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AutoMated Vessels and Supply Chain Optimisation for Sustainable Short SEa Shipping

MOSES Pilot Demonstration 2 Evaluation Report

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List of Acronyms

Abbreviation / acronym	Description
BT	Binnenvaart Tank (Shallow Water Basin)
COLREGS	Convention on the International Regulations for Preventing Collisions at Sea
D1.1	Deliverable number 1, belonging to WP1
DP	Dynamic Positioning
EC	European Commission
EGA	Effective Gravity Angle
GUI	Graphical User Interface
IMO	International Maritime Organization
ISO	International Organization for Standardization
KPI	Key Performance Indicator
MARIN	Maritime Research Institute Netherlands
MSDV	Motion Sickness Dose Value
MMS2	MARIN Measurement System (v2) – data acquisition for analogue signals
MSES	MARIN Synchronised External Systems – data acquisition for digital signals
MSI	Motion Sickness Index
NATO	North Atlantic Treaty Organization
OCIMF	Oil Companies International Marine Forum
PIANC	Permanent International Commission for Navigation Congresses
SGISC	Second Generation Intact Stability Criteria
SI	Success Indicator
SMB	Seakeeping and Manoeuvring Basin
STANAG	Standardization Agreement (NATO)
T1.1	Task 1, belonging to WP1
TEU	Twenty-foot Equivalent Unit
WP	Work Package
XMF	eXtensible Modelling Framework

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Executive Summary

This is the technical report for T7.3 “Pilot Demonstration 2 - Innovative Feeder Vessel”. T7.3 was led by MARIN. Pilot Demonstration 2 is part of the scope of work of the Horizon 2020 project MOSES.

The report D7.3 was prepared by MARIN, with various contributions from NTUA. In addition, technical discussions with NTUA, DNV, AST and PCT during project meetings are reflected in the contents of this report.

Pilot Demonstration 2 concerns the demonstration of the autonomous operation of the Innovative Feeder Vessel. A 1:17 scale model of the ship made a round-trip through MARIN's Seakeeping and Manoeuvring Basin (SMB), without operator input, including automated docking and undocking. The environment included an area of open sea, with irregular waves and gusting wind, in which a schematic port of departure and arrival was placed.

D7.3 discusses the applied technical approach and the results of Pilot Demonstration 2. The scale models, including instrumentation and actuator hardware are described. The algorithms for vehicle control and autonomy are discussed, including their relation to the time-domain simulations documented in D3.2. The test set-up, the modelling of environmental conditions, the test program and the applied data analysis are presented. Finally, the report contains a discussion of the results and a selection of photographs of the model, the test basin and the execution of the tests.

The technical approach of combined time-domain simulations and model tests, as discussed in Chapter 3 of this deliverable, proved to be successful. First, the algorithms for vehicle control and autonomy were developed, implemented and tested in a simulation environment. This part of the work was described in D3.2. Second, the simulation models were adapted, step-by-step, for use in the basin tests. As a final step, the simulated ship and the surroundings were replaced by a physical scale model, which was placed in a model basin.

The experimental scope of work consisted of several series of tests, with different objectives. The final series of tests was the actual demonstration of the feeder autonomous capabilities.

First, system identification tests were carried out. The aim was to derive properties of the scale model of the innovative feeder vessel, using dedicated measurements. These included thrust-RPM relations of the thrusters and wind fans, as well as manoeuvring properties of the ship.

Second, round-trip variations were carried out. A round-trip was defined in the basin, with the beginning and end in the docked situation at the schematic port model. Sailing of the round-trip was repeated with several systematic variations in the environmental conditions and vessel control. The results showed that the vessel could make the round-trip and dock at the port autonomously in all considered environmental conditions.

Third, port approach variations were carried out. A second, longer, round-trip was defined in the basin, with the beginning and end in the docked situation at the schematic port model. Variations were made in the track that defines the approaching phase. The shape of the track in the approaching phase has an effect on the position accuracy and remaining velocity when starting the pre-docking phase.

Subsequently, Dynamic Positioning (DP) tests were carried out. The DP station keeping performance of the innovative feeder was tested in different collinear environmental conditions, using a range of heading set-points. The effect of heading set-point on the energy consumption and positioning accuracy was investigated.

Finally, demonstration tests were performed. A third, longer, round-trip was defined in the basin, with the beginning and end in the docked situation at the schematic port model. This round-trip also included variations in speed along the trip. Buoys were placed in the basin to mark the route. This route was made specifically for use during the visitors' day of Pilot Demonstration 2.

The Pilot Demonstration 2 contained several new techniques and modelling methods. In the basin tests a completely wireless ship model was used, with wireless transfer of measurement and control signals by Wi-Fi. The algorithms for autonomous control were running on PC inside the model. Furthermore, a camera-based system for relative position measurement was developed for use during the docking phase, but unfortunately it could not be made operational for use during the basin tests.