## Appendices: control actions' catalogue

Control a numbe	ction er:			1	IMO Flag state administratio	n Classi soci	fication eties	
Control acti	ion nai	ne:	Internatio	onal legislation				
Туре:			Input					
Textual des	criptio	n:	Codes, leg shipping	gal acts and regulation	n governing vario	us aspects of uni	manned	
Rationale:			Internation regulatory	ional Maritime Organisation or flag states shall mainta ory control over shipping, including unmanned ships				
Hazards resulting:	All ha	zards						
Potential inadequacy	for :	Contro not p	l action is rovided	Unsafe control action is provided	Control action provided in wro time	is Control ac ong provided j short or to	ction is for too oo long	
Consequences:		Substandar and act shipping	d conditions in unmanned	Improper regulatory supervision over unmanned shipping				
Potential causes:		Need for re recognized; obstructed	gulation is not ; works are	Regulatory bodies have inadequate understanding of maritime industry				
Feasible mitigation measures potential	and	Workshops conference Procedures regulations	s, lobbying s, lobbying on 3 ' creation	3 Workshops, 3 conferences, lobbying 3 Procedures on 3 regulations' creation				
Protection against cor degradatior	ntrol n	Providing #2, internation industry co	control action proactive al and within- operation	Providing control action #2, proactive international and within- industry cooperation				

Control a numb	action er:				2			Classification societies		<b>→</b>	IMO Flag stat administrat	e tion
Control act	ion na	me:	Suggest	ior	ns for improvemen	t						
Туре:			Feedbad	ck								
Textual des	scripti	on:	Suggest	ior	ns for improvemen	t or	' upo	date of legisla	tion			
Rationale:			Classific improve	ati em	on societies sho ent of internationa	n societies should cooperate with Administration nt of international regulations					inistration	on
Hazards resulting:	All ha	azards										
Potential inadequacy	for y:	Contro not p	l action is rovided	Unsafe control action is provided		Co pro	ontrol action ovided in wro time	is ng	Cor pro sho	ntrol actior ovided for t ort or too lo	n is 100 101	
Consequences:		Improper re supervision unmanned	egulatory over shipping		Improper regulatory supervision over unmanned shipping							
Potential causes:		Classification to deliver re Administration process rep	on societies fa eports; tion fails to orts	ail	Incorrect reports are delivered, data is processed incorrectly							
Feasible mitigation measures potential	and	Obligation data Lobbying	to share	3 3	Procedures on cooperation on regulations creation	3						
Protection against co degradatio	ntrol n	Ensuring th are not igno	at suggestior pred	IS								

Control a numb	action er:				3		IMO Flag state administration	<b>→</b>	Company managers
Control act	ion na	ime:	Internati	ior	nal legislation				
Туре:			Input						
Textual des	scripti	on:	Codes, le shipping	ega	al acts and regulatior	n go	overning various a	spects o	f unmanned
Rationale:			Internati regulato	or ry	al Maritime Organisation or flag states shall mainta control over shipping, including unmanned ships				
Hazards resulting:	All ha	azards							
Potential inadequacy	for y:	Contro not p	l action is rovided		Unsafe control action is provided		Control action is rovided in wrong time	Control action is provided for too short or too long	
Consequences:		Improper re supervision unmanned	egulatory over shipping		Improper regulatory supervision over unmanned shipping	Leg be <sup>-</sup> int	gislation is issued fore consulting terested parties		J
Potential causes:		Need for re recognized; obstructed	gulation is not works are	t	Regulatory bodies have inadequate understanding of maritime industry	Pre int	essure from society, tended misuse		
Feasible mitigation measures potential	and	Workshops conference	, s, lobbying	3	Workshops, 3 conferences, lobbying	Pro leg	ocedures on 3 gislation creation		
Protection against co degradatio	ntrol n	Providing co #4, proactiv internation industry co Accident/in investigatio	ontrol action /e al and within- operation cident ns		Providing control action #4, proactive international and within- industry cooperation Accident/incident investigations				

Control ac numbe Control actio Type:	ction r: on nan	ne:	<i>Suggest</i> Feedbac	<i>ion</i>	<b>4</b> s for improvemen	Company managers		<b>→</b>	IMO Flag state administrati	e ion	
Textual desc	ription	n:	Suggest	ion	s for improvemen	t or	r update of legislat	ion			
Rationale:			Company managers or industr improvement of international reg				try associations gulations	sho	ould	cooperate	on
Hazards resulting:	All haz	ards									
Potential inadequacy: Consequences:		Contro not p mproper re upervision nmanned	l action is provided egulatory over shipping	;	Unsafe control action is provide Improper regulatory supervision over unmanned shipping	l ed	Control action provided in wro time Legislation is issued before consulting interested parties	Control action is provided in wrong time Legislation is issued before consulting		ntrol action ovided for to ort or too lo	is oo ng
Potential causes:	n a c	leed for co ot recogni ssociation isagreeme	ooperation is ized, s' members ents		Associations' members disagreements		Delay to e.g. complexity of issue in question, lack of data or resources				
Feasible mitigation measures potential Protection against con degradation	and E	rocedures ooperation reation msuring th re not igno	on n on laws'	3	Procedures on cooperation on laws' creation	3	Procedures on cooperation on laws' creation	3			

Control a numb	action er:			5a		Company managers	$\rightarrow$	Classification societies
Control act	ion na	me:	Suggestion	s for improvement				
Туре:			Feedback					
Textual des	scripti	on:	Suggestion	s for improvement	or upo	date of rules for	classifica	ation
Rationale:			Company improveme	managers or inde	ustry rules :	associations sl and thereby on a	hould c a level o	ooperate on f safety
Hazards resulting:	All h	azards						
Potential inadequacy	for /:	Contro not p	l action is provided	s Unsafe control p		Control action is provided in wrong time		trol action is vided for too rt or too long
Consequences:		Improper re supervision unmanned	egulatory over shipping	Improper regulatory supervision over unmanned shipping	Sug afte issu	Suggestions submitted after the rules' update is issued		
Potential causes:		Need for co not recogni association disagreeme	ooperation is ized, s' members ents	Associations' members disagreements	Del of i of c	Delay to e.g. complexity of issue in question, lack of data or resources		
Feasible mitigation measures potential	and	Procedures cooperation creation	on 3 n on rules'	Procedures on cooperation on rules' creation	3 Pro coo cre	ocedures on operation on rules' eation	3	
Protection against co degradatio	ntrol n	Ensuring th are not igno	at suggestions pred					

Control a numb	action er:			5b		Company managers		$\rightarrow$	Classification societies	'n
Control act	ion na	me:	Operation	al or statistical date	a					
Туре:			Input							
Textual des	scription	on:	Informatio improve th	n sent by company to a classification society in order to neir services						
Rationale:			Classificati shipping da	ification societies should have a complete picture of unmann ing daily routine in order to provide with complex services						ed
Hazards resulting:	All ha	azards								
Potential inadequacy	for y:	Contro not p	ol action is Unsafe control provided action is provided		Control action is provided in wron time	s Ig	Con pro sho	trol action vided for to rt or too loı	is 20 ng	
Consequences:		Classification have impro unmanned operations'	on societies per model of shipping practice	Classification societies have improper model o unmanned shipping operations' practice	f	Classification societies have improper model of unmanned shipping operations' practice				
Potential causes:		Managers r share sensi	not willing to tive data	Incorrect processing or interpretation of data		Reports are too complex to combine				
Feasible mitigation measures potential	and	Obligation certain I information	to send 3 kinds of	Automatic reporting Use of leading safety indicators	3 3	Automatic reporting Use of leading safety indicators	3 3			
Protection against co degradatio	ntrol n	Ensuring th solely to im	at data is used prove safety							

Control actior number:	1		6a	Classification societies	Company managers				
Control action n	ame:	Rules for c	lassification						
Туре:		Input							
Textual descript	ion:	Rules issue vessels and	ed by classification societies which shall be followed by all companies						
Rationale:		Such rules implement	es are traditional in shipping industry, requiring all actors to nt minimum standards of safety performance						
Hazards All h resulting:	azards								
Potential for inadequacy:	Contro not p	ol action is provided	Unsafe control action is provided	Control action is provided in wrong time	Control action is provided for too short or too long				
Consequences:	Improper r supervisior unmanned	egulatory 1 over shipping	Improper regulatory supervision over unmanned shipping	Improper regulatory supervision over unmanned shipping					
Potential causes:	Need for is developme classificatio recognized	suing or ent of rules for on is not	Cooperation between various industry actors is flawed	Rules are being compiled too long					
Feasible mitigation measures and potential	Procedures cooperatio creation Issuing procedures exceeding requirement for classific	s on 3 n on rules' company 2 the nts of rules ration	Procedures on 3 cooperation on rules' creation Issuing company 2 procedures exceeding the requirements of rules for classification	Procedures on 3 cooperation on rules' creation Issuing company 2 procedures exceeding the requirements of rules for classification					
Protection against control degradation	Providing c #5a Review of accident/in	ontrol action	Providing control action #5a and #5b Review of accident/incident reports	Providing control action #5a and #5b					

Control action number:			6b	Classification societies	Company managers				
Control action na	ame:	External au	udits						
Туре:		Inspection							
Textual descript	on:	Inspections aiming in ensuring that remote control company and its employees follow rules for classification, international regulations and code of good practice							
Rationale:		Any non-co	ompliance with the at	npliance with the above shall be identified and corrected					
Hazards All h resulting:	azards								
Potential for	Contro	laction is	linsafe control	Control action is	Control action is				
inadequacy:	not n	rovided	action is provided	provided in wrong	provided for too				
	norp	Toviaca		time	short or too long				
Consequences:	Potentially practice rer unnoticed	inadequate nains	Potentially inadequate practice remains unnoticed	Potentially inadequate practice remains unnoticed	Potentially inadequate practice remains unnoticed				
Potential causes:	Company d comply wit	oes not h ISM Code	Audits are performed not according to procedures Auditing procedures are not exhaustive	Audits are performed too rarely Audits are performed in a way that does not allow to assess all necessary activities	Audits are performed not according to procedures Auditing procedures are not exhaustive Auditing procedures are too complex to follow				
Feasible mitigation measures and potential	Obligatory compliance regulations	with all	Elaboration and 3 constant improvement of auditing procedures	Elaboration and 3 constant improvement of auditing procedures Proper cooperation 3 between auditors and the audited company	Elaboration and 3 constant improvement of auditing procedures				
Protection against control degradation	Obligatory audits	periodical							

Control a numb	action er:		7a		Cargo age	nts	$\rightarrow$	Company managers		
Control act	ion nam	e: Cargo in	formation and s	towage						
Туре:		Feed								
Textual des	scription	: Quantita	tive and quali	tative in	formation per	rtainin	g to	commodities		
		intendeo	for shipment							
Rationale:		Compan	y managers sha	l have ful	l information p	ertain	ing to	cargo loaded		
		on board	d in order to gua	rantee its	s safe delivery					
Hazards	1.4 Ves	sel is incapable o	f properly conta	ining dan	ingerous chemicals or energy					
resulting:	2.5 Ves	sel does not mee	t stability criter	а						
	2.6 Ve	ssel's watertight	t integrity is n	ot maint	maintained (due to shear forces, bending					
	momer	its or puncture)								
	3.1 Ves	sel's cargo is not	loaded/stowed	properly	ly					
	3.2 Ves	sel is unable to n	naintain proper	cargo stov	, towage conditions					
	4.3 Ves	sel does not mee	t fire safety pre	cautions						
	4.4 Ves	sel's watertight i	atertight integrity is not maintained							
	5.1 Ves	sel is unable to n	nable to maintain integrity of tanks containing oils or oily mixtures							
	6.3 Sys	em does not me	et international	, classifica	ificatory or national regulations					
Potential	for	Control action is	is Unsafe control		Control action is		Cor	ntrol action is		
inadequacy	nadequacy: n		action is pr	ovided	provided in w	rong	pro	vided for too		
					time		cho	rt or too long		
	C	omnany has improper	Accepted cargo (	loes not	• · · · ·		3110			
	m	odel of cargo's	match its declare	ed	Cargo is rejected		3110			
	m pi	odel of cargo's operties	match its declare quantity or quali	ed ty	Cargo is rejected		3110			
Consequences:	m pi Ca	odel of cargo's operties argo is not accepted	match its declare quantity or quali Information on c	ed ty argo's	Cargo is rejected		3110			
Consequences:	m pi Ci	odel of cargo's operties argo is not accepted	match its declare quantity or quali Information on c properties are no understood	ed ty argo's ot	Cargo is rejected		3110			
Consequences:	m pi Ca	odel of cargo's operties argo is not accepted	quantity or quali Information on c properties are no understood Cargo is stowed	ed ty argo's ot	Cargo is rejected		3110			
Consequences:	m pi Ci	odel of cargo's operties argo is not accepted	match its declare quantity or quali Information on c properties are no understood Cargo is stowed incorrectly	ed ty argo's ot	Cargo is rejected		3110			
Consequences: Potential	m pr C: In ac	odel of cargo's operties argo is not accepted pproper cargo ceptance procedures	match its declare quantity or quali Information on c properties are no understood Cargo is stowed incorrectly Improper cargo I procedures	ed ty argo's ot oading	Cargo is rejected Cargo information delivery is delayed		3110			
Consequences: Potential causes:	m pr Ca In ad	operties operties argo is not accepted pproper cargo cceptance procedures	match its declare quantity or quali Information on c properties are no understood Cargo is stowed incorrectly Improper cargo I procedures Cargo loading pr	ed ty argo's ot oading ocedures	Cargo is rejected Cargo information delivery is delayed		3110			
Consequences: Potential causes:	m pi Ci	odel of cargo's operties argo is not accepted pproper cargo cceptance procedures	match its declare quantity or quali Information on c properties are no understood Cargo is stowed incorrectly Improper cargo I procedures Cargo loading pr misinterpreted Cargo informatic	ed ty argo's ot oading ocedures n	Cargo is rejected Cargo information delivery is delayed		3110			
Consequences: Potential causes:	m pr Ca In ac	odel of cargo's operties argo is not accepted proper cargo aceptance procedures	match its declare quantity or quali Information on c properties are no understood Cargo is stowed incorrectly Improper cargo I procedures Cargo loading pr misinterpreted Cargo informatic misinterpreted	ed ty argo's ot oading ocedures n	Cargo is rejected Cargo information delivery is delayed		3110			
Consequences: Potential causes: Feasible	In ac	odel of cargo's operties argo is not accepted pproper cargo sceptance procedures	<ul> <li>match its declared quantity or quali Information on comproperties are not understood Cargo is stowed incorrectly</li> <li>Improper cargo I procedures Cargo loading promisinterpreted Cargo informatic misinterpreted</li> <li>Issuing improvement</li> </ul>	ed ty argo's ot oading ocedures n and 3	Cargo is rejected Cargo information delivery is delayed Implementation	of 3	3110			
Consequences: Potential causes: Feasible mitigation	In ca pr ca pr	applementation of rgo acceptance ocedures	<ul> <li>match its declare quantity or quali Information on c properties are no understood</li> <li>Cargo is stowed incorrectly</li> <li>Improper cargo I procedures</li> <li>Cargo loading pr misinterpreted</li> <li>Cargo informatic misinterpreted</li> <li>Issuing improvement procedures</li> </ul>	ed ty argo's ot oading ocedures n and 3 of 3	Cargo is rejected Cargo information delivery is delayed Implementation cargo acceptan procedures	of 3 ce	3110			
Consequences: Potential causes: Feasible mitigation measures	and mp pr Ca pr and	Approper cargo sceptance procedures applementation of rgo acceptance ocedures	<ul> <li>Accepted dargo dargo</li> <li>match its declare</li> <li>quantity or quali</li> <li>Information on c</li> <li>properties are no</li> <li>understood</li> <li>Cargo is stowed</li> <li>incorrectly</li> <li>Improper cargo l</li> <li>procedures</li> <li>Cargo loading pr</li> <li>misinterpreted</li> <li>Cargo informatic</li> <li>misinterpreted</li> <li>Issuing</li> <li>improvement</li> <li>procedures</li> </ul>	ed ty argo's ot oading ocedures n and 3 of 3	Cargo is rejected Cargo information delivery is delayed Implementation cargo acceptan procedures	of 3 ce	3110			
Consequences: Potential causes: Feasible mitigation measures potential	and mp pr and	Applementation of rgo acceptance ocedures	<ul> <li>A recepted angle of the second second</li></ul>	ed ty argo's ot oading ocedures n and 3 of 3	Cargo is rejected Cargo information delivery is delayed Implementation cargo acceptan procedures	of 3 ce	3110			
Consequences: Potential causes: Feasible mitigation measures potential Protection	and Lee	Applementation of rgo acceptance ocedures	<ul> <li>Interprete dargo dargo</li> <li>match its declare</li> <li>quantity or quali</li> <li>Information on control</li> <li>properties are not</li> <li>understood</li> <li>Cargo is stowed</li> <li>incorrectly</li> <li>Improper cargo logo</li> <li>procedures</li> <li>Cargo loading primisinterpreted</li> <li>Cargo information</li> <li>misinterpreted</li> <li>Cargo information</li> <li>misinterpreted</li> <li>Issuing</li> <li>improvement</li> <li>procedures</li> <li>Legal consequen</li> <li>non-compliance</li> </ul>	ed ty argo's ot oading ocedures n and 3 of 3 ces for	Cargo information delivery is delayed Implementation cargo acceptan procedures	of 3 ce	3110			
Consequences: Potential causes: Feasible mitigation measures potential Protection against co	and Lee ntrol	Approper cargo argo is not accepted approper cargo aceptance procedures applementation of rgo acceptance ocedures agal consequences for on-compliance	<ul> <li>Accepted angle of a second seco</li></ul>	ed ty argo's ot oading ocedures n and 3 of 3 ces for	Cargo is rejected Cargo information delivery is delayed Implementation cargo acceptan procedures	of 3 ce	3110			

Control action number:			7b	Cargo agents	Company managers				
Control action na	ame:	Commerci	al pressure						
Туре:		Input							
Textual descripti	on:	Pressure f cargo in sł	om cargo shipper to act in unsafe way in order to e.g. deliver orter time						
Rationale:		Actors un pressure o	familiar with specificity of unmanned shipping may put sor on company to act in an unsafe manner						
Hazards All h resulting:	azards								
Potential for inadequacy:	Contro not p	l action is rovided	Unsafe control action is provided	Control action is provided in wrong time	Control action is provided for too short or too long				
Consequences:			Operators ignore system's limitation to satisfy client's expectations						
Potential causes:			Improper cooperation between company and cargo agents						
Feasible mitigation measures and potential			Implementation of 2 strict policy with regard to operational limits and commercial pressure						
Protection against control degradation			Implementation of disciplinary procedure for violation of limits						

Control a numbe	ction er:			7c	Cargo agents	Company managers		
Control acti	ion na	me:	Payments					
Туре:			Input					
Textual des	cripti	on:	Payments f	for cargo shipments				
<b>Rationale:</b>			Company	operating/managing	; the vessel shall b	e paid for cargo		
			shipments					
Hazards	All ha	azards						
resulting:								
Potential inadequacy	for :	Control not pr	action is ovided	Unsafe control action is provided	Control action is provided in wrong time	Control action is provided for too short or too long		
Consequences:		Company doe sufficient res operate the v and efficient	es not have sources to vessel safely ly	Company does not have sufficient resources to operate the vessel safely and efficiently	Company periodically has insufficient resources to operate the vessel safely and efficiently			
Potential		Payment bac	cklogs	Margins' miscalculation	Payment backlogs			
causes:		Margins' mis	nent orders		Margins' miscalculation Lack of shipment orders			
Feasible mitigation measures potential	and	Implementat procedures freight calculation Implementat advance payr	tion of 2 for rate tion of 3 ments	Implementation of procedures for freight rate calculation Implementation of advance payments	Implementation of procedures for freight rate calculation Implementation of advance payments			
Protection against cor degradation	ntrol n	Efficient mar Shareholders	keting policy s' supervision	Shareholders' supervision	Efficient marketing policy Shareholders' supervision			

Control a numb	action ber:				8		Compan manager	rs	$\rightarrow$	Cargo a	agents
Control act	tion na	ne:	Vessel	info							
Туре:			Feedba	ack							
Textual de	scriptio	n:	Vessel	ger	neral description, inf	orm	ation of a	vailable	e car	go spac	ce and
			cargoe	s pc	ossible to carry						
Rationale:			Cargo	agei	nts shall have sufficie	nt i	nformation	about	the v	essel in	order
			to trus	rust her with their cargo. This may be particularly significa							n early
			stages	of a	utonomous shipping	tech	nology dev	elopme	ent as	shippe	rs may
			be unwilling to utilise such a novel way of transporta					portati	on.		
Hazards	3.1 Ve	essel's ca	rgo is no	not loaded/stowed properly							
resulting:	3.2 Ve	essel is u	nable to	le to maintain proper cargo stowage conditions							
					Unsafe control						
Potential	for	Contro	laction	ic	linsafe control	C	Control actio	on is	Cor	ntrol act	tion is
Potential inadequac	for y:	Contro not n	l action rovided	is	Unsafe control	C pr	Control actio covided in w	on is vrong	Cor pro	ntrol act vided fo	tion is or too
Potential inadequac	for y:	Contro not p	l action rovided	is	Unsafe control action is provided	C pr	Control actio rovided in w time	on is vrong	Cor pro sho	ntrol act vided fo rt or too	tion is or too o long
Potential inadequac	for y:	Contro not p Cargo is no	l action rovided	is	Unsafe control action is provided	C pr Car	Control actic covided in w time go is loaded properly	on is vrong	Cor pro sho	ntrol act vided fo rt or too	tion is or too o long
Potential inadequact Consequences Potential	for y:	Contro not p Cargo is no Improper n	l action rovided t loaded narketing	is	Unsafe control action is provided Cargo is loaded improperly Improper marketing	Car imp	Control actic covided in w time go is loaded properly proper marketin	on is vrong	Cor pro sho	ntrol act vided fo rt or too	tion is or too o long
Potential inadequact Consequences Potential causes:	for y:	Contro not p Cargo is no Improper n procedures	l action rovided : loaded narketing	is	Unsafe control action is provided Cargo is loaded improperly Improper marketing procedures	Car imp Imp pro	Control actic rovided in w time go is loaded properly proper marketin cedures	on is vrong	Cor pro sho	ntrol act vided fo rt or too	tion is or too o long
Potential inadequact Consequences Potential causes:	for y: :	Contro not p Cargo is no Improper n procedures	l action rovided t loaded marketing	is	Unsafe control action is provided Cargo is loaded improperly Improper marketing procedures Information is given in an incomprehensible form	Car imp pro Infc inco	Control actic covided in w time go is loaded properly proper marketin cedures prmation is given pomprehensible f	on is vrong g n in an form	Cor pro sho	ntrol act vided fo rt or too	tion is or too o long
Potential inadequact Consequences Potential causes: Feasible	for y: -	Contro not p Cargo is no Improper n procedures	l action rovided c loaded harketing	<b>is</b>	Unsafe control         action is provided         Cargo is loaded         improperly         Improper marketing         procedures         Information is given in an         incomprehensible form         Implementation       of	Car imp Imp pro Infc incc	Control actic covided in w time go is loaded proper ly proper marketin cedures prmation is given pomprehensible fo plementation	g n in an form of 3	Cor pro sho	ntrol act vided fo rt or too	tion is or too o long
Potential inadequact Consequences Potential causes: Feasible mitigation	for y:	Contro not p Cargo is no Improper n procedures	l action rovided t loaded harketing ation of on	<i>is</i>	Unsafe control action is provided         Cargo is loaded improperly         Improper marketing procedures Information is given in an incomprehensible form         Implementation of procedures on cooperation with	Car imp pro Info inco	Control actic covided in w time go is loaded proper marketin cedures promation is given pomprehensible f polementation cedures precedures	g form form of on irith	Cor pro sho	ntrol act vided fo rt or too	tion is or too o long
Potential inadequact Consequences Potential causes: Feasible mitigation measures	for y: 	Contro not p Cargo is no Improper n procedures Implement procedures cooperation clien <u>ts</u>	l action rovided t loaded marketing ation of on with	<b>is</b>	Unsafe control         action is provided         Cargo is loaded         improperly         Improper marketing         procedures         Information is given in an         incomprehensible form         Implementation of         procedures         Implementation of         cooperation         with         clients	Car imp Imp pro Infc incc Car	Control actic rovided in w time go is loaded properly proper marketin cedures pormation is given pomprehensible f polementation cedures operation w nts	g n in an form of 3 on rith	Cor pro sho	ntrol act vided fe rt or to	tion is or too o long
Potential inadequact Consequences Potential causes: Feasible mitigation measures potential	for y: and	Contro not p Cargo is no Improper n procedures cooperation clients	l action rovided c loaded harketing ation of on with	<b>is</b> 3	Unsafe control         action is provided         Cargo is loaded         improperly         Improper marketing         procedures         Information is given in an         incomprehensible form         Implementation of         procedures         Implementation of         cooperation         with         clients	Car imp Imp pro Infc inco Coo clie	Control actic covided in w time go is loaded proper marketin cedures prmation is giver promprehensible f plementation cedures pperation w nts	on is prong g n in an form of 3 on rith	Cor pro sho	ntrol act	tion is or too o long
Potential inadequact Consequences Potential causes: Feasible mitigation measures potential Protection	for y: and	Contro not p Cargo is no Improper n procedures cooperation clients	l action rovided t loaded harketing ation of on with	<b>is</b> 3	Unsafe control         action is provided         Cargo is loaded         improperly         Improper marketing         procedures         Information is given in an         incomprehensible form         Implementation of         procedures on         cooperation with         clients         Constant monitoring of	Car imp pro Infc incc coo clie	Control actic covided in w time go is loaded proper marketin cedures pormation is given pormation is given pormation is given pormation is given pormation is given pormation is given pormation we cedures poperation we nts	g n in an form of 3 on rith	Cor pro sho	ntrol act vided fe rt or to	tion is or too o long
Potential inadequact Consequences Potential causes: Feasible mitigation measures potential Protection against co	for y: and	Contro not p Cargo is no Improper n procedures cooperation clients Constant m clients' sati	l action rovided c loaded harketing ation of on with onitoring o sfaction	<b>is</b> 3	Unsafe control action is providedCargo is loaded improperlyImproper marketing procedures Information is given in an incomprehensible formImplementation of procedures on cooperation with clients3Constant monitoring of clients' satisfaction	Car imp pro Infc incc clie	control actic covided in w time go is loaded proper marketin cedures pormation is given pomprehensible fo polementation cedures operation w nts	g n in an form of 3 nith hg of	Cor pro sho	ntrol act	tion is or too o long

Control actio number:	n		9	Shore-based control centre	Company managers
Control action	name:	Operation	al reports		
Туре:					
Textual descrip	tion:	Operationa	al experience passed t	o upper hierarchy lev	els
Rationale:		Operators order to o meetings.	should share their constantly improve t	experience with com he system in a form	npany managers in of i.e. reports or
Hazards All resulting:	hazards				
Potential for inadequacy:	Contro not µ	ol action is provided	Unsafe control action is provided	Control action is provided in wrong time	Control action is provided for too short or too long
Consequences:	Company r not have p operations	nanagers do roper model of	Company managers do not have proper model of operations	Company managers do not have up-to-date model of operations	
Potential causes:	Operationa not prepar Reports are Lack of pro suggestion communic	al reports are ed e not processed icedure for s' ation	Incorrect reports are prepared Reports are misunderstood	Reports processing is delayed	
Feasible mitigation measures and potential	Implement procedures reports' su Implement key safety	ation of 3 s for bmission ation of 2 indicators	Implementation of 3 simple procedure for reports' submission	Proper assignment of 2 resources and workforce	
Protection against contro degradation	Operators encourage reports. Th should ma referred to	shall be d to submit e reports ndatorily be	Operators shall be encouraged to submit complex reports. The reports should mandatorily be referred to.	User-friendly system for suggestions' submission	

Control a numb	action er:			10a	Company managers	Shore-based control centre						
Control act	ion na	me:	Operation	Operational procedures and their updates								
Туре:			Input	nput								
Textual des	scriptio	on:	Procedures well as dur	s to be followed by o ing emergency situati	perators as part of the ons.	eir daily routine as						
Rationale:			Operators'	decisions should be	based not only on the	eir experience, but						
			also on pre	escriptive advices.								
Hazards resulting:	All ha	zards										
Potential inadequacy	for /:	Contro not p	l action is provided	Unsafe control action is provided	Control action is provided in wrong time	Control action is provided for too short or too long						
Consequences:		Operators i proper pro	not following cedures	Operators not following proper procedures	Operators not following proper procedures							
Potential causes:		Procedures Procedures available to	are not issued are not operator	Procedures are not updated Procedures are not understood Procedures are incorrect	Procedure updates are delayed							
Feasible mitigation measures potential	and	Training of	operators 2	Constant revision of 3 procedures by external experts Training of operators 2	Training of operators 2							
Protection against co degradatio	ntrol n	Providing c #9 Revisions o accident/in	ontrol action f cident reports	Providing control action #9 Revisions of accident/incident reports	Providing control action #9							

Control actio number:	n		10b	Company managers	Shore-based control centre					
Control action	name:	Audits								
Туре:		Inspection	nspection							
Textual descrip	tion:	Periodical	checks to ensure that	procedures are being	; followed					
Rationale:		Operations company's	s shall be audited not s personnel familiar w	t only by external inst ith them.	itutions, but also by					
Hazards All resulting:	hazards									
Potential for inadequacy:	Contro not p	l action is provided	Unsafe control action is provided	Control action is provided in wrong time	Control action is provided for too					
Consequences:	Potentially practice rel unnoticed	inadequate mains	Potentially inadequate practice remains unnoticed	Potentially inadequate practice remains unnoticed	Potentially inadequate practice remains unnoticed					
Potential causes:	Internal au procedures followed	diting s are not	Audits are performed not according to procedures Auditing procedures are not exhaustive	Audits are performed too rarely Audits are performed in a way that does not allow to assess all necessary activities	Audits are performed not according to procedures Auditing procedures are not exhaustive Auditing procedures are too complex to follow					
Feasible mitigation measures and potential	Elaboration constant improveme auditing pr Implement leading indicators	and and 3 ent of ocedures ation of 2 safety	Elaboration and 3 constant improvement of auditing procedures	Elaboration and 3 constant improvement of auditing procedures Implementation of 2 leading safety indicators	Elaboration and 3 constant improvement of auditing procedures					
Protection against control degradation	Employmen assigned so auditing du	nt of a person blely with ities.								

Control a numb	action er:			10c	Company managers Shore-based control centre	:			
Control act	ion na	ame:	Trainings						
Туре:			Input	Input					
Textual des	scripti	on:	Trainings models etc	s' skills in operations, procedures, ment	tal				
Rationale:			Operators should constantly improve their understanding of the behaviour						
Hazards resulting:	All h	azards							
Potential inadequacy	for y:	Contro not p	l action is provided	Unsafe control action is provided	Control action is Control action i provided in wrong provided for too time short or too lon	is O Ia			
Consequences:	:	Operator's skills	insufficient	Operator has improper mental model of the system	Operator is unprepared to perform his/her dutiesOperator is unprepared to perform his/her duti	d ies			
Potential causes:		Operator's confidence Need for tr recognized	self-over- aining is not	Trainings are insufficient Tutor's mental model of system is incorrect	Operator is allowed to perform duties before completing training Trainings are inefficient due to i.e. budget restrictions Trainings are prolonged and thus considered 'boring'	t			
Feasible mitigation measures potential	and	Trainings mandatory	being 3	Procedures on 3 trainings	3 Procedures on 3 Optimized standards of trainings	3			
Protection against co degradatio	ntrol n	Compulsor operator's	y renewal of licenses	Trainings should be given by senior operators					

Control a numb	action er:				11			Hydrogra	aphic e	]-	$\rightarrow$	Charts Nautical publication	IS
Control act	ion na	me:	Update	s									
Туре:			Input										
Textual des	scriptio	on:	Update	odates of nautical information									
Rationale:			Virtual	Сар	otain shall have fu	ll an	nd re	liable info	orma	tior	n rega	rding the a	area
			of oper	atic	on								
Hazards	1.2 V	essel ent	ers a No	Go	Area								
resulting:	1.6 S	/stem do	es not pr	ovi	de assistance to p	erso	on in	distress					
	2.1 V	essel ent	ers a No	Go	Area								
	6.2 V	essel con	tributes	to d	lelay of other ship	s' tr	affic	2					
	6.3 S	ystem do	es not m	eet	international, clas	ssifi	cato	ry or nati	onal	reg	ulatio	ns	
Potential inadequacy	for /:	Contro not p	l action i provided	s	Unsafe contro action is provide	l ed	Co pro	ontrol act ovided in time	tion i wroi	's ng	Coi pro sho	ntrol action wided for t rt or too lo	n is too ong
Consequences:		Improper n vessel's env	nodel of vironment		Improper model of vessel's environment		lmp vess	roper model el's environr	of nent				
Potential causes:		Updates ar Control act inadequate	e not issued ions #14,16 e		Inaccurate surveys Improper data process	ing	Upd dela	ates' process yed	sing is				
Feasible mitigation measures potential	and	Procedures issuing upd	s for lates	3	Procedures for updates' creation	3	Proc issui	cedures ing updates	for	3			
Protection against co	ntrol												
degradatio	n												

Control a numb	action er:				12		( N pub	Charts autical lications		$\rightarrow$	Passa	ge plan	
Control act	ion nar	ne:	Model	of e	nvironment								
Туре:			Input										
Textual des	scriptio	า:	Nautical information provided to VC										
<b>Rationale:</b>			VC shall have full and reliable information regarding the op							eratior	nal are	a	
Hazards	1.2 Ve	ssel ent	ers a No	Go	Area								
resulting:	1.6 Sy	stem do	es not pr	ovi	de assistance to pe	erso	n in distre	ess					
	2.1 Ve	ssel ent	ers a No	Go	Area								
	6.2 Ve	ssel con	tributes	to c	lelay of other ship	s' tr	affic						
	6.3 Sy	stem do	es not m	eet	international, clas	sific	catory or r	national	reg	ulatic	ns		
Potential	for	Contro	l action i	c	linsafe contro	Control action is			Control action is		s		
inadequacy	/:	not n	rovided action is provi			bd	provided	l in wroi	ng	pro	ovided	for to	0
	adequacy: not prov											a	
		norp	lovided				ti	me		shc	ort or t	oo lon	<u>y</u>
Consequences:		mproper n ressel's env	nodel of vironment		Improper model of vessel's environment		ti Improper m vessel's env	odel of ironment		shc	ort or t	oo lon	<u>y</u>
Consequences: Potential		mproper n ressel's environ	nodel of vironment ta is not issu	ied	Improper model of vessel's environment Improper nautical data	is	ti Improper m vessel's env Nautical dat	<b>me</b> odel of ironment a is provide	ed	shc	ort or t	oo lon	<u>y</u>
Consequences: Potential causes:		mproper n ressel's env lautical da communica	nodel of vironment ta is not issu ation with wed	ied	Improper model of vessel's environment Improper nautical data issued Data analysis algorithm	is	ti Improper m vessel's env Nautical dat with delay	<b>me</b> odel of ironment a is provide	d	shc	ort or t	oo lon	<u>y</u>
Consequences: Potential causes:		mproper n ressel's env Nautical da Communica ressel is fla	nodel of vironment ta is not issu ation with wed	ied	Improper model of vessel's environment Improper nautical data issued Data analysis algorithm are improper	is IS	ti Improper m vessel's env Nautical dat with delay	odel of ironment a is provide	d	shc	ort or t	oo lon	<u>y</u>
Consequences: Potential causes: Feasible		mproper n ressel's env lautical da Communica ressel is fla Jautical p	nodel of vironment ta is not issu ation with wed ublications	ied 3	Improper model of vessel's environment Improper nautical data issued Data analysis algorithm are improper Nautical publications	is Is 3	ti Improper m vessel's env Nautical dat with delay	me odel of ironment a is provide	ed 3	shc	ort or t	oo lon	<u>y</u>
Consequences: Potential causes: Feasible mitigation		mproper n ressel's env lautical da Communica ressel is fla lautical p nanageme procedures	nodel of vironment ta is not issu ation with wed ublications nt	ied 3	Improper model of vessel's environment Improper nautical data issued Data analysis algorithm are improper Nautical publications management procedures	is Is	ti Improper m vessel's env Nautical dat with delay Nautical software/ha maintenanc	ime odel of ironment a is provide rdware e	ed 3	shc	ort or t	oo lon	9
Consequences: Potential causes: Feasible mitigation measures	and	mproper n ressel's envi Jautical da Communica ressel is fla Nautical pr nanageme procedures	nodel of vironment ta is not issu ation with wed ublications nt	ied 3	Improper model of vessel's environment Improper nautical data issued Data analysis algorithm are improper Nautical publications management procedures	is Is 3	ti Improper m vessel's env Nautical dat with delay Nautical software/ha maintenanc	ime odel of ironment a is provide urdware e	ed 3	shc	ort or t	oo lon	9
Consequences: Potential causes: Feasible mitigation measures potential	and	mproper n ressel's em lautical da Communica ressel is fla Jautical pr nanageme procedures concedures	nodel of vironment ta is not issu ation with wed ublications nt untrol	and 3	Improper model of vessel's environment Improper nautical data issued Data analysis algorithm are improper Nautical publications management procedures Development of data analysis algorithms	is Is 3	ti Improper m vessel's env Nautical dat with delay Nautical software/ha maintenanc	ime odel of ironment a is provide urdware e	ed 3	shc	ort or to	<u>oo lon</u>	9
Consequences: Potential causes: Feasible mitigation measures potential	and	mproper n ressel's em lautical da Communica ressel is fla lautical pi nanageme procedures consuring co actions #14	ublications nt taisnot issu ation with wed ublications nt , 16	aed 3 3	Improper model of vessel's environment Improper nautical data issued Data analysis algorithm are improper Nautical publications management procedures Development of data analysis algorithms	is Is 3	ti Improper m vessel's env Nautical dat with delay Nautical software/ha maintenanc	incomment ironment a is provide irdware e	ad 3	sho		<u>oo lon</u>	9
Consequences: Potential causes: Feasible mitigation measures potential Protection	and	mproper n ressel's em lautical da communica ressel is fla lautical pr nanageme procedures crocedures crocedures rocedures	nodel of vironment ta is not issu ation with wed ublications nt untrol , 16	and 3	Improper model of vessel's environment Improper nautical data issued Data analysis algorithm are improper Nautical publications management procedures Development of data analysis algorithms Constant search for	is Is 3	ti Improper m vessel's env Nautical dat with delay Nautical software/ha maintenanc	ime odel of ironment a is provide urdware e	d 3	shc		oo lon	9
Consequences: Potential causes: Feasible mitigation measures potential Protection against con	and	mproper n ressel's em lautical da Communica ressel is fla lautical prinanageme procedures corrocedures	ublications nt untrol	aed 3 3	Improper model of vessel's environment Improper nautical data issued Data analysis algorithm are improper Nautical publications management procedures Development of data analysis algorithms Constant search for improved software solutions	is Is 3	ti Improper m vessel's env Nautical dat with delay Nautical software/ha maintenanc	inder of ironment a is provide irdware e	d 3	shc		oo lon	9

Control a numb	action er:				13		Sh	ore-based htrol centre	]_	$\rightarrow$	Passa	ige plan	
Control act	tion nar	ne:	Update	25									
Туре:			Input										
Textual des	scriptio	n:	Strateg	ic-le	evel passage plan o	or it:	s update	S					
Rationale:			Passage major u	e pl upda	anning should be ates should be acce	at epte	least su ed by hir	pervised n/her.	by	oper	ator. S	imilar	ly,
Hazards	1.2 Ve	ssel ent	ers a No	Go	rea								
resulting:	1.3 Ve	ssel imp	oroperly i	inte	racts with other m	an-	made ob	ojects					
	1.6 Sy	stem do	es not pr	ovi	de assistance to pe	erso	n in dist	ress					
	2.1 Ve	ssel ent	ers a No	Go	Area								
	2.2 Pr	opulsior	/steerin	g ge	ar operational para	ame	eters car	nnot be m	nain	taine	b		
	2.4 Ve	ssel's na	avigation	al c	apabilities are seve	erec	d by wea	ather con	ditio	ons			
	6.2 Ve	ssel con	tributes	to c	lelay of other ships	s' tr	affic						
	6.3 Sy	stem do	es not m	eet	international, class	sific	atory or	national	reg	ulatio	ns		
									<u> </u>				
Potential	for	Contro	laction	ic	linsafe control		Contro	ol action	is	Со	ntrol a	ction i	is
Potential inadequacy	for y:	Contro	l action i	is	Unsafe control	d	Contro provide	ol action d in wro	is ng	Co pro	ntrol a ovided	ction i for too	is 0
Potential inadequacy	for y:	Contro not p	l action i rovided	is	Unsafe control action is provide	d	Contro provide	ol action ed in wro time	is ng	Cor pro sho	ntrol a ovided ort or to	ction i for too oo lon	is o g
Potential inadequacy Consequences:	for y:	Contro not p /essel has i nission obj	l action in provided no model of ectives	is	Unsafe control action is provide Vessel has incorrect model of mission objectives	d	Contro provide Vessel has model of r objectives	ol action i ed in wro time incorrect nission	is ng	Col pro sho	ntrol a ovided ort or to	ction i for too oo lon	is o g
Potential inadequacy Consequences: Potential causes:	for y:	Contro not p Vessel has i mission obj Procedures blanning ar Communica vessel is fla	I action in rovided no model of ectives for passage e not follow ation with wed	<b>s</b> red	Unsafe control action is provide Vessel has incorrect model of mission objectives Procedures for passage planning are incorrect Procedures for passage planning are not followe	e <b>d</b>	Contro provide Vessel has model of r objectives Procedure planning a Procedure planning a	bl action in ed in wron time incorrect mission s for passage re incorrect s for passage re not follow	is ng	Col pro sho	ntrol a ovided ort or to	ction i for too oo lon	is o g
Potential inadequacy Consequences: Potential causes: Feasible mitigation measures potential	for y: and	Contro not p /essel has in mission obj Proceduress olanning ar Communica /essel is fla Ensuring co actions #14 Developme oassage proceduress Developme co-safe med	I action in provided no model of ectives for passage e not follow ation with wed ntrol , 16 nt of planning nt of fail- chanism	s ed 3 3 2	Unsafe control action is provide	ed 3	Contro provide Vessel has model of r objectives Procedure planning a Procedure planning a Developm passage procedure	bl action a cd in wrow time incorrect mission s for passage re not follow ent of planning s	ed 3	Col pro sho	ntrol a ovided ort or to	ction i for too oo lon	is o g
Potential inadequacy Consequences: Potential causes: Feasible mitigation measures potential Protection against co	for y: and ntrol	Contro not p Vessel has in mission obj Procedures olanning ar Communica vessel is fla ensuring co actions #14 Developme obassage procedures Developme co-safe med	I action in rovided no model of ectives for passage e not follow ation with wed ntrol , 16 nt of planning nt of fail- chanism	s red 3 3 2	Unsafe control action is provide	ed 3 3	Contro provide Vessel has model of r objectives Procedure planning a Procedure planning a Developm passage procedure	ol action	e e red 3	Col pro sho	ntrol a ovided ort or to	ction i for too oo lon	is o g

Control acti number:	ion				14a		Shore-based control centre	]_	Communication subsystem	]		
Control action	n name	e:	Strateg	trategic decisions' relay								
Туре:			Input	nput								
Textual descri	iption:		Decisio	Decisions made by operator are relayed to the VC via communication link								
Rationale:			Major s	yst	em's adjustments	or	updates must be	peri	odically transmitted	d		
			to the v	ess	el in order to mai	ntai	n overall supervisi	on				
Hazards A	ll haza	rds										
resulting:					1							
Potential fo	or (	Contro	l action i	s	Unsafe contro	1	Control action	is	Control action is			
inadequacy:		Control action is not provided			action is provide	ed	provided in wroi	ng	provided for too			
	C+-	-			Incorroct desisions are		time	ic	short or too long			
Consequences:	no	t relayed	to the vesse	el	relayed to the vessel	delayed	1 15	transmitted to the vessel	4			
Potential causes:	Da co co sul Ne de Op ma	ta conne ntrol cen mmunica bsystem eed for st cision is perator is ake decis	ection betwe tre and ation flawed rategic not recogniz unable to ion	en ed	Data transfer incorrect Operator's attitude / la of skill	ack	Data transfer rate insufficient Improper data bufferin	g	Data connection between control centre and communication subsystem flawed	n		
Feasible mitigation measures ar potential	Re Op pro Fa me	ake decision edundancy berational ocedures il-to-safe echanism 2 2 2 2 3 2 2 2 2 2			Error identification algorithms Trainings	2	Redundancy Transmission control algorithms	3	Redundancy Error identification algorithms	3		
Protection against contr	Tra ol	ainings										
degradation												

Control action number:			14b	Communication subsystem							
Control action na	ame:	System up	stem updates relay								
Туре:		Input									
Textual description	on:	Software u	updates								
Rationale:		VC's as we	ell as other software s	shall be updated period	odically to eliminate						
		bugs, impl	ement new regulation	ns, improve performa	nce etc.						
Hazards All h	azards										
resulting:											
Potential for	Contro	l action is	Unsafe control	Control action is	Control action is						
inadequacy:	not p	orovided	action is provided	provided in wrong	provided for too						
Consequences:	VC uses ou software	tdated	VC uses inadequate software, improper decisions are made	VC uses outdated software Updates' installation interferes with VC's decision-making process	Incomplete updates are transferred Improperly prepared updates are issued						
Potential	Need for u	pdates is not	Incorrect update is issued	Update takes too long to	Improper update						
causes:	recognized Updates ar	e not issued	Update is issued in an improper format Update is sent do improper part of the system	compile Improper update management procedures/algorithms	management procedures/algorithms						
Feasible mitigation measures and potential	Procedures updates manageme	s for 3 ent	Procedures for 3 updates management On-shore testing of 3 updates	Procedures for 3 updates management On-shore testing of 3 updates	Procedures for 3 updates management						
Protection	Implement	ing a constant-	Implementing a constant-								
against control	improveme	ent culture	improvement culture								
degradation											

Control a numb	action er:				15			Communicatio subsystem	n	Shore-based control centre		
Control act	ion na	ime:	Feedba	ck r	elay							
Туре:	Feedback											
Textual des	scripti	ription: Data regarding status of both vessel and environment						Ī				
Rationale:	Data provided by sensors shall peri					iodically be tra	ansr	nitted to the shore-				
			based control centre for analysis									
Hazards	All h	azards										
resulting:												
Potential	for	Contro	l action i	~	Uncafo contro	1	С	ontrol action i	s	Control action is		
inadequacy	inadequacy:			vided action is provided		provided in wrong			provided for too			
		ποι μ	ioviaeu		action is provided		time			short or too long		
		SBCC has n	o informatio	n	SBCC has incorrect		SBCC has outdated			SBCC has incomplete		
consequences:		regarding v	essel s statu	S	status	5	stat	tus		status		
Potential		Control act	ion #17		Control action #17		Cor	ntrol action #17		Control action #17		
causes:		inadequate	e etion hotwo	on	inadequate		inadequate			inadequate		
		control cen	tre and	en			insu	ufficient				
		communica	ation				Imp	proper data bufferin	g			
Faacibla		subsystem	flawed	3	Error identification	2	Rec	lundancy	3	Redundancy 3		
reasible				5	algorithms	-	nee					
magailon	and						Tra	nsmission control	3	Error identification 2		
potential	anu						aigu					
Protection		Performan	ce tests of		Performance tests of							
against co	ntrol	communica	ation link		communication link							
degradatio	n											

Control action number:	ו		16		Communication subsystem	Virtual Captain					
Control action r	ame:	Decisions'	and updates' relay								
Туре:		Input									
Textual descript	ion:	Decisions I	Decisions made by operator are relayed to the VC via communication link								
Rationale:		Major syst	Major system's adjustments or updates must be periodically transmitted								
		to the vess	to the vessel in order to maintain overall supervision								
Hazards All I resulting:	nazards										
Potential for inadequacy:	Conti not	rol action is provided	Unsafe control action is provided	C pr	Control action is ovided in wrong time	Control action is provided for too short or too long					
Consequences:	Strategic not relay	decisions are ed to the vessel	Incorrect decisions are relayed to the vessel	Dec dela	cisions' transmission is ayed	Incomplete data set is transmitted to the vessel					
Potential causes:	Control a inadequa Data con vessel an commun subsyster Shipborn malfunct Vessel ou commun Data is tr different	ctions #14a,b ite nection between d ication m flawed ication m malfunction e antenna ion itside ication range ansferred to vessel	Control actions #14a,b inadequate Data transfer incorrect Operator's attitude / lack of skill Other vessel's data is transmitted	Cor inac Dat insu Imp	ntrol actions #14a,b dequate ta transfer rate ufficient proper data buffering	Control actions #14a,b inadequate Data connection between control centre and communication subsystem flawed					
Feasible mitigation measures and potential	Redundancy From identification algorithms Global-range communication subsystems to be used Fail-to-safe mechanism		Error identification 2 algorithms Trainings 3	Rec Tra algo	dundancy 3 Insmission control 3 orithms	Redundancy 3 Error identification 2 algorithms					
Protection against control degradation	commun	ince tests of ication link	communication link								

Control a numb	action er:				17			Virtual Captain	]-	➤ Communication subsystem		
Control act	tion na	ame:	Feedbac	:k r	elay							
Туре:			Feedbac	:k								
Textual des	scripti	on:	Transmi	Fransmission of information pertaining to the status of vessel and								
			environ	environment								
Rationale:		Data gat	Data gathered by on-board sensors should periodically be transmitted to									
		the SBC	C fo	or analysis			-					
Hazards	All h	azards	•									
resulting:												
Potential	for	Cantan	1		11		С	ontrol action i	s	Control action is		
inadequac	y:	Contro	action is	;	Unsafe control	-	pro	ovided in wroi	ng	provided for too		
		ποι ρ	roviaea		action is provide	a		time		short or too long		
		SBCC has n	o information	۱	SBCC has incorrect		SBC	C has outdated		SBCC has incomplete		
Consequences		regarding v	essel's status		status		information on vessel's status			information on vessel's status		
Potential causes:		Communica subsystem Shipborne a malfunction Vessel outs communica Sensors' m	ation malfunction antenna n ide ation range alfunction		Data transfer incorrect Data processing incorre On-board data management algorithm flawed Sensors' array insufficie	ct s nt	Data insu Imp	a transfer rate fficient roper data bufferin	g	Communication subsystem malfunction Shipborne antenna malfunction Data sets' size exceeding transmission slots limits		
Feasible		Redundanc	y	3	Raw data transfer,	4	Red	undancy	3	Transmission control 3		
mitigation		Error ide	entification	R	on-shore analysis		Tran	smission control	3	algorithms		
measures	and	algorithms		5	Design and	3	algo	orithms	5	Redundancy 3		
potential		Global-ran		4	implementation of a							
		communica	ation	4	of sensors							
		subsystems	s to be									
		used										
		Fail-to-safe		2								
		mechanism										
Protection		Performan	ce tests of		Performance tests of							
against co	ntrol	communica	ation link		communication link							
degradatio	n											

Control a numb	action er:				18			Virtual Captain	]_	$\rightarrow$	Passage pla	มท
Control act	ion nar	ne:	Ad hoc	adj	ustments							
Туре:			Contro									
Textual des	scriptio	n:	Minor a require	adju me	istments to ship's nts	plar	nneo	d route due to	e.g	. colli	sion avoida	nce
Rationale:			VC mu navigat operate	st k ion or	be capable of adju al situation arisin	ustir ng	ng t with	the passage pl nout direct ir	lan Ivol	in o lveme	rder to har ent of hur	ıdle nan
Hazards	1.1 Ve	ssel vio	lates min	imι	im CPA with anoth	ier s	ship					
resulting:	1.2 Ve	ssel ent	ers a No	Go	Area							
	1.3 Ve	ssel imp	properly i	nte	racts with other m	an-	mac	de objects				
	2.1 Ve	ssel ent	ers a No	Go	Area							
	2.4 Ve	ssel's n	avigation	al c	apabilities are seve	erec	d by	/ weather cond	litic	ons		
	6.2 Ve	ssel cor	ntributes	to c	lelay of other ship	s' tr	affic	C				
	6.3 Sy	stem do	es not m	eet	international, clas	sific	cato	ory or national	reg	ulatic	ons	
Potential	for	Contro	l action i	s	Unsafe control			ontrol action is	s na	Co	ntrol action	is
mauequacy	y.	not p	provided		action is provide	ed 🛛	pro	time	iy	sho	ort or too la	na
Consequences:		Passage pla to local con	an not adjus nditions	ted	Passage plan adjusted incorrectly		Pass inco	sage plan adjusted prrectly				
Consequences:Table p to local ccPotential causes:Control ac #29,31,34Passage p algorithm			ions 35 inadequa anning flawed	te	Control actions #29,31,34,35 inadequa Passage planning algorithms inaccurate	te	Con inac Pass algo	ntrol actions #34,35 dequate sage planning prithms inaccurate				
Feasible mitigation	and	mprovem control alg	ent of orithms	3	Improvement of control algorithms	3	Imp con	provement of trol algorithms	3			
potential	anu											
Protection				<u> </u>								_
against co	ntrol											
degradatio	n											

Control a numb	action er:				19		Passage plan	]_	Virtual Captain
Control act	ion nar	ne:	Model	of ir	ntentions				
Туре:			Feed						
Textual des	scriptio	n:	Vessel's	int	tended route				
Rationale:			Vessel dangers	sha s to	Il follow a pre-proproproproproproproproproproproproprop	gra	mmed route in	ord	er to avoid known
Hazards	1.1 Ve	ssel viol	ates min	mu	m CPA with anothe	r sh	nip		
resulting:	1.2 Ve	ssel ent	ers a No	Go	Area				
	1.3 Ve	ssel imp	properly i	nte	racts with other ma	n-m	nade objects		
	2.1 Ve	ssel ent	ers a No	Go	Area				
	2.4 Ve	ssel's na	avigation	al ca	apabilities are sever	ed	by weather cond	ditic	ons
	6.2 Ve	ssel con	tributes	o d	lelay of other ships'	tra	ffic		
	6.3 Sy	stem do	es not m	eet	international, classi	fica	atory or national	reg	ulations
Potential	for	Contro	action is		Unanfo control		Control action i	s	Control action is
inadequacy	/:	not n	rovided	3	Unsafe control action is provided		provided in wroi	ng	provided for too
		norp	Toviaca	rovided action is provided			time		short or too long
Consequences:		VC not rece navigationa	eiving al orders		VC following wrong route	۲ ۲	VC not receiving timely navigational orders		
Potential		Control act	ion #13		Control action #13	(	Control action #13		
causes:		nadequate	e n not		inadequate Wrong passage plan	i	inadequate	20	
		orepared	innot		uploaded	с С	delayed	11	
		Passage pla	an prepared i	n	Operator's lack of skill				
		unreadable	format		misinterpreted by VC				
Feasible		Protection	against	4	Implementation of	3 F	Protection against	4	
mitigation		o AL-5	trom AL-3 without		passage planning procedures	t	to AL-5 without		
measures	and	orepared	passage			F	prepared passage		
potential		olan, unles	s as a fail-		Automatic strategic	3 F	plan, unless as a fail-		
					algorithms				
Protection								L	
against co	ntrol								
degradatio	n								

Control a numb	action er:				20			Virtual Captain	]	$\rightarrow$	Auxiliary systems	
Control act	tion nan	ne:	Equipm	ent	set-points							
Type:			Contro									
Textual des	scriptio	า:	Decisio	ns c	on working parame	ter	s of	auxiliary subsy	yste	ms		
Rationale:	-		VC sha	all I	be capable of co	ntr	ollir	ng auxiliary p	roc	esses	s by adjust	ing
			equipm	ent	's working parame	ter	S					
Hazards	1.4 Ve	ssel is ir	ncapable	of p	properly containing	; da	nge	erous chemical	s or	ener	зy	
resulting:	1.5 Ve	essel is	boarded	by	unauthorized pers	son	nel	or such comr	noc	lities	are placed	on
_	board											
	2.2 Pro	pulsior	/steering	g ge	ear operational para	am	eter	rs cannot be m	aint	taine	d	
	2.3 Ve	ssel is d	enied pa	ssa	ge by coastal state'	s a	uth	orities				
	2.5 Ve	ssel doe	es not me	et s	stability criteria							
	2.6 V	essel's	watertig	ht i	integrity is not m	nair	ntai	ned (due to	she	ar fo	orces, bend	ing
	mome	ents or puncture) essel's cargo is not loaded/stowed properly										
	3.1 Ve	/essel's cargo is not loaded/stowed properly /essel is unable to maintain proper cargo stowage conditions										
	3.2 Ve	ssel is unable to maintain proper cargo stowage conditions										
	4.3 Ve	essel does not meet fire safety precautions										
	4.4 Ve	ssel's w	atertight	int	egrity is not mainta	ine	ed					
	4.5 Ve	ssel's p	ower sup	ply	is not provided or i	insi	uffic	cient				
	5.1 Ve	ssel is u	nable to	mai	intain integrity of ta	ank	s co	ontaining oils o	r oi	ly mi	xtures	
	5.2 Ve	ssel is u	nable to	ma	intain proper fuel c	on	bus	stion paramete	ers			
	6.3 Sys	stem do	es not m	eet	international, class	sitio	cato	ory or national	reg	ulatic	ons	
Potential	for	Contro	l action i	s	Unsafe control		С	ontrol action is	s	Со	ntrol action	is
inadequacy	y:	not p	orovided		action is provided	d	pro	ovided in wron	ng	pro	ovided for to	00
		•			•			time		sho	ort or too lor	ng
Consequences:	:	oss of con equipment	troi over		equipment		equ	s of control over lipment		Loss c equip	ment	
Potential	4	Actuators r	ot reliable	in	Inadequate control		Dat	a transmission withi	n	Actua	tors unreliable o	r
causes:	t	he vessel i	neffective		Equipment incapable of		Inef	fficient control		with V	/C's commands	Б
	Ň	/C not ope	rational		complying with VC's		algo	orithms				
Faasibla		mproved r	eliability	3	commands	2	Dat	a transmission	2	Impro	wed	3
reasible	·				algorithms	5	mar	nagement	2	equip	ment's	5
miligation	and	Viring red	undancy	3	Enhanced autonomy	2	algo	orithms		reliab	ility	
notontial	anu	nhanced	autonomy	3	on subsystems' level	3	Enh	nanced autonomy	3	E		
potentiai	C	on subsyste	ems' level				on s	subsystems' level				
	r	Manual coi	ntrol	1		1						
Protection												
against co	ntrol											
degradatio	n											
ucgiaualio	11											

Control a numb	action er:				21			Auxiliary subsystems	]_	→	Auxiliary processes		
Control act	ion na	me:	Actuatio	on									
Type:			Control										
Textual des	scriptio	on:	Control	ove	er auxiliary proces	ses							
Rationale:			Auxiliar	y s	ubsystems shall k	be d	сара	ble of proper	ly c	contro	lling affiliat	ted	
			process	es									
Hazards	1.4 V	essel is ir	ncapable	of p	properly containing	g da	ange	rous chemical	s or	ener	gy		
resulting:	1.5 V	'essel is	boarded	by	unauthorized per	sor	nel	or such com	noc	dities	are placed	on	
	board	t											
	2.2 P	ropulsior	n/steering	g ge	ar operational par	am	eter	s cannot be m	ain	tainec			
	2.3 V	essel is d	enied pas	ssag	ge by coastal state	's a	utho	orities					
	2.5 V	essel doe	es not me	et s	tability criteria								
	2.6 \	/essel's	watertigh	nt i	ntegrity is not r	nai	ntair	ned (due to	she	ear fo	rces, bendi	ing	
	mom	ents or p	nts or puncture) ssel's cargo is not loaded/stowed properly										
	3.1 V	essel's cargo is not loaded/stowed properly essel is unable to maintain proper cargo stowage conditions											
	3.2 V	essel is unable to maintain proper cargo stowage conditions essel does not meet fire safety precautions											
	4.3 V	/essel does not meet fire safety precautions											
	4.4 V	essel does not meet fire safety precautions essel's watertight integrity is not maintained											
	4.5 V	essel's po	ssel's watertight integrity is not maintained ssel's power supply is not provided or insufficient										
	5.1 V	essel is u	sel's power supply is not provided or insufficient sel is unable to maintain integrity of tanks containing oils or oily mixtures										
	5.2 V	essel is u	nable to i	mai	ntain proper fuel	con	nbus	stion paramete	ers				
	6.3 S	ystem do	es not m	eet	international, clas	sifi	cato	ry or national	reg	ulatio	ns		
Potential	for	Contro	l action i	c	linsafe control	,	C	ontrol action i	s	Cor	trol action	is	
inadequacy	y:	not n	rovided	5	action is provide	pro	ovided in wror	ng	pro	vided for to	00		
	_							time		short or too long			
Consequences:		Loss of con process(es)	trol over the		Loss of control over the process(es)	ġ	Loss proc	s of control over the cess(es)	•	Loss of control over the process(es)			
Potential		Control act	ion #20		Control action #20		Con	trol action #20		Contro	l action #20		
causes:		inadequate	unreliable		inadequate Machinery baying		inad Dela	lequate		inadeo	luate		
		Consumabl	es not		insufficient capacity		equ	ipment's specificity		manag	ement algorithn	ms	
		provided			Machinery improperly		and	processes controlle	ed				
					designed/installed		imp mar	roper process nagement algorithm	IS				
Feasible		Rigorous		3	Capacity surpluses	3	Imp	lementation of	3	Impler	nentation of	3	
mitigation		maintenan	ce regime		by design		lead	ling performance		leadin	g performance		
measures	and	Redundant		3	Extensive testing	3	indi			Indica	ors		
potential		equipment		-									
		Resilience-	based	1									
		design	Suscu	т									
		Proceduros		2									
		consumabl	es'	3									
		manageme	nt										
Protection		External au	dits of		Implementation of		Coll	ection and analysis	of	Collect	ion and analysis	s of	
		maintenan	ce effort		leading safety indicator	licators performance data performance data		formance data		perfor	mance data		
against co	ntrol			ion of									
against co	ntrol	Implement	ntation of										

Control a numb	action er:				22		Auxiliary processes	]_	Internal sensors		
Control act	ion na	ne:	Sensing								
Туре:			Feed								
Textual des	scriptic	n:	Examina	atio	on of processes' status	S					
Rationale:			Auxiliar	y ƙ	processes' control m	nust	t be based o	n a	ctual state of the		
			process	es a	as measured by senso	ors					
Hazards	1.4 Ve	essel is ir	ncapable	of p	properly containing da	ange	erous chemical	s or	energy		
resulting:	1.5 V	essel is	boarded	by	unauthorized persor	nnel	or such com	mod	lities are placed on		
	board										
	2.2 Pr	opulsion	n/steering	g ge	ar operational param	ete	rs cannot be m	ain	tained		
	2.3 Ve	essel is d	enied pas	sag	ge by coastal state's a	uth	orities				
	2.5 Ve	essel doe	es not me	et s	stability criteria				c i i		
	2.6 V	essel's	watertigh	nt i	ntegrity is not mai	ntai	ined (due to	she	ar forces, bending		
		oments or puncture) 1 Vessel's cargo is not loaded/stowed properly									
	3.1 V	L Vessel's cargo is not loaded/stowed properly L Vessel is unable to maintain proper cargo stowage conditions									
	5.2 V	.2 Vessel is unable to maintain proper cargo stowage conditions									
	4.5 V	ssel uue	s not me	int <i>i</i>	agrity is not maintain	o d					
	4.4 V	ssel's m	ower sun	nlv	is not provided or ins	eu uffi <i>i</i>	cient				
	5.1 Ve	essel is u	nable to	mai	intain integrity of tan	ks co	ontaining oils o	or oi	lv mixtures		
	5.2 Ve	essel is u	nable to	mai	ntain proper fuel con	nbu	stion paramete	ers	.,		
	6.3 Sy	stem do	es not m	eet	international, classifi	cato	ory or national	reg	ulations		
Potential	for			_		C	Control action	s	Control action is		
inadequacy	<i>ı</i> :	Contro	l action is	S	Unsafe control	pr	ovided in wrol	ng	provided for too		
		not p	iroviaea		action is provided	-	time		short or too long		
Consequences:		Confusion of process	over the stat	е	Confusion over the state of process	Cor of p	nfusion over the stat process	te	Confusion over the state of process		
Potential		Sensors un	reliable		Sensors' malfunction	No	n-continuous		Non-continuous		
causes:		Required parts of the result o	arameter measured		Parameters outside sensors' working range	cha one	aracteristics of senso eration	ors'	characteristics of sensors'		
			neusureu		Sensor's accuracy	Ser	nsors' idleness due t	0	operation		
					insufficient	me spe	asured phenomeno ecificity	n's			
Feasible		Redundant	or highly-	3	Redundant or highly- 3	Use	e of highly-	3	Implementation of 4		
mitigation		reliable ser	isors		reliable sensors	sen	nsitive sensors		continuously-probing sensors		
measures	and	Indirect		3	Implementation of 3						
potential		measureme	ent		wide-range sensors						
Protection		Constant se	earch for and		Constant search for and	Cor	nstant search for an	b	Constant search for and		
against co	ntrol	installation sensors	ot improved		installation of improved sensors	inst sen	tallation of improve	d	installation of improved sensors		
degradatio	n	Use of lead	ing indicator	s	Use of leading indicators	Use	e of leading indicato	rs	Use of leading indicators		
		on sensors'	performanc	e	on sensors' performance	Ose of leading indicators on sensors' performance		on sensors' performance			

Control a numb	action er:				23		Auxiliary subsystems	Internal sensors			
Control act	ion nai	ne:	Sensing								
Туре:			Feed								
Textual des	scriptio	n:	Examina	atic	on of subsystems' stat	us					
Rationale:	-		Auxiliar	y s	subsystems' control	mus	st be based on	actual state of the			
			process	es	as measured by senso	ors					
Hazards	1.4 Ve	essel is ir	ncapable	of	properly containing da	ange	erous chemicals o	or energy			
resulting:	1.5 V	essel is	boarded	by	unauthorized persor	nnel	l or such commo	odities are placed on			
	board										
	2.2 Pr	opulsior	n/steering	g ge	ear operational param	nete	rs cannot be mai	ntained			
	2.3 Ve	essel is d	enied pas	ssa	ge by coastal state's a	uth	orities				
	2.5 Ve	essel doe	es not me	et	stability criteria						
	2.6 V	essel's	watertigł	nt	integrity is not mai	ntai	ined (due to sł	near forces, bending			
	mome	ents or p	uncture)								
	3.1 Ve	1 Vessel's cargo is not loaded/stowed properly									
	3.2 Ve	.2 Vessel is unable to maintain proper cargo stowage conditions									
	4.3 Ve	essel doe	es not me	et	fire safety precautions	S					
	4.4 Ve	essel's w	atertight	int	egrity is not maintain	ed					
	4.5 Ve	essel's po	ower sup	ply	is not provided or ins	uffi	cient				
	5.1 Ve	essel is u	nable to	ma	intain integrity of tan	ks c	ontaining oils or	oily mixtures			
	5.2 Ve	essel is u	nable to i	ma	intain proper fuel con	nbu	stion parameters				
	6.3 Sy	stem do	es not m	eet	international, classifi	cato	ory or national re	gulations			
Potential	for	Contro	l action is	5	Unsafe control	С	ontrol action is	Control action is			
inadequacy	y:	not p	rovided		action is provided	pro	oviaea in wrong	provided for too			
	_	Confusion	war tha state	2	Confusion over the state	Con	time	Short or too long			
Consequences:		of machine	ry	5	of machinery	ofn	nachinery	of machinery			
Potential		Sensors uni	reliable		Sensors' malfunction	Nor	n-continuous	Non-continuous			
causes:		Required pa cannot be r	arameter neasured		Parameters outside sensors' working range	cha ope	racteristics of sensors'	characteristics of sensors'			
					Sensor's accuracy	Sen	sors' idleness due to				
					insufficient	mea	asured phenomenon's				
Feasible		Redundant	or highly-	3	Redundant or highly- 3	Use	of highly- 3	Implementation of 3			
mitigation		reliable sen	sors		reliable sensors	sen	sitive sensors	continuously-			
measures	and	Indirect		3	Implementation of 3			probing sensors			
potential		measureme	ent	-	wide-range sensors						
Protection		Constant se	arch for and		Constant search for and	Con	istant search for and	Constant search for and			
against co	ntrol	installation	of improved		installation of improved	inst	allation of improved	installation of improved			
degradatio	n	sensors Use of lead	ing indicator	s	sensors Use of leading indicators	sen: Use	sors of leading indicators	sensors Use of leading indicators			
		on sensors'	performanc	e	on sensors' performance	Use of leading indicators on sensors' performance		on sensors' performance			

Control a numb	action er:	n 24 Internal sensors Virtue								Virtual Captain				
Control act	ion na	me:	Data or	ı ea	uipment and proce	esse	es' s	tatus						
Type:			Feedba	ck ,	, ,									
Textual des	scriptic	n:	Informa	atio	n on measured val	ues	S							
Rationale:	•		Informa	atio	n on measured va	lue	es sh	ould be comp	oilec	d and	fed to the VC			
			for it to	ma	ke informed decis	ion	S							
Hazards	1.1 Ve	essel viol	ates min	imu	m CPA with anoth	er s	ship							
resulting:	1.2 Ve	essel ent	ers a No	Go	Area		- 1-							
U	1.3 Ve	essel imp	properly i	nte	racts with other m	an-	mac	le objects						
	1.4 Ve	essel is ir	ncapable	of p	properly containing	g da	ange	rous chemical	s or	ener	gy			
	1.5 V	essel is	boarded	by.	unauthorized per	son	nel	or such com	nod	lities	are placed on			
	board													
	2.1 Ve	essel ent	ers a No	Go	Area									
	2.2 Pr	opulsior	/steering	g ge	ar operational par	am	eter	s cannot be m	aint	taine	d			
	2.3 Ve	2.3 Vessel is denied passage by coastal state's authorities 2.4 Vessel's navigational capabilities are severed by weather conditions												
	2.4 Ve	2.4 Vessel's navigational capabilities are severed by weather conditions 2.5 Vessel does not meet stability criteria												
	2.5 Ve	2.4 Vessel's navigational capabilities are severed by weather conditions 2.5 Vessel does not meet stability criteria												
	2.6 V	2.6 Vessel's watertight integrity is not maintained (due to shear forces, bending												
	mom	ents or p	uncture)											
	3.1 Ve	essel's ca	argo is no	t lo	aded/stowed prop	erly	у							
	3.2 Ve	essel is u	nable to	mai	ntain proper cargo	o ste	owa	ge conditions						
	4.3 Ve	essel doe	es not me	et f	ire safety precauti	ons	S .							
	4.4 Ve	essel's w	atertight	inte	egrity is not mainta	aine	ed							
	4.5 Ve	essel's po	ower sup	ply	is not provided or	insu	uttic	ient						
	5.1 Ve	essel is u	nable to	mai	ntain integrity of t	ank	KS CC	ontaining oils c	or oi	ly mi	xtures			
	5.2 Ve	essel is u	nable to	mai	Intain proper fuel o	com	1DUS	tion paramete	ers					
	6.2 V	esser cor	oc not m		ielay of other ships	s li cifi	ramo	ry or pational	rogi	ulatio				
Detential	0.3 Sy	stem do	es not m	eet	International, class	SIIIC		ry or national	regi		ntrol action is			
Potential	ior	Contro	l action i	s	Unsafe control		- C(	ontroi action i ovidad in vera	s	0	nirol action is			
mauequac	y.	not p	orovided		action is provide	d	pro	time	ıy	cha	ort or too long			
	-	VC has no d	lata on the		VC has improper data o	n	VCI	nas outdated data o	n	3/10	on too long			
Consequences:		state of pro	ocess or		the state of process or		the	state of process or						
Detential		equipment	's status	25	equipment's status	25	equ	ipment's status	25					
Potential		inadequate	10113 #22,23,	25	inadequate	25	inac	lequate	25					
causes:		Data transr	nission		Data transmission		Data	a transmission						
Feasible		Redundant	wiring	3	Data integrity	2	Data	a transmission	2					
mitigation			Ĩ		validation algorithms		mar	nagement						
measures	and						algo	orithms						
potential														
Protection														
against co	ntrol													
degradatio	n													

Control a numb	action er:				25		Engine / rudder		→ Internal sensors
Control act	ion na	me:	Sensing	1					
Туре:			Feed						
Textual des	scriptio	on:	Examin	ing	engine/rudder status				
Rationale:			State o	f pi	ropulsion and steering	su	bsystems shoul	d be	e known to the VC
			for it to	m	ake informed decisions	5			
Hazards	1.1 V	essel vio	lates min	im	um CPA with another s	hip			
resulting:	1.2 V	essel ent	ers a No	Go	Area				
_	1.3 V	essel imp	properly	nte	eracts with other man-r	ma	de objects		
	2.1 V	essel ent	ers a No	Go	Area		-		
	2.2 P	opulsior	n/steerin	g ge	ear operational parame	ete	rs cannot be ma	inta	ined
	2.5 V								
	4.3 V								
	4.5 V	essel's p	ower sup	ply	is not provided or insu	uffi	cient		
	5.2 V	essel is u	nable to	ma	intain proper fuel com	bu	stion parameter	s	
	6.2 V	essel cor	ntributes	to	delay of other ships' tra	affi	c		
	6.3 S	vstem do	es not m	eet	international, classific	ato	ory or national r	egul	lations
Potential	for					Control action is			Control action is
inadequacy	<b>v</b> :	Contro	l action i	S	Unsafe control	pro	ovided in wrong	,	provided for too
• •	·	not p	rovided		action is provided	time			short or too long
Consequences:	-	Confusion of machine	over the stat	e	Confusion over the state of machinery	Con of m	fusion over the state nachinery	C o	onfusion over the state f machinery
Potential		Sensors un	reliable		Sensors' malfunction	Non	-continuous	. N	on-continuous
causes:		Required p	arameter measured		Parameters outside	chai	racteristics of sensors' ration		naracteristics of sensors'
		cannot be i	neusureu		Sensor's accuracy	Sen	sors' idleness due to	Ŭ	peration
					insufficient	mea	asured phenomenon's	5	
Foosiblo		Redundant	or highly-	3	Redundant or highly- 3	spec Use	of highly-	3 Ir	nplementation of 3
mitigation		reliable ser	isors	-	reliable sensors	sens	sitive sensors	C	ontinuously-
moscuroc	mitigation				Implementation of 2			р	robing sensors
measures	measures and Indirect measure				wide-range sensors				
potential	potential								
Protection	Protection Constant			ł	Constant search for and	Con	stant search for and	C	onstant search for and
against co	ntrol	sensors	or improved		sensors	sens	sors	S	ensors
degradatio	n	Use of lead	ing indicato	rs	Use of leading indicators	Use	of leading indicators	U	se of leading indicators
		on sensors'	performance	e	on sensors' performance	on sensors' performan		0	n sensors' performance

Control a numb	action er:				26			Virtual Captain	]_	$\rightarrow$	Engine / rudder	
Control act	tion na	me:	Equipm	nent	set-points							
Туре:			Contro									
Textual des	scripti	on:	Decisio	ns c	on working parame	eter	rs of	propulsion an	d st	teerin	g subsystem	าร
Rationale:			VC sha	all I	be capable of co	onti	rollir	ng auxiliary p	oroc	cesses	by adjust	ing
			equipm	nent	's working parame	eter	ſS					-
Hazards	1.1 V	essel vio	lates min	imι	Im CPA with anoth	er s	ship					
resulting:	1.2 V	essel ent	ers a No	Go	Area		•					
Ū	1.3 V	essel imp	properly i	nte	racts with other m	an-	-mac	de objects				
	2.1 V	essel ent	ers a No	Go	Area							
	2.2 P	opulsior	h/steering	g ge	ar operational par	am	eter	s cannot be m	ain	tained	b	
	2.4 V	essel's na	avigation	al c	apabilities are seve	ere	d by	weather con	ditic	ons		
	2.5 V	essel doe	es not me	et s	stability criteria							
	3.1 V	essel's ca	argo is nc	ot lo	aded/stowed prop	berl	у					
	3.2 V	essel is u	nable to	mai	intain proper cargo	o st	owa	ge conditions				
	4.3 V	essel does not meet fire safety precautions										
	5.2 V	essel is u	nable to	mai	intain proper fuel	con	nbus	tion paramete	ers			
	6.2 V	essel cor	ntributes	to c	lelay of other ship	s' tr	raffic	C				
	6.3 S	vstem do	es not m	eet	international, class	sifi	cato	ry or national	reg	ulatio	ons	
	6.5 \$	ystem's	interacti	on	with other assets	vith other assets (including unmanned vessels) leads to						
		emer	gence of	any	of above		-					
Potential	for	Contro	laction	ic	linsafe control	,	C	ontrol action i	s	Со	ntrol action	is
inadequacy	y:	not r	rovided	3	action is provide	d	pro	ovided in wrong		pro	ovided for to	00
		norp	noviaca			u		time		sha	ort or too lor	ng
Consequences:	:	Loss of con	trol over		Loss of control over		Loss	s of control over		Loss c	of control over	
Potential		Actuators r	not reliable		Inadequate control		Data	a transmission with	in	Actua	tors unreliable o	r
causes:		Data transi	nission with	in	algorithms		the	vessel ineffective		incapa	able of complying	g
000000		the vessel i	neffective		Equipment incapable of complying with VC's	t	algo	ficient control		with \	/C's commands	
					commands		- 0-					
Feasible		Improved	reliability	3	Improved control	3	Data	a transmission	2	Impro	oved	3
mitigation		of machine	ry				mar algo	nagement prithms		equip reliab	ment s ility	
measures	and	Redundant	; wiring	3	Enhanced autonomy	3						
potential		Enhanced	autonomy	3	on subsystems' level		Enh on s	anced autonomy subsystems' level	3			
		on subsyst	ems' level	5	Manual control	1						
		Manual co	ntrol	1								
				1								
Protection		Maintenan	ce of		Maintenance of							
against co	ntrol	equipment			equipment							
degradatio	n											

Control a numb	action er:				27		Engine / rudder	]_	$\rightarrow$	Navigation		
Control act	ion na	me:	Regulat	ion	1							
Type:			Control									
Textual des	scriptio	on:	Control	ove	er vessel's course a	and	spe	ed				
Rationale:			Main e	ngir	ne and rudder sha	ll b	e ca	apable of prope	erly	influ	encing vesse	eľs
			movem	ent	ts							
Hazards	1.1 V	essel viol	ates min	imι	um CPA with anoth	ner s	ship	)				
resulting:	1.2 V	essel ent	ers a No	Go	Area							
	1.3 V	essel imp	properly i	nte	racts with other n	nan-	-ma	de objects				
	2.1 V	essel ent	ers a No	Go	Area							
	2.2 Pi	opulsior	i/steering	g ge	ear operational par	ram	ietei	rs cannot be m	aint	taine	d	
	2.4 V	essel s na	avigation	ar c	apapilities are sev	ere	a by	y weather cond		ons		
	2.5 V	essel uue	rgo is no	t lo	aded/stowed pro	herl	v					
	3.2 V	essel is u	nable to	mai	intain proper carg	o st	ง ๊ดพล	age conditions				
	4.3 V	essel doe	es not me	et f	fire safety precaut	ions	s					
	5.2 V	essel is u	nable to	ma	intain proper fuel	con	nbus	stion paramete	ers			
	6.2 V	essel con	tributes	to c	delay of other ship	s' tr	raffi	ic				
	6.3 Sy	vstem do	es not m	eet	international, clas	ssifi	cato	ory or national	reg	ulatic	ons	
	6.5 S	ystem's	interactio	on '	with other assets	(in	Icluc	ding unmanned	d ve	essels	s) leads to t	he
		emer	gence of	any	of above							
Potential	for	Contro	l action i	s	Unsafe control			Control action is provided in wrong			ntrol action	is
inadequacy	y:	not p	rovided		action is provided			ovided in wron	ŋg	pro	ovided for to	0
	F	Loss of con	trol over		Loss of control over			Loss of control over			of control over	ıg
Consequences:		vessel's mo	vement		vessel's movement		ves	ssel's movement		vesse	l's movement	
Potential		Control act	ions #21,26		Control actions #21,26		Cor	ntrol actions #21,26		Contr	ol actions #21,26	5
causes:		Machinery	unreliable		Machinery having		Del	lays related to		Impro	oper process	
		Consumabl	es not		insufficient capacity		equ	uipment's specificity	d	mana	gement algorithr	ns
		provided			designed/installed		Imp	proper process	a			
		D'		2			ma	nagement algorithm	s	t e e e l e		
Feasible		maintenan	ce regime	3	by design	3	lead	ding performance	3	leadir	ng performance	3
mitigation	and	Dodundant		2		2	indi	licators		indica	ators	
notontial	and	machinery		3		3				E		
potentiai		Posilionso		4								
		design	Jaseu	1								
		Procedures		2								
	Procedur consuma											
	managem											
Protection	Protection External a			1								
against co	ntrol	maintenan	ce effort									
degradatio	n	leading safe	ety indicator	s								

Control	oction									٦		Environm	ental	7
Control a	action				28			Nav	igation		$\rightarrow$	sensor	'S	
Control act	tion na	me:	Sensing											
Туре:			Feed											
Textual de	scripti	on:	Examina	ntio	n of processes' sta	tus	5							
Rationale:			Vessel's	со	urse and speed as	s w	vell a	s oth	er elen	nent	ts of	her move	emei	nt
			should b	be n	neasured for VC to	m	ake i	nform	ed dec	isio	ns			
Hazards	1.1 \	essel viol	ates mini	mur	m CPA with anothe	er s	ship							
resulting:	1.2 \	essel ent	ers a No G	So A	Area									
	1.3 \	essel imp	properly ir	nter	acts with other ma	an-i	mad	e obje	cts					
	2.1 \	essel ent	ers a No G	So A	Area									
	2.2 P	ropulsion	/steering	gea	ar operational para	ame	eters	s cann	ot be m	nain	taine	ed		
	2.4 \	essel's na	avigationa	l ca	pabilities are seve	rec	d by	weath	ier con	ditio	ons			
	2.5 \	essel doe	es not mee	et si	tability criteria									
	3.1 V	'essel's ca	argo is not	: loa	aded/stowed prop	erly	У							
	3.2 \	Vessel's cargo is not loaded/stowed properly Vessel is unable to maintain proper cargo stowage conditions												
	4.3 \	essel doe	es not mee	et fi	re safety precaution	ons	5							
	5.2 V	essel is u	nable to r	nair	ntain proper fuel c	om	nbust	ion pa	ramet	ers				
	6.2 \	essel con	tributes t	o de	elay of other ships	' tr	affic							
	6.3 S	ystem do	es not me	et i	nternational, classificatory or national regulations									
	6.5 9	system's	interactio	n v	with other assets (including unmanned vessels) leads t									e
		emer	gence of a	iny	of above						1			
Potential	for	Contro	l action is	;	Unsafe control		Со	Control action is			C	ontrol acti	ion is	;
inadequac	y:	not p	orovided		action is provided	d	pro	provided in wrong				ovided fo	r toc	)
		• •		_	Necesile metice		Maaa	tir	ne		sh	ort or too	long	J
Consequences	:	component	tion ts are not		components are		com	ers moti ponents	on are					
		known			measured improperly		mea	sured wi	th delay					
Potential		Sensors un	reliable		Sensors' malfunction		Non-	continue	ous					
causes:		cannot be r	measured		sensors' working range		oper	ation	s of sense	515				
					Sensor's accuracy		Sens	ors' idlei	ness due t	:0				
					insufficient		mea: spec	sured ph ificity	enomeno	n's				
Feasible		Redundant	or highly-	3	Redundant or highly-	3	Use	of	highly-	3				
mitigation			t or highly- 3 I nsors		reliable sensors		sens	itive sen	sors					
0		reliable ser	isors			t 3 Implementation of 3								the second se
measures	and	reliable ser	isors	3	Implementation of	3								
measures potential	and	Indirect	ent	3	Implementation of wide-range sensors	3								
measures potential Protection	and	Indirect Constant se	ent earch for and	3	Implementation of wide-range sensors	3	Cons	tant sea	rch for an	d				
measures potential Protection against co	and	reliable ser Indirect measureme Constant se installation	ent earch for and of improved	3	Implementation of wide-range sensors	3	Cons insta	tant sea llation o	rch for an	d d				
measures potential Protection against co degradatio	and ontrol	reliable sen Indirect measureme Constant se installation sensors Use of lead	ent earch for and of improved	3	Implementation of wide-range sensors Constant search for and installation of improved sensors Use of leading indicators	3	Cons insta sense Use o	tant sea llation o ors of leadin	rch for an f improve g indicato	d d ors				

Control a numb	action ber:				29			Environmental sensors	]-	$\rightarrow$	Virtual Captain		
Control act	tion na	me:	Data or	ı ve	ssel's motion and e	env	iron	ment					
Туре:			Feedba	ck									
Textual de	scripti	on:	Informa	atio	n on measured valu	ues	5						
Rationale:			Informa	atio	n on measured val	ues	s sha	all be compiled	d an	d tra	nsmitted to	VC	
			for it to	o m	ake informed deci	isio	ons.	Data pertaini	ng t	o sh	ip's movem	ent	
	1		and the	en	vironment is some	tim	ies s	strongly linked	•				
Hazards	1.1 V	essel vio	lates min	imu	m CPA with anothe	er s	ship						
resulting:	1.2 V	essel ent	ers a No	Go	Area								
	1.3 V	essel imp	properly i	nte	racts with other ma	an-	mac	de objects					
	1.6 S	ystem do	pes not pr	ovi	de assistance to pe	rso	on in	n distress					
	2.1 V	essel ent	ers a No	Go	Area			_					
	2.4 V	essel's na	el's navigational capabilities are severed by weather conditions el does not meet stability criteria										
	2.5 V	essel doe	el does not meet stability criteria el's cargo is not loaded/stowed properly										
	3.1 V	essel´s ca	sel's cargo is not loaded/stowed properly										
	3.2 V	essel is u	inable to	mai	ntain proper cargo	) sto	owa	ge conditions					
	6.2 V	essel cor	itributes	to d	lelay of other ships	í tr	affic						
	6.35	/stem do	es not m	eet	international, class	rnational, classificatory or national regulations							
	0.5 3	ystem s	s interaction with other assets (including unmanned ve						esser	s) leads to	the		
Detential	for	emer	gence of	any				antral antion i		6-	ntral nation	ia	
Potential	TOP	Contro	l action i	s	Unsafe control		Control action is			C0	ntroi action	IS	
inadequac	y:	not p	provided		action is provide	d	pro	timo	'Ig	pro ch/	ovided jor la	00 na	
		Vessel's m	otion		Improper data is fed to		Out	dated information i	s	5//0		ny	
Consequences		componen	ts and		VC		fed	to VC	-				
		environme	ntal conditio	ns									
Potential		Control act	ions #28,30		Control actions #28,30		Con	trol actions #28,30					
causes:		inadequate	2		inadequate		inac	dequate					
causes.		Data transi the vessel	mission with ineffective	in	Data transmission within the vessel ineffective	n	Data the	a transmission with vessel ineffective	in				
							Info	ormation overflow					
Feasible		Redundant	wiring	3	Data integrity	2	Data	a transmission	2				
mitigation							algo	prithms					
measures	and												
potential													
Protection													
against co	ntrol												
degradatio	n												

Control a numb	Control action number: ntrol action name:			30					]_	Environmental sensors		
Control act	ion na	me:	Sensing									
Туре:			Input									
Textual de	scripti	on:	Data pr	ovio	ded by Global Navi	igat	ion S	Satellite Syster	n			
Rationale:	r		The dat	The data is a vital information for the purposes of navigation process								
Hazards	1.1 V	essel vio	lates mini	s minimum CPA with another ship								
resulting:	1.2 V	essel ent	Go /	Area								
	1.3 V	3 Vessel improperly interacts with other man-made objects										
	2.1 V	Vessel enters a No Go Area										
	2.4 V	essel's na	ssel's navigational capabilities are severed by weather conditions									
	6.2 V	essel cor	l contributes to delay of other ships' traffic									
<b>.</b>	6.3 System does not meet international, classificatory or national regulations											
Potential	for	Contro	l action is		Unsafe control		CC	ontrol action is	5	Control action is		
inadequacy	y:	not p	orovided	ed action is provided				provided in		provided for too		
		Data on ve	ssel's nositio	n	Data on vessel's nositio	n		wrong time		short or too long		
Consequences:		course and	speed missi	ng	course and speed	,, ,						
Detential		GNSS offlin			inaccurate GNSS malfunction							
Potential		Vessel's an	itenna array		Vessel's antenna array							
causes:		unreliable			malfunction	_			_			
Feasible		Use of reckoning	f dead	2	Use of dead reckoning	2						
mitigation												
measures	and	Use of e	Navigation	2	Use of eNavigation	2						
potential		techniques			techniques							
Protection	Protection											
against control												
degradation												

Control a numb	action er:				31		Envir	onment		Environmenta sensors	al		
Control act	tion na	me:	Sensing	1									
Туре:			Input										
Textual des	scriptio	on:	Examin	ing	the environment								
Rationale:			Enviror	nme	ntal conditions sho	oul	d be know	wn to tł	ne VC	for it to ma	ake		
			inform	informed decisions on adjustment of certain parameters									
Hazards	1.1 V	essel vio	ates minimum CPA with another ship										
resulting:	1.2 V	essel ent	ers a No Go Area										
	1.3 V	essel imp	properly i	roperly interacts with other man-made objects									
	1.6 System does not provide assistance to person in distress												
	2.1 V	2.1 Vessel enters a No Go Area											
	2.4 V	4 Vessel's navigational capabilities are severed by weather conditions											
	2.5 V	5 Vessel does not meet stability criteria											
	2.6 \	.6 Vessel's watertight integrity is not maintained (due to shear forces, bending											
	mom	ents or p	uncture)										
	3.1 V	.1 Vessel's cargo is not loaded/stowed properly											
	3.2 V	essel is u	nable to	mai	intain proper cargo	Sto	wage con	ditions					
	4.4 V	essel s w	atertight	inte to d	egrity is not maintai	ine	0 offic						
	0.2 V	esser cor	es not m	oot	international class	u o lific	atory or n	ational r	عمياء	ions			
Potential	for	/stem do		cci			Control	action is		Control action	ic		
inadequacy	101	Contro	l action i	is	Unsafe control		nrovided	in wrond		control action is			
maucquac	у.	not p	orovided		action is provided	d	proviaea in wrong time			hort or too lo	na		
	-	VC's lack of	f 'situation		VC's 'situation		VC's 'situation	n awareness	5′ VC′	s 'situation awarer	ness'		
Consequences	:	awareness	,		awareness' flawed		flawed		flav	ved			
Potential		Sensors un Required p	reliable arameter is		Sensors' malfunction		Non-continuc	ous s of sensors	/ Noi	n-continuous gracteristics of sens	ors'		
causes:		not measu	red		sensors' working range		operation	3 01 3613013	ope	eration	5013		
							Sensors' idler	ess due to					
							specificity		5				
Feasible		Providing c	ontrol	2	Redundant or highly-	3	Use of	highly-	3 Use	e of continuous	3		
mitigation		action #40 Redundant	or highly-	ч	reliable sensors		sensitive sens	sors	pro	bing			
measures	and	reliable ser	isors	5	Use of wide-range	3	Use of cor	ntinuous	3				
potential					sensors		probing						
Protection		Constant se	earch for an	d	Constant search for and		Constant search for and			Constant search for and			
against co	ntrol	installation	of improve	d	installation of improved		installation of	nstallation of improved		allation of improve	ed		
degradatio	n	Use of lead	ling indicato	rs	Use of leading indicators	;	Use of leading	g indicators	Use	e of leading indicate	ors		
<b>.</b>	on sensors	' performan	ce	on sensors' performance	9	on sensors' p	erformance	on	on sensors' performance				

Control action number:			32		Other unmanned ships	]	→ Environmental sensors					
Control act	ion na	ne:	Data exch	ange								
Туре:			Input									
Textual des	scriptio	n:	Data exch	anged between unma	nne	d ships						
Rationale:			It might b	e beneficial for unma	nne	ed vessels to, fo	or ii	nstance, coordinate				
			collision a	collision avoidance actions. At minimum, Automatic Identification System								
	1		standard data should be exchanged.									
Hazards	1.1 V	essel vio	lates minim	um CPA with another	ship	)						
resulting:	1.2 V	essel ent	ers a No Go	Area								
	1.3 V	essel imp	properly inte	eracts with other man-	ma	de objects						
	2.1 V	essel ent	ers a No Go	Area								
	2.3 V	essel is d	lenied passa	nied passage by coastal state's authorities								
	2.4 V	essel's na	avigational o	apabilities are severe	d by	y weather cond	itio	ns				
	6.2 Vessel contributes to delay of other ships' traffic											
	6.3 5	stem do	es not meet	not meet international, classificatory or national regulations								
Detential	0.4 Sy	stemst	lommunicat	ion subsystem uninter	1110	nany interferes	wit					
Potential	tor	Contro	rol action is Unsafe control		C	ontrol action is	5	Control action is				
inadequacy	y:	not p	provided action is provided			time	g	provided jor too				
	F	Important	information	Information about other	Info	ormation about other	r	short of too long				
		about othe	er vessel is	vessel is incorrect	ves	sel is outdated						
Consequences:		missing Coordinatio	on cannot be	Coordination is carried	Coc	ordination is carried						
		carried out	:			,						
Potential		Own vesse	l's	Own vessel's	Oth	ner vessel transmits						
causes:		malfunctio	n	malfunction	Dat	ta reception algorithr	ns					
		Other vess	el does not	Other vessel transmits	flav	wed						
		transmit ne Radio com	ecessary data munication	incorrect data Data reception	Info	ormation overflow						
		jammed		algorithms flawed								
		Data recep	tion algorithms									
		Vessels use	e different data									
		transfer sta	andards	Deducidant enterior 2	Dec		2					
Feasible		Redundant	antennas 3	Redundant antennas 3	кес		3					
mitigation		Use of a	data from 2	Use of data from 2	Use	e of data from	2					
measures	and	other sour	ces	other sources	oth	ler sources						
potential Implement			ation of 4									
global st data exch			ndard for nge									
Protection Internatio			nal and industry	International and industry cooperation								
against co	ntrol											
degradatio	n											

Control action number:					33			Virtual Captain	]_	$\rightarrow$	Other unmanned ships	
Control act	ion na	me:	Data ex	chc	ange							
Туре:			Feed									
Textual des	scripti	on:	Data ex	cha	anged between un	mar	nne	d ships				
<b>Rationale:</b>			It migh	t be	e beneficial for ur	nma	nne	ed vessels to, f	or i	nstar	ice, coordina	ate
			collisior	n av	voidance actions. A	۹t m	ninir	mum, Automat	ic lo	dentif	ication Syste	em
			standar	standard data should be exchanged.								
Hazards	1.1 V	essel vio	lates mini	imu	im CPA with anoth	ner s	ship					
resulting:	2.3 V	'essel is d	enied pas	ssag	ge by coastal state	's a	uth	orities				
	6.2 V	'essel cor	tributes	to d	lelay of other ship	s' tr	affi	с				
	6.3 S	ystem do	es not m	s not meet international, classificatory or national regulations								
	6.4 S	ystem's c	communi	cati	ion subsystem unintentionally interferes with other assets							
	6.5 \$	System's	interactio	ction with other assets (including unmanned vessels) leads to th								the
		emer	nergence of any of above									
Potential	for	Contro	l action i	<b>c</b>	Linsafe control			Control action i	s	Со	ntrol action	is
inadequacy	/:	contro not r	rovided	2	action is provided		pr	ovided in wroi	ng	pro	ovided for to	00
		norp	noviueu			u		time		shc	ort or too lor	ng
Consequences:		Other vess important i about own Coordinatio carried out	el is missing information ship on cannot be		Other vessel receives incorrect information about own ship Coordination is carried out incorrectly		Oth inco abo Coo out	ner vessel receives orrect information out own ship ordination is carried t incorrectly				
Potential		Control act	ion #29		Control action #29			ntrol action #29				
causes:		inadequate	e or voscol's		inadequate		ina Ow	dequate				
		sensors/an	tenna array		sensors/antenna array		sen	nsors/antenna array				
		malfunctio	n 	_	malfunction		ma	Ifunction				
		flawed	er algorithm	S	flawed	15	flav	ved	IS			
		Vessels use	e different da	ta			-					
		transfer sta	andards	2	Dedundant antonnas	2	Dec	dundant antonnac	2			1
Feasible		Reduitdant		5		5	Rec		5			
mitigation		Data	transfer	3	Data transfer	3	Dat	ta transfer	3			
measures	and	algorithms	ent		algorithms		ma algo	orithms				
potential							. 0					
		ation of ndard for	4									
	global sta data <u>excha</u>											
Ducht attai	Internation	al and induc	trv									
Protection Internatio cooperatio			n	ιy								
against co	ntrol											
degradatio												

Control action number:	n		34		Shore-based control centre	]	$\rightarrow$	Alarms / limits			
Control action r	name:	Update									
Туре:		Control									
Textual descript	tion:	Adjustmen	ts of parameters' limi	ts							
Rationale:		Working p	Working parameters of the system shall be kept within certain limits.								
		These coul	These could be altered by operators based on phase of vessel's voyage or								
		weather co	onditions for instance								
Hazards All	nazards										
resulting:											
Potential for	Canton		line of a sectoral	C	Control action i	s	Со	ntrol action is			
inadequacy:	Contro	or action is	Unsafe control	pr	ovided in wroi	ng	pro	vided for too			
	ποτ μ	proviaea	action is provided		time	sho	ort or too long				
Consequences:	Unsafe sys remain uni OR Operator's requested leading to emergenci	tem's states noticed assistance is too frequently, belittling of es	Unsafe system's states remain unnoticed OR Operator's assistance is requested too frequently, leading to belittling of emergencies	Lim for	Limits are improperly set for conditions prevailing						
Potential	Improper p	procedures on	Improper procedures on	proper procedures o	n						
causes:	limits' adju	istments	limits' adjustments	limits' adjustments							
	Operators' skill/experi	lack of ience	operators' lack of skill/experience	Ope skil	erators' lack of l/experience						
	Operators	are given too	Operators are given too	Ope	erators are given too	)					
	great flexib	oility in	great flexibility in	gre adi	at flexibility in						
	Control act	tions #14a,16	Control actions #14a,16	auj	using the mints						
	inadequate	2	inadequate								
Feasible	Implement	tation of 3	Implementation of 3	Imp	olementation of	3					
mitigation	proper pro	Cedules	proper procedures	pio							
measures and	Restriction	of a 3	Restriction of a 3	Res	striction of a	3					
potential	limits	co which can be	limits can be	aeg lim	its can be						
	adjusted		adjusted	adj	usted						
	Trainings	3	Trainings 3	Tra	inings	3					
Protection	Implement	tation of 'safety	Implementation of 'safety	ementation of 'safety Implementation of 'safe							
against control	first' cultur	e	first' culture	tirs	ť culture						
degradation											

Control action number:			35		Alarms / limits	Virtual Captain				
Control action na	me:	Warnings								
Туре:		Input								
Textual description	on:	Levels of certain parameters that must not be exceeded								
Rationale:		VC shall ke	VC shall keep operational parameters of the system within limits							
Hazards All ha resulting:	azards	rds								
Potential for inadequacy: <i>Contro</i> <i>not</i> p		l action is provided	Unsafe control action is provided		Control action is provided in wrong time	Control action is provided for too short or too long				
Consequences:	remain unr	oticed	remain unnoticed							
Potential causes:	Control act inadequate Limits' data accessed	ion #14a,16,34 a cannot be	Control action #14a,16 inadequate Data misinterpreted by VC	.34						
Feasible mitigation measures and potential Protection against control	Fail-to-safe	: AL-3 2	Data integrity validation algorithms	3						

Control action number:				36		Virtual Captain	Ship's 'mental' model				
Control acti	ion na	ime:	Update								
Туре:			Feedback								
Textual des	cripti	on:	Updates of	Updates of VC's inherent model of the vessel, processes and subsystems							
Rationale:			Model of t updated	Model of the system as built-in for VC should constantly be improved and updated							
Hazards resulting:	All ha	azards	rds								
Potential inadequacy	ential for lequacy: not provided			Unsafe control action is provided	ן ויק	Control action is rovided in wrong time	Control action is provided for too short or too long				
Consequences:		Mental mo	del incorrect	Mental model incorrect Software errors cause the VC to crash	e Sot VC	ental model incorrect oftware errors cause the C to crash	Mental model incorrect				
Potential causes:		Control act inadequate Software m	ion #14b alfunction	Control action #14b inadequate Software malfunction	Co ina Sot	ontrol action #14b adequate oftware malfunction	Control action #14b inadequate Incomplete data set is downloaded				
Feasible mitigation measures potential	and	Extensive software	testing of 3	Extensive testing of software	3 Ext sof	tensive testing of a ftware	Extensive testing of 3 software				
Protection against con degradation	ntrol 1	Implement improveme	ing a constant- ent culture	Implementing a constant- improvement culture imp		plementing a constant- provement culture	Implementing a constant- improvement culture				

Control action number:				37		Ship's 'mental' model	Virtual Captain				
Control act	ion na	me:	Mental mo	Mental model							
Туре:			Input								
Textual des	scripti	on:	VC's inhere	's inherent model of the vessel, processes and subsystems							
Rationale:			VC shall u operations	VC shall use built-in mathematical model of particular subsystems' operations and the environment							
Hazards resulting:	All ha	azards	rds								
Potential for inadequacy: <i>Contro</i> <i>not</i> p			l action is provided	Unsafe control action is provided	C	ontrol action is provided in wrong time	Control action is provided for too short or too long				
Consequences:		VC cannot	make decisions	Decisions are based on inaccurate or incomplete information							
Potential causes:		Model data accessed	a cannot be	Control action #14b,36 inadequate Pre-programmed models of processes are flawed							
Feasible mitigation measures potential	and	Fail-to-safe	: AL-3 2	Extensive tests of 3 software							
Protection against co degradatio	ntrol n										

Control a numb				38			Coastal state's authorities	]_	Shore-based control centre			
Control act	ion na	me:	Reques	ts o	r commands			•				
Туре:		Input	Input									
Textual description:			Reques authori	Requests, orders, command and advices issued by coastal states' authorities, such as VTS								
Rationale:			Coastal certain environ	Coastal states shall be capable of requiring unmanned ships to follow certain advices issued by them as required due to e.g. traffic, security or environmental concerns								
Hazards resulting:	All h	azards										
Potential inadequacy	Potential for inadequacy: not provide			5	Unsafe control action is provided		C pr	Control action is provided in wrong time		Control action is provided for too short or too long		
Consequences:		Operator h model of si	as incomplete tuation		Operator has improper model of situation		Ope mo	erator has outdated odel of situation				
Potential causes:		Information or delivered Information different co operator	n is not issue d n is sent to a ompany or	d	Inaccurate information communicated Information is misinterpreted by operator	ccurate information is municated issued due to e.g. delay in processing interpreted by rator			s r in			
Feasible mitigation measures potential	and	Implementation of a system for identification of unmanned vessels' management companies by authorities and data exchange Procedures on data 3 exchange			Procedures on data exchange Trainings	3	Pro exc	ocedures on data change	3			
Protection against co degradatio	ntrol n	Safety-orie workshops industry pla	nted with differen ayers	nt	Safety-oriented Safety-oriented workshops with different industry players industry players							

Control a numb	action er:			39		Shore-based control centre	Coastal state's authorities					
Control act	tion na	ame:	Reports	?eports								
Туре:			Feedback	oack								
Textual description:			Reports sent by operators to coastal states' administrations regarding									
			e.g. dange	e.g. dangerous goods carried on board, navigational status etc.								
Rationale:			Coastal st	Coastal states' administrations should have full picture of situation in								
	1		their wate	rs – such information	may	/ be provided by s	ystem's operators					
Hazards	All h	azards										
resulting:		n					1					
Potential for Control			l action is	Unsafe control		ontrol action is	Control action is					
inadequacy	inadequacy:		provided	action is provided	pre	ovided in wrong	provided for too					
						time	short or too long					
Consequences:	:	Local authorinformation unmanned operations	orities have no n on vessel's	Local authorities have improper information on unmanned vessel's operations	Loca outo unn ope	al authorities have dated information on nanned vessel's erations						
Potential		Informatio	n is not issued	Information is compiled Re		oorts take too long to						
causes:		or delivere Informatio	d n is sent to	manually	com	npile						
		wrong auth	norities									
Feasible		Procedures	s on data 3	Procedures on data 3	Pro	cedures on data 3						
mitigation					EXCI							
measures	and			Implementation of a 3								
potential				data exchange								
Protection		Safety-orie	nted	Safety-oriented								
against co	ntrol	industry pla	with different avers	workshops with different								
-			· ·									

Control action number:			40				Outsourced data providers	Shore-based control centre			
Control actio	on nam	e:	Outsou	rcea	d data						
Туре:			Input								
Textual desc	:	Information provided by third parties									
Rationale:			SBCC's personnel may request data that can be provided by external								
			institut	institutions: weather or traffic density information for instance							
Hazards /	ards										
resulting:											
Potential inadequacy:	for	Control action is not provided			Unsafe control action is provide	d	Control action is provided in wrong time	Control action is provided for too			
Consequences:	Outsource provided; quences: not have f situation i location			S	Operator receives incorrect information		Operator receives outdated, therefore incorrect, information	Operator receives incomplete information			
Potential causes:	Co in Re av Re in O pr	ontrol act adequate equested vailable equested unreadal perator ig ovided	InterpretationControl action #41IteinadequateIteData source unreliableId data notData misinterpretationId data deliveredData misinterpretationId bable form ignores the data-		Control action #41 inadequate Data source unreliable Data processing is delayed	Control action #41 inadequate Data license expired					
Feasible mitigation measures a potential	and Pr	Procedures on data 3 exchange and use		Procedures on data exchange Trainings	3	Procedures on data 3 exchange	Procedures on data 3 exchange				
Protection against cont degradation	trol In In	rol Safety-oriented workshops with industry players Implementing a improvement cu		nt nt-	Safety-oriented workshops with different industry players Implementing a constant- improvement culture		Safety-oriented workshops with different industry players Implementing a constant- improvement culture	Safety-oriented workshops with different industry players Implementing a constant- improvement culture			

Control a numbe	ction er:			41	Shore-based control centre	Outsourced data providers						
Control acti	ion na	ime:	Requests f	or outsourced data								
Туре:			Feedback									
Textual des	cripti	on:	Requests to provide additional data pertaining to weather conditions etc.									
			in vessel's	in vessel's location								
Rationale:			Operators	may require data av	ailable from external	sources in order to						
			maintain f	ull situation awarenes	SS							
Hazards	All h	azards										
resulting:				1	1	Γ						
Potential for Control			l action is	Unsafe control	Control action is	Control action is						
inadequacy	inadequacy: not u		provided	action is provided	provided in wrong	provided for too						
		•	dete is soluber		time	short or too long						
Concernences		requested	nor provided;	requested	not required							
consequences.		maintain fu	Ill situation									
Potential		Need for a	dditional	Operator's lack of skill or	Operator's lack of skill or							
causes:		information	n is not	experience	experience							
		recognizeu		requesting data	requesting data							
Feasible		Procedures	on data 3	Procedures on data 3	Procedures on data 3							
mitigation		exchange		exchange	exchange							
measures	and											
potential												
Protection		Safety-orie	nted	Safety-oriented	Safety-oriented							
against cor	ntrol	industry pla	with different avers	industry players	industry players							
degradation	n	Implement	ing a constant-	Implementing a constant-	Implementing a constant-							
		improveme	ent culture	improvement culture	improvement culture							