European Maritime Safety Agency

CMOROC Appendix G – Reference Groups

Identification of Competences for MASS Operators in Remote Operation Centres

V 2.2

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EMSA

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1. Workshops

1st Workshop of the Autonomous Maritime Systems Working Group (DGON e.V.)		
Identifier	DGON W1	
Date	12.07.2022	
Location	Bremen	
Facilitation	University of Appl. Sc. Bremen - Maritime Studies -	Prof. Thomas Jung
Participants	It was a panel of several experts with representatives from science, industry and shipping.	
	University of Appl. Sc. Bremen **Maritime Studies** (https://www.hs-bremen.de/en/)	Malte Pertiet Frederike Aschenbrenner Steffen Willauer
	DGON e. V. German Institute of Navigation (https://www.dgon.de)	Thoralf Noack Holger Klindt
	BSH Federal Maritime and Hydrographic Agency (https://www.bsh.de)	Martin Portier
	DLR German Aerospace Center (https://www.dlr.de)	Arne Lamm Marcel Saager Dr. Nicola Wendt Jason Halog
	University of Appl. Sc. Wismar-Warnemünde (https://www.hs-wismar.de/en)	Reinhard Müller
	Humatects (https://humatects.de/)	Dr. Marie-Christin Harre
	Institute of Automatic Control RWTH Aachen (https://www.irt.rwth-aachen.de/)	Maximilian Nitsch Tim Reuscher
	MTC Marine Training Center Hamburg (https://mtc.hamburg/)	Andreas Hartmann
	Lawyers Ahlers & Vogel (https://www.ahlers-vogel.de/en/)	Tammo Schwerdt
	Raytheon-Anschütz Manufacturer of navigation instruments and monitoring/control systems (https://www.anschuetz.com/)	Jan Christopher Lütt, Wilko Bruhn
	Rheinmetall Electronics (https://www.rheinmetall.com/en)	Ingo Schöneich, Robert Schäfer
	Schulte Group Shipping group (https://www.schultegroup.com/)	Lennart Swoboda
	Telespazio (https://www.telespazio.de/en/home)	Osman Kalden

	Wärtsilä Voyage Manufacturer of transport safety systems, especially in the field of shipping and maritime transport (https://www.wartsila.com/voyage)	Erich Rüde Eva Beykirch
Goal	The goal was to discuss the operational profiles of remotely operated vessels with and without crew on board.	
Description	The agenda was as follows: 1. Welcome and Introduction, definition of the objectives of the workshop 2. Presentation of the CMOROC Study 3. Presentation of initial core processes and discussion about ▪ Which operational processes do we need to consider for remotely controlled ships without crew on board? ▪ Which are differences between determined use cases? ▪ Which processes and tasks can be performed by a crew on board of a remote-controlled ship? 4. Discussion and Summary The results were incorporated in the more detailed specification of tasks and processes (see appendix C and appendix D). Most important statements and findings that were made during the workshop can be found in section Results of this appendix (referenced with the identifier DGON W1).	

Table 1: 1st DGON e.V. Workshop.

2nd Workshop of the Autonomous Maritime Systems Working Group (DGON e.V.)		
Identifier	DGON W2	
Date	07.02.2023	
Location	Bremen	
Facilitation	University of Appl. Sc. Bremen Maritime Studies	Prof. Thomas Jung
Participants	The entire DGON working group was invited, the following representatives were present. It was a panel of several experts with representatives from science, industry and shipping.	
	University of Appl. Sc. Bremen **Maritime Studies** (https://www.hs-bremen.de/en/)	Prof. Dr. Ilknur Colmorn Ivan Nikolov Frederike Aschenbrenner Steffen Willauer
	University of Appl. Sc. Wismar - Warnemünde (https://www.hs-wismar.de/en)	Dr. Michael Baldauf
	Shipping institute Warnemünde e.V. (https://fiw.hs-wismar.de/bereiche/sal/forschung/schiffahrtsinstitut-warnemuende-e-v/)	Anna Gleue
	Northrop Grumman Sperry Marine Manufacturer of navigation, radar and control systems (https://www.sperrymarine.com/)	Pascal Goelnitz
	Fraunhofer Center for Maritime Logistics and Services	Robert Grundmann

	(https://www.cml.fraunhofer.de/en.html)	
	Humatects (https://humatects.de/)	Dr. Marie-Christin Harre Noelle Rousselle
	DGON e. V. German Institute of Navigation (https://www.dgon.de)	Holger Klindt
	Harbour Pilots Hamburg	Donatus Kulisch
	DLR German Aerospace Center e.V. (https://www.dlr.de)	Dr. Andreas Lüdtke Marcel Saager
	Raytheon Anschütz Manufacturer of navigation instruments and monitoring/control systems (https://www.anschuetz.com/)	Jan Christopher Lütt
	BSH Federal Maritime and Hydrographic Agency (https://www.bsh.de)	Martin Portier
	Wärtsilä Voyage Manufacturer of transport safety systems, especially in the field of shipping and maritime transport (https://www.wartsila.com/voyage)	Erich Rüde
Goal	The goal of the second DGON Workshop was to discuss and validate the defined processes and to discuss possible ROC models.	
Description	The agenda was as follows: 1. Welcome and Introduction, definition of the objectives of the workshop. 2. Presentation of the use cases and processes for better orientation of the participants 3. Systematic discussion of the processes (Planning & Tracking, Cargo Operations, Navigation, Operation Engineering, Maintenance, Malfunctions & Emergencies) based on the questions: What can be automated? Who is involved? From where? What are the specific challenges? 4. Discussion of possible ROC models 5. Summary Most important statements and findings that were made during the workshop can be found in section Results of this appendix (referenced with the identifier DGON W2).	

Table 2: 2nd DGON e.V. Workshop.

IAMU Workshop (International Association of Maritime Universities		
Identifier	IAMU	
Date	11.07.2023	
Location	Bremen & Online	
Facilitation	University of Appl. Sc. Bremen Maritime Studies	Prof. Thomas Jung
Participants		
	University of Appl. Sc. Bremen **Maritime Studies** (https://www.hs-bremen.de/en/)	Prof. Dr. Ilknur Colmorn Prof. Thomas Jung
	University of Appl. Sc. Wismar - Warnemünde (https://www.hs-wismar.de/en)	Prof. Michael Baldauf Dr.-Ing. Förster Capt. Daniel Rostek
	EMSA	Antonio Hevia Rodriguez
	University of Dubrovnik	Prof. Srđan Vujičić Prof. Miho Kristić
	Italian Shipping Academy	Capt. Vittorio Sava
	Jade Hochschule / University of Appl. Sc.	Prof. Dr. Georgios Athanassiou
	Humatects (https://humatects.de/)	Dr. Marie-Christin Harre
	Maritime University of Szczecin	Capt. Ph. D. Eng. Piotr Wołejsza
	University of Split	Assoc. Prof. Rino Bosnjak
	DLR German Aerospace Center e.V. (https://www.dlr.de)	Marcel Saager
	Aalto University	Victor Bolbot
Goal	The goal of the IAMU Workshop was to discuss and validate the defined competences and initial curricula.	
Description	The agenda was as follows: 1. Welcome and Introduction, definition of the objectives of the workshop. 2. Presentation and explanation of the competence tables 3. Breakout Session: Groups discuss different competence tables 4. Presentation & discussion of findings concerning competences 5. Presentation & explanation about curricula development 6. Discussion of • Modules and their objectives and content • Practical training • Course sequence • Workload, duration, simulator use 7. Summary Most important statements and findings that were made during the workshop are included in Appendix E (Competence Tables) and Appendix F (Module Catalogue)	

Table 3: IAMU Workshop.

2. Interviews

Interview at Scandlines Ferry	
Identifier	FERRY I
Date	25.10.2022
Location	Scandlines Ferry between Puttgarden and Roedby
Interviewer	Dr. Marie-Christin Harre, Marcel Saager, Noelle Rousselle
Participants	Master, First Officer, Second Officer, Chief Engineer from Scandlines (https://www.scandlines.de/)
Goal	The goal of the interview was to discuss the individual tasks of the processes with the interview participants to find out if any important tasks were missing and to understand the exact procedures of the tasks. A particular focus was on navigation since the ferry's route is relatively short and many berthing and de-berthing maneuvers are performed in a short time. Furthermore, the focus of the interview was on tasks related to the passengers, as special emergency plans are necessary for the safety of the passengers.
Description	For each process, the individual tasks were discussed with the captain, the first officers on board and the chief engineer. The following guiding questions were used: 1. What is an important subtask in this task in a remote-control scenario? 2. Who performs this task? (Operator ROC, crew on board, third person). 3. Does someone always need to be available to perform this task? 4. If intervention is required, is it time critical? 5. Who needs to be communicated with within the task? 6. What information/data is needed to perform the task? 7. What is the outcome of the task? 8. How much do you think the task can be automated? The answers and results of this questions have been incorporated in the DCOS models in appendix C. The focus of this interview was on the process of navigation and cargo since ferries have the distinction of carrying passengers. If necessary, additional questions were asked. Most important statements and findings that were made during the interview can be found in section Results of this appendix (referenced with the identifier FERRY I). In addition to the interview, an observation was conducted (see **Observation at Scandlines**).

Table 4: Scandlines Interview.

Interview with Jebsen Shipping Partners	
Identifier	FEEDER I1
Date	01.11.2022
Location	Jork, at Jebsen Shipping Partners
Interviewer	Dr. Marie-Christin Harre, Marcel Saager, Noelle Rousselle
Participants	Arnd Becker, Managing Director of Jebsen Shipping Partners, responsible for technical and nautical management (https://www.jebsenship.com/)
Goal	Validate and identify specifics of bulk short sea cargo
Description	Jebsen Shipping Partners operates a modern ship management and is a fusion from the companies MF Jebsen Group, Kahrs Bereederung, Lubeca Marine and Becker Ship-Management. The company has a lot of experience in the field of high standard ship and investment management. The interview took about two hours. During the interview, the previously defined processes were discussed with the expert having a focus on the short sea cargo vessels. Most important statements and findings that were made during the interview can be found in section Results of this appendix (referenced with the identifier FEEDER I1).

Table 5: Jebsen Shipping Partners Interview.

Interview with Schulte Group	
Identifier	FEEDER & BULKER I2
Date	13.03.23
Location	Hamburg
Interviewer	Prof. Thomas Jung
Participants	Lennart Swoboda, Department for Ship Automation (https://www.schultegroup.com/)
Goal	The goal of the interview was to determine possible development of technologies in automation in the near future and to determine requirements to remote operators of automated systems.
Description	The Schulte Group installed several years ago a department for automation pf ships. They use own vessels to install new automation equipment. Projects are visual sensors (Eye Captain) on bulk carriers and container vessels and unmanned bridge on a container vessel (B ZERO). Still there are great challenges in automation of seagoing ships. Examples are • Interfaces between stability calculator and ballast water systems are critical because of different interests of manufacturers. • Use of data in many cases difficult because manufacturer do not give access to all data bases. • Interfaces between automated systems are difficult to coordinate, no standards available. • Certification of new technologies is difficult; the vessels may get lost of classification. • Standardization is a big issue. • One ROC for all vessels will be difficult, to many different interests. Also, difficult to integrate chartered vessels. • Maintenance will stay as a big issue. Operators must be able to operate new technologies.

	• Knowledge and use of sensor devices • Options by artificial intelligence • Use of new communication systems • very good comprehension for situational awareness • use of HMI (processing of many data as high number of ships, quick focussing to new situation) • regular recurrent trainings in simulators will be necessary Further important statements and findings that were made during the interview can be found in section Results of this appendix (referenced with the identifier FEEDER & BULKER I2).

Table 6: Schulte Group Interview.

Interview with Wärtsilä Voyage	
Identifier	FEEDER I3
Date	13.03.23
Location	Hamburg
Interviewer	Prof. Thomas Jung
Participants	Hendrik Busshoff, Head of Product Autonomy Solutions (https://www.wartsila.com/voyage/autonomy-solutions)
Goal	To determine possible development of technologies in automation in the near future and to determine requirements to remote operators of automated systems
Description	Wärtsilä Voyage is developing autonomy solutions for different sectors in shipping. They are manufacturer of navigation and automation systems. Automation of seagoing ships is stepping forward. • Bridge layouts will get more and more simplified. • Focus on situational awareness and on the most important information. • Human centered design is needed to support the take-over of an autonomous controlled vessel. • Challenge of big data volumes in transfer • Experiences with research vessel AHTI • Operators need understanding of high automated ship control systems. • It is necessary to know limitations of used technologies. • Use cases as ferries in the North Sea and Baltic Sea with their challenges were discussed. Further important statements and findings that were made during the interview can be found in section Results of this appendix (referenced with the identifier FEEDER I3).

Table 7: Wärtsilä Voyage Interview.

Interview with Harren Bulkers	
Identifier	BULKER I
Date	16.03.2023
Location	Bremen
Interviewer	Dr. Marie-Christin Harre, Prof. Thomas Jung, Steffen Willauer
Participants	Joachim Zeppenfeld, Managing Director from Harren & Partner (https://www.harren-bulkers.de/company/management-team.html)
Goal	Validate and identify specifics of bulk carriers
Description	Harren & Partner is a German shipping company based in Bremen, Germany. Harren & Partner provides a range of services, including ship management,

	technical management, commercial management, and crew management. The company operates a diverse fleet of vessels, including container ships, bulk carriers, tankers, and heavy lift vessels. In addition to its shipping operations, Harren & Partner has also diversified into other areas, including renewable energy and real estate. The company is known for its innovative approach to business and its commitment to sustainability. The following points were discussed: Discussion about the specifics of bulk carriers. Explanation of outcomes of data capture on board of a bulk carrier by the navigational officer S. Willauer (who sailed on the vessel). Validation of processes, restrictions in automation were discussed. Challenges are • the future technologies for propulsion and machinery, • navigation in underdeveloped countries, • maintenance of the entire vessel and • preparing and cleaning holds for cargoes. In general, the company is seeing the advantages of automation, but they must be economic. Further important statements and findings that were made during the interview can be found in section Results of this appendix (referenced with the identifier BULKER I).

Table 8: Harren Bulkers Interview.

3. Observations

Observation at Scandlines	
Identifier	FERRY O1
Date	25.10.2022
Location	Scandlines Ferry between Puttgarden and Roedby
Interviewer	Dr. Marie-Christin Harre, Marcel Saager, Noelle Rousselle
Participants	Master, First Officer, Second Officer, Chief Engineer from Scandlines (https://www.scandlines.de/)
Goal	The goal of the observation is to match the tasks of the captain and the officers with the defined tasks and to get background knowledge about the tasks. Observations can often be more suitable than interviews when performing tasks because they provide a direct and immediate understanding of an individual's actual actions and decisions. In addition, it is possible to understand how the officers and master communicate with each other, what external communications are needed, and what situations are particularly safety-critical. The route Puttgarden - Roedby is particularly interesting, because it is a very narrow passage within the Baltic Sea and the passage is currently even more complex due to the construction site for the tunnel between Germany and Denmark.
Description	For the purpose of the observation, the route Puttgarden - Roedby was sailed several times (ferry M/S Schleswig-Holstein). The berthing and de-berthing manoeuvres could be observed several times. The participants were asked to comment on their actions (if possible) and to describe what the current focus of the task was. In this way, insights into the decision-making processes and priorities of the participants could be gained and these could later be taken into account when defining the processes and tasks (see DCoS models in appendix C). A tour of the engine room was also provided. This made it possible to gain a better understanding of the interaction of the individual components. In parts, Scandlines has already retrofitted batteries that require less maintenance and can be used for future MASS. The results were incorporated in the DCoS models in appendix C. Further important statements and findings that were made during the observation can be found in section Results of this appendix (referenced with the identifier FERRY O1).

Table 9: Observation at Scandlines.

Observation at Scandlines	
Identifier	FERRY O2
Date	01. September 2022 – 03. September 2022, 02. February 2023 – 03. February 2023
Location	Scandlines Ferry between Puttgarden and Roedby
Interviewer	Frederike Aschenbrenner
Participants	Seafaring Crew on Board (Master, nautical officers, technical officers)
Goal	The goal was to document the onboard processes of the ferry. The basis for this was a table with predefined processes and tasks, which were used to help the team members to determine what to look out for during the observation.
Description	The journey was on board the ferry "Schleswig-Holstein", which operated in the Fehmarn Belt between Roedby and Puttgarden. The passage took a total of 45 minutes, the port stay 7 to 15 minutes. This trip was repeated many times in the observation. It was observed how the crew performed operational tasks. For this purpose, the resources and information with which the crew worked and the workflow of their tasks were recorded. The results were incorporated in the DCoS models in appendix C and the processes in appendix D.

Table 10: Observation 2 at Scandlines.

Observation at a Bulk Carrier (Pabari)			
Identifier	BULKER O		
Date	04. October 2022 to 01. December 2022		
Location	**Location**	**Action**	**Date**
	Rotterdam, Netherlands	Departure	04.10.2022
	Kiel Canal, Germany	Passing	05./06.10.2022
	Kleipeda, Lithuania	Arrival	07.10.2022
		Loading	09.10.2022
		Departure	12.10.2022
	Skagen, Denmark	Pilotage	14.10.2022
	Pointe-Noire, Republic of Congo	Arrival	05.11.2022
		Departure	11.11.2022
	Banana Pilot Station, Republic of Congo	Arrival	12.11.2022
	Matadi, Republic of Congo	Arrival	12.11.2022
		Departure	17.11.2022
	Banana Pilot Station, Republic of Congo	Arrival	17.11.2022
	Recalada Pilot Starion, Argentine	Arrival	30.11.2022
	San Lorenzo, Argentina	Arrival	01.12.2022
Interviewer	Steffen Willauer		
Participants	Seafaring Crew on the MV Pabari (Master, nautical officers, technical officers)		
Goal	The goal was to validate the previously defined tasks and processes. For this purpose, a team member was sent to the Parabi to make corresponding observations. In this way, the operational profiles of the bulk carrier were analysed.		
Description	The ship (Pabari, Bulk Carrier) sailed from Rotterdam to Klaipeda in ballast conditions, then loaded with wheat to Pointe Noire and Matadi in West Africa.		

	The observation took place between voyage from Klaipeda (Europe) to Pointe Noire and Matadi (Africa). The processes from the predefined process table were identified and observed several times during the journey. The results were used to validate the processes and tasks and, if necessary, to extend them with additional information (see appendix C, appendix D).

Table 11: Observation at Bulk Carrier (Pabari).

Travel "Short Sea Cargo" (Planned in December, did not take place)

Due to external circumstances (accident) the voyage was cancelled on short notice. The shipping company offered another ship for January / February 2023, but to organisational issues and constraints in availability of planned investigators the investigation on board was to be cancelled.

Based on the outcomes of the investigations on the ferry and the bulker the processes were discussed within the project team. The team used the experience of Prof. Thomas Jung who is holder of a valid STCW Certificate of Competence as Master and has experience on several container ships in worldwide and feeder services.

4. Results

In addition to detailed input on the processes & tasks that have been incorporated into the DCoS models (see **Appendix C**), the interviews, workshops and observations were used to obtain statements on MASS and future ROC. These were partly repeated so that they could also be validated. The statements are listed below, indicating where these findings were obtained or additionally validated. The repetition of certain findings strongly suggests that particular emphasis is placed on these by the reference group.

	Findings & Statements for ROC & Operator Competencies	DGON W1	DGON W2	FERRY I/O1	BULKER I	FEEDER I1	FEEDER & BULKER I2	FEEDER I3
Voyage Planning & Tracking								
VP1	Voyage planning can be carried out in the day shift.			x		x		
VP2	Voyage planning & Voyage Tracking can be conducted in a Fleet Operation Center.		x		x			
VP3	The system in the ROC should be able to automate large parts of Voyage Planning.			x		x		
VP4	The system in the ROC should be able to automate large parts of the voyage tracking.			x				
Cargo Operations								
C1	Cargo operations must be carried out around the clock.					x		
C2	The system in the ROC should be able to automate large parts of cargo planning - especially ballasting.			x				
C3	When monitoring cargo, it might be helpful to have still people on board to detect liquefied cargo.					x		
C4	It is to be expected that a higher level of shore-side support will have to be offered for loading processes. The question of responsibility must also be clarified here. It is difficult to verify correct loading from a remote position, and sensor technology may be economically unattractive.		x					

	Findings & Statements for ROC & Operator Competencies	DGON W1	DGON W2	FERRY I/O1	BULKER I	FEEDER I1	FEEDER & BULKER I2	FEEDER I3
	Workshop and interview participants envision that future ROCs will have to share responsibility for individual processes more than is the case today. For example, a captain will no longer be responsible for the entire processes of a ship, but formal handovers will have to take place. A person at the port is thus responsible for checking that the cargo is correct, after which the responsibility for the ship in the context of navigation is handed over to the ROC.							
C5	For bulk carriers, preparing and cleaning holds for cargoes when there is no crew on board is a major challenge, requiring the provision of appropriate personnel on board to take over this task, clear lines of responsibility and handovers.				x			
Navigation								
N1	If the planning or logging step is automated, the operator must be able to acquire the knowledge about the planning in an easy way since he/she needs the information in the context of navigation.			x				
N2	The operator must be able to switch quickly between different vessels and to adapt mentally to another vessel. (This can be simplified in the ROC by using sister ships for one operator)			x				
N3	In the future, standardisation will be an important factor in reducing the cognitive workload of operators in order to make the mental switch between different vessels even easier.		x		x			
N4	The ROC must provide an adequate substitute for the current acoustic			x	x	x		

	Findings & Statements for ROC & Operator Competencies	DGON W1	DGON W2	FERRY I/O1	BULKER I	FEEDER I1	FEEDER & BULKER I2	FEEDER I3
	and haptic feedback from the ship that can be felt on the bridge for the operator steering the ship. (often referred to as *ship sense* in the state of the art)							
N5	The ROC must allow the operator to deliberately exploit limits (e.g. during de-berthing manoeuvres, scraping along the fenders to anticipate the effect of the wind, etc.)			x				
N6	The operator must have knowledge of the vessel (e.g. maneuverability) in order to safely control it in (de-) berthing.			x				
N7	Navigation at sea can probably be automated and only requires a small amount of monitoring by an operator in the ROC.	x	x	x	x	x		
N8	Navigation in underdeveloped countries will be a challenge, as these countries will not upgrade their ports to the same extent as more developed countries. This will affect bulk carriers in particular, as they cover long distances.	x			x			
Maintenance								
M1	The ROC design should favor continuous maintenance by personnel onboard. (This is preferred for cost reasons by shipping companies. Involvement of external companies for this task and maintenance in port would cause higher costs and is therefore not preferred).		x			x		
M2	During maintenance and monitoring, machine noise is an important factor for technicians in assessing the condition of technical equipment.			x		x		

	Findings & Statements for ROC & Operator Competencies	DGON W1	DGON W2	FERRY I/O1	BULKER I	FEEDER I1	FEEDER & BULKER I2	FEEDER I3
Emergencies								
E1	The management of emergencies is difficult to handle without personnel on board; especially on ships with passengers, the persons on board (service, riding crew) have to be trained in special emergency measures (e.g. crowd management).			x		x		
General Findings								
G1	Main challenges are emergency handling, replacement of haptic/acoustic feedback, communication with other ships, standardization of ships.	x	x	x	x	x	x	
G2	There will be a longer transition phase with combined traffic (autonomous, non-autonomous). These pose further challenges to an ROC (for example, communication of an operator in the ROC with a navigator on a conventional vessel; autonomy must also adapt to the behavior of conventional vessels, the behavior of conventional vessels is not as predictable for operators of an ROC as autonomous vessels).		x		x			
G3	It must be decided who has the main responsibility (e.g. as the master today). Responsibility should be allocated according to the level of competence of the operators involved. It is likely that responsibilities will need to be shared more than is currently the case.		x					
G4	For future ROCs, it will be important to apply human factors engineering approaches to provide future operators with good situational	x	x					x

	Findings & Statements for ROC & Operator Competencies	DGON W1	DGON W2	FERRY I/O1	BULKER I	FEEDER I1	FEEDER & BULKER I2	FEEDER I3
	awareness and to support the take-over of an autonomously controlled vessel.							
G5	Operators need to understand highly automated ship control systems and be aware of the limitations of the technologies used.						x	x
G6	Nowadays, it happens repeatedly that communication is conducted with a wrong ship due to confusion. In an ROC, this problem is likely to be exacerbated.					x		
G7	If the number of crew members is reduced, the human aspect for the remaining crew members on board must not be neglected (isolation).	x	x		x			
G8	Economic considerations should always be taken into account when designing the future ROC and MASS.		x	x	x	x		
G9	It is conceivable that operators on operational level will continue to be positioned on the bridge of the ship during training, while the management level will be predominantly located in the ROC.		x					

Table 12: Findings & Statements.

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