Progress on the Pilot Project 1 until 31.12.2024. (M19-M24)

Improved fire evacuation VR model of a ship engine room

CHALLENGE! To provide an improved, more realistic, albeit safer environment for onboard firefighting training.

HOW? By building a fire scenario in a virtual reality (VR) environment of a ship engine room (ER) based on fire spread results obtained by computational fluid dynamics (CFD) analysis.

WHY? The problem with the current VR models is that the fire is modelled rudimentary, i.e. as a concentrated flame that does not spread, making users less susceptible to the stimulus.

FINAL RESULT→ Functional VR model of fire spread in ship ER, reaching TRL4/TRL5.

GOALS FOR INNO2MARE PROJECT: To advance maritime fire safety and to digitalize the maritime education and training (MET) process.

PROGRESS ON ACTIONS:

Action	Start-End	Accomplished
1. State-of-the-art literature review, existing solutions analysis, mapping research gaps solutions	M1-M3	Yes
2. Selection and design of a representative ship ER	M1-M3	Yes
3. Building a VR model of ER	M4-M6	Yes
4. Developing and defining fire scenarios	M7-M9	Yes
5. CFD modelling of fire spread in ER	M10-M12	Yes
6. Implementing CFD analysis results in VR model	M12-M18	Yes
7. Testing of improved VR model	M19-M30	Ongoing
8. Equipment procurement & subcontracting	M3-M6	Yes
9. Dissemination	M1-M48	Ongoing

In the following, more details are given on every action performed.

1. State-of-the-art literature review, existing solutions analysis, mapping research gaps solutions

Please see the Progress on Pilot Project 1 until 30.06.2023 (M1-M6).

2. Selection and design of a representative ship ER

Please see the Progress on Pilot Project 1 until 30.06.2023 (M1-M6).

3. Building a VR model of ER

Please see the Progress on Pilot Project 1 until 30.06.2023 (M1-M6).

4. Developing and defining fire scenarios

Please see the Progress on Pilot Project 1 until 31.12.2023 (M7-M12).

5. CFD modelling of fire spread in ER

Please see the Progress on Pilot Project 1 until 31.12.2023 (M7-M12).

6. Implementing CFD analysis results in VR model

Please see the Progress on Pilot Project 1 until 30.06.2024 (M13-M18).

7. Testing of improved VR model

The results of the performed CFD fire spread analysis are presented as the evolution of smoke and temperature over time. Here, images of the last time step (600 s) for smoke and temperature isosurfaces are shown in Fig. 1. They show the distribution of smoke and temperature across the ER.

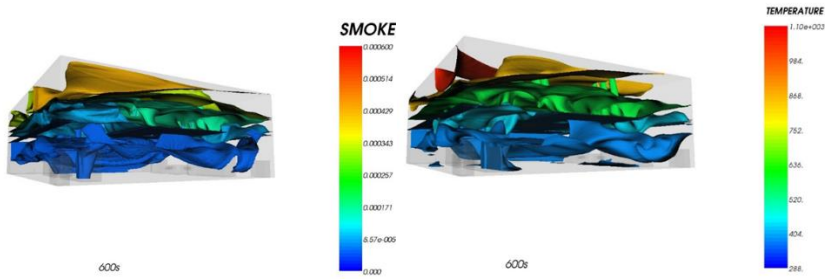

Figure 1. CFD analysis results presented at the last time step (600 s) in the form of isosurfaces representing smoke and temperature.

Experimental validation of CFD results is nearly impossible to perform in this case, but some confidence in using the developed numerical model can be gained by alternating the input parameters and observing the change of temperature and smoke density. Here, fuel quantity was alternated to investigate the effect it has on the distribution of temperature and smoke density over the height of the engine room, Fig. 2.

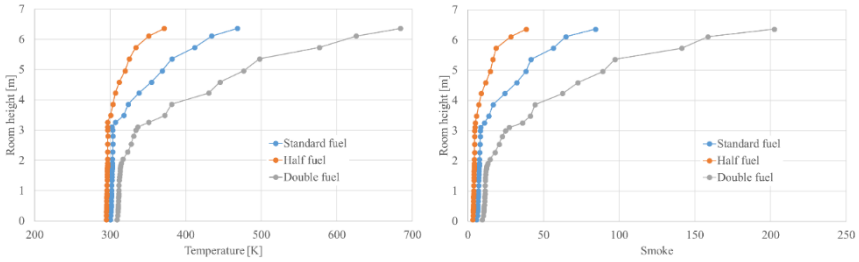

Figure 2: Comparison of the effect of fuel quantity on the distribution of temperature and smoke, in time step t = 300 s.

In Fig. 2 it can be noted that doubling the quantity of fuel in the engine has an effect on raising the temperature. On the other hand, lowering the fuel quantity to half of the amount used in the standard simulation, has an effect in lowering the temperatures, also. The profile of temperature

distribution over the height of the engine room shows higher temperature values close to the ceiling on the upper deck. Similar behaviour can be noted for the smoke density across the room height.

In addition to this, for standard fuel quantity, the distribution of temperature and smoke density was recorded for four different time steps in the simulation (180 s, 300 s, 420 s, 600 s), Fig. 3.

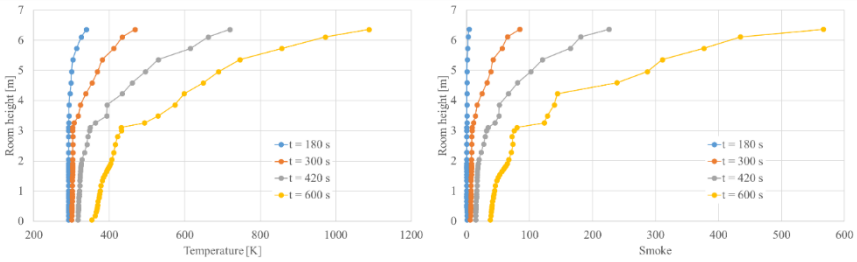

Figure 3: Comparison of distribution of temperature and smoke, in four different time steps and for a standard quantity of fuel.

A gradual development of the temperature profile over the four recorded time steps can be noticed, with temperatures rising as the simulation progresses forward. Similar behaviour can also be noticed for smoke distribution.

8. Equipment procurement & subcontracting

Please see Progress on Pilot Project 1 until 30.06.2023 (M1-M6).

9. Dissemination

The following papers have been published in international scientific journals or conference proceedings:

1. Glujić, Vukelić, Bernečić, Vizentin, Ogrizović. Coupling CFD and VR for advanced firefighting training in a virtual ship engine room, *Results in engineering*, 2024.
2. Glujić, Vizentin, Vukelić; Bernečić, Ogrizović. Advanced CFD Fire Model in Ship Engine Room with VR Integration, *International Association of Maritime Universities (IAMU) Conference,* Buzzards Bay, USA, 2024.
3. Glujić, Vizentin, Vukelić, Bernečić, Ogrizović. Advanced Integrated CFD-VR Model of Ship Main Engine Fuel Line Fire, *26th Symposium on Theory and Practice of Shipbuilding (Sorta 2024)*, Zadar, Croatia, 2024.