"Mircea cel Batran" Naval Academy Scientific Bulletin, Volume XIX – 2016 – Issue 2
The journal is indexed in: PROQUEST / DOAJ / Crossref / EBSCOhost / INDEX COPERNICUS / DRJI / OAJI / JOURNAL INDEX / I2OR / SCIENCE LIBRARY INDEX / Google Scholar / Academic Keys/ ROAD Open Access / Academic Resources / Scientific Indexing Services / SCIPIO / JIFACTOR

SOME SPECIFICS OF REDUCING THE IED RISK IN OFFSHORE SECURITY ENVIRONMENT

Valentin S. VASILEV[1]

[1] "Nikola Vaptsarov" Naval Academy,Varna, 'Vasil Drumev' Str., 73, E-mail: valentin-vasilev@naval-acad.bg

Abstract: *Improvised Explosive Devices (IED) undoubtedly pose significant threat to all spectrums of offshore constructions. It is necessary,security of offshore industry to be prepared to withstand against harmful impacts caused in asymmetric way - unclearly defined motivationduring selection of targets and usage of improvised devices in order to materialize damage. Effects are more than undesirable such as having an effect on moral of personnel or economic status of company.Oil spills should be considered as main objective or, at least, as an imminent aftereffect realized by IED-attack.*

Keywords: *counter-IED efforts, critical vulnerability, maritime security, offshore industry, risk management.*

The security environment in Black sea region ischanging significantly.Offshore industry and vide spectrum regional conflicts in vicinity give particular characteristics. Traditional challenges and risks are transformed into 'hybrid' threats. There are some noticeable trends that unveil new comprehensive aspects e.g. every single physical offshore objects could be possible targets.Contemporary realities are precondition for asymmetry during processes of interaction between security objects and subjects. It refers to the usage of IED as an unfavorable destructive chain of events. Options for reaction are limited into narrow interval representing dichotomy[1]between strengthening substantial constructive elements, and discontinuance of disrupting 'the domino effect'.Protection of Offshore Drilling Units, fixed, tension leg andSingle Point Anchored Reservoir (SPAR),Floating ProductionStorage and Offloading Systems (FPSO) become matter of growing concern because of imminent risks with environmental, economic and public aftereffects.Improvised Explosive Devices (IEDs) are feasible means of impact the security. Therefore, it is compulsory for maritime security authorities to seek after applicable approaches to reducing impact of IED on offshore constructions [9].Enhancement of effectiveness during countering IED is associated withknowledge of the characteristics of offshore targets, specifics of use of improvised device and opportunities for making and deploying IEDs with specificparticularities offshore.

An IED-attack is not only the use of a "homemade" bomb but it is also implementation of destructive device to destroy, incapacitate, harass, or distract. IEDs are used by criminals, vandals, terrorists, suicide bombers, and rebels. IEDs are appeared in many forms, in range from a small pipe bomb to a sophisticated device capable of causing massive damage and loss of life. IEDs could be carried or delivered by supplies; carried, placed, or thrown by a person; delivered in a package; or concealed in ship`s compartment prior moment of attack [8].

Realization of IED-attack should be considered as serious **security incident**[2] onan offshore facility. It is an occurrence of event with detrimental consequences to the functioning of offshore industry elements. It normally has reflection in safety of personnel, environmental conditions, status of public opinion and financial wellbeing of offshore companies [7].It is identifiable not only on national level but also it has regional dimensions.

On the one hand, the principal hazard risks of great importance that could cause lossof life of offshore workers – fire and explosion correlated with hydrocarbon releases, loss of structural integrity and stability and pollution of environment, are investigated systematically. So there are compiled detailed safety precautions.

On the other hand, the risk of IED in offshore environment is not enough explored. It becomes a significant threat to offshore industry due to inevitable contemporary realism and devastating effects in security and ecological aspects.

Threat to offshore facility is an emergence and evolution of destructive processes in specific

[1]The term'dichotomy'is used in meaning of division into two mutually exclusive and,in some extent, contradictory clusters formed by particular constructive and organizational measures taken in order to protect offshore facility.

[2] According to the ISPS-Code, it is a particular activity or circumstances that threatening security of the ship, including mobile or floating platforms, or interactions between ships and platforms, etc.

DOI: 10.21279/1454-864X-16-I2-018

“Mircea cel Batran” Naval Academy Scientific Bulletin, Volume XIX – 2016 – Issue 2
The journal is indexed in: PROQUEST / DOAJ / Crossref / EBSCOhost / INDEX COPERNICUS / DRJI / OAJI / JOURNAL INDEX / I2OR / SCIENCE LIBRARY INDEX / Google Scholar / Academic Keys/ ROAD Open Access / Academic Resources / Scientific Indexing Services / SCIPIO / JIFACTOR

environmental conditions so that occurrence of an accidental event becomestriggering factor for a series of potentially destructive processes and it upsets the balance of the system. According to system analyses, IEDs effects would be projected ontooffshoreobject consideredas a complexsystem, composed by elements or subsystems being in mutualrelationship each other. Therefore, threats become visible in wide spectrum effects. Trigger would be formed by intention combined withabilitytouse explosive deviceor lack of counteractions.It sometimescreates conditionsfor development ofdestructiveprocess, observablebyoccurrence of chain of events thatare usuallycause and effect relations.

According to another point of view, the threat can be realized as physical destruction of offshore object or particularstructural element, or as a deviation from the normal operational condition of critical sub-system caused by hydro-meteorological phenomena or another “border line”environmental condition as the result reflects on security, safety or ecology.It is obvious that all threats, regardless of genesis, cause an effect in following aspects - safety, security, ecology or combination of them.

Normally, threats to maritime security are asymmetric in nature. **Asymmetric threats** occur in hostile environment within situation of opposition between two or more opponents with diverse opportunities to overcome another`s willpower. Their potentials differ significantly, both in quantitative and qualitative aspects. For example, asymmetry is cognitive in numbers and military capabilities[3]of opposing troops or paramilitary groups [12]. In fact, asymmetry is everywhere around us - in economic indicators of neighboring countries, in criterions used for forming social groups, etc.

The destructive process would be realized if a stochastic security event occurs where there are “favorable” conditions.If the probability of realizing the destructive process against offshore installation is denoted as ***P (x,y),*** the probability of existence of particular circumstances for realization of given destructive event***x*** as***p(x)***,and ***p(y/x)***is probability of realization of another stochastic event ***y***that triggers and the destructive process***x***.When ***x***has already occurred, then the conditional probability would be described byfollowing equation:

$$P(x,y) = p(x)p(y|x) \quad (1)$$

For example, the probability of realization of IED-attack on board of offshore facility is ***P(x,y)*** is equal toprobability ***p(x)***of given terrorist organization cell to penetrate the security system and to assemble IED,multiplied by the probability of collision ***p(y/x)***of seized vessel with producing platform***.***

Actually, analyses of offshore threat caused by IED requires exploration of Cause and Effect correlation,and could bedescribed as an implementation of IED, related with reciprocal intended actionand its direct result against offshore facility. Obviously, there are correlation between object and subject of IED-attack. In other words, it is a process, evolving in defined time period and specific maritime security environment.Activated IED against offshore installation could initiate uncontrollable chain of events. It affects safety of personnel, security of offshore industry, and last but not least, ecological aspects of environment in its adjacent areas.It is a kind of security incident in offshore zone - likely happened because of gap in security instructions, prescribed standard operational procedures, or negligence and lack of adequate qualification of personnel or preparedness to react. As a result, effects are more than undesirable such as having an effect on moral of personnel or economic status of company. Oil spills should be considered as main objective or, at least, as an imminent aftereffect.

Environmental conditions, both in ecological and safety and security aspects, are revealed by monitoring of beforehand selected a finite amount of indicators that figure outeffects on the offshore industry in terms of security, safety and ecology.It is obvious that the normal functioning of the offshore industry requires maintaining an **acceptable level of security** in order to providespecific environment, where destructive processes become controllable. Undoubtedly, it is compulsory a great deal of resources and efforts to be allotted over and over again by offshore steak-holders - concession grantor (usually the Government), concession operator and Natural Gas (Oil) Company.

Actually, IED-attack fits in particular way into the contemporary perception of a hybrid threat concept.In this line of thinking, it happens in security environment and affects all the aspects such as political, social, economic, informational and even military dimensions. It smites directly definite critical vulnerabilities of given system with coordinated impacts and aims achieving

[3] Usually, it is an ability to move from initial condition or place to desired effect, condition or state according to preplanned ‘path’ in specific operating environment.

DOI: 10.21279/1454-864X-16-I2-018

preplanned effects. The phenomenon evolves gradually into a conflict situation wherein one party reaches the desired final condition with respect of security, so that another usually is paralyzed before realization that the conflict is started. In fact, it is "unusual" conflict situation that could be happen when the type and scale of threat is below the threshold of sensibility for perception and responsiveness [14].

Furthermore, the core aspect of counter-IED (CIED) efforts is determination of offshore facility critical vulnerabilities and certain environmental preconditions of attack. So, an effort become focused in time aspect and in spatial aspect and it is very important when available resources in offshore environment, such as reaction time and number of specialized CIED-teams, are extremely limited. IED-attack, projected on security, safety and ecology of an offshore installation, is a physical prerequisite for releasing a chain of destructive processes. It have an effect directly on targeted critical vulnerability that probably is less protected or it would have devastating aftereffects on stability of the system and would initiate uncontrollable "domino effect".Due to these composite outcome and reflections of "backwashes", synergic indeterminateside effects should be expected.For instance, identification of vulnerabilitiesin technicalaspect, in personnel safety could be used to improve protection, thus eliminating or at least mitigating the consequences [4].

In this context, **critical vulnerability** of offshore physical object isasystem feature that affects any piece of organized and concerted activities or normal operation of the system.It is anabstract informational gap in the system's securityor essential element, which once exposed on attack, leads to operational malfunction, shortage of personnel`s safety and cause environmental pollution with hydrocarbons. If the threat is materialized as IED-attack against Jack-Up Drilling Unit,then the above mentioned critical vulnerability should be attached with concrete physical element, such as:

- **Drilling Equipment** (Derricks, Draw-works[4], Rotary Table, Top Drive,Mud Pumps, and Solids Control).

- **Power Equipment** (Main power - diesel engines and generators, Power Distribution Equipment).

- **WellControlEquipment** (Diverter, BOP[5]-handling).

- **Mooring Equipment** (Winches, Anchor Lines).

- **Hydraulic Power Unit (HPU) & Controls**(All the rig accessories requiring hydraulic power should have independent hydraulic power unitwith standard controls).

- **High Pressure Mud Piping and Water System** (consisted of Pumps, Pipes, Valves, Cement Standpipes, Vibrator Hose, Rotary Hose, Active and Reservoir Mud Tanks, Water and Chemical Tanks).

- **High Pressure System**[6] (Pneumatic and Pressure Pumps, Suction and High-pressure testing manifolds, Valves, Adjustable air regulator set, Reservoir)

- **Hull** (its sections close to waterline, and especially submerged part of the hullare extremely vulnerable).

- **Mast and substructure** (Mast Construction and Equipment, Mast Controls, Telescopic Front and Rear Levelling Jack Screws, heliport, Pedestal Cranes,etc.)

-**Rig Control System**(Power Control rooms - main and auxiliary,Draw-works controls, Driller's cabin/draw-works interface controls,Top Drive Instrumentation Systems, Hydraulic Power Unit Controls, Mud Pumps, and Rig Air System).

-**Rig Fuel System** (Fuel tanks - mainfuel storage and day tank, Fuel Filter System,manifold togetherDiesel Fuel Transfer Pumps).

- **Rig Intercom System** (Line Balance Assembly, Wall Mount Audio Messenger Interface, Outdoor and Indoor Stations) [2], etc.

Additional to that, deepwater production platforms, such as semi-submersible and fifth generation SPARplatforms, have got critical vulnerabilities linked with station keeping system. Station keeping ability should provide safely and reliably maintenance of position over the well head for as long time as necessary to perform the task. Generally, there are two station keeping methods. First one is pretty traditional and is by physically securing the floating platform to the seafloor. It is relatively simple, not too expensive and safe approach. Main disadvantage is that increasing the water depth pose real challenge. Second station keeping method is dynamic positioning (DP) and it is commonly used in deep waters, i.e. approximately in water depths more than 500 meters. DP is an active station keeping method

[4] Draw-works - primary hoisting machineries, a component of rotary drilling rig.Draw-worksprovide a means of raising and lowering the traveling blocks.

[5] Blow-out preventer (BOP) is specialized mechanical device (valve), used to seal, control and monitor oil and gas wells to prevent blowout, the uncontrolled release of hydro-carbons from well.

[6] High pressure test incorporates glycol injection to prove integrity of fittings.

DOI: 10.21279/1454-864X-16-I2-018

using the vessel`s propulsion complex to maintain desired "hover" position and heading [5].

Traditional mooring equipment consists of chain or steel wire, evolved specialized stockless anchors, winches, higher capacity windlasses and additional floatation. Some rigs carry their anchors and wire ropes but usage of Anchor Handling Vessels (AHV) is more common. Usage of mooring gear beyond depths of 160 meters becomes more or less problematic because of weight and consequent negative effect on variable deck load of platform.

Newer generation platforms are designed to be more flexible in respect of water depth.DP is computer assisted maneuvering system. It consists of all associated subsystems needed to control position and heading. DP is applicable not only in deep waters but also in areas where mooring is impractical due to subsea conditions. Normally, it is more sophisticated process in comparison with mooring and requires trustworthy informational support. For that reason, there are a specific critical vulnerabilities crucial for safety, security and ecology, such as:

- Positioning System (ensuring measurement of position, heading, attitude, surge and sway in any given moment, normally monitoring subsystem is placed on board in command and control center).

- Reference Sensors (Differential GPS, Hydro-acoustic Position Reference System[7], Wind sensors, Gyros, Motion Reference Unit - MRU, Vertical Reference Unit - VRU).

- Propulsion and Thrusters (Azimuth Thrusters with fixed or controllable pitch, Variable Speed Thrusters with fixed pitch. There are a variety of configurations, but commonly - twin screw fixed pitch mains and number of bow and stern tunnel thrusters as necessary).

- Main Engines and Power Management (an integral part of DP System are diesel-electric power plants, complex electrical distribution systems and above mentioned propulsion complex).

- Platform construction (The "redundancy" concept is implemented in *Class 2* and *Class 3*Platforms[8]).

Along these lines, all above mentioned constructions, compartments, equipment, machinery and sensors would be pointed out as possible targets for IED-attack. Notwithstanding their redundancy and reservation of systems, they are attractive as the aim of an attack - their vulnerability could be used because of vast spectrum effects and scale of consequences for safety, economy, ecology and repercussion in society.

The system analysis is a powerful instrument that supports CIED efforts. If an IED-attack, together with the Maritime Transportation Systemand all threatened offshore objects aredepictured as complex system it would be possible a several major groups of vulnerabilities to be figured out.The most serious vulnerabilities are those ininputs of the system and linked with its functioning offshore and onshore critical infrastructure, i.e. points of contact between offshore system and environment. Indicative examples of onshore vulnerabilities are logistics airports and harbors because of unavoidable constant flow of personal and supplies. Any immediate impact on above mentioned vulnerabilities would be indicator of weaknesses in process of application of minimal security requirements, or it should be considered as a gap in security legislation [13].

Furthermore, the production process should be assumed as another source of vulnerabilities. For instance, violation of drilling operation or production process, physical damage of deepwater pipeline, shuttle tanker or floating storage and offload system. Moreover, Maritime Transportation System is crucial for offshore industry due to distinctive interdependence. It is of the nature of presumption that IED-attack could be realized against specially designed offshore vessels such as Platform Supply Vessel (PSV), Anchor Handling Tug Supply (AHTS), Construction Support Vessel (CSV), Diving Support Vessel(DSV), Accommodation Vessel, Crane Vessel, Offshore Barges and Safety Standby Vessels (SSBV), etc.According to the position of source of threat and the direction of evolution of destruction, IED-attack could be systematized as **outer-genesis** or **inner-genesis** in relation of physical boundaries of offshore facility.

On the one hand, the threat would be realized by intruder on board offshore platform or auxiliary vessel, i.e. it has got inner-genesis. Targets of IED-attack are expected to be compartment on board with controlled access or restricted

[7] There are three basic HPR Systems - Long Baseline (LBL), Short Baseline (SBL) and Ultra Short Baseline (USBL). Generally, LBL uses one hydrophone with at least three beacons on the seabed, but SBL - at least three hydrophones on board and one beacon on the seafloor. Normally, USBLsare used in shallow waters.

[8] Class 3 requirements are higher - at least two complete engine rooms and further separated relevant equipment such as switchboard rooms, transformer rooms, thruster equipment spaces, or compartments for DP control system, reserve piping and wiring.

DOI: 10.21279/1454-864X-16-I2-018

"Mircea cel Batran" Naval Academy Scientific Bulletin, Volume XIX – 2016 – Issue 2
The journal is indexed in: PROQUEST / DOAJ / Crossref / EBSCOhost / INDEX COPERNICUS / DRJI / OAJI / JOURNAL INDEX / I2OR / SCIENCE LIBRARY INDEX / Google Scholar / Academic Keys/ ROAD Open Access / Academic Resources / Scientific Indexing Services / SCIPIO / JIFACTOR

areas[9][4]. Normally, restricted areas on board are sensitive security areas such as navigational bridge, engine room, control rooms, compartments fitted with communication equipment, and specialized equipment that affect essential process of facility.

On the other hand, the possibility of outer-genesis threats realization is considerably high. Then, the source of a destructive process would be initiated directly on an outer surface in order to affect vital constructive element and to ensure that integrity would be disrupted. The direction, in that case, is from outside to inside. The attack would be centered especially on hull under water line, underwater location near propellers, rudders and bow thrusters, if the object is a platform, a rig or an auxiliary vessel. If the target is a pipeline, then position of explosive device would be placed directly on the pipeline or in its vicinity.

Depending on distance to the nearest shore and respectively on the water depth and environmental conditions in deployment zone, offshore objects possess distinctive characteristics of construction and, therefore, unique critical vulnerabilities.

The first group objects, deepwater drilling and producing platformsare situated in Offshore Development Areas (ODA) at considerable distance from the coast line.Normally, these particular areas are promulgated by means of navigational maps, hydrographic charts, notices to mariners, radio navigation warnings, fortnightly bulletins, etc. Distances vary from about 20 nautical miles or less to more than 130 nautical miles, depending on characteristics of continental shelf and water depths - usually below 370 meters. They are in Exclusive Economic Zone (EEZ) but out of the coastal states territorial waters. Protection of these objects has been matter of concern of United Nation`s International Maritime Organization (IMO) for years. Nowadays, safety zones are established automatically[10]extending 500 meters from any part of oil and gas installation. It is mandatory for vessels of all nations to respect them. It is considered as an illegal act (under section 23 of the Petroleum Act 1987) to penetrate a safety zone except under the outlined special circumstances[11].There following offshore objects are assumed to form the first group - Compliant towers (from 370 meters to 910 meters), Semi-submersible platforms (up to 3000 meters), Drill ships (up to 3700 meters), Tension-leg platforms (180 - 1300 meters) and fifth generation SPAR platforms (floating over 2400 meters of water), Floating Storage and Offloading (FSO), and shuttle tankers, Unit for Maintenance and Safety, and Towing Vessels.

The second group brings together objects positioned relatively close to the coast and therefore, they are in littoral zone, where the effects of terra firma and sea are interfered.Sea lanes are in vicinity of ODA and it is very important safety and security factor. Protection of above water projected fixed facilities or floating units is possible to be ensured by means of 500 meters safety zone and guard vessels. Requirements of ISPS-Code are applicable on fixed platforms for the production and processing of oil or gas in shallow waters. Waterdepthsaresuitable for Large and Small Conventional fixed platforms, Gravity Based Structures, Jack-updrillingrigs (to 120-170 meters), Self-Installing Platforms, Subsea Pipelines.

Offshore object, situated in ODA with depths up to 20 meters, are exposed on increased risk of IED-attack. Normally, they are placed in Territorial waters where the intensity of cabotage navigation is significant. There are invicinity approaches towards harbors and anchorages. Usually, there are fixed, natural gas production platforms. It is suitable zone for establishing Gas storage facility using seabed particularities. Some shallow water oil and gas platforms process subsea wellslinked to the project platform with export through offshore pipelines and onshore processing plants. Depths in range up to 20 meters are applicable for IED deployment by means of fishing boats, boats propelled by outboard motors, yachts, etc. Moreover, diver`s decompression procedures are simple and amateurish SCUBA diving apparatus are accessible enough. Hidden and unauthorized placement of explosive device is very realistic scenario of realization of threat.

[9] According to the requirements of ISPS-Code, controlled access compartments and restricted areas should be established on board and their extent, time duration of application and taken security measures are specified by the applicable Ship Security Plan (SSP).

[10] A 500 meters safety zone is established around any offshore facility in accordance with requirements of international maritime legislation such as the United Nations Conventions on the International Law at Sea, the Petroleum Act 1987, etc.

[11]Generally, exceptions are: 1) to lay, inspect, test, repair, alter, renew or remove a subsurface cable or pipeline in or near that safety zone; 2) to provide services for the installation, to transport people or goods to or from the installation, under authorization of a government department, or to inspect any installation in the zone; 3) if it belongs to a lighthouse authority and is performing duties relating to the safety of navigation; 4) to save or attempt to save life or property. When it is done due to bad weather or when in distress penalty is not statutory.

DOI: 10.21279/1454-864X-16-I2-018

Deepwater cross-border pipeline is offshore object with linear dimensions. It is also vulnerable by IED-attack when it is in shallow waters and in that part, where it emerges ashore. Besides, lines of maritime communications from any offshore physical object to specialized logistic shore-based infrastructure should be established. Thus, there are spatial zones where activities are concentrated on a single area into a short time. There and in ODA, the risk ofarising and realization of the threat is higher than elsewhere.

Impact of IED on vulnerabilities of offshore object could be projected upon figured out in duration of time critical spatial zones.Normally, there are multiple critical vulnerabilities in the zone. For example, critical subsystems, or particular critical elements, processes of drilling, producing or transferring personnel and logistic supplies are considered as attractive target to attack. So, IED-attack would be focused in spatial and in time aspects and it is a great possibility to initiate chain of uncontrolled causal events, so called "domino effect", with multiple synergic effects and aftereffects on safety, security and ecology aspects.

If offshore facilities are considered as probable targets of IED-attack, they have to be systematized in accordance with level of mobility for counteraction purposes. In fact, the mobility is very important factor that contributes to the result of impact. According to the ability to move or to be moved freely and easily in offshore environment, possible targets are divided as follows:

- **Mobile** - supportvessels (PSV, AHTS, CSV, DSV, Accommodation Vessels, Crane Vessels, Offshore Barges and SSBV) and shuttle tankers.

- **Unmovable** - All kind of bottom supported gravity-based fixed structures, Jack-ups, Compliant Towers, Jackets, subsea pipelines, inshore infrastructure.

- **Relatively unmovable** - broad spectrum of floating on the sea surface Drill-ships, Single Hull Platforms, Semisubmersibles, Tension Leg Platforms, SPAR, FSO vessels, etc.

Furthermore, analysis and estimation of environmental conditions surrounding above mentioned offshore objects shows that Fast Incoming Attack Crafts (FIAC), fishing boats with overall length not more than 20 meters or similar-sized sailing and propelled vessels, are probable platforms that could carry explosive devices. Another possible realization of IED-threat is intrusion on board of facility or violation of safety zone and restricted areas.Isolated cases are available when personnel are dispatched in advance on board and then it is a precondition for illegal intervention, violation or sabotage.

Intrusion on board offshore platform would have various realizations in accordance with the state of security environment. One of the most dangerous unlawfulactions is armed attack.It is possible scenario, a security incident to be provoked by terrorists armed with Small Arms and Light Weapons concealed among personnel during boarding next shift or delivering supplies procedures.

Used on board IED elements of offshore platform and in its inner compartmentsare not differ from those on shore. Generally, it is likely to consist of variety of components that include an initiator, switch, main charge, power source, and a container. Most of recently realized acts of terrorism point out that the space close to container or even inside the container, may be added materials that enhancethe effect such as nails, glass, or metal fragments designed to increase the strength of explosion. IED can be initiated by means of wide spectrum of methods depending on the intended target on board - by wire, fuse cord, timer or remote control.

Furthermore, used materials as explosive component probably are widespread over all maritime activities. Available materials are chemical or natural fertilizers, especially a nitrogenous derivates and ammonium nitrate, different types of gunpowder (found in carried signal equipment, pyrotechnics, and even fireworks), hydrogen peroxide, ethylene glycol dinitrate. Explosives must contain a fuel and an oxidizer, which provides the needed oxygen to intensify theexplosive conversion. A common example is ANFo, a mixture of ammonium nitrate, which acts as the oxidizer, and fuel.The scope of impact depends on its size, construction, and placement, and whether it incorporates a high explosive or propellant. The damage radius based on the volume or weight of explosive (TNT equivalent) and the type of device [8].

Effects of explosion in a superstructureor other compartment inside the hull may blow out windows; destroy walls; and shut down systems such as power, ventilation, damage control, and others. Evacuation routes may be disrupted or destroyed and then, arisen and smoke through stairways and ventilation. An IED-attack may cause disruptions in communication services control abilities or even integrity in constructive aspect, which may continue for days after the attack. A known tacticsare use of distraction actions, such as gunfire, small bombs, or other surprises, to attract personnel out of shelter, or to provoke them to get closer, and then to detonate

DOI: 10.21279/1454-864X-16-I2-018

a second destructive device at the gathering point. In an attack, there could be planning bombings at multiple locations. Search and rescue efforts can be hampered by the need to respond to more than one site. Secondary hazards are possible when the explosioncause ignition of highly flammable materials [8] and linked natural gas facilities, fuel reservoirs, storage tanks and production fittings.

An IED-attack could be conducted by vessel, yachtand other floating unit and drone that could carry explosive devices on board. It is possible a motor vessel, yacht or other floating unit to be hijacked, and subsequently to be deviated from fairway in vicinity of offshore facility.Used tactics depend on mobility and maneuvering capabilities of all evolved objects.

The hull would be partly destroyed in place of contact, if it concerns all types of floating structures. The impact is realized by means of kineticenergy of attack unit, possible combined with simultaneously conducted IED-attack carried by the same attack unit. Flood would be caused by chain of causation after collision. Possible consequences are waste of life and injuries, severe damages and financial harm. The leakage of hydrocarbons in water causes imminent risk to ecosystem.

Another impact might be focused on particular constructive element of unmovable or relatively unmovable offshore units. This is a variant of kinetic collision affecting jack ups with simultaneously or consecutive explosion of IED. These offshore drilling and production objects are extremely attractive targets due to lack of mobility.

Drifting on surface, remote controlled underwater, on surface and airborne drones could be used to perform an attack by carrying improvised explosives. The latter group of impacts project growing capacity to affect protection of offshore objects due to its hidden genesis, dormant evolution and sudden realization. Therefore, it is a threat that should not to be ignored. Potential targets of these drones are critical vulnerabilities on upper deck or main deck, "choke points" in superstructure and hull of the unit. Effects on safety include as serious injury and fatality, as financial losses, lowering the moral and motivation of personnel. Pollution of environment would be catastrophic in scope and affecting equilibrium of ecosystem.

Further, used in offshore environment IEDs have to meet a number of specific requirements, such as great deal of variety during process of obtaining materials, constructive particularities, and methods of delivery to the target. It is a reflection of human nature, so counteractions need to correspond to all essential aspects of IED-attack evolution, implemented in proper technics, tactics and procedures. IED in offshore environment, widely defined according to the concept of realization, including assembling, possible target and tactics, is an explosive devicethat is designed to affect personnel of particular facility or to cause unacceptable material or moral damages to personnel of the Operator, Maritime governmental andNon-governmental Institutions, etc. Patterns of description or fixed oversimplifiedstereotypes are hard to be found out via examination of assembling the device, origin of used materials and concept of attack logistics and approaches of delivery point out, that [8].

Normally, designated for offshore platform IED is consisted of traditional, widely spread out elements and diffused technologies.Regardless of that, the detailed analysis of recent incidents worldwide shows that even expensive and high-tech components would be utilized. There are several minimal requirements of IED construction and use in maritime environment. In other words, there are critical elements in functional aspect. Awareness about that is with crucial importance in respect of CIED planning process. There are following identifiable critical features on IED:

- Explosive compartment– It contains mostly high explosives[12] - low sensitive substances or mixtures, detonated usually by primary explosives, i.e. it is requiredconsiderably more energy to be initiated. It is matter of great importance to estimate the type of used explosives. Various chemicalcompounds such as nitro compounds (TNT, nitromethane, etc.), Nitramineexplosives (tetryl hexogen, etc.), Nitrates of polyol[13] (nitroglycerin, nitroglycol), cellulose nitrate, and the like, are used ashigh explosives, especially in Eastern Europe and Middle East areas. IED applicable in maritime environment would contain a large amount of high explosives, because of sizable constructive elements of targets. These explosives should be detonated stepwise in distinct stages due to theirs specific physical and chemical characteristics.

- Initiating and sensor section–It is fitted close to the explosive compartment and is designed to trigger the process of explosive transformation. Assembled sensors are used to accept and convert into initiating signal *apriori*defined external impact. There are following

[12] Explosive materials are categorized in respect of the blast speed. Materials that detonateare said to be "high explosives". For example, the front of wave during the blast moves with speed in range from approximately 5800 mps for TNT to8500 mps for C-4.

[13]It is an alcohol containing multiple hydroxyl groups.

DOI: 10.21279/1454-864X-16-I2-018

fundamental physical principles of actuate the unit. For example, common methods are usage of sensitive primary explosive such as **blasting caps**, which come in a variety of types, including non-electric caps, electric caps, and fuse caps. On the one hand,electric blasting caps are consistentlyverygood in quality and performance, so possess an ability to fuse the blast with high probability, and on the other hand are used in commercial mining, excavation works, demolition of shore objects, or often are utilized in specialized factories where an object of crime of stealing and illegal sales.Widespread wireless methods to transmit controlling initiating signal are detonation by means of specialized radio receiver or cell phone[14]. It is possible an appliance for measuring time to be used when IED is concealed on board. Another applicable method in offshore environment is contact fusing. It is based on realized physical contact between carrying platform and hull or supports of production platform. It is appropriate because of reduced necessity of power supply equipment.

-Power supplysection– Generally, a higher capacity accumulator battery would be used in offshore environment where it is required anextra endurance source of energy. Normally, the electronic equipment is consisted of series of distinct stage appliancesdue to requirement the triggering signal to be transmitted in stepwise manner – from sensitive primary explosive, trough primary explosives, and finally to detonating charge.Sensors have to be operational for a long time, to be reliable in order to avoid uncontrolled explosion, and to be relatively safety for perpetrators.Naturally, the initiating unit should be activated immediately before intended explosion. Any unadvisedly activity would doom the attack to fail, because delivery to target offshore takes a lot of time.

- Smite-enhancement section–There are a number of approaches used to increase the impact of explosion on personnel, facility and environment. The analysis and evaluation of attack consequences point out existenceof different "enhancements" [8]. The shock action would be bold by means of various pieces of metal or cheap small metal parts. The damage radius will be increased if fuel tanks or reservoirs with flammable liquids are exposed to the shock wave impact. Toxic materials and biological active substances are used during assembling so called "dirty bombs".

- Container and delivering platform – These elements have to ensure required capabilities to place the explosive compartment together with the initiating and sensor section, power supplyand blast-enhancement elements. Actually, they could be combined and integrated when the impact is intended by using adirectly hitting attack craft. First of all, the attackingvessel serves itself as a container, because entire amount of explosives could be stored on board during transportation phase and, after that are ready for realization phase. The carrying capacity of selected vessel ensures delivery to the facility. Next, initiating and sensor section would be fitted securely on board, protected from blows of winds, humidity and sea weaves damages. Definitely, it could be related to the power supply section and smite-enhancement section, too. Furthermore, there are many possibilities for multiplying the impact on target – for example, the navigation collision would lead to destructive changes of hull or another vital construction element, and after that an explosion of fuel reservoirs and added flammable product to be expected.For this reason, it is possible to be used outboard propelled rigid-hulled FIACs, as well as Rigid Inflatable Boats (RIB), rigid buoyant boat (RBB) andinflatable boats. It is not excluded to be involved into IED-attack stolen tenders, sailing yachts, fishing boats and even motor vessels.

Another aspect of defining CIED efforts is a rough estimation of used explosive quantity. It depends on number of factors. Determinative factors are the scope of expected impacts in safety, security and ecological dimensions ofenvironment; probable perpetrator`saccess to explosives and dual-use materials; training of perpetrators and last, but not least, possible offshore target constructive particularities.

Usually, effects could be drawn as a logical conclusion and proved by means of simulation. The IED-attack against offshore oil and gas platform would cause damage or destruction of particular constructive element with subsequent affection on the production process, or completely loss of the facility. The aim of attack could be devastation of ecological equilibrium of environment or at least, it would be unacceptable aftereffect.

Possible access to explosives and double-use materials are limiting condition and projected on perpetrator`s training, it is determinative for IED characteristics in quantitative and qualitative aspects. The detailed planning precedesan IED-attack.It includes gathering of target information and comprehensive analysis of critical vulnerabilities, such as type of object, construction

[14] Use of cell phone is more common onshore or seaward near the coast because of limitation posed by GSM coverage.

DOI: 10.21279/1454-864X-16-I2-018

particularities, environmental conditions, personnel, logistics, communications, taken security and safety measures, etc. Normally, perpetrators pay special attention to physical details of targeted facility and deep estimation of probabilities to affect any chosen vulnerability and to multiply consequences of impact. Constructive elements, mechanisms, gears and devices are carefully selected, such as large surface elements (a tin steel sheet of hull, a deck supported above the water, buoyant columns having an outboard surface, walls of living quarters), linear objects (pipeline, cable route, beams, derricks or support legs), etc.

An explosion close to hull steel sheet sets a good example of destruction a critical structural element, i.e. outside accessed critical vulnerability. Widespread thicknesses of commonhull`s sheets vary from 20 mm to 40 mm in accordance of approved international safety requirements. It depends on a facility`s type, a scantlings and a factor of safety[15][11]. Obviously, perpetrators need of information concerning above mentioned details broadened by damage control capabilities such as description ofdamage control appliances available on board, details of Ship Security Plan, Damage Control Plan, and other related to safety and security documents [4]. It is to say, that they would make an estimation concerning the size of hole in the hull of floating platform so that the caused water flood to be sufficient for complete flood of a large compartment, or several fragment compartments, andsubsequent loss or disruption of buoyancy of entire facility.Admittedly, the final state would be unfavorable impact on production process and its subsequences such as injuries or fatalities, financial loss or harmed company reputation, destabilization of security, ecological crises, or synergic combination.

On the one hand, it is reasonable in term of CIED efforts, the formed offshore IED system to be represented by its elements "Container and delivering platform", when the source of threat is situated fare out of safety zone in so called "monitoring zone". They are the largest elements of the system and, therefore, have got the most detectable physical field. Its components, such as magnetic field, hydro acoustic field, optical field and radar field, could be detected during monitoring. Detected clutter has to be considered as indicator of probable source of threat existence.

On the other hand, the analysis of access to double-use materials gives an important point of reference for decreasing the security ambiguity. When projecting possible technical realizations and gathered statistic information of Naval Forces, Border Police, Customs Authorities for prevented traffic of illegal goods or preventive detention, upon currently revealed indicators of security environment state, it would become possible an imminent IED-attack to be brought to light.

Next, it is important, the IED-attack to be presumed as IED-system, that includes several functionalaspects. It is just an "outcrop" of IED-attack realization. For that reason, assets of specialized authorities have to be based on comprehensive proactive activities.They have to influence nearly all elements of the system and tofocus impact on links and relations between system`s elements. Actually, important elements of IED-system are perpetrators itself, as well as a specific logistics and procedures for manning and acting. The planning process, motivation of doers, logistic support and coordination are conducted by quasi-control cell, and therefore, early warning is hard to be reached [8]. The IED becomes a powerful instrument of contemporary"net-of-nets" terrorist structures and transboundary organized criminal groups to affect security on all levels [15].

The implementation of system approach during scientific research of realization of IDE-attack shows that system elements, relations and linksbetween them are changing in random manner. Nowadays, relations between elements are shaped as network-centric or as the most effective network-of-networks [8].The impact on them has to be also dynamically oriented, adequate to changes of all environmental aspects and adapted to threat evolution.The adequate counteraction of an IED-system is related with setting a scale, spatial and dimensional frameworks that form a comprehensive modelof IED in offshore security environment.

In addition to that, the Five-level Security Model[16] [15] is applicable when CIED efforts are refined by authorities. It influences the scope of effects upon offshore security environment, as follows:

- Every one offshore security incident, caused by realization of IED-attack, has got a reflection on the lowest security level. The security of individualshas got an expression in aspectof "safety", i.e. an effect on individual safety. The

[15] The *factor of safety* is a design criterion, a dimensionless quantity that a particular constructed element should achieve. Generally, the factor of safety is equal to ultimate stress (N/m^2), divided by the applied stress (N/m^2)[11].

[16] Levels are designed as a part of a model of security environment – personal security, security of a group, national security, regional security and global security.

DOI: 10.21279/1454-864X-16-I2-018

realization of stochastic "unfavorable event" such as explosion of improvised device leads to injuries or fatality and human rights violations, at all. Affected individuals are single members of crew on board platform or vessel, personnel, passengers, including tourists on board luxury yachts or fishermen.

- The IED-attack has security implications for given group of individuals[17] and it is clear enough to be recognized as security phenomenon on company level. The security of group concerns those effects, which are directly linked with operation of offshore companies, engaged in offshore activity - Drilling contractor, Service Company, or suppliers.It relates with inner security environment of company. There are economic, social and environmental consequences, distinguished on level two. Company activities should be adapted by resource management according changes in security environment.

- The IED incident in offshore zone has not got a direct impact on national security. However, effects causing by multiple IED-attacks against offshore objects or other objects of maritime critical infrastructure superpose influence of national security.Large scale oil spill influences biodiversity and tourism.

- CIED efforts on regional level aim to break links and relations between elements of the system. Counteraction against transboundary illegal activity would be effective on this level if there are sound cooperation and mutual understanding of security environment particularities between neighbor and allied countries. Characteristics and long term tendencies are identified there, so as possible approaches for optimization of CIED efforts. Conditions for evolution of threat are linked particularly with exterior security of government [15].

Standard procedures are crucial factor in reducing the risk. Usually, standard operational procedures are promulgated by national publications. In order to improve cooperation between interacting nations and allies, procedures are promulgated by bilateral or allied publications. Successful efforts in offshore zone require comprehensive approach and forming favorable conditions for cooperation between governmental institution and other related non-governmental organizations [8]. Actually, there is institutional vacuum out of territorial waters. Changing security poses significant challenges to naval forces. They have to possess capability to act independently as well as to cooperate with Maritime Agencies, Border police and Customs Authorities, when needed.

The CIED effort is a sophisticated complex of proactive and reactive actions.Its effectiveness increases,when there are as well organized C4ISTAR[18]frameworkstructure,as it is possible, trained personnel, standard procedures and acceptable in quality or quantity logistic support. These activities are sharp-pointed especially against realization of threat for personal and public security. The hybrid character of the IED threat underlines requirements for widely based cooperation between military units and non-military experts. For that reason, the importance of maritime operations and joint exercises against IED threat will be expanded and become more detailed in near future – for example counter-IED efforts inside the framework given by operations for protection a maritime critical infrastructure, control of traffic of weapons and illegal goods and counter-terrorism [6, 16].

Contemporary security environment is complicated and it is consisting of many phenomena. The process of maintaining capabilities to counteract IED-attacks and to protect offshore industry facilities could have bold deterring effect, so it is key approach toward reducing the risk of IED offshore. Countermeasures are effective when all authorized by international and national low participants in the process are completely involved, and dedicated to the idea of solving problem. It includes activities aiming influence on physical and moral sources of threat, revealing structure of terrorist organizations and theirs dormant cells, as well as prevention of illegal traffic of double-use materials and physically neutralization of explosive devices, and mitigating consequences. It is crucial, capabilities and interoperability between governmental and non-governmental institutions to be developed constantly [6, 16].

Effectiveness of CIED efforts in offshore zone should become more extensive using sattelites. Satellite monitoring systems and long range monitoring systems are applicable for monitoring of coastal and offshore zones. These systems have got a wide spectrum of capabilities in ecological monitoring, control of shipping and prediction of movement of surface objects. It is

[17]For instance, it is a crew of supply vessel, personnel of drill ship or employees on board production platform - technical, supervisory and management personnel, etc.

[18] C4ISTAR it is an architecture framework designed to focus defense capabilities (Command, Control, Communication, Computers, Intelligence, Surveillance, Target Acquisition and Reconnaissance).

DOI: 10.21279/1454-864X-16-I2-018

possible to use existing systems, such as CleanSeaNet (designed to enhance maritime safety and security, ecological monitoring and efficiency of maritime transport)in cooperation with European Maritime Safety Agency (EMSA) [1].

Another option is internet based system*Seatrack Web (STW)*. It is oil drift forecasting system. It consists of three modules – a meteorological forecast, an oil-drift model and a graphical user interface. It has got capability to do analyses of past performance and estimates based on voyage predictions of vessels, along with oil spill monitoring. The on-line available custom application is named Fleetweb[10].

BlackSeaTrackWeb (BSTW) is an oil-spill modeling system. The system is based on the STW-model, using open source Geographic Information System (GIS) server technology. It is adapted to the Black Sea conditions and it is observing system which is implemented to regional crisis management plans. It supports the search and rescue process and has got detailed data base of sea currents. The access to the system is carried through internet. There are capabilities to monitor sailing vessels in the region and to contribute to enhancement of security [9].

Systems for monitoring of coastal zone supplement satellite monitoring systems. They are also based on GIS. For instance, the Integrated Safety Offshore System (K-Safe) or Information Management System (K-IMS) developed by Kongsberg MaritimeCompany. Available system that has a lot of integrated informational layers for complex safety and security of harbors and open sea areas is developed by TRANSAS Company, etc.

Furthermore, the risk of IED-attack offshore could be reduced by decreasing the level of uncertainty.It is possible by means of threshold of accessibility to IED`s components thus limiting possibilities to assemble and use successfully explosive device.The accessibility is defined by technological complexity of fitted components, governmental capability to control trade of double-use goods, ergonomics and simplicity in use,and correlation between price and achieved effect.The following implications could be figured out taking into account particularities of IED in offshore environment and accessibility:

- There is a high probability of hi-tech components usage, especially in initiating and sensor section (micro controllers, processors, L-band, K^u-band and K^a-band communications[19], etc.). It brings quality characteristics of IED.
- The use of widely spread double use materials is possible in explosive compartment ("ceramic explosives" which are mixture of Al_2O_3 with Hexogen or Penthryteor Ten, Ammonium Nitrate and Fuel Oil- ANFO, etc.).It incorporates quantity characteristics of IED.
- There is possible use of cheap common materials in assembling smite-enhancement and power supply sections (Deep cycle and Starting Batteries, Thin Plate Pure Lead and Lithium Batteries, etc.).
- Container and delivering platform is probably the most expensive and traceable element. For that reason it should be expected that it would be seized before attack.
- Simplified and ergonomic devices are precondition for attracting a broad range of collaborators and to make easy their training and preparation to attack.

In summary, it should be said that being familiar with vulnerabilities of each type of offshore object, it reduces the risk of realization of IED-attack. The process of assembling an explosive device in offshore environment requires specific maritime knowledge about navigation, technical skills, excellence in explosives and communications. These severe requirements make the closed circle of suspects very traceable, but it is extremely hard to reveal IED-attack without proactive counteractions. The process of assembling needs of large amount of explosives and hi-tech equipment. So, these adverse activities leave distinctive "footprints", which authorities have to follow. There are also outlined challenges, linked with collaboration between governmental institutions and stakeholders in reference to offshore security and countering terrorist attacks.The usage of standard operational procedures and sharing of specialized information optimizes interoperability and reduces security risks.

[19]Satellite communication Ultra High Frequencies are as follows: L-band (0.5-2,0 GHz), K^u-band (10.9-17,0 GHz) and K^a-band (18-31 GHz).

DOI: 10.21279/1454-864X-16-I2-018

BIBLIOGRAPHY

[1] Directive 2014/100/EU of the European parliament and of the council // Official Journal of the European Union, 57, 2014, p.82-87.
[2] Eurasia Drilling Company: RIG fleet specifications.Available on 20 April 2016 on <http://www.eurasiadrilling.com/media/57203/ASTRA%20Specifications.pdf>
[3] Georgiev, Georgi. Prospects and Challenges for Oil and Gas Exploration in western Black Sea //International Scientific-Applied Conference “New Technologies in the Offshore Industry”, Varna, 2013, p. 13-25.
[4] International Ship and Port Facility Security Code (ISPS Code), International Maritime Organization (IMO). London, 2003.
[5] Klaoudatos, L. Station Keeping for Deepwater Offshore Drilling Units; an Economic and Operational Prospective, available on 20 April 2016 <http://www.maritimeeconomics.com>
[6] Kolev, Kiril. Management of maritime security. Varna, 2014.
[7] Kolev, Kiril. Upravlenie na bezopasnostta na morskia transport. Varna, 2012.
[8] Hunter, Jane.Tracking IED harm, p.40.Available on 20 April 2016 <https://aoav.org.uk/wp-content/uploads/2015/03/ied_data.pdf>
[9] Kubryakov, Korotayev, Thoorens, Liungman, Ambjorn. New tool for the Black Sea environmental safety: BlackSea Track Web // EGU General Assembly 2012, 4, 2012.
[10] Liungman, Mattson. Scientific documentation of Seatrack Web; physical processes, algorithms and references, 2011, 32 p.
[11] Lloyd’s Register (1997), Classification of Ship Rules and Regulations, Notice No 3: Effective Dates of Latest Amendment, London.
[12] Lorenz, Akiva J. Al Qaeda’s Maritime Threat, Maritime Terrorism Research Center, 2007, 22 p.
[13] Offshore Oil and Gas Resources Sector Security Inquiry. Office of the Inspector of Transport Security, Common wealth of Australia, 2012.
[14] Pawlak, Patryk.At a glance // European Parliamentary Research Service, 2015.
[15]Slatinski, Nikolay. Pette niva na sigurnostta. Sofia, 2010.
[16]United Nations Convention on the Law of the Sea (UNCLOS-1982),1982.

DOI: 10.21279/1454-864X-16-I2-018