



UNMANNED SURFACE VEHICLES IN MARITIME CRITICAL INFRASTRUCTURE PROTECTION APPLICATIONS — LNG TERMINAL IN ŚWINOUJŚCIE

Rafał Miętkiewicz

Polish Naval Academy, Faculty of Command and Naval Operations, Śmidowicza 69 Str., 81-127 Gdynia, Poland; e-mail: r.mietkiewicz@amw.gdynia.pl

ABSTRACT

In order to first Baltic LNG terminal in Świnoujście construction, issues concerning maritime critical infrastructure protection as a part of Maritime Security appeared. With the increasing natural gas demand LNG terminal in Świnoujście could be a possible terrorist attack target as well as the LNG carriers crossing the choke point of Baltic Straits and sailing through the littoral waters of Polish and other Baltic counties coastline. Experts do not fully agree on possible effects and results of successful terrorist assault on LNG carrier at sea nor at harbor.

Unmanned platforms begin to play prominent role in military, oceanography or academic applications. With the announcement of reducing the hazard for deck operators especially in high-risk regions, it is predicted that unmanned platforms will play crucial role in Maritime Security systems in the nearest future. This paper discusses the design of the USV dedicated to LNG terminal protection tasks introduces potential equipment options and missions scenarios of first Polish unmanned platform 'Edredon'.

Key words:

unmanned surface vehicles, maritime security applications, unmanned platforms, unmanned maritime vehicles.

Research article

© 2018 Rafał Miętkiewicz

This is an open access article licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

INTRODUCTION

Over 90% of the information, people, goods, and services that sustain and create opportunities for regional economic prosperity flow across the maritime domain. With emerging such as piracy, natural resource disputes, drug trafficking, and weapons proliferation, a rapid response capability is needed in all maritime regions [8].

According to the natural gas trade situation in East and Middle-East Europe connected with fully dependence from Russia, necessity of sources supplies diversification appeared. Last actions in Ukraine proved the increasing role of political, economic and social risks at regional scale but with great international situation input. Based on that, construction of the LNG terminal in the coast of Poland was acknowledged as a strategic decision for the future interests of Poland, and guarantee of energetic security of the country. A decision about situating LNG terminal in Świnoujście has been made on grounds of the lower costs of transport (shorter route than the alternative investment in Gdańsk), greater demand for gas in the north-western Poland and lower costs of building [6].

Increasing applications inherent to the many USV's constructions proved the realistic role for such platform for harbor protection implementations (Protector role in Singapore harbor security system, operations in the Persian Gulf and Mediterranean, reportedly deployed against Hamas).

Harbor security systems architecture of Centurion (Total Port Maritime Surveillance Concept) [1], Harbor Guard Integrated Waterside Surveillance and Security System [9] as well as national concepts like Maritime Infrastructure Protection System (CTM) and Integrated, Multisensory Harbor Monitoring and Protection System (WAT) were analyzed during researches. Weak and strong factors of indicated systems have been assumed.

Based on research results (historical occurrences analysis, experts estimations, own coverage) of potential terrorist attack (asymmetric threats) targets have been divided into two purposes. First one is LNG terminal as sea harbor situated near vital waterway (Szczecin), City (approximately 40 000 citizens) or ferry terminals and integral facility (land LNG tanks, railroad, gas pipelines) also with LNG carrier inside the harbor. Second one is LNG carrier sailing with the charge across the chock point of Baltic Straits and shallow waters of Baltic Sea, because of the possible impact of terrorist attack on national energetic security and LNG trade market in the region. Many of identified threats for LNG terminal (with LNG carrier inside) and LNG carrier at open sea (also at anchorage, waterway, entrance channel) are similar but some inequalities have been observed.

LNG TERMINAL SPECIFICATION

LNG terminal in Świnoujście is a specific facility dedicated to off-taking and re-gasification of liquefied natural gas which covers the total area of 48 hectares. Planned capacity of re-gasification is 5 bn m³ per annum (initial capacity). Depending on the future demand for LNG it is possible to increase received gas to 7.5 bn m³ (target capacity). Two (optionally three) containers have been built with capacity of 160 000 m³ each (height — 40 m, diameter — 80 m). Cryogenic character of resource cause application special LNG carriers. LNG terminal will accommodate methane carriers with max length of 315 m and total width of 50 m with the draught up to 12.5 m (*Q* — flex type) ranging from 120 000 m³ to 216 000 m³ of gas [5]. LNG terminal is equipped with truck reloading stations and LNG bunkering station. With the external port, breakwaters, process and unloading platforms, LNG terminal is one of the most significant infrastructure project. Recognized as strategic for national economy LNG terminal allows receive natural gas by sea from many directions in the world. This vital investment with the objective to improve energy security will provide diversification of gas supply sources.

HAZARDS IDENTIFICATION

Potential number of attack scenarios is practically unlimited. The time, place and method of strike depends on terrorists. Spectrum of terrorist threats is wide. It is practically impossible to build one define index of threats. The 'classical' methods of attack with devices like aircraft hijacking, car bomb attack, kidnapping, fast boats suicide attacks have been expanded (e.g. improvised explosive devices). The phenomena of terrorism has evaluated to 'super terrorism' in the last decade. Arsenal of weapons of mass destruction has been adopting [4]. It is worth to mention about some latest facts from maritime domain like:

- use of RHIBs as vessel borne improvised devices (VBIED) during Libian Revolution by Khadafi loyalists in 2011 (with large quantity of explosives — 1 tone of Semtex-H onboard and human decoy mannequins);
- sea-mine laid by the pro-Khadafi forces with earlier Iraqi conflicts incidents outline the great role of sea-mines;
- piracy activity near African coast proved the ability to capture the ship even with considerable distance from the sea shore ('Sirius Star', 'Maersk Alabama', 'Tatin') by the groups of pirates faking fishermen;

- Sri Lanka Civil War with numerous improvised armament (mini-submarines, improvised sea mines, underwater suicide attacks vehicles, fast crafts — also blast boats for suicide attacks with elements of Stealth technology with less radar signature, made of laminate constructed in manufactures hidden deep in jungle);
- asymmetric methods of modern conflicts;
- USS ‘The Sullivans’ unsuccessful attack proved the undertaking the new trails of strike;
- oil and LNG tankers shipments descent (politically unstable or unfriendly regions and countries);
- chemical tanker ‘Dewi Madrim’ boarding in 2003 (Sumatra Coast) assumed by the experts as an example of terrorist training mission (practicing operation of navigating of such large ship) [2];
- economic impact of possible terrorist attack on oil tankers, or chemical tankers (‘Limburg’ attack as well as Khawr Al-Amaya Oil Terminal and Al-Basrah Oil Terminal attack during Iraqi War);
- terrorists seek the best place to hit the vessel with high-speed crafts or limpet mines and try to change tactics for attacking the LNG carrier from inside.

USV ‘EDREDON’ — SHORT DESCRIPTION

‘Edredon’ is a technology demonstrator of the first unmanned surface vehicle made in Poland. The construction of ‘Edredon’ is based on the rigid hull of a hybrid boat with the length of 5.7 m, load capacity of 1 tone and max speed up to 30–35 kn. Platform has operational range up to 20 km. The major components of the vehicles includes [3]:

- navigation system, GPS, AIS, ARPA, electronic compass, autopilot, sounder, plotter, electronic chart, log;
- position tracking system;
- remote control system (coded);
- power supply system;
- observation system consist: day/light camera, laser, distance measurement, sonar, panoramic camera;
- chemical and meteorological sensors;
- communication system.

Focused on the maritime security applications affair, results of researches as a matter of demonstrating possibilities of use of the unmanned surface vehicles

as a vital part of LNG sea terminal protection will be presented. With reconfigurable modules (open architecture), low structure and high maneuverability 'Edredon' is a appropriable tool for harbor protection missions as response to emerging asymmetric threats (including terrorists). 'Edredon' can be remotely controlled from the Mobile Control Center (MCC) located in standard container (situated at harbor, other shore point or on vessels board) equipped with navigational purposes, navigation devices and planning station.

The core vehicles fire systems component include remotely controlled armament module with 7.62, ZSMU-127 KOBUS (Turrets — remote controlled weapon station), with grenade launcher and optionally non-lethal weapon system e.g. acoustic emitter (Long Range Acoustic Device), markers, water cannons to optionally deterring or designating intruder.

Main deck space configuration architecture assures sufficient place for AUV/ROV, towing sonar or underwater camera docking station. Launching and recovery system for AUV/ROV together with underwater vehicle information transfer system program are underway.

USV MISSIONS

Assumption of possible seaborne surface and underwater hazards has been conducted primary. With a reference to dynamic characteristics of many of identified threats, time deficit between hazard situation symptoms, threat classification and counteraction has been confirmed.

LNG terminal sea area has been split into two crucial security parts. First one, situated inside harbor is assigned to surface, and underwater situation monitoring. Many of LNG terminal crucial installations (regasification devices, gas portage pipelines, fire security facilities installations) require continued sea side monitoring (atmospheric and water environments abutment). Vital aspect is permanent underwater infrastructure monitoring (underwater sabotage) of piers, LNG carriers mooring places or underwater gas lines (also for tankers underwater hull inspection before entrance for limpet mines and other danger hull mounted devices carry probability reducing). Second patrol area is situated outside the breakwaters and include waterways and anchorages. Patrol scenario is focused on early possible hazard symptoms detection and identification together with immediate counteraction readiness. Possibility of creation the buffer zones outside the LNG terminal integral area has been anticipated during scenarios composing with couple spheres (for

initial threat object identification, warnings broadcast, target designation and using of constraint methods). Such solution creates more time for other harbor security subjects alert.

All USV missions could be realized in two primary versions (fig. 1). Alfa variant means routine patrol with practice execution of planned and programmed mission scenario (with autonomy tracking, data collecting) together with additional task performing. Second option, the Bravo variant means emergency action as an answer for unexpected unit (other source emergency signal receiving, USV mission support).

Routine patrols and intervention actions are expected in both subareas. As a main unmanned platforms base point some location inside the LNG terminal in Świnoujście has been proposed (near the main entrance with suitable embankment).

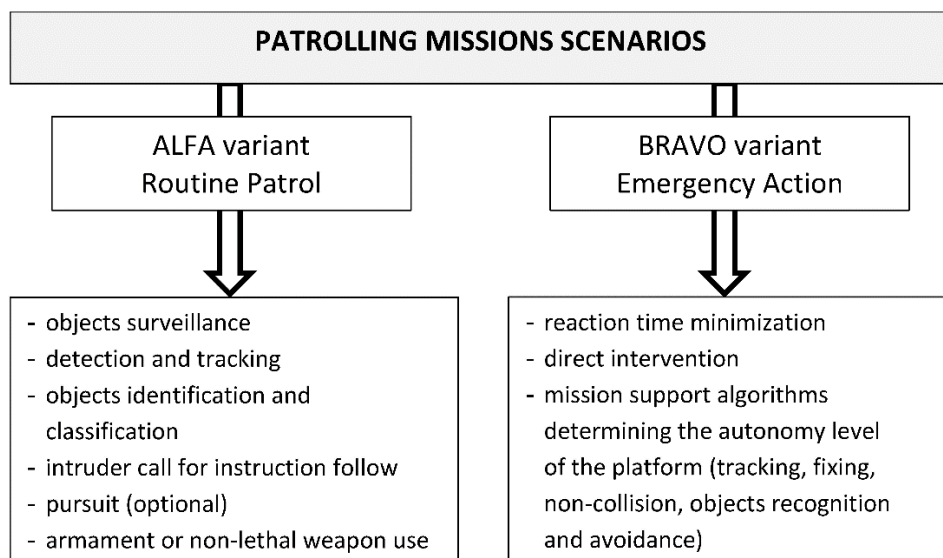


Fig. 1. Patrolling missions scenarios variants (simple version)

For LNG terminal in Świnoujście following mission and submissions have been created (some):

- harbor patrol;
- outside zone patrol;
- LNG carrier surveillance;
- underwater situation monitoring;
- SAR missions support.

Tab. 1. Simple possible unmanned surface vehicle mission characteristic

Mission characteristics	
Mission name	Harbor patrol
Mission goal	<ul style="list-style-type: none"> - hydro technical infrastructure surveillance - LNG terminal sea bottom surveillance - underwater LNG carrier hull inspection with AUV/ROV - environmental data collection - chemical, biological, radiological monitoring
Speed	Specific submission requirements adjusted. Determined by the balance of main sensors characteristics and economic fuel consumption (for operational time enhancer)
Priorities	Tracking with waypoints for hazard symptoms on the surface, water column and sea bottom
Additional tasks	<ul style="list-style-type: none"> - underwater ship's hull inspection - bathymetric survey - hydro meteorological data collection - underwater objects data base creation for periodically updating and comparing
Basic sensors	<ul style="list-style-type: none"> - optoelectrical systems head - AUV/ROV - towed devices (sonar)

CONCLUSIONS

In accordance with 'The Navy Unmanned Surface Vehicle (USV) Master Plan' [7] classification, two groups of autonomous platforms have been indicated as useful for LNG terminal in Świnoujście protection applications. Harbor class autonomous vehicles with autonomous around 12 hours, length between 3 and 7 m, based on RHIB hull ('Edredon') proved as applicable tool for inside harbor security missions. Displacement as well as load capacity are enough for sensors and deck missions modules. On the other hand wide modern threats scope outside protection area has been distincted. In such conditions connected with larger load capacity demand, better seaworthiness, higher range and autonomous, fleet class platform has been indicated as the goal solution for open sea applications (waterways monitoring). USV mission composing together with mission integration with harbor security system is another step in effective critical maritime objects protection systems upgrading research process. Theoretical and practical assumptions of effective use of unmanned platforms have been realized during research. With a scope of more than one hundred of worlds USV construction, several dozen of predisposed platforms were analyzed with hull types, displacement, propeller systems, sensors, communication element with data transferring, autonomous level and actual operational status.

During sea trials it has been proven that highly independent remotely controlled vehicle ('Edredon') is capable of performing many vital, critical missions. The main advantage of increasing unmanned vehicles role is connected with lack of deck operators onboard. Long and tiresome surveillance missions could be much more effectiveness with reducing the human factor. Moreover with autonomous mission status no personnel nor capital assets are exposing to unnecessary risk. Unmanned surface platforms with balanced capacity have wide variety of possible solutions in Maritime Security.

REFERENCES

- [1] Bick T., *Centurion a Total Port Maritime Surveillance Concept*, [online], www.northropgrumman.com [access 26.02.2013].
- [2] Hurst C., *The Terrorist Threat to Liquefied Natural Gas: Fact or Fiction?*, Institute for the Analysis of Global Security (IAGS), 2008.
- [3] Kitowski Z., *Autonomous unmanned surface vehicle 'Edredon'*, 'Polish Hyperbaric Research', 2012, No. 3(40).
- [4] Radu O., Slamnoiu G., Zarnescu L., Cosereanu L., *Harbor Protection Against Terrorist Threats: Difficulties and Possible Solutions*, RTO-MP-SCI-180, 2006.
- [5] Tański T., *Terminal LNG in Poland*, Baltic Ports Organization, Klaipeda, April 2015.
- [6] *Terminal LNG w Polsce*, [online], www.polskielng.pl/lng/terminal-lng-w-polsce, [access 06.08.2015].
- [7] *The Navy Unmanned Surface Vehicle (USV) Master Plan, 2007*, [online], www.navy.mil, [access 20.06.2016]
- [8] *Unmanned Systems Integrated Roadmap FY2011-2036*, USA Department of Defense, 2011.
- [9] Wetmore R., *White Paper — Integrated Coastal & Harbour Surveillance System*, New Hampshire 2008.

WYKORZYSTANIE BEZZAŁOGOWYCH JEDNOSTEK NAWODNYCH W OCHRONIE MORSKICH OBIEKTÓW INFRASTRUKTURY KRYTYCZNEJ — NA PRZYKŁADZIE TERMINAŁA LNG W ŚWINOUJŚCIU

STRESZCZENIE

Budowa gazoportu w Świnoujściu jest niezmiernie istotna dla bezpieczeństwa energetycznego państwa. W związku z dywersyfikacją dostaw surowca o znaczeniu strategicznym należy zapewnić

odpowiedni poziom ochrony tego specyficznego pod wieloma względami morskiego obiektu infrastruktury krytycznej. Jedną z idei jest włączenie do systemu ochrony terminala LNG morskich pojazdów bezzałogowych, których rozwój w ostatnich latach jest bardzo dynamiczny. Postęp technologiczny umożliwia dziś, co potwierdził bezzałogowy pojazd 'Edredon', wybudowanie w oparciu o krajowy potencjał naukowy i przemysłowy platform zdolnych do realizacji szerokiej gamy zadań na morzu.

Słowa kluczowe:

bezzałogowe jednostki nawodne, platformy bezzałogowe, autonomiczne systemy morskie.

Article history

Received: 06.03.2018

Reviewed: 23.04.2018

Revised: 21.05.2018

Accepted: 22.05.2018