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Working Party on Inland Water Transport

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Smart shipping and inland navigation

Autonomous shipping and Inland Navigation

Note by the secretariat

I. What is autonomous/smart shipping?

1. Autonomous ships are the next generation of vessels that are essentially an extension of remotely operated vessels. Navigation and performance of such vessels will be controlled from an onshore operating centre, by means of detectors, sensors, cameras, satellite communication systems etc. However, people will still need to monitor the vessel from the shore or to perform maintenance operations on a vessel. It is expected that crew members will not entirely disappear, but their profile and task will certainly change. This approach, on the one hand, will give the sector a chance to attract specialists with new qualifications and, on the other hand, will help to cope with the shortage of crew members.

2. The benefits of autonomous shipping are obviously a reduction in crew-related operational costs and safety. On an inland waterway vessel, the crew costs amount to one-third of the total operational costs. On unmanned vessels, energy-consuming crew facilities, such as heating and sanitary facilities, may be dispensed with. Reducing the crew can thus significantly reduce the total operational costs of a vessel.

3. Autonomous shipping might also reduce the human-related errors, as the influence of the human factor will be minimized or excluded. Furthermore, an autonomous vessel can navigate full-time, as there is no crew that needs to rest. This will economize the travel time and allow cargo to arrive faster at the destination.

4. Autonomous shipping could pave the way for new business models, such as smaller inland waterways that today are not in use. This will, furthermore, support the modal shift from road to water transport. However, there are still many questions concerning autonomous shipping on the inland waterways that need further clarification.

5. This issue has been addressed by international organizations: IMO, the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), the World

Association for Waterborne Transport Infrastructure (PIANC), the European Commission, the Central Commission for the Navigation of the Rhine (CCNR) and others.

6. For inland waterways, member States are undertaking initiatives and/or developing projects and road maps for smart and autonomous shipping: Flanders (Belgium), Finland, Germany, Netherlands, Norway, Russian Federation, United Kingdom of Great Britain and Northern Ireland and others.

7. Several cooperation initiatives and projects were organized at the international, national and/or regional levels, including:

- The Marine Autonomous Systems Regulatory Working Group (MASRWG) established in 2014 under the auspices of the Government of the United Kingdom of Great Britain and Northern Ireland,[1]
- The Norwegian Forum for Autonomous Ship (NFAS);
- A research project “Advanced Autonomous Waterborne Applications Initiative” (AAWA) launched in Finland in 2015;
- A project “One Sea Autonomous Maritime Ecosystem” founded in Finland in 2016;
- Projects “Maritime Unmanned Navigation through Intelligence in Networks” (MUNIN)[2] of the European Commission and “Safety and Regulations for European Unmanned Maritime Systems” (SARUMS) by the European Defence Agency;
- The International Network for Autonomous Ships (INAS), an informal group of national or regional interest organisations worldwide on unmanned, autonomous and smart ships established on 30 October 2017.

8. This issue is being regularly addressed at international fora; in 2018: the workshop “Autonomous sailing” at the IVR Congress 2018 (17-18 May, Strasbourg (France)), the international workshop “Automation on European Inland Waterways” held by the European Transport Workers' Federation (8-9 September 2018, Saint-Petersburg (Russian Federation)), Autonomous Ship Technology Symposium (27–29 June 2018, Amsterdam (the Netherlands)), First International Conference on Maritime Autonomous Surface Ship (ICMASS 2018) (8-9 November 2018, Busan (Republic of Korea)) and others.

II. UNECE Workshop “Autonomous shipping and Inland Navigation”

A. How it was organized and speakers

9. The workshop “Autonomous shipping and Inland Navigation” was held on 14 February 2018, at the fifty-second session of the Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation, Organized jointly by UNECE and De Vlaamse Waterweg nv.

10. The workshop focused on introducing smart and autonomous shipping on inland waterways, advantages and implications, possibilities for synergy with maritime transport and a selection of items for further consideration with a view to supporting member States that intend to guide the inland waterway sector towards more automatization and propose

[1] www.ukmarinealliance.co.uk/content/masrwg-code-practice.
[2] www.unmanned-ship.org/munin/.

possible activities toward the sound legislation and regulation in support of innovative transport such as autonomous shipping and building a framework which enables the commercial use of autonomous ships in a safe way.

11. The workshop was moderated by Mr. J. Fanshawe (MASRWG). Key speakers were Mr. J. Fanshawe, the Chair of the Marine Autonomous Systems Regulatory Working Group (MASRWG) (the United Kingdom of Great Britain and Northern Ireland), Ms. A.-S. Pauwelyn (De Vlaamse Waterweg nv, Belgium), Mr. F. Guichard (UNECE secretariat), Mr. F. Zachariae (IALA), Mr. B. Boyer (CCNR), Mr. G. Vromans (LR), Mr. Ø. J. Rødseth (NFAS/SINTEF Ocean), Mr. J. Merenluoto (DIMECC), Mr. J. Boll (Maritieme Academie Harlingen), Mr. T. Fonseca and Mr. M. Baldauf (WMU).

The workshop programme and the presentations are available at https://www.unece.org/trans/main/sc3/wp3/wp3doc_2018.html.

12. Mr. J. Fanshawe described the work being carried out by MASRWG in relation to safety of maritime autonomous surface ships (MASS), recent developments, advantages and challenges of autonomous shipping. Among crucial issues, safe operation, responsible ownership, recognized accreditation, training and integration into the maritime domain were mentioned. Recent progress in MASS regulatory basis included the industry codes, codes of conduct and practice, the IMO scoping exercise to be adopted by the Maritime Safety Committee in May 2018.

13. Ms. A.-S. Pauwelyn continued with an overview of the activities and tasks of De Vlaamse Waterweg nv in relation to innovations and autonomous shipping on inland waterways. As the first step in 2015, benefits and impacts of autonomous shipping had been identified; the assessment of the existing regulatory framework held in 2016 had discovered gaps in the regulatory basis for crews, traffic and transport of dangerous goods and allowed to propose possible solutions. The following step was establishing test areas jointly with the Netherlands in the cross-border area and the adaptation of the Flemish legislation with a view to enable autonomous shipping on inland waterways by 2020. Other challenges were the need for international technical and safety requirements, social acceptance, cyber security and other issues.

14. Mr. F. Guichard presented the work of UNECE related to Intelligent Transport Systems (ITS) and progress reached in the automotive sector. He further highlighted the ongoing work on new legal instruments aimed at addressing higher levels of automation and mentioned the work of the Working Party on Braking and Running Gear, the subsidiary body of the World Forum for Harmonization of Vehicle Regulations (WP.29) related to Automatically Commanded Steering Functions and cybersecurity, in particular, the Guidelines on Cyber Security and Data Protection adopted in March 2017 and the Task Force on Cyber security and Over The Air.

15. Mr. F. Zachariae highlighted the activities of IALA in the context of autonomous shipping, in particular, the e-Navigation concept. IALA was currently working on: (a) Maritime Service Portfolios (MSP), an application containing a crucial information for navigation to be automatically transferred to a ship, (b) resilient position, navigation and timing (PNT) as a response to an increased dependence on automated systems, (c) harmonized standards on data modelling and (d) connectivity for autonomous ships through the Maritime Connectivity Platform (MCP), VHF Data Exchange System (VDES) and smart navigation.

16. Mr. B. Boyer presented ongoing activities of CCNR in terms of innovation and digitalization, including automation and autonomous shipping. CCNR was currently working on a definition of automation levels in inland navigation in order to allow a legal analysis for next stages, develop international regulations and take into account specificities of inland navigation as compared to maritime shipping. Objectives and follow-up would

include establishing a comprehensive international definition of automation levels, creating basis for the future work on autonomous shipping and exploiting synergies with other activities, such as Task Group 204 on cybersecurity in inland navigation of the World Association for Waterborne Transport Infrastructure (PIANC).

17. The approach of classification societies in cyber security was demonstrated by Mr. G. Vromans. It was pointed out that currently there were no prescriptive rules or international standards for this innovative technology. The activities of LR in the field of cyber enablement were introducing new class notations, procedures and guidelines, including the type approval of components with cyber enabled systems. He further mentioned recent progress reached by LR in ensuring cyber security and described projects on ensuring safe operation of autonomous vessels and cyber security where LR was participating.

18. Mr. Ø. J. Rødseth presented an overview of the activities of SINTEF and NFAS in the field of MASS. Autonomous and unmanned ships were distinguished based on the operational area and the distribution of functions between the automation system and the operator and, consequently, categories of autonomy levels and MASS types had been introduced. Among the benefits of autonomous shipping, he mentioned reducing the total transport costs, energy efficiency, efficiency, safety and greening, while obstacles were cyber security, the shore infrastructure, legal, liability and private law aspects. It was pointed out that autonomous shipping would not be limited by fully unmanned ships.

19. Mr. J. Merenluoto informed the participants about activities and tasks of the project One Sea-autonomous maritime ecosystem, -where DIMECC was one of the key partners. The primary aim was to lead the way towards an operating autonomous maritime ecosystem by 2025 based on the digitalization of the maritime industry. For this purpose, roadmaps with a timeline towards 2025 had been developed to ensure a smooth transition from remotely operated vessels to fully autonomous vessels; they covered operational and technical aspects, security and safety, regulatory work, traffic control and ethics. Among key issues, he mentioned the intelligent infrastructure. interoperability, safety and security models, interaction between different types of vessels during the transition period, cyber security and the compatibility between sea-going and inland vessels.

20. In his presentation, Mr. J. Boll identified the challenges that autonomous navigation would bring for educational institutions, in particular, in relation to a new legislation in the European Union for professional qualifications in inland navigation: the legal framework, training and skills required for fully autonomous and partly autonomous vessels.

21. The presentation of Mr. T. Fonseca and Mr. M. Baldauf was dedicated to research work of WMU related to MASS. Mr. Baldauf continued discussing distinctions between autonomous and unmanned ships. He mentioned the technological background for MASS, challenges and opportunities and emphasized the need for updating IMO instruments to cover these vessels types. He presented the ongoing study conducted by WMU focused on the integration of autonomous ships into existing traffic schemes by using “mixed” traffic scenarios and preliminary observations.

22. The following documents were presented by the secretariat:

- decisions of the Maritime Safety Committee at its ninety-eighth session about a regulatory scoping exercise for the use of MASS;
- potential analysis of innovative solutions for inland navigation on waterways in the Berlin-Brandenburg region by the Hanseatic Transport Consultancy;
- information about the project Roboat from the Amsterdam Institute for Advanced Metropolitan Solutions.

B. Statements, comments and interventions

23. The following statements and comments were made:

- the need to make digitalization, autonomous shipping and modernization of the fleet more attractive for investments (ERSTU);
- this issue should be addressed in an integrated way as an intelligent inland water transport system on a service-based approach, with using RIS as one of integrating elements (European Commission);
- the regulatory framework of IMO was not applicable to inland navigation and, therefore, it was essential to look for synergies between inland navigation and the maritime sector (CCNR);
- for industry and insurance it was essential to have certainty for future investments in terms of future development, possibilities and legal framework, while paying attention to ethics (IVR, also on behalf of the European Barge Union);
- the task of member States, River Commissions and UNECE was making efforts to developing the legal and regulatory framework as the first step for the realization of this concept by industry; compatibility between maritime shipping and inland waterways should be taken into account (Sava Commission);
- the progress in limited test areas has been demonstrated, therefore it can be assumed that autonomous shipping on inland waterways in the coming years would develop gradually based on specific transport systems, thus giving additional time for developing regulations (SINTEF);
- autonomous shipping systems that would appear would be similar, based on existing experience, and that one of key tasks was developing corporate infrastructures in multimodal domains (Moderator).

C. Round table discussions and the questionnaire

24. The round table was dedicated to digitalization, priorities, advantages and challenges of autonomous shipping on inland waterways and interaction with the maritime sector. The participants were invited the multiple-choice questionnaire distributed by the secretariat. The questions are given in the table below.

1. Is the concept of autonomous shipping relevant for inland waterways?	Yes, it is or will become relevant	62%
	For certain types of craft or other conditions	14%
	For certain waterways	14%
	It needs further assessment	43%
2. Automation levels that could be relevant for inland navigation:[3]	Hybrid solutions	62%
	Short-manned vessels	54%
	Smart vessels	38%
	Remotely operated unmanned vessels	31%
	Fully autonomous vessels	23%
	Other levels of automation are applicable	14%

[3] See definitions in ECE/TRANS/SC.3/WP.3/2018/1.

3. Types of craft could be suitable for autonomous operation:	Motorized cargo vessels	43%
	Motorized tankers	14%
	Barges in assemblies of craft	21%
	Ferries	14%
	Supply vessels	7%
	Other types	
4. Is your administration/organization engaged in autonomous navigation projects?	Yes, for the maritime sector	14%
	Yes, for inland waterways	21%
	It is planned for the coming years	7%
	No, it is not foreseen	14%
	It can only be possible after the regulatory framework is available or other preparatory work is accomplished	7%
5. What could be the advantages of autonomous shipping?	Cost savings over time	43%
	Improving navigation safety	57%
	Minimizing the human factor risks	64%
	Reducing the environmental impact	36%
	Improving the operational efficiency	43%
	Enlarging the navigation zone	7%
	Introducing new jobs	14%
	Insurance-related issues	14%
6. Potential risks and challenges of autonomous shipping:	Lack of the regulatory basis	71%
	Development of automated technology	50%
	Additional costs	57%
	New qualifications and assessment	36%
	New safety management principles	43%
	Potential job losses	14%
	Decrease in diligence of crew members	29%
	Public acceptance and consumer preference	14%
7. Which added values could bring autonomous shipping at the pan-European level?	Harmonization and exchanging best practices	57%
	Making the sector more competitive	43%
	Enhancing mobility	21%
	Ensuring navigation safety	36%
	Fostering innovations	57%
	Security	14%
	Common education standards and competencies	14%
8. What could be priorities and next steps for the development of autonomous shipping on inland waterways?	Dissemination of information	43%
	R&D work related to automated technology	71%
	Development of the legislative basis	64%
	Developing education standards and competencies of crews	29%
	Developing certification models	29%
	Experience of the maritime sector and IMO	14%
	Development of insurance policy	36%
	It is premature to propose any actions	7%

D. Automation levels proposed by CCNR

25. Automated navigation covers a very wide range of technical solutions and use cases - ranging from simple navigation assistance to fully automated navigation. With a purpose of establishing a comprehensive internationally accepted definition of automation levels and support further works such as an analysis of regulatory needs, CCNR proposed for discussion the definitions of automation levels which are given in the table below. Although technology synergies are expected with the maritime sector, the CCNR considers that inland navigation has its own specificities that should be taken into account such as the composition of the crews, enclosed and restricted navigation, the passage of the locks, the height of water and bridges and some other features. This definition of levels of automation for river vessels is currently being finalised within CCNR bodies and its adoption is foreseen in December 2018.

	Level	**Designation**	**Vessel command (steering, propulsion, wheelhouse, …)**	**Monitoring of and responding to navigational environment**	**Fallback performance of dynamic navigation tasks**
Boatmaster performs part or all of the dynamic navigation tasks	0	**No automation** the full-time performance by the human boatmaster of all aspects of the dynamic navigation tasks, even when enhanced by warning or intervention systems *E.g. navigation with support of radar installation*			
	1	**Steering assistance** the context-specific performance by a steering automation system using certain information about the navigational environment and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks *E.g. rate-of-turn regulator* *E.g. trackpilot (track-keeping system for inland vessels along pre-defined guiding lines)*			
	2	**Partial automation** the context-specific performance by a navigation automation system of both steering and propulsion using certain information about the navigational environment and with the expectation that the human boatmaster performs all remaining aspects of the dynamic navigation tasks			
System performs the entire dynamic navigation tasks (when engaged)	3	**Conditional automation** the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks, including collision avoidance, with the expectation that the human boatmaster will be receptive to requests to intervene and to system failures and will respond appropriately			
	4	**High automation** the sustained context-specific performance by a navigation automation system of all dynamic navigation tasks and fallback operation, without expecting a human boatmaster responding to a request to intervene *E.g. vessel operating on a canal section between two successive locks (environment well known), but the automation system is not able to manage alone the passage through the lock (requiring human intervention)*			
	5	**Full automation** the sustained and unconditional performance by a navigation automation system of all dynamic navigation tasks and fallback operation, without expecting a human boatmaster will respond to a request to intervene			

E. Outcome of the workshop

26. It was pointed out that the approaches used in inland navigation and maritime shipping had much in common, however, differences between them should be taken into account while seeking for synergies in terms of technologies, cyber security and other aspects.

27. The participants agreed that international cooperation was of major importance for developing this concept, in particular, international regulatory basis.

28. It was mentioned that the added value of autonomous shipping at a pan-European level would be **a harmonized approach and exchanges of best practices; fostering of innovations; making the sector more competitive and attractive; ensuring navigation safety and enhancing mobility**.

29. Priorities and next steps for the development of autonomous shipping on inland waterways were: **(a) research and development in automated technology; pilot projects and tests; (b) development of the legislative base; (c) dissemination of information; and (d) development of insurance policies**.

30. The participants agreed that **international cooperation** was of major importance for developing this concept.

III. What could be next steps?

31. Based on the outcome of the discussion and the answers to the questionnaire, the following steps could be considered:

- consideration and acceptance of the definition of automation levels by SC.3;
- analysis of bottlenecks and possible solutions
- preparing a road map for further steps to be undertaken in terms of international cooperation for the promotion of autonomous/smart shipping
- recommendations.