

Defence, Safety & Security

# Resilient Ship Design Course

**TNO** innovation  
for life

**Protecting against under water  
and above water threats**

17-21 June 2024 - Rotterdam



# Rotterdam 17-21 June 2024

Although warships have several layers of defence, history has shown a multitude of incidents where these have all failed resulting in battle damage of the ship. Much can be done in the design of the ship to provide an adequate level of resilience against anti-ship missiles, UNDEX threats, shaped charges, gunfire or asymmetric threats. You can learn all about it in this course organised by TNO Defence Research from the Netherlands.

## For whom?

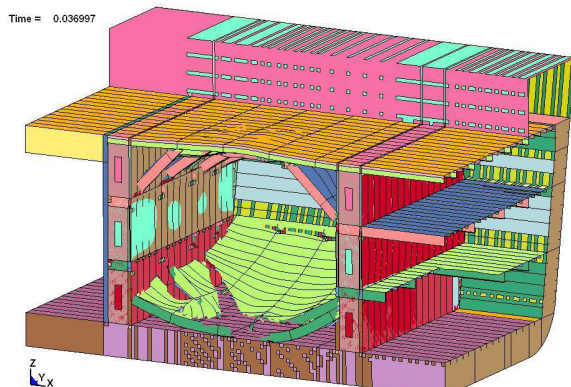
- Navy personnel
- Survivability experts
- Shipyards – Designers of naval vessels
- Naval ship manufacturing industry
- Managers of new naval projects
- Project engineers who prepare specifications of naval equipment and installations
- Engineers who monitor naval building or upgrade projects
- Technical procurement officers
- Classification societies



## Purpose of the course

The main purpose of the course is to understand the basics of designing against modern above water and underwater threats. Participants will learn the principles of ship survivability, so that they are able to design themselves, to communicate with specialists, to tackle an underwater shock problem or to deal with above water threats. The learning goal is to apply countermeasures affordably with a minor mass penalty. The knowledge can also be applied to upgrade ships for new threats.

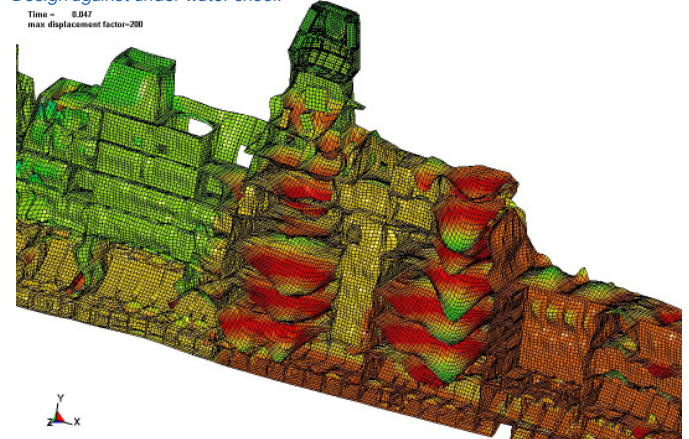
Simulation of an internal explosion in a reinforced ammunition storage



## Format

This tenth edition of the course consists of four and a half days. It includes case studies linking theory to actual incidents. TNO presents internationally acclaimed guest speakers from NL MoD.

Design against under water shock



## Course programme

### Threats

- Description of anti-ship missiles
- Grenades, shaped charges and bullets
- Close-in explosions like on USS Cole
- Mines and torpedoes

### General ship survivability design

- Relevant aspects that determine survivability, design goals, guidelines, possibilities for vulnerability reduction
- From staff requirements to equipment shock specifications
- Integrating vulnerability reduction in ship design, practical issues and pitfalls

### Underwater shock

- Phenomena and effects
- Mechanics of a single mass-spring damper system
- Shock Response Spectrum
- Shock resistant designs
- Introduction dynamic analysis methods
- Behaviour of springs
- Shock specifications
- Laboratory shock test methods

### Blast response

- Basics of blast
- External blast
- Blast phenomena in a ship
- Governing loads on structural elements
- Response of the structure (SDOF)
- Approach for blast resistant design
- Structural details
- Composite materials

### Ballistics

- Basic ballistics: failure mechanisms, penetration mechanics
- Fragments, bullets, shaped charges and countermeasures
- Fragment ejection from warhead
- Behind armour effects
- Test methods
- Protection solutions

### Fire and countermeasures

- Hazard identification and design fires
- Modeling of fire
- Active and passive fire fighting
- Demo of Fire Dynamics Simulator

### Damage control

- System lay-out and network analysis
- Autonomous recovery
- Reconfiguration and OODA-loop
- Recoverability
- Damage control optimisation
- Manning and resilience in operations

### Practical elements

- Laboratory ballistics test demo
- Laboratory shock test demo
- Case studies: USS Stark, ROKS Cheonan, USS Princeton and USS Samuel B. Roberts
- Exercises in workshops
- Software tools for blast, fragment protection and fire safety engineering

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**“Provided insights you won’t find anywhere else”**

**“Well worth the money”**

**“Excellent course for topics that are not readily accessible”**

**“Very well organized”**

**“[...the demos are] so cool!”**

- Comments on previous editions

## Lecturers



### Erik Carton

Senior scientist ballistic protection and materials. Active in blast and impact phenomena, including explosive metal working. Generated energy based engineering models for bullet interactions.



### André van Erkel

Team leader. Expert in ship vulnerability for 38 years. Focused on: structural modelling, blast modelling, explosive testing of ships and metal failure modelling. Developed blast resistant bulkheads and doors.



### Kirk Green

Senior Consultant; with TNO since 2008. Technical and commercial point of contact for Naval hock and Vibration testing. Vast expertise in understanding and applying customer's requirements for world-wide Naval builds.



### Bart de Jong

Medior scientist. Involved in various projects concerning the safety of current and future vessels of the Royal Netherlands Navy. Main research area consists of the effect of underwater shock.



### René van Meurs (MoD)

Ship Vulnerability Reduction Officer. Manages R&D projects on warship vulnerability and supports the Netherlands' MoD Staff, Operational Command, DMO designers and project engineers on vulnerability. René is NL delegate for NATO ST/SCS.



### Marleen Rakhorst-Oudendijk

Senior human factors scientist. Involved in various projects concerning the Battle Damage Repair organisation on board naval vessels. Main research area is the team performance of naval crew in the external and internal battle.



### André Vaders (MoD)

Senior Expert Structural Mechanics. Member of the NL-UK BNCP team for the aspects shock, vulnerability and structures. Member of the NL-GE Shock Expert Group.



### Jimmy Verreault

Senior scientist. Expert in modelling high dynamic events such as blast waves, ballistics, warheads and underwater explosion applied in different areas such as the Royal Netherlands Navy, Army and Air Force.



### Rogier van der Wal

Senior scientist. Experienced in protection against fire and ballistics. Provided integral solutions for the Royal Netherlands Navy to maximise resilience of both the Joint Support Ship and Patrol Vessels.



### Mark Bobeldijk

Medior Scientist. Involved in various projects concerning the vulnerability and protection of military platforms. Main research area is the simulation of terminal ballistics.



### Noud Altinga

Project Manager. Involved in various projects concerning the vulnerability and protection of naval ships. Main research area is digitalization and the development & analysis of new platforms.



### Guido Delhaes

Scientist. Extensive experience in shock and vibration testing on many different items for national and international customers. Research area "behaviour of structures under high dynamic loading".

### Keynote speaker

High-ranking officer from the Royal Netherlands Navy

### Moderator

Rob Wesdorp, Senior Naval Consultant & Expert Advisor

# Important details

## Dates and venue

The Resilient Ship Design Course will take place from 17 to 21 June 2024. Venue is the nhow hotel, Wilhelminakade 137, 3072 AP Rotterdam.

## Cost

The costs are € 3600 excl. VAT. The price includes a hard copy and digital copy of the course proceedings, software tools, lunches and beverages and the diner on Thursday. There is an early bird discount of 10% for applications placed before the 31st of December 2023.

## Registration

You can register by filling in the form on [www.tno.nl/resilientshipdesigncourse](http://www.tno.nl/resilientshipdesigncourse)

## Cancellation

Cancellations received in writing more than six weeks before the event will be subject to an administration charge of €500. Cancellations received after this time cannot be accepted and are subject to the full event fee. Delegates may be substituted. TNO preserves the right to cancel the course no later than six weeks before the start, in which case paid registration fees will be refunded.



## Detailed daily schedule

### Monday - introduction to ship vulnerability

- Keynote on ship survivability
- Resilience of ships
- Threats and weapon effects
- Case study ROKS Cheonan

### Tuesday - undersea and shock mechanics

- Introduction to underwater explosions
- From staff requirements to shock specifications
- Mechanics and shock response of mass-spring systems
- Case study USS Princeton
- Shock resistant designs and modelling of springs
- Shock specifications, laboratory tests and test methods
- Workshop: What shock mounts to use?

### Wednesday - ballistics and laboratory tours

- Numerical simulation methods
- Ballistic threats and protection basics
- Fragment, bullets, RPGs and countermeasures
- Shock laboratory tour and demonstration of shock test
- Laboratory for Ballistics Research tour and ballistic test

### Thursday - blast and structures

- Integrating above water vulnerability reduction in ship design
- Basics of blast
- Blast in ships
- Case study USS Stark
- Blast response of structures
- Blast resistant design
- Workshop blast analysis
- Social event in the evening

### Friday - systems analysis and damage control

- Operational resilience in ship design
- Damage control and fire fighting
- Case study USS Samuel B. Roberts
- Systems analysis
- Autonomous recovery
- Workshop systems

Website: [www.tno.nl/resilientshipdesigncourse](http://www.tno.nl/resilientshipdesigncourse)

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