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MODERN TORPEDO COUNTERMEASURES FOR WARSHIPS

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AIM

1. The aim of this paper is to highlight the importance of the installation of a heavyweight torpedo countermeasures system on board any Navy's surface ships, in order to improve their survivability during operations under submarine threat. This paper will also recommend the generic composition that a torpedo countermeasure system (soft-kill) should have, according to the actual capabilities of the torpedoes launched by submarines.

INTRODUCTION

2. From all of the principles of war, the most exploited by submarines is surprise; to do that, the whole crew will do its utmost to avoid revealing its presence, until the moment of a torpedoes' release. Today, it is not only submarine stealth that has been enhanced to maintain surprise, but heavyweight torpedoes (HWT) technology has also been improved, in order to achieve better results, increasing the damage threat to warships.

3. According to Global Firepower, forty navies of the world officially operate submarines[1], so the probability for a warship to face a torpedo threat in the assigned operation area is very high. Surface ships are high value assets for any navy, because they not only carry expensive equipment and weapons, but also a high number of trained crew, which gives the capacity to complete their defined roles. To accomplish any task, warships are required to avoid damages that can negatively impact their main capabilities, which include, among others, torpedo defence systems.

[1] Global Firepower, "Submarine Strength by Country", accessed 02 February 2015, http://www.globalfirepower.com/navy-submarines.asp.

4. This paper will highlight the importance of fitting Navy ships with a torpedo countermeasure system, as well as to describe a generic system required to counteract the main capabilities of actual torpedoes. The first part will focus on describing the type of torpedoes that need to be counteracted, by analyzing the main capabilities of them. It will then explain why standard anti torpedo measures are no longer enough to counteract torpedoes. Finally it will propose the main components a torpedo countermeasure system should have to improve its survivability under submarine attack threat.

DISCUSSION

Defining the Threat imposed by Modern Torpedoes

5. In order to define the countermeasures required to be implemented on board surface ships, first we will describe the threat imposed by modern torpedoes to warships. To support this, the main capabilities of a generic modern torpedo will be described, by using the main unclassified capabilities of the "Black Shark Torpedo"[2] integrated by the Chilean Navy on board their two types of submarines. Modern torpedoes referenced will include those capable of being launched at any depth, with self-contained processors and acoustic detection devices, carrying acoustic or magnetic fuses, and finally with the capability to remain connected to the launching submarine by a control cable during all or part of the run.

6. Most of the navies operating submarines utilize HWT as their main weapon against surface ships[3]. What really makes HWT extremely dangerous is the sum of many new capabilities integrated in a single weapon, such as:

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[2] Jane's Navy International, "Big hitters: heavyweight torpedoes follow an incremental course", accessed 02 February 16, http://www.janes360.com/images/assets/551/51551/heavyweight_torpedoes_follow_an_incremental_course.pdf

[3] Naval Strike Forum (Lexington Institute) Aircraft Carrier (In) Vulnerability, accessed 03 February 2016, 20-21 http://lexingtoninstitute.org/wp-content/uploads/aircraft-carrier-invulnerability.pdf.

a. More efficient propulsion systems, which in addition to high endurance batteries and navigation control devices, permit the weapon to achieve speeds up to fifty knots, making it able to counteract the highest speed of an evading surface targets. At the same time, propellers associated to those systems were also enhanced, making the whole weapon not only faster, but also harder to detect with normal acoustic hull- mounted sonars.

b. Inertial navigation systems connected to high precision depth sensing devices provide tri-dimensional navigation capability and high accuracy in shallow waters, which contribute to performing attacks close to ports and coast lines, where surface ships normally search for anti-submarine (ASW) protection.

c. Higher effective range, which improves the time the weapon can spend in the water prior to the attack, performing maneuvers either to remain undetected, searching for targets and conducting their own search and re-attack programs. This imposes a greater challenge to surface ships, because submarines do not need to approach as close as before to launch torpedoes, making them harder to detect and allowing them to keep the initiative.

d. Enlarged wire guidance capability, through optic fiber cables, giving the capability to the torpedo to remain connected to the launching submarine for greater distances and exchanging high volumes of information. This helps to neutralize the main problem of the fire-and-forget weapons, which in the case of a bad pre-setting, they can miss their targets after being launched. With this kind of device ships' evasive maneuvers can be better avoided, because specialized

operators can correct the torpedo's navigation parameters at any moment, as well as to re-program its run according at any moment to best follow the attacked ship.

e. Self-homing programs associated to advanced acoustic heads (incorporated sonar), which in case of a wire-guidance cable cut, will allow the torpedo to continue its own target approximation, by using different search and attack patterns. For surface ships, this implies that although the submarine is forced to evade, forcing the operator to perform a torpedo guiding cable cut, the weapon will remain in the water with high probability of impact.

f. New acoustic and magnetic influence fuses produce the torpedo explosion under the ship's keel, generating much more damage than before.

g. Improved electronics, linked to fast signal processing, which provides high target discrimination and anti-acoustic countermeasures capability (ACCM) to the torpedo.

7. Finally, we can state that at present, surface ships are facing a bigger threat generated by more destructive torpedoes, capable of counteracting evasive maneuvers even in shallow waters. Larger effective ranges improve surprise effect and the capability to remain controlled from the launching submarine, helps to enhance hit probability. Moreover, performance acoustic heads in addition to faster processors, gives the torpedo high target discrimination capabilities and hit probability.

8. Knowing the threat imposed by modern torpedoes, the next step will be to analyze why conventional countermeasures are no longer enough to avoid impact on ships.

Conventional Devices and Actions are not enough against Modern Torpedoes

9. Conventional devices include sonars mounted on the ship's structure (known as hull mounted arrays, HMAs), towed countermeasures arrays and static jammers or target generators launched from the ships. Conventional actions are maneuvers executed by the ship to avoid an incoming torpedo, including changes of speed and course. The most important action to be performed in order to apply any torpedo countermeasure is to detect the incoming torpedo; also the higher detection range, the greater time we will have to react against the weapon.

10. HMAs installed on board warships (see Figure 1) can operate mainly in two modes in order to perform underwater detection, active or passive. The first refers to transmitting active acoustic pings which travel through the ocean until they touch and reflect back to the transmitter, and, the second consists of analyzing the noise patterns by listening to the environment near the ship through hydrophones. To detect submarines, sonars are normally operated in active mode, because their radiated noise level is very low, and in passive mode its discrimination ability is difficult.

11. If the decision is to try to detect torpedoes, then the sonar must be switched to passive mode, because the combination of radiated noise and size of those weapons (smaller and noisier than a submarine) make them not detectable in active mode. As the main priority for the HMA will remain always on trying to detect submarines before torpedoes, it will normally be operated in active mode. Another problem for HMAs is that they are very affected by the ship's own radiated noise, so when sonars operate in passive mode, they are very perturbed, impacting negatively in the process of target discrimination.

12. In summary, the most important goal for the surface ship is to perform continuous submarine search and at the same time keep the capability of torpedo early warning. The only way to achieve both capabilities at the same time is by installing an independent torpedo sensor.

Figure 1 – Example of Hull Mounted Array (HMA)
Source: Military & Aerospace Electronics[4]

13. Torpedo towed countermeasures are devices that are placed some meters behind the ship propellers, with the aim to perturb torpedoes' acoustic heads (Figure 2). The main problem associated to this kind of systems is that they work radiating constant noise, at fixed frequencies levels, and they are not far away from the towing ship. A modern torpedo will receive the noise generated by this device and may interpret it as a valid target, beginning its pursuit. There are two main problems to the effectiveness of this countermeasure:

a. First the torpedo remains linked with the submarine, who continues tracking the ship under attack, with the operator guiding the weapon to the ship and not to the countermeasure.

b. Second, if the torpedo finally attacks the countermeasure, due to the small sonar section, it will not generate the explosion and will label the contact as not valid. All this will happen very close to the surface ship, generating a high probability for the torpedo to detect it and perform a valid attack.

[4] Available in http://www.militaryaerospace.com/articles/2014/12/ctg-sonar-transducers.html.

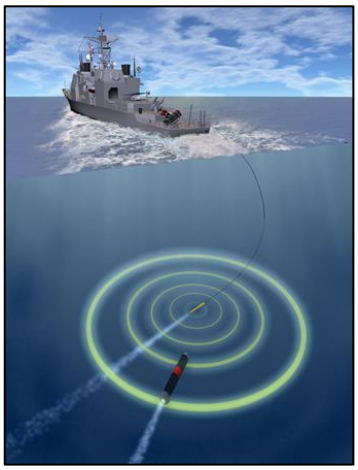

Figure 2 – Example of Towed Torpedo Countermeasure
Source: The Military Officers Association of America[5].

14. Static jammers and target generators (decoys) launched individually from ships are very similar to the towed countermeasures; the only difference is that they do not remain attached to the surface ships. Jammers generate high level of noise in a broad frequency band to confuse the torpedo's acoustic head (Figure 3), while target generators create new targets close to the ship in order to confuse the torpedo processing system. The main problem associated to these devices is that they cannot move, generating a static high level radiated noise source in the water. Modern torpedoes can process the target information and distinguish static sources, labeling them as not valid contacts.

15. Finally, although decoys can give some more time to the ships to perform a maneuver and try to evade the torpedo, it will not assure the required survivability, because the ship will increase its speed, what will bring as consequence an increment on its radiated noise. This will be detected either by the submarine or the torpedo.

[5] Available in: http://moaablogs.org/message/2013/05/mil-tech-nixie-is-integral-part-of-u-s-navy-torpedo-defense-system/

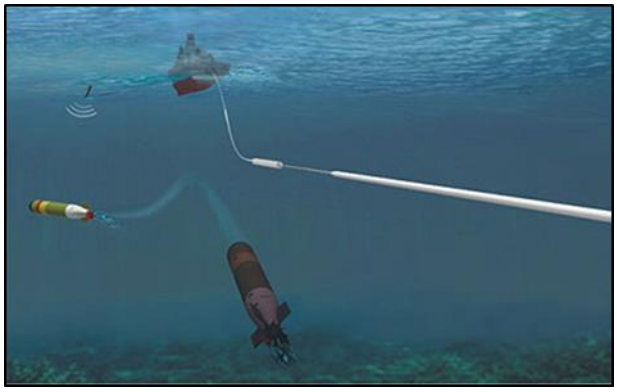

Figure 3 – Example of Torpedo heading to a Decoy
Source: Pakistan Defence Forum[6].

16. In this sub-section it was demonstrated that conventional devices on their own have a low probability to defeat a modern torpedo, meaning that these, alone, are not enough to improve the ship's survivability, under torpedo attack. Now we will focus on what is required by a warship to counteract modern HWT.

Proposed Layout of an Integrated Torpedo Countermeasure System

17. In the analysis above, we concluded that modern torpedoes are a dangerous threat for warships and, at the same time, conventional devices carried by those units are not enough to provide an adequate defence against this type of weapon. This part of the paper will propose an integrated torpedo countermeasure system, required to increase the probability to defeat incoming torpedoes. The term integrated refers to the capacity to interconnect different devices in order to generate one common reaction (See Figure 4). This reaction must include the ship's maneuver, in course and speed, necessary to keep or increase the distance with the torpedo.

18. The proposed system should be integrated by three main components[7]:

a. Sensors, independent from the ship's main sonar, in order to detect, classify and calculate the trajectory of the incoming torpedo. It is important to state that in the

[6] Available in: http://defence.pk/threads/aselsan-hzr-surface-ship-torpedo-defence-system.119022/
[7] Operational Analysis on Torpedo Defence

case of detecting a torpedo, the priority will change from detecting the submarine, to avoid ship's damage, and the HMA can be switched to passive, in order to support the determination of the torpedo location.

b. Central processing unit, which receives information from the sensors and provides advice on the best maneuver the ship should perform, in order to increase distance with the torpedo, as well as to define the best combination of jammers and decoys to confuse the torpedo as much as possible. This unit should be able to generate a reaction with jammers and decoys in automatic and manual mode, because this will help to gain some time.

c. Jammers and decoy launchers, which should be fired in a programmed sequence, with the aim to divert the torpedo, while the ship continues to enlarge distance.

19. As Navies around the world operate differently, the way they combine these three main components of the integrated system can be different, but the most important is to detect the torpedo early, react with the ship, and at the same time launch the best configuration of jammers and decoys in order to confuse the weapon's logic as much as possible. A very valid tactic used by some Navies is the snapshot, which consists of launching a torpedo from the ship against the submarine, as soon as an incoming HWT is detected. Although the submarine could be not detected, the noise generated by a lightweight torpedo (LWT[8]) will cause at least a reaction, for example to cut the wire guidance cable and initiate the evasion, which will oblige the torpedo to follow its internal logic, increasing the possibilities to counteract it.

[8] Lightweight torpedoes are used to attack submarines.

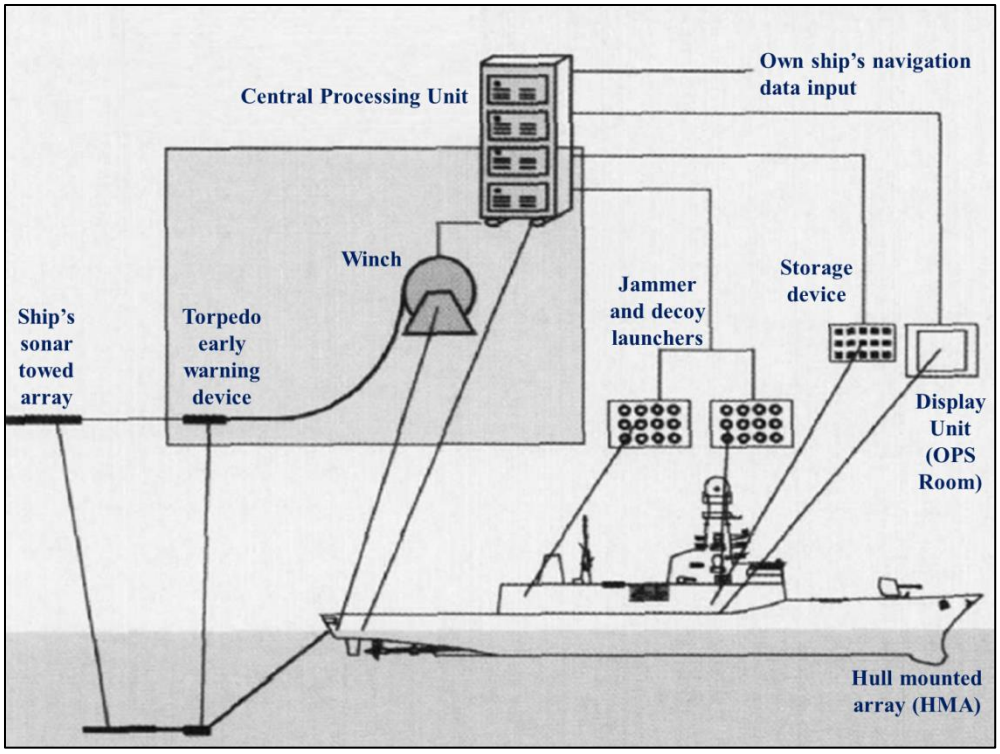

Figure 4 – Example of Integrated Torpedo Countermeasure System
Source: Naval Forces, Naval Forces N22 (5), 2001, p.19. (Adapted by the author)

CONCLUSION

20. This paper has analyzed the importance that a Navy fits its ships with a torpedo countermeasures system, in order to increase their survivability during operations under submarine threat. Three main points were discussed, first, the threat that modern torpedoes represent for warships, second, the reasons why conventional systems are not enough to protect surface ships from torpedoes, and, third, the way how an integrated torpedo countermeasures system should be composed to achieve its goal to avoid a torpedo impact on their own ship.

21. Regarding the modern torpedo capabilities, it was proven that today they are more destructive, can reach greater distances under effective control from the launching submarine, and have greater detection and discrimination capability, which also increases its hit probability. According to the aforementioned new capabilities, it was demonstrated that conventional stand-

alone capabilities, although they can achieve some weak results, are not enough to ensure the required integrity of ships under torpedo attack.

22. Finally, the basic layout of an integrated torpedo countermeasure system was presented and each component was also explained. The most important conclusion is that integration plays a key role, because it permits the reaction to be concentrated on one main system, which receives the required information from the incoming weapon and at the same time gives advice on the way the ship can be maneuvered to keep or increase distance with the weapon. It also recommends the best configuration of jammer and decoys to be launched, in order to confuse the torpedo logic.

23. If a Navy needs to keeps their ships' integrity to perform the required tasks that will contribute to accomplish the mission, a torpedo countermeasures system should be fitted, in order to increase its survivability while operating in areas where submarine threat is expected.

RECOMMENDATIONS

24. The following recommendations result from the analysis presented in this paper:

a. Perform a detailed technical study, according to the type of ship to be fitted with an integrated countermeasures system and the torpedo necessary to be counteracted.

b. Decide the type of system to be developed or purchased.

c. During the process, consider to contact the same enterprises that produce HWT, in order to get more specialized information.

Figure 4 – Effects of Modern HWT on Surface Warships
Source: www.reddit.com[9]

[9] Available on https://www.google.co.uk/search?safe=active&biw=1366&bih=623&tbm=isch&sa=1&q=impact+of+the+ADCAP+Torpedo&oq=impact+of+the+ADCAP+Torpedo&gs_l=img.3...2210279.2215825.2.2216251.27.16.0.0.0.0.0.0..0.0.....0...1.1.64.img..27.0.0.1z3fDxvt0Vc&bav=on.2,or.&bvm=bv.113370389,d.cGc&dpr=1&ech=1&psi=VHOzVrz4JdHCjwOu2764Dg.1454601046397.5&ei=jnOzVtfvCcire83KpsgP&emsg=NCSR&noj=1#emsg=NCSR&imgrc=LTXc6vaus2u1GM%3A

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operational.pdf&usg=AFQjCNHmIiDy_VpygpZrUbUvKcac1npt7g&bvm=bv.113034660,d.amc.

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