TNO
TNO is an independent innovation organisation. TNO connects people and knowledge to create innovations that sustainably boost the competitive strength of industry and the welfare of society.

TNO focuses its efforts on seven themes including Defence, Safety and Security: TNO works on a safe and secure society by creating innovations for people working in the armed forces, law-enforcement agencies, emergency services and industry.

CONTACT
Martin van Dongen, MSc

Oude Waalsdorperweg 63
P.O. Box 96864
2509 JG The Hague
The Netherlands

E martin.vandongen@tno.nl
P +31 888 66 3839

CONCEPT DEVELOPMENT & EXPERIMENTATION (CD&E)

To aid in the selection and further development of possible improvements for the ships self defence TNO applies Concept Development & Experimentation (CD&E) and ACE. CD&E is a creative process where a concept is developed through brainstorms, evaluation sessions and analyses combined with input from experiments. It leads to a robust concept that has been tried and tested in simulated experimental and operational settings, exposing aspects that could have been overlooked without experiments. For V804 the different added values of a UAV or USV are clearly presented, operators have worked with developmental CMS support while their feed-back improved the support design and the whole concept of NLW's is now under revision due to experiences with simulation. The outcomes of these experiments help the RNLN to shape and choose the right options for the future.

ADVANCED CD&E ENVIRONMENT (ACE)

To experiment with all those technological and doctrinal concepts an experimentation environment at TNO is enhanced for AWW in the littoral.

TNO ACE (Advanced CD&E Environment) is a collection of facilities for experimentation in interactive simulation environments. It offers a place for the operational user to meet new technologies and ideas and help develope and experience new concepts. For V804 a set of simulation models work together and simulate navy vessel operations. Several asymmetric threat scenarios are implemented in ACE and sensors, C2 and weapon effectiveness can be assessed in a comprehensive way.

TNO ACE allows for human in-the-loop simulation and submerses the operators and commanding officers into a realistic environment. In the past three years ACE was used for several studies ranging from experimenting with early prototype technological improvements with one operator to full scale doctrinal concept testing with a crew: all using ACE, all improving their concept.

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SHIP SELF DEFENCE
IN THE LITTORAL ENVIRONMENT

TNO innovation for life

THE PROBLEM

In the past decade navy ships have become susceptible to asymmetric attacks. Expeditionary operations increase the risk since these operations are often close to the coast. Situational Awareness is limited and reaction times are short.

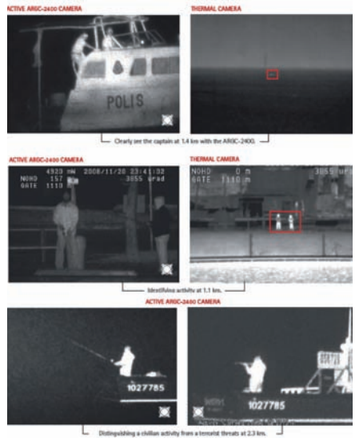
THE PROGRAMME

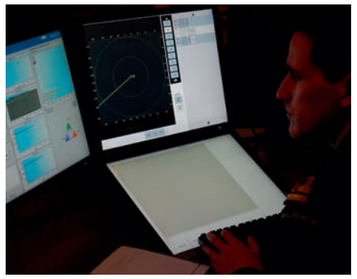
The *TNO ship self defence* programme (V804) was initiated by the Royal Netherlands Navy to come up with short and long term solutions to defend against asymmetrical surface threat against ships in the littoral environment. The goal is to evaluate new technological and doctrinal solutions. Evaluation is done using a mix of technical analysis and (human in the loop) simulation and experimentation.

SUMMARY

The *TNO ship self defence* programme provides the Royal Netherlands Navy with short term affordable and effective solutions for defending their vessels in an expeditionary operational environment in which the asymmetrical threat can be diverse and dangerous. These solutions can drive the decision making process for the acquisition of new ship self defence measures.

SHIP SELF DEFENCE





SENSOR SOLUTIONS

TNO Defence, Security & Safety has a broad expertise in the field of sensor systems. In this programme current sensor systems of the large navy vessels are evaluated against this very specific type of threat. Weak points are determined as well as possible short term solutions for this problem. One specific technology that is studied more in depth is the use of laser systems for detection and identification. These systems increase the detection and identification performance against very small targets in high clutter conditions.

COMMAND AND CONTROL

The detection of the threat is only half the problem. Determining the threat's intent and the best course of action are also major challenges. Short time lines and uncertainty put pressure on command teams. New command and control tools to support the decision making process have been investigated. The emphasis has been on identification support. Behaviour is logged and presented in new ways. Collecting significant events in the history of a track and comparing several of such histories helps the crew with their analysis of the cooperation between and the intent of multiple tracks.

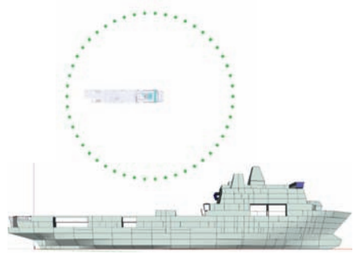
In order to evaluate the tools with officers of the Royal Netherlands Navy they have been implemented in a simulation environment (TNO ACE). In a first evaluation the tools have been received positively, especially the multi-track data analysis. The evaluation is a step towards operational implementation in future combat management systems of the Navy.

USV'S

Recent years show an increased use of Unmanned Vehicles (UXV's: Ground/Air/Surface/Semi-Submersible/Underwater) for military applications. Also the Navy is interested in the capabilities of these platforms realizing that the future will be "unmanned where possible, manned where required". Various types of USV's were implemented in the ACE environment, including aspects like size, payload, speed, control, location, endurance, dual mode (manned/unmanned).

This enables a better quantification of the contribution of USV's as well as the problems to be solved, e.g. the simultaneous command & control of more UXV's (USV's but also possibly UAV's), the communication, the deployment options and the payload to be carried. It also gives more insight into the number of people required for the guidance and command & control of all those UXV's, otherwise unmanned may prove to require more instead of less people!

IN THE LITTORAL ENVIRONMENT



WEAPONS AND AMMUNITION

Gun and missile systems are developed for engaging threats as far out as possible. The asymmetric threat lays down new requirements for an effective very short range layered defence that in addition is scalable in lethality. Repelling the threat is the best option and non (or less) lethal weapon technology is assessed for this application. We down selected the available range of non-lethal weapons to those systems that best fit in a future ship self defence concept. The utility of the most promising systems (nets, laser, acoustic hailer) was investigated in the TNO ACE simulation environment. To this end, ACE was extended with dedicated weapon models and a target response model.

PHYSICAL PROTECTION

If all active means fail to prevent an attack on the ship, physical protection is the last line of ship self defence. Within the programme methods were developed to evaluate the penetration of small calibre gunfire and RPG7 into the ship. These methods were subsequently integrated in the survivability assessment tool RESIST. Goal for this development is the ability to design for adequate ballistic protection. The approach was tested by analysis of both the Joint Support Ship and the Patrol Vessel. Through this work it has come to light that there are some weak spots in the ballistic protection of both vessels and suggestions for improvement were made.