Grant Agreement No: 605221
Project Acronym: SHOPERA
Project Title: Energy Efficient Safe **SH**ip **OPERA**tion

Deliverable D7.5

Interim Report

On Dissemination Activities and Planned Exploitation of Results

Due date of deliverable: *31-03-2015*

Actual Submission date: *27-04-2015*

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PU	
-dissemination level-	

Status of Deliverable: ~~*Draft*~~*/Final*

Document Reference Number: *SHOPERA-D7.5-rev02*

[1] **dissemination level**	
CO	Confidential, only for members of the consortium (including Commission Services)
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Document History

Document ID.	Date	Description
SHOPERA-D7.5-rev01	27-04-2015	Initial version
SHOPERA-D7.5-rev02	01-05-2015	Updated and extended

Document Control Sheet

Title: Interim Report on Dissemination Activities and Planned Exploitation of Results

Abstract

The report describes dissemination results and planned dissemination activities of the project SHOPERA; Interim Exploitation Plan is proposed.

Summary Report:

Introduction. The report describes dissemination results and planned activities of the project SHOPERA. Interim Exploitation Plan is proposed for further refinement and implementation until the end of the project. Dissemination is facilitated mainly through technical publications in international scientific journals, conferences and workshops. A project-specific web site is created including a public area, allowing free access to selected deliverables, reports and publications. Four public workshops are planned; the first public workshop was organised in Hamburg on 2014-10-30.

State of the Art. Introduction of the Energy Efficiency Design Index raised concerns that ship designers might lower the installed power to achieve the EEDI requirements, addressed by adding a requirement of a sufficient propulsion power needed to maintain the manoeuvrability of the ship under adverse conditions to the Reg. 21, Ch. 4 of MARPOL Annex VI. Work carried out by IACS to develop corresponding guidelines is documented in IACS EE-WG 1/4 (2010), MEPC 62/5/19 (2011), MEPC 62/INF.21 (2011), MEPC 64/4/13 (2012), MEPC 64/INF.7 (2012), MSC-MEPC.2/Circ.1 (2012), MEPC 65/WP.10, Annex 5 (2013), MEPC 65/4/3, Annex 1 (2013) and IMO Res. MEPC 232(65) (2013).

Value added to SHOPERA. SHOPERA aims at revising the existing, *2013 Interim Guidelines*, by establishment of first-principles manoeuvrability criteria and corresponding environmental conditions, development of practical assessment procedure and required numerical tools, carrying out extensive optimisation studies to combine safety and efficiency requirements and evaluation of the impact of the proposed revised Guidelines on ship design and operation. Because of the very high expected impact of SHOPERA results on the ship design and shipping industry, it is important to timely ensure awareness of all stakeholders of SHOPERA approach and results, acceptance of SHOPERA results, as well as feedback from the stakeholders to shape the way forward. This puts dissemination and exploitation activities in the focus of SHOPERA work. The document is aimed to provide a summary of existing and planned dissemination results and to facilitate the efforts of the Exploitation Committee concerning the development and implementation of the Exploitation Plan until the end of the project.

Achievements. Summary of existing and planned dissemination activities; Interim Exploitation Plan

Not achieved. Not relevant

Input from other Deliverables. D7.1. Proceedings of 1st Public Workshop *Introduction of the Project to Key Stakeholders*

Exploitation of results. The proposed Interim Implementation plan will be extended, finalised and implemented until the end of the project.

This executive summary may be published outside the SHOPERA consortium. *YES*

Work carried out by	**Approved by**
Vladimir Shigunov	*Name of internal reviewer and date of acceptance:* Torsten Mundt
	Name of external reviewer(or WP leader) and date of acceptance: Apostolos Papanikolaou

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1 Introduction

1.1 Background

The introduction of the Energy Efficiency Design Index (EEDI) was a major step towards improving energy efficiency of shipping and reducing GHG emissions. At the same time, it has raised concerns that ship designers and ship builders might choose to lower the installed power and ship's speed to achieve the EEDI requirements, instead of optimizing ship's speed-powering performance. This may lead to insufficient propulsion power to maintain manoeuvrability of ships under adverse weather conditions. The above concerns refer especially to Phase 3 of the EEDI implementation, from 2025-01-01, when the required EEDI is to be reduced by up to 30% compared to present base level (2013). Following a proposal from the International Association of Classification Societies (IACS), the following requirement was added to the Reg. 21, Ch. 4 of MARPOL Annex VI: "*For each ship to which this regulation applies, the installed propulsion power shall not be less than the propulsion power needed to maintain the manoeuvrability of the ship under adverse conditions as defined in the guidelines to be developed by the Organization.*" Work carried out by IACS to develop such guidelines, see MEPC 64/4/13 and MEPC 64/INF.7, served as basis for the *Interim Guidelines for Determining Minimum Propulsion Power to Maintain the Manoeuvrability of Ship in Adverse Weather Conditions*, MSC-MEPC.2/Circ.1 (2012) referring at first to bulk carriers, tankers and combination carriers. Discussions within IMO led to *2013 Interim Guidelines for Determining Minimum Propulsion Power to Maintain the Manoeuvrability of Ship in Adverse Weather Conditions*, ref. MEPC 65/4/3, Annex 1 (2013), see IMO Resolution MEPC 232(65), valid for Phase 0 and Phase 1 of EEDI implementation (until 2020-01-01).

To address the challenges of the problem of norming manoeuvrability of ships in adverse conditions, an European research project called SHOPERA (Energy Efficient Safe SHip OPERAtion, see www.shopera.org), funded by the European Commission in the frame of FP7, was launched in October 2013, aiming at developing suitable methods and tools and systematic case studies which will enable the development of improved Guidelines and their submission for consideration to IMO-MEPC in 2016. A strong European RTD consortium was formed[1], representing the whole spectrum of the European maritime industry, including classification societies, universities, research organisations and model basins, ship designers, shipyards and ship operators. The project will:

- Validate the proposed adverse weather conditions using data from deep water and coastal areas as well as ship accident databases.
- Develop and fine-tune existing high fidelity hydrodynamic simulation software tools for efficient analysis of the seakeeping and manoeuvring performance and safety of ships in complex environmental and adverse weather conditions (including the consideration of winds and waves).

[1]National Technical University of Athens (NTUA, coordinator), DNV-GL, Lloyds Register (LR), Marintek (MRTK), Instituto Superior Tecnico (IST), Univ. Duisburg-Essen (UDE), Registro Italiano (RINA), Flensburg Schiffbau Gesellschaft (FSG), Uljanik Shipyard (ULJ), VTT, Flanders Hydraulics Research (EVFH), CEHIPAR, Strathclyde University (SU), Denmark Technical University (DTU), Tech. Univ. Berlin (TUB), Delft University of Technology (DUT), Naval Architecture Progress (NAP), Danaos Shipping Company Ltd. (DANAOS), FOINIKAS Shipping Co., CALMAC Ferries Ltd.

- Perform seakeeping and manoeuvring model tests in seaway using a series of prototypes of different ship types to provide the required basis for the validation of employed software tools. Validated software tools for the manoeuvrability assessment of ships in adverse weather conditions will be integrated into a ship design software platform and combined with a multi-objective optimization procedure, looking for sufficient powering and steering requirements for safe ship operation in adverse weather conditions while keeping the right balance between ship economy, efficiency and safety of the ship and the environment.
- Put together design teams that comprise designers, shipyards, owners, classification societies and national administrations to conduct investigations on the impact of the proposed new Guidelines for minimum propulsion power and steering efficiency to maintain manoeuvrability in adverse conditions on the design and operational characteristics of various ship types. The impact of EEDI will be investigated in parallel by implementation of the developed holistic optimisation procedure in a series of case studies.

The work is organised into the following work packages:

- WP1 - Environmental Conditions and Requirements for Different Ships provides met-ocean data to validate the proposed adverse weather conditions, defines relevant ship types and sizes, conducts a risk analysis of marine accidents related to manoeuvring in adverse weather conditions and proposes safety criteria to be addressed by the project.
- WP2 - Development and Refinement of Numerical Hydrodynamic Tools performs development and refinement of numerical hydrodynamic tools. It is expected to significantly improve the current state-of-the art in the scientific field of manoeuvring in adverse weather conditions by improving the capabilities of a series of numerical methods.
- WP3 - Experimental Studies provides experimental data for validation of the tools by performing seakeeping and manoeuvring model tests for a series of prototypes of different ship types to provide the required basis for the validation of numerical methods.
- WP4 - Validation, Sensitivity Studies and Level 1 Methods validates numerical tools using model test data. Selected test cases will be used for an open international benchmark study to evaluate the present state-of-the-art of numerical methods. Simple models of propulsion and steering devices and engine will be developed for the implementation in the numerical simulation tools. Simplified assessment methods (referred to as Level 1 methods) will be developed to reveal the safety margins of ship designs. Intact stability problems will be addressed in a coupled way with manoeuvrability in adverse weather conditions.
- WP5 - Adaptation/Integration of Tools - Multi-objective Optimisation Platform integrates software tools for hydrodynamic assessment of ships in adverse weather conditions into a ship design software platform and sets up multi-objective optimisation procedures to assess ship's performance holistically, looking for the manoeuvrability requirements in adverse weather conditions while keeping balance between economy, efficiency and safety.
- WP6 - Application – Case Studies conducts investigations on the impact of the proposed new guidelines on the design and operational characteristics of various ship types, by implementation of the developed integrated holistic optimisation procedure in a series of case studies. This will be achieved by putting

together teams that comprise designers, classification societies, yards and universities, while operators and ports will provide expertise and data.

- WP7 - Dissemination, Exploitation, Submission to IMO disseminates the results of the project to the public, provides for exploitation of the results through submission to IMO of new guidelines for sufficient manoeuvrability in adverse weather conditions, including minimum power and steering performance requirements, and develops exploitation plan for resulting knowledge, numerical tools, software and design methods. Wide dissemination of the project results will be facilitated through technical publications in international scientific journals and conferences.

2 Dissemination

2.1 Description of Work

Dissemination of the research output will be facilitated mainly through technical publications in international scientific journals, conferences and workshops. The consortium will also facilitate the dissemination of the research output to a wider audience through a series of articles in public mass media. A project-specific web site will be created (within 3 months from the starting date of the project) and will be updated and maintained by the coordinator during the elaboration of the project and for at least 3 years after the project's end. A public area will be maintained on the project's web site, allowing free access to selected deliverables, reports and publications resulting from the elaboration of the project. Four public workshops are planned:

- Introduction of the project to key stakeholders
- Benchmarking of numerical tools for manoeuvrability simulations in adverse conditions
- Criteria and standards for sufficient manoeuvrability under adverse conditions
- Presentation of the results to key stakeholders

2.2 Publications

2.2.1 Published Papers

Gadelho, J.F.M., Rodrigues, J.M., Lavrov, A. and Guedes Soares, C. (2015), "Determining hydrodynamic coefficients of a cylinder with Navier-Stokes equations", Maritime Technology and Engineering, Guedes Soares, C. & Santos T.A. (Eds.), Taylor & Francis Group, London, UK, pp. 1001-1008.

IMO MEPC (2014) EU Project "Energy Efficient Safe SHip OPERAtion" (SHOPERA), Paper MEPC 67/INF.14 submitted by Germany, Norway and United Kingdom

Liu, S., Papanikolaou, A., Zaraphonitis, G., "Prediction of added resistance of ships in waves", Ocean Engineering, vol. 38, pp. 641-650, 2011.

Liu, S., Papanikolaou, A., "On Nonlinear Simulation Methods and Tools for Evaluating the Performance of ships and Offshore Structures in Waves", Journal of Applied Mathematics, Volume 2012, Article ID 563182, doi:10.1155/2012/563182.

Liu, S., Papanikolaou, A., Zaraphonitis, G., “Practical Approach to the Added Resistance of a Ship in Short Waves”, Proc. Ocean (Offshore) and Polar Engineering Conference (ISOPE-2015), 21-26 June, Hawaii (USA).

Papanikolaou, A., Liu, S. Zaraphonitis, G., “Time Domain Simulation of Nonlinear Ship Motions Using an Impulsive Responsive Function Method”, 2nd Int. Conference on Maritime Technology, ICMT2014, July 2014, Glasgow (UK).

Papanikolaou, A., Zaraphonitis, G., Bitner-Gregersen, E., Shigunov, V., El Moctar, O., Guedes Soares, C., Reddy, D.N., Sprenger, F., “Minimum Propulsion and Steering Requirements for Efficient and Safe Operation (SHOPERA)”, Invited paper, 37th Motorship Propulsion and Emissions Conference, 4-5 March 2015, Hamburg (Germany).

Papanikolaou, A., Zaraphonitis, G., Bitner-Gregersen, E., Shigunov, V., El Moctar, O., Guedes Soares, C., Reddy, D.N., Sprenger, F., “Energy Efficient Safe Ship Operation (SHOPERA)”, Proc. RINA Int. Conference on Influence of EEDI on Ship Design, Sept. 2014, London (UK).

Papanikolaou, A., Zaraphonitis, G., Bitner-Gregersen, E., Shigunov, V., El Moctar, O., Guedes Soares, C., Reddy, D.N., Sprenger, F., “Energy Efficient Safe Ship Operation (SHOPERA)”, Poc. 12th Int. Marine Design Conference (IMDC2015), 11-14 May 2015, Tokyo (Japan)

Prpić-Oršić, J., Vettor, R., Guedes Soares, C. and Faltinsen, O.M. (2015), “Influence of ship routes on fuel consumption and CO2 emission”, Maritime Technology and Engineering, Guedes Soares, C. & Santos T.A. (Eds.), Taylor & Francis Group, London, UK, pp. 857-864.

Sames, P., Bülow, S., Shigunov, V., “Energy Efficiency Design Index und sicheres Manövrieren in schwerem Wetter”, STG Jahrbuch, 2013.

V. Shigunov and V. Bertram (2014) Prediction of added power in seaway by numerical simulation, 9th Int. Conf. on High-Performance Marine Vehicles HIPER 2014, Athens, Greece, 3-5 December

Shigunov, V., Papanikolaou, A., “Criteria for Minimum Powering and Maneuverability in Adverse Weather Conditions”, The 14th International Ship Stability Workshop (ISSW), 29th Sept.- 1st Oct. 2014, Kuala Lumpur, Malaysia.

V. Shigunov and T. E. Schellin (2014) Tow forces for emergency towing of containerships, Proc. 33-rd Int. Conf. on Ocean, Offshore and Arctic Engineering OMAE2014, June 8-13, San Francisco, California, paper OMAE2014-23918

H. Söding, V. Shigunov, T. Zorn and P. Soukup (2013) Method rolls for simulating roll motions of ships, Ship Technology Research – Schiffstechnik 60(2)

H. Söding, V. Shigunov, T. E. Schellin and O. el Moctar (2014) A Rankine panel method for added resistance of ships in waves, J. Offshore Mech. Arct. Eng. 136(3) 031601·1-031601·7

Sutulo, S. and Guedes Soares, C. (2015), "Preliminary analysis of ship manoeuvrability criteria in wind", Maritime Technology and Engineering, Guedes Soares, C. & Santos T.A. (Eds.), Taylor & Francis Group, London, UK, pp. 933-946.

N.P. Ventikos, A. Koimtzoglou and K. Louzis (2015) Statistics for marine accidents in adverse weather conditions, Maritime Technology and Engineering, Guedes Soares & Santos (Eds.), Taylor & Francis Group, London, UK, pp. 243-251

Vettor, R. and Guedes Soares, C. (2015), "Detection and analysis of the main routes of voluntary observing ships in the North Atlantic", Journal of Navigation, Vol. 68, pp. 397-410.

Vettor, R. and Guedes Soares, C. (2015), "Multi-objective evolutionary algorithm in ship route optimization. Maritime Technology and Engineering, Guedes Soares, C. & Santos T.A. (Eds.), Taylor & Francis Group, London, UK, pp. pp. 865-876.

Vettor, R. and Guedes Soares, C., (2015) "A Ship Weather Routing Tool to Face the Challenges of an Evolving Maritime Trade", RIN International Navigation Conference 2015 (RIN-INC 2015), 24-26 February, Manchester, UK.

Zhou, X., Sutulo, S. and Guedes Soares, C. (2015), "Analysis of the numerical errors in the application of the 3D moving patch method to ship-to-ship interaction in shallow water", Maritime Technology and Engineering, Guedes Soares, C. & Santos T.A. (Eds.), Taylor & Francis Group, London, UK, pp. 973-984.

2.2.2 Accepted for Publication

Söding, H. and Shigunov, V., "Added resistance of ships in waves" Ship Technology Research – Schiffstechnik **62**(1) 2015, pp. 2-13

Vettor, R. and Guedes Soares, C., "Multi-objective route optimization for onboard decision support system", 11th International conference on marine navigation and safety of sea transportation (TRANSNAV 2015), Gdynia, Poland.

4th World Maritime Conference, 2015.

4th TRA Conference, 2016.

2.2.3 Submitted for Publication

Bitner-Gregersen, E.M., Vantorre, M., Guedess Soares, C. (2015). Adverse weather conditions for ship manoeuvrability. Abstract sent to TRA 2016.

2.2.4 Presentations at International Conferences

Liu, S, Papanikolaou, A., On the added resistance of ship in oblique seas, Proc. 5th Int. Conference on Coupled Problems in Science and Engineering, IACM Special Interest Conference, 17-19 June 2013, Ibiza, Spain.

Liu, S., Papanikolaou, A., Zaraphonitis, G., Time domain simulation of nonlinear ship motions using an impulse response function method, Proc. 2nd International Conference on Maritime Technology (ICMT 2014), 7-9 July 2014, SU Glasgow.

Shigunov, V., Papanikolaou, A., Criteria on minimum powering and maneuverability in adverse weather conditions, 14th International Ship Stability Workshop (ISSW 2014), 28 September – 1 October 2014, UTM Kuala Lumpur/Malaysia.

Papanikolaou, A., Bitner-Gregersen E., El Moctar, O., Guedes Soares, C., Reddy, R., Spengler, F., Shigunov, V., Zaraphonitis, G., Energy Efficient Safe Ship Operation (SHOPERA), Proc. Int. Conf. on the Influence of EEDI on Ship Design, The Royal Inst. of Naval Architects, 24-25 September 2014, London, UK.

Lusis, K., Ventikos, N., Eliopoulou, E., Papanikolaou, A., Statistics of marine accidents in adverse weather conditions, Proc. 2nd International Conference on Maritime Technology and Engineering (MARTECH 2014), publ. CRC Press/Balkema – Taylor & Francis Group, 15-17 October 2014, IST Lisbon.

Papanikolaou, A., Bitner-Gregersen E., El Moctar, O., Guedes Soares, C., Reddy, R., Spengler, F., Shigunov, V., Zaraphonitis, G., Energy Efficient Safe Ship Operation (SHOPERA), Proc. Int. Marine Design Conference IMDC2015, University of Tokyo and Soc. Of Naval Arch. And Ocean Engineers of Japan, 11-14 May 2015, Tokyo, Japan.

Papanikolaou, A., Bitner-Gregersen E., El Moctar, O., Guedes Soares, C., Reddy, R., Spengler, F., Shigunov, V., Zaraphonitis, G., Minimum Powering and Steering Requirements of Ships in Adverse Weather Conditions, Proc. 37th Motorship Propulsion and Emission Conference, 4-5 March 2015, Hamburg, Germany.

Papanikolaou, A., Energy Efficient Safe Ship Operation (SHOPERA), Proc. 1st International Workshop on Environmentally Friendly Ships, Nippon Kaiji Kyokai (NKK) and Yokohama National University, 4th March 2015, Yokohama, Japan. (2nd workshop on April 28th, 2015 in Athens).

Liu S., Papanikolaou, A., Practical approach to the added resistance of a ship in short waves, Proc. 25th International Ocean and Polar Engineering Conference ISOPE 2015, Kona, Big Island, Hawaii, USA, June 21-26, 2015.

Liu S., Papanikolaou, A., Prediction of Parametric Rolling of Ships in Single and Triple Frequency Regular Waves, Proc. 12th Int. Conf. on the Stability of Ships and Ocean Vehicles STAB 2015, The University of Strathclyde, Glasgow, UK, 14-19 June 2015.

2.3 First Public SHOPERA Workshop

To exchange views with external experts in ship design, hydrodynamics, safety and operation, shipowners, regulators and other stakeholders on hydrodynamic, design and regulatory aspects of norming manoeuvrability in adverse conditions, fine-tune the objectives of the project and the way ahead and, at the same time, facilitate acceptance of the project outcomes by the key stakeholders, four public workshops are organised within the project.

The first workshop “Introduction of the Project to Key Stakeholders” was organised by GL with the assistance of NTUA on October 30, 2014, in Hamburg, to communicate the objectives of the project to the wider scientific and technical community and to the various stakeholders.

The first part of the workshop included presentations by external speakers, representing the majority of views of industry and experts at IMO (BIMCO, Greek and Danish Shipowners Associations, IACS, ITTC), industry research groups in the subject area (Common Research Ships), as well as overseas research views from Japan and India. Industry representatives underlined very high expectations about the outcome of the project regarding the future regulatory work on EEDI at IMO.

In the second part, SHOPERA partners presented challenges addressed by SHOPERA along with the state of work and the proposed way ahead. Discussions were lively and most valuable in the substance. The common feeling was that the workshop greatly contributed to the understanding of some controversial matters and clarified the view of how to proceed in the next few years, even if the subject is politically very tricky and scientifically very demanding.

The main output from this workshop is the awareness of the key stakeholders of the project and facilitation of the acceptance of the expected results. The feedback from the external participants will be used to refine the objectives of the project and shape the way ahead.

List of Presentations:

- Jeppe Skovbakke Juhl (BIMCO) EEDI – Minimum power to ensure safe maneuvering in adverse conditions
- George A. Gratsos (Hellenic Chamber of Shipping) Minimum power requirements for safe navigation
- Hans Otto Kristensen (Danish Shipowners' Association) Some thoughts about minimum power for safe maneourvring in adverse weather conditions
- Torsten Mundt (DNV GL) IACS contribution on the minimum required power issue: A retrospection
- Frans Quadvlieg (Cooperative Research Ships, Group on Manoeuvrability in Waves) Manoeuvring in adverse weather
- Reint Dallinga, Olav Rognebakke (Cooperative Research Ships, Added Resistance in Waves Group) Added resistance - physical insights. Cooperative Research Ships JIP results
- Masaru Tsujimoto (National Maritime Research Institute) Japan's research activities on minimum propulsion power requirement - Hydrodynamic approach
- Apurba Ranjan Kar (Indian Register of Shipping) Ship Manoeuvrability: An overview of ongoing studies by Indian Register of Shipping
- Anton Minchev (FORCE Technology) Manoeuvring aspects at ultra-slow speeds
- Apostolos Papanikolaou (SHOPERA, NTUA) Introduction: Overview SHOPERA
- Elzbieta M. Bitner-Gregersen (SHOPERA, DNVGL) Met-ocean description
- Koimtzoglou A., Louzis K., Eliopoulou E., Ventikos N.P. (SHOPERA, NTUA) Identification of ships and risk analysis of relevant marine accidents
- Vladimir Shigunov (SHOPERA, DNVGL) Manoeuvrability criteria
- Carlos Guedes Soares (SHOPERA, IST): Development and Refinement of Numerical Hydrodynamic Tools
- Ould El Moctar (SHOPERA, UDE): Numerical Investigation of Added Resistance in Waves
- Florian Sprenger (SHOPERA, MRTK) Experimental Studies

2.4 Future Public SHOPERA Workshops

The second Public SHOPERA Workshop, "Benchmarking of Numerical Tools for Manoeuvrability Simulations in Adverse Conditions", is planned in October 2015 in Lisbon and will be organized by IST, UDE and NTUA. The objective of this workshop is to present the results of validation and benchmarking of the various numerical tools for the analysis of the hydrodynamic performance of ships in comparison with the results from model tests. Along with the members of the Advisory Committee, experts in ship hydrodynamics will be specifically invited, as well as other experts in ship design, safety and operation, shipowners, regulators and other stakeholders. The output from this workshop will be the evaluation of the world-wide state-of-the-art of numerical tools for manoeuvrability assessment in adverse conditions. This will be taken into account in developing Guidelines to be submitted to IMO. Additionally, this input will be used for dissemination of the gained knowledge in the project to the wide scientific and technical community outside of the project.

The third Public SHOPERA Workshop "Criteria and Standards for Sufficient Manoeuvrability under Adverse Conditions" is planned for March 2016 in London, and will be organized by LR, RINA and NTUA. During this workshop the developed criteria, standards and Guidelines for sufficient manoeuvrability under adverse conditions will be presented and discussed, to ensure feedback from the experts in ship design, operation and regulators. The members of the Advisory Committee, external experts in ship design, ship hydrodynamics, safety and operations, ship owners, regulators will be invited. The output from this workshop will be feedback to fine-tune the results of the project in accordance with the expectation of the key stakeholders.

The fourth Public SHOPERA Workshop "Presentation of the Results to Key Stakeholders" is planned for October 2016 in Athens and will be organised by NTUA, GL, DNV, LR and RINA. This workshop will provide the overall presentation of the elaboration of the project, with emphasis on the set objectives, adopted procedures, major achievements, key results, conclusions and recommendations. In particular, the developed new Guideline proposal for the required minimum propulsion power and steering performance for various types of ships to maintain manoeuvrability under adverse conditions will be presented and discussed with the scientific community and key stakeholders. The members of the Advisory Committee, external experts in ship design, ship hydrodynamics, safety and operations, ship owners, regulators will be invited. The output from this workshop will be wide awareness of the key stakeholders, particularly IMO members, of the proposal to update the Guidelines, and better acceptance of the project results, on the one hand, and the feedback received at the workshop on the other hand. The feedback will be used to refine the Guidelines and for the formal submission to IMO.

3 Exploitation Plan

3.1 Description of Work

The updated guidelines for the minimum required power and steering performance to maintain manoeuvrability under adverse conditions will be submitted to IMO for consideration; possible adoption in IMO's regulatory framework would ensure wide exploitation of the results. The guidelines will be based on the developed Level 1 procedures while keeping open the possibility of direct performance assessment using numerical methods and model tests. Therefore, the new numerical methods, software tools and testing techniques developed in the project would be required in the industry upon adoption of the updated guidelines. In addition, the developed

optimisation techniques, combining safety in adverse conditions with EEDI requirements, would also de demanded by the industry.

Existing software tools, already developed by a project partner, that were refined, adapted or extended during the elaboration of the project, will remain at the disposal of this partner for their exploitation after the end of the project by providing services to the industry or use in research/education and development. New software tools that will be developed during the elaboration of the project will remain for their exploitation at the disposal of the partners that were involved in their development. Innovative experimental techniques and procedures developed in the project will be further exploited by the corresponding partner that was responsible for their development.

The optimized ship designs will be exploited by the partners involved in their development. The new knowledge and understanding of the behaviour of various types of ships at low speed under adverse sea conditions will be openly available to the scientific community for further exploitation.

Activities and measures for the exploitation of the research output will be coordinated by an Exploitation Committee, consisting of the Project Coordinator, the WP1, WP6 and WP7 leaders (DNV, LR and GL), RINA and also DAN and FSG as representatives of the participating ship operators and yards. A preliminary Exploitation Plan will be issued with the Mid-Term Assessment Report and will be finalised at the end of the project. The Exploitation Committee will be responsible for ensuring that the results of the project are exploited to the full and in accordance with the intimated exploitation plans. Dissemination and communication strategies are to be consistent with the exploitation plan, also taking duly into account any applicable IPR agreements, especially referring to the newly developed or refined existing software tools of the partnership.

3.2 Exploitation Results

The ultimate aim of the project is to develop updated guidelines for various types of ships to maintain manoeuvrability under adverse conditions. The proposal for the guidelines will be prepared for submission to IMO; the key results and conclusions of the project will be submitted as an accompanying information paper. The submission may be done through IACS and/or by supporting national (flag states) delegations.

To ensure awareness of the key stakeholders at IMO about the project approach and results and provide for acceptance of the results to the IMO at the end of the project, the following activities have been conducted:

1. Submission of information paper to IMO/MEPC regarding objectives and the time plan of SHOPERA, to announce the project to the regulators and Administrations, explain aims, deliverables and deadlines, ensure awareness of the key stakeholders at IMO about the project and provide for acceptance of the results to the IMO at the end of the project. The paper, IMO MEPC (2014) EU Project “Energy Efficient Safe SHip OPERAtion” (SHOPERA), Paper MEPC 67/INF.14, submitted by Germany, Norway and United Kingdom, is included in the Appendix).
2. IMO/MEPC 67 takes account of SHOPERA and decides to wait up the completion of the project in September 2016 before updating the *2013 Interim Guidelines*.
3. Several IMO delegation papers to MEPC refer to the SHOPERA project and its anticipated contribution, see e.g. IMO MEPC 68/3/25 (2015) International Workshop on Environmentally Friendly Ships submitted by Japan.

4. Japan initiates a parallel to SHOPERA RTD project, funded by the Japan Government, NKK class and Japan Shipyard Research Association, and considers a possible common contribution to IMO in collaboration with SHOPERA.
5. 1st International Workshop on Environmentally Friendly Ships organized by the Japan project in Yokohama, March 4, 2015, included an invited SHOPERA presentation by A. Papanikolaou.
6. 2nd International Workshop on Environmentally Friendly Ships organized by the Japan project took place in Athens on April 28, 2015. The workshop involved wide European participation (EMSA, Netherlands, Denmark) and invited SHOPERA presentation by A. Papanikolaou and V. Shigunov.

3.3 Interim Exploitation Plan

The table below lists the key expected project outcomes, their exploitation area and timeline and responsible partners. This plan is to be extended, updated and finalized by the Exploitation Committee until the end of the project.

ID	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use	Owner and other Partner(s) involved
D1.1.1	Environmental data sets	Ship design Rule development	Direct commercial use is not planned	DNV, IST, GL, EVFH
D1.2.1	Accident data	Ship design Rule development	Direct commercial use is not planned	NTUA, DNV, GL, LR, RINA, DAN, CAL, FNK
D1.3.1	Safety criteria	Ship design Rule development	Direct commercial use is not planned	GL, DNV, LR, RINA, UDE, NTUA, IST, DAN, CAL, FNK
D2.1.1	Potential flow methods for seakeeping and stability in waves	Ship design Rule development	M15	IST, ULJ, NTUA, LR
D2.2.1	Potential flow methods for manoeuvring in waves	Ship design Rule development	M15	DNV, GL, IST, NTUA, RINA, LR, DTU
D2.3.1	Potential flow methods for manoeuvring in confined waters	Ship design Rule development Training	M15	IST, SU, LR
D2.4.1	Field methods to determine ship hydrodynamic characteristics	Ship design	M15	TUB, VTT, IST, SU, UDE, LR

D2.5.1	Field methods for direct predictions of ship motions	Ship design	M15	UDE, IST, LR
D5.1.1	Integrated optimization platform	Ship design	M30	NTUA, IST, UDE, FSG, ULJ, VTT, DUT, NAP
D7.7.1	Revised guidelines for sufficient manoeuvrability in adverse conditions	Regulations Ship design	M36	GL, DNV, RINA, LR, NTUA, FSG, DAN

4 Appendix

Germany, Norway and the United Kingdom (2014) EU Project "Energy Efficient Safe SHip OPERAtion" (SHOPERA), IMO MEPC 67/INF.14