European Maritime Safety Agency

CMOROC Appendix E - Competence Tables

Identification of Competences for MASS Operators in Remote Operation Centres

V 2.2

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The tables shall be applied for remote operation centres to both degrees of autonomy: with or without crew on board.

The tables represent the minimum requirements for ROC operators of MASS-systems.

Roles of ROC Operators

Explanation of the roles needed for Remote Operation of MASS

Role in ROC	Capability	Qualification as …	Competence at …	Table
Remote Fleet Supervisor	Supervisor and direct control	MASS Senior Navigator	management level	MASS-1.2
Remote Senior Navigator	Direct control	MASS Senior Navigator	management level	MASS-1.2
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2. MASS Competence Tables

MASS-1.1 for MASS ROC Navigators (Operational Level)

Specification of minimum standard of competence for MASS ROC Navigators in charge of monitoring MASS of 30m length or more, designated as watch officer in a Remote Operation Center or on board when remotely controlled.

Function: **Operation of a MASS system at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Operate a MASS system	to explain the technical design of a MASS and to name the differences to a conventional ship	2	S.3
	to explain the operational design of a remote-control center for a MASS	2	S.3
	to explain the operational design and components of the workstations with its equipment to control a MASS	2	S.3
	to explain digital platforms	2	S.3
	to apply procedures to operate a MASS in different remote-control modes by using the workstations	3	S.3
	to operate all navigational and communication controls in the ROC and on the MASS	3	S.3
	to map applications and hardware of automation systems to field level, control level, or supervisory level respectively (“Automation Pyramid”)	4	S.3
	to name examples of interfaces and protocols being used on each level of automation	4	S.3
	to explain the navigational and communication system of a MASS	2	3.2 3.4 3.5.2 3.6
	to explain automatic port facilities	2	4.3
Document and analyse MASS data	to document and file operational data	3	1.4
	to analyse data indicating performance, availability, and reliability of all MASS systems	4	1.4
	to determine data being relevant for operation of a MASS, i.e., parameters reflecting operational states of all relevant systems on a MASS	4	1.4
	to optimize data for evaluation purposes	4	1.4
	to save all data and information of the MASS system	3	1.4 S.3
	to prepare regular status reports from operational data	4	1.4
Interpret data from the system	to understand the basics of automation and control techniques	2	1.2
	to explain the limitations and conditions of automation and control techniques	2	1.2
	to interpret aggregated information of the automation and control techniques appropriately	4	1.2

Use of communication networks	to explain the design and use of satellite and cellular networks available at sea	2	S.3
	to explain the design and use of navigation and communication networks	2	S.3
	to monitor cellular and satellite communication networks	4	3.2 3.3 3.4

Function: **Remote navigation of a MASS at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Operate navigational and communication MASS systems	to operate the navigational and communication system of a MASS	3	3.1.2
	to operate the remote-control system with its specific interfaces	3	M.2
	to describe the system of sensors and how to use them to keep situational awareness	3	M.2
	to discuss the application of MASS-specific systems and their use for autonomous ships	2	3.1.2
	to discuss the objectives and systems of the automation	2	1.2
	to discuss the basics of automation control systems	2	1.2
	to explain the different degrees of autonomy of the navigational and communication systems	2	S.3
Plan and conduct a MASS passage	to plan a passage with consideration of MASS relevant communication and data transfer demands	4	3.1.1
	to plan a passage with consideration of MASS relevant navigational aids	4	3.1.1
	to prepare all navigational and communication systems of a MASS for operation, such as updates and settings	4	3.1.1
Determine position and status of MASS	to use all navigational tools remotely to verify and assess the MASS position, course and speed	4	3.1.2 3.2
	to interpret the environmental conditions remotely and to verify and assess the status of the MASS in the sea	4	3.3 3.4
	To use specific navigational aids for MASS	3	3.5.1 3.5.2
Handle a MASS in monitoring mode	to initiate manoeuvres of the MASS to avoid collisions	4	3.2
	to control the speed and course remotely according to the manoeuvring parameters of the MASS	4	3.3 3.4
	to take over control according to levels of alarm	4	
	to explain the handling of a MASS regarding the mooring equipment and the use of automated port facilities	2	3.1.2 3.5.2 3.6
	to explain the handling of a MASS regarding the anchoring equipment	2	3.5.1
	to monitor and operate all connections of the MASS with the shore	4	3.6
	to keep the MASS in position for discharging operations	3	4.3

Conduct and maintain a safe remote navigational watch	to maintain a safe remote watch	3	M.2
	to take over manual control from automated systems in all situations	4	3.1.2
	to intervene if critical deviations and situations occur	4	1.2
	to apply collision-avoidance regulations for a MASS	4	3.2 3.3 3.4
Monitor and control the navigation of a MASS	to monitor and operate the data and information exchange between MASS and all relevant stations	4	3.1.2
	to monitor and operate sensor systems by interpretation and analysing reliability of provided information	4	3.1.2
	to monitor the automated functionalities of a MASS	4	3.1.2
	to analyse and adjust automated systems in terms of navigational parameters	4	3.1.2
	to monitor and operate the data and information exchange between MASS and all relevant stations	4	3.2
	to monitor and operate sensor systems by interpretation and analysing reliability of provided information	4	3.3 3.4
	to monitor the automated functionalities of a MASS	4	3.5.1
	to analyse and adjust automated systems in terms of navigational parameters	4	3.6
	to take over control from automated systems according to alarm levels	4	
	to explain and consider the limitations of automation, e.g., in challenging traffic situations or weather conditions	2	1.2
	to monitor the automation and check whether the automation objectives are being met	4	1.2
	to monitor and interpret the sensor data of the MASS (take a proper outlook)	4	1.2
	to assess the reliability of sensor values	4	1.2
	to assess interdependencies between different elements of information	4	1.2
	to interpret errors and critical situations correctly	4	1.2
Operate human-machine interfaces	to maintain appropriate situational awareness when using the human-machine interfaces when monitoring or controlling remotely	3	M.2
	to maintain situational awareness with limited sensor availability	3	S.3
	to apply behavioural techniques to keep situational awareness and to make decisions when using information by sensors and machines	3	S.1
Communicate as MASS with other stations or automated systems	to communicate as part of a MASS system with other stations by using standardised phrases	3	S.1
	to apply international communication standards for MASS operations	3	S.1
	to monitor the communication of the MASS with ROC and automated navigational aids or systems	4	1.2

Function: **Maintaining a MASS system at operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Maintain all navigational and communication equipment	to operate remote system updates of navigational and communication systems	4	5.1.2 5.2
	to apply all settings of the navigational and communication equipment remotely	3	
	to analyse malfunction alarms and to identify need for corrections	4	
	to operate maintenance and repairs of MASS systems	3	

Function: **Monitoring of cargo or mission operations of a MASS at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Monitor automated cargo and mission operations	to monitor and check specific MASS systems (automated berthing systems, ship-shore-connections, cargo or mission operation remote monitoring systems)	3	2.2 2.4
	to monitor cargo or mission related equipment by remote control	3	
	to monitor the interfaces of the MASS to terminal and port operations	3	
	to support cargo or mission operations by providing all required information to other parties involved	3	
	to monitor persons (crew and passengers) on the MASS	3	
	to describe different types of MASS and their specific constructional differences	2	2.1
	to explain the handling of cargo on a MASS, e.g., container, break bulk, bulk, liquid, or ro-ro-cargo	2	2.1
	to describe the specific requirements of handling of different cargoes on a MASS	2	2.1
	to explain the control of persons on board of a MASS	2	2.1
	to apply and monitor sensor-based cargo monitoring systems	3	2.3
Maintain seaworthiness of the MASS	to use remote controlled or autonomous systems to control stability, trim, and stress	3	2.1 2.3 2.4
	to use remotely controlled or autonomous pumping systems for liquids (ballast water, fuels, …) and to control tank filling remotely	3	
	to monitor the ship stability, trim, and stress remotely	3	
Inspect and report defects and damage to MASS structures	to inspect a MASS for structural damages and report these when the MASS is in the port.	4	2.2 2.4

Function: **Controlling the operation of the MASS and care for persons on board at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Application of leadership and teamworking skills	to explain the challenges for humans involved in highly automated systems	2	S.1
	to organise workload and minimise stress when working with automated systems	3	S.1
Contribute to the safety of personnel and MASS	to explain the specific emergency operations for a MASS with and without crew on board	2	6.1
	to explain critical equipment of a MASS and its possible malfunctions	2	6.2
	to explain how to get critical equipment of a MASS back under control	2	6.2
	to explain emergency situations of a MASS and their possible impacts to the MASS	2	6.3
	to perform a takeover in manual control to get the MASS system back under control after malfunctions or emergencies occur	3	6.3
	to identify malfunctions and to initiate an immediate remote response	4	6.2
	to identify emergency situations and to initiate an immediate **remote** response	4	6.3
	to apply MASS specific safety equipment	3	S.1
Contribute to the security of personnel and MASS	to ensure security procedures for the MASS at sea and in port	3	6.3
	to understand and monitor person identification and counting devices to control access to the MASS	3	2.2
	to explain and apply the applicable and relevant cyber security measures to protect the MASS system	3	6.3
Apply MASS related management systems	to explain management systems for quality, energy, environmental protection, safety, and security	2	M.4
	to set quality improving measures in place and to communicate them to all involved persons	3	M.4
Apply MASS related risk management	to use appropriate tools to identify and assess operational risks in the operation of MASS	4	M.3
	to determine measures to mitigate operational risks and to implement them	4	M.3
Monitor compliance with legislative requirements	to explain international and national MASS legislation and regulation	2	S.2

MASS-1.2 for MASS ROC Senior Navigators (Management Level)

Specification of minimum standard of competence for MASS ROC Senior Navigators, MASS Masters, and Fleet Supervisors for MASS of 30 m length or more, in a Remote Operation Centre or on board when remotely controlled.

Function: **Operation of a MASS system at the management level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Manage a MASS system	to determine and measure standards of performance of a MASS system	5	1.4
	to evaluate performance, reliability, and availability of all MASS and ROC subsystems	5	1.4
Manage documentation and analysing of voyage data	to determine relevant data for the operation of a MASS, i.e., parameters reflecting operational states of all relevant systems on a MASS	4	1.4
	to use software tools for data analysis	3	1.4
	to use digital platforms	3	1.4
	to structure and evaluate collected data and information	5	1.4
	to derive baselines and thresholds for equipment from operating data that may be used for generating meaningful alarms and events	5	1.4
	to control the performance of a MASS system	5	1.4
Optimise the MASS system	to evaluate the reliability of automation and control systems	5	1.4
	to derive information to analyse the MASS system	5	1.4
	to optimise operations of MASS by using digital twins	5	1.4
	to map applications and hardware of automation systems to field level, control level, or supervisory level respectively (“Automation Pyramid”)	4	1.4

Function: **Remote navigation of a MASS at the management level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Plan and track a MASS voyage	to plan and use automated facilities and services at sea and in ports	3	1.1 1.2 1.3
	to analyse the requirements for navigation and port operations	4	
	to identify all possible restrictions for a MASS system on the specific planned voyage	4	
	to plan schedules for MASS voyages	5	
	to identify and evaluate consequences of changes in the voyage	5	1.2 1.3
Plan and approve a MASS passage	to evaluate and release a passage plan for a MASS	5	3.1.1
	to evaluate provided navigational data and information with respect to the demands of a MASS	5	3.1.1

Manoeuvre and handle a MASS in all conditions	to manoeuvre a MASS based on sensor data	5	3.2 3.4
	to anchor a MASS based on sensor data	5	3.5.1
	to berth and unberth a MASS based on sensor data	5	3.1.2
	to communicate remotely with port services when berthing or unberthing	3	3.5.2
	to handle a MASS safely in all manoeuvres such as berthing, anchoring, fairway, and sea passages	5	3.1.2 3.5.1
	to handle a MASS according to environmental influences	5	3.5.2
Monitor and conduct direct control of a MASS	to take direct control of the MASS (get quickly into the loop and adapt quickly to the situation and the vessel involved)	5	1.2
	to adjust and change parameters of the automation	5	1.2
	to interpret errors and critical situations correctly (especially when dealing with subsequent errors)	5	1.2
	to take over command by changing from automated to manual mode of a MASS	5	3.1.2 3.2 3.3 3.4 3.5.1 3.5.2
	to evaluate and ensure the data and information exchange between MASS and all relevant stations	5	
	to evaluate the reliability of data and information provided by sensor systems	5	
	to coordinate and adjust the different automated functionalities of a MASS	5	
	to analyse and adjust automated systems in terms of navigational parameters	5	
Develop and improve human-machine-interfaces	to implement and improve human-machine interfaces	5	M.1
	to improve the human-machine interaction, especially to keep the situational awareness on a high level	5	M.2

Function: **Maintenance and repair of a MASS system at management level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Determine maintenance demands	to apply maintenance strategies such as predictive, condition-based, or risk-based maintenance for a MASS	3	5.1.1
	to derive maintenance requirements from operating data and to plan the tasks and jobs for a MASS	5	5.1.1
	to perform remote analysis of system parameters and communication protocols to identify the root cause of failures	4	5.1.1
	to evaluate spare part demands and to manage availability to ensure safe operation of MASS	5	5.1.3
Manage remote inspections, maintenance, and repair	to determine maintenance equipment for remote use and control	4	5.1.1
	to derive maintenance requirements from operating data (“predictive maintenance”)	5	5.1.1
	to manage maintenance, inspection, and repairs of MASS systems	3	5.1.2
	to guide personnel on board to support maintenance and repair tasks	4	5.2

	to report incidents to IT service providers and to track incident/problem management	4	
	to interoperate with IT service providers and to comply to respective service processes	4	
	to report incidents to IT service providers and to track incident/problem management	4	
	to evaluate the options for a remote maintenance of navigational and communication equipment	5	5.2
	to evaluate the options for a remote maintenance of MASS structure and deck equipment	5	5.2
	to manage remote maintenance with or without riding crews on board	5	5.2

Function: **Management of cargo or mission operations of a MASS at the management level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Plan and ensure safe cargo and mission operations	to plan and control automated cargo and mission operations	5	2.1
	to establish an efficient coordination and communication with all parties involved in automated port operations	5	2.2 2.4
	to take care of cargo and missions on a MASS when at sea and to initiate all required remote-controlled activities for a safe shipment or execution of tasks	5	2.3
Operate a safe carriage of persons and passengers	to plan procedures and control of passengers and other persons on board of a MASS to ensure a safe carriage	5	2.1
	to control persons and passengers, and monitor passengers on board remotely	5	2.3
	to evaluate the behaviour of persons on board by remote observations	5	2.3
	to establish a communication between ROC and MASS areas with persons on board	4	2.3
	to organise the care for persons and passengers on board of the MASS	4	2.3
	to monitor passenger and accommodation areas to ensure safety of persons	4	2.3
	to handle luggage and personal effects safely	5	2.2 2.4
Control trim, stability, and stress of a MASS	to plan and set the parameters for stability conditions of a MASS passage	5	2.1
	to evaluate the stability of the MASS	5	2.1
	to evaluate the reliability of the remote stability control system	5	2.2 2.3 2.4
	to remotely evaluate hazards to the MASS in the seaway**,** the cargo, and persons on board and to establish appropriate measures	5	2.3
	to coordinate all activities to control stability, trim, and strength of a MASS	5	2.2 2.4

Manage defects and damages of MASS structure or deck equipment	to perform remote inspections of the structure and deck equipment	3	2.2 2.4
	to evaluate defects or damages of a MASS	5	
	to initiate corrective measures to ensure safe cargo and mission operations	5	

Function: **Controlling the operation of the MASS and care for persons on board at the management level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Develop and improve the organization of a MASS system	*Process management*		M.1
	to organize MASS systems	5	M.1
	to use organisation development tools	3	M.1
	to implement process management	5	M.1
	to develop, implement, and supervise standard operating procedures	5	M.1
	Structural organisation		M.1
	to develop and determine structural organisation	5	M.1
	to allocate tasks and functions to operators	5	M.1
	to implement communication brokers to achieve seamless internet access	2	M.1
Apply leadership and teamwork skills	to apply a MASS-ROC-related resource management	3	M.2
	to foster teamwork and communication in the entire MASS team in ROC and at sea	5	M.2
	to enable coordinated teamwork in different distributed locations	5	M.2
	to identify behaviours of operators in distributed work locations	5	M.2
	to identify the level of situational awareness in a team of operators and to improve in case of loss of sufficient S/A	5	M.2
	to implement and improve systematic decision-making procedures in remote monitoring and control	5	M.2
	to identify too high workloads in the operator and MASS team and to reduce stress levels by appropriate measures	5	M.2
Develop and maintain safety for the MASS and persons on board	to establish a safety culture in the entire MASS-ROC-system	5	M.2
	to manage that all remote-controlled safety equipment is in operational availability	5	6.1
	to evaluate malfunctions and emergency situations and to initiate appropriate measures	5	6.2 6.3
	to organize, control, and operate emergency response activities in the ROC and on a MASS	5	
	to set up measures to get a MASS system back under control after malfunctions or emergencies	5	
	to manage entering of a MASS not under control (NUC)	5	
Maintain security of the MASS, its crew and passengers	to implement and to apply a MASS and ROC security plan	5	6.1 S.1
	to implement concepts of cyber security on board and ashore	3	6.1

	to evaluate the MASS and ROC security-related situation and to initiate appropriate measures	5	6.1 S.1
	to assess cyber risks and to identify cyber attacks	5	6.1
Implement management systems and improve the MASS system	to apply all relevant management systems	3	M.4
	to determine objectives related to the required standards	3	M.4
	to communicate the requirements with all stakeholders and interested parties	3	M.4
	to determine the appropriate organisation and management of the named systems	5	M.4
	to set up processes for continuous improvement	5	M.4
	to manage all relevant measures and activities to obtain the determined objectives	5	M.4
	to conduct internal and external audits of MASS and ROC management systems	5	M.4
Apply risk management and appraise risks	to identify hazards for the operations of a MASS system, covering all technical, organisational, and human-related aspects	4	M.3
	to derive risks which may arise from the operation of a remote-controlled MASS	4	M.3
	to identify and evaluate risk levels and to determine appropriate mitigation measures by applying systematic risk management tools	5	M.3
	to set measures in place to reduce risk	5	M.3
	to manage risk mitigating activities	5	M.3
	to identify hazards for the operations of a MASS system, covering all technical, organisational, and human-related aspects	4	M.3
Monitor compliance with legislative requirements	to apply international and national regulatory framework for MASS, ROC, and shipping	3	M.2 S.2 1.1
	to apply national and international regulatory framework for the shore-based operators	3	M.2 S.2
	to apply classification cycles for MASS systems and consider intervention schemes requirements	5	
	to manage MASS system related certificates	5	
	to monitor and control compliance with legislative requirements and measures concerning MASS systems	4	
Consider economic aspects in operations of MASS systems	to use resources and infrastructure cost-effectively	3	S.4
	to determine technical and operational benefits	4	S.4
	to evaluate economic effects of optimisation measures	5	S.4

MASS-2.1 for MASS ROC Engineers (Operational Level)

Specification of minimum standard competences for MASS ROC Operations Engineers in charge of monitoring MASS of 30 m length or more, designated as duty engineer in a Remote Operation Centre or on board when remotely controlled.

Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro- cess
Operate a MASS system	to explain the technical design of a MASS and to name the differences to a conventional ship	2	S.3
	to explain the operational design of a remote-control center for a MASS	2	S.3
	to explain the operational design and components of the workstations with its equipment to control a MASS	2	S.3
	to explain digital platforms	2	S.3
	to apply procedures to operate a MASS in different remote-control modes by using the workstations	3	S.3
	to operate all engineering controls in the ROC and on the MASS	3	S.3
	to map applications and hardware of automation systems to field level, control level, or supervisory level respectively (“Automation Pyramid”)	4	S.3
	to name examples of interfaces and protocols being used on each level of automation	4	S.3
	to explain automatic port facilities	2	4.3
Document and analyse MASS data	to document and file operational data	3	TJ
	to analyse data indicating performance, availability, and reliability of all MASS systems	4	TJ
	to determine data being relevant for operation of a MASS, i.e., parameters reflecting operational states of all relevant systems on a MASS	4	1.3 JW
	to optimise data for evaluation purposes	4	1.3
	to save all data and information of the MASS system	3	1.3 S.3
	to prepare regular status reports from operational data	4	JW
Interpret data from the system	to understand the basics of automation and control techniques	2	1.2
	to explain the limitations and conditions of automation and control techniques to perform optimally	2	1.2
	to explain the digital twin of the MASS	2	4.1.2
	to interpret aggregated information of the automation and control techniques appropriately	4	1.2
Use of communication networks for remote control	to explain the design and use of satellite and cellular networks available at sea	2	S.3
	to explain the design and use of navigation and communication networks	2	S.3
	to monitor cellular and satellite communication networks	4	4.2.1 4.2.2 4.2.3

Function: **Marine engineering at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Operate propulsion and auxiliary MASS system	to operate the remote-control system with its specific interfaces	3	M.2 4.2.3
	to describe the system of sensors and how to use them to keep situational awareness	2	4.2.3
	to discuss MASS-specific propulsion and auxiliary systems and their use for autonomous ships	2	4.2.1 4.2.2
	to discuss the objectives and systems of the automation	2	1.2
	to discuss the basics of automation control systems	2	1.2
	to explain the different degrees of autonomy of propulsion and auxiliary systems	2	4.2.1 4.2.2
	to explain the limitations of automation, e.g., in challenging environmental conditions	2	1.2
	to explain the provisions and requirements of non-fossil fuels	2	4.1.1
	to operate automatic port facilities for bunkering and discharge	3	4.3
	to operate and control automated bunker systems with monitoring and control functions	3	4.1.1
	to operate and monitor automated battery charging system with monitoring and control functions	3	4.1.1
	to operate system checks of automated systems by using operational scenarios	3	4.1.2
	to explain the fundamentals of process data processing	2	4.2.1 4.2.2 4.2.4
	to explain fundamentals of mathematics and statistics in terms of operation engineering	2	
	to explain the sensor technologies used in automated systems	2	
	to explain robotic technologies and how to use them in MASS operation engineering	2	
	to explain hydrodynamic parameters, provisions of coatings and air lubrication systems influencing hull performance	2	4.2.3
	to explain physical parameters influencing MASS performance	2	4.2.3
	to operate fuel cells	3	4.2.2
	to operate wind propulsion systems (as Flettner rotors, rigid sails)	3	4.2.2
	to operate power generation by solar cells and wind turbines	3	4.2.2
Monitor a MASS system	to monitor the automation and check whether the automation objectives are being met	4	1.2
	to intervene if critical deviations and situations occur	4	1.2
	to monitor and interpret the sensor data of the MASS	4	1.2
	to assess the reliability of sensor values	4	1.2
	to assess interdependencies between different elements of information	4	1.2
	to monitor and operate the data and information exchange between MASS and all relevant stations	4	4.2.1
	to monitor and operate sensor systems by interpretation and analysing reliability of provided information	4	4.2.1

	to monitor the automated functionalities of a MASS	4	4.2.1
	to analyse and adjust automated systems in terms of engineering parameters	4	4.2.1
	to interpret errors and critical situations correctly (e.g. especially when dealing with subsequent errors)	4	1.2
Conduct and maintain a safe engineering watch	to maintain a safe remote watch	3	M.2
	to take over the manual control from automated systems in all situations	4	4.2.1 4.2.2
	to intervene if critical deviations and situations occur	4	1.2
Operate human-machine interfaces	to maintain appropriate situational awareness by using the human-machine interfaces and monitoring or controlling remotely	3	M.2
	to maintain situational awareness with limited sensor availability	3	S.3
	to apply behavioural techniques to keep situational awareness and to make decisions when using information by sensors and machines	3	S.1
Communicate as MASS with automated systems	to communicate as part of a MASS system with other stations by using standardised phrases	3	S.1
	To monitor the communication of the MASS with ROC	4	1.2

Function: **Remote electrical, electronic, and control engineering operations at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Operate automation and autonomy of MASS systems	to operate the control systems and communication systems for a MASS	3	S.3
	to maintain availability and reliability of the control and communication systems for a MASS	3	S.3
	to apply tests and checks and to evaluate the quality of the MASS system performance	5	S.3
	to decide on appropriate measures to stabilize a MASS control and communication system and to keep it available	5	S.3

Function: **Maintenance and repair at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Analyse maintenance demands	to use risk-based and predictive maintenance tools for inspection and maintenance	4	5.1.2
	to perform remote analysis of system parameters and communication protocols to identify the root cause of failures	4	5.1.2

Maintenance and repair of MASS machinery and equipment	to operate maintenance and repairs of MASS systems	3	5.1.2
	to integrate machinery and equipment into the remote-control system again after repairs and to operate tests accordingly	3	5.1.2
	to operate remote-controlled maintenance tasks on a MASS	4	5.2
	to apply all settings of the operational engineering equipment remotely	4	5.2
	to analyse malfunction alarms and to identify need for corrections	4	5.2

Function: **Controlling the operation of the MASS and caring for persons on board at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Application of leadership and team-working skills	to explain the challenges for humans involved in highly automated systems	2	S.1
	to organise workload and minimize stress when working with automated systems	3	S.1
Contribute to the safety of personnel and ship	to explain the specific emergency operations for a MASS with and without crew on board	2	6.1 6.3
	to explain critical equipment of a MASS and its possible malfunctions	2	6.2 6.3
	to perform a take-over in manual control to get the MASS system back under control after malfunctions or emergencies occurred	3	6.2 6.3
	to identify malfunctions and to initiate an immediate remote response	4	6.2 6.3
	to apply MASS specific safety equipment	3	S.1
Contribute to the security of personnel and MASS	to ensure security procedures for the MASS at sea and in port	3	6.3
	to understand and monitor person identification and counting devices to control access to the MASS	3	2.2
	to explain and apply the cyber security measures to protect the MASS system	3	6.3
Apply MASS related management systems	to explain management systems for quality, energy, environmental protection, safety, and security	2	M.4
	to set quality improving measures into place and to communicate them to all involved persons	3	M.4
Apply MASS related risk management	to use appropriate tools to identify and assess operational risks in the operation of MASS	4	M.3
	to determine measures to mitigate operational risks and to implement	4	M.3
Monitor compliance with legislative requirements	to explain international and national MASS legislation and regulation	2	S.2

MASS-2.2 for MASS ROC Senior Engineers (Management Level)

Specification of minimum standard of competence for MASS ROC Senior Operations Engineers in charge of controlling MASS of 30 m length or more, in a Remote Operation Centre or on board when remotely controlled.

Function: **Operation of a MASS system at the management level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Manage a MASS system	to determine and measure standards of performance of a MASS system	5	1.4
	to evaluate performance, reliability, and availability of all MASS and ROC subsystems	5	1.4
	to analyse the automatic control systems by diagnostic applications	4	4.2.1
	to analyse automatic control systems by using digital twins	4	4.2.2
	to use robotic systems for inspections on MASS	3	4.2.4
	to evaluate the performance of auxiliary and machinery automatic controlled systems	5	4.2.1 4.2.4
	to evaluate the performance of propulsion automatic controlled systems	5	4.2.2
	to evaluate the remote-control system for integrity and reliability	5	4.2.3
Manage documentation and analysing of voyage data	to determine data being relevant for operation of a MASS, i.e., parameters reflecting operational states of all relevant systems on a MASS	4	1.4
	to use software tools for data analysis	3	1.4
	to use digital platforms	3	1.4
	to structure and evaluate collected data and information	5	1.4
	to derive baselines from operating data that may be used for generating meaningful alarms and events	5	1.4
	to control the performance of a MASS system	5	1.4
Optimise the MASS system	to evaluate the reliability of systems of automation and control systems	5	1.4
	to derive information to improve the MASS system	5	1.4
	to optimise operations of MASS by using digital twins	5	1.4
	to map applications and hardware of automation systems to field level, control level, or supervisory level respectively (“Automation Pyramid”)	4	1.4

Function: **Marine engineering at the management level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Plan a MASS passage	to plan a passage of a MASS with specific evaluation and consideration of energy consumption	5	3.1.1
	to plan a passage of a MASS with specific evaluation and consideration of availability of propulsion and auxiliary systems	5	3.1.1
	to identify and evaluate consequences of changes in the voyage	5	1.2

Control a MASS system	to take direct control of the MASS (get quickly into the loop and adapt quickly to the situation and the vessel involved)	5	1.2
	to change parameters of the automation	5	1.2
	to evaluate and ensure the entire control and communication system for operating a MASS	5	S.3
	to evaluate the reliability of data and information provided by sensor systems	5	4.1.2
	to coordinate and adjust the different automated functionalities of a MASS	5	4.1.2
	to operate remote controls of the propulsion plant	4	4.2.2
	to evaluate the remote-control system for integrity and reliability	5	4.2.2
	to give advice to keep data availability, consistency, and reliability	5	S.3
Develop and improve human-machine-interfaces	to implement and improve human-machine interfaces	5	M.1
	to improve the human-machine interaction, especially to keep the situational awareness on a high level	5	M.2
Manage propulsion and auxiliary MASS systems	to manage automated and remote-controlled bunkering systems	5	4.1.1
	to manage automated battery charging systems	5	4.1.1
	to evaluate the operability of new propulsion systems such as wind systems, fuel cells, electric systems	4	4.2.2
	to consider all regulations for bunkering and discharge by using automated port facilities	5	4.3
Manage automation and autonomy of MASS systems	to manage the control systems and communication systems for a MASS	3	S.3
	to evaluate system checks based on operational scenarios and to manage corrective measures	5	4.1.2
	to evaluate systems integrity and reliability by applying plausibility checks and using digital twins	5	4.1.2
Establish integration of service providers	to establish operational platforms for information processing, also in cooperation with data service providers	3	S.3
	to implement communication brokers to achieve seamless internet access	2	S.3
	to interoperate with IT service providers and to comply to respective service processes	4	S.3
	to involve IT service providers and to track related incident/problem management	4	S.3

Function: **Maintenance and repair at the management level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Determine maintenance demands	to apply maintenance strategies such as predictive, condition-based, or risk-based maintenance for a MASS	3	5.1.1
	to derive maintenance requirements from operating data and to plan the tasks and jobs for a MASS	5	5.1.1

	to perform remote analysis of system parameters and communication protocols to identify the root cause of failures	4	5.1.1
	to evaluate spare part demands and to manage availability to ensure safe operation of MASS	5	5.1.3
	to use a digital twin for evaluating the spare part demands	5	5.13
Manage remote inspections, maintenance and repair	to determine maintenance equipment for remote use and control	4	5.1.1
	to derive maintenance requirements from operating data ("predictive maintenance")	5	5.1.1
	to manage maintenance, inspection, and repairs of MASS systems	3	5.1.2 5.2
	to guide personnel on board to support maintenance and repair tasks	4	
	to report incidents to IT service providers and to track incident/problem management	4	
	to interoperate with IT service providers and to comply to respective service processes	4	
	to report incidents to IT service providers and to track incident/problem management	4	
	to evaluate the options for a remote maintenance of navigational and communication equipment	5	5.2
	to evaluate the options for a remote maintenance of MASS structure and deck equipment	5	5.2
	to manage remote maintenance with or without riding crews on board	5	5.2

Function: **Controlling the operation of the MASS and care for persons on board at the management level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Develop and improve the organization of a MASS system	*Process management*		M.1
	to organize MASS systems	5	M.1
	to use organisation development tools	3	M.1
	to implement process management	5	M.1
	to develop, implement, and supervise standard operating procedures	5	M.1
	Structural organisation		M.1
	to develop and determine structural organisation	5	M.1
	to allocate tasks and functions to operators	5	M.1
	to implement communication brokers to achieve seamless internet access	2	M.1
Apply leadership and teamwork skills	to apply a MASS-ROC-related resource management	3	M.2
	to foster the teamwork and communication in the entire MASS team in ROC and at sea	5	M.2
	to enable coordinated teamwork in different distributed locations	5	M.2
	to identify behaviours of operators in distributed work locations	5	M.2
	to identify the level of situational awareness in a team of operators and to improve in case of loss of sufficient S/A	5	M.2
	to implement and improve systematic decision-making procedures in remote monitoring and control	5	M.2

	to identify too high workloads in the operator and MASS team and to reduce stress levels by appropriate measures	5	M.2
Develop and maintain safety for the MASS and persons on board	to establish a safety culture in the entire MASS-ROC-system	5	M.2
	to manage that all remote-controlled safety equipment is in operational availability	5	6.1
	to evaluate malfunctions and emergency situations and to initiate appropriate measures	5	6.2 6.3
	to organize, control, and operate emergency response activities in the ROC and on a MASS	5	
	to set up measures to get a MASS system back under control after malfunctions or emergencies	5	
Maintain security of the MASS, its crew and passengers	to implement and to apply a MASS and ROC security plan	5	6.1 S.1
	to implement concepts of cyber security on board and ashore	3	6.1
	to evaluate the MASS and ROC security-related situation and to initiate appropriate measures	5	6.1 S.1
	to assess cyber risks and to identify cyber attacks	5	6.1
Implement management systems and improve the MASS system	to apply all relevant management systems	3	M.4
	to determine objectives related to the required standards	3	M.4
	to communicate the requirements with all stakeholders and interested parties	3	M.4
	to determine the appropriate organisation and management of the named systems	5	M.4
	to set up processes for continuous improvement	5	M.4
	to manage all relevant measures and activities to obtain the determined objectives	5	M.4
	to conduct internal and external audits of MASS and ROC management systems	5	M.4
Apply risk management and appraise risks	to identify hazards for the operations of a MASS system, covering all technical, organisational, and human-related aspects	4	M.3
	to derive risks which may arise by operation of a remote-controlled MASS	4	M.3
	to identify and evaluate risk levels and to determine appropriate mitigation measures by applying systematic risk management tools	5	M.3
	to set measures in place to reduce risk	5	M.3
	to manage risk mitigating activities	5	M.3
	to identify hazards for the operations of a MASS system, covering all technical, organisational, and human-related aspects	4	M.3
Monitor compliance with legislative requirements	to apply international and national regulatory framework for MASS, ROC and shipping	3	M.2 S.2 1.1
	to apply national and international regulatory framework for the shore-based seafarers	3	M.2
	to apply classification cycles for MASS systems and consider intervention schemes requirements	5	S.2

	to manage MASS system related certificates	5	
	to monitor and control compliance with legislative requirements and measures concerning MASS systems	4	
Consider economic aspects in operations of MASS systems	to use remote-controlled resources and infrastructure cost-effectively and economically	3	S.4
	to determine technical and operational benefits	4	S.4
	to evaluate economic effects of optimisation measures	5	S.4

MASS–3.1 for MASS ROC System Administrators (Operational Level)

Specification of the minimum standard of competence for MASS ROC System Administrators operating remote-controlled systems for MASS of 30 m length or more, in a Remote Operation Centre.

Column 1	Column 2		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Operate a MASS system	to explain the technical design of a MASS and to name the differences to a conventional ship	2	S.3
	to explain the operational design of a remote-control center for a MASS	2	S.3
	to explain the operational design and components of the work positions with its equipment to control a MASS	2	S.3
	to explain digital platforms	2	S.3
	to apply procedures to operate a MASS in different remote-control modes by using the workstations	3	S.3
	to map applications and hardware of automation systems to field level, control level, or supervisory level respectively (“Automation Pyramid”)	4	S.3
	to denominate examples of interfaces and protocols being used on each level of automation	4	S.3
Document and analyse MASS data	to document and file operational data	3	1.4
	to analyse data indicating performance, availability, and reliability of all MASS systems	4	1.4
	to determine data being relevant for operation of a MASS, i.e., parameters reflecting operational states of all relevant systems on a MASS	4	1.4
	to optimise data for evaluation purposes	4	1.4
	to save all data and information of the MASS system	3	1.4 S.3
	to structure and evaluate collected data and information	5	1.4
	to derive baselines from operating data that may be used for generating meaningful alarms and events	5	1.4
	to prepare regular status reports from operational data	4	1.4
Interpret data from the system	to understand the basics of automation and control	2	1.2
	to explain the limitations and conditions of automation and control to perform optimally	2	1.2
	to interpret aggregated information of the automation and control appropriately	4	1.2
Use of communication networks for remote control	to explain the design and use of satellite and cellular networks available at sea	2	S.3
	to explain the design and use of navigation and communication networks	2	S.3
	to monitor cellular and satellite communication networks	4	4.2.1 4.2.2 4.2.3

Function: **Remote electrical, electronic and control engineering operations at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Operate automation and autonomy of MASS systems	to operate the control **systems** and communication systems for a MASS	3	S.3
	to maintain availability and reliability of the control and communication systems for a MASS	3	S.3
	to apply tests and checks and to evaluate the quality of the MASS system performance	5	S.3
	decide on appropriate measures to stabilise a MASS control and communication system and to keep it available	5	S.3
	to explain the features of fieldbus standards and their network-based equivalents	2	S.3
	to discuss the function of analogue and digital interfaces between MASS control systems and on-board hardware	2	S.3
	to explain the design and use of satellite and cellular networks available to MASS systems	2	S.3
	to explain the design and use of navigation and communication networks	2	S.3
	to operate backup facilities to maintain data protection and availability	4	S.3
	to operate on-board facilities for monitoring and troubleshooting	4	S.3
	to operate and monitor automated battery charging systems	3	4.1.1
	to operate system checks of automated systems by using operational scenarios	3	4.1.2
	to explain the fundamentals of process data processing	2	4.2.1 4.2.2 4.2.4
	to explain fundamentals of mathematics and statistics in terms of operation engineering	2	
	to explain the sensor technologies used in automated systems	2	
	to analyse the performance of automation control and data processing systems	4	4.2.3
	to analyse the performance of automation control and data processing systems	4	4.2.3
Establish integration of service providers	to establish operational platforms for information processing, also in cooperation with data service providers	3	S.3
	to implement communication brokers to achieve seamless internet access	2	S.3
	to interoperate with IT service providers and to comply to respective service processes	4	S.3
	to involve IT service providers and to track related incident/problem management	4	S.3
Improve and operate human-machine-interfaces	to improve human-machine interfaces to demands of MASS control	4	S.3
	to apply behavioural techniques to keep situational awareness and to make decisions when using information by sensors and machines	3	S.1

Function:	**Maintenance and repair at the operational level**		
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Analyse maintenance demands	to use risk-based and predictive maintenance tools for inspection and maintenance	3	5.1.1
	to derive maintenance requirements from operational data and to plan the tasks and jobs for a MASS	5	5.1.1
	to perform remote analysis of system parameters and communication protocols to identify the root cause of failures	4	5.1.1
Maintenance and repair of MASS control systems	to apply maintenance and repair of control systems of hotel equipment	3	5.1.2 5.2
	to integrate machinery and equipment into the remote-control system again after repairs and to operate tests accordingly	3	5.1.2
	to restore system function from backups in case of data loss	4	5.2
	to evaluate the options for a remote maintenance	5	5.2
	to manage remote maintenance with or without riding crews on board	5	5.2
	to guide personnel on board to support maintenance and repair tasks	4	5.2

Function: **Controlling the operation of the MASS and care for persons on board at the operational level**			
Column 1	**Column 2**		
Fields of competence	Competences: The operator is able …	C/L	Pro-cess
Application of leadership and teamworking skills	to explain the challenges for humans involved in highly automated systems	2	S.1
	to organise workload and minimise stress when working with automated systems	3	S.1
Contribute to the safety of personnel and MASS	to explain the specific emergency operations for a MASS with and without crew on board	2	6.1 6.3
	to explain critical **automation** equipment of a MASS and its possible malfunctions	2	6.2 6.3
	to perform a take-over in manual control to get the MASS system back under control after malfunctions or emergencies occur	3	6.2 6.3
	to identify malfunctions and to initiate an immediate remote response	4	6.2
	to identify emergency situations and to initiate an immediate remote response	4	6.3
	to get automation of critical equipment of a MASS back under control	4	6.2 6.3
	to apply MASS specific safety equipment	3	S.1
Contribute to the security of personnel and MASS	to implement concepts of cyber security on board and ashore	5	6.3
	to ensure security procedures for the MASS at sea and in port	3	6.3
	to identify cyber attacks and to implement counter measures	5	6.3
	to explain and apply the cyber security measures to protect the MASS system	3	6.3

Apply MASS related management systems	to explain management systems for quality, energy, environmental protection, safety, and security	2	M.4
	to set quality improving measures in place and to communicate them to all involved persons	3	M.4
Monitor compliance with legislative requirements	to explain international and national MASS legislation and regulation	2	S.2