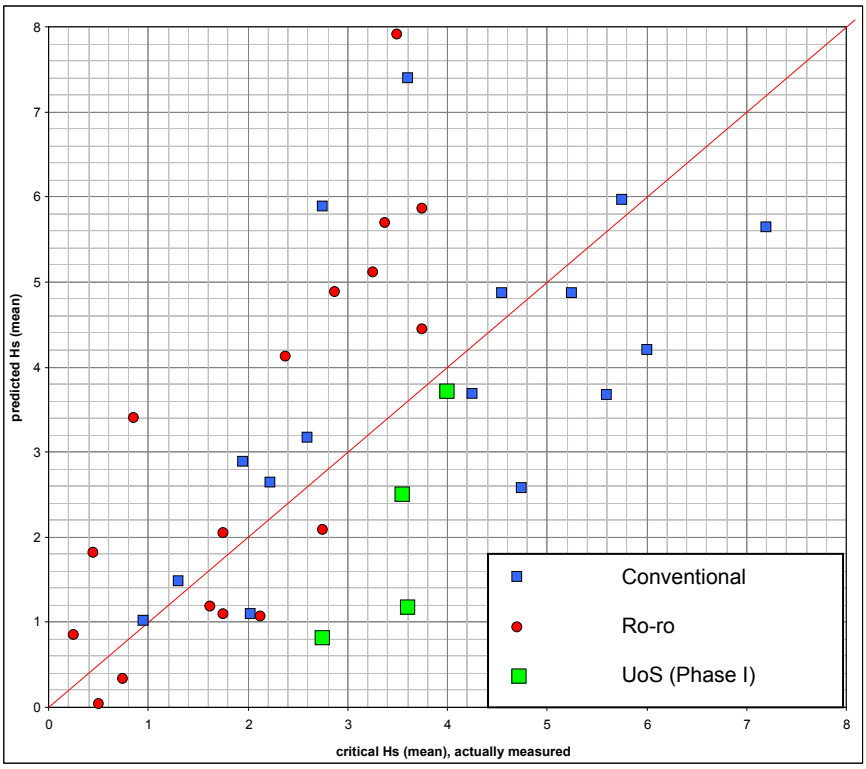

Figure 1 - Theoretical and experimental critical sea state values for conventional and Ro-Ro / Ro-Pax ships (SOLAS 2009 formulation)

[3] Cantekin Tuzcu and Sigmund Rusaas, - Recommended new harmonized probabilistic damage stability regulations – factor s, HARDER No: GRD1-1999-10721, 2003-05-31

$$Hs = 4 \cdot \frac{GZ_{\max}}{0.25m} \cdot \frac{RANGE}{25\deg}$$

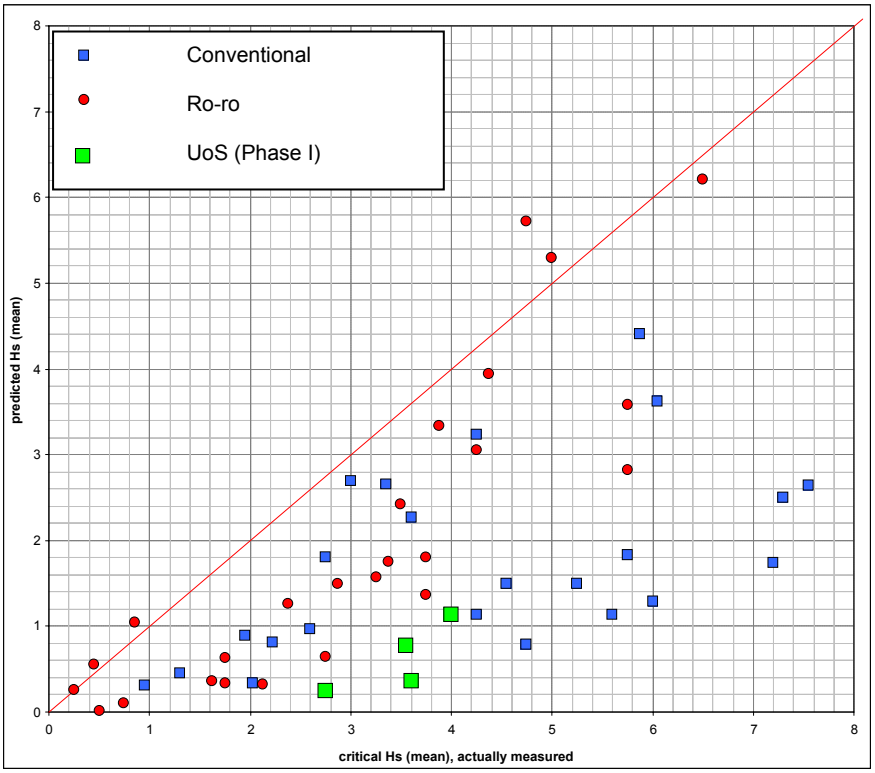

Figure 2 - Theoretical and experimental critical sea state values for conventional and Ro-Ro / Ro-Pax ships (proposed formulation)

13. It can be seen in these figures that the formulation of s_i, proposed by UoS, would ensure that for ro-ro passenger ships (circles on the figures), the critical wave height is underestimated in the majority of the damage cases. That means that the critical wave height calculated using the UoS formulation is lower than the measured wave height from model tests, which will generally (some degree of uncertainty is inherent in the model tests) represent realistic conditions.

Alternative proposal for an additional coefficient – s_{WOD}

14. During the subsequent internal discussions with experts within the EU an alternative solution has been proposed, namely a different s_i formulation based on design experience, with the objective to address the impact of accumulated water on deck by means of "*an amendment to SOLAS II/1 to reduce the risk of rapid capsize for roro passenger ships*" (SLF 55/INF. XX).

15. It is proposed to include an additional s_{wod} coefficient that will achieve an improved level of survivability only in damage cases where a vehicle deck is penetrated as follows:

$$s_i = \min (s_{intermdiate};\ s_{final} * s_{moment} * s_{wod})$$

16. The formulation of this coefficient was guided by the intact stability criteria as follows:

$$S_{wod,j} = \left[\frac{GZ_{max}}{0.2} \cdot \frac{Range}{20}\right]^{\frac{1}{4}}$$

17. Numerical calculations for 8 ship designs were made, and, after comparing the GM values for each design, concluded that "*for both damage cases the regulation 8 and the*

SOLAS90 requirements are of the same magnitude, while the new proposal is closer to the water on deck [Stockholm Agreement] GM requirement." (see also Figure 3)

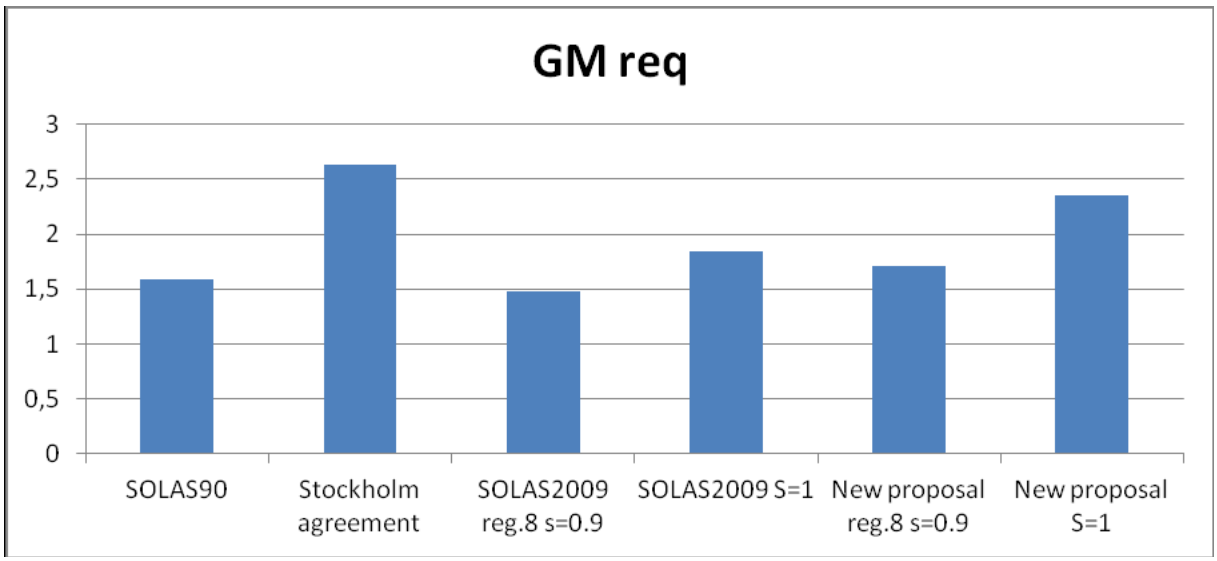

Figure 3 - Comparison of mean GM requirements

18. It was concluded - inter alia - that "*The proposals to introduce a special s-factor to be used for any damage including the car deck may bring special attention of the ship designers to these damages and the introduction of side casings is a likely solution*" and that "*the results seems to be consistent and the method is robust*", while also suggesting that wider validation should be carried out.

GOALDS study

19. It is understood that the GOALDS study, which is about to be published, will make a holistic proposal on damage stability. However it will introduce a new concept to be applied in addition to the current regulations and so is not considered here.

20. Nevertheless, significant work on the damage stability of ro-ro passenger ships was carried out with extensive model testing of two designs by HSVA[4]. A summary of the model test results together with the numerical calculations according to SOLAS 2009, the UoS and the alternative proposal can be found in Table 1.

Design	GZ_{max} (m)	Range	H_s model test (m)	H_s SOLAS2009 (m)	H_s UoS (m)	H_s alternative (m)
R2 KG1	0.236	47.6˚	3.6	above 4m	3.776	above 4m
R2 KG2	0.151	21.9˚	2	above 4m	2.116	3.020
R1 KG1	0.178	15˚	4.3	3.75	1.709	2.503
R1 KG2	0.152	13.8˚	3.6	3.45	1.342	1.809
R1 KG3	0.126	12.5˚	2.9	3.125	1.008	1.230

Table 1 - Comparison of critical wave heights based on model tests and numerical simulations

21. Although no specific conclusions can be drawn from such a small sample, it can be observed that:

[4] Dr. Petri Valanto, 'Damage Stability Tests at the HSVA with RoPax R2 & R1' public presentation, Oslo 2011

1 SOLAS 2009 overestimates the survivability of R2 designs and R1KG3;
2 The UoS proposal is close to the performance of R2 designs, but still overestimates their survivability while underestimating that of R1 designs;
3 The alternative proposal overestimates the survivability of R2 designs while underestimating that of R1 designs.

Analysis of the s_i formulation

22. The s_i formulation of SOLAS 2009 estimates the probability of surviving damage in calm waters, but it is modified by the denominators to provide additional safety to compensate for the effect of waves. In the case of water on vehicle decks however, additional dynamic phenomena occur that may lead to the capsize of ro-ro (passenger) ships more frequently than on other conventional vessels. The research indicates that the survivability of ro-ro passenger ships may be overestimated by the s_i formulation of SOLAS 2009.

23. The formulation of s_i is a practical device that should estimate the physics involved as closely as possible, not only catering for the dynamic effect of waves on ro-ro passenger ships but also estimating the effect of reduced survivability when water on (vehicle) decks (WOD) occurs.

24. It is concluded therefore that the formulation of s_i in SOLAS 2009, should be modified to estimate the effect of water on deck when it occurs.

Proposals

25. As described above, there are two main proposals to modify the formulation of s_i to estimate the effect of reduced stability when WOD occurs. The UoS denominators of 0.25m and 25˚ have been extensively tested several times in the past, while the alternative proposal has to be seen as a practical approach based on design experience and guided by intact stability criteria and which is only applied in damage cases that involve a vehicle deck.

26 During the discussions mentioned above a further concept was suggested concerning the reintroduction of some level of residual freeboard following damage in order to allow a margin for the survival uncertainties associated with both s_i and a flooded or partially flooded bulkhead deck, particularly for ro-ro passenger vessels and in consideration of the longer term viability of a ship for the assessment of safe return to port.

Action requested of the Sub-Committee

27. The Sub-Committee is requested to:

1. agree in principle that the s_i formulation should estimate the effect of WOD when it occurs; and

2. instruct the SDS working group to consider the proposals in this document as well as the concept concerning residual freeboard and the INF papers referred to herein, and make a proposal for the s_i formulation that will adequately estimate the effect of reduced stability of ro-ro passenger ships when WOD occurs.