

**Smart Shipping**

**Code of Practice for testing in Flanders**

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This Code of is based on “Autonomous vehicles – Code of Practice for testing in Belgium” of the FSP Mobility and Transport.

1. **Introduction**

1.1. The present Code regulates the testing of automated vessels in a real world environment in Flanders.

In concrete terms, tests of this nature may take place on condition that the vessel is used in accordance with the applicable laws and regulations and providing a tester is present, or, in certain specific cases, minimally a test operator, who takes responsibility for the safe operation of the vessel.

1.2. It is up to the manufacturer or the testing organisation to ensure that innovative technologies for automated or fully automated vessels are developed and tested thoroughly before being brought onto the market. Much of this development can be done in test laboratories or on dedicated test tracks. However, to ensure that these technologies are capable of 'safe behaviour' in the various situations that may present themselves, they will need to be subjected to controlled testing in a 'real world environment' also. Thus, the testing of new automated vessel technologies on the inland waterways should be facilitated whilst care must be taken that these tests are designed and conducted in order to minimise potential risk.

1.3. This Code of Practice has been published to help manufacturers and/or testing organisations intending to test these technologies in real conditions. This Code of Practice provides clear guidelines and recommendations to maintain safety during this testing phase.

1.4.The present Code of Practice does not contain any actual rules of law but has been developed to promote responsible planning and carrying out of tests. Testing organisations shall use this Code in conjunction with detailed knowledge of the statutory, regulatory and technological framework

1. **Object, scope and definitions**

Object

2.1. This Code of Practice provides guidelines for organisations wishing to conduct testing of partially or even fully automated vessel technologies on the inland waterways in Flanders. The present Code lists the minimum conditions the competent authorities expect to be respected in order to guarantee safety and minimise potential risks. 'Minimum conditions' means that additional conditions may be imposed for specific applications which may vary according to the waterway and the kind of vessel covered by the application.

2.2. Naar verwachting dragen nauwkeurige tests bij tot een weldoordachte ontwikkeling van geautomatiseerde vaartuigen die, wanneer ze in ‘automatische stand’ worden gebruikt, blijk zullen geven van een voorbeeldig vaargedrag en op die manier de veiligheid van alle vaarvaarweggebruikers zullen verbeteren, alsook zorgen voor een vermindering van de uitstoot.   
It is expected that careful testing will contribute to the well-planned development of automated vessels which, when operated in 'automated mode', will display exemplary sailling behaviour, improving the safety of all waterway users, and reduce emissions.

Scope

2.3. This Code of Practice is intended for the following applications:

* The testing of partially or even fully automated vessel technologies on the Flemish inland waterways (see 2.4).
* The testing of a wide range of vessels, from smaller automated scale models, through to more conventional vessels from all CEMT-classes.

Definitions

2.4. For the purpose of this documents, the following definitions shall apply

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Level | Designation | Vessel command (steering, propulsion, wheelhouse, …) | Monitoring of and responding to navigational environment | Fallback performance of dynamic navigation tasks | Remote control |
| 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* |  |  |  | No |
| 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)* |  |  |  | No |
| 2 | Partial automation the context-specific performance by a navigation automation systems 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 |  |  |  | Subject to context specific execution, remote control is possible (vessel command, monitoring of and response to environment or fallback performance). It may have an influence on crew requirements (number or qualification) |
| 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 avoidance1, 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 intervene2  *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 |  |  |  |

1 "Collision avoidance" is the critical task in responding to the environmental conditions (other vessels, bridges,…).

2 This level introduces two different functionalities: the ability of “normal” operation without expecting human intervention and the exhaustive fallback. Two sub-levels could be envisaged.

Testing organisation

2.7. A testing organisation is any institution or person wishing to test (new) technologies for partially or even fully automated vessels on the inland waterways in Flanders. The testing organisation submits the application and bears full responsibility for the tests to be conducted.

Tester

2.8. A tester is the person who is seated in the vessel in a position where he is able to control the vessel’s speed and direction at any time.

Test operator

2.9. A test operator is the person who oversees testing of an automated vessel. The test operator must not necessarily be seated in the vessel but must at all times be able to override the automated operation of the vessel, especially when there is no tester in the vessel.

Test assistent

2.10. A test assistant assists the tester or test operator with the testing, for example by monitoring the information relayed via screens or other information systems designed to provide feedback and by observing the reactions of other inland waterway users.

1. **General requirements**

Safety requirements

3.1. Het is de verantwoordelijkheid van de testorganisatie om zich ervan te vergewissen dat alle

geplande tests voldoen aan de toepasselijke wetgeving en dat de betrokken vaartuigen

geschikt zijn om aan het scheepvaartverkeer deel te nemen, voldoen aan alle toepasselijke

vaartuigvereisten en kunnen worden gebruikt op een wijze die verenigbaar is met de van

kracht zijnde regelgeving.  
Responsibility rests with the testing organisation for ensuring that all tests planned meet the relevant legislation and that the vessels involved are worthy to take part in the inland waterway traffic, meet all the relevant vessel requirements and can be used in a way that is compatible with the legislation prevailing.

Testing organisations shall:

* ensure that testers and test operators hold the relevant certificates and have received the appropriate training (see Section 4);
* conduct a (prior) risk analysis of any tests proposed and develop appropriate risk management strategies (with documentation in support);
* be aware of the possible impact of these tests on other inland waterway users;
* allow representatives of the competent authorities to attend the tests.

Where tests on the inland waterways are considered, an application form will have to be completed.

3.2. The responsibility for the safe and orderly testing of the technologies in question on the inland waterways invariably rests always with the testing organisations. The mere compliance with the present guidelines does not by definition mean that all reasonable steps to minimise risks have been taken.

3.3. Where the vessel also carries passengers, the testing organisation (or tester) is obliged to inform them about the tests.

Insurance

3.4. All statutory requirements in matters of insurance apply. Anyone conducting tests with automated vessels on inland waterways must be covered by appropriate insurance and also satisfy the other statutory requirements (a copy will need to be submitted).

Competent authorities

3.5. Testing organisations must engage with the competent authorities with responsibility or competence for the test location (the waterway manager).

3.6. Any specific infrastructure requirements that are considered necessary within the framework of the tests, including traffic signals, will need to be put in place as agreed with the inland waterway manager.

3.7. Testing organisations shall compile a report after each test on the inland waterways. Where necessary, they shall propose any changes that may be required for risk management purposes. This report shall be discussed with the relevant authority (the waterway manager).

Engagement

3.8. Communication-related initiatives shall be coordinated with the competent authority (the waterway manager).

3.9. Once the necessary permits have been obtained and no less than 3 working days prior to the start of the trials, the testing organisation shall notify the times and locations of the test and of the registration data of the test vessels via the following address: [smartshipping@vlaamsewaterweg.be](mailto:smartshipping@vlaamsewaterweg.be)

1. **Requirements for testers, test operators and test assistants**

Requirements for a tester/operator overseeing the tests

4.1. The testing of automated vessels on the inland waterways shall be done in the presence of a suitably trained tester or a test operator. Details with regard to the required boatmasters’ certificate and training are set out in sections 4.5 to 4.9.

4.2. The tester or test operator is responsible for the safe operation of the vehicle at all times. The tester and test operator must be familiar with and understand the systems under test, including their capabilities and limitations, and must be able to anticipate the need to intervene and resume control when necessary.

4.3. The tester or operator must have been duly authorised by the testing organisation to fulfil the role in question. Testing organisations shall have robust risk management, process and training procedures in place for testers and test operators, and shall ensure that the aforesaid persons hold the appropriate boatmasters’ certificate.

4.4. Those entrusted with testing are expected to have knowledge of the law and regulations applicable. Law and regulations can be found at <https://www.visuris.be/Reglementering>

Certificate requirements

4.5. The tester or test operator must hold the appropriate category of certificate for the vessel under test. This applies even if the vessel’s ability to operate entirely in automated mode is being tested. It is strongly recommended that the certificate holder also has several years’ experience of navigating the relevant category of vessel.

4.6. The testing organisation shall take due care in its selection and guidance of testers and test operators. Testing organisations are expressly advised not to use persons whose navigation history indicates that they may increase the possible risks.

Tester or test operator training

4.7. Testing organisations shall develop and implement procedures to ensure the competency of testers and test operators. Testers and test operators need skills over and above those of skippers of conventional vessels, and/or in normal conditions. For example, it is important to ensure that they have an excellent understanding of the capabilities and potential limitations of the technologies under test and are able to assess and, where possible, control the risks associated therewith. It is also recommended that they get the opportunity to familiarise themselves with the characteristics of the vessel and technologies under test.

4.8. Testers and test operators must be familiar with the modalities of the automated systems under test, and be aware of the situations in which they may have to intervene. Training should cover potentially hazardous situations that may be encountered, and the appropriate action to be taken at that moment in time - including safely resuming control.

4.9. It is vital that those conducting the tests are fully aware of the mode in which the vehicle is operating and of the manner in which control is passed between the tester or test operator and the vehicle.

Tester and operator working hours

4.10. Testers and operators shall remain alert and ready to intervene if necessary throughout the test period.

Tester/operator behaviour

4.11. Testing organisations shall implement clear rules regarding tester and test operator behaviour and ensure that these are known and understood.

4.12. Testers and test operators should be conscious of the way they are perceived by other road users, for example continuing to maintain gaze in directions appropriate for normal navigation.

Test assistents

4.13. Depending on the nature of the tests being conducted and the vehicle involved, testing organisations may deploy a test assistant. For instance, if the vessel is a conventional one which has been adapted to include functions related to automated technologies, a test assistant can assist the tester by monitoring information displayed on screens or via other feedback systems.

1. **Vessel requirements**

General vessel requirements

5.1. Any organisation wishing to test automated vessel technologies on the inland waterways must ensure that the vessels under test can be used in a way that is compatible with the legislation prevailing in Belgium.

Experience with technologies under test

5.2. Organisations wishing to test automated vessel technologies on the inland waterways shall demonstrate that the vessels and/or technologies have been adequately tested beforehand.

5.3.Vessel sensor and control systems should be sufficiently developed to be capable of appropriately responding to all types of inland watereay users which may be encountered during the test in question.

Data recording

5.4. Automated vessels under test should be fitted with a data recording device that is capable of recording data from the sensor and control systems linked to the automated functionalities, including other information associated with the vessel’s movements.

5.5. As a minimum, this device should record the following information:

* whether the vessel is operating in classic or automated mode;
* the speed of the vessel;
* steering commands and activation;
* braking commands and activation;
* activation of the vessel’s audible warning system;
* the location of the vessel (on the waterway);
* the operation of the vessel’s lights and indicators;
* sensor data concerning the presence of other waterway users or objects in the vicinity of the vessel;
* remote commands that (may) influence the vessels’s movements (where applicable);

Where some of the aforesaid elements are irrelevant within the framework of the proposed tests, or cannot be recorded, the testing organisation shall explain this on the application form.

5.6. These data should allow one to establish who or what was controlling the vessel at the time of an incident. The data shall be securely stored and, in the event of an incident, be provided to the official bodies upon request. Testing organisations are expected to fully cooperate with the competent authorities in the event of an investigation into an incident.

5.7. In addition, it may be useful to fit vessels under test with a video and audio recording system. However, this device should not be considered as an alternative to the data recording requirements specified in the section above.

Data protection

5.8. Testing is likely to involve the collection and/or processing of personal data. Where data are collected about the behaviour or location of individuals in the vehicle allowing those individuals to be identified, the activity comes within the scope of the General Data Protection Regulation of 25 May 2018. The testing organisation, and by extension all the persons involved, shall ensure that the data protection legislation is complied with, including the requirement that the personal data are used fairly and lawfully, kept securely and for no longer than necessary.

5.9. A (prior) assessment of the impact on privacy of the proposed tests and/or the procedures implemented is not a legal requirement but can be useful in terms of helping a project comply with the data protection legislation. An assessment like this can be developed flexibly and proportionally, depending on the complexity of the test.

Cyber security

5.10. As stated in section 4, a tester or test operator shall oversee the movements of the vessel under test at all times so that control of the vessel can be safely resumed whenever necessary.

5.11. Nevertheless, manufacturers providing vessels, and other organisations supplying parts for the tests, need to ensure that all prototypes of automated controllers have appropriate levels of security built into them to ward off any risk of unauthorised access.

5.12. Testing organisations and/or other entities involved are advised to adhere to and apply the security principles as set out in Standard IEC 61508, or equivalent on software trustworthiness, as best as possible.

Process for transition between automated and classic modes

5.13. Een belangrijk onderdeel van de veiligheid van het testen van geautomatiseerde vaartuigen is het beheer van de overgang van klassieke besturing naar automatische stand en, in het bijzonder, van de automatische stand terug naar klassieke besturing.

An important part of the safety of automated vessel testing is the management of the transitions from classic control to automated mode and, in particular, from automated mode back to classic control.

5.14. The system used shall:

* be straightforward and easily understood by the tester or test operator;
* ensure that the tester or test operator can establish clearly whether the vessel is in classic or automated mode;
* ensure that the tester or test operator is given appropriate and ample warning to resume control of the vessel whenever necessary;
* allow the tester or test operator to quickly and easily resume control of the vessel whenever necessary.

5.15. Ensuring minimal transition periods between classic and automated modes, with the least possible risk, forms an important part of the vessel development process and the organisation of the envisaged tests.

Failure warning

5.16. Prior to the start of any test, the tester or test operator shall check the proper functioning of the system under test, including the proper functioning of the emergency procedures put in place.

5.17. In the event of a malfunction or failure of the automated navigation systems under test, the tester or test operator must be notified by means of an audible signal which may be accompanied by a visual warning. The emergency procedure(s) put in place are activated and, if necessary, the test must be aborted. Testing shall not be resumed until such time as the system is demonstrably operational again.

5.18. The vessel’s automated braking and steering systems shall be designed in such a way that, in the event of failure, manual braking and steering remains possible.

Software versions

5.19. Automated driving systems will require the interaction and the correct functioning of several computers and/or electronic control modules. It is essential that:

* all software versions and revisions used during testing are documented and recorded;
* all software versions and revisions have been extensively and demonstrably tested (reporting) before being deployed on the inland waterways.