

MODERNIZATION OF THE ROMANIAN TUG “HERCULES” TO FULFIL THE CLASS NOTATION CORRESPONDING TO THE RULES OF INTERNATIONAL ASSOCIATION OF CLASSIFICATION SOCIETIES

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Abstract: *The subject of this study is to show the technical alternative given by the importance and necessity of tug “HERCULES” modernization in the context of offshore activities development on Romanian Exclusive Economic Zone for Search and Rescue and pollution. This study presents the modernization stages of the tug “HERCULES” to fulfil the class rule requirements established by the International Association of Classification Societies.*

Keywords: *tug modernization; Search and Rescue, pollution*

INTRODUCTION

To rescue the people in distress in the Romanian maritime area, HM King Carol II decided to establish in 1936 the "Sea Rescue Society of shipwrecked persons in Romanian territorial waters – SALVAMAR" that had two motorboats, "ALBATROS" and "PESCARUS".

At the end of World War II, having survived the missions of escorting the *Romanian Navy* convoys, the motorboat "ALBATROS" passes into the service of the commercial fleet "NAVROM", within the technical rescue ships Group, which since 1990 has been known as the *Naval Intervention and Rescue group - (GISN) - Constanta*.

Given the conditions of European Union membership and the fact that it carried out state duties, in 2004 the Naval Intervention and Rescue Group G.I.S.N. was renamed the Romanian Agency for Life Saving at Sea (ARSVOM).

ARSVOM is a public institution under the Ministry of Transport, which provides government sustained activities like search and rescue of human life at sea and interventions in case of marine pollution in the Romanian area of responsibility.

ARSVOM fulfils the obligations the Romanian state has under international conventions and agreements it is a signatory part of, conducting search and rescue of life at sea, and executes interventions in case of pollution according to Romania's tasks as laid out in the Regional Plan and the National Preparedness Plan for response and cooperation in marine pollution.

As well, ARSVOM may perform by contract, search and rescue operations, assistance and salvage, re-floating of ships and wrecks, diving operations and works needed on ships according to the specific activities, towage, fire fighting, icebreaking in ports and waterways.

To accomplish the given missions ARSVOM owns a fleet of 12 vessels: a ocean going tug "HERCULES", three SAR vessels ("ALBATROS SAR", "OPAL SAR" and " SAR TOPAZ"), three intervention boats to launch and manoeuvre anti-pollution booms ("CRISTAL", "SAFIR" and "RUBIN") and five service boats.



Figure 1 - Tug "HERCULES" – general view

The vessel "Hercules" is a multifunctional ocean going tug, designed for towing and positioning of mobile offshore drilling rigs (MODU), to supply offshore drilling rigs, for interventions during storms higher than sea state grade 4, towing and salvage of damaged or stranded ships, ice breaking on the maritime Danube, ocean line towing, emergency towing and manoeuvring large ships in port, fire fighting on other vessels, dockside or offshore facilities, performing salvage operations or works with divers, combating pollution including deployment of oil-booms and oil recovery.

The ship class given by the Romanian Naval Authority is for fitting and construction, as a maritime ocean going tug with unlimited class, which can navigate in the ice field without the help of any icebreaker.

The ship was designed to be serviced by a crew of 24 persons, in addition to which 16 survivors can be placed in dedicated cabins or an intervention/rescue team with the same number of persons in dedicated cabins.

"Hercules" has a length of 68.73 m, a width of 16.5 m, an mean draft of 6.5 m and a displacement of 3795 DWT. Propulsion was provided by two licensed MAN reversible engines built in Resita-Romania, with an output of 3300 BHP each at 430 rpm, which were coupled to two gearboxes built in Resita under Renk license, with a transmission ratio 3.5:1 to two variable pitch propellers with four blades and a diameter of 4100 mm placed in Kort nozzles.

Steering was ensured by two synchronized rudders, steering driven by two electro-hydraulic gensets, Hydroster type, every 250 KNm and a transverse bow thruster, Zamech type, electro-hydraulic, driven at 290 Kw.

The towing system consisted of two Menarom towing winches, placed in pair, each having a 800 m cable with a diameter of 51 mm on the drum and a pulling force of 50 Tonn.

Loading installation was composed of a 5-10 Tonn derrick, using 3 electromechanical winches.

External fire fighting installation was fitted with two electrically driven pumps with a capacity of 500 m³ / h each, 4 monitors for water and foam and a plant that produces water curtain protection for the hull.

1. MODERNIZATION DESIGN, PREPARING OF THE DOCUMENTS

The objective of the first stage is to examine the technical condition of the vessel, analyzing the technical documentation regarding the ship, setting and finalizing technical solutions which will be implemented in order to achieve ship refurbishment and modernization of multifunctional maritime tug HERCULES.

The objective of the refurbishment and modernization works is to get a modern and efficient ship which can perform the following duties:

- Assistance and intervention to ships manoeuvres in port areas;
- Towing operations on unlimited navigation area;
- Fire fighting interventions for ships, offshore facilities and dockside;
- Opening route in the ice field on the coastal area of the Black Sea and the Danube estuary;
- emergency towage, assistance, salvage and refloating operations;
- Saving of human lives: crew recovery, emergency care, MEDEVAC operations;
- offshore facilities supply, occasional transport of materials, equipment and reserves.

The vessel will be fitted with all the equipment and facilities, at least at the minimum level required by

the legislation in force, with the following objectives:

- Bringing the ship in accordance with the latest rules and applicable regulations;
- Transfer of the ship class, from the supervision of the RNA (Romanian Naval Authority) under the supervision of an IACS member classification society and with subsidiaries in Romania.

Ship facilities are divided into two categories:

- Generally standard features, common to every ship;
- Facilities and additional features required to perform the specific functions, according to the symbol of class notations.

The main objectives assumed in the technical proposal are:

- Transfer of class by a classification society member of IACS;
- Obtaining the following class notations:
 - ✓ Notation - *Salvage*
 - ✓ Notation - *Special service-standby rescue vessel*
 - ✓ Notation - *Fire-fighting ship E*
 - ✓ Notation - *ICE CLASS 1A SUPER*

Ship Inspection was carried out in two steps by visiting all areas of the ship, discussing with the representatives of the ship owner and crew on the ship's performance, taking notes of their requirements and analysing the best solutions for modernization.

During inspections and investigations the following were noted:

- a) **The crew** – a crew of 36 people is proposed, 24 persons as permanent crew, additionally a group of 12 persons can be taken on board, occasionally in specific missions.
- b) **The structure of the hull** – plating and structure - is in good shape, thickness measurements from last docking and inspection by Bureau VERITAS indicates a low degree of wear and confirms that structurally the ship can be used for one more cycle of 20 years. Obviously remediation works will be required, such as local anode replacement, sand blasting, painting, etc.
- c) **Propulsion**. Each of the two lines consists of a propulsion motor, gearbox, controllable pitch propeller machine, line shafts, pitch propeller and nozzle. Considering the behaviour of the ship in its last missions and as per the statements of the crew, the controllable pitch propeller machine, line shafts and propellers and blades are in good condition. However, it is imperative that the propulsion engines and gearboxes are changed. They are technologically outdated, have high levels of emissions, more than the current standards allow, high specific consumption and their condition is technically poor. Having analysed the elements, the following

conclusions were revealed on the propulsion lines:

- Will keep the current solution with line shafts, pitch propellers in nozzle;
- Will give up the solution with engines on heavy fuel (HFO) and only the solution on diesel (MDO / MGO) will remain;
- Power will be maintained at minimum 2 x 3300 BHP;
- Will use medium or low engine rpm, max. 900 rpm;

d) **Generating system** - consists of two shaft generators, two diesel-generators and a stationary diesel generator. There are no emergency diesel generators. The technical condition of the shaft generators is unsatisfactory, three diesel generators are in an advanced state of wear and their operation is uncertain.

Thus it is recommended to:

- Give up the shaft generators;
- Install three identical diesel generators (one standby), with a minimum power of 400 kWe (recommended 450 kWe);
- Install an emergency diesel generator (required by the rules, but non-existent);
- Use one of the three mentioned above, as stationary generator.

This configuration provides more safety and flexibility of the electrical power generating system of the ship.

e) **Bow-thruster system** is electrically driven, using star-delta starter, with a controllable pitch propeller. It is necessary to at least replace the star-delta system starter with one by variable frequency, but the replacing of the entire equipment should not be ruled out completely.

f) **Steering system** is functional, made up of two rudders, two hydraulically driven machinery and two electro-hydraulic power-packs. Hydraulic actuation systems require an overhaul and an upgrade, in accordance with the requirements and functionality rules applied after modernization of the vessel.

g) **Anchoring systems and manoeuvre** - are functional and meet operating needs. Size of the anchors and chains meet current rules and can be maintained.

h) **Towing** is provided by two systems:

- System of 50 tons disk hook, guiding curves and a guiding roller. The system is functional but has inferior characteristics of the vessel towing capacity. The cable guiding roller, located in the centre line, raises issues of functionality due to lack of access on aft.
- 2 towing winches system that can work in tandem, two drums, 2x25 / 2x50 tons and guides for cable guiding rollers on sides. The system is manually controlled and requires upgrading / modernization as required by current rules.

i) **Lifting installation** - At the moment, the lifting system consists of a derrick of 10/5 tons. The derrick is functional but extremely heavy and difficult to use at sea. On forward deck there are two cranes of 0.5 tons, in good working order.

j) **Life Saving equipment** - Major LSA equipment consists of two enclosed fire protected boats of 44 persons, gravitationally davit launched. Boats and davits show a high degree of physical and moral wear, resulting in the need of replacing. Regarding the life-rafts, lifejackets and existing lifebuoys etc., the ship will be inspected and if necessary they will be replaced and / or supplemented in the number and characteristics required by the legislation.

k) **External Fire-Fighting System** - The ship is fitted with four water / foam monitors using a local manual control and two electrically driven pumps. High starting current used by fire pumps recommends replacing of the current starters by electronic "soft starters".

Water monitors, manually operated, will require a special notice from the classification society. The existing system generating the water curtain will remain and eventually will be repaired.

In order to obtain the class notation Fire-fighting E complementary, in accordance with these specific class notations, it will be necessary to purchase a greater number of fire equipment, fire-suits, fire hydrants, deck hoses and accessories, etc.

l) **The re-floating system.** -The ship is equipped with two electrically driven pumps for re-floating, vacuum pumps, pipes and fittings, etc. The system is in satisfactory working condition but needs overhaul and punctual upgrades.

m) **Engine Room related equipment (ER)** - ER installations, due to the degree of physical and moral wear but also as a result of replacing the main engines and DGs, need to be changed. Punctual, in duly justified cases, it may be decided to keep some equipment, but only after inspection and some repair works. Except for the Fi-Fi system and External system for re-floating mentioned above, the following equipment could be reused, as follows:

- 1 electrically driven air compressor;
- 1 diesel driven air compressor;
- 1 fuel separator;
- 2 air starting bottles for Main Engines, but without safety systems and air distribution plant;
- Kingston line;
- ER ventilation system;
- CO2 fire extinguishing system;

n) **Existing piping systems** - outside of the machinery rooms are in good working order and therefore it is proposed to maintain them. Ballast installation, bilge installation, installation of wells, ventilation installation and fire fighting water to the ship will need to be upgraded.

o) **Electrical installations.** In general, electrical equipment shows a high degree of physical and moral wear. Therefore, the main switchboard, main alarms machinery console, navigation console, bow-thruster switchboard, and other distribution panels require replacement. The cable ducts will be replaced in the second stage, after checking the state of wear, including insulation resistance. Another element to consider is their geometry, which was analyzed under the new arrangement of equipment on board. Radio-navigation equipment and communication will be replaced in accordance with the requirements of the classification society.

p) **Observations**

- ✓ Upgrading of steering, allowing independent operation of the two rudders;
- ✓ Installation in the wheelhouse, overlooking the operational aft deck area of a desktop command and control equipment located on the main deck, specific to the ship dedicated functions (towing operations, pollution combat, salvage, etc.)
- ✓ Improvement of the visibility from the wheelhouse. At the moment the ship does not offer suitable conditions of visibility according to SOLAS requirements, nor in the conduct of specific rescue operations, fire fighting, etc.

2. DESIGN THEME

The following working hypotheses / operational features and accessories which must form the basis of refurbishment and modernization works have been established:

- Crew: The number of people on board is set at 24 persons permanently manned + 12 support personnel for specific missions + 50 rescued persons according to class notation "rescue vessel"
- Power:
 - ✓ ME - 2 x 2400 kW (minimum) (Note: regardless of the installed power, the propeller does not consume more than 2400 kW / line);
 - ✓ DG minimum 3 x 400 kWe at least one standby (recommended 3 x 450 kWe);
 - ✓ EDG 1 x 100 kWe.
- *Bollard pull* - will consider these values:
 - ✓ Value of sampling 1100 kN;
 - ✓ effective value 930 kN;
- *Speed* - the following speeds will be used:
 - ✓ cruising speed at 100% MCR = 13.8 Kn;
 - ✓ economic speed at 85% MCR = 12-12.5 Kn;

- ✓ line towing (85% MCR) = 7 Kn;
- *Autonomy* - the following values are established:
 - ✓ economic speed (85% MCR) 5000 Nm;
 - ✓ towing (85% MCR) 3000 Nm;
 - ✓ water and food supplies (crew of 24 persons) 60 days;
 - ✓ water and food supplies (crew of 36 persons) 40 days.

3. Ships class symbol

Construction hull notation:

It will be established together with the classification society which will make the class transfer. In principle it will be assigned •HULL •MACH where the symbol • means that the ship was accepted in class but following some classification procedures do not meet the requirements to receive the symbol✳ (the usual practice in cases of class transfer).

Service notations:

▪ **Salvage tug** – specially designed ship, fitted with specific equipment for salvage and towing operations.

▪ **Fire-fighting ship E** – ship designed and equipped for fire fighting operations; class E notation - the ship that does fulfil the requirements to receive category 1, 2 or 3.

▪ **Special service-standby rescue vessel** – specially designed ship and equipped for rescue operations; notation is completed with the maximum number of survivors rescued on board and operating area.

Notation regarding navigation area

▪ **Unrestricted navigation** – ship designed for operation in any region and any time of year (with seasonal restrictions in Arctic area only).

Optional notations:

▪ **ICE CLASS IA SUPER** – ship which has the structure, power and other features to allow operation in crashed ice without the assistance of an icebreaker

The symbol of class proposed and followed by this ship modernization:

I • HULL • MACH, Salvage tug, Fire-fighting ship E, Special service-standby rescue vessel (50 survivors, Black Sea), Unrestricted navigation, ICE CLASS 1A SUPER

4. UPGRADING OF THE SHIP

4.1 Upgrading the propulsion and energy generation compartments

Due to the age of the vessel installations, the systems of valves and pipelines and the electrical wiring ducts will be removed and will be completely replaced over the advancement of the works for fixing the new equipments and new engines on both compartments, the propulsion

and the generation of the vessel electricity, respectively.

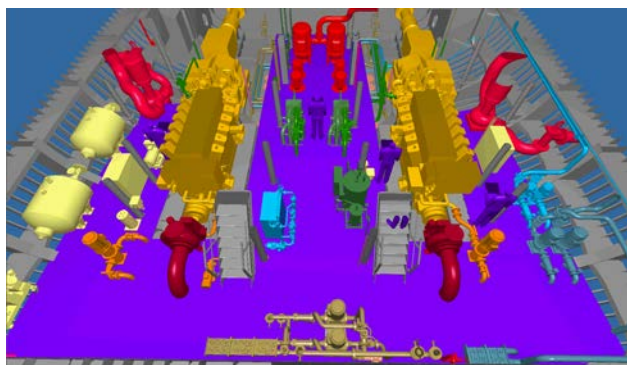


Figure 2- 3D representation of the propulsion compartment intermediate deck level - proposal

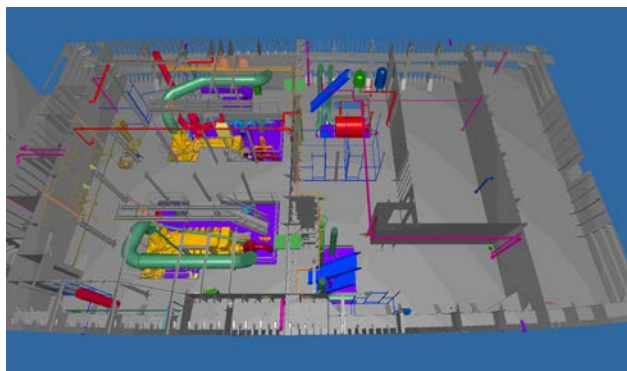


Figure 3 - 3D representation of the Engine Control Room and propulsion compartment at intermediate deck level – proposals

The compartment of energy generation

After removing the old installations and pipelines in the forward compartment of D. G.'s, it began the changing of Kingston main line, placement and adjustments of Diesel generators basements, fixture of the faecal tank and the related pressure booster pumps of the fresh water plant existing on board.

Also was completed fixing the base of new marine boiler and related equipment which replaced the old steam and hot water marine boiler of the vessel.

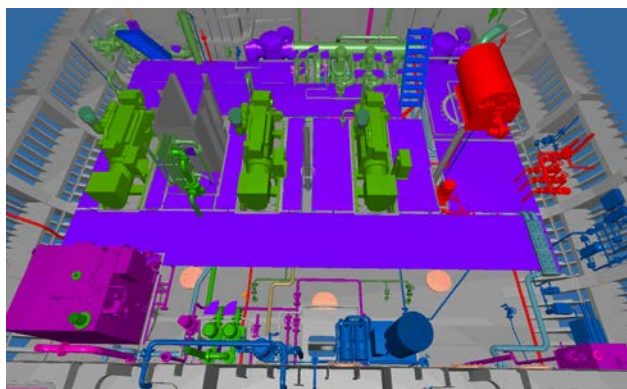


Figure 4 - 3D representation of the DG's compartment - proposals

After the completion of large equipment placement in the compartment and fixture in the new basements, the connexion between piping systems and the related valves will start.

Propulsion engines compartment

In the initial phase the removal of piping systems, pumps and valves, cooling equipment, ventilation, pre-lubrication of old main engines, fuel plant and other nearby installations was carried out.

The second stage consisted of removing and extracting the parts of main engines, gearboxes, exhaust pipes and heat recovery boilers of the ship.



Figure 5 -Removing and extraction of the ME gearbox

The third stage consisted of hydroblasting and application of paint protection on the two compartments after manufacturing of the engines, gearboxes and D. G.'s basements .



Figure 6 -Cleaning and paint protection of forward bulwark in ER

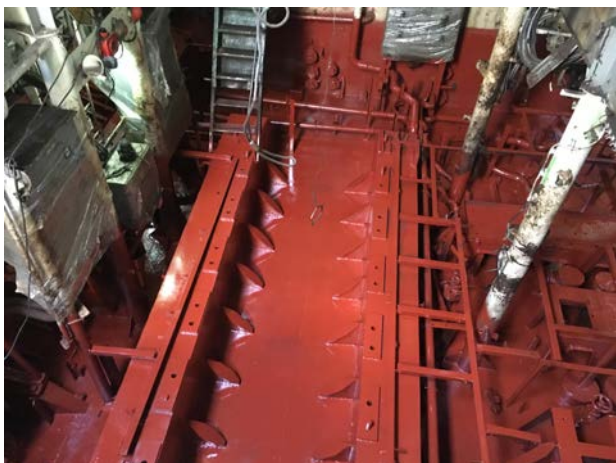


Figure 7- Cleaning and protection by paint of the double bottom deck and the basement of ME

The main engines installed are ABC 12VDZC900 / 174 – 900rpm with a nominal power of 3300 BHP each, with an increase up to 3795 BHP which will be connected to a gearbox produced in Romania by Diesel Mecanica and by pitch control box to shaft lines and propellers.



Figure 8- Main Engine ABC 12VDZC900 / 174 – 900rpm

4.2 Upgrading towing system

The towing system is composed of two hydraulic winches of 50 tons each, arranged "side by side" which will be upgraded with adjustable hydraulic brakes and clutches, with local control and remote controls placed on navigational bridge in aft operating console. Integrated to towing system will also be other equipments, such as: the disk hook of 150 tons, which will replace the current 75 tons (with releasing from distance system and depending on the heeling angle), plus two tugger winches least 5 tons pull on the main deck and an electrically driven drum containing the spare towing line (placed in one of the rescue holds of the vessel). The vessel will be fitted with a cable guiding frame, near the hook assembly and gob chains connected to four strong points placed on deck level.

4.3 Upgrading navigation bridge

Navigation bridge will have a new arrangement with a new navigation console and integrated navigation equipment at the current level, with an ergonomic design.

A portable desk for manoeuvre control will be provided and will take part from aft integrated manoeuvring console which contains the monitoring of main engines, towing winches, starting panels for fire pumps, ballast pumps, etc.

4.4 Main deck arrangement

On the main deck, port and starboard side there will be arranged a Rescue Zone area, where the bulwark and ventilation pipes will be removed. This area will be provided with lighting both in normal and in emergency operation, removable guardrail and rescue scramble nets. These areas will be designated as rescue and assembly areas. On aft area the towing line guiding rollers and the bulwark have been reconfigured and will have a design for guiding and stopping the towing lines and for crew protection.

4.5 Upgrading of lifting installation

The marine derrick of 10/5 tons at 20 meters will be replaced with SORMEC offshore telescopic crane of 5 tons at 20 meters, which satisfies the conditions for obtaining the ship's RESCUE class.



Figure 9- SORMEC offshore telescopic marine crane

The crane will be located on a foot that connects the main deck and boats deck, instead of the former port derrick winch, this location generates increased lifting capacity and an improved operating angle and range. For the ship's utilities, two cranes of 0.5 tons are maintained at forecastle deck on each side of the vessel.

4.6 Modernization of LSA system

The enclosed lifeboats and davits will be replaced by a rescue boat single-point slewing davit on

starboard side and a fast rescue boat launched by a single point luffing davit in portside.



Figure 10 - Rescue boat single-point slewing davit

Due to the number of survivors rescued on board, the number of liferafts will be increased by 50% and their new location will be on triple rack fixed near the ships funnels on boat deck.

Also, for the saved persons there will be arranged a special hosting space (a separate compartment) or a container taken on board according to the ship's mission.

For deceased persons recovered from the water there will be arranged a dedicated compartment or a special refrigerated container.

Infirmary and consulting rooms will be upgraded.

4.7 Modernization of fire-fighting system



Figure 11- External Fire-Fighting main pump

Conclusions

Classification and class symbol

The class symbol proposed to be obtained by this modernization:

I • HULL • MACH, Salvage tug, Fire-fighting ship E, Special service-standby rescue vessel (50 survivors, Black Sea), Unrestricted navigation, ICE CLASS IA SUPER

- It will take into account the note made in "BV Letter of Classification Requirements for Hercules" issued by Bureau VERITAS (BV);
- Intact Stability will be under current legislation;
- Damage Stability will be checked but the ship will not take the class notation - SDS;
- All unchanged items (the hull, shaft lines, installations, etc.) are subject to verification and approval by the Class to an extent agreed with Bureau VERITAS;
- The volume of existing documentation on the ship is insufficient, which can create problems in the

Installation for external fire-fighting will be modified by the introduction of two pumps of at least 800cbm / hour, which will be engaged by the main engines through 1,000 Kw PTO couplings by mounting of two remotely controlled monitors, mounting on the main deck, each side a secondary battery for at least 8 hydrants with hoses and nozzles, necessary for interventions on other ships or port/offshore facilities.



Figure 12 - Fire-fighting remotely controlled monitors

A local fire fighting fixed installation generating water mist is provided in the dangerous area of the main engines and DG's , boiler area and the dangerous area of fuel separators.

4.8 Re-floating installation

The ship is equipped with two centrifugal electrically driven pumps without priming, placed in the main engines room (characteristics: Q = 1000cbm / h at H = 25 m).

For priming, a system that produces a hollow suction of about 0.07 to 0.8 bar is provided. Electro-pumps suction pipes are coupled to two caissons with a groups of valves, located on the main deck, both sides of the ship. Caissons are provided with ten ramifications for hoses DN 200, for re-floating near the vessel.

relationship with BV;

- Documents and new drawings will be submitted for approval to classification society BV;

It will be necessary to obtain derogations from BV class for some deviation from the legislation, arising from existing ship and whose alternative solution would be unrealistic.

Some of the most important issues currently identified are:

- double bottom structure (floor plates);
- aft'peak bulwark structure;
- aft'peak floor plates;
- inside tilting of the main bulwark;
- external fire fighting installation.

In order to achieve the transfer of class, at first docking of the ship, BV will conduct a detailed inspection of the ship. On this occasion it is possible to highlight the necessity of completing additional remedial works to the body structure, structure inside the tanks, cathodes protection, sea chest, etc.

Regarding modernization

Multifunctional tug HERCULES can be upgraded so it can perform the proposed functions, namely:

- Intervention and manoeuvre assistance for large vessels in port areas;
- Line towing due to unlimited navigation class;
- Fire fighting interventions at ships, offshore facilities and harbour installations;
- Opening route in the ice field on the coastal area of the Black Sea and the Danube estuary;
- Salvage – re-floating, towing and recovery;
- Rescue – crew recovery, emergency care, MEDEVAC operations, etc;
- Offshore facilities supply, occasional transport of materials, equipment and reserves.
- Special underwater works with divers
- Pollution combat including deployment of oil-booms and oil recovery.

After modernization, multifunctional tug "Hercules" owned by the Romanian Agency for Life Saving at Sea will become a highly efficient vessel fitted for special operations in the Economic Exclusive Zone of Romania, and beyond.

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