

Simulation of damage control for lean manned warships

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[Start presentation](#)

Agenda



1. TNO
2. Battle damage throughout history
3. The design process in the Netherlands
4. Simulation of battle damage
5. Simulation of damage control
6. Case study
7. Conclusion

Goal for today

To evaluate the **benefit of simulating** damage control actions on a battle damaged ship.

- Simulation of **battle damage** from naval shells or anti-ship missiles
- Evaluation of **crew capabilities** to control the damage
- Determine lean **crew size** that meets the requirements of the command aim





1926

FOUNDATION

Physics Laboratory



1946/47

**FOUNDATION
RVO-TNO**

The National Defence Organisation TNO (RVO-TNO).

Defence laboratories in RVO-TNO open.



1961

**INFRARED
CAMERA**

One of the first infrared cameras in the world. The camera with in-house-developed indium antimonide sensor, optics and electronics, facilitates image registration based on heat. Infrared cameras are still indispensable for operating at night.



1970

**GAS-DETECTING
EQUIPMENT**

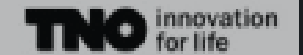
A kit to detect poison gas which has been used for years by Defence. The kit, including pump, test tubes and detection paper, makes detection easy using colour reactions.



1980

**TNO
ACT**

The defence research at TNO and the RDO (Council for Defence Research) is enshrined in the TNO Act.



FROM THEN TO NOW



1981

**WALRUS
MOCK-UP**

A 1:1 wooden mock-up of the Walrus-class submarine is being built to optimise the ergonomics and layout. The construction of the mock-up also highlights errors in the technical design.



1995

**ACTIVE PHASED
ARRAY RADAR**

The knowledge about phased array radars accumulated since the 1960s is used in the development of the APAR for the Air Defence and Commando Frigate (LCF). With four active antennae, the APAR can track low-flying goals and guide air missiles.



2007

DESDEMONA

Design and construction of the most advanced 3D motion simulator in the world, which combines the possibilities of a hexapod and a centrifuge and therefore provides a hyper-realistic simulation of flying, driving and sailing.



2016

**3D PRINT ENERGETIC
MATERIALS**

3D printing makes it possible to produce gunpowder, rocket propellant and warhead cargoes on site. By using smart shapes and material combinations, it is possible to improve the performance.



2018

**TESTING
HIGH ENERGY LASER**

Testing interactions between laser and target and expanding insight into the materials which protect from laser weapon systems.



TNO Naval activities

Integrated Topside

Communications

Combat Management Systems

Signature Management

Maritime Theatre Missile Defense

Sea Flow Mapping

Smart Sensor Solutions
Radar, EW, ESM, Sonar

Vulnerability
Blast, ballistics and UNDEX

Structures
Pressure Hull
Composites

Manning Concepts

Weapon Systems

Multi Platform
Engagement

Performance Modeling

Moskva

- Hit 13 April 2022, sank 14 April 2022
- Allegedly hit by two R-360 Neptune anti-ship missiles
- Russia reported that the ship had sunk in stormy seas after the fire reached munitions onboard and they exploded
- 37 crew members reported killed
- 118 injured



Neptune ASM



6 x AK-630
close in weapon systems



Moskva

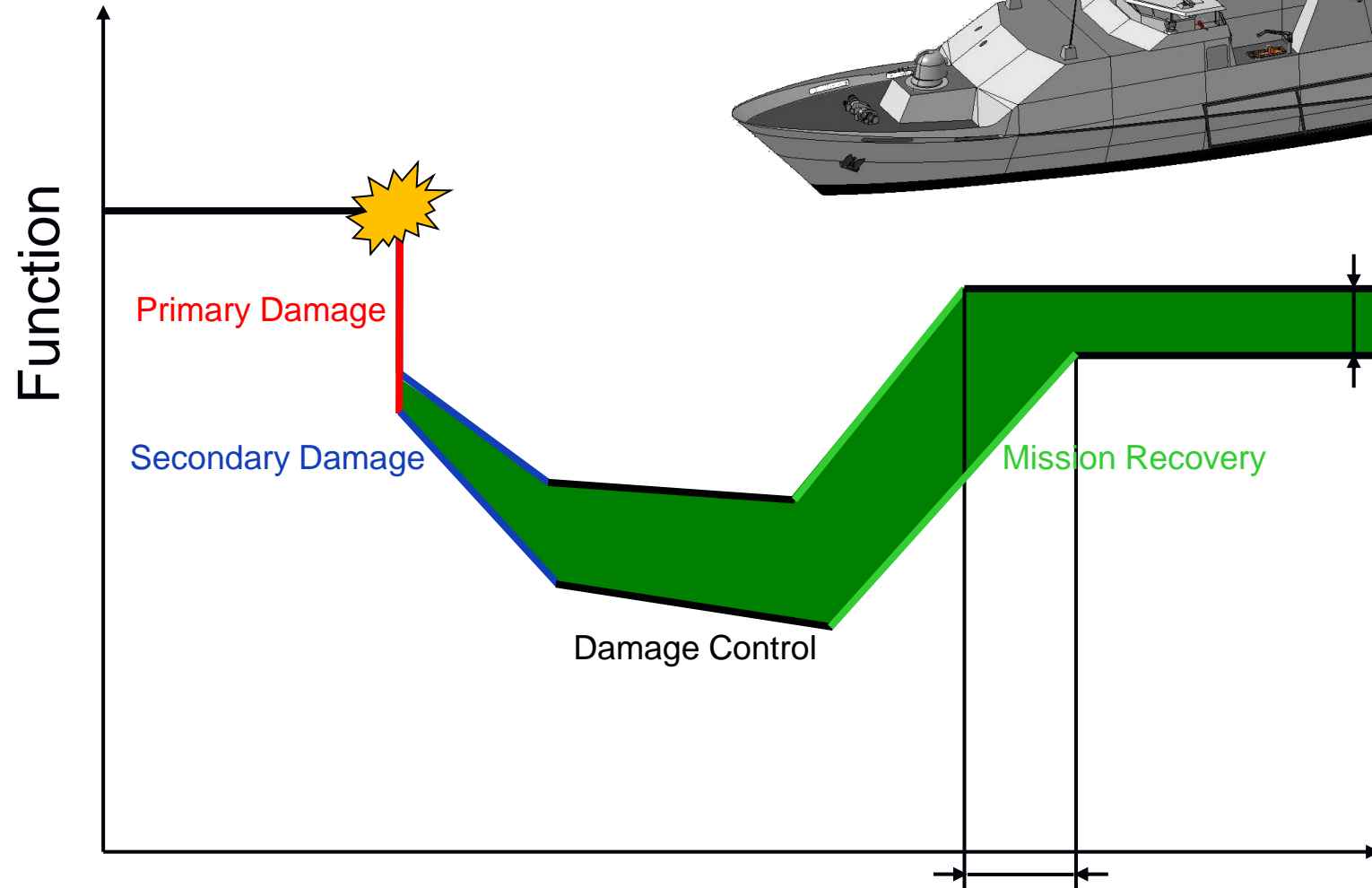
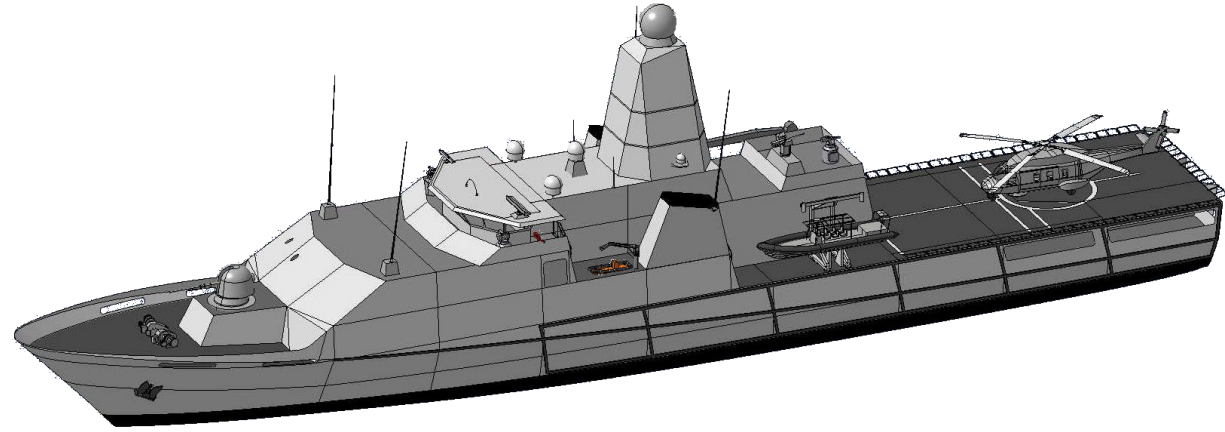
HMNZS Manawanui

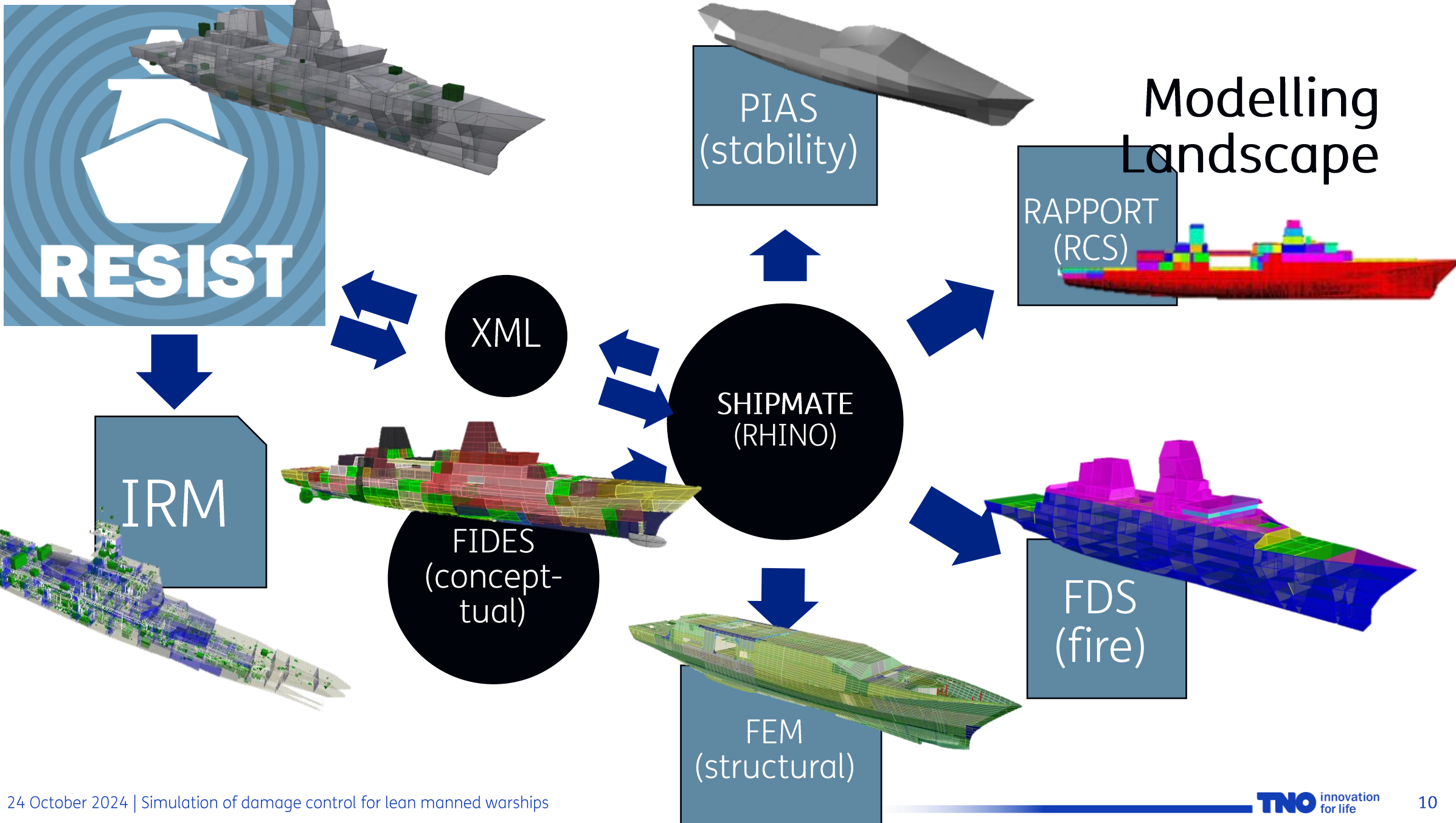
October 5, 2024

Royal New Zealand Navy HMNZS Manawanui (A09) support vessel runs aground off of Samoa and then later burns and sinks.



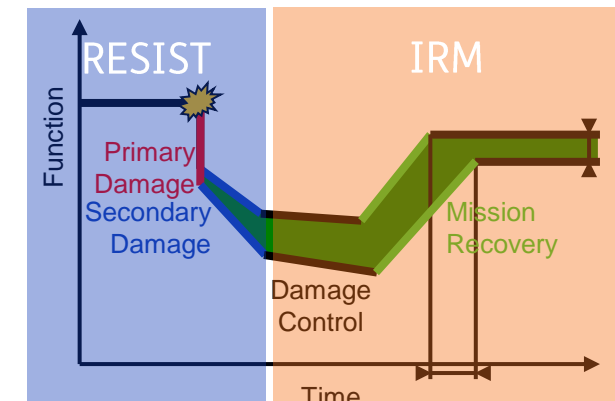
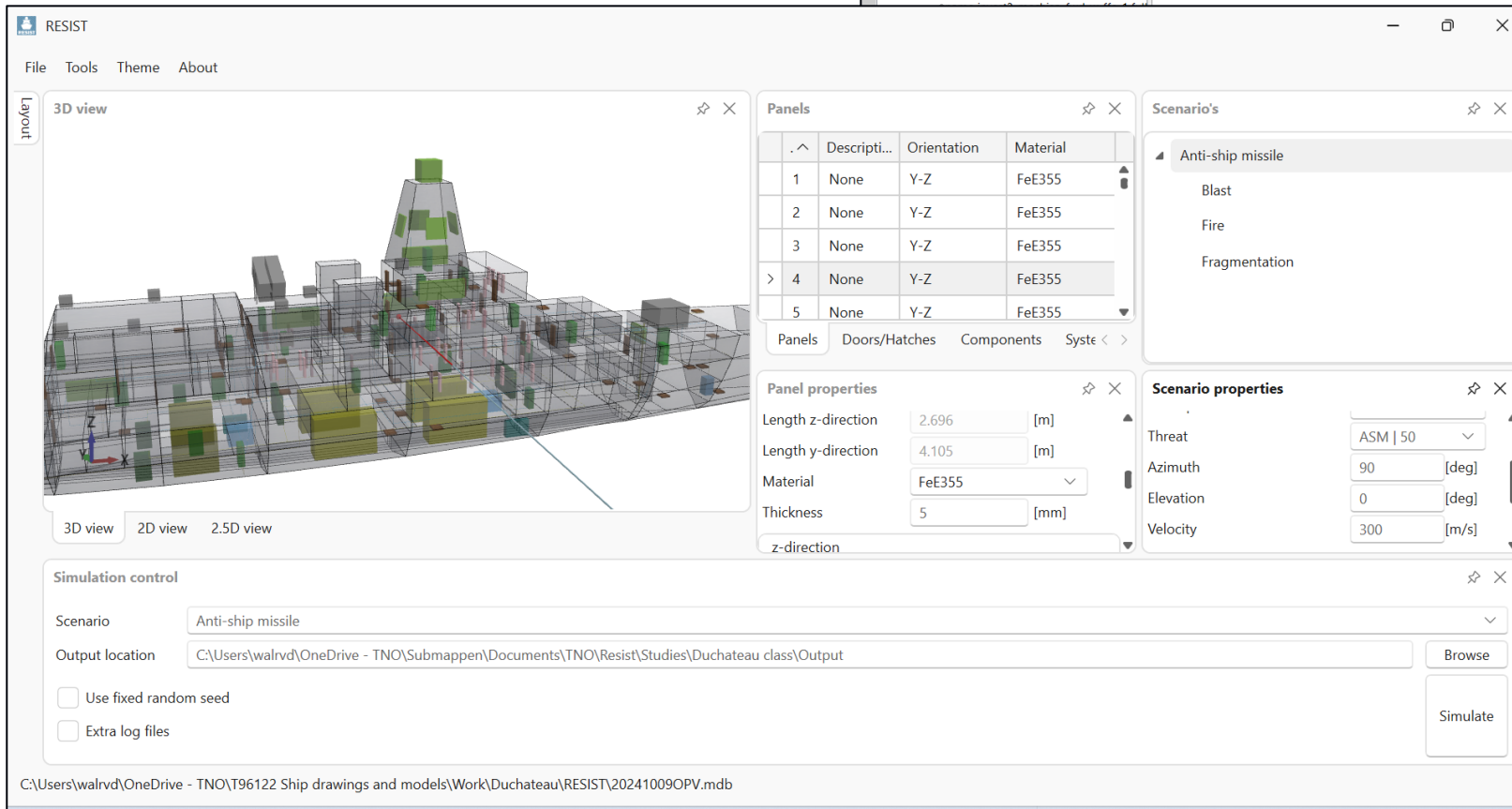
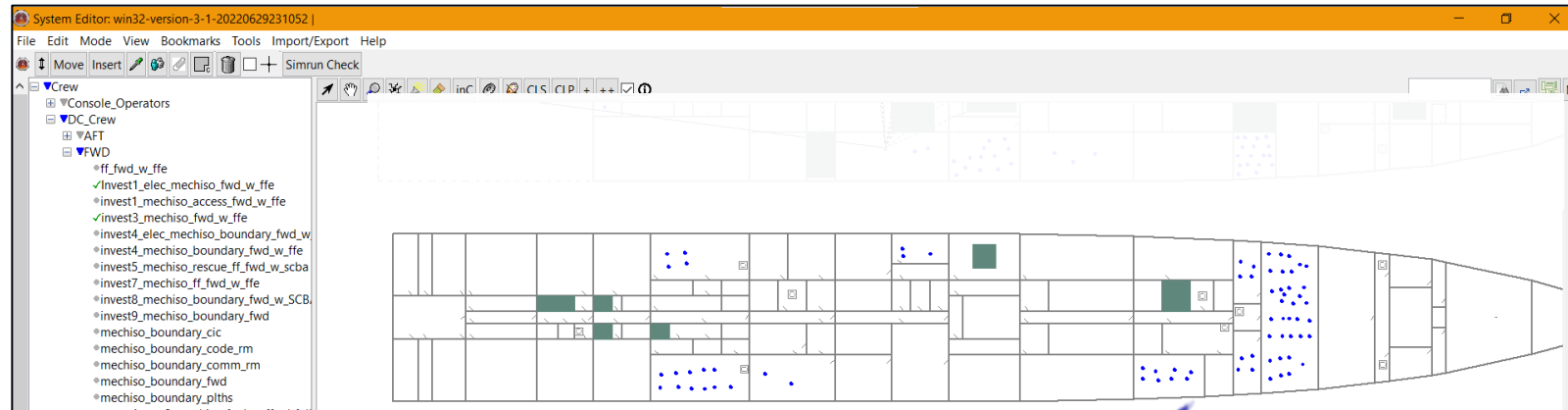
Operational state





RESIST & IRM

Rule-based approach (i.e. not scripted)
allows for endless possibilities



Case study – Damage Control aboard Corvette



Case study – Damage Control aboard Corvette

Goal: validate Integrated Recoverability Model (IRM)

- IRM integrated in TNO toolchain
 - RNLN platforms and doctrines
- Validation based on DC exercises

Simulate and time the damage control after anti-ship missile hit:

- Time at which fire is attacked by fire picket
- Time at which boundary management is established
- Time to muster non-DC crew

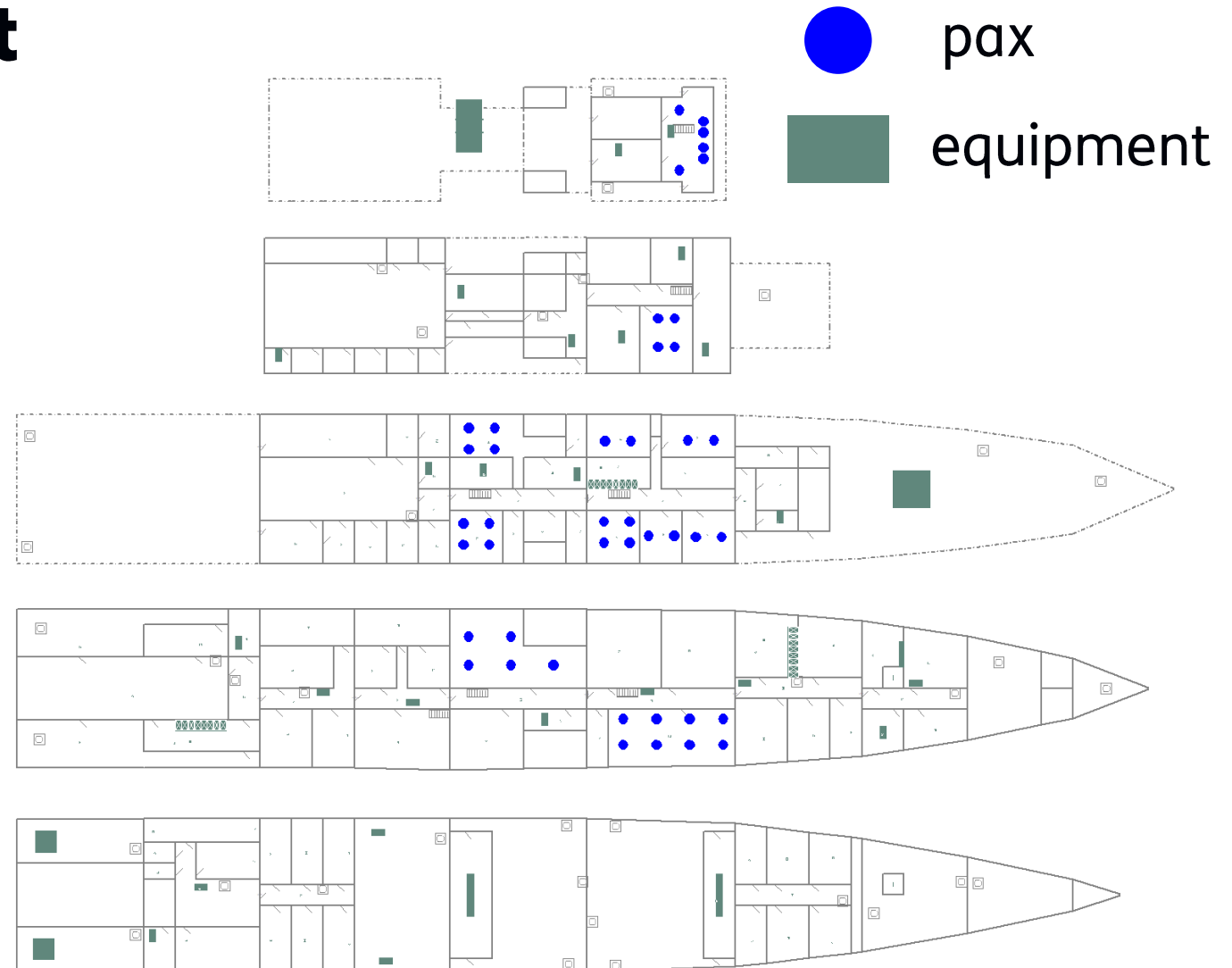


¹ “Modelling of damage control in battle conditions” – Rogier van der Wal, Derek Skahen

Duchateau study object

Unrestricted ship for publication/communication

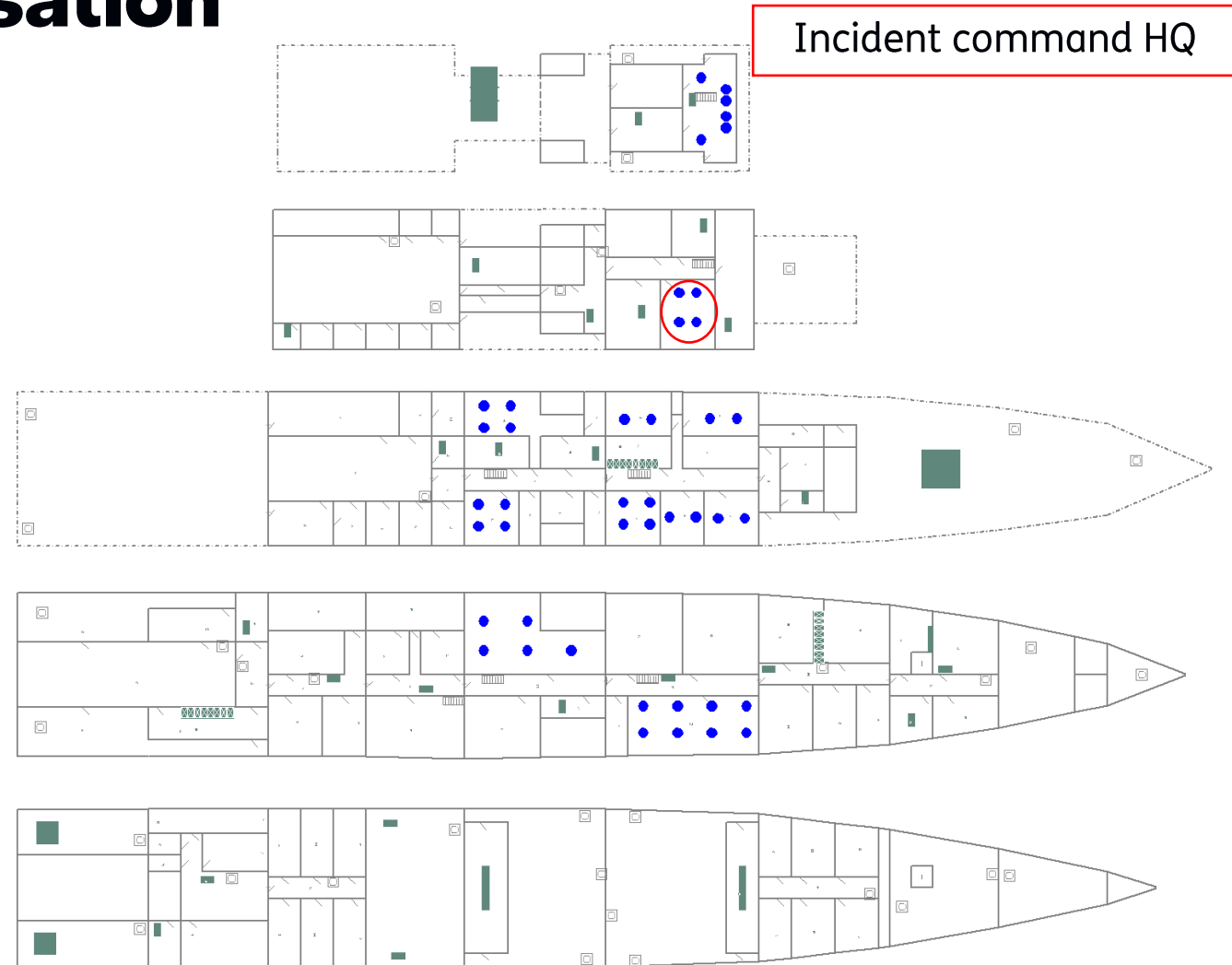
- Low level of automatization
- 39 pax
- 2 fire attack crews (4 pax)
- 4 boundary management crews (2 pax)
- Incident command team (4 pax)



Damage control organisation

Command and control

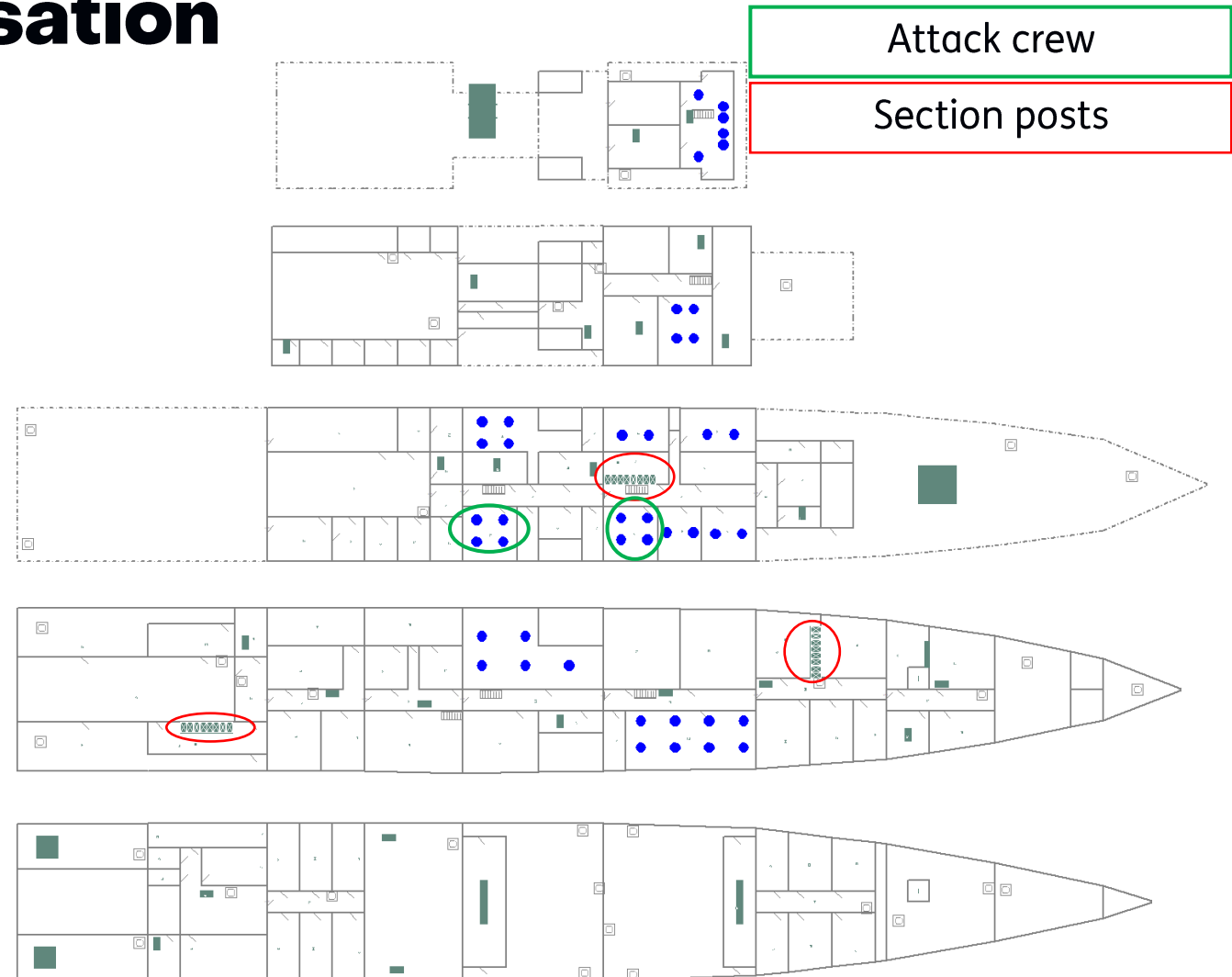
1. Establish smoke boundary between bulkheads
2. Decide on fire attack route/boundary management priorities



Damage control organisation

Attack crew, AP3 and AP4

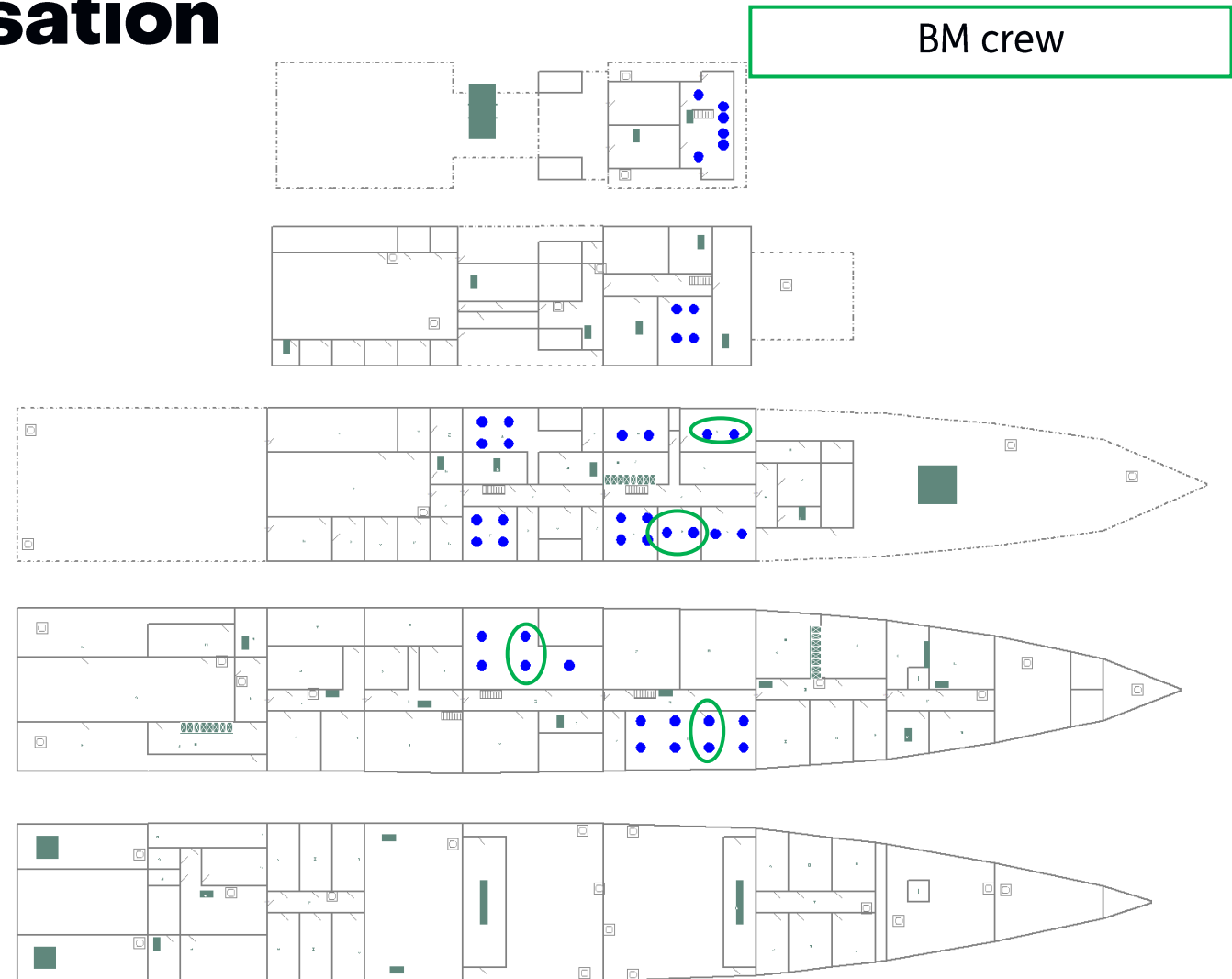
1. Attack changes into full firefighting ensemble at section post
2. Time is written near the section post
3. Relieved by next attack crew



Damage control organisation

Boundary management crew (BM)

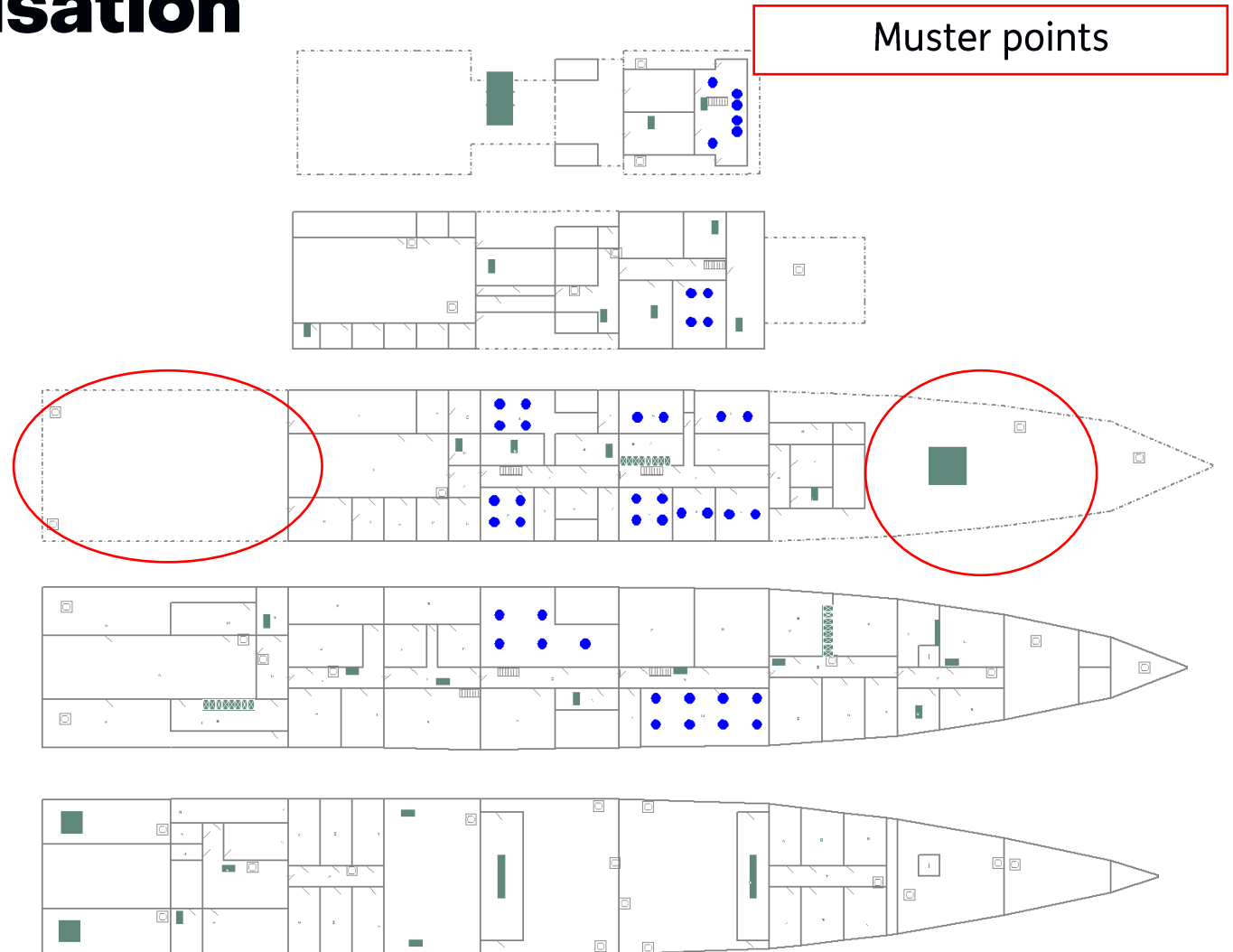
1. Informed at Command & Control on priorities
2. Establish fire boundary



Damage control organisation

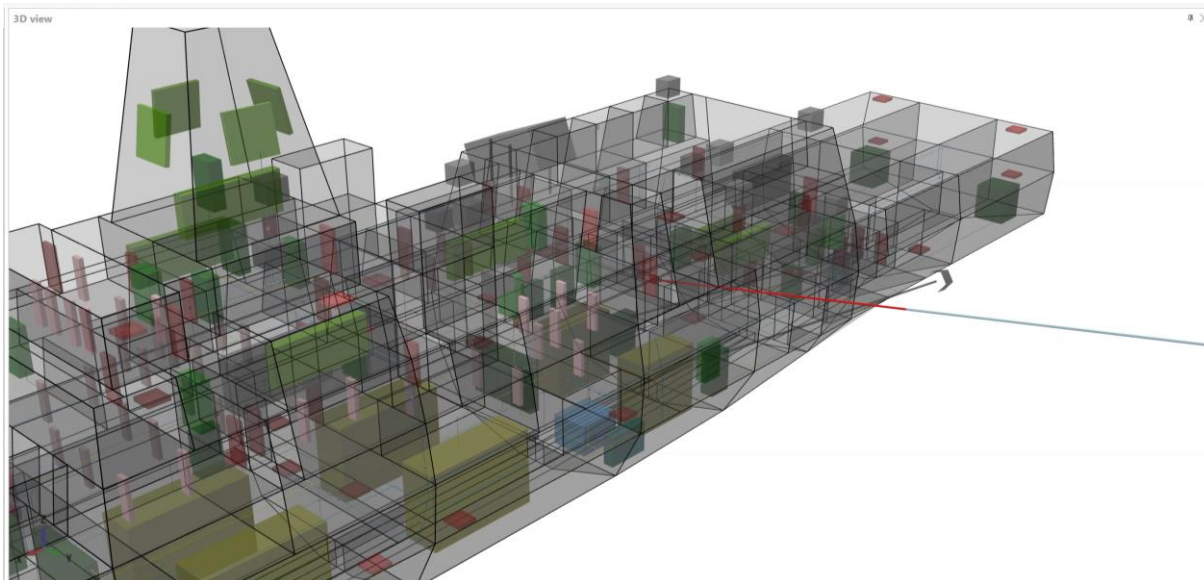
Unassigned crew

1. Muster at forward or aft weatherdeck

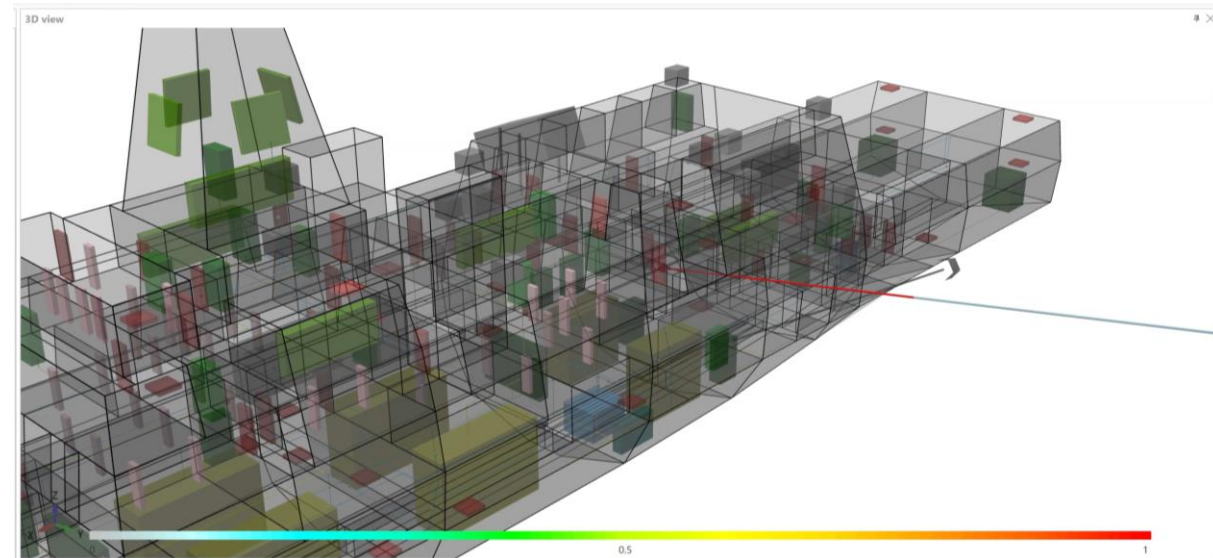


Scenario - Anti-ship missile hit

- Fragmentation of the warhead
- Blown out decks and bulkheads
- Fire spread by remaining fuel/compartment combustibles



Spread of the fragments

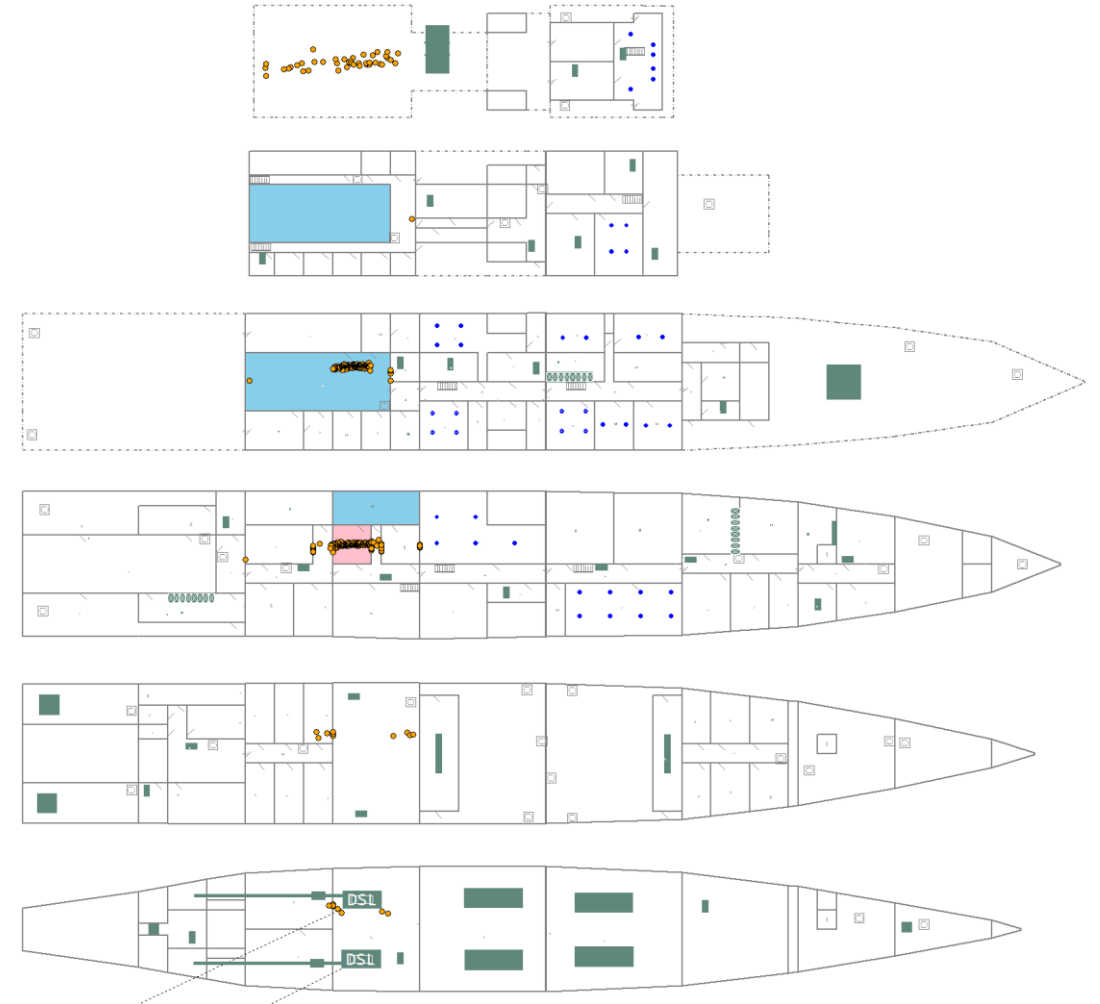
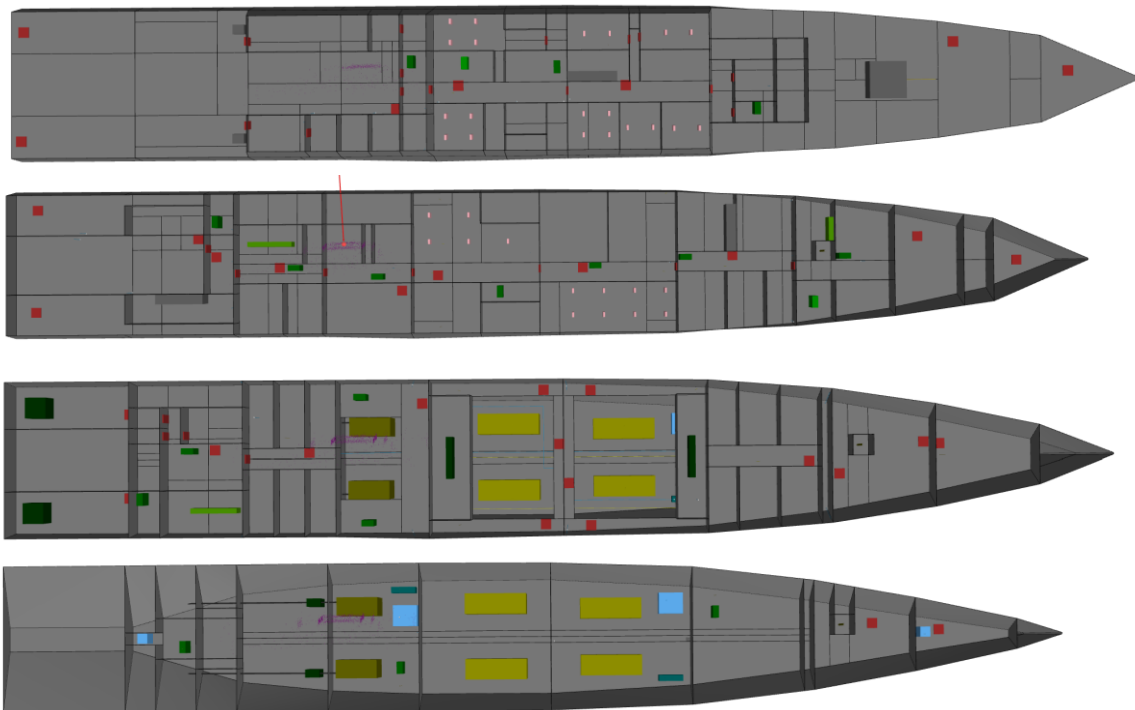


Structural failure

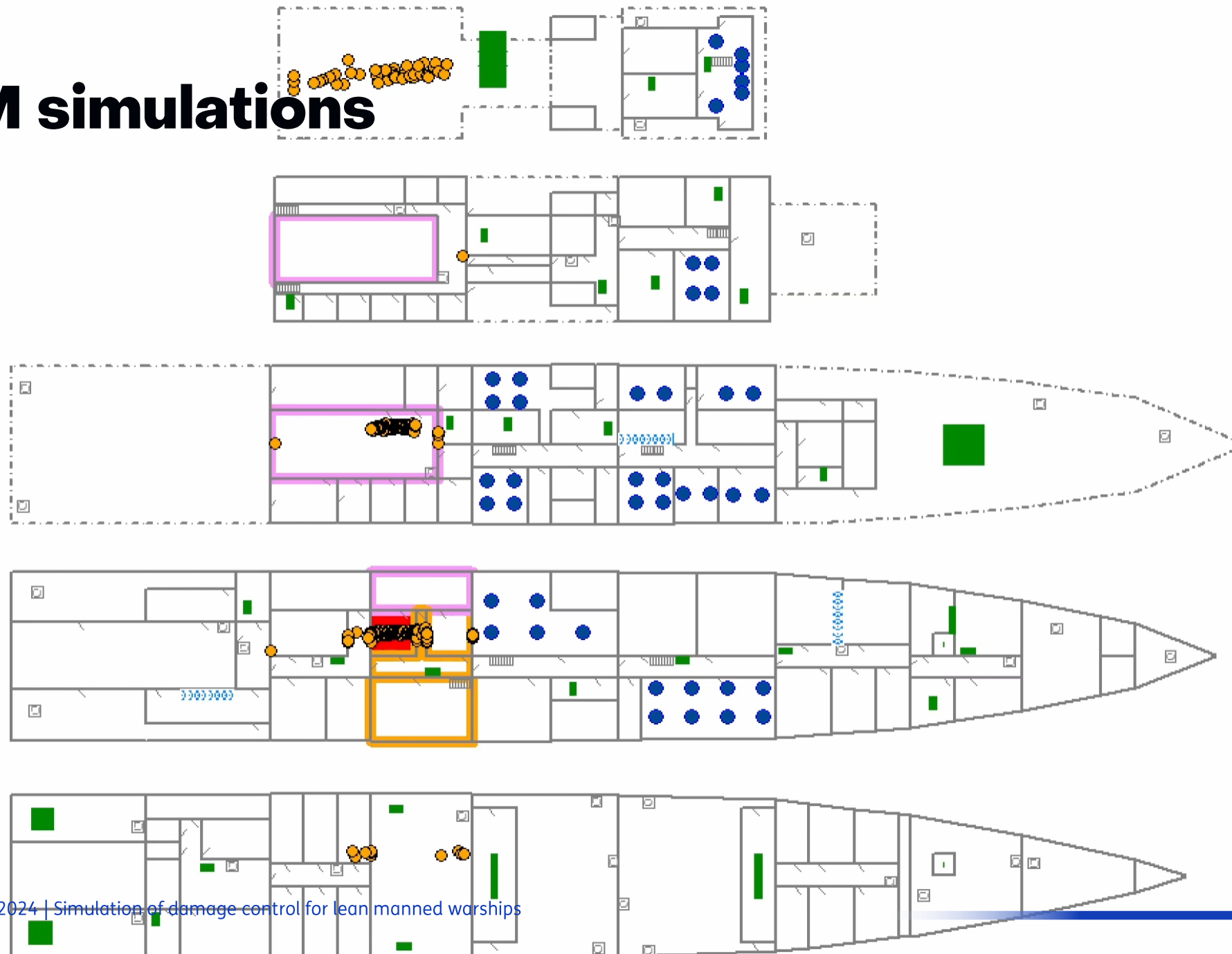
Scenario - Anti-ship missile hit

Damage status known

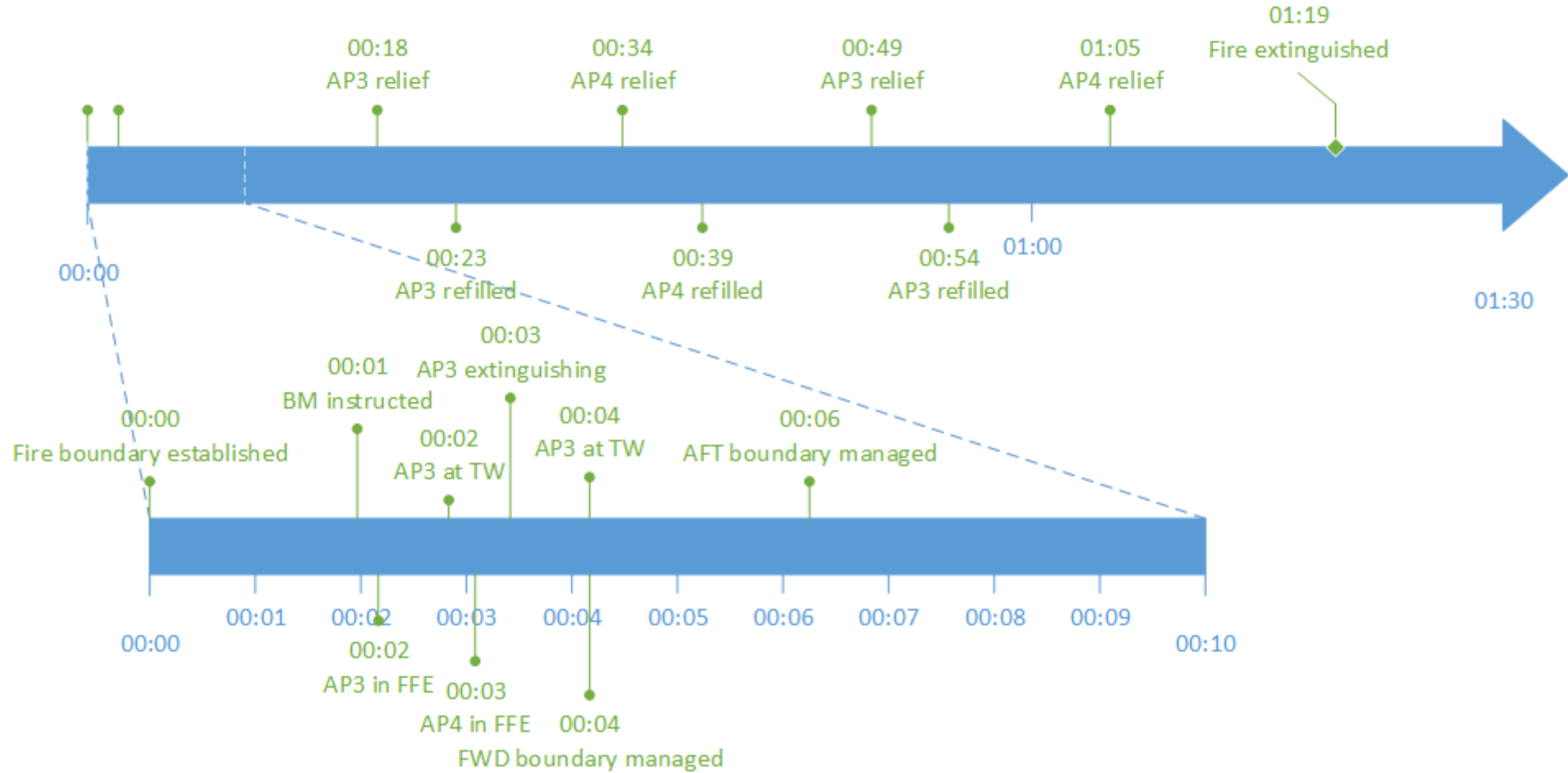
- Fire
- Collapsed decks



IRM simulations



Timeline



Conclusion

- Powerful tool for **evaluating** organisation of damage control
- NE is able to **limit** distribution of **sensitive material** to a national level
- Battle damage and **battle damage repair** can be included
- Capability to **quantify required crew** size for damage control and battle damage repair
- When crew size is a given: capability to assess **residual functional** and **structural capabilities**.



Outlook

- Availability of functional chains for the command aim
- Crew incapacitation
- Automatization

