DMA SAFETY ANALYSIS FOR HIGH-SPEED OFFSHORE VESSELS CARRYING UP TO 60 PERSONS

Report of HAZID and risk-reducing measures workshops

Søfartsstyrelsen/ Danish Maritime Authority

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Applicable contract(s) governing the provision of this Report:

Objective:

Identification of all hazards and risk-reducing measures for Crew Transfer Vessels (CTV) related to the increase of number of persons on board.

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1 EXECUTIVE SUMMARY

To respond to the development within the offshore wind industry, the Danish Maritime Authority (DMA) are examining the possibilities for establishing an equivalent safety standard to the passenger craft safety standard, by creating a safety standard for high-speed offshore crafts which transports more than 12 wind turbine technicians. The intended safety standard should mitigate the particular hazards this type of vessels encounter due to the nature of their operations and the increased number of persons on board. The current regulations only allow for up to 12 passengers on board, but there is a need in the industry to increase this number. A possible new safety standard shall therefore be applicable for up to 60 persons on board, including 12 passengers. DMA has engaged DNV GL to facilitate two workshops, one to identify the hazards (HAZID) and one to identify the risk-reducing measures. The HAZID workshop was conducted on November 8th 2016, and the workshop concerning risk-reducing measures was conducted on December 1st.

The scope of the assessment was high-speed offshore crafts carrying up to 60 persons including the crew, and considered all phases of operation:

- Transit to/from wind farm
- Docking/undocking at the wind turbine
- 24-hour operation/overnight accommodation
- Transfer of personnel and equipment to/from the wind turbine or larger vessels (floating hotels or SPS certified vessels)
- External coordination of ship traffic within offshore wind farms and the possibility of external assistance in case of evacuation

The participants of the workshop were operators, Masters, designers, Chief Engineers, and more, from the industry. DMA was present as observers, and DNV GL led the workshop. During the first workshop 48 hazards within 12 topics were identified. 23 of these was categorized as "High" risk, 17 as "Medium" risk, and 8 as "Low" risk. The topics which appeared to be most critical were "Fire/explosion safety", "Structural safety", and "Escape, evacuation and recovery" with respectively 6, 8, and 7 "High" and "Medium" risk hazards. The "High" and "Medium" hazards were the scope for identifying risk-reducing measures during the second workshop. The risk analysis was carried out based on the general International Maritime Organisation (IMO) guidelines for Formal Safety Assessment (MSC-MEPC.2/Circ.12/Rev.1). The identified measures were operational and structural measures, probability and consequence reducing measures, and following IMO's guideline for goal-based standards (MSC.1/Circ.1394/Rev.1). "Fire and explosion safety", "Structural safety/Damage stability", "Escape, evacuation and recovery", and "Dangerous goods" were the topics to which the participants contributed the most. A recurring discussion during the workshop was whether to include the wind turbine technicians in the muster list on board.

The work was initiated before a decision regarding Industrial Personnel was reached in the IMO at the Maritime Safety Committee's 97th session (MSC 97). Nevertheless, wind turbine technicians are expected to meet the criteria described in the forthcoming IMO interim recommendations, on the safe carriage of more than 12 industrial personnel on board vessels engaged on international voyages, and wind turbine technicians are therefore not considered or treated as passengers under SOLAS regulation I/2(e) but as industrial personnel

The High-Speed Craft (HSC) Code requirements for cargo crafts were used as a basis during the second workshop, and the goal was to come up with risk-reducing measures not already covered by the Code, and thereby creating a safety level equivalent to that of a passenger craft. The HSC Code requirements for passenger craft are similar in structure to the cargo requirements, but include stricter requirements due to the number of passengers permitted to be carried on board. A review of the two sets of requirements, highlighting the differences was presented at the start of the second workshop.

The hazards of highest interest to the DMA are the hazards for which the DMA can regulate the requirements for mitigating measures. In general, these are the requirements regarding safety issues directly linked to construction and equipment of the vessels. Of the 12 hazard topics, the following 5 are the most relevant:

- Fire/explosion safety
- Structural safety
- Damage stability
- Escape, evacuation and recovery
- Dangerous goods

Within the above topics, the "High" and "Medium" ranked hazards important to consider when increasing the number of WTT on board are, but not limited to, the following:

- Fire in galley
- Electrical fire
- Fire in engine compartment
- Fire in accommodation
- Loss of structural integrity
- Grounding
- Unsuccessful evacuation
- Unsuccessful rescue
- Man-overboard during transit
- Crew overboard
- Man-overboard during idling
- Incorrect handling of dangerous goods
- Incorrect storage of dangerous goods
- Incorrect waste handling of waste from turbines e.g. oily rags

2 INTRODUCTION

The Danish Maritime Authority (DMA) is experiencing, like Administrations in other countries, a development towards larger crafts carrying more than 12 wind turbine technicians. To respond to the development within the offshore wind industry, the Danish Maritime Authority (DMA) are examining the possibilities for establishing an equivalent safety standard to the passenger craft safety standard, by creating a safety standard for high-speed offshore crafts which transports more than 12 wind turbine technicians to and from wind farms. A possible new safety standard for this type vessel should ensure mitigation of the special hazards this type of vessels encounter due to the nature of their operations and the increased number of persons on board, and create an acceptable safety level. Such a standard could, among other aspects, take into consideration structure of the vessel, damage stability, carriage of dangerous goods, increased consequence of a fire and delayed evacuation due to overnight accommodation on board, and "walk-to-work" concepts.

The approach, to answer the above-mentioned development within the offshore wind industry, consists of two workshops to cover hazard identification (HAZID) and safety measures. This report is a compilation of the reports from each of the workshops, /1/ /2/. The HAZID workshop, conducted November 8th 2016, was purely focused on identifying hazards related to crew transfer vessels (CTVs) transporting and transferring wind turbine technicians, and the increase of persons on board from crew + 12 passengers to a total of 60 persons (crew and wind turbine technicians). The second workshop, conducted December 1st 2016, focused on identifying risk-reducing measures for the identified hazards.

2.1 Industrial personnel

The work was initiated before a decision regarding Industrial Personnel was reached in the International Maritime Organization (IMO) at the Maritime Safety Committee's 97th session (MSC 97). Nevertheless, wind turbine technicians are expected to meet the criteria descried in the forthcoming IMO interim recommendations, on the safe carriage of more than 12 industrial personnel on board vessels engaged on international voyages, and wind turbine technicians are therefore not considered or treated as passengers under SOLAS regulation I/2(e) but as industrial personnel. The result of this work is intended to be used in development of a safety standard for vessels carrying more than 12 industrial personnel.

3 HAZID AND RISK-REDUCING MEASURES WORKSHOP

3.1 Objective and methodology

The objective of the two workshops was to identify all hazards and risk-reducing measures related to the operation of CTV's and the increase of number of persons on board.

The hazards identified covers all phases of operation:

- Transit to/from wind farm
- Docking/undocking at the wind turbine
- 24-hour operation/overnight accommodation
- Transfer of personnel and equipment to/from the wind turbine or larger vessels (floating hotels or SPS certified vessels)

For each phase, the participants of the first workshop:

- Identified relevant hazard(s)
- Identified the causes and potential consequences of the hazard
- Listed existing barriers
- Raised actions and additional information/comments

After all hazards were identified, the risk was assessed in terms of probability and consequence taking existing barriers into account. Hazards relevant for vessel, personnel, and environment were included.

For each hazard, the participants of the second workshop identified both operational and structural measures to mitigate the hazard. Examples of operational measures are: training, manuals, assessments, procedures. Structural measures are here understood to include technical equipment and can for example be redundancy in systems, sufficient number of survival suits, design of vessel. The measures are both probability reducing and consequence reducing measures. The risk assessment was carried out based on the general IMO guidelines for Formal Safety Assessment, /3/.

The High-Speed Craft (HSC) Code cargo craft requirements, /4/, are the basis for the potential development of a safety standard by DMA. The risk-reducing measures were formulated based on the International Maritime Organization's (IMO's) guideline for goal-based standards, /5/. Chapter 4.3. IMO defines *goals* as: "… high-level objectives to be met. A goal should address the issue(s) of concern and reflect the required level of safety."

3.2 Risk matrix

The following risk matrix, Figure 1, was used during the first workshop as a basis for the risk ranking. The matrix consists of three likelihood categories and three consequence categories.

			Likelihood categories		
			1	2	3
			Failure not heard of in industry	Failure occurred in industry	Failure occurred several times in industry
Consequence categories	1	No or minor - injuries to personnel - damage to material/environment	L	L	M
	2	Serious - injuries to personnel - damage to material/environment	L	M	H
	3	1 or more fatalities to personnel Major damage to material/environment	M	H	H

Figure 1 Risk matrix

Based on input from the participants the risk matrix categories were updated during the workshop. The agreed definitions are shown in Figure 1. The wording of the likelihood categories was changed to be industry specific, and the consequence categories changed to include material and environmental damage.

"Industry" is understood as the wind farm crew transfer industry.

3.3 Assumptions

The workshops focused on the hazards not covered by the HSC Code cargo craft requirements and where the number of persons on board or the type of operation relevant for transport of personnel to and from wind farms will affect the risk level.

The following topics were not included in the scope of the workshop:

- Hull made of composite materials
- Power generation from batteries
- The regulation on occupational health and working environment for crew and technicians is not included in the scope since the regulation is not affected by the increased number of persons on board. However, fatigue due to 24-hour operations and disrupted sleeping patterns came up during the discussions and fatigue was included as a hazard in the log sheet, see Chapter 4
- Wind farm installation vessels
- Lifting operations/cranes

3.4 Participants

All workshop participants are listed in Table 1. An "X" in the "WS 1" and/or "WS 2" column indicates that the person respectively attended the HAZID workshop and/or the risk-reducing measures workshop. A more comprehensive list including competence area and experience can be found in Appendix A.

Table 1 Participant list

#	Name	Company	Role	WS 1	WS 2
1	Christian Bækmark Schiolborg	Danish Maritime Authority	Special Adviser – Technical Regulation	X	X
2	Per Sønderstrup	Danish Maritime Authority	Director – Maritime Regulation and Legal Affairs	X	
3	Torsten Arnt Olsen	Danish Maritime Authority	Chief Ship Surveyor		X
4	Kasper Raunskov Rasmussen	Danish Maritime Authority	Ship Surveyor	X	
5	Morten Nicolai Kiersing	Danish Maritime Authority	Ship Surveyor		X
6	Ellen Kristine Ombler	DNV GL	Facilitator	X	X
7	Nora Helen Lund Lyngra	DNV GL	Scribe	X	X
8	Participant	OSK-ShipTech	Senior Naval Architect	X	X
9	Participant	Esvagt	Head of Ship Management – Operations	X	
10	Participant	Esvagt	Ship Management – Operations		X
11	Participant	NT Offshore	CEO	X	
12	Participant	World Maritime Offshore	Chief Operations Officer	X	
13	Participant	Northern Offshore Services	Chief Operating Officer	X	X
14	Participant	Northern Offshore Services	Project and New-Building Manager	X	
15	Participant	Northern Offshore Services	HSE Manager	X	X
16	Participant	Northern Offshore Services	Master of Crew Transfer Vessel	X	X
17	Participant	Fred. Olsen Windcarrier	Master of Crew Transfer Vessel	X	
18	Participant	SeaHealth	Occupational Health and Communication Consultant	X	X

19	Participant	Siemens Wind Power	Marine Operations Manager	X	X
20	Participant	MHI Vestas Offshore Wind	Marine Project Manager	X	X
21	Participant	Dong Energy	Senior Maritime Specialist	X	X
22	Participant	Danish Shipowners' Association	Deputy Director	X	X
23	Participant	Danish Maritime	Technical Director	X	X

4 RESULTS

During the workshops input, assessments, discussions and comments from the participants were noted in a log sheet. The following subchapters outline the result, while the complete HAZID and risk-reducing measures log can be found in Appendix B. Text with red colour in the cells indicates changes related to the HAZID-workshop done during the risk-reducing measures workshop. Text in the log with blue colour are comments given by DNV GL Senior Consultant and Quality Assessor for the delivery of the project, Simon Mockler.

4.1 Hazard identification

At the start of the HAZID workshop the participants were asked to come up with the hazards and aspects they thought of as the most important for the workshop. This resulted in the following list:

- Qualification and medical condition of the persons on board
- Size of the vessel
- Injuries to people due to contact with wind turbine
- High transit speed
- Weather conditions
- Movement of vessel combined with type of people on board
- Cargo operations
- Launch of vessel on/off another ship
- Transfer of persons from vessel to wind turbine and between vessels
- Simultaneous operations
- Different design of boat landings
- Crew qualifications and crowd management
- Number of crew
- Operational schemes (24-hour operation)
- Navigational hazard (in wind farm)
- Technical redundancy
- Distance to rescue service
- Blackout and lack of propulsion
- Definition of operational limits, operational area
- Fire risk
- Grounding/collision
- Man-overboard
- Emergency scenario
- Lifesaving appliances
- Procedures specific for operation
- Use of safety harness
- Safety management system
- Safety culture

All the above points were covered in the workshops, except the point regarding launch of vessel on/off another ship. This was discussed and evaluated to not be relevant for a vessel with more than 12 technicians on board.

The hazard identification was performed by systematically discussing 12 different HAZID topics which were agreed upon and assessed for the four operational phases. The topics can be found in Table 2. Not all topics are relevant for all four phases.

Table 2 Hazard rating for each topic

Topic	No of hazards	H	M	L
1. Fire/explosion safety	11	5	1	5
2. Structural safety	9	5	3	1
3. Damage stability	2	2	0	0
4. Escape, evacuation and recovery	7	3	4	0
5. Overnight accommodation offshore	1	0	0	1
6. 24-hour operation	3	1	1	1
7. Dangerous goods	3	0	3	0
8. **"Walk**-to-work"	2	1	1	0
9. Manning	3	1	2	0
10. Operational aspects	4	2	2	0
11. Small boat operation from CTV	1	1	0	0
12. Manoeuvrability	2	2	0	0
SUM	48	23	17	8

Table 2 gives also an overview of the risk ratings agreed upon during the HAZID workshop. In total 48 risks were identified. Of these are 23 rated as "High" risk, 17 as "Medium" risk, and 8 as "Low" risk.

Table 3 gives a description of the risk rating categories. These categories determined whether a hazard needed risk-reducing measures. The hazards with category "High" and "Medium" were given special attention and was pursued in the second workshop; the risk-reducing measures workshop.

Table 3 Description of risk categories

Category	Description
High	Risk-reducing measures must be discussed
Medium	Risk-reducing measures should be discussed to ensure that the risk is as low as reasonably practical.
Low	It is not necessary to include risk-reducing measures, as the increase in number of persons on board does not influence the risk level and the risk is acceptable.

The 23 hazards which obtained the "High" risk category are the following:

- Fire in galley
- Electrical fire
- Fire in engine compartment
- Fire on the bridge
- Fire in accommodation
- Hard impact at boat landings
- Missed landings
- Collision with another vessel
- Dropped objects from turbine onto vessel
- Grounding
- Loss of structural integrity
- Lack of knowledge of damage stability
- Unsuccessful evacuation
- Man-overboard during transfer of personnel to/from turbine or vessel offshore
- Medical states requiring first aid
- Fatigue
- Loss of position while using "walk-to-work" system
- Inexperience crew
- Communication error and misunderstandings
- Simultaneous operations (SimOp) where vessels are not aware of each other
- Launch and recovery
- Lack of propulsion
- Loss of power

The 17 hazards which obtained the “Medium” risk category are the following:

- Fire in cargo compartments and other compartments or stores rooms
- Impact with wind turbine cabling anodes
- Damage to fendering
- Impact with accommodation vessel
- Unsuccessful rescue
- Man-overboard during transit
- Crew overboard
- Man-overboard during idling
- Insufficient maintenance
- Incorrect handling of dangerous goods
- Incorrect storage of dangerous goods
- Incorrect waste handling of waste from turbines
- Failure of “walk-to-work” systems
- Insufficient manning
- Unqualified crew
- Inconsistent procedures and standards
- Lack of coordination at wind farm

4.2 HSC Code cargo craft vs. passenger craft requirements

A comparison of the High-Speed Craft (HSC) Code, /4/, cargo craft requirements and the HSC Code passenger craft requirements was prepared and presented by DNV GL at the start of the risk-reducing measures workshop. The goal was to highlight relevant content and differences between the two sets of requirements. The HSC Code cargo rules forms the basis upon which additional requirements are to be developed to acquire a level of safety equal to or as near to HSC Code passenger rules as possible or practical. For the hazards where the HSC Code cargo craft requirements are insufficient to achieve the intended safety level, the passenger craft requirements can be used as a guideline. DMA’s scope included to reveal hazards not sufficiently covered by neither the cargo nor the passenger requirements.

Table 4 gives some of the main differences between the cargo and the passenger craft requirements, presented during the second workshop. The complete presentation can be found in Appendix C.

Table 4 Main differences cargo and passenger craft requirements

Cargo craft requirements	Passenger craft requirements
Time at service speed from safe refuge limited to 8 hours	Time at service speed from safe refuge limited to 4 hours
Max 15° inclination after damage	Max 10° inclination after damage
	Craft to be designed for the collision design acceleration g_{coll}
Fixed sprinkler system to be installed in crew accommodation areas of sizes above 50 m2	Fixed sprinkler system to be installed in public spaces, service spaces, crew accommodation areas, storage rooms etc.
Redundancy: maintain essential machinery and control, but not return to port of refuge	Return to port of refuge for HSC Passenger Category B[1] craft under its own power
- 2 power bilge pumps - 2 pumps per hull on multihull craft - 1 pump allowed if cross hull bilge pumping is possible	- 3 power bilge pumps (Cat. B craft) - 2 power bilge pumps (Cat. A craft) - 2 pumps per hull on multihull craft
Emergency source of power: Essential services according to HSC Code Ch.12.8.2 to be served for 12 hours	Emergency source of power: Category A craft: - Essential services according to HSC Code Ch.12.7.3 to be served for 5 hours Category B craft - Essential services according to HSC Code Ch.12.7.4 to be served for 12 hours

4.3 Goals for risk-reducing measures

The 12 topics used in the HAZID workshop were pursued in the risk-reducing measures workshop, see Table 5. At the start of the discussion of each topic a short brainstorming was performed to emphasize the overall *goal* for the risk-reducing measures within the topic, see Table 5. The intension for the specification of these goals was to make the participants consider the overall motivation for introducing a risk-reducing measure, and not be too specific in their formulations, following IMO's guideline for goal-based standards, /5/. Goals were not included for all topics, only where the participants found this necessary.

[1] The passenger craft requirements are divided into two categories, A and B: A ≤ 450 persons on board, B > 450 persons on board.

Table 5 Hazard topics

Topic	*Goals* of risk-reducing measures
1. Fire/explosion safety	- Prevent (fire triangle) - Protect crew and vessel - Avoid fire - Protect people, prevent. Focus on safety of additional persons on board - Early detection - Contain fire vs. extinguish fire
2. Structural safety	- Prevent injuries - Prevent damage to hull
3. Damage stability	
4. Escape, evacuation and recovery	- Leave vessel in rapid and safe manner - Be rescued
5. Overnight accommodation offshore	
6. 24-hour operation	- Prevent fatigue - Protect health of crew and technicians - Minimize risk of human errors
7. Dangerous goods	- Limitations to what type of cargo allowed - Be compliant with IMDG Code (difficult)
8. "Walk-to-work"	
9. Manning	
10. Operational aspects	
11. Small boat operation from CTV	
12. Manoeuvrability	

4.4 Risk-reducing measures

For each hazard with either "High" or "Medium" risk ranking, operational and structural risk-reducing measures were discussed. These measures cover barriers not already listed in "Existing barriers" from the first workshop. The key takeaway points for each topic are cited in the following paragraphs.

During the workshop, it was highlighted by several of the participants that rules should provide flexibility, and that some risk-reducing measures might be appropriate if 60 persons on board while unnecessary if only approved for 24 wind turbine technicians + crew. This was included as comments in the log sheet where the participants found this necessary.

4.4.1 Fire and explosion safety

For "Fire and explosion safety" risk-reducing measures included:

- fire-fighting manual
- resilient mountings for electrical equipment
- CCTV in engine compartment/stores/other compartments
- fixed fire-fighting systems
- assessment of redundancy weak-points
- restrictions for smoking
- restrictions for personal electrical equipment

It was also commented that a galley on board will be more demanding regarding fire safety, and that the necessity of a galley or pantry on board should be clarified. Further, it was assumed that the probability of fire in the vessel's electrical system does not increase if the number of persons on board rises to 60. Anyhow, the increase of persons on board will lead to an increase of personal electrical equipment on board, and the need for regulation of such equipment was discussed.

4.4.2 Structural safety/damage stability

For "Structural safety/Damage stability" the discussions mainly covered:

- how to approach landings and how persons on board shall behave during this part of operation
- requirements to the response time of the propulsion system
- requirements for fender design
- the use of Electronic Chart Display and Information System (ECDIS) and Automatic Identification System (AIS)
- arrangements and procedures for emergency towing

The CTV's are designed to handle tough impacts, but this does not protect the persons on board from injuries. Impacts will most likely happen during operation in borderline weather conditions.

4.4.3 Escape, evacuation and recovery

The discussions regarding "Escape, evacuation and recovery" dealt with:

- the mustering plan
- size and location of mustering area
- time available for evacuation
- hull design making it easier to escape but also easier to recover persons
- man-overboard (MOB) boats

It was commented that "flight" is still the overall strategy for vessels with increased number of persons on board, therefore is the location and safety of mustering stations/areas essential.

4.4.4 Overnight accommodation offshore/24-hour operation

With respect to "Overnight accommodation offshore/24-hour operation" the risk-reducing measures suggested were:

- rest hour regulations
- maximum number for overnight stays offshore
- control of boat landing impact forces
- noise levels and vibration
- weather restrictions
- design of vessel for easy maintenance

Another suggestion was to rest and sleep on board accommodation vessels. It was suggested that requirements connected to persons sleeping on board should, in the extent possible, take the vessels operational profile into consideration. E.g. if persons only sleep on board while the vessel is at anchor or in port, noise and vibrations generated from the engines or caused by vessel movements have only limited influence on the quality of peoples sleep. If rest is to be done on board the CTV there should be focus on the level of noise and vibration in the cabins.

4.4.5 Dangerous goods

The main takeaway form the "Dangerous goods" discussion is that requirements suited for CTVs are missing. The International Maritime Dangerous Good (IMDG) Code is challenging to apply. Tailored requirements should be developed with the operation and design of the CTV in focus. Input from the workshop covers:

- knowledge of the cargo on board
- specific requirements with respect to personal protective equipment (PPE)
- compartments with ventilation and fire rating
- designated areas for dangerous goods

It was noted that larger vessels will give the possibility to carry more dangerous goods than what is common today.

4.4.6 Walk-to-work systems

The increase of persons on board to 60 will not affect or be affected by a walk-to-work system. No risk-reducing measures have therefore been listed for this topic. The development of a certification system for these technologies is ongoing in the industry.

4.4.7 Manning

A recurring topic during the workshop was whether to include the wind turbine technicians in the muster list on board by giving them simple tasks and areas of responsibility in case of an emergency. This was brought up with regards to fire-fighting, evacuation, man-overboard, and manning.

4.4.8 Operational aspects

The hazards identified for "Operational Aspects" are covered by the International Safety Management (ISM) Code and/or are the responsibility of the charterers. It was also mentioned that the HSC Code passenger requirements could be used for this topic.

4.4.9 Small boat operation from CTV

Regarding "Small boat operation from CTV" it was discussed to what extent we in the future will see the use of tender boats/work boats/daughter crafts from larger CTV's, as already used today from Service Offshore Vessels (SOV). It was also discussed whether wind turbine technicians could conduct specific training and thereby help during launch and recovery of tender boat/work boat/tender craft.

The idea of smaller CTV's being launched from a larger vessel, in the future, was also introduced.

Whether approval in accordance with industry standards regarding lifting equipment and operations e.g. NORSOK R-002 "Lifting equipment" might be a possibility was also mentioned during the discussions.

4.4.10 Manoeuvrability

To ensure manoeuvrability, redundancy of important machinery, systems and equipment is suggested. It was highlighted that training in how to use these systems is important. It was also mentioned that the HSC Code passenger requirements could be used for this topic, as power and propulsion is regarded as critical system.

4.5 Construction and equipment related hazards

The hazards of highest interest to the DMA are the hazards for which the DMA can regulate the requirements for mitigating measures. In general, these are the requirements regarding safety issues directly linked to construction and equipment of the vessels. Of the 12 hazard topics, the following 5 are the most relevant:

- Fire/explosion safety
- Structural safety
- Damage stability
- Escape, evacuation and recovery
- Dangerous goods

Within the above topics, the "High" and "Medium" ranked hazards important to consider when increasing the number of WTT on board are, but not limited to, the following:

- Fire in galley
- Electrical fire
- Fire in engine compartment
- Fire in accommodation
- Loss of structural integrity
- Grounding
- Unsuccessful evacuation
- Unsuccessful rescue

- Man-overboard during transit
- Crew overboard
- Man-overboard during idling
- Incorrect handling of dangerous goods
- Incorrect storage of dangerous goods
- Incorrect waste handling of waste from turbines e.g. oily rags

4.6 Industry standards

Due to the lack of tailored regulations for the CTVs, the industry has implemented requirements of their own. In the log these are referred to as "industry standard". Some examples, which were mentioned during the workshops, are given below:

- The use of CCTV for surveillance of the engine compartment in case of fire.
- Redundancy of important machinery, systems, and equipment.
- AIS is required.
- Procedures for voyage planning.
- Redundancy of life-saving appliances (LSA).
- Several industry standards are governing requirements for training of wind turbine technicians.
- Site specific search-and-rescue plan.
- One person shall never be outside on deck alone.
- Vessels shall be equipped to pull a person out of the water within 5 minutes.
- First aid training is mandatory for crew and wind turbine technicians.
- Required to have Automated External Defibrillator (AED) on board.
- Requirements for walk-to-work systems.

5 REFERENCES

/1/ DNV GL (2016) "DMA safety analysis for high-speed offshore vessels carrying up to 60 persons - HAZID report of workshop #1". Report number: 2016-1055 Rev. 2.

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/3/ The International Maritime Organization (IMO) (2015) "Revised guidelines for formal safety assessment (FSA) for use in the IMO rule-making process". MSC-MEPC.2/Circ.12/Rev.1.

/4/ The International Maritime Organization (IMO) (2000) "International Code of Safety for High-Speed Craft, 2000 (2000 HSC Code)".

/5/ The International Maritime Organization (IMO) (2015) "Generic guidelines for developing IMO goal-based standards". MSC.1/Circ.1394/Rev.1.

APPENDIX A

Participant list

	Name	Affiliation	Position	Role / Competence area	Experience
1	Christian Bækmark Schiolborg	Danish Maritime Authority	Special Adviser, Technical Regulation	Workshop convener / Rules and Regulation	Delegate at IMO working- and expert groups on the subject of Industrial Personnel. Ship Surveyor at the Danish Maritime Authority. He has sailed has marine engineer before joining the Danish Maritime Authority. Education: Post Graduate Diploma as Marine Chief Engineer and Master Mariner.
2	Per Sønderstrup	Danish Maritime Authority	Director – Maritime Regulation and Legal Affairs	Workshop convener / Rules and Regulation	Master Mariner, EMBA shipping & logistics, working experience in maritime regulation, survey and certification, STCW, SOLAS and related Codes. Working experience with the development of offshore standards at IMO.
3	Torsten Arnt Olsen	Danish Maritime Authority	Chief Ship Surveyor	Workshop convener / Rules and Regulation	Maritime regulation, survey and inspection (DMA) Ship design and construction (Marine consultants) Technical & system support (Shipowners) Education: Naval Architect, M.Sc.
4	Kasper Raunskov Rasmussen	Danish Maritime Authority	Ship Surveyor	Workshop convener / Rules and Regulation	Ship surveyor at DMA since March 2015. DMA Department "ship's" delegate over the past year with regards to the offshore segment and the handling of dangerous goods and development towards transport of technicians. New building responsible on the first Danish approved cargo ship transporting up to 24 technicians. Prior to DMA position 2 years hiring in the tanker fleet. Education: Prof. Bach. Ship's officer and diploma as Master Mariner.
5	Morten Nicolai Kiersing	Danish Maritime Authority	Ship Surveyor	Workshop convener / Rules and Regulation	Dual purpose ship officer. Primarily engaged on container and passenger vessels. Employed five years with DMA, three of these as a ship surveyor. Primary areas are CTV, diving, IMDG, ISPS.
6	Ellen Kristine Ombler	DNV GL	Consultant, Safety Maritime Advisory	Project Manager / Workshop facilitator	Master of science; Marine Technology. 5 years' experience from risk management services. Specialization in barrier management, especially in development of barrier strategies and risk management processes. Has facilitated numerous risk assessment workshops.

7	Nora Helen Lund Lyngra	DNV GL	Consultant, Safety Maritime Advisory	Workshop co-facilitator / Workshop scribe	Master of science; Marine Technology with specialization in structures. Has completed a 2 year surveyor training programme, and been working as fleet in service surveyor in Rotterdam.
8	Participant	OSK-ShipTech	Senior Naval Architect	Vessel design and construction	Employed with Ole Steen Knudsen / OSK-ShipTech since graduation from the Technical College of Elsinore 1984. Design of specialized vessels and small craft, here amongst CTV and FRB between 7,5 and 32m length to varying sets of rules. Experience with hull design in aluminum since 2005. Damage stability in connection with initial design of Passenger vessels. Fire safety construction for all types of ships during design and conversion.
9	Participant	Esvagt	Head of Ship Management – Operations	Ship and crew	25 years of seagoing experience as Fisherman, master of fishing vessel and in the offshore industry/Merchant ships role as Able seaman, mate and finally Master. 5 years of experience as HSEQ manager and present role is responsible for Ship Management Operation in Esvagt. Education: Master, Various HSEQ related courses/education.
10	Participant	Esvagt	Ship Management – Operations	Ship and crew	Latest 3 years in role as HSEQ manager in ESVAGT. Approx. 20 years of seagoing experience, related to operation and navigation, e.g. ESVAGT as mate and master, Mate in Maersk Supply Service and Maersk Line and lieutenant of reserve in Royal Danish Navy. Education as Master Mariner, Deck apprentice in A.P. Møller and educated as carpenter.

11	Participant	NT Offshore	CEO	Ship and crew	Employed with NT Offshore as CEO since 2007 Sailed for 15 years Worked (none profit) Greenland home rule selected group for special maritime rules for arctic areas. Co-founder of NT Offshore, World Marine Offshore, M-Tech Offshore Technical manager and Ship manager for 14 years in different companies. RAL, NTO, WMO, ESVAGT. Educated: Marine engineer 1989 Project management 2002 Finance management 2006 Organization & company management 2007
12	Participant	World Marine Offshore	Chief Operations Officer	Ship and crew	
13	Participant	Northern Offshore Services	Chief Operating Officer	Ship and crew	Education: College of Applied Engineering and Maritime studies, Bachelor of Science (Master mariner) and College of Applied Engineering and Maritime studies, Commercial Management and Organization in Nautical Science. Work at sea for 17 years in deck department 5 years as a Captain, on oil & chem tankers, Bulk, Survey, pax catamarans etc. COO in NOS for 6 years. Member of BV Nordic Committee, Danish Shipowners' Association Offshore Committee, CWN, IMCA CMID Committee etc.
14	Participant	Northern Offshore Services	Project and New-building Manager	Ship and crew	Education: Bachelor of Science in Marine Engineering. Has sailed as marine engineer and chief engineer on various vessels since 1998, Site manager for new-building (offshore vessels, oil and gas) for 4 years.
15	Participant	Northern Offshore Services	HSE Manager	Ship and crew	Education: Bachelor of Nautical Science, active unlimited Master Mariner. Work at sea for 17 years, mostly in deck officer positions. 4 years as Master, combined large RoRo/LoLo ship (1 year on a CTV). Continuously performed maritime training such as advanced firefighting, crowd and crisis management, human behavior and bridge recourse management, basic safety, GMDSS, dangerous cargo, medical. 3 years with HSEQ work on maritime management level in offshore industry with focus on risk analysis, job safety analysis, vessel security risk profiles, project risk assessments, HSEQ reporting, vessel safety inspections/audits.

16	Participant	Northern Offshore Services	Master of Crew Transfer Vessel	Ship and crew	Education, university of applied engineering And maritime studies. Been working in the windfarm industry since 2010. Employed as a master at NOS since 2013.
17	Participant	Fred. Olsen Windcarrier	Master of Crew Transfer Vessel	Ship and crew	Education: Svendborg seafarer school as ordinary Seaman (OS), Marstal Navigation school as Captain restricted. Experience: 3 years' ordinary seaman on merchant ships (Coasters) 3 years 2nd officer, 6 years' Chief officer, 2 years as captain on CTV.
18	Participant	SeaHealth	Occupational Health and Communication Consultant	Rules and Regulation / Occupational Health	Occupational Health and Safety Consultant for seafarers working in Danish merchant fleet, including offshore wind vessels. Delegate at Wind Europe, IMCA Renewable subcommittee and member of G+ steering committee. Coordinator of Cross-Wind Network, which is a health and safety forum for offshore wind companies at operational level. Besides, covering areas as work flows and preventive matters e.g. new ship buildings, drinking water, food, ergonomics. Background: Engineer in occupational and environmental management plus master in toxicology.
19	Participant	Siemens Wind Power	Marine Operations Manager	Wind Turbines	- Tender, contract management of vessels servicing the wind industry, - IMO delegate (DMA) – offshore subjects - DMA ship surveyor - Education: Dual Purpose Officer (Master Mariner/Marine Engineer)
20	Participant	MHI Vestas Offshore Wind	Marine Project Manager	Wind Turbines	Responsible for evaluation of vessels and logistical concepts for MHI Vestas Offshore Winds service and completion setups with focus on operational efficiency and cost optimization. He has a background in shipbuilding, mainly smaller specialized vessels and 3 years as Vessel Superintendent responsible for CTV operations. Education: Marine Engineer.

21	Participant	Dong Energy	Senior Maritime Specialist	Wind Turbines	Dong Energy Wind Power Operations, Offshore Logistics Covering inter alia vessel management, maritime safety and regulation, offshore logistics management and sea area surveillance. Background: Dual Purpose Ship Officer. DFDS A/S. Mechanical Engineer. Svendborg Brakes A/S, X-Yachts and DONG Energy Wind Power Engineering.
22	Participant	Danish Shipowners' Association	Deputy director	Rules and Regulation	Working experience as master in fishingvessels in the Arctic. Ship surveyor in the Danish Maritime Authority – working with legislation, survey and international negotiation. Education: Fishingmaster 1 and certified programme writer.
23	Participant	Danish Maritime	Technical director	Rules and Regulation	Education: Ship Master´s Examination, B.Sc. Naval Architecture and Leadership & Management. Experience: Active as mate on bulk carrier, RoRo Passenger ships and HSC´s. Work as Class Surveyor & QMHSE auditor for 17 years. Continuously performed maritime training such as STCW tanker safety & operations, classification and statutory surveys, ISM -, ISO 9000 & 14000 auditing and Risk Management including exam. Management positions with bulk, tanker, RoRo cargo & passenger ship and container ship owners. Has experience from participation in company shore-based emergency team. Experience as ISM responsible company rep. and DPA positions. Has participated in HAZID´s. Delegate at IMO.

APPENDIX B
HAZID and risk-reducing measures log sheet

HAZID and risk-reducing measures log, rev. 0

Project: DMA SAFETY ANALYSIS FOR HIGH SPEED OFFSHORE VESSELS CARRYING UP TO 60 PERSONS

Date workshops: 08.11.2016 and 01.12.2016
Place: DMA, Valby

ID	Hazard	Cause	Consequence	Existing barriers	Probability	Consequence	Risk	Operational-risk reducing measures	Structural risk-reducing measures	Comments from HAZID workshop	Comments from risk-reducing measures workshop
1	Fire/explosion safety										
1.1	Fire in galley	Cooking Lack of cleaning Overheating Electric equipment	Fatality Injury Need of first aid Material damage	Portable fire extinguishers Requirements for non-combustible materials Training Proper cleaning Maintenance (Fixed fire extinguishing system) Heat and smoke detectors	2	3	H	Extended safety induction. Fire-fighting manual covering cooking area.	If there is a *galley* on board: fixed fire-fighting (fifi) system in place If there is no *galley* on board: existing barriers are considered sufficient.		Fixed fire extinguishing system is not an existing barrier for crew transfer vessels (CTVs) today. Galley is not common on board CTVs today. The difference between a galley and a pantry should be clarified. If there is no accommodation on board a pantry should be sufficient. If there is accommodation on board a galley is needed. If vessel is only doing day operation neither pantry nor galley is necessary. The wind turbine technicians (WTT) should undergo safety training including fire fighting (see also 1.11).
1.2	Electrical fire	Short circuit Water ingress Overheating	Fatality Injury Need of first aid Material damage Loss of power	Fuses Heat detectors Maintenance Smoke detectors Flame resistant cables	3	2	H		Suspension to be installed on electrical cabinets and cables to prevent vibration damage. Robust installation of electrical equipment in general. Resilient mounting.		Existing barriers/rules are considered to be adequate. Standards for electrical cabinets exists today. The probability of electrical fire is assumed to not increase if the number of persons on board rises to 60. See 1.6 for personal electrical equipment. Vessels today: electrical equipment has fallen down due to vibrations.
1.3	Fire in engine compartment	Poor maintenance Oil leak Hot surfaces Lack of cooling Hot work	Fatality Injury Need of first aid Material damage Loss of power Loss of propulsion	Fixed fire extinguishing system CCTV Insulation Quick closing valves Fire dampers Smoke/heat detectors Alarm system on engines/machinery Preventive training House keeping	3	3	H	Fire-fighting manual. Assessment of navigational safety in case of "loss" of one engine compartment and/or appurtenant equipment. Assessment and identification of weak points wrt redundancy.	CCTV in engine compartment. Separation of engine compartments. Specification of which fixed fifi systems are accepted. Remote release of fifi systems. Requirements related to control of hot surfaces (prevention of ignition of leakage). Technology for monitoring the atmosphere; detecting dangerous atmosphere, i.e. leak detection.		Use of CCTV is an industry standard. Not part of the regulations today.
1.4	Dangerous goods (DG)	Chemicals Electrical equipment Flammable liquids Batteries Spray cans Paint Lubricants Acetylene Oxygen Nitrogen Waste Lack of proper fire extinguishing systems for DG Lack of limitations to DG	Fatality Injury Need of first aid Material damage Loss of power Loss of propulsion Self reactive fire Fuel for fire started elsewhere	Specific areas for DG Location on deck; easy to detect fire/smoke	2	1	L				
1.5	Fire on the bridge	Electrical equipment Smoking	Escape leaves vessel not under control	Smoke detectors	2	3	H	Fire-fighting manual. Smoking restrictions.	Requirements for non-combustible materials. Means of emergency communication; hand-held. Dedicated smoking area.		The bridge is manned 24/7 and a fire will therefore most likely be detected at an early stage. Simultaneous operation of emergency steering and emergency propulsion is difficult with today's number of crew on board (normally 2).

ID	Hazard	Cause	Consequence	Existing barriers	Probability	Consequence	Risk	Operational-risk reducing measures	Structural risk-reducing measures	Comments from HAZID workshop	Comments from risk-reducing measures workshop
1.6	Fire in accommodation	Human factors(smoking, private electrical equipment; chargers, cell phones, etc.) Electrical equipment Ship stores Hot work	Fatality Injury Need of first aid Material damage Need to relocate personnel Lack of crowd management	Smoke detectors Portable extinguishers A60 Emergency response plans Requirements for non-combustible materials Training Proper cleaning Maintenance Fixed fire extinguishing system	2	3	H	Restrictions to personal electrical equipment on board, e.g. require CE-mark. Restrictions to use/charging of such equipment. Fifi manual. Policy for Portable Appliance Testing for vessel/crew appliances	Reduce number/have specific location for sockets. Sufficient number of sockets reduce use of extension cords. Sufficient fifi system based on persons on board, size of rooms, accommodation on board.	Relevant for all types of small vessels Sometimes a vessel is fitted with A60 instead of sprinkler system; passenger vessels has to have sprinkler system.	No personal electrical equipment should be left unattended. Difference in requirements wrt fifi system depending on the vessel being alongside or offshore.
1.7	Fuelling operations (from vessel to wind turbine)	Line fracture Loss of position Hot surfaces	Free surface fire Environmental damage Injuries to personnel involved Material damage	Procedures Check lists Break away couplings Smoking/hot work restrictions on deck during operation Oil spill collecting equipment to mitigate consequence	1	2	L			Today: site specific procedures.	
1.8	Bunkering operation (offshore)	Line fracture Loss of position Hot surfaces No *standard* coupling / break away system Lack of weather limitations	Free surface fire Environmental damage Injuries to personnel involved Material damage	Restrictions to simultaneous operations; hot work, smoking etc. Break away coupling	1	2	L			Basically open systems for bunkering, as when fuelling a car.	
1.9	Bunkering operation (by shore)	Lack of break away coupling/ no standard connection	Free surface fire Environmental damage Injuries to personnel involved Material damage	Restrictions to simultaneous operations; hot work, smoking etc.	1	2	L				
1.10	Bunkering operation on board another vessel	Spill Hot surface	Free surface fire Environmental damage Injuries to personnel involved Material damage Spread of fire to the bigger vessel	Procedures Check lists Automatic shut down of filling equipment	1	2	L				
1.11	Fire in cargo compartments/ other compartments/ stores	Combustible materials Piping systems; spreading of fire No detection Fire in dangerous cargo	Injuries to personnel involved Fatalities Material damage Need of first aid	Fire hose to reach all compartments of vessel Smoke detectors Fire drills Closing of ventilation system.	2	2	M	Vessel specific fifi manual with roles and responsibilities depending on number of persons on board. WTT should participate in drills.	CCTV in the stores/ compartments. Dedicated storage areas for dangerous substances, with fulfilled ventilation requirements etc.	No defined cargo space for these vessels. Redundancy in fire pump/generators are flag state specific and keel laying date specific.	Safe manning wrt wind turbine technicians is an ongoing discussion. Can the WTTs contribute to/ supplement e.g. fire-fighting teams? Industry wants to limit number of crew on board, use of wind turbine technicians would be beneficial. With accommodation for wind turbine technicians with separate cabins, smoke divers will be necessary. Increase in number of persons on board up to 60 will most likely require more than 2 crew members. If wind turbine technicians are included in safety organization on board; task should be simple and easy to learn through e.g. safety instruction.

ID	Hazard	Cause	Consequence	Existing barriers	Probability	Consequence	Risk	Operational-risk reducing measures	Structural risk-reducing measures	Comments from HAZID workshop	Comments from risk-reducing measures workshop
2	**Structural safety**										
2.1	Hard impacts at boat landings	High speed Technical failure Environmental conditions Lack of experience Time pressure	Deformations Fracture of hull Slips, trips, and falls Stress of persons due to lack of sleep, due to hard impacts with landings.	Soft bow (some vessels) Manoeuvrability Redundancy (requirements from industry) Field of vision Weather criteria, weather window; site specific Procedures Some vessel specifically classed	3	2	H	Make sure people are seated and using seat belts when approaching landings (also see 2.9). Procedure describing how to approach landings in a safe way. Crew training; specific for the approach of landings.	Requirements for structure to handle impacts (e.g. fenders). Constructed in accordance with class notation. Measurement of g-forces with restrictions to maximum allowed value. Requirement to response time of propulsion system of vessel. PA system for accommodation	The displacement of the vessel is critical for the impact on a wind turbine.	Class notation today: structure made strong enough to handle impacts, but this does not directly protect persons on board from injury. If there is overnight accommodation on board one must make sure no one is standing up in their cabin while vessel is approaching landing. Restrictions for doing transfer of persons while others are sleeping will lead to restrictions on operational hours. ISM certification required for procedures.
2.2	Missed landings	High speed Technical failure Environmental conditions Lack of experience Time pressure	Deformations Fracture of hull Slips, trips, and falls Damage of turbine structure	Familiarisation Experience Manoeuvrability Redundancy (requirements from industry) Field of vision Weather criteria, weather window; site specific Procedures Some vessel specifically classed	3	2	H	Site operating limits when operating in marginal conditions (G9 Good Practice Guideline 3.3.1)	Requirement to response time of propulsion system of vessel.		Closely related to 2.1. One will most likely miss landings when operating in borderline weather conditions, or when control of vessel is lost.
2.3	Impact with wind turbine cabling, anodes	High speed Technical failure Environmental conditions Lack of experience Time pressure	Deformations Fracture of hull Slips, trips, and falls Damage of turbine structure	Familiarisation Experience Manoeuvrability Redundancy (requirements from industry) Field of vision Weather criteria, weather window; site specific Procedures Some vessel specifically classed	2	2	M	Site familiarization for crew related to landing.	Requirement to response time of propulsion system of vessel.		Closely related to 2.1. One will most likely miss landings when operating in borderline weather conditions, or when control of vessel is lost.
2.4	Damage to fendering	Difference in landing designs	A barrier for the hull is removed	Check list Fender material Replacement of damaged fenders.	3	1	M		Requirements related to design of fenders.	Lack of standardization is a challenge	There is no unified requirement for design and layout of fenders today. Need to achieve both impact reduction and a 'sticky' connection to the turbine
2.5	Damage to hull	Exceeding operational limitations wrt weather	Aluminium hull more prone to fractures Loss of redundancy/ power	Guidelines	2	1	L			Differences in hull design; monohull vs multihull Redundancy not required, but industry standard	
2.6	Impact with accommodation vessel	Movement of accommodation vessel due to wind/current	Big damage to CTV (aluminium hull)	Design of boat landing Communication between vessels Side fendering	3	1	M	Site familiarization for crew.	Requirement to response time of propulsion system of vessel.		Same situation as for impact with wind turbine(see 2.3), but less severe since accommodation vessel is afloat and not fixed. Need to also consider rolling/pitching motion of accommodation vessel - examples of CTV getting 'caught' under the boat landing of accommodation vessel
2.7	Collision with another vessel	Lower "safe margin" between vessels High speed Lighter craft Less time to act	Damage to CTV Loss of CTV Loss of stability Loss of buoyancy	Manoeuvrability AIS/identification of other vessels in the area is industry required COLREG	2	3	H	Electronic Chart Display and Information System (ECDIS) Automatic Identification System (AIS) Bridge Resource Management	Requirements to damage stability. Requirements to bilge system. Vision/line of sight. Radar. Navigation/control position ergonomics - easy accessibility of controls and information displays	Lower "safe margin" related to distance to another CTV compared to standard in other sea traffic.	ECDIS is not required today. Damage stability requirements related to inclination should take into account number of persons on board.

ID	Hazard	Cause	Consequence	Existing barriers	Probability	Consequence	Risk	Operational-risk reducing measures	Structural risk-reducing measures	Comments from HAZID workshop	Comments from risk-reducing measures workshop
2.8	Dropped objects from turbine onto vessel	Improper handling of tools, parts, cargo Ice accumulation	Injury of personnel on deck Damage to vessel structure, deck	Lifting procedures	3	2	H	Definition and requirements for routine and special lifts.	Shatter proof glass in roof windows on bridge.	PPE to prevent injury to personnel; not relevant for structural safety. No structural reinforcement in place to handle dropped objects.	Routine lift covered by procedures, special lifts covered by regulations. ISM certification required for procedures.
2.9	Grounding	Choice of base port Tidal conditions Lack of sufficient voyage plan Black out/drifting aground High speed	Damage to hull Loss of stability Injury of personnel	Procedures for voyage planning (industry standard) Anchorage (drifting aground)	3	2	H	Emergency towing procedure. Procedure for when people have to be seated during transit (also see 2.1).	Redundancy of propulsion. Emergency towing arrangements. Seating arrangement in order to avoid injuries. Specific location for loose baggage/personal items. Damage stability/subdivision arrangement		Weather conditions, area of sailing etc. will effect the procedures for when people have to be seated. ISM certification required for procedures.
3	**Damage stability**										
3.1	Loss of structural integrity	See 2 "Structural Safety" above.	Loss of evacuation time		2	3	H			Damage stability to ensure sufficient evacuation time	See 2 "Structural Safety" above.
3.2	Lack of knowledge of damage stability		Unnecessary evacuation Lack of evacuation		3	3	H	Familiarization and competence in order to understand the stability booklet.	Stability calculation system.		Vessels today rarely change loading condition.
4	**Escape, evacuation and recovery**										
4.1	Unsuccessful evacuation	Not enough time	Fatalities Man-overboard	PPE Stability requirements LSA Training Emergency drills Structural fire protection Disembarkation system	2	3	H	Requirements for evacuation time based on number of persons on board. Mustering plan to be approved. If the WTTs are included in the vessel's safety organization it should be specified how the crew can use them as a resource, mainly for easy tasks.	Emergency suits with dedicated storage location. Built in ladder or low free board, instead of mobile ladder, to ensure easy evacuation. Increased number of people require rapid evacuation.		"Flight" is still the overall strategy for vessels with increased number of persons on board. Vessels might move outside wind farms and emergency response plans while moving between wind farms and to/from base ports. Could consider restrictions on POB during relocation voyages.
		Unavailable LSA	Fatalities Man-overboard	Redundancy of LSA as industry requirement Maintenance system for LSA Technicians bring their own transfer/emergency suit					Standard of LSA redundancy	Different rules applies to different vessels and from different flag states. SOLAS not applicable for CTV More LSA will require more time for maintenance	
		Lack of training	Fatalities Man-overboard	Specific responsibilities of crew during evacuation Legal requirements for training of crew Requirements for training of technicians(several industry standards)				Drills including WTT, ref. 1.11		Passenger vessels has requirements for crowd and crisis management. Emergency drills (crew and technical personnel)	
		Blocked escape routes	Fatalities Man-overboard	Procedures for not blocking escape routes							Today the common layout on board a CTV is that the cargo is stowed in the front, while mustering/ escape is in the aft (usually above engine room). In case of engine room fire this is not the ideal mustering area.
		Safe mustering area limited	Fatalities Man-overboard	Safety plan with designated mustering area Safety induction for technicians				Sufficient size of area and alternative locations for mustering area.	Clearly marked mustering area to avoid cargo being placed there.		
		Narrow escape routes	Fatalities Man-overboard	Designed for max no of persons on board							
		Insufficient manning to handle successful evacuation	Fatalities Man-overboard	Safe manning certificate Rest hours schemes (legal requirement); more crew on board if not sufficient rest for the ones originally there Emergency response plans Emergency cooperation plans Communication plans Alarm systems				Include WTT in vessel's safety organization		Crew not able to e.g. activate life raft: insufficient manning	

ID	Hazard	Cause	Consequence	Existing barriers	Probability	Consequence	Risk	Operational-risk reducing measures	Structural risk-reducing measures	Comments from HAZID workshop	Comments from risk-reducing measures workshop
4.2	Unsuccessful rescue	Lack of alerting/ awareness of third party Lack of AIS signal offshore	Fatalities	GMDSS on board the vessel Pyrotechnics	1	3	M	Rescue time based on life-saving appliances (LSA) and number of persons on board. Definition of safe refuge to be formulated. Mapping of nearby facilities relevant for rescue assistance. Simplified SAR plan.	Means of locating persons. Personal Locator Beacons becoming industry standard (G9 Guideline Table 2).		Personal locator beacons not standardised between sites
		Insufficient external rescue capacity	Fatalities	Site SAR plan (industry practice) On shore monitoring Other vessels. Not a permanent barrier, but can most likely to be counted on						Wind turbines used as safe haven for people. Must be taken into account when increasing number of persons on board	
		Vessel trading outside limitations (SAR, emergency plans,)	Fatalities	Procedures for inspection before allowed to enter the site Limitations in trading route. Exemptions to be handled by the flag state. Specific procedures for transferring vessels from one location to another, without technicians							
		Rough weather conditions preventing external rescue	Fatalities Man-overboard	Weather restrictions						Does the limitations to the vessel include rescue limitations wrt harsh weather?	
4.3	Man-overboard - during transit	Personnel on deck	Injury Fatality	Company standards: at least two persons outside at the same time. Rescue: vessel has to be able to pull a person out of the water within 5 min (industry standard) Rescue: crane, net, different solutions; not standardized (subject to flag state approval)	1	3	M	WTT should be able to assist in rescue of man over board by being assigned simple tasks by the crew. Safe manning perspective will govern number of crew on board. Specific intervals for drills for evacuation, man over board and fire. The drills should now and then include the on board WTTs.	Requirements for type of rescue equipment and time to rescue a man over board. Low free board in an area to make it easier to pick up people. Arrangements operable by minimum number of crew on board	No limitations for personnel on deck wrt harsh weather No MOB-boat on board; exemption due to low freeboard	Today rescue equipment is mainly industry standard. Management and coordination of WTT should be included in drills, also for the sake of the WTTs experience and training. Today drills are conducted at one month intervals. There will be additional requirements for vessels with accommodation for WTT.
4.4	Man-overboard - during transfer of personnel to/ from turbine or vessel offshore	Improper use of safety equipment (e.g. JoJo-line) Issues with fall arrest systems Sudden movement of the vessel Weather conditions	Injury Fatality	JoJo-line when used correctly Communication between deck man and master Red/green light for technician (a possibility, takes vessel movement into account) Crew competence Technician competence	3	3	H	Procedures covering how to pick up a man over board.	Low free board in an area to make it easier to recover persons.	Designated wave watcher; today Master has the overview of the sea state Sudden movement can be e.g. large wave due to marginal conditions, or loss of/error in propulsion control.	ISM certification required for procedures.
		Slips, trips, and falls Ice on walk ways	Injury Fatality	PPE Awareness Railings Anti-slip surface of deck						No specifications for ice on walkways	
4.5	Crew overboard	Slips, trips, and falls Ice on walk ways	Injury Fatality	If only 2 in crew both will stay inside all the time. PPE	1	3	M	Restrictions to when crew members can go outside. Procedures for operation of MOB boat.	It should be possible to operate rescue equipment by a single person. Requirement for MOB boat based on length of vessel and number of crew. It should be possible for man over board to get on board by own means and/ or sling.	If in transit and no technicians on board.	There is no point in having a MOB boat if number of crew on board insufficient to operate it. ISM certification required for procedures.

ID	Hazard	Cause	Consequence	Existing barriers	Probability	Consequence	Risk	Operational-risk reducing measures	Structural risk-reducing measures	Comments from HAZID workshop	Comments from risk-reducing measures workshop
4.6	Man-overboard - during idling	Crew on deck Technicians on deck Maintenance Mooring operations	Injury Fatality	Railing PPE Procedures, work place assessment	1	3	M	Restrictions to when crew members can go outside. Procedures for operation of MOB boat.	It should be possible to operate rescue equipment by a single person. Requirement for MOB boat based on length of vessel and number of crew. It should be possible for man-overboard to get on board by own means and/ or sling.		There is no point in having a MOB boat if number of crew on board insufficient to operate it. ISM certification required for procedures.
4.7	Medical states requiring first aid	Dropped objects Hypothermia Illness Dangerous cargo	Evacuation Fatality	All crew and all technicians have first aid training (industry standard) First aid/medical equipment on board, medical chest Assistance of medic over radio, flag state requirement Medical fitness certificate for crew and technicians (industry standard)	3	3	H	First aid to be included in drills. Specific training for crew based on number of persons on board.	Automated External Defibrillator (AED) should be on board. Larger vessels has sickbay/ "hospital".	Different medical chests; B, C	Today AED is industry standard to have on board.
5	**Overnight accommodation offshore**										
5.1	Fatigue	Vessel movements Noise and vibration Time pressure Alarms	Higher risk of human errors	Regulations for rest hours MLC/ILO approved cabins; takes noise, vibrations into account	3	2	H	Occupational health requirements. Restrictions for number of nights allowed to stay overnight offshore. Specify rest hours regulations. Weather restrictions for operation.	Requirements for noise levels, vibration, and bumping (during landings) could take into account the effect on WTT and crew	Overnight accommodation for both crew and technicians Risk reducing measures; different types of alarms	The ILO requirement for noise levels in cabins is also valid here. Vibration and bumps are the main problems. MLC covers occupational health. Different design of cabins of crew and cabins of WTT could be considered. Stricter design requirements for the crew cabins.
5.2	Emergency situation	Covered above: 4.1 "Unsuccessful evacuation"								Less people = swifter evacuation	
6	**24-hour operation**										
6.1	Fatigue	Bumping into turbines while crew are sleeping Uneven engine loads (Disrupted sleeping pattern)	Higher risk for human errors	Some vessels: soft bow damping impact	3	2	H	Requirements for silent periods and operational patterns; including max speed, slow approach to landings etc. Training for doing comfortable landings should be done with vessels not operating 24-hours. Experience matrix for manning.	Soft bow/landing.	Noise and vibrations measured during transit; varying engine loads close to turbines	The ILO requirement for noise levels in cabins is also valid here. Vibration and bumps are the main problems. MLC covers occupational health. Different design of cabins of crew and cabins of WTT could be considered. Stricter design requirements for the crew cabins. Rest could be done on board an accommodation vessel while the CTV continues to operate.
6.2	Loss of lighting for transfer of technicians			Transfer lights on vessel Search lights on vessel	1	1	L				
6.3	Insufficient maintenance	Insufficient spare parts Insufficient time		Redundancy (industry standard) Procedures, Planned Maintenance system	2	2	M	Technical competence among crew. Planning operation to allow for maintenance.	Design vessel for easy maintenance. Requirement for identification of critical spare parts.	Some tasks can't be done offshore. Housekeeping/maintenance can't be done during transit.	
7	**Dangerous goods**										
7.1	Incorrect handling	Lack of training/awareness	Fatality Injury Need of first aid Material damage Loss of power Loss of propulsion Self reactive fire Fuel for fire started elsewhere Long term effects due to exposure Spill	Training PPE Cargo manifests Procedures	3	1	M	Requirements related to handling of the different types of dangerous goods. Should be based on type of operation and vessel design. Knowledge of cargo on board.	Specific requirements to PPE wrt type of dangerous goods.	Not always adequate	The application of the International Maritime Dangerous Goods (IMDG) code to CTVs differs between flag states. Approach to IMDG code is under development.

ID	Hazard	Cause	Consequence	Existing barriers	Probability	Consequence	Risk	Operational-risk reducing measures	Structural risk-reducing measures	Comments from HAZID workshop	Comments from risk-reducing measures workshop
7.2	Incorrect storage	Lack of training/awareness No proper storage area available Packing Stowage	Fatality Injury Need of first aid Material damage Loss of power Loss of propulsion Self reactive fire Fuel for fire started elsewhere	Exemption by flag state to carry some quantities of dangerous cargo	3	1	M	Include information about designated storage areas for DG (dangerous goods) in drills.	Designated areas for DG. Fire fighting intended for the DG. Ventilation of compartment/area with DG. Fire rated compartments. Possibility to throw DG overboard, as last resort.	IMDG code not much used: does not fit the CTV well. "Simplified" specifications for how to handle DG, where to store it etc. are needed.	Larger vessel will give the possibility to carry more dangerous goods than what is common today.
7.3	Fire (See 1.4 "Fire/explosion safety" above)										
7.4	Incorrect waste handling (waste from turbine)	Lack of knowledge of technicians packing waste at the wind turbine Commercial pressure for handling the waste	Fire Environmental issues Exposure of the crew	MARPOL Waste management plan	3	1	M	Knowledge of waste types.		Part of operational pattern	
8	**"Walk-to-work"**										
8.1	Loss of position	Technical failure Human error	Collision Man-overboard (see 4.4) Injury of personnel	Procedures Redundancy PPE Some types; safety line	2	3	H			Size of vessel will have impact on "walk-to-work" technology chosen. Several types exist.	Nothing new wrt HSC cargo vs. HSC passenger, one should look to SPS/existing regulations for walk-to-work systems. Development of certification of systems is ongoing. At the moment the systems are regulated by industry and classification standards and guidelines. Should be covered by risk assessment and/or FMEA specifically for the system in question.
8.2	Failure of "walk-to-work" system	Technical failure Human error Lack of standardization of training Lack of standardization of system	Change in operation Human errors	Some systems; redundancy Vessel specific procedures	2	2	M			Independent industry Competition	Nothing new wrt HSC cargo vs. HSC passenger, one should look to SPS/existing regulations for walk-to-work systems. Development of certification of systems is ongoing. At the moment the systems are regulated by industry and classification standards and guidelines. Should be covered by risk assessment and/or FMEA specifically for the system in question.
9	**Manning**										
9.1	Insufficient manning	See 4.1 "Insufficient manning to handle successful evacuation"		Safe manning certificate Rest hours schemes (legal requirement); more crew on board if not sufficient rest for the ones originally there Emergency response plans Emergency cooperation plans Communication plans Alarm systems	2	2	M	When establishing Safe Manning one should take into account the roles and responsibilities of WTT and bridge team in case of emergency situations. Description of which situations where a larger bridge team is needed		Training related to crowd control Bridge management	Regulations for Safe Manning take into account type of operation and vessel including number of persons on board. For consideration; if crew on CTVs has to have type rating certificates.
9.2	Inexperience			Crew management. Internal procedures for competence management.	3	2	H			Competence of crew: good procedures gives a good understanding of expectations. Smaller vessels behave differently offshore than bigger vessels. Background of Master can have something to say. CTV is a segment of its own. Maintaining certificates of the Master/crew might be hard due to size of vessel. (STCW.)	

ID	Hazard	Cause	Consequence	Existing barriers	Probability	Consequence	Risk	Operational-risk reducing measures	Structural risk-reducing measures	Comments from HAZID workshop	Comments from risk-reducing measures workshop
9.3	Unqualified			Crew management. Internal procedures for competence management.	2	2	M			Fishermen, STCW. Technical personnel; need of a common minimum standard of fitness, competence and training	
10	**Operational Aspects**										
10.1	Communication, misunderstanding	Lack of qualified people Multicultural crew	Operational errors Violence Human errors	Common working language Understanding Safety culture Hierarchy on board	3	2	H	ISM regulates this hazard. Working language shall be specified.		ISM code sets requirements for language, to be approved by flag	HSC passenger requirements can be used as a guide.
10.2	Inconsistent procedures, standards	Several stakeholders involved	Fail to act	Bridging documents; to make consistency between procedures, standards	3	1	M				Responsibility of charterers. (G9 Guideline 5.1)
10.3	Lack of coordination at wind farm	Several stakeholders involved	Fatigue Increased work load	Marine coordination, approved by coastal state	3	1	M				Responsibility of charterers. Need to verify what "level" of coordination is available.
10.4	Simultaneous operations (SimOp) are not aware of each other	Lack of communication Lack of SimOp analysis, procedure		Permit to work	3	2	H	ISM		More people, more going on at the same time. SimOp on board vs.. SimOp with another vessel/wind turbine etc.	Responsibility of charterers for SimOp's in wind farms. SimOp's on board covered by ISM and "permit to work"
11	**Small boat operation from CTV**										
	Launch and recovery	Different types of arrangements, LARS(launch and recovery systems)	Fatality	Procedures Designated crew for operation	2	3	H	Specific training for WTT (similar requirements for launching of MOB, see 4.5, 4.6).	Approved launch and recovery arrangements in accordance to e.g. NORSOK R-002 "Lifting equipment".	Operator's responsibility Many as the same discussions as for "walk to work" To be discussed in next work shop	Not sure if the vessel still will be a CTV if has a small boat on board.
12	**Manoeuvrability**										
12.1	Lack of propulsion	Black out Fire Electrical/ mechanical failure Human error	Collision (see 2.7) Grounding (see 2.9) Incapacitated	Redundancy Procedures Maintenance FMEA	3	2	H	Redundancy training; how to switch between systems and operate.	Redundancy in propulsion (needs to be documented).		HSC passenger requirements can be used as a guide. ISM certification required for procedures.
12.2	Loss of power	Black out Fire Electrical/ mechanical failure Human error	Collision (see 2.7) Grounding (see 2.9) Incapacitated	Redundancy (emergency power) Procedures Maintenance FMEA	3	2	H	Redundancy training. Testing of redundancy.			HSC passenger requirements can be used as a guide.

APPENDIX C

HSC Code cargo and passenger craft requirements

DNV·GL

MARITIME

Comparison

HSC Cargo / HSC Passenger

November 2016

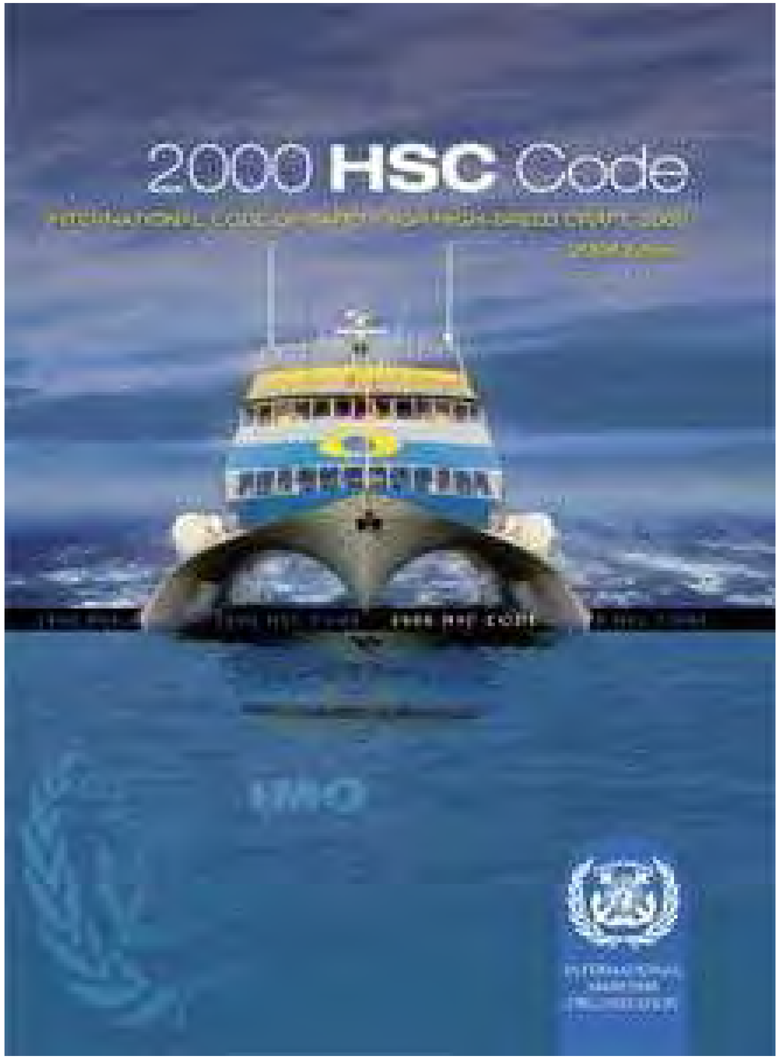
Per Annar Sandaune
Passenger, Ro-Ro, Light Craft & Naval (MCANO872)

Ungraded

SOLAS Chapter X: Safety measures for high-speed craft

2000 HSC Code

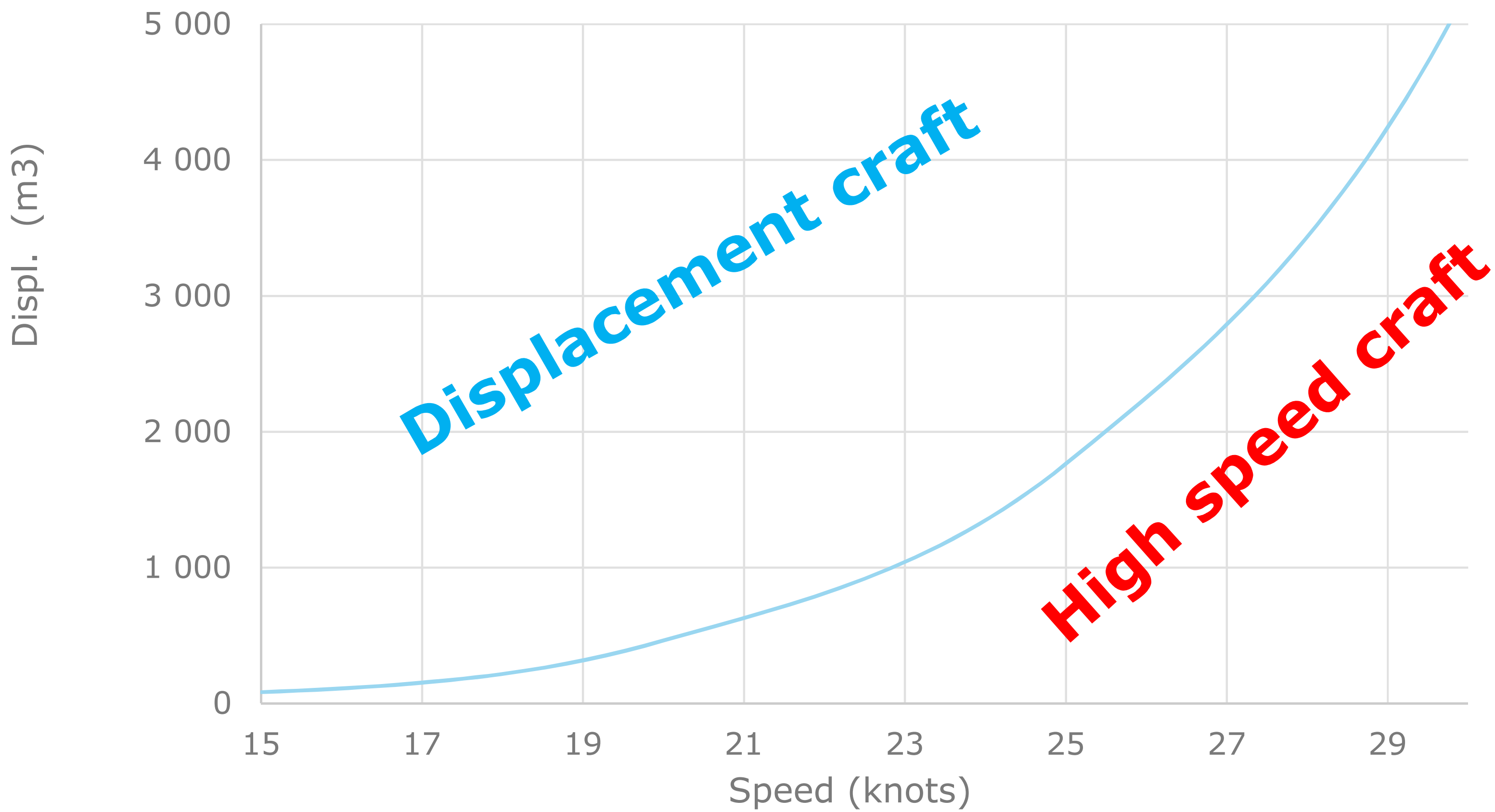
- International Code of safety for High Speed Craft
  - Preceded by 1996 HSC Code and DSC Code
    - International Code of safety for High Speed Craft (HSC Code) 1996-2002
    - Code of Safety for Dynamically supported craft (DSC Code) 1977 - 1996



Ungraded

SOLAS - Definition of a HSC craft (Ch.1)

$$V \geq 7.16 \cdot \Delta^{0,1667}$$



Ungraded

Basic principles of 2000 HSC Code

- The HSC code was developed with the following principles for equivalent safety to SOLAS:
  - Restricted distance from safe refuge
  - Control of operation by flag state and port state. Permit to operate.
  - Restricted operating conditions (worst sea state)
  - Increased requirements to navigation
  - Means for communication with base port

Ungraded

DNV·GL

Basic principles of 2000 HSC Code

  - Facilities for rapid evacuation
  - Rescue services (assistance) available throughout the voyage for Category A craft (≤ 450 pax)
  - Redundant propulsion for Category B (> 450 pax) and Cargo craft
  - No sleeping berths allowed
  - Seats to be provided for all passengers
  - Reliable weather forecast for the area of operation to be available at any time
  - Safety based on Failure Mode Effect Analysis (FMEA)
  - Safety with respect to collision

- Summary:
  - Technical requirements and operational restrictions form the basis for equivalence to SOLAS

Failure Mode and Effect Analysis (FMEA)

FMEA to be prepared for all HSC craft

- FMEA to be performed in the design phase (ref. HSC Code Annex 4)
- FMEA is based on a single failure concept
  - Fire and flooding in one compartment (except on bridge) to be handled as a single failure scenario for Category B craft
- A test programme to demonstrate the outcome of the FMEA to be prepared

- Scope for FMEA:
  - machinery systems and associated controls
  - directional control system
  - stabilization system
  - integrated control and monitoring system
  - electrical system.

Ungraded

Principles of restricted operation

HSC Cargo

- Time at service speed from safe refuge limited to 8 hours
- Shall retain capability to navigate safely subsequent to any damage

HSC Code service restrictions		
Craft type	**Distance from refuge**	**Condition**
HSC Category A craft (<450 passengers)	4 hours	Assisted
HSC Category B craft (≥ 450 passengers)	4 hours	-
HSC Cargo craft	8 hours	-

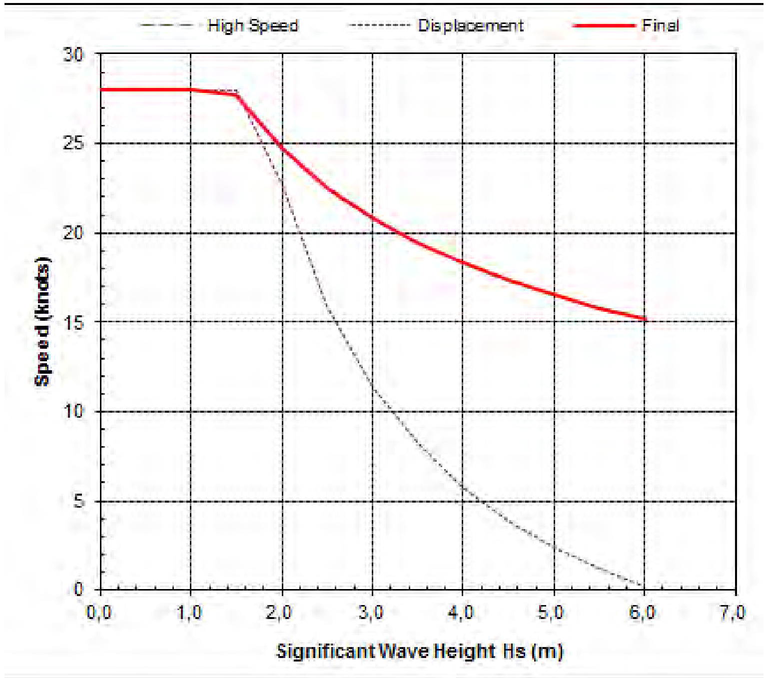
HSC Passenger

- Category A (≤ 450 pax):
  - Time at service speed from safe refuge limited to 4 hours
  - To be assisted from shore
- Category B (> 450 pax):
  - Time at service speed from safe refuge limited to 4 hours
  - Shall retain capability to navigate safely subsequent to any damage

Ungraded

Principles of weather restricted operation

- Operation restrictions (purpose is to limit loads on the structure)
  – Significant wave height is the average of the 1/3 highest wave heights within a wave spectrum
  – Visual observation of the wave height by an experienced person coincides well with the significant wave height.



Ungraded

DNV·GL

Stability criteria (Ch.2)

HSC Cargo

- Max 15° inclination after damage
- 20° inclination may be accepted if reduced to 15° within 15 min by cross-flooding or counter-ballasting, provided non-slip deck surfaces and suitable holding points.

HSC Passenger

- All passenger craft
  - Max 10° inclination after damage
  - 15° inclination may be accepted if reduced to 10° within 15 min by cross-flooding or counter-ballasting, provided non-slip deck surfaces and suitable holding points.
- Category B after 100% raking damage
  - Max 20° inclination.
  - GZ Range and area below the GZ curve

All HSC craft

- Definition of damages (bottom, side) are the same
- Unprotected openings shall be above the equilibrium waterline + 50 % of significant wave height (H_S)
- Positive freeboard to survival craft embarkation position

Ungraded

Accommodation and escape measures (Ch.4)

Common requirements for HSC Cargo and HSC Passenger craft

- Passive Precautions (Before accident)
  - Design acceleration level
  - Accommodation design
  - Seating construction
  - Safety belts
  - Baggage stores, shops & cargo compartments
- Active Precautions (After accident)
  - Public address and information system
  - Exits and means of escape
  - Evacuation time

Requirements specific for HSC Passenger craft

- Vertical acceleration levels at longitudinal centre of gravity not to exceed 1g
- Craft to be designed for the collision design acceleration g_{coll}

Ungraded

Accommodation design levels (Ch.4)

Definition of g_{coll}

$$g_{coll} = 1.2 \times (\frac{P}{g \times \Delta})$$

where

$P = Impact\ load$

$g = Gravity\ constant$

$\Delta\ = Craft\ displacement$

- The impact load P depends on
  - Construction material
  - Craft length (HSC Code Ch.1 definition)
  - Craft depth (keel to upper strength deck)
  - Impact speed

Ungraded

Accommodation design levels (Ch.4)

Design level 1: g_{coll} less than 3

- No restrictions in seating direction
- No seat belts requirement
- Padding of projection objects
- Kiosks, bars, etc., no special requirements
- Baggage, no special requirements

Design level 2: g_{coll} = 3 to 12

- Forward or backward seating direction, high seatback
- Lap belt in seats when no protective structure forward
- Padding of projection objects
- Kiosks, bars, etc., on aft side of bulkheads, or other specially approved arrangements
- Baggage placed with protection forward
- Dynamically tested seats and tables (Annex 10).

Ungraded

DNV·GL

Evacuation time (Ch.4)

Definition

- Available evacuation time

$$Evacuation\ time = \frac{SFP - 7}{3}$$

Where

$$SFP = Structural\ fire\ protection\ time$$

- Verification of evacuation time:
  - Evacuation analysis in accordance with IMO MSC/Circ.1166
  - Evacuation demonstration under controlled conditions.

HSC Passenger

- Category A:
  - Time from abandon craft announcement, normal distribution of passengers.
- Category B:
  - Time from order to abandon, passengers and crew wearing lifejackets, prepared for evacuation and distributed at assembly stations.

All craft

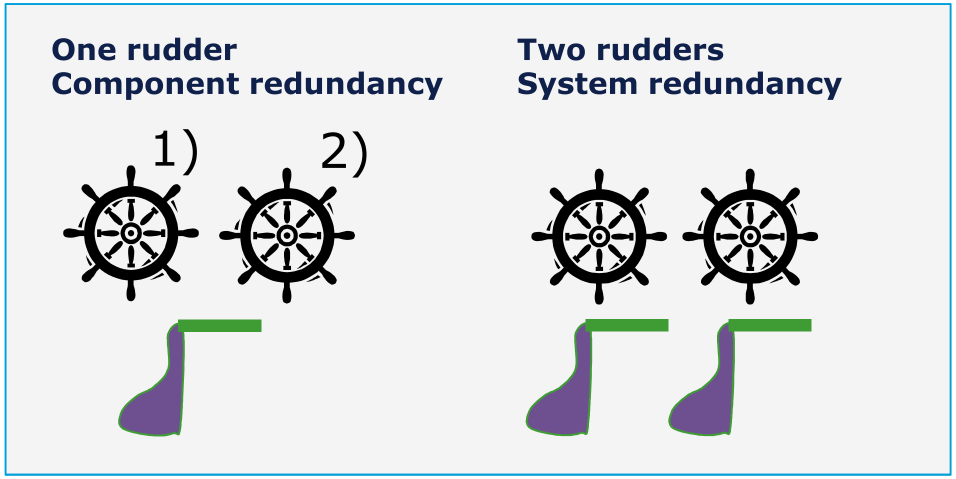
- Time to prepare survival craft to be included.

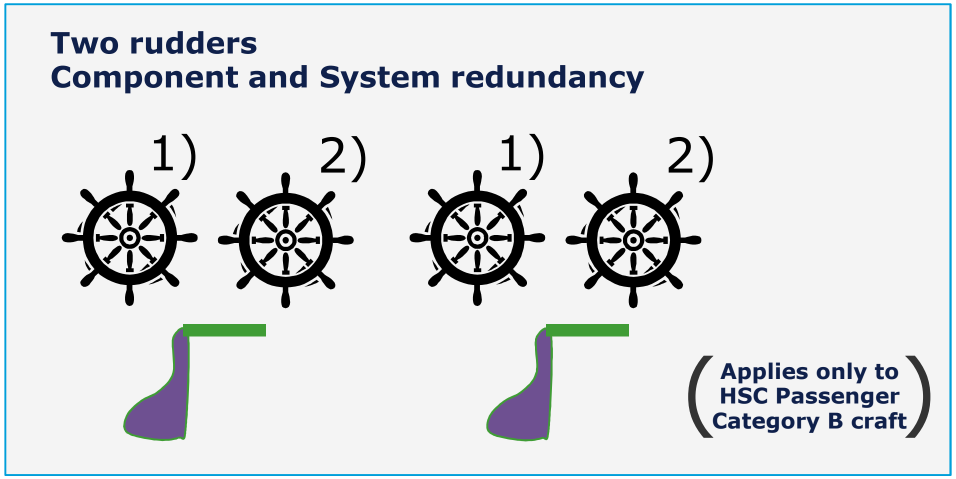
Ungraded

Directional control (Ch.5)

Common requirements for HSC Cargo and HSC Passenger craft

- *The probability of total failure of all directional control systems should be extremely remote when the craft is operating normally* (HSC Code 5.2.1)
  - Main[1)] + Auxiliary[2)] is required
  - Auxiliary[2)] may be manually driven
  - Category B requires backup
  - Local control and indication is also required





Ungraded

DNV·GL

Fire safety (Ch.7) – HSC Code basic philosophy

A combination of the following four elements are required:

- Detection, crew attendance and monitoring (CCTV)
- Escape ways (and safe haven if applicable)
- Passive fire protection
  - Structural fire protection (limited / light weight)
  - Control of combustible materials
- Active fire protection
  - Manual: fire hoses, portable extinguishers, etc.
  - Fixed: CO_2, deluge, sprinkler

Ungraded

DNV·GL

Fire safety (Ch.7)

Passenger areas (low fire risk)

- no structural fire protection (except any stores)
- control of combustible materials
- sprinkler (manual or automatic) if pass. > 200
- fire hoses and portable extinguishers
- no fire detection or CCTV (except small enclosed spaces)
- two escape routes / or direct access to a marine evacuation system

Engine room (high fire risk)

- "no" control of combustible materials
- structural fire protection
- fire extinguishing system (2 x CO_2)
- fire hoses and portable extinguishers
- fire detection and CCTV
- two escape routes (if L > 5m)

Ungraded

Fire safety (Ch.7)

Basic requirements for all HSC Craft

- Fire insulation to provide protection for a period of 60 minutes in areas of major fire hazard (e.g. engine rooms)
- Fuel tank not to be located in areas of major fire hazard or if so, insulated to 60 minutes fire integrity
- Ventilation ducts to be possible to close outside the space where they are installed
- Smoke and fire detection to be installed in all major and moderate fire risk spaces
- Fixed fire extinguishing system to be installed in all major fire risk spaces
- 2 independently driven fire pumps

Fire safety (Ch.7)

HSC Passenger craft

- Public spaces to be divided into two zones (Category B craft only)
  - For each zone there shall be an alternative safe area
- Each safe zone shall be ventilated independently of other safe zones
- Fixed sprinkler system to be installed in public spaces, service spaces, crew accommodation areas, storage rooms etc.

HSC Cargo craft

- Control stations, lifesaving appliances, escape routes and embarkation places to be located adjacent to crew accommodation areas
- Cargo spaces to be fitted with fire detection system and fixed fire extinguishing system
- Fixed sprinkler system to be installed in crew accommodation areas of sizes above 50 m^2

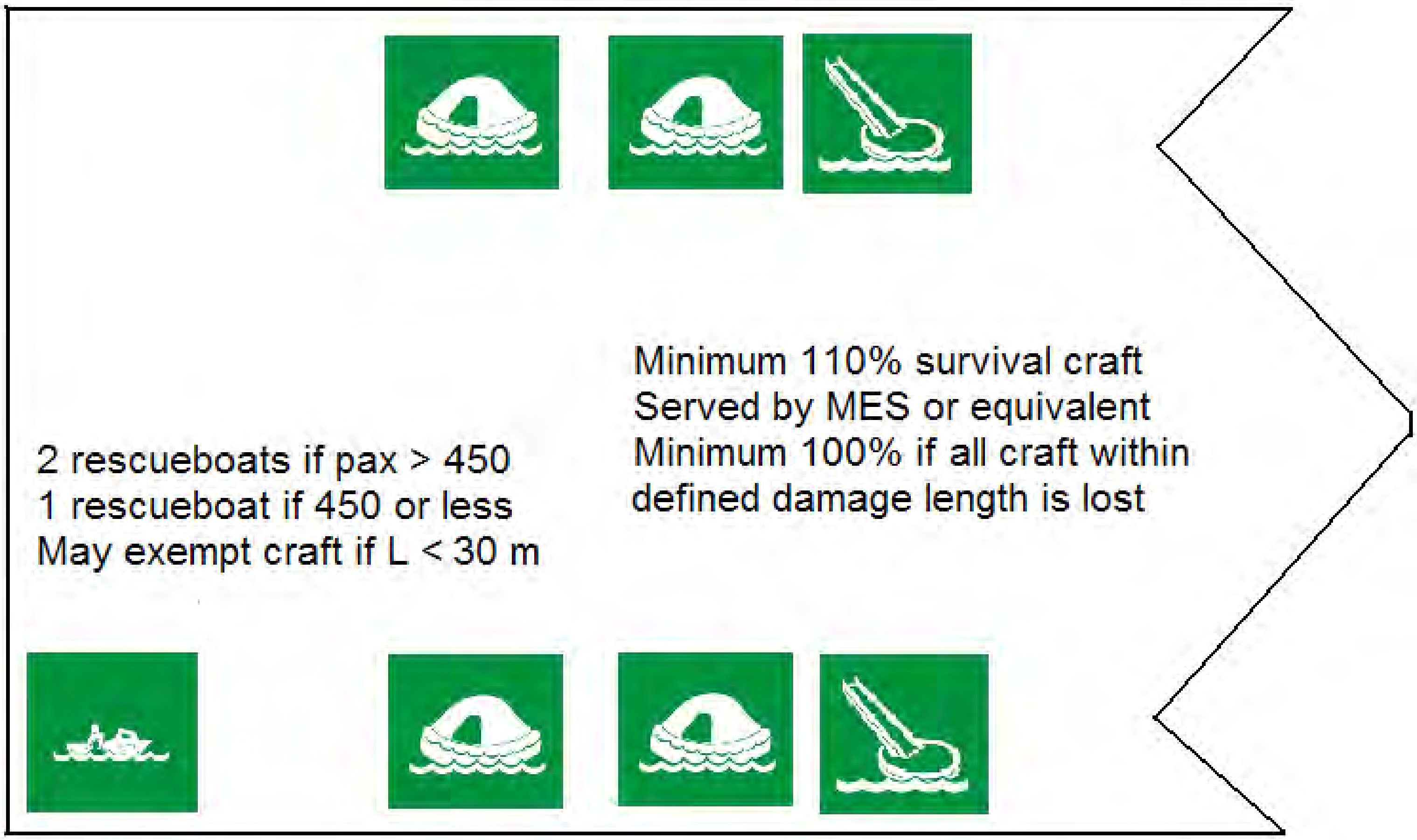
Carriage of dangerous goods (applicable to all HSC Craft carrying DG)

- Additional requirements related to water supplies, sources of ignition, detection system, ventilation, bilge pumping, personnel protection, portable and fixed fire extinguishing, separation of spaces

Ungraded

Lifesaving appliances and arrangements (Ch.8)

Common requirements for all HSC Craft



Ungraded

Lifesaving appliances and arrangements (Ch.8)

Number and stowage of lifejackets on HSC

- 1 for every person on board + 5 % extra + children 10 % total number of passenger

- After 1 July 2010
  - Infant 2,5 % if voyage less than 24 hour or all if voyage more than 24 hours
  - Large size – suitable accessories (up to 140 kg /1750 mm chest girth)

Ungraded

Machinery (Ch.9)

Redundancy requirements for HSC Cargo and Passenger Category B craft

- Independent means of propulsion for HSC Passenger category B craft
- Return to port of refuge for HSC Passenger Category B craft under its own power
  - Required in the event of fire or other casualties in any one compartment on board
- HSC Cargo craft to maintain essential machinery and control, but not return to port of refuge
  - Required in the event of fire or other casualties in any one compartment on board

Two propellers/waterjets
Component and System redundancy
HSC Passenger Category B craft

Ungraded

Auxiliary systems (Ch.10)

HSC Cargo craft

- 2 power bilge pumps
- 2 pumps per hull on multihull craft
- 1 pump allowed if cross hull bilge pumping is possible

HSC Passenger craft

- 3 power bilge pumps (Cat.B craft)
- 2 power bilge pumps (Cat.A craft)
- 2 pumps per hull on multihull craft

Ungraded

Remote control, alarm and safety systems

HSC Cargo craft

- Remote control of propulsion

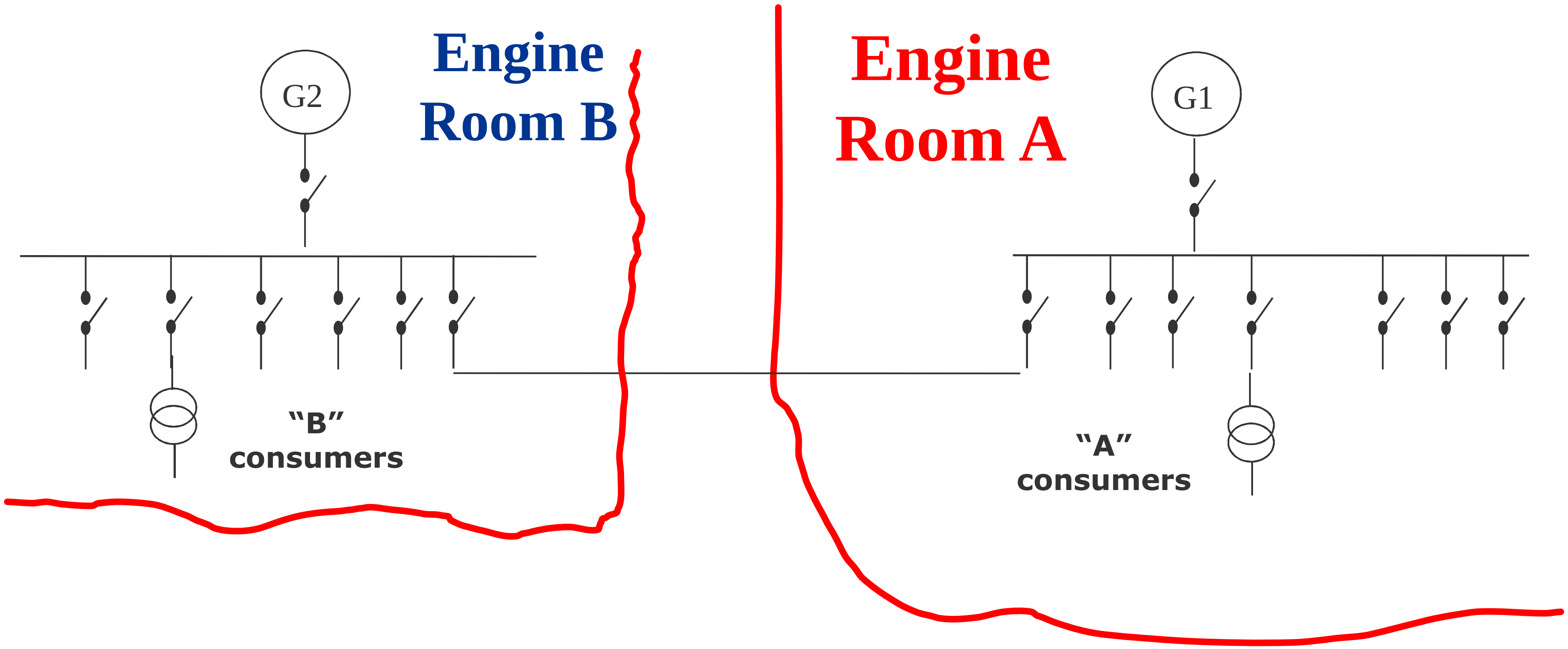
HSC Passenger craft

- Remote control of propulsion
- Category B craft requires backup of remote control from bridge

Ungraded

Electrical installations (Ch.12)

Requirements to all HSC craft for independent systems



Ungraded

Electrical installations (Ch.12) – Emergency source of power

HSC Cargo craft

- Essential services according to HSC Code Ch.12.8.2 to be served for 12 hours
- Unless automatic start of emergency generator a transitional source of power (30 min.) required for:
  - Emergency lighting
  - Main navigation lights
  - Internal communication equipment
  - Fire detection / general alarm system
  - Watertight doors

HSC Passenger craft

- Category A craft:
  - Essential services according to HSC Code Ch.12.7.3 to be served for 5 hours
- Category B craft
  - Essential services according to HSC Code Ch.12.7.4 to be served for 12 hours

Ungraded

Shipborne navigational systems and equipment and voyage data recorders

Common requirements to all HSC craft

- Compasses
- Speed and distance measurement
- Echo sounding device
- Radar installations
  - 9 GHz for all craft
  - **Category B craft above 500 GT** to have 3 GHz radar in addition (or another 9 GHz radar)
- Electronic positioning systems
- Rate-of-turn indicator (**craft above 500 GT**) and rudder angle indicator
- Nautical charts and nautical publications
- Searchlight and daylight signalling lamp
- Night vision equipment
- Steering arrangement and propulsion indicators
- Automatic steering aid (automatic pilot)
- Radar reflector (craft below 150 GT)
- Sound reception system
- Automatic identification system (AIS)
- Voyage data recorder:
  - All HSC Passenger craft
  - HSC Cargo craft above 3000 GT

Ungraded

Radiocommunications (Ch.14)

Common requirements to all HSC craft

- Global Maritime Distress and Safety System Identities (GMDSS)
- Radio installations
  - VHF
  - NAVTEX receiver
  - Inmarsat maritime safety information reception capability
  - Satellite EPIRB
- HSC Passenger craft only:
  - Two-way on-scene radiocommunications for search and rescue purposes
- Additional radio equipment requirements given for Sea areas A1, A2, A3 and A4
- Continuous watch to be maintained while at sea
- Availability of sources of energy independent of main and emergency electrical systems

Ungraded

Operating compartment layout (Ch.15)

Common requirements to all HSC craft

- Field of vision from the operating compartment
- Operating compartment design and layout
- Instruments and chart table
- Lightning
- Windows
- Communication facilities
- Temperature and ventilation
- Colours
- Safety measures

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SAFER, SMARTER, GREENER

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