CCNR
CENTRAL COMMISSION
FOR THE NAVIGATION OF THE RHINE

Explanatory note related to the international definition of levels of automation in inland navigation

Edition 2022

Legal notice

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1. Introduction

This explanatory note contains additional information related to the international definition of the levels of automation edition 2022. In case of contradictions between the explanatory note and the definition, the adopted definition is the document to consider. If necessary, the CCNR will update this explanatory based on experience gained.

This explanatory note does not replace or complement future or existing regulations.

2. Preliminary definitions

Automation level and maximum level of automation

An automated craft may achieve **different levels of automation during its voyage**. "**Maximum level of automation**" is understood as the maximum level an automated craft can achieved during its voyage. Indeed, during a voyage with an automated craft, the level of human intervention may change so that for the same craft on some stretches of waterway the automated navigation system may play a big role in the control of the craft while in another context (confined navigations), the human will operate the craft. This is notably the major difference between levels 4 and 5: for the latter the automation is irrespective of the context in question.

3. Table related to the automation levels

a) Signification of pictograms

Pictogram	Signification	Fallback performance
	The action for which this pictogram is used is performed by the human boatmaster.	The boatmaster is considered to be ultimately responsible and is expected to intervene
	Individual aspects of action for which this pictogram is used are performed either by the boatmaster or by the system, depending on the type of action to be performed.	The boatmaster is considered to be ultimately responsible and is expected to intervene.
	The action for which this pictogram is used is performed by the system.	The system is elaborated enough to be able to intervene.

b) Examples

Levels of automation	Designation	Examples
0	**No automation**	Navigation with support of radar installation.
1	**Steering assistance**	Rate-of-turn regulator Basic track guidance assistant for inland navigation (basic TGAIN) used for steering assistance.
2	**Partial automation**	Advanced system used for steering assistance and command of the propulsion like advanced track guidance assistance for inland navigation (advanced TGAIN). This system may have a function of collision avoidance warning.
3	**Conditional automation**	Advanced system including a collision avoidance function and which steers the craft.
4	**High automation**	Craft operating on a canal section between two successive locks (environment well known) is fully steered by an automated navigation system, but the automated system is not able to manage alone the passage through the lock (requiring human intervention).
5	**Autonomous = Full automation**	A craft being operated on a free-flowing or canalised waterway, possibly involving the passage of locks, and for which the automated navigation system performs all tasks (routine and emergency tasks) without restriction.

c) Focus on level 4 “High automation”

For level 4 it is stated that it “*introduces two different functionalities: the ability of “normal” operation without expecting human intervention and the exhaustive fallback performance. Two sub-levels could be envisaged.*”

Indeed, while the human boatmaster must intervene in level 1, 2 and 3 not only on demand, but also in case of system failure, level 4 assumes, that the system is sufficiently advanced in context specific situations not only to no longer require boatmaster intervention in difficult situations, but also to monitor itself and react autonomously to system failures (“fail-safe” approach).

Therefore, this level covers two very different aspects of automation (perfect system for all unusual traffic situations and comprehensive backup system). This could lead to a division in two sub levels.

For time being this distinction is not made in the definition mainly due to a lack of experience related to this level and the developments.

4. Remote control in relation to automated navigation

A priori, the remote control and monitoring of crafts is independent of a craft's level of automation.

Full automation means *"the sustained and unconditional performance by an automated navigation system of all dynamic navigation tasks and fallback performance, without expecting a boatmaster responding to a request to intervene"*. Remote control means that navigation decisions are taken by a human or a machine external to the craft. In other words, "Remote control" is understood as a mean to perform part or all the needed navigation tasks from shore or from another place than from the craft (e.g., craft command, monitoring of and responding to navigational environment and fallback performance of dynamic navigation tasks). These tasks executed remotely could be performed from a technical point of view by a human or by a machine. Therefore, remote control is not in itself automation even if both are linked.

Automation and remote control therefore are two different concepts, even if they may use technologies and technical equipment that are partly identical. Depending on the level of automation, the automated system fitted aboard the craft allows control of the rudder or propulsion system. This action is by means of an electronically received order.

- This command can be given either locally or remotely.
- This command can come either from a human or from a machine.

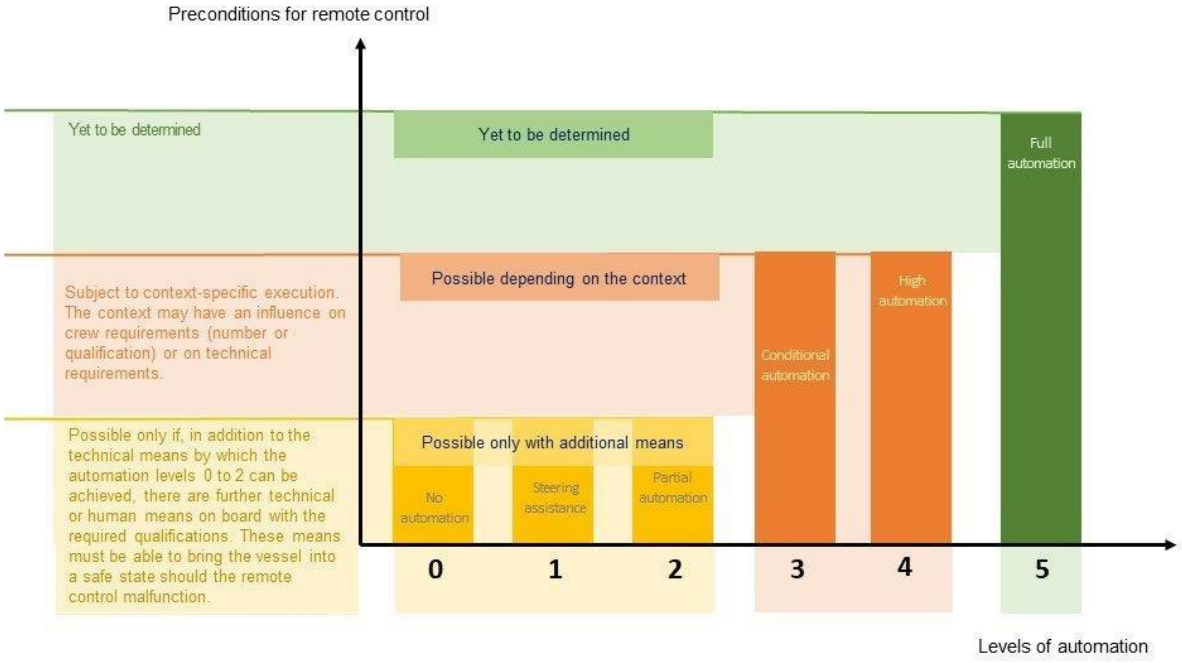
Remote control and automation therefore require identical features to convert an order issued by a remotely located machine or human into tangible action on the rudder and/or propulsion system.

There is also a connection between these two concepts in the event of a malfunction. Indeed, if the remote control were to be interrupted, there might be provisions whereby the craft is able either to reach a safe location without posing a hazard to other crafts or to be safely immobilised without this excessively inconveniencing other crafts. There are several solutions for achieving this state:

- There is someone aboard the craft who possesses the necessary skills to perform such a task.
- The craft possesses a level of automation such that it is capable of independently and safely reaching a safe location or is capable of automatically dropping anchors in the event of communication being interrupted.

Another solution would be to have an additional and completely redundant remote control system. If therefore the primary remote control is no longer in operation, another control system could be activated using alternative technical means.

In the absence of an obvious link between remote control and automation, the diagram below indicates the need for additional conditions to make remote control possible, depending on the level of automation. These conditions should guarantee safe navigation when the level of automation of the craft is not sufficient to ensure safe control of the craft in the event of a malfunction of the remote control. For instance, the remotely operated craft should also be equipped with the necessary equipment that allows a boatmaster who would be on board to immediately take control of the craft.



5. Contact

If you have any questions or remarks to improve this explanatory note, please do not hesitate to contact the CCNR Secretariat at the following address: ccnr@ccr-zkr.org