

SLF 52 Agenda Item 11

“Damage Stability Regulations for Ro-Ro Passenger Ships”

Round 2 – including the Results of the Round 1 Questionnaire and a new discussion paper and questionnaire

Developments since Round 1

1. Since round 1 was sent out a number of requests have been received to join the correspondence group so an updated list of members is included with this paper for your information. For the benefit of these new members, this round will encompass the terms of reference, the complete round 1 discussion paper and responses received from member states.
2. The following new papers have been added to the web-site and they can be accessed on <http://www.mcga.gov.uk/c4mca/imosdscg.htm>.
 - C14A RP592 Final Powerpoint Presentation (UK/NL)
 - C15 RP592 Final Report.pdf (UK/NL)
 - DENMARK1 Paper on SOLAS 2009 and Stockholm Agreement
 - EU1 COSS Summary Record for European Parliament
 - ITALY2 Comparison of RoPax Designs, SOLAS90+SA vs SOLAS 2009
 - C16 Supplementary Calculations on C15 for ships with long lower holds
3. For the benefit of everybody, especially the new CG members, here is a full account of what has happened so far. The round 1 discussion paper and questionnaire were sent out on 2 October 2008 inviting replies by 19 December 2008. However, there was a strong feeling expressed in writing and verbally by many members that we needed to see the results of the latest research projects before we could properly comment on the important issue of whether or not SOLAS 2009 adequately covers the problem of water on deck. Most of the studies done up till that time (all available on the above MCA web-site) applied to existing ships designed to comply with SOLAS90 and the Stockholm Agreement. We really needed to see what sort of ships could be designed using SOLAS 2009 only. The deadline was therefore removed until at least some of the results of these new projects became available. Some countries did provide official comments on the round 1 questionnaire, however, and these are shown below.
4. In the meantime pressure was building on the European Commission for a decision on the future of the Stockholm Agreement, which the majority of member states felt need no longer be applied to new ro-ro passenger ships with keels laid after 1st January 2009. A meeting of COSS (Committee on Safe Seas and the Prevention of Pollution from Ships) was therefore held on 12 - 13 of November 2008 in Brussels. This was followed by a technical experts meeting on 11 December 2008, at which attempts were made to draft a new set of requirements within the EU ro-pax ship stability Directive

combining compliance with the SOLAS 2009 amendments and the Stockholm Agreement, as there was now sufficient concern being expressed by some members as to whether it was safe to revoke the Stockholm Agreement from 1st January 2009.

5. Denmark produced a paper arguing that it would be preferable to use only a probabilistic approach rather than combining probabilistic and deterministic methods and made some proposals for amending SOLAS 2009 accordingly. Denmark has kindly agreed that this paper be made available for us to study (see DENMARK1 on the MCA web-site).

6. The Danish paper was presented and discussed at the next COSS meeting held on 3 February 2009 which was preceded on 2 February by a technical meeting where final attempts were made to produce an acceptable set of requirements within the EU directive which combine SOLAS 2009 and the Stockholm Agreement. After much debate, the chairman of COSS finally decided that there was insufficient agreement on the draft text, so the final decision was that new (post 1 January 2009) ro-ro passenger ships should continue to comply with the Stockholm Agreement (including the model test option) in addition to SOLAS 2009. It was left to individual member states to decide how this decision should be implemented but Member States were to abide by a commonly agreed table of legislative requirements applicable according to the date of construction and class of ro-pax ship concerned.

7. The basis of this decision by the European Commission was that there remained too much uncertainty surrounding the overall safety of SOLAS 2009-designed ro-ro ships to justify revoking the Stockholm Agreement. It was agreed that this is not an ideal situation as it would be preferable for all concerned to be able to take advantage of the flexibility of design offered by SOLAS 2009 on its own. The EC therefore urged IMO to address the concerns and try to provide further re-assurance that SOLAS 2009 on its own can be safely applied to ro-ro passenger ships and further research was encouraged. The summary of the February meeting of COSS is included on the MCA web-site for information (Ref. EU1 - see paragraph 3.1.2 where the withdrawn draft Commission proposal referred to was the attempted new set of requirements combining SOLAS 2009 with the Stockholm Agreement).

8. Turning now to the new research work – we have the results of 2 projects on the web-site to consider - C14A (Powerpoint presentation) and C15 (technical paper) from the jointly-funded UK/NL project (RP 592) and ITALY2 from EUROYARDS. The results of a third major project sponsored by EMSA and being undertaken by HSVA in Hamburg are expected at the end of June. As time is pressing on it is felt that we could now make a “re-start” by formally seeking your opinion on C14A, C15 and ITALY2; we can set a deadline towards the end of July for your responses to these first two papers and, hopefully, the EMSA paper too so that we can start to work towards presenting our findings to SLF 52 next January. For your information the objectives of the EMSA project are shown below.

Invitation to tender N° EMSA/OP/09/2008 concerning

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.

2. Objective, scope and description of the contract

The purpose of the contract is to obtain a study intended to facilitate the decision of the rule makers and amendment of the European Union Directives as follows:

- Annex I and II of the Directive 2003/25/EC, as amended.
- Annex I of the Directive 98/18/EC, as amended.

The study will provide the state of the art of regulatory provisions for the calculation of damage stability of ro-ro passenger vessel. For the purpose of this tender specification regulatory provisions for the calculation of damage stability of ro-ro passenger vessels are:

- International instruments. International instruments shall mean the relevant international conventions, the relevant resolutions and circulars of International Maritime Organization (IMO) and the relevant international testing standards.
- International conventions. International conventions shall mean:
 - The 1966 International Convention on Load Lines (LL66), as amended,
 - The 1972 Convention on International Regulations for Preventing Collisions at Sea (COLREG), as amended,
 - The 1973 International Convention for the Prevention of Pollution from Ships (MARPOL), as amended, and,
 - The 1974 International Convention for the Safety of Life at Sea (SOLAS), as amended.

The study will be based on the tests carried out in the ship laboratory of the contractor according to the testing programme informed in point 2.3.

The expected outcome is a study containing suggestions for index A parameter(s) S_i (possibly also p_i , v_m) under IMO SOLAS 2009, Ch.II-1, Reg.7-2 Damage Stability Rules, to address the issue of accumulated water on deck for ro-ro passenger ships in hull damage and range of natural conditions corresponding to Stockholm Agreement rules, as minimum.

For the guidance of non-EU members, directive 2003/25/EC, above, covers the implementation of the Stockholm Agreement and 98/18/EC is the directive which implements SOLAS into European legislation, including domestic passenger and ro-pax ships.

Of course, you need not restrict your comments to these research projects only – your general views or results from your own studies, projects and designs would be of great help and interest to us all in our deliberations.

9. You will also be interested to know that there is another relevant EU funded research programme starting up this autumn – GOALDS (**GOAL**-based **D**amage **S**tability). It is a long term project, the results of which will unfortunately not be available to us before we meet at SLF 52 but a project abstract is given below for your information:-

“The new probabilistic damage stability regulations for dry cargo and passenger ships (SOLAS 2009), which entered into force on January 1 2009 represent a major step forward in achieving an improved safety standard through the rationalization and harmonization of damage stability requirements. There are, however, serious concerns regarding the adopted

formulation for the calculation of the survival probability of very large ROPAX and cruise vessels; thus eventually of the Attained and Required Subdivision Indices for passenger ships. Furthermore, present damage stability regulations account only for collision damages, despite the fact that accident statistics, particularly of passenger ships, indicate the profound importance of grounding incidents.

The aim of the proposed research project is to address the above issues by:-

- Improving and extending the formulation introduced by MSC 216 (82) for the assessment of probability of survival of ROPAX and cruise ships in damaged condition based on the extensive use of numerical simulations.*
- Performing extensive model testing to investigate the process of ship stability deterioration in the damaged condition and to provide the required basis for the validation of the numerical simulation results.*
- Elaborating damage statistics and probability functions for the damage location, length, breadth and penetration in case of a grounding accident based on a thorough review of available information regarding grounding accidents worldwide.*
- Formulating a new probabilistic damage stability concept for ROPAX and cruise ships, incorporating collision and grounding damages, along with an improved method for calculation of the survival probability.*
- Establishing new risk-based damage stability requirements for ROPAX and cruise vessels based on cost/benefit analysis to establish the highest level for the required subdivision index.*
- Investigating the impact of the new formulation on the probabilistic damage stability evaluation of passenger and ROPAX ships.”*

10. To help us get started on this task here are the conclusions of the two new papers on which we would like your opinions at this stage:-

10.1 EUROYARDS PAPER (ITALY2); Conclusions

10.1.1 The application of the uniform method to calculate SOLAS90+SA ships and SOLAS2009 ships has shown that for most of the analyzed ships SOLAS2009 give higher GM requirements than for SOLAS90 and the Stockholm Agreement. However for smaller ships with less number of persons on board the requirements for SOLAS2009 may be less demanding than the previous requirements. This is the result of the political decision of MSC78, where the general tendency of the required index formula has been decided and it was admitted that high attained index observed on small ships was not justified.

10.1.2 The major impact of the Stockholm Agreement to SOLAS2009 designs is the B/5 penetration and the possibility within SOLAS2009 to locate a large lower hold outside the B/5 line, up to B/10 to the hull. In such a case any B/5 damage causes a much worse flooding scenario and higher GM requirements as with lower holds limited by B/5 bulkhead. However, these

situations for which required GM to fulfil Stockholm Agreement is higher than this necessary to obtain the required index for SOLAS 2009 are observed for a limited number of damage cases, otherwise the required index would not be attained. Also the effect of the lower hold as such may be worth for further research.

10.1.3 Although it seems for the majority of ships investigated in this study that SOLAS2009 requires higher GM values, the question of the ToR for the ISCG, whether SOLAS2009 will provide at least an equivalent level of safety for ropax vessels as the previous rules is difficult to assess as the definition of safety level might be interpreted in a different way. However, taking into account that the new SOLAS2009 requirements are based on a probabilistic approach, which means by its nature that individual designs may differ from the mean safety level, the result of this investigation shows that generally, with the new regulations, at least an equivalent level of safety has been achieved in comparison with SOLAS 90 + Stockholm Agreement.

10.1.4 In any case this study gives evidence that the new damage requirements may lead to lesser stability requirements than before only for some specific designs. It may be a good advice to the CG to concentrate on those specific details, which are ships with a smaller number of persons on board and lower holds extending up to the B/10 line and to discuss possible consequences.

10.2 UK/NL PROJECT RP592 PAPER (C15); Conclusions

10.2.1 During the course of this project, outlines of two Ro-Ro ship type designs, Ship 1 and Ship 2, were developed and optimised for compliance with the SOLAS'09 regulations. A range of limiting KG curves was derived for various stability regulations, and advanced analyses of ship survivability were performed.

10.2.2 Of the two ships, Ship 2 offers some **16%** more of easily accessible Ro-Ro space than Ship 1, which renders this design solution very attractive commercially, although the exact benefit has not been quantified. This gain would be somewhat mitigated by the 1.17m higher GM value required by Ship 2 at deepest draught to comply with SOLAS'09, in comparison with the GM of Ship 1. In addition, Ship 2 offers superior protection of vital ship systems from the effects of collision.

10.2.3 It was shown that modification to the formulation of the "s factor" of SOLAS'09, by replacing $GZ_{\max}=0.12$ with a value of 0.25m, representative of Ro-Ro data on survivability, would lead to reduction of Index A of approximately 1%. Therefore it would be advisable to make this amendment to the "s" formulation, to be consistent with the HARDER data; the impact on the value of Index A, at least for the designs considered in this study, would not be very great, but there remains a possibility that it could be more significant for other designs.

10.2.4 It was found that the instrument for stability provision SOLAS'09, as adopted at MSC216 (82), allows for consistent provision of survivability in line with its adopted measure, the Index R. Two distinctively different ships designed to the same R would display the same survivability as verified by numerical simulations.

10.2.5 On the other hand, it was also confirmed that the requirements of SOLAS'95 (Stockholm Agreement) are the most stringent regulations on damage stability available at present (especially at deepest draughts).

10.2.6 However, it was found that the level of survivability implied in SOLAS'95 is not consistent for different ship designs, with some commercially attractive solutions rendered as prohibitive, even though the overall level of survivability between them was found through alternative techniques to be highly comparable.

10.2.7 Therefore, it would seem advisable that the stability level of SOLAS'95, be maintained on the basis of different, more holistic requirements. It was proposed and demonstrated that by ensuring that $A_{DS} = A_{DL} = A_{DP} \geq R$, or that $A \geq R$ for any draught, the level of survivability implicit within SOLAS'95 would be preserved. It is not inconceivable that other solutions are possible.

10.2.8 However it was also confirmed that compliance with either standard, SOLAS'95 or SOLAS'09, does not ensure survival in **all** feasible collision flooding cases. Indeed, in SOLAS'09, some **(1.0 - R) percentage** of flooding cases a typical ship may suffer in a collision, are allowed to be completely non-survivable, with zero or only marginal level of stability - insufficient to withstand the impact of higher sea states!

10.2.9 It would therefore be advisable to revise the goals of the SOLAS convention to amend this serious vulnerability to the possibility of rapid capsizing.

THE NEXT SECTIONS ARE MAINLY FOR THE BENEFIT OF NEW MEMBERS OF THE CORRESPONDENCE GROUP AND COMPRISE THE FOLLOWING:-

Terms of Reference

Round 1 Discussion Paper

Round 1 Questionnaire with Responses

List of Reference Papers available at the time on the MCA web-site (see paragraph 2 above for new additions)

FOR LONGER-TERM MEMBERS OF THE CG ONLY THE RESPONSES TO THE ROUND 1 QUESTIONNAIRE ARE NEW SO YOU MAY WISH AT THIS POINT TO GO STRAIGHT TO THE ROUND 2 PAPER/QUESTIONNAIRE AT THE END

Terms of Reference

1. Taking into account discussions in plenary at SLF51 and documents MSC 84/22/12 and MSC 84/22/23 the correspondence group is instructed to:
 - 1.1 examine the impact of the damage stability requirements of the SOLAS 2009 amendments on ro-ro passenger ships, in comparison with the SOLAS 1990 regulations in association with the Stockholm Agreement;
 - 1.2 define criteria to be used for the evaluation of the two approaches and determine whether the level of safety between them is generally equivalent;
 - 1.3 assess existing and new studies on the subject as well as design experience;
 - 1.4 if it is found that safety levels are not generally equivalent, identify possible rectification measures; and
 - 1.5 submit a report to SLF 52 under the agenda item "Damage stability regulations for ro-ro passenger ships.
2. In this connection, the Sub-Committee encouraged all parties that have carried out studies on the subject to forward relevant information to the above correspondence group.

SLF 52 Agenda Item 11

“Damage Stability Regulations for Ro-Ro Passenger Ships”

SDS Correspondence Group – Round 1 Discussion Paper

Please note that the referenced documents are all available on the MCA web-site:- <http://www.mcga.gov.uk/c4mca/imosdscg.htm>

A brief summary of each document is given at the end of this section.

1. Background

1.1 It is generally recognised that the new harmonized probabilistic damage stability regulations coming into force on 1st January 2009, presently contained in IMO MSC.216(82) (**Ref. B1**) with Explanatory Notes (**Ref. B2**) and referred to in this document as SOLAS 2009, represent a major step forward in assessing the survivability of passenger and cargo ships after damage. Not only will the new regulations offer designers much greater flexibility in arranging the subdivision of their new vessels, with the attendant possibility of improved layouts resulting in more economic operability, but also the resulting designs will be subjected to a much more rigorous and detailed analysis of their damage stability characteristics.

1.2 Calculation of the Attained Index, “A”, will give a measure of the survivability of different designs, enabling Owners to compare their relative merits in a way not possible with the current prescriptive regulations where the degree of compliance is not readily quantifiable. The probabilistic regulations used in SOLAS2009 also provide a pathway to a more risk-based approach to design, and experience in their use will eventually establish clear links between the “R” or “A” index and the attendant level of risk associated with each design.

1.3 In recognizing all these advantages of the probabilistic approach to damage stability, including particularly the benefits of analyzing new designs more thoroughly, we must equally be absolutely certain that the new regulations offer at least an equivalent overall level of survivability as the existing prescriptive regulations, which have evolved over a number of years, often, regrettably, as a result of accidents leading to heavy loss of life.

1.4 It was a main requirement of the new regulations that this equivalence would be maintained and to this end a potential loophole in the probabilistic regulations, whereby shallow raking damage to a passenger ship could cause a major casualty, was closed by the insertion of a deterministic regulation (Reg. 8). Regulation 9, covering double bottom designs, also has a deterministic element.

1.5 In setting the appropriate level of R for larger passenger ships by regression analysis of the results of Attained Index A for existing SOLAS90-compliant ships, it was found that the survivability levels were unexpectedly

low for longer vessels. The downward slope of the plot of R against ship length had to be adjusted to an upward sloping line to ensure consistency with the underlying philosophy that the larger the ship the safer it should be. It turned out that this unexpected result was partially attributable to the fact that the SOLAS90 assumed damage length was inappropriately low for longer vessels; this demonstrated one of the benefits of the new probabilistic method which requires a more thorough analysis of the design over greater assumed damage lengths and penetration depths.

1.6 Given that ro-ro ships are known to be specially prone to rapid capsizes following the flooding of the large open vehicle deck space and taking into consideration the concerns expressed in MSC 84/22/12 (**Ref. B3**) and MSC 84/22/23 (**Ref. B4**) resulting in MSC 84/24 paragraph 22.59 (**Ref. B5**), further investigation of these important issues by the CG would be most welcome.

2. Proposed Work Programme for Addressing the TOR

TOR 1.1

The UK and Netherlands commissioned a research project, RP592, in December 2007 which is almost complete and which attempts to assess the impact of the 2 sets of regulations on ro-ro passenger ship design. The specification for the project is on the web-site (**Ref. C13**) as is a Powerpoint presentation of the initial findings (**Ref. C14**). Full results of this project will be made available to the CG at the earliest opportunity.

The concerns which led to us commissioning this research were primarily the following:-

- 2.1 SLF 45/3/3 (**Ref. A2, page 24**) states that for ro-pax ships a GZ_{max} of 0.25 m should be used when calculating “s” in new Regulation 7-2. We wanted to know if the use of GZ_{max} 0.12 m in S2009 was a mistake and if so what impact it would have on the calculation of “A”. Further background to this can be found in (**References A3 and A8**). The latter reference is an MCA internal memorandum and adds more data points to the Mean H_s - GZ_{max} curves shown in (**Ref. A3 (fig. 1)**). It clearly shows the contrast between ro-ro passenger ships which comply with SOLAS90 only and those which have been upgraded to comply with the Stockholm Agreement. The latter points fit quite well with the GZ_{max} 0.12 metres H_s -mean 4.0 metres regression line typical of passenger ships, indicating how effective the Stockholm upgrades are in reducing the adverse effects of WOD.
- 2.2 We were worried about the $s=0$ cases, particularly those involving high probability damages to an undivided vehicle deck space which experience has shown often lead to rapid capsizes. In the probabilistic method, such cases can be “ignored” as long as “A” is ultimately greater than or equal to “R” but such “ignored” cases could lead to heavy casualties in ro-ro passenger ships. For “s” to be 0, either residual GZ (hence range) would need to be zero or the final

equilibrium heel angle greater than 15 degrees. If a ro-ro passenger ship were to suffer a high-probability side damage involving the vehicle deck would it be defensible in an inquiry to argue that we knew such a straightforward damage would almost inevitably result in rapid capsizing with potentially heavy loss of life but was not further considered because the overall damage stability met an internationally agreed standard ($A=R$)?

- 2.3 We were concerned that residual freeboard does not appear to feature in the equation for $s_{final,i}$ as the relationship between this parameter and Significant Wave Height was very important in the Stockholm Agreement. At one time **(Ref. A7)** it seemed as though the “FB Factor Method” would be used as an alternative to the SEM (static equivalent method) for making some provision for water on deck. Further background to these issues, including the decision to drop both the SEM and FB method at SLF 47 can be found in **(References A3, A4, A5, A6 and A7)**.

- 2.4 We appreciate the reasons given for SWH and residual freeboard having little impact on WOD using the probabilistic method as shown in the following extracts:-

*“On the Water on Deck Effect (WOD) compared with the GZ approach, used in a probabilistic concept of survival” by S.Rusaas **(Ref. A3)**, presented at the informal Inter-Sessional CG meeting at Malmo on 8-9th December 2003 it is stated, in conclusions (1) and (2), at the end:-*

- (1) The largest expected difference in the s-factor is in the order of 10% by including the WOD or not. This difference may be expected in the relatively narrow area between $H_s=1$ to approximately 3 m. Below and above this area any WOD effect is believed to be marginal. Assuming that a maximum of 10% of the damage cases may be in this critical area, the maximum expected effect of WOD would be approximately 1% in the attained index.*
- (2) It seems that the GZ approach, most probably because of the Range parameter, predicts the critical wave height also for the ro-ro type of damages with better accuracy than originally expected.*

The “s” formula quoted in S. Rusaas’ paper above uses a TGZ_{max} and GZ_{max} of 0.12 m., which, according to SLF 45/3/3 **(Ref. A2 page 24)**, was only applicable as an alternative to the SEM (Static Equivalent Method) for passenger ships and not ro-ro ships for which a GZ_{max} figure of 0.25 m was more appropriate. When this point was raised by the UK at a meeting of EU member states at EMSA, Lisbon in March 2007 the following additional explanation was given by the Norwegian delegation, attending as observers:-

“From the model tests, it was shown that in order to achieve a critical wave height of 4 m, a GZ height of approx. 0.12 m was necessary for

non-RORO ships, and approx. 0.25 m for RORO ships. This difference was thought to stem from water accumulation on the RORO deck. To solve this in a more robust way, the SEM method was developed, and the resulting s-factor should be the least of $s(GZ)$ and $s(SEM)$, where $s(GZ)$ was based on $TGZ=0.12$ for all types of ships. When testing this out on real calculations, it was demonstrated that SEM did not have any visible effect on the overall A-factor for any of the test ships. A study of this effect was made by S. Rusaas, which suggested two main reasons from this: (1) water on deck has only effect in wave heights above approx. 2 meters, and there are only approx. 10% of the collisions which happens in those wave heights, and (2) the range criterion takes care of low freeboard cases more robustly than originally thought (the lesser the freeboard, the shorter the range)".

The points made by the Norwegian delegation above are understood and indicate that the effect of WOD as calculated by the SEM on index "A" is minimal since only 10% of collisions in the Collision Damage Database occur in sea-states of SWH 2.0 metres and above. In sea-states with SWH less than 1.5 m model tests conducted over the years have generally shown that the WOD effect is minimal and this is reflected in the Stockholm Agreement regulations where the amount of accumulated water is estimated with reference to residual freeboard and SWH (>1.5 m only).

The probabilistic formulations incorporated into SOLAS 2009 are based on statistics from the Collision Damage database rather than anticipated risks but the question should be asked as to whether consideration should be given to allowing in some way for the possibility of collisions involving side damage in sea-states of up to 4.0 m SWH, as is attempted in the Stockholm Agreement. To put this another way, supposing a ro-ro passenger ship was involved in a major collision resulting in loss with heavy casualties in SWH 3.0 m, for example, and there was a legal inquiry into the disaster, would it be sufficient to argue that statistics indicated that the probability of a collision in a sea-state with SWH > 2.0 metres was regarded as too low to be covered by in the regulations?

2.5 Whether or not the results of RP592 have clarified any or all of the above 4 points is still being assessed and we hope that CG experts will be able to help us to interpret the results once the final paper is available. A comprehensive series of papers and documents describing earlier studies on the likely impact of S2009 on ro-ro passenger ship design is available on the web-site **(References C1 to C14)**. An outline of each document is given at the end of this discussion paper. We obviously would encourage many more studies, published results and design experience to be forwarded to the CG for consideration, as required by TOR 1.3.

TOR 1.2

2.6 We would like to thank Italy for forwarding proposed guidelines, prepared by Euroyards, for carrying out design studies comparing SOLAS90/Stockholm with S2009. The document has been placed on the web-site **(Ref. ITALY1)** and came with the following covering note:-

This Guideline has been drafted by stability experts of different European Shipyards, members of EUROYARDS, and is submitted to the SDS Correspondence Group on behalf of Finland, Germany and Italy.

The purpose of this submission is to support the discussion on the first two terms of reference of this CG :

- 1) examine the impact of the damage stability requirements of the SOLAS 2009 amendments on ro-ro passenger ships, in comparison with the SOLAS 1990 regulations in association with the Stockholm Agreement*
- 2) define criteria to be used for the evaluation of the two approaches and determine whether the level of safety between them is generally equivalent.*

As explained in the "Purpose" of the attached Guideline, it may be necessary to carry out damage stability calculations in addition to those already published in a number of studies related to this subject.

As these calculations may be carried out by a number of different Delegations, it is advisable to define a standard of the scope of these calculations, to achieve comparable results.

Our document is therefore aimed at providing some guidance on how to perform these calculations and which results should be made available to the CG, when investigating the effect of the new harmonized damage stability in comparison with SOLAS 90 and the Stockholm Agreement.

To support this task, existing and new ship designs have to be calculated in such a way that the results are comparable and the change in methodology from deterministic SOLAS 90 to probabilistic SOLAS 2009 is properly accounted for.

Please note that this Guideline should only be used when recalculating old and new ships to achieve comparable results.

The purpose is not to calculate or define any "safety level".

In other words, the Guideline is to be considered only as a methodology to achieve consistent and comparable results from different organizations.

2.7 France has already indicated support for this document.

2.8 We have asked our RP 592 research team to consider this document when preparing conclusions for their study.

2.9 We invite all CG members to indicate support, or otherwise, for this document in the questionnaire below.

TOR 1.3

2.10 We hope that the process of assessing existing and new studies on this subject will be started with this discussion paper and carry on throughout the period of time between now and SLF 52 in January 2010.

2.11 As indicated in 2.5 above the MCA web-site already contains a series of papers and documents on the subject **(References C1 to C14)**.

TOR 1.4

2.12 We consider that the issues raised in TOR 1.1 – 1.3 as described above relate largely to whether the determination of attained index “A”, in particular “ $s_{final,i}$ ” in S2009, is taking sufficient account of water on deck after damage. Should members conclude, during the course of our investigation, that there is no problem with the regulations in their current form in this respect then this group can report back positively to the SLF S-C.

2.13 However, there is also the issue of whether the required index “R” is set at an adequate level. Clearly “A” and “R” must be linked – it is easier to achieve “R” if the parameters in “ $s_{final,i}$ ”, for example, are set too low.

2.14 There have been some papers published recently **(Refs. A10 and A11)** linking the level of “R” with the risk or vulnerability of ships to capsize. The UK recently carried out a study (RP.564) on an existing ro-ro passenger ship compliant with IMO Res. A.265 which was shown to be vulnerable to rapid capsize following a shallow 2-compartment damage. The results of this study will be made available shortly to this CG.

2.15 It is proposed therefore that in the second round we will invite discussion on the “R” factor for ro-ro passenger ships, whether or not the first round shows there is a problem with the calculation of “A”.

2.16 Another issue which will need to be considered is that if it is eventually concluded that rectification measures are needed to the S2009 regulations specifically for ro-ro passenger ships should these be included in the main body of the regulations applied to all member states or dealt with by a footnote allowing application under a regional agreement, as is the present case with the Stockholm Agreement?

TOR 1.5

2.17 A report will be prepared for submission to SLF 52

TOR 2

2.18 It is emphasized that all parties carrying out studies or design analysis on ro-ro damage stability under S2009 are encouraged to advise the CG of any work in progress and forward the results for our consideration. The work

of SAFEDOR, SURSHIP and the new model test programme initiated by EMSA may be particularly relevant to our considerations.

3. Proposed Timetable

3.1 The following preliminary timetable is proposed, which could change as the CG progresses:-

Round No.	Subject	TOR	Issued	Deadline
1	"A" index	1.1 – 1.3	2/10/08	19/12/08
2	"R" index	1.1 – 1.3	12/2/09	27/4/09
3	Rectification?	1.4	27/5/09	25/8/09
Report		1.5		Early Oct 09 (13 weeks before SLF 52)

SLF 52 Agenda Item 11

“Damage Stability Regulations for Ro-Ro Passenger Ships”

Questionnaire Responses

SDS Correspondence Group – Round 1 Discussion Paper

Q1. Does the proposed work programme in Section 2 cover the TOR?	
EU France Japan	Yes Yes (In general)
Italy	No
<p>Comments:</p> <p>France:- At this stage we feel that it is anticipated to consider that a GZmax of 0.12 m is too low for the ro-ro passenger ships. The results of calculation will probably provide more information to decide whether or not the GZmax will have to be increased.</p> <p>Germany:-</p> <ul style="list-style-type: none">• The reference in Sect. 2, TOR 1.1 is limited to one research project (RP592) only All other studies are ignored in the work programme. We regard it as important to include all available and future projects in the reference to allow an open minded review.• The TOR describes, that it should be identified, if there is a lack of safety for RoPax vessels where this study can only be a part of it.• Probabilistic and deterministic methods can hardly be compared and methods should be developed to identify weak points in SOLAS2009 for RoPax vessels. As SOLAS2009 is based on a probabilistic approach you will always find designs, which comply with SOLAS2009 but not with SA, as the R formula is based on a very small database of sample ships. The main difference is the transverse extent of damage. SOLAS90 and SA are based on B/5 damages only, while SOLAS2009 uses B/10 in regulation 8. This allows placing the large lower hold closer to the shell. A B/5 damage is then unlikely to be survived, thus the SA requires higher GM requirements.	

Italy:-

- It is understood that the research project RP592, commissioned by UK and Netherlands, is just one contribution in a wider investigation programme. The analysis undertaken by Euroyards members, using detailed designs of real RoPax ships, should also be considered as an essential contribution to carry out the work programme in TOR 1.1 and 1.3. This important analysis is being carried out.
- It is recommended to ascertain from the beginning if all these studies and investigations actually cover the whole range of ro-ro passenger ships, in terms of size and design. Euroyards sample ships will cover a very wide range of L, range and LSA, however with a majority of medium/large ro-ro passenger ships.
- To match the results of such investigations, with consistent and comprehensive evaluation criteria, it is fundamental that common Design Comparison Guidelines are used - for such reason it is recommended to use the available methodology (see Q3). Any possible enhancement of this methodology, if deemed necessary, ought to be agreed beforehand.
- In the TOR there is no specific mention of considerations on the required index R. The reasons put forward to support this analysis are noted, however at the time being it is considered more appropriate to address this matter only if the results of the analysis will demonstrate that safety levels are not generally equivalent, and possible rectification measures should be identified (TOR 1.4).

Q2. Is the proposed work timetable in Section 3 acceptable?

	Yes
EU France Italy Japan	No
Comments: EU:- Official results of EMSA studies (HSVA) only available in the beginning of May 2009.	

France:-

In our opinion the work program should take into account the following items :

1. Definition of the method for the calculations, and agreement on this method,
2. Calculation of a selection of sample test roro passenger ships,
3. Analysis of the results,
4. Proposal for improvement, if necessary.

Please clarify the proposed deadline dates, in particular the date at which all the sample calculations should be completed. Please note that up to now we have only one roro passenger ship project to comply with Solas 2009 and some of the parameters for the calculation may not be available immediately at the beginning of 2009. We understand that the calculations should be performed before the "rectification process" issued around 25/05/2009. Please confirm

Germany:-

- In the timetable it should be indicated at which stages discussions rounds will be initiated (including contents as far as this is predictable with today's knowledge)
- Sufficient time for re-circulation of summarised results should be allocated
- More rounds should be made to collect the different opinions and to find an agreement on the findings

Italy:-

The Euroyards evaluation has been shared so that each Shipyard is now working on a few different ships - at the end there will be about 12 worked examples and comparisons.

This important work - considered an essential contribution for the evaluation - requires some time to be carried out appropriately. The proposed deadline for Round 1 - mid December - to complete the evaluation of "A" cannot be met.

This integrated response will be reasonably available before the end of April 2009, for all ships being examined, including some general comments and comparison of the results, to support and facilitate the discussion in the CG. Participants will anyway endeavour to speed-up, as far as practicable, this joint analysis.

More time will be needed after this submission for the discussion rounds, to evaluate the findings in a free and open debate. Considering the October 2009 deadline for the final submission of the CG report, Italy is confident that the available timeframe is still adequate to collect the different opinions and to reach an agreement on the findings.

Japan:-

It is not possible to perform calculations before the determination of the method for calculations. Also, it is difficult to consider “R” index and “rectification” separately. Thus, the schedule should be changed as follows:

Round1: Determination of the method for calculations

Round42: Calculations of “A” index

Round23: Consideration for “R” index and, if necessary, “rectification”

Q3. Are the Design Comparison Guidelines referred to in Section 2.6 and in (Ref. ITALY1) on the web-site acceptable?

EU	Yes
France	Yes
Italy	Yes
Japan	(basically)
	No

Comments:

EU:-

Acceptable, but comparisons between two standards has more academic value than contribution to any practical solutions for the ship design, due to different mathematical bases.

Germany:-

- Although it is very difficult to compare SA and SOLAS2009 ships, this guideline may be used that comparative calculations are made in the same way and can be collected in a common database
- In case participants deviate from the workflow, this should be justified and clearly indicated in the presentation of results to allow comparison

Italy:-

Having sponsored these Guidelines, Italy considers essential to have consistent and comprehensive evaluation criteria (see Q1).

If the methodology used in other investigations deviate from this proposed workflow, this should be justified and clearly indicated in the presentation of results, to ensure a fair comparison.

Japan:-

We agree with the Italian proposal that calculations should be conducted in a uniform way.

Japan has considered performing calculations to contribute to the work of the CG.

Calculations are to analyse the safety levels of ship of two types: the first type satisfies "SOLAS90+SA" and the second satisfies "SOLAS2009". By this way, we can compare the safety levels of ships of these two types.

However, there are some questions in conducting such calculations.

In our understanding, for the current Ro-PAX, accumulated water on deck stipulated in SA is overestimated in numeric standards and therefore it is adjusted by model test for compliance with the standards. Thus, the actual safety level of existing ship (SOLAS90+SADESIGN) is considered the safety level of ships based on the model test that satisfy "SOLAS90+SA". So, in comparative calculations, it is necessary to calculate "A" index of SOLAS2009 for such an actual ship and its compartment. Also, compliance evaluation of SOLAS2009DESIGN with SOLAS90+SA should be compared with the safety level based on a model ship test above-mentioned. Therefore, we propose an evaluation method, which we believe is the fairest way for making comments on the Italian proposal, as follows.

Comments to Italian proposal

1. ANNEX 1

In calculations of item 9 based on Annex1, for ships which satisfies SA by conducting model tests, it should be required to present required GM in accordance with SOLAS 90 alone, required GM and its increase to comply with SA by conducting model tests, and required GM and its increase to comply with SA by conducting calculations of numeric standards, as reference for safety evaluation based on SOLAS90+SA calculations in SOLAS2009DESIGN in Annex2.

2. ANNEX 2

In conducting SA calculations on SOLAS2009DESIGN, we would like to confirm that assumed damage cases should be "damaged range required by SOLAS90."

It is already mentioned that requirements of SA based on numeric standards are considered as overestimation compared with those based on model tests. On the other hand, it is difficult to verify the compliance of SA by conducting model tests under the current timetable proposed now. Therefore, calculations for SA compliance will be conducted based on numeric standards for the moment. In conclusion, as proposed above, we propose that the decision on safety level evaluation SOLAS90+SA in SOLAS2009DESIGN should be made by considering the safety levels of SA (model test) and SA(numeric standards) that will be obtained as a result of calculations in Annex1.

Q4. At this stage, after studying Section 2 and the reference documents on the web-site together with any internal research work or design work undertaken so far, do Member States consider that the calculation of the Attained Index “A” in S2009 takes sufficient account of the special damage stability characteristics of ro-ro passenger ships relating to the risk of sudden capsize following water accumulation on large open deck areas near the damaged waterplane following side damage in a seaway?

Please bear in mind that this question is only asked now to obtain a picture of current views which, it is accepted, may change as more research is undertaken, information received and design experience gained during the course of the CG. This, or similar, questions will therefore be asked several times during the CG.

France Italy	Yes
EU	No

Comments / Reasons:-

EU:-

After comments of some major expert groups, this basic concern has been recently proven by preliminary results of studies.

France:-

Based on the discussion held in the last SLF meeting. Of course the study which will be performed with our exercise will provide more information.

Germany:-

- The validation work for SOLAS 2009 and further German and Swedish research projects seem to indicate that SOLAS 2009 meets the standards of SOLAS 90 & SA. However diverging results of different research projects are basis enough to support further research for the validation of a sufficient level of safety.

Italy:-

Preliminary considerations on the results of the available studies - supported also by the long discussions at SLF and the design experience - indicate that SOLAS 2009 regulations are generally adequate.

However the analysis in progress within this CG with an open minded, consistent and comprehensive approach is the correct way to pinpoint any shortcoming in the regulations - if any - and propose suitable revisions.

Japan:-

No answer.

We've been working based on the comparative calculations to obtain the answer to the Q4. Therefore, we cannot answer the question 4 at present.

References

Please note that the documents referenced below are all available on the MCA web-site:- <http://www.mcga.gov.uk/c4mca/imosdscg.htm>

A1. SLF 45/3/4 *“Selection of sample ships for the evaluation of Required Subdivision Index R and procedure for calculating the Required Subdivision Index R – Report from the research project HARDER”* dated 19th April 2002; submitted by Germany, Norway and the UK.

A2. SLF 45/3/3 *“Investigations and proposed formulations for the factor “s”: the probability of survival after flooding. Report from the research project HARDER.”* dated 19th April, 2002; submitted by Norway and the UK.

A3. *“On the Water on Deck Effect (WOD) compared with the GZ approach, used in a probabilistic concept of survival”* by S.Rusaas, presented at the Inter-Sessional WG meeting at Malmo in December 2003.

A4. *“ISCG Informal Meeting Summary”* (Malmo, December 8th-9th, 2003) distributed to CG members on 18th December 2003.

A5. *“Some Concerns about the Implementation of the new SEM in SOLAS”* by Prof.-Dr.-Ing S. Kruger of the Technical University of Hamburg-Harburg, dated 2/12/2002.

A6. *“SEM – Comments about the Proposal from Germany”* by L. Letizia, dated 22/12/2003.

A7. SLF 47/3/9 *“Specific survivability standards for ro-ro ships”* dated 9/7/2004; submitted by Germany.

A8. *“SOLAS 2009 – Fitness of the GZ-based formulation for Ro-Ro vessels”*, by Dr Cantekin Tuzcu; (internal MCA memo dated 26/9/2007).

A9. *“Stockholm Agreement – Past, Present and Future (Part I)”* by Vassalos and Papanikolaou in February 2001.

A10. *“Ship Vulnerability to Flooding”* by Jasionowski and Vassalos, presented at the 3rd International Conference on Design for Safety in San Francisco in 2007.

A11. *“SOLAS 2009 – Raising the Alarm”* by Jasionowski and Vassalos, presented at the 10th International Ship Stability Workshop, Hamburg in 2007.

Further References (B1 to B5) and Background Information (B6 & B7):-

- B1.** MSC.216(82). Contains the SOLAS 2009 amendments
- B2.** Explanatory Notes. The latest available version is SLF 51/17 Annex 1
- B3.** MSC 84/22/12. EU paper proposing a new work programme item covering ro-ro stability, dated 5th February 2008
- B4.** MSC 84/22/23. CESA paper commenting on 84/22/12 and asking for technical papers referred to in the paper to be made available.
- B5.** MSC 84/24 paragraph 22.59

Specific ship stability requirements for ro-ro passenger ships

22.58 The Committee considered document MSC 84/22/12 (Austria *et al*), proposing to review the damage stability requirements of the revised SOLAS chapter II-1, which will enter into force on 1 January 2009, to ensure that the issue of water on deck, which is a specific safety concern for ro-ro passenger ships, is adequately addressed within those requirements; and document MSC 84/22/23 (CESA), wherein, supporting in general, the proposal to review ship stability requirements for ro-ro passenger ships, CESA, while pointing out that the combined use of the revised SOLAS chapter II-1 and the Stockholm Agreement would not be appropriate, as they are based on different concepts, expressed the opinion that the decision could be taken only after the technical background of the proposal is made available and that the scope of the review should also address the issue of compatibility of the revised SOLAS chapter II-1 damage stability requirements with other legislation still regulating the design of ro-ro passenger ships.

22.59 Following the discussion, the Committee agreed to include, in the work programme of the SLF Sub-Committee, a high-priority item on "Damage stability regulations for ro-ro passenger ships", with two sessions needed to complete the item, and instructed SLF 51 to give a preliminary consideration to the matter and to include the item in the provisional agenda for SLF 52. In this regard, Member Governments and international organizations were invited to submit any studies on the above matter to SLF 52.

B6. SOLAS/CONF.3 Resolution 14 was the original regional agreement on specific stability requirements for ro-ro passenger ships, adopted by IMO on 29th November 1995. It differs from the Stockholm Agreement (dated 26-27th February 1996) in that the volume of entrapped water on the vehicle deck is assumed constant at each angle of heel and trim. In the Stockholm Agreement, water height is assumed constant, meaning that, given positive initial residual freeboard, the volume of water on the vehicle deck decreases as heel increases. When the deck edge submerges, the volume of floodwater starts to increase again.

B7. SLF 45/3/2 "*Watertight Integrity and Immersion Limits when determining the "s" factors*", submitted by Germany, Norway and the UK, dated 19th April, 2002. This paper explains the reasoning behind the removal of the term "margin line" from the future SOLAS2009 regulations and its replacement with "immersion limit lines". The opening sentence states:-

"Although the processing of all results from the model testing of damaged ships is not yet complete it has become evident that deck corner immersion or

the static heeling angle has relatively small significance in determining the survival capability of a damaged ship."

No distinction is made in this paper between "passenger ship" and "ro-ro passenger ship".

Additional Background Information – not referred to in the text

C1. *"Subdivision and Damage Stability of Ships" by Maciej Pawlowski of the Technical University of Gdansk, hardback book, published in 2004. The book contains a very detailed technical background to the subject, including probabilistic damage stability, water-on-deck and SEM.*

C2. *"Comparison of 8 existing Ro-Pax ships according to the Revised SOLAS Ch.II-1 MSC.194(80) – Report of Damage Stability Study" by M.Soininen and P.Kojonen of Elomatic on behalf of the Finnish Maritime Administration, dated 23/8/2007. The paper concludes:-*

6. CONCLUSIONS

A definite general answer cannot be given whether safety marginal increases or decreases when using new probabilistic rules. Three ships of eight calculated ships would not attain the required index. GM-limits are generally almost similar or somewhat higher than in SOLAS90+SA. On the other hand the Ship3, which is according to A.265, manages with even lower GM-limit.

Because all of these eight ships have been constructed within about from 14 to 30 years ago prior to SOLAS90 and "Stockholm Agreement", and they are not unified in their basic arrangement but varies depending on their original purpose. Within these ships there are one- and two-compartment ships, cargo ships converted into passenger ships and purpose built passenger/car ferries. As it might be expected it looks like that those ships, where sponson and/or ducktail have been constructed, have better margin than those ships without sponson and/or ducktail.

With these eight ships whether double bottom height is according to the new rules or not, it has no practical influence to the attained index. Ships with lower double bottom, however, attain proper index, whereas one ship with higher double bottom does not.

In calculation of required index based on EN-text which allows the administration to define the factor of N_2 between one and two, can have an effect of 5-6 % in R-index. Ship7 would attain proper index if this factor is less than two.

Even though a time of cross flooding or a time that it takes for the flooding water to pass through non-WT bulkheads were not studied, it can be clearly found that in the ships that have unsymmetrical flooding A-index decreases drastically.

C3. *"Report on Damage Stability Study Dated 23/8/07 commissioned by the Finnish Maritime Administration" – internal MCA report dated 12/10/2007. This report looks closely at the data provided in the Finnish study and concludes:-*

OVERALL CONCLUSIONS

This excellent study provides us with a great deal of evidence that the new regulations are not taking WOD into account and that as a result are wrongly predicting that a ship can operate safely in a given sea state at a much lower GM than would be allowed under SOLAS90+SA.

It would be very interesting to know whether the SA limiting GM curves are derived from calculations or from model tests. It is known that the SA calculation method is quite conservative so it would be helpful to have this point clarified.

The fact that the new probabilistic regulations do not appear to be allowing for the WOD effect should not hide the fact that there are problems with SOLAS90. For example, the 1-compartment standard applied to Ship 5 is shown to give rise to low survivability. Also Ship 8, which relies heavily on B/5 bulkheads is revealed to have a relatively low survivability by S2009.

However, the over-riding concern about the S2009 regulations is that they do not appear to be accounting for the WOD effect. The results of this study confirm suspicions that a mistake was made when IMO SLF adopted the S_{final} equation using a factor of 0.12 for all ships instead of 0.12 for non ro-ro ships and 0.25 for ro-ro passenger ships.

The change needed to correct the regulations would be to make a distinction between conventional and ro-ro passenger ships and, for the latter, changing the 0.12 factor to 0.25 for all cases of damage involving the garage space. It could also be argued that the 0.25 factor should only be used for damage cases resulting in a residual freeboard of less than 2 metres. It could also be argued that the factor of 0.25 could be linked to an SWH of 4.0 metres and 0.12 could be used for ships operating in regions with SWH 1.5 metres. The factor would then vary linearly as SWH varied between 1.5 and 4 metres. This should then automatically re-introduce the limiting GM curve increasing as draught increases and varying GM curves dependent on SWH / sea areas.

According to the protocols of IMO when adopting new regulations it is now too late to correct this fault before S2009 comes into force on 1st January 2009. In this event we in the UK are already advising owners and builders to apply the Stockholm Agreement on top of S2009 until such time as the necessary corrections can be agreed and implemented.

Another major issue with the new regulations not covered by the FMA study is the possibility that plausible damage cases may have catastrophic consequences for ro-ro passenger ships. This study was not designed to test this out but the UK study, which will involve designing 2 new ships from scratch using S2009, should demonstrate whether it could happen in which case a major re-think of the new regulations may be required to try to prevent catastrophic damage situations from arising.

C4. *“Impact of the ‘Stockholm Agreement’ on new probabilistic damage stability rules” by Andreas Hildingsson; M.Sc Thesis. Dept of Shipping and Marine Technology, Chalmers University of Technology. Report No. X-05/180 dated 2006. An outline summary of the thesis and its overall conclusions are given below:-*

Summary

The purpose of this thesis is to study the impact of the "Stockholm Agreement" on the new probabilistic damage stability rules used in the revised SOLAS Ch. II-1. This is done by studying attained indices and damage cases for 8 different ro-ro passenger ships.

Some of the ships were calculated for the design before and after the ships were rebuilt to fulfil the Stockholm agreement. The changes in attained indices were studied as well as specific damage cases that contributed to the change of the attained index. Some models were not appropriate to calculate before the vessels were rebuilt. In this case only the designs used today, when the ships fulfil the Stockholm Agreement, were calculated and their attained indices were analysed.

The probabilistic damage stability according to the revised SOLAS Ch. II-1 was calculated using the computer software NAPA Release 2005.2-6 and actual stability data, such as loading conditions, were taken from the Swedish Maritime Administrations archive.

The result shows that the attained indices, calculated in this work, increases significant when the ships are rebuilt to comply with the Stockholm agreement. Another notable result is that low attained indices are obtained for larger ro-ro passenger vessels.

One of the main conclusions is that the "Stockholm Agreement" might not longer be needed when a ro-ro passenger ships are calculated and approved according to the revised SOLAS Ch. II-1. The author's opinion is that the Stockholm Agreement not longer is needed when ships are designed according to the revised SOLAS.

C5. *"SOLAS 2009 and IMO/Circ.1891 (Stockholm Agreement) – Damage Stability Investigation of 2 ships and contrast of the Requirements" by Jan Schreiber; Dipl-Ing Thesis Technical University Hamburg-Harburg in co-operation with Germanischer Lloyd; dated May 2006.* This thesis contains a detailed analysis of 2 existing ro-pax ships, the "Nils Holgersson" and the SAFEDOR project ship, each compliant with SOLAS90 and the Stockholm Agreement; it compares their safety levels with the SOLAS2009 regulations and concludes:-

From the results of the calculations performed, the conclusion can be drawn, that SOLAS 2009 for these two ships and for the input data stated provides at least the same level of safety as the current SOLAS incl. the Stockholm Agreement IMO/Circ.1891.

C6. *"Stockholm Agreement and SOLAS 2009" – presentation by MCA at a meeting in the offices of EMSA in Lisbon, 27th March 2007.* The main conclusion was that the SOLAS 2009 in its present form cannot be relied upon to cater properly for WOD and that it was therefore not safe to dispense with the Stockholm Agreement until SOLAS 2009 is corrected.

C7. *"Swedish position on the Stockholm Agreement and SOLAS 2009 damage stability requirements"; letter dated 15th February 2007 from the Swedish Maritime Safety Inspectorate to EMSA.* It ends as follows:-

Further development of ro-ro passenger ship safety with regard to collision accidents

Sweden is in favour of continuing proactive measures in order to increase the safety of ro-ro passenger ships as well as other types of ships. With regard to collision such measures should fit into a rational approach which could be summarized by the following four steps:

1. the probability of a collision occurring,
2. the probability of damage position and extent after a collision,
3. the probability of survival after a damage,
4. the overall level of safety to be applied in regulations.

Step 2-4 are explicitly included and quantified in the new Chapter II-1 of SOLAS 2009 by the formulae of p , s and R . Step 1 is implicitly guided by other regulations such as SOLAS Chapter V, STCW, routing measures etc. but has not yet been quantified in the regulations.

The SA deals specifically with step 3. If the approved new description of survivability is shown to be less adequate for specific ship types, we certainly will support further development to make it more physically correct and robust. We are also in favour of a continuous review of the safety level expressed as the required index R . However, applying SA in its present form on top of these four steps would, in our opinion and based on existing knowledge, neither be rational nor the most effective way of increasing safety.

C8. *“Assessment Report – Study of Applicability of Stockholm Agreement Requirements in Conjunction with Future SOLAS 2009 revised Damage Stability Rules”*; EMSA study dated 9th March, 2007. This summarizes references C5 – C7 above, presents the positions of other EU countries and concludes:-

CONCLUSIONS OF THE ASSESSMENT

The main conclusion from the presentations is that there is lots of space for interpretation in the future SOLAS 2009 Damage Stability Rules, even though the above studies have incorporated the Explanatory Notes of Damage Stability Calculation (IMO SLF 47/4), as presented in their current development phase.

As the results of calculations show, just less than half of the vessels that fulfil SOLAS 90 including Stockholm Agreement, fulfil also SOLAS 2009.

The other half does not fulfil SOLAS 2009. The reasons for this are very difficult to point out and absolute conclusions are hard to draw.

Presented as a single case of the SW studies, it is possible to fulfil the damage stability criteria according to SOLAS 2009 calculation rules, by a vessel approved originally with SOLAS 90 calculations but without fulfilling the Stockholm Agreement requirements. This “shortcut” would give considerable advantage to some owners, flying under the flag of a MS which has ratified the Stockholm Agreement, to simply convert the SOLAS 90 vessel to SOLAS 2009 by calculations, without rebuilding onboard. (According to other explanations, this is not practically possible.) More clarifications would be needed for this.

It is obvious the Stockholm Agreement calculation rules are of deterministic base and may not be used as such with the probabilistic calculations. (As commented by UK presentation, “the two rules are different”). However, two to three member states claim that they apply Stockholm Agreement Rules with Res.A.265.

As the IMO legislation continues to develop for Ro-Ro passenger vessels, presenting new requirements for other problem solutions involving the same stability matters, the time is getting short for the involvement of Stockholm Agreement Requirements.

Solutions to the basic issue, namely the need to implement the Stockholm Agreement Requirements within the new SOLAS 2009, have not been found.

C10. *“Responses to EMSA questionnaire to Industry on various issues relating to SOLAS 2009 and the Stockholm Agreement”* by Prof. D. Vassalos; prepared for the EU COSS meeting in Brussels 16/11/2007. One response indicates that SOLAS 2009 does not take WOD into account (see response to Q5).

C11. *“Definition of the Point of No Return”* by Tuzcu; extract from Ph.D Thesis.

C12. *“Development of Factor-s: Damage Stability Probability”* by Tuzcu; presented at the 8th International Stability Conference STAB2003 held in Madrid.

C13. Specification for UK/NL research project RP592. The main objective was to prepare outline designs for two new ro-ro passenger ships, optimized to comply with the new SOLAS regulations (IMO MSC.216(82)) using the latest version of the accompanying explanatory notes.

C14. Powerpoint presentation dated 17th September 2008 showing the initial findings from UK/NL research project RP592.

The following papers have been submitted to the CG by various member states:-

ITALY1. *“How to compare Ro-Pax Ferries built under SOLAS 90 and SA with new designs according to SOLAS 2009”* by Euroyards stability group, dated 27th August 2008. The purpose of this document is to provide a Guideline on how to perform the calculations and on which results should be made available to the correspondence group, where the effect of the new harmonized damage stability on the safety level compared to SOLAS90 and the Stockholm Agreement (SA) is to be investigated. To support this task, existing and new ships or designs have to be calculated in such a way that the results are comparable and the change in methodology from deterministic SOLAS90 to probabilistic SOLAS2009 is accounted for.

SLF 52 Agenda Item 11

“Damage Stability Regulations for Ro-Ro Passenger Ships”

SDS Correspondence Group – Round 2 Discussion Paper and Questionnaire

**Target date for replying to the questionnaire is Friday 31st July, 2009.
The results of the EMSA project at HSVA will be placed on the web-site as soon as they become available.**

1. First of all, we would like you to consider the EUROYARDS Stability Group paper (ITALY2 on the MCA web-site) and we would like to thank the project team for providing these results for us in such a well-prepared and well-presented format. Mr Allesandro Maccari of Fincantieri has very kindly offered to help any individual members by answering technical questions or providing further clarification as needed. He can be contacted by e-mail on:-

Alessandro.Maccari@fincantieri.it .

If these individual questions and answers are thought to be helpful to the group as a whole, the correspondence will be circulated (but only with the consent of Mr. Maccari and the member involved).

The questions asked will be similar for all three of the new research projects:-

Q1. In ITALY2 are the calculation methods used to highlight the safety levels provided by SOLAS90+Stockholm Agreement (SA) and SOLAS 2009 acceptable?	
	Yes
	No
Comments:	

Q2. For ITALY2, do you agree with the discussion of the results and the conclusions or are there any points with which you either disagree or would like us to examine in more detail within the CG?	
	Yes
	No
Comments:	

Q3. On the basis of ITALY2, would you consider that SOLAS 2009 as it stands can be used to design ro-ro passenger ships of an acceptably high standard of safety and certainly no less safe than SOLAS90+SA? If not, have you any suggestions as to how SOLAS 2009 can best be improved or any areas that may require more investigation?	
	Yes
	No
Comments:	

2. Secondly, we would like you to consider the results of the jointly-funded UK/NL research project RP592 (Paper C15 on the MCA web-site, together with the Powerpoint presentation C14A). Dr Andrzej Jasionowski has very kindly offered to help any individual members by answering technical questions or providing further clarification as needed. He can be contacted by e-mail on:-

a.jasionowski@safety-at-sea.co.uk

Again, if these individual questions and answers are thought to be helpful to the group, the correspondence will be circulated (but only with the consent of Dr Jasionowski and the member involved).

Q4. In C15, are the calculation methods used to highlight the safety levels provided by SOLAS90+Stockholm Agreement (SA) and SOLAS 2009 acceptable?

	Yes
	No

Comments:

Q5. For C15, do you agree with the discussion of the results and the conclusions or are there any points with which you either disagree or would like us to examine in more detail within the CG?

	Yes
	No

Comments:

Q6. Paper C15, makes some clear recommendations on changes to the calculation of factor A for Ro-Pax vessels in the SOLAS 2009 regulations and a suggestion that the R factor be increased to reduce the number of non-surviving damage cases. Do you think that these proposals could or should be adopted at SLF 52 in January 2010, (after further consideration and adjustment if necessary), or do we need to do much more research over a longer time-scale (such as the GOALDS project, for example) before making a decision?

	Yes
	No

Comments:

Q7. On the basis of C15, would you consider that SOLAS 2009 as it stands can be used to design ro-ro passenger ships of an acceptably high standard of safety and certainly no less safe than SOLAS90+SA? If not, have you any different proposals as to how SOLAS 2009 can best be improved or any areas that may require more investigation?

	Yes
	No
Comments:	

A similar set of questions will be circulated as soon as the results of the EMSA project are available. There will also be a final question on your overall feelings on the water-on-deck / SOLAS 2009 issues having had the chance to study all three new research papers.

3. Arising independently from each of these new research papers, there seems to be a common theme regarding the safety of ro-ro passenger ships fitted with long lower holds. Until SOLAS 2009 came into force, such holds, extending up to 50% of the LBP, were protected from side damage by B/5 longitudinal bulkheads as determined by the maximum penetration depth assumed both in SOLAS90 and Resolution A.265. Optimizing a design using SOLAS2009 only it seems possible that these protective bulkheads could be moved outboard to as little as B/10 (to meet the minor damage regulation 8) approximately doubling the probability of hold-penetrating damage with the potential for leading to very rapid capsizes with high casualties.

In the UK a consultant has performed a study indicating that a ro-ro ship with a long lower hold complying with SOLAS90 and the Stockholm Agreement (and meeting the floodable length requirements, or some equivalent) could operate under SOLAS 2009 alone with a much increased draught (or an extra payload of some 1500 tonnes, in this particular case).

The UK has also carried out some further calculations on one of the two new designs developed in RP 592 looking at the influence on maximum KG of damage to the lower hold, including the effect of margin line non-immersion. The results are on the web-site (see reference **C.16**).

We are puzzled as to how such large differences can arise given that SOLAS 2009 was designed to offer an equivalent level of safety to SOLAS 90.

Q8. Although not strictly within our terms of reference, would you be in favour of opening a dialogue within the correspondence group on the issue of long lower holds to try to find out if there is a discrepancy between SOLAS90/A.265 and SOLAS2009, the possible reasons for this and whether action may be needed to amend the regulations? Meantime any thoughts you may have on this issue now would be most welcome.

	Yes
	No
Comments:	