

EDF-2021-NAVAL-R: Smart ships

Proposals are invited against the following topic:

EDF-2021-NAVAL-R-SSHM: Ship Structural Health Monitoring;

Budget

The Union is considering a contribution of up to EUR 43 500 000 to support proposals addressing any of the above mentioned topics and their associated specific challenge, scope, targeted activities and functional requirements, while considering a contribution of up to:

EUR 14 500 000 to support an individual proposal addressing the topic EDF-2021- NAVAL-R-SSHM.

Several actions, addressing different topics, may be funded under this call.

Researching on structural health monitoring techniques and their integration in an expert system specific for naval vessels.

Specific challenge

The specific challenge is directed towards the transition from traditional time-based scheduled maintenance schemes to condition based maintenance (CBM) and complete lifecycle monitoring and management of naval vessels. Such a transition is of paramount importance for reasons associated with reduced maintenance costs, increased operational availability, increased safety, and optimization of operational performance.

Strategic importance is identified as the overarching goal to utilize the big amount of data from sensor measurements by innovative means. When included in the monitoring system, this will offer new information and capabilities on-board and on-shore. Model analysis and tools will further help optimization of design, support the implementation of sensor systems, such as the location and number of sensors, as well as optimize the hull and ship maintenance program. Sensor-based model tools will also be relevant for simulated exercises and training.

Scope

The proposals must aim to obtain improved naval vessels' operational capability through research on advancing the utilization of data from the state of the art, and/or innovatively improve the hull ship structural health monitoring systems, using modern data science tools, such as machine learning, artificial intelligence (AI), digital twin models or other. This will address key topics, such as safe operational envelopes both in peacetime operations and crisis/war situations, weapon systems accuracy improvement, sensors' optimal placement and networking, ship hull structural computational modelling and lifetime extension, damage detection/diagnosis and prognosis, vibration contribution to the hydro-acoustic signature – or more general the vessel's signatures and condition – and their integration in a decision- making system for naval vessels.

Targeted activities

The proposals must cover the following activities as referred in article 10.3 of the EDF Regulation, not excluding possible upstream activities eligible for research actions if deemed useful to reach the objectives:

- studies, such as feasibility studies to explore the feasibility of new or improved technologies, products, processes, services and solutions;
- the design of a defence product, tangible or intangible component or technology as well as the definition of the technical specifications on which such design has been developed which may include partial tests for risk reduction in an industrial or representative environment.

The targeted activities must in particular include:

- Extension of the on-board SHM systems to detect features in data related to damage detection and assessment, and in that way expand operational envelopes by optimal utilization of vessel capabilities.
- Identification of local/global structural vibrations that contribute to the vessel's hydrodynamic signature and establish tools to aid operators in visualization and prediction, with the result of avoid being recognized/positively identified by “red forces”.
- Exploration of the possibilities in utilizing SHM measurements of local and global hull deformation/vibrations to improve the precision of weapon systems on board the vessel.

A detailed planning of potential subsequent phases must be generated, including the identification of implementation priorities, according to the operational needs.

Functional requirements

The proposed solution must provide a collaborative environment with the capability:

- To detect features in data related to damage detection and assessment, expanding operational envelopes by optimal utilization of vessel capabilities. All the necessary functions for diagnosis, prognosis, and early warning of events on-board the naval vessel enabling necessary functionality should be integrated, to cover variable and potentially challenging operational, loading, and environmental conditions achieving high correct detection rates at low false alarm rates;
- To consider the human element in multi-level data analysis for different and even remote users (vessel's captain or crew, onshore/ naval base maintenance service, fleet management).

The proposals must also include a technological demonstrator for the proof of concept:

- A design of one or more systems including detailed computational (simulation) models to estimate the structural integrity of the ship with correlation capabilities from measured data.
- A physical realisation of one or more of the designed systems including sensor selection and placement, condition monitoring systems, and the possibility for manipulation to

introduce failures. This to demonstrate the concept effectiveness for predictive maintenance.

- A framework/concept/platform for secure on-shore data collection, analysis and reporting of SHM data to the Navy and other units of the European nations' Armed forces.
- The demonstration of the upgradability of the designed systems and its effect on an operation.

For the purpose to seek for interoperability between actions under the two topics considered in this call for proposals, it is encouraged that the proposal addresses possible linkages to the other actions under the topic EDF-2021-NAVAL-R-DSSDA (Digital Ship and Ship Digital Architecture).

Expected impact

- Achieve an incremental and extensive representation of structural aging/damages and detection capabilities.
- Set condition-based maintenance on well-established and feasible criteria.
- Increase the awareness of current fleet's status.
- Provide decision-making support during navigation based on real-time observations for load alleviation as well as failure management.
- Improve design rules for next generation of naval surface vessels through post-processing of data.