FRONTLINE PERSPECTIVE

ANATOMY OF A 'DRONE BOAT'

A water-borne improvised explosive device (WBIED) constructed in Yemen

December 2017

BACKGROUND

On 30 January 2017, a small vessel loaded with explosives struck the Royal Saudi Naval Forces frigate Al-Madinah. The attack took place in the Red Sea, some 30 km from the Yemeni port city of Al Hudaydah. Initially described as a suicide attack by the Saudi-led Coalition, and claimed as a missile attack by Yemen's Ansar Allah 'Houthi' forces, the United States Navy stated publically that the vessel was a remotely controlled boat, operated by Houthi fighters.[1] Beyond these statements, little is known about the vessel, but the incident has drawn attention to the threat posed to international shipping by so-called 'drone boats' operating from Yemen's coastal waters. The technical term for such a vessel is a water-borne improvised explosive device (WBIED).

On 5 March 2017, the United Arab Emirates (UAE) Presidential Guard forces invited a Conflict Armament Research (CAR) field investigation team to document a WBIED in their possession they claim was constructed and deployed by Houthi forces in Yemen. Western diplomats also independently claim that the vessel originates with Houthi forces, although the exact circumstances of seizure remain unclear.

This Frontline Perspective aims to contribute to the emerging debate on WBIED use in the Red Sea by providing a detailed technical overview of the device's construction. While the WBIED features elements manufactured in Iran, unlike previous CAR reports—which have provided firm evidence of Iran's support to Houthi forces—the evidence presented below does not necessarily infer direct Iranian involvement in the device's construction, but suggests that certain components were sourced from Iran or through Iranian channels.[2]

Video screenshot showing the final stages of an attack by an explosive-filled surface vessel on Royal Saudi Naval Forces frigate Al-Madinah uploaded to YouTube® by the US Naval Institute (www.usni.org):
https://www.youtube.com/watch?v=N2KObg4gAC4.

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THE VESSEL

The vessel is a 10-metre patrol boat, manufactured by the UAE-based company Al Fattan Ship Industry, and initially provided to the UAE Coast Guard (Figure 1).[3]

Prior to the onset of the most recent hostilities in Yemen, the UAE donated more than 60 such vessels to the Yemeni Navy.[4]

Figure 1
10-metre patrol boat configured as a WBIED.
Documented by a CAR field investigation team in the UAE, 5 March 2017.

ENGINES

The vessel is equipped with two 200 horsepower L200A Yamaha outboard engines (Figure 2). In a prompt and comprehensive response to a formal trace request issued by CAR, the Yamaha Motor Co. Ltd. confirmed that it had supplied the two engines to the Al Fattan Ship Industry in September and October 2013, respectively. Yamaha also informed CAR that, in response to its strict end-user controls, the UAE had notified the company that the engines would be fitted to an Al Fattan patrol boat and supplied to the Yemeni Navy for ‘coast guard patrolling.’[5]

Figure 2
One of two L200A Yamaha outboard engines on the vessel.
Documented by a CAR field investigation team in the UAE, 5 March 2017.

MAIN MODIFICATIONS

The vessel’s basic structure is unmodified and the boat retains the engines fitted by the Al Fattan Ship Industry prior to export to the Yemeni Navy. The steering system and the throttle control are factory-fitted and the tubular steel tower structure above the vessel is an original feature. The vessel’s conversion to a WBIED involves external modifications to a) enable its remote command and guidance and b) host an improvised explosive device (IED). The IED is composed of a power source, switch, initiator, container, and main charge, which collectively can be described as the ‘explosive train.’

COMMAND AND GUIDANCE

The WBIED is radio controlled through a purpose-built computerised guidance system. The computer and all associated electronic controls are housed in an improvised control unit, which is constructed of riveted sheet aluminium (Figure 3 and Schema 1, A). The control unit has a hinged lid and six electrical plug sockets, of varying sizes and pin configurations, which connect to sensors, antennae, and servomotors on the vessel. CAR’s field investigation team identified the functions of four of the plug sockets by connecting plugs found on the vessel. These include a seven-pin camera input/output, a seven-pin GPS antenna input, a five-pin throttle output, and a two-pin power supply.

Figure 3
Purpose-built computerised guidance system fitted with a Farsi-marked keyboard.
Documented by a CAR field investigation team in the UAE, 5 March 2017.

Steering wheel and throttle control. Documented by a CAR field investigation team in the UAE, 5 March 2017.

Most of the cables used to connect the command and guidance elements bear the name of an Iranian manufacturer, the Simia Cable Co., and the Iranian certification body, the Institute of Standards and Industrial Research (ISIRI), together with the words 'Made in Iran.' While Simia produces a range of commercial products, and probably exports, the Iranian Defence Industry also employs Simia cables of the same types fitted to the WBIED. For example, a CAR field investigation team documented cables bearing the same markings, fitted to an Iranian-manufactured D-30I 122 mm howitzer, in Blue Nile State, Sudan, on 9 February 2017 (Figure 4).[6]

Figures 4
Simia-branded cables on the WBIED (left) and Iranian D-30I howitzer (right).
Documented by a CAR field investigationteam in the UAE, 5 March 2017, and a CAR field investigation team in Blue Nile State, Sudan, 9 February 2017.

The control unit is connected by cable to a remotely operated video camera, mounted on a turntable and gimbal (Figure 5 and Schema 1, B) and affixed to the vessel's tubular steel tower. A Garmin-branded GPS antenna and Nexus-branded 35° autopilot compass are also mounted on the tower and connected by cable to the control unit (Figure 6 and Schema 1, C). These observations suggest that the remote operator has the capacity to stream live video footage of the vessel's progress and track its position via GPS.

The operator also controls the vessel's speed via the control unit. A Simia-branded cable from the control unit connects to a servomotor, which mechanically operates the vessel's throttle (Figure 7 and Schema 1, D). This system operates as follows: The servomotor (1) is connected to a threaded, rotating bar (2). The bar passes through a steel

Figure 5
Remotely operated video camera.
Documented by a CAR field investigation team in the UAE, 5 March 2017.

Figure 6
35° autopilot compass (right) and Garmin GPS system (left).
Documented by a CAR field investigation team in the UAE, 5 March 2017.

cylinder (3), which is tethered to the throttle by two steel plates and is fitted with canvas straps and clips (4) to prevent upward movement of the cylinder. Depending on the direction of turn, the rotation of the threaded bar pushes or pulls the steel cylinder, thereby advancing or reversing the throttle.

Two sensors, which are each connected by cables to the control unit, are positioned adjacent to the upper and lower limits of the throttle's travel. This feature probably informs the remote operator when the throttle is open or closed (information, which would not be apparent from remotely operating the servomotor alone).

CAR did not document an added electro-mechanical means of steering the vessel. Unlike the throttle, no evidence suggested that a servo-assisted mechanism had been fitted to either the wheel or to the two outboard motors. The vessel's normal steering mechanism is via hydraulic pipes. The wheel is connected to a SeaStar-branded helm. On rotation of the wheel, the helm pumps hydraulic fluid through hoses to a steering cylinder affixed to the outboard engines, which moves them either left or right in unison.

This system is purely mechanical and would not allow the engines to be steered electrically without modification. Although CAR's field investigation team did not document the item, CAR believes that the vessel must have been guided by means of a hydraulic power assist autopilot. This device would have been fitted to the hydraulic hoses between the helm and the steering cylinder—below the rear deck and relatively inaccessible to inspection—and connected by cable to an autopilot controller.[7] If this is correct, an autopilot controller would have been modified and connected to the improvised control unit. The 35° autopilot compass on the vessel's tower suggests such a controller was fitted.

Figure 7
Servomotor-operated throttle.
Documented by a CAR field investigation team in the UAE, 5 March 2017.

Combined, these features would enable a remote operator to steer the vessel and increase or decrease speed, while monitoring the vessel's progress via video camera and GPS tracking.

SCHEMA 1: GUIDANCE

A

Computerised guidance system
Connected to remotely operated camera (**B**), GPS antenna and 35° autopilot compass (**C**), and electrically operate throttle control (**D**).

Forward view

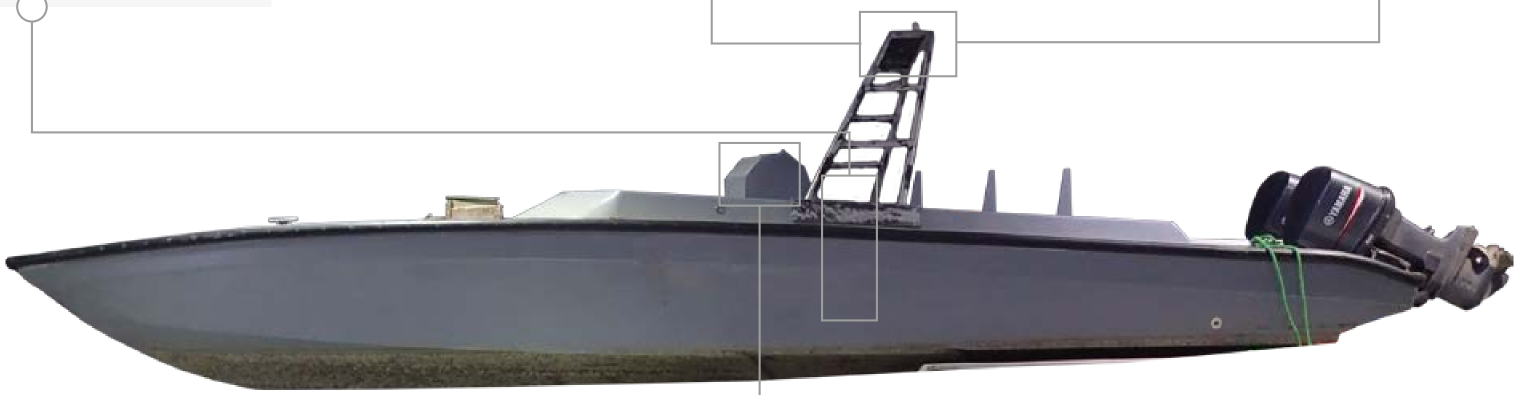
Rear view

B

Remotely operated video camera on turntable and gimbal

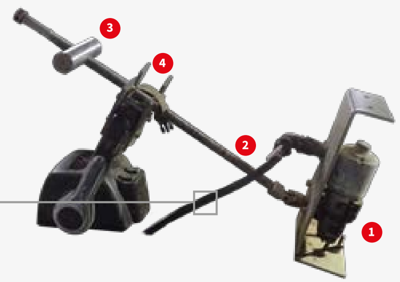
C

GPS antenna and 35° autopilot compass



D

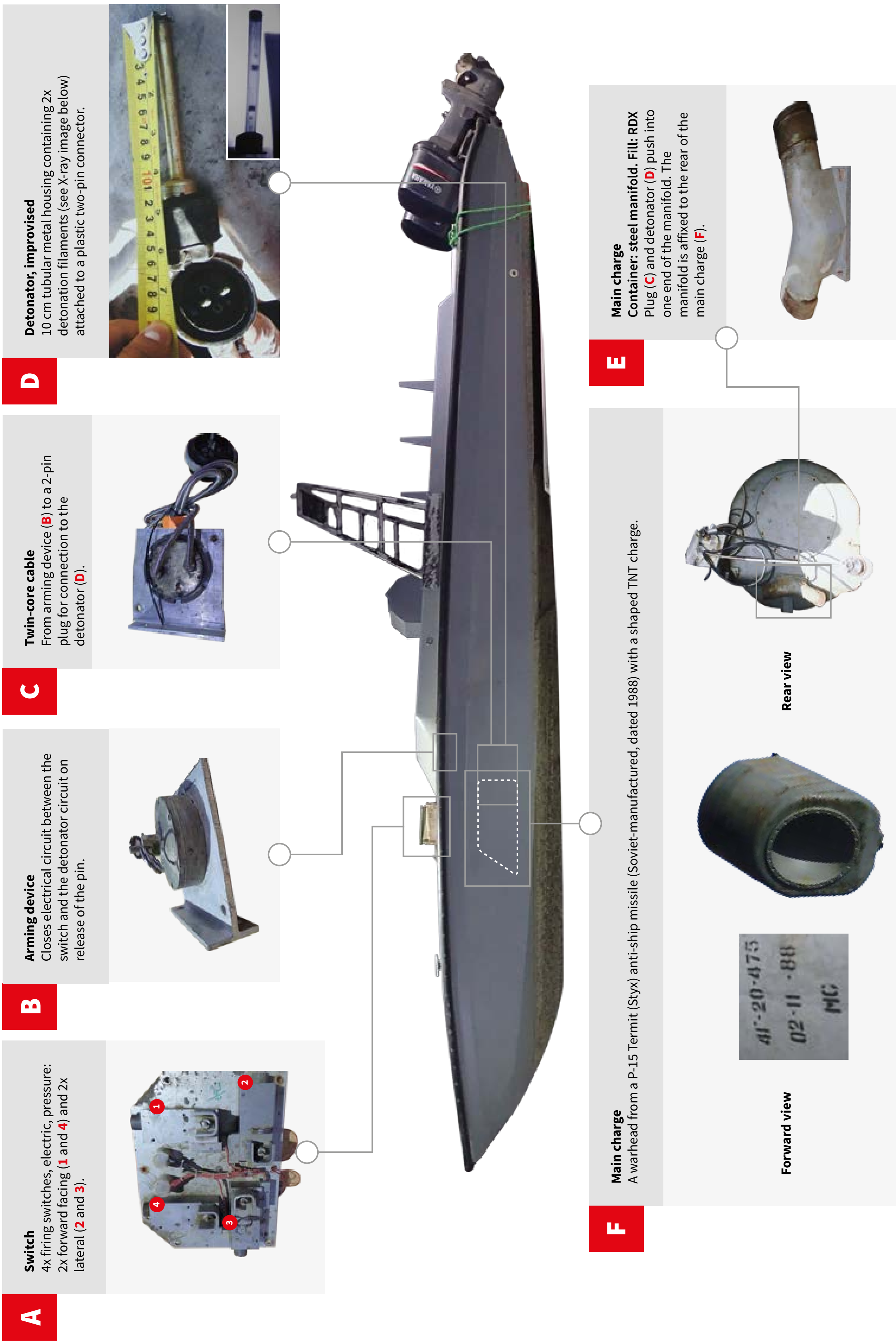
Throttle control
Motor (**1**) connected to a universal joint and used to turn a threaded bar (**2**). The bar passes through a steel cylinder (**3**), which is tethered to the throttle by means of two steel plates, with canvas straps and clips (**4**) to prevent upward movement of the cylinder. Depending on the direction of turn, the rotation of the threaded bar pushes or pulls the steel cylinder, thereby advancing or reversing the throttle. When deployed, the cylinder (**3**) is positioned inside the metal plates (**4**) and secured by the canvas straps.



E

Electrical cabling

SCHEMA 2: EXPLOSIVE TRAIN



EXPLOSIVE TRAIN

Four pressure switches of heavy construction are mounted on the deck, forward of the helm. The switches are welded to a steel baseplate and arranged with two switches pointing forwards, in the vessel's direction of travel, and two facing port and starboard, respectively (Figure 8 and Schema 2, A). Each switch consists of a solid, cylindrical piece of machined steel, fitted into a box-like steel housing. Pressure applied to the forward end of the cylinder causes it to move rearward into the housing, which joins two electrical contacts.

Figure 8
Four improvised pressure switches mounted on a steel baseplate.
Documented by a CAR field investigation team in the UAE, 5 March 2017.

Wires from each of the four switches converge on the baseplate, where they are combined in a four-pin electrical plug socket. A four-pin plug connects a single, Simia-branded cable to the baseplate socket. This cable runs sternwards, below deck, to an improvised arming switch (Figure 9 and Schema 2, B). The switch consists of two spring-loaded plates, which are held apart by a cotter pin and ring. Removal of the pin causes the two plates to spring into contact, which closes the electrical circuit. On closing the circuit, an audible alarm, which is wired into the circuit, sounds continuously. This alarm indicates that any activation of the switches will initiate the explosive device.

MULTIPLE STRANDS OF EVIDENCE PRESENTED IN THIS REPORT SUGGEST THAT THE WBIED ORIGINATED IN YEMEN, WAS MODIFIED WITH EXTERNAL COMPONENTS AND EXPERTISE, AND DEPLOYED BY HOUTHI FORCES.

Figure 9
Improvised arming switch.
Documented by a CAR field investigation team in the UAE, 5 March 2017.

Figure 10
Improvised detonator fitted to a black plastic two-pin plug socket.
Documented by a CAR field investigation team in the UAE, 5 March 2017.

A Simia-branded twin-core cable passes from the arming switch to a two-pin plug (Schema 2, C). An improvised detonator of 10 cm in length, consisting of two detonation filaments within a tubular metal housing, is fitted to a black plastic two-pin plug socket (Figure 10 and Schema 2, D). The cable from the arming switch is connected to the detonator via a two-pin plug.

The detonator, plug, and socket assembly is surrounded by a rubber gasket, which secures the assembly when pushed into one end of a steel manifold (Schema 2, E). The manifold contains the first of two main charges and is filled with RDX explosive.

The manifold is bolted to the rear of the warhead section of a Soviet-manufactured P-15 Termit (Styx) anti-ship missile, which is lot-marked and includes a production date code for 1988. The Soviet Union sold 20 such missiles to Yemen in a deal concluded in 1989.[8] The P-15 is the second main charge in

Figure 11
Rear view of P-15 warhead, showing attached RDX-filled manifold (left of frame).
Documented by a CAR field investigation team in the UAE, 5 March 2017.

the IED (Figure 11 and Schema 2, F) and features a shaped TNT charge, which is designed to focus explosive energy and penetrate the hull of a naval vessel.

The detonation of the RDX-filled first main charge would initiate detonation of the P-15 second main charge. The P-15 charge is positioned in the vessel to focus blast energy forwards in the direction of travel, at a shallow upward angle.

The positioning of the P-15 charge and the arrangement of the switches—with two of the four facing in the direction of travel, suggests that the vessel has been designed to impact a larger vessel at an angle perpendicular to the target's hull (i.e. a head-on impact into the side of a ship). The two lateral switches are designed to initiate the device in the event of a glancing (non-perpendicular) impact.[9]

CONCLUSION

Multiple strands of evidence presented in this report suggest that the WBIED originated in Yemen, was modified with external components and expertise, and deployed by Houthi forces.

First, there is a precedent for Houthi forces using fast, explosive-filled boats to target Saudi-led Coalition naval assets. The most recent case is the January 2017 attack off the Yemeni port city of Al Hudaydah, which damaged the Royal Saudi Naval Forces frigate Al-Madinah.

Second, senior UAE military officers confirm that the UAE donated identical Al Fattan 10-metre patrol boats to the Yemeni Navy. These officers also confirm that the vessels are currently in service with Houthi forces and that the Saudi-led coalition has destroyed a number of them during offensive operations in Yemen.

Third, at CAR's request, the engine manufacturer, Yamaha Motor Company, traced the vessel's two outboard engines to a 2013 consignment from its factories to the UAE. Yamaha received notice from the UAE, prior to export, that the engines would be fitted to an Al Fattan patrol boat before donation to the Yemeni Navy.

Finally, the Soviet-manufactured P-15 warhead is of a type transferred by the Soviet Union to Yemen, following a deal concluded in 1989. The warhead's date of manufacture is 1988, which precedes the deal by one year. There is no publically available record of the Soviet Union or Russia having transferred weapons of this type to any other states in the region during or since 1988.

CAR is currently attempting to trace a range of uniquely identifiable components employed in the WBIED's guidance system and explosive train. Although these elements include a Farsi-script keyboard—suggesting Farsi-speaking technicians involved in its operation—and Iranian-manufactured cables, each may be commercially available in Yemen. As such, they do not constitute enough evidence of Iranian involvement in the WBIED's design or manufacture. However, exploitation of the computerised guidance system would likely provide additional information on sources on external support.

This Frontline Perspective is the second report in a series from CAR that provides mounting evidence of Houthi forces using improvised weapon systems against the Saudi-led Coalition's high-value assets. CAR will continue to monitor weapons used in the Yemen conflict and will provide documented evidence of any evolution in weapon trends as the conflict progresses.

Stern view of the vessel. Documented by a CAR field investigation team in the UAE, 5 March 2017.

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ENDNOTES

1 Statements by the Saudi-led Coalition reported in Binnie (2017). Commander of the Bahrain-based US Fifth Fleet and head of US Naval Forces Central Command, Vice Admiral Kevin Donegan, cited in Cavas (2017).

2 See previous reporting by Conflict Armament Research (2016 and 2017a).

3 The vessel’s measurements are as follows: overall length 10 m, load waterline length 8.31 m, and beam 2.30 m. General details about the vessel can be found on the company’s website. See Al Fattan (2017).

4 Statements provided by senior members of the UAE armed forces in meetings with CAR held in March 2017.

5 On 30 March 2017, the Yamaha Motor Company Ltd. responded promptly and comprehensively to a formal trace request issued by CAR on 16 March 2017. In its response, Yamaha informed CAR that, in 2013, the company provided two 200A/L200A outboard engines to its Dubai-based distributor for transfer to the Al Fattan Ship Industry. Because Yamaha operates a strict end-use notification policy when supplying products to defence and security forces, the company requested end-user confirmation from the UAE prior to export. The UAE informed Yamaha that the two motors, with serial numbers 1053407 and 1010502 and subject to CAR’s trace request, would be fitted to an Al Fattan patrol boat, sold to the UAE Navy, and donated to the Yemeni Navy for ‘coast guard patrolling.’ Yamaha shipped the engines in two consignments to the UAE from Shimizu, Japan, on 23 September 2013 and 8 October 2013.

6 See Conflict Armament Research (2017b).

7 Assessment based on industry technical manuals produced by Teleflex (1998) and SeaStar Solutions (2008).

8 SIPRI (2017) reports that, between 1990 and 1991, the Soviet Union delivered 20 P-15U anti-ship missiles to Yemen for deployment on the Yemeni Navy's Tarantul class corvettes. Yemen ordered the missiles in 1989. SIPRI holds no further records of Soviet or Russian exports of P-15 missiles to the region after 1988.

9 The shaped charge, when fitted within a P-15 missile, would be positioned to ensure detonation from a precise standoff distance. It is unlikely that this distance could be replicated when deploying the warhead in the WBIED—primarily because the vessel would splinter on impact, allowing the movement of both switches and main charge, and altering the standoff distance.

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