HOW TO COUNTER A WBIED ATTACK

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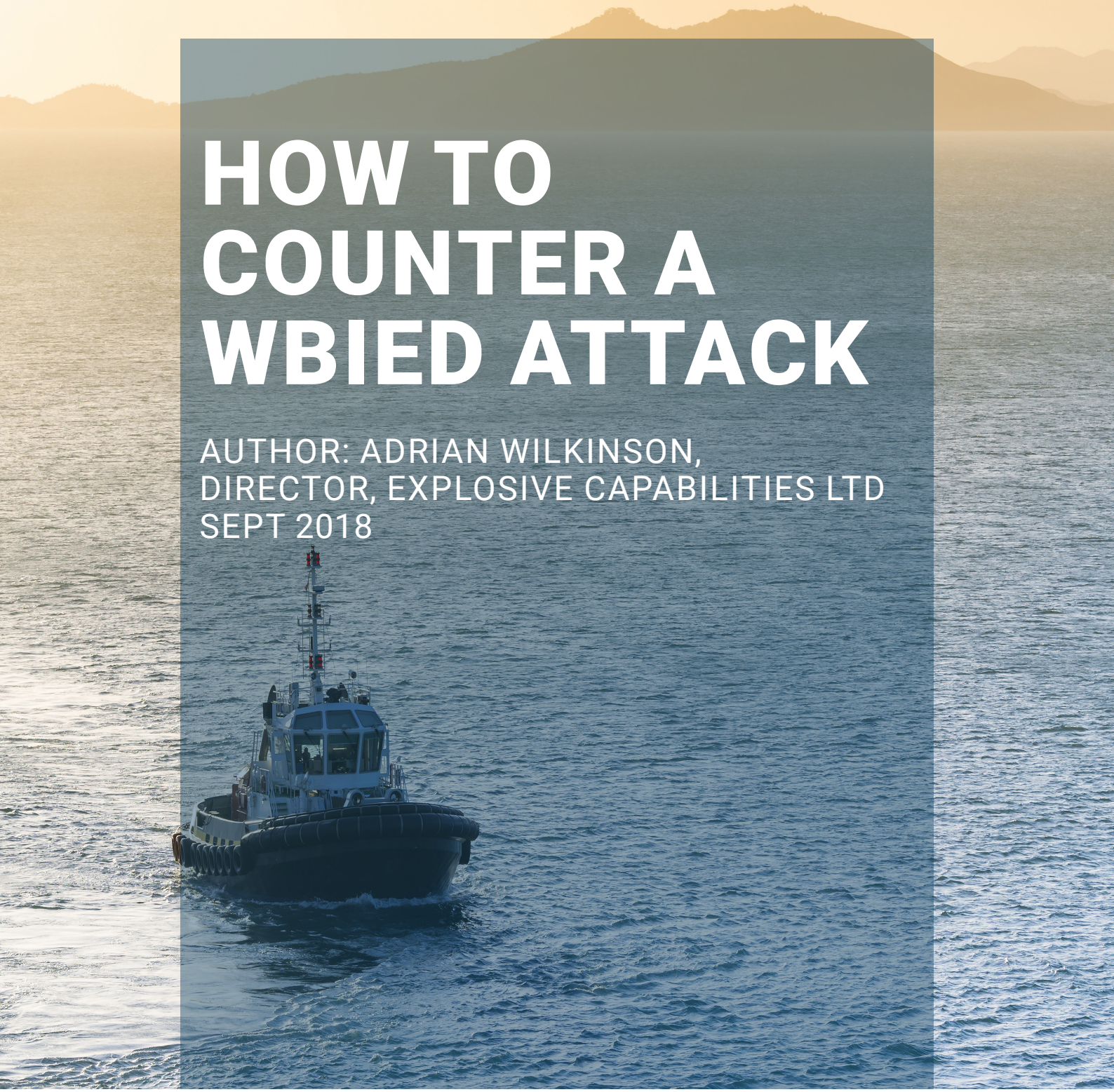
SEPT 2018



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ARX

KEY POINTS

The emergence of the Houthi waterbourne IED (WBIED) threat in early 2017 presents challenges for the protection of commercial shipping in the Red Sea and Straits of Bab al-Mandab.

It is HIGHLY LIKELY that the Houthi still maintain the capability to deploy WBIEDs immediately.

Section 2 of BMP5[4] states that a WBIED attack is likely to involve one or more speedboats operated by a number of individuals approaching and firing both small arms and RPGs.

The incoming speed, small cross-sectional area of vulnerable points and closing profile of a WBIED makes it a particularly challenging target for kinetic attack with small arms fire. Although single shot rounds should theoretically provide better accuracy, the closing speed and angles of approach means that automatic fire may be a more appropriate response to ensure disablement.

The kinetic attack of the WBIED outboard motors using small arms ammunition is therefore not a recommended technique to defeat an incoming WBIED attack.

The kinetic attack of the warhead using small arms ammunition is therefore not a recommended technique to defeat an incoming WBIED attack.

It is HIGHLY UNLIKELY that PCASP on board a vessel could guarentee to hit the 0.26m2 frontal target area of a WBIED outboard motor moving at over 30kts and shifting due to wave motion. If the WBIED outboard motor were to be engaged at 500m then the PCASP would have less than 30 seconds, equating to less than 10 well aimed shots, to hit the target. The consequences of failure to hit being potentially catastrophic.

SITUATION REPORT
(Defining a Crisis)

Introduction

The emergence of the Houthi waterbourne IED (WBIED) threat in early 2017 presents challenges for the protection of commercial shipping in the Red Sea and Straits of Bab al-Mandab. The threat has continued throughout 2018, with the most recent interdiction of an attempted WBIED attack being on, or about, 7 September 2018.[1]

As the WBIED platform is effectively on automatic pilot, and hence unmanned, the disablement of technical systems within the WBIED, or destruction by sinking, present the only real options for interdiction. There are no crew members to deter or engage. Whilst military vessels are well equipped with Close-In Weapon Systems (CIWS) and armed helicopters to interidict this threat, the practical protection available for commercial vessels is much more limited.

The Houthi designed WBIED (2017) were all deployed on the Al Fattan 10m Patrol Boat platform [2] until the 7 September incident, where a new design (WBIED (2018)) was used. Prior to the current Yemen conflict the United Arab Emirates had donated sixty Al Fattan vessels to the Yemeni Navy.

To date there has been one confirmed attack against a Saudi Navy vessel, two attacks on ports in Yemen and a number of unconfirmed interdictions by the Saudi Arabia-led coalition. It is therefore HIGHLY LIKELY that the Houthi still maintain the capability to deploy WBIEDs of these types.

This "Quick Look" report examines the technical threat, interdiction options and makes recommendations for the technology to be considered by private maritime security companies (PMSC) and privately contracted armed security personnel (PCASP) on board ships.

Figure 1: Houthi designed WBIED (2017)- Image courtesy CAR

Figure 2: Houthi designed WBIED (2018)- Image courtesy AI

IDENTIFYING PARAMETRES[3]

Section 2 of BMP5[4] states that a WBIED attack is likely to involve one or more speedboats operated by a number of individuals approaching and firing both small arms and RPGs. Yet on the evidence to date for Houthi attacks, the attack on the RSN Al Madinah on 30 January 2017, a single unmanned craft was used.[5] The design of the Houthi WBIED (2017) allows for a remote modus operandi, with the crew leaving the WBIED once in optical range of the target vessel. Table 1 considers the threat parameters to be considered for the development of interdiction and disablement options:

Table 1
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FACTOR	DATA	REMARKS
Speed	- Maximum 45 Knots (20.6 m/s) - Highly manouverable	The target vessel cannot "outrun" the WBIED. At 45 knots maximum speed the WBIED is travelling at 2.5 times the velocity of the 18 knots typical cruise speed of VLCC 6
Approach Profile	- 2.3m Breadth -10m Length -1.0m Height above water	Presents a 2.3m 2 Frontal Target Area for a direct approach by the WBIED. As the range decreases the Target Area will increase as the deck of the WBIED becomes visible.
Target Acquistion	- TV camera mode - Auto-pilot mode	In camera mode the WBIED will "lock on" to the target vessel and change course automatically to keep the target in camera view. In auto-pilot mode, the WBIED will follow a pre-loaded track. This mode would not be used to attack ships in transit, but was certainly used in a harbour attack against Mukha, Yemen, on 12 August 2017.

Vulnerable Points for Potential Disablement

Vulnerable points for kinetic attack options to attempt disablement of a WBIED (2017) are limited and are summarised below.

Table 2:

FACTOR	INFORMATION	REMARKS
Hull	- 2.3m Breadth[7] - 1.0m Height above water	2.3m^2 Frontal Target Area, increasing as range to target decreases.
Warhead[8]	- 454kg High Explosive RDX[9] -Shaped object	- 0.45m^2 Frontal target area - HEDP (High Explosive Dual Purpose) - 726.4kg TNT equivalence - Kinetic perforation[10] of the 38mm thick shaped charge (ballistic disc) liner[11] is required to hit the explosive content.
Power	- 2 x 200HP L200A Yamaha	- 0.2m^2 Frontal target area[12]
Remote Pilot	- Computer module	- Destruction would disable the optical tracking system.
TV Camera	- Mounted in perspex dome on mast	

IDENTIFYING PARAMETRES

Primary Factors for Potential Disablement

Successfully interdicting a vulnerable point on an incoming WBIED will be dependent on the primary factors in Table 3.

Table 3:

FACTOR	INFORMATION	REMARKS
Speed	- 45 knots (23.2m/s)	-See table 4 for kinetic response times
Approach Angle	- Angle of bow may negate a kinetic attack on power source at range.	- At 90 degrees to the vessel - Lesser angles increase target profile on approach
Component Targeted	- See vulnerable points	
Attack type	- Kinetic - Laser - Concealment by smoke	- Small arms engagement. - Laser attack against CCTV. - Shielding from CCTV.

Table 4 illustrates the limited response times available for kinetic engagement until the impact of the WBIED on the protected vessel at 500m and 1,000m initial engagement ranges.

Tabe 4:

WBIED SPEED (Knots)	WBIED SPEED (m/s)	ENGAGEMENT TIME (S)		REMARKS
45	23.2	21.6	43.2	Maximum speed of Al Fattan 10m Patrol Boat
40	20.6	24.3	48.6	Used for worse case “engagement opportunity time” in this paper
35	18.0	27.7	55.4	
30	15.4	32.5	65.0	Median
25	12.7	39.3	78.6	
20	10.3	48.5	97.0	
15	7.7	64.9	129.8	

Kinetic Disablement Options and Likely Effectiveness

The incoming speed, small cross-sectional area of vulnerable points and closing profile of a WBIED makes it a particularly challenging target for kinetic attack with small arms fire. Although single shot rounds should theoretically provide better accuracy, the closing speed and angles of approach means that automatic fire may be a more appropriate response to ensure disablement.

The selection of weapon types by ships’ security teams is not covered specifically in international standards.[13] Guidance on Rules for the Use of Force is provided,[14] which is based on the “100 Series Rules”.[15] These are designed to cover circumstances where a proportional response is required for an attempted attack by a manned craft. As the WBIED is unmanned then proportionality is no longer an issue, and it allows for the most effective modus operandi to defeat a technical threat.

IDENTIFYING PARAMETRES

The performance comparisons of a likely range of small arms ammunition are in Table 5.

Table 5:

ROUND[16]	BULLET MASS (g)	MUZZLE VELOCITY (m/s)	MUZZLE ENERGY (J)	PERFORATION OF B555 STEEL[17] (mm)	RELATIVE PERFORATION EFFECTIVENESS[18]	REMARKS
7.62 x 39mm Ball	8.0	710	2010	4.0	1.0	57-N-271 round
7.62 x 45mm Ball L2A2	9.3	855	3410	6.0	1.5	NATO FMJ used in commercial maritime-company trials[19]
7.62 x 45mm AP M61	9.45	838	3318	12.7	3.1	NATO AP
0.338" M33 Ball	16.2	915	6782			Used in commercial maritime company trials
0.50" M33 Ball	42.8	887	16837	12.7	3.1	
0.50" M8 AP-I	40.3	887	15869	25.0	6.2	
12.7 x 108mm AP-I	49.0	825	16675		6.0	B32 round. Estimate based on 0.50" API

TARGETS

Warhead target

Frontal kinetic attack by small arms fire against the warhead is not an effective option for 7.62mm calibre ammunition as even 7.62mm armour piercing-incendiary (API) rounds will not perforate the estimated 38mm thick ballistic disc liner.[20] NATO 7.62 x 45mm M993 rounds will only perforate 16mm of rolled homogeneous armour (RHA) at 300m.

Perforation perfomance information for the 0.338" Lapua Magnum round is not available in open source information. Yet, as it has a relative muzzle energy of twice that of 7.62mm ammunition, and the ballistic disc thickness is approximately three times the perforation capability of the 7.62mm AP round, it is considered UNLIKELY that the 0.338" Lapua Magnum round could defeat this target from a frontal attack perspective.

It is also UNLIKELY that 0.50in calibre ammunition will perforate the ballistic disc of the warhead from a frontal attack angle. From a side attack angle it would MOST LIKELY perforate the warhead casing and retain sufficient kinetic energy to break up the RDX high explosive content which may reduce the WBIED detonation effects on impact with the target vessel. As RDX is relatively stable and insensitive to shock it is ALMOST CERTAIN that the impact of 0.50in rounds will not result in deflagration or detonation of the explosive content.

The kinetic attack of the warhead using small arms ammunition is therefore not a recommended technique to defeat an incoming WBIED attack.

Hull target

The fibreglass hull of the WBIED would be vulnerable to perforation by small arms fire of all calibre, but single shots would not cause sufficient damage to stop the WBIED by water ingress. Significant damage to the hull would be necessary within the median 32 seconds "engagement opportunity time" available for an incoming WBIED from 500m, so it is HIGHLY LIKELY that automatic fire would be necessary. Even then it is assessed as UNLIKELY that 7.62mm calibre ammunition would cause sufficient damage in that time to defeat the attack.

As each round of 0.50in calibre ammunition has nearly five times the muzzle (kinetic) energy of the NATO 7.62mm round, and four times its relative perforation effectiveness, it is LIKELY that the use of sustained automatic fire from 0.50in Ball ammunition against the hull of the WBIED would defeat the WBIED attack.

Engine target

Recent confidential concept trials [21] used a range of calibres against static small (10HP) outboard motors. Results for the 7.62 x 45mm calibre were not particularly encouraging, with this calibre CERTAINLY NOT being capable of defeating even the small outboard motor used before the hypothetical WBIED would have closed the 500m between the first engagement round and its target. In real life the WBIED would have impacted the vessel being protected.

Results for the 0.338in Lapua Magnum round were more encouraging as this calibre had sufficient kinetic energy to defeat the static small outboard motor at the practical 500m engagement range. The effect of a 0.338in round on a 200hp outboard motor has yet to be determined, and Houthi WBIED routinely have two such motors to power their WBIED. Although the 0.338in round has 1.9 times the kinetic energy of the 7.62mm round[22], it is provisionally assessed that using single shots it would be UNLIKELY to be able to defeat the larger 200HP engine within the 24 seconds "engagement opportunity time" available for an incoming WBIED. As an automatic 0.338in machine gun is not yet commercially available, this option will be discounted in this report.[23]

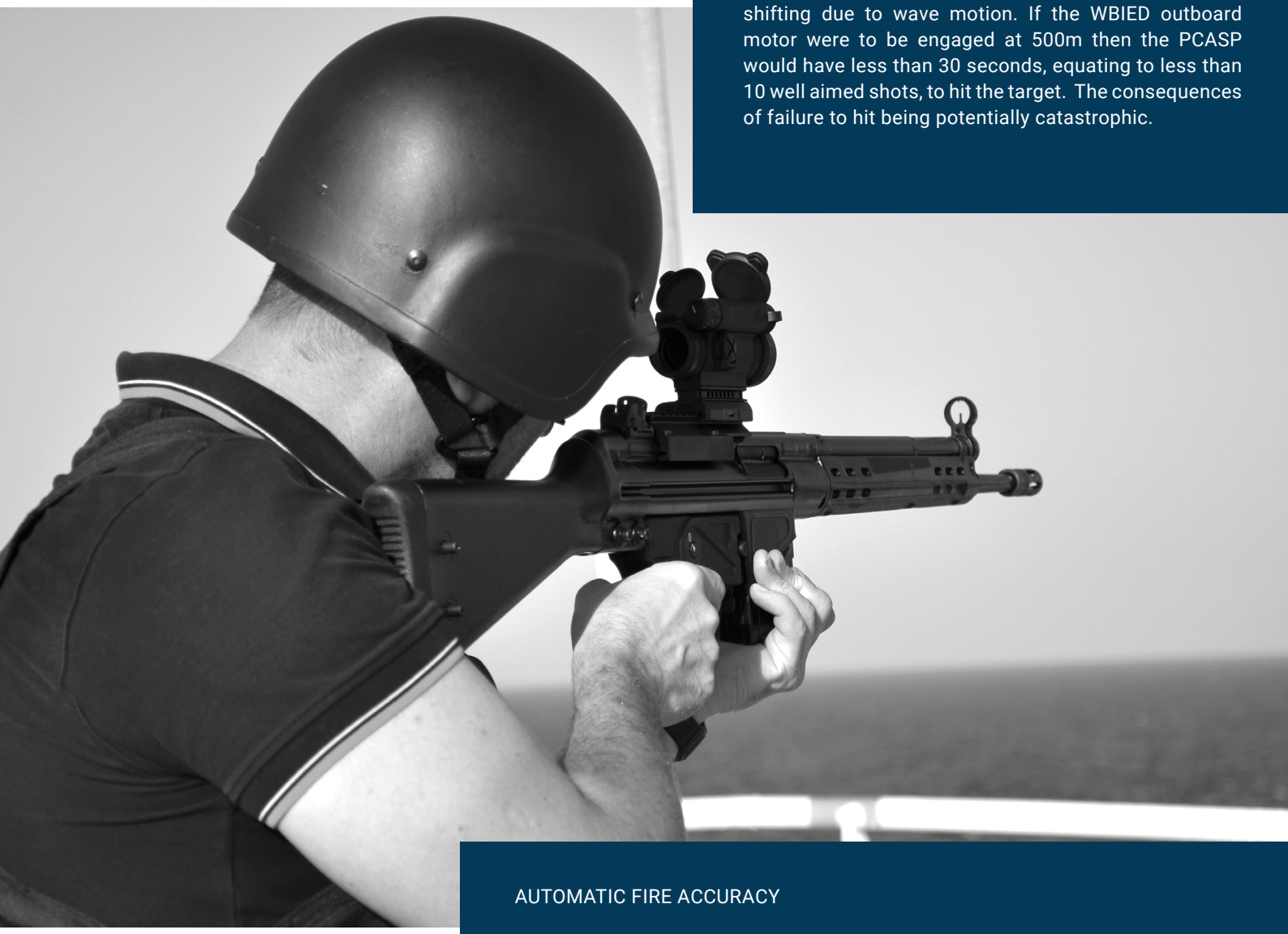
No trials have been conducted using larger calibre 0.50in or 12.7mm ammunition. As these rounds have between six times the perforation relative effectiveness of the 7.62mm round [24] it is CERTAIN they would be more appropriate as the ammunition of choice to interdict the larger HP engines.

The kinetic attack of the WBIED outboard motors using small arms ammunition is therefore not a recommended technique to defeat an incoming WBIED attack.

ACCURACY

SINGLE-SHOT ACCURACY

It is HIGHLY UNLIKELY that PCASP on board a vessel could guarentee to hit the 0.26m2 frontal target area of a WBIED outboard motor moving at over 30kts and shifting due to wave motion. If the WBIED outboard motor were to be engaged at 500m then the PCASP would have less than 30 seconds, equating to less than 10 well aimed shots, to hit the target. The consequences of failure to hit being potentially catastrophic.



AUTOMATIC FIRE ACCURACY

A 0.50in machine gun can fire at its cyclic rate of 650 to 850 rounds per minute for one minute before a barrel change is required. In the 24 seconds “engagement opportunity time” available for an incoming WBIED a 0.50in machine gun could therefore discharge 260 to 340 rounds.

At ground level the beaten zone of a machine gun at 500m measures approximately 1m x 88m = $85m^{2.25}$ This would decrease by possibly 30% (to $60m^{2}$) from a machine gun mounted at height on a VLCC infrastructure. The plan view surface area of a Houthi WBIED is $23m^{2}$, which equates to 38% of the beaten zone. It is thus HIGHLY LIKELY that a minimum of 99 to 130 of the 0.50in rounds fired at cyclic rate would impact the Houthi WBIED. The impact of 99 to 130 0.50in rounds impacting on the fibreglass or light metal skiff would be HIGHLY LIKELY to result in such damage to either sink the WBIED or cause such instability that the WBIED could not maintain a stable course.

NON-KINETIC DIABLEMENT OPTIONS

LASER ATTACK:

Theoretically if the CCTV component of the WBIED is disabled, the WBIED will continue on its last course from when it had the target vessel in its sight until it runs out of fuel. High power Class 3 and Class 4 lasers have proved to be effective at attacking the CCD/CMOS[26] components within a CCTV camera. The damage mechanisms being: 1) temporary blinding; 2) burned out pixels; and/or 3) destruction of the silicon substrate. There are, however, drawbacks that may limit the use of such a system in the disablement of a Houthi WBIED:

a) The laser beam must be aimed exactly through the CCTV lens, so the greater the target distance, the more difficult it is to hit the image array. Although the CCTV may be initially blinded, as the angle of attack opens up as the vessel being protected moves away from the attack line of the WBIED the laser will lose effectiveness and the CCTV may become operational again;

b) Since the laser beam ruins the image array by overheating the chip it must be held on target for some period of time;

c) A high mW output laser is required. For example a commercial red Class 3A laser would not disable a CCTV at 100m range. A 500mW+ laser would ALMOST CERTAINLY destroy the CCD/CMOS array;[27]

d) Such high power lasers have a range of over 150 miles, so would be a threat to any individuals in line of sight out to the horizon;

e) The perpetrators can take countermeasures by fitting blocking filters, although they would have to select a filter within the operating frequency band of the laser; and

f) The system must be operated with special safety goggles and individuals should have attended a laser safety course.

It is recommended that a laser specialist be consulted to further assess the potential effectiveness of this approach.[28]

SMOKE CONCEALMENT:

Recent confidential concept trials[29] used smoke generators to produce a sector of smoke from the rear of the vessel.

A limiting factor for smoke deployment is that the CCTV image used in the guidance system may not be that of the stern of the target vessel, and is more likely to be a full beam image allowing the WBIED to attack the side of the vessel at 90 degrees optimum. Concealment of the target vessel could only then be achieved by the deployment of smoke generators on the bow of the vessel. Ship safety should not be compromised as navigation by radar can continue.

Even then factors that will PROBABLY make the use of smoke an unrealistic option as a primary defensive mechanism include:

a) The relative wind direction between the WBIED and the target vessel;

b) The effect of cross deck wind resulting in smoke dispersion and dissipation;

c) The time taken to build an effective smoke screen; and

d) The size and cost of smoke generators capable of producing and maintaining a large enough smoke screen.

CONCLUSION

Section 2 – "The Threat" in BMP5 requires amendment to include the modus operandi of a single, unmanned WBIED approach.

The current recommendation at Section 5 of BMP5 in respect to manouvering is HIGHLY UNLIKELY to be effective in out-running a WBIED of Houthi design. Similarly the use of CCTV targetting means that hydrostatic pressure is UNLIKELY to be effective as the WBIED will keep attacking until all fuel has been expired or it has been interdicted.

The current weapons[30] used by ship security teams are UNLIKELY to interdict or disable a WBIED of Houthi design.

The use of laser to permanently damage the CCD/CMOS components within the CCTV guidance system of the WBIED requires further research.

The number of uncontrollable variables probably makes the use of smoke for concealment as a primary defensive mechanism unrealistic.

Based on current open source information kinetic attack of the WBIED hull by 0.50in or 12.7mm heavy machine guns, operated at cyclic rates by the PCASP, is currently the only realistic option to ALMOST CERTAINLY ensure disablement of the WBIED.

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FOOTNOTES

ARX

1.https://www.arabyoum.com/English/7283470/Yemen-foils-Houthi-attempt-against-international-shipping#.W5eHaTzrwA4whatsapp.
2.http://www.alfattan.net/Products/10-meter-patrol-boat/.
3. Obtained from: 1) CAR (Conflict Armament Research), Anatomy of a Drone Boat, December 2017. www.conflictarm.com/download-file/?report_id=2550&file_id=2564; and 2) Confidential sources.
4. BMP5. Best Management Practices to Deter Piracy and Enhance Maritime Security in the Red Sea, Gulf of Aden, Indian Ocean and Arabian Sea. Version 5. June 2018. http://www.mschoa.org/docs/default-source/public-documents/bmp5.pdf?sfvrsn=2.
5. Similarly, attacks against shore targets (Jizan, Saudi Arabia on 24 April 2017 and Mukha, Yemen on 12 August 2017 utilized a single unmanned WBIED approach.
6. Very Large Crude Carrier.
7. Ibid.
8. From P-15 Termit (NATO: STYX) Anti-Ship Missile.
9. Research Department eXplosive. Cyclotrimethylenetrinitramine or Hexogen.
10. The term “perforate/perforation” refers the damage caused by a projectile that has fully passed through the target, or damage caused by the blast/shock wave. It should not be confused with “penetration”, which the damage caused by a projectile that has not fully passed through the target, or damage caused by the blast/shock wave that has distorted but not perforated the target.
11. For a ballistic disc attack mode, the liner material thickness is approximately 5% of the charge diameter. In this case with the diameter of the warhead being 760mm, a charge liner thickness of 38mm is likely.
12. Engine Cover is 600mm Width, 440mm High.
13. ISO 28007-1:2015. Ships and marine technology - Guidelines for Private Maritime Security Companies (PMSC) providing privately contracted armed security personnel (PCASP) on board ships (and pro forma contract) -- Part 1: General. First edition. 1 April 2015.
14. Ibid. Clause 5.3.
15. 100 Series Rules. An International Model Set of Maritime Rules for the Use of Force. 3 May 2013. https://www.humanrightsatsea.org/wp-content/uploads/2015/04/20130503-100_Series_Rules_for_the_Use_of_Force.pdf.
16. Data from Jane’s Ammunition.
17. Compass® B555 is a low-alloy steel armour plate with strength, hardness and toughness properties above ISO 6831/1V-1970 and US Mil-S-46100B-1977 requirements. http://www.sleemanengineering.com/products-innovations/armour-steel/.
18. Based on perforation of steel.
19. Private trials by a commercial maritime security company..
20. Conclusion extrapolated from Deniz. T. Penetration of Hardened Steel Plates. MSc Thesis, Middle East Technical University. August 2010.
21. Conducted in 2018 by a private commercial maritime security company.
22. 6,708J versus 3,520J at muzzle velocity.
23. General Dynamics in the USA have developed a 0.338” Lightweight Medium Machine Gun (LWMMG) to fill the capability gap between 7.62mm and 12.7mm machine guns. https://www.youtube.com/watch?v=JNB7khjOSXc. https://www.gd-ots.com/wp-content/uploads/2017/11/Lightweight-Medium-Machine-Gun-MMG.pdf.
24. 15,550J versus 3,520J at muzzle velocity.
25. Extrapolated from http://asktop.net/wp/download/gta07-10-001.pdf.
26. Charge Coupled Device/ Complementary Metal Oxide Semiconductor.
27. http://www.mts-iss.com/affects-of-lasers.html.
28. Any system deployed would have to be in compliance with Protocol IV – Protocol on Blinding Laser Weapons (30 July 1998) of the Convention on Prohibitions or Restrictions to the Use of Certain Conventional Weapons (CCW). https://www.unog.ch/80256EE600585943/(httpPages)/4F0DEF093B4860B4C1257180004B1B30?OpenDocument.
29. Conducted in 2018 by a private commercial maritime security company.
30. 5.56mm to 7.62mm.