Appendix 5-13
UXO Desk Study

ORIEL WINDFARM
OFFSHORE RENEWABLE ENERGY

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ORIEL WIND FARM PROJECT

Environmental Impact Assessment Report
Appendix 5-13: UXO Desk Study

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ACRONYMS

Term	Meaning
ALARP	As Low as Reasonably Practicable
AOI	Area of Interest
ESTCP	Environmental Security Technology Certification Program
UKHO	United Kingdom Hydrographic Office
UXO	Unexploded Ordnance

EXECUTIVE SUMMARY

Background

RPS Explosives Engineering Services (RPS EES), part of RPS Energy Ltd, has been commissioned by Oriel Windfarm Limited to conduct a desktop study for potential Unexploded Ordnance (UXO) contamination at the Oriel Wind Farm Project, hereinafter referred to as "the Project".

The principal aim of RPS EES, for this report, is to provide the Applicant with an appropriate and pragmatic assessment of the risks posed by UXO to the Project in order to identify a suitable methodology for the mitigation of any identified risks to an acceptable level in accordance with the 'ALARP' (As Low As Reasonably Practicable) Principle.

Risk Level

Based on the conclusions of the research and the risk assessment undertaken, RPS EES has found there to be a low risk of encountering UXO during the proposed operations. This is primarily due to the assessed low probability of encountering an item of UXO within the Project site. As a blanket risk has been assigned to the project area, no risk zone mapping has been created.

It should be noted that potential sources of UXO do exist in the wider area although they are at such a distance that they are deemed unlikely to have a direct impact on the site.

Migration appears to be unlikely although encounters with munitions along the coastline have been identified. As such, the possibility that munitions may have migrated to within the Project site cannot be entirely dismissed.

The assessed risks on site have been presented in the table below:

Ordnance Variant		Activity						
		Seabed Activities					Surface Activities	
		Cable Lay on Seabed	Plough	Jetting	Trenching	Drilling	Support Vessel	Snag on Vessel
Small Arms Ammunition		Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Land Service Ammunition		Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
≤ 155mm Projectiles		Low	Low	Low	Low	Low	Low	Low
>155mm Projectiles		Low	Low	Low	Low	Low	Low	Low
HE Bombs	Allied Origin	Low	Low	Low	Low	Low	Low	Negligible
	Axis Origin	Low	Low	Low	Low	Low	Low	Negligible
Sea Mines	Allied Origin	Low	Low	Low	Low	Low	Low	Negligible
	Axis Origin	Low	Low	Low	Low	Low	Low	Negligible
Torpedoes		Low	Low	Low	Low	Low	Low	Negligible
Depth Charges		Low	Low	Low	Low	Low	Low	Negligible
Dumped Munitions (Conv.)		Low	Low	Low	Low	Low	Low	Low
Dumped Munitions (Chem.)		Low	Low	Low	Low	Low	Low	Low
Missiles/Rockets		Low	Low	Low	Low	Low	Low	Negligible

Recommendations

Based on the identified risk levels, it is recommended that appropriate mitigation is implemented prior to and/or during the scheduled operations. The recommended mitigation for the site is delivery of Explosives Site Safety Guidelines. These are outlined in greater detail in the report.

1 INTRODUCTION

1.1 Instruction

RPS Explosives Engineering Services (RPS EES), part of RPS Energy Ltd, has been commissioned by Oriel Windfarm Limited to conduct a desktop study for potential Unexploded Ordnance (UXO) contamination at the Oriel Wind Farm Project, hereinafter referred to as "the Project". A site location map has been presented at Appendix 001.

1.2 Scope of Work

The following facets will be covered within this report:

- **UXO Risk Analysis:** Assessment of the specific military, former military and UXO related activities that have taken place within the vicinity of the project area, to further review any previous UXO clearance/mitigation operations that have already been undertaken; then to assess the risks associated with the identified types of UXO with the potential to be present to the proposed works.
- **Recommendations:** Based on the outcome of the assessment, RPS EES will recommend appropriate mitigation measures that should be taken to allow works to proceed safely and with minimal disruption. These recommendations will be designed to reduce the risk on site to ALARP (As Low As Reasonably Practicable).

This report focuses on historical activities that have occurred within the proposed Area of Interest (AOI) and its immediate surroundings, with respect to the likelihood of encountering potential UXO.

1.3 Definitions

The terms 'Site' or 'Area of Interest' ('AOI') refer to the Project area i.e. the offshore wind farm area and offshore cable corridor (see Appendix 001). For the purposes of this assessment, a further 10 km buffer surrounding the AOI is also considered (see Appendix 006). This buffer is utilised to define features that may have an immediate impact on the site rather than those which may have an indirect impact through migration and natural processes.

Selected terminology referred to throughout this report is presented at Appendix 002.

1.4 Aims

The principal aim of RPS EES, for this report, is to provide the Applicant with an appropriate and pragmatic assessment of the risks posed by UXO to the Project within the specified AOI in order to identify a suitable methodology for the mitigation of any identified risks to an acceptable level in accordance with the 'ALARP' Principle. RPS EES will compile this report considering the statement in paragraph 1.2.

The ALARP Principle is clearly defined in Appendix 003.

1.5 Reporting Conditions

This study consists of a desk-based collation and review of available documentation and records relating to the possibility of UXO being present within the AOI. Certain information obtained for the purposes of this study is either classified, restricted material or considered to be confidential to RPS EES. Therefore, summaries of such information have been provided.

It must be emphasised that this desk study can only indicate the potential for UXO to be present. Further geophysical surveys and target investigation may be necessary to provide confirmation of the presence of UXO and the actual risks involved.

Note: Our appraisal relies on the accuracy of the information contained in the documents consulted and that RPS EES will in no circumstances be held responsible for the accuracy of such information or data supplied.

1.6 Sources of Information

The main sources of information consulted by RPS EES for this report were obtained from within the public domain. In addition, the below sources were reviewed:

- RPS Archives;
- Military Archives;
- National Archives;
- Historic Maps, Aerial Photographs and Records;
- Internet Research; and
- United Kingdom Hydrographic Office (UKHO).

1.6.1 Specific Documents

RPS EES has consulted a number of research documents to compile this report. These are listed below:

- Wilson, J., McKissick, I., Jenkins, S., Wasyl, J., DeVisser, A., Sugiyama, B., (2008), Predicting the Mobility and Burial of Underwater Munitions and Explosives of Concern Using the VORTEX Model, ESTCP Project MM-0417, Environmental Security Technology Certification Program (ESTCP);
- Missiaen, T., Noppe, L., (2010), Detailed seismic imaging of a chemical munition dumpsite in the Bornholm Basin, south-western Baltic, Environ Earth Sci 60:81–94, DOI 10.1007/s12665-009-0171-9;
- Crossley J, (2011), The Hidden Threat, The Story of Mines and Mines by The Royal Navy in World War I;
- Dundalk Democrat. (2016). The Summer's night Dundalk was bombed. https://www.dundalkdemocrat.ie/news/peter-kavanagh-trip-through-time/211501/the-summer-s-night-dundalk-was-bombed.html;
- AFLOAT. (2013). Live Surface to Air Firing Practices at Gormanston Air Defence Range, Co. Meath. https://afloat.ie/safety/marine-warning/item/23561-live-surface-to-air-firing-practices-at-gormanston-air-defence-range-co-meath;
- Skerries Coast Guard. (2017). Live firing at Gormanston Range. http://www.skerriescoastguard.com/?tag=gormonston;
- Bulletin. (2009). Air Defence Shoot Gormanston. http://forum.irishmilitaryonline.com/archive/index.php/t-15296.html;
- FlyinginIreland. (2018). https://flyinginireland.com/wp-content/uploads/2017/08/IMG_0148.png (image);
- The Irish Story. (2013). Today in Irish History, August 14, 1922, The anti-Treaty IRA attack on Dundalk. http://www.theirishstory.com/2013/08/14/today-in-irish-history-august-14-1922-the-anti-treaty-ira-attack-on-dundalk/#.XVFZH-hKiUl; and
- Gavin & Doherty Geosolutions. (2018). Oriel Wind Farm Project Site Data Review.

1.7 Legislation

Whilst undertaking this desk study, the requirements of various legislation have been considered, the details of which can be found within Appendix 004.

2 SITE DETAILS AND DESCRIPTION

2.1 Area of Interest (AOI)

The Area of Interest (AOI) (or 'site') consists of two (x2) sections; these include the offshore cable corridor and the offshore wind farm area.

The offshore cable corridor encompasses an estimated area of 2,760 Hectares (ha). RPS EES understand that the landing point is located at Dunany, County Louth.

In addition, the offshore wind farm area comprises an area of approximately 2,757 ha. It is situated an approximate 5 km southeast of the coastline at Templetown, County Louth.

The Project has been presented at Appendix 001.

2.2 Proposed Scheme of Work

RPS EES understand that the Applicant proposes to create a new offshore wind farm and associated interconnecting cable route in the Irish Sea.

The marine elements of the Project (below the High-Water Mark) are described in volume 2A of the EIAR (see chapter 5: Project Description) and will consist of:

- 25 wind turbine generators (WTGs) and associated fixed monopile foundations,
- Inter-array cables,
- One offshore substation mounted on a fixed monopile foundation,
- One export cable; and
- Temporary offshore construction facilities.

Standard wind farm construction techniques will be employed, including trenching for cable installation, and installation of foundations through piling and drilling.

2.3 Geology and Bathymetry

The Applicant has provided pertinent geological and bathymetric data for the AOI in a report entitled: *Archaeological Assessment for Oriel Offshore Windfarm Project North-Western Irish Sea (06R118)* completed by The Archaeological Diving Company Ltd.

"The multi-beam data acquired by the Irish National Seabed Survey describes an area of shelving seabed from a highpoint of -12m and -14m in the northwest and western sectors that drops away gradually and consistently to depths of -32m and -33m in the east and southeast sectors of the larger License area (Figures 6-7). The topography echoes the presence of the Cooley mountains c. 5km to the northwest, and the more gently sloping landscape to the south."

In addition, a map provided by the Applicant indicates that the predominant geological types observed within the offshore wind farm area are mud, gravel and sand. At this juncture, RPS EES are unaware of the exact depths at which the aforementioned geological horizons are located beneath the seabed.

The above-mentioned geological/bathymetric map has been presented at Appendix 005.

An *Oriel Wind Farm Project Site Data Review* report completed by Gavin and Doherty Geosolutions Ltd (2018) indicates that:

"Sediment migration was recognised in the area, but the current velocities in the area were discounted as being significant enough to cause an issue, particularly with relation to scour which could easily be mitigated against. Differential settling was recognised as a potential geotechnical constraint given the high degree of lateral variability at the site and low shear strength characteristics of certain surface sediment."

3 UNEXPLODED ORDNANCE RISK ANALYSIS

3.1 Potential UXO Sources

RPS EES has identified a series of sources associated with the above-mentioned military activities that could have the potential to influence UXO contamination within the bounds of the AOI.

Grounded on desk-based research undertaken, it has been possible to determine the potential types of ordnance utilised in select military activities in the region. For the sake of completeness, all identified activities that could have contributed to potential contamination have been recognised and summarised in the subsequent sections.

3.2 Naval Conflict

RPS EES has been unable to find evidence to indicate that naval battles were experienced within the AOI, or its immediate environment.

At a greater distance, the remnants of a series of Kriegsmarine U-boats have been discovered within the Irish Sea. The nearest identified position of a U-boat (U-1051) was identified an estimated 50 km southeast of the AOI.

RPS EES are confident that the distance between the wreckage of U-boat U-1051 and the AOI excludes the potential for UXO contamination to be present at the site attributed from this source.

3.3 Historic Mine Laying

RPS EES has identified no evidence to indicate that a historic mined area intersects the bounds of the AOI, or its immediate environment.

At a greater distance, a series of German WWI minefields have been identified in the Irish Sea.

The nearest identified position is located adjacent to the port of Dublin, an estimated 40 km south of the site. Moreover, an additional German WWI minefield has been identified south of the Isle of Man, an estimated 75 km east of the site.

In addition, a map contained within the British Mining Operations 1939-1945 (Vol 2) book indicates that an Allied minefield associated with Operation “CH” exists an estimated 50 km east of the AOI.

RPS EES are confident that the distance between the AOI and the aforementioned historic mined areas is too great for this source to have a UXO-related risk at the site.

3.4 WWII Aerial Conflict and Bombing Campaigns

At the onset of WWII (1939-1945), the Republic of Ireland (Éire) declared itself neutral in the conflict. As an upshot of this stance, the nation experienced reduced quantities of German Luftwaffe air raids in comparison to countries that comprise the United Kingdom (UK).

It would be prudent to maintain an awareness that Éire port installations and urban areas adjacent to the Northern Ireland border did experience occasional air raid activities; an assumed consequence of human error by the Luftwaffe.

Mistaken for the city of Liverpool, the town of Dundalk experienced an air raid on the night of the 23 July 1941. A 1000lb bomb was dropped, in addition to 10 smaller ordnance devices. Anecdotal evidence in a local publication suggests that the devices were jettisoned at intervals across a consistent flightpath (line), between the rear of a coal yard (Cooper’s) and towards Thomastown.

RPS EES understand that the air raid caused minor damage to residential infrastructure, with no fatalities recorded. The 1000lb bomb is confirmed to have landed on wasteland and functioned as intended. The force of the detonation is known to have caused damage to properties at Castle Road.

Throughout WWII, it was recurrent practice for bomber aircraft to jettison excess ordnance in order to gain altitude, evading fire from Anti-Aircraft (AAA) batteries. In addition, the removal of auxiliary ordnance from aircraft would have improved the chances of the aircraft reaching its destination.

Although remote, it is possible that Luftwaffe aircraft could have intentionally jettisoned munitions in the Irish Sea, upon return from air raids in Northern Ireland.

RPS EES has found no evidence to indicate that additional air raid activities were experienced in Dundalk, or its immediate coastal environment.

3.5 Shipwrecks and Downed Aircraft Containing Munitions

Data for known shipwrecks obtained from the NMS Wreck Inventory of Ireland Database show a known wreck located within the offshore cable corridor (Topaz SS Wreck Site W00248), as well as an unidentified wreck to the south of the Topaz SS Wreck Site, also within the offshore cable corridor (Unidentified Wreck Site W00276) (see Figure 15-5 in volume 2B, chapter 15: Marine Archaeology). Known wreck sites are described in detail in volume 2B, appendix 15-1: Marine Archaeology Technical Report.

Importantly, RPS EES have found no evidence to indicate that this wreck could result in UXO contamination at the site.

In addition, the UKHO records observe one (x1) obstruction feature in the offshore wind farm area; although, RPS EES believe this feature is a foundation block for an Oriel anemometer mast.

Additional wrecks and obstructions have been registered within a 10 km radius of the AOI; although, RPS EES has observed no evidence to indicate that the vessels stored UXO-related items.

Despite the lack of evidence indicating that UXO-related devices were present on vessels within a 10 km radius of the AOI, the Applicant should maintain an awareness of this potential source of UXO contamination.

A map that illustrates the location of the above-mentioned shipwrecks/obstructions has been presented at Appendix 006. However, full regard should be given to appendix 15-1: Marine Archaeology Technical Report which provides a complete record of shipwrecks.

3.6 Military Presence

A series of military installations and associated practice areas (operative and inoperative) have been identified within the immediate environment of the site. RPS EES understand that activities associated with select sources could have the potential to impact upon the wind farm and relevant cable infrastructure.

3.6.1 Ardglass Naval Exercise Area

A PEXA Chart (Q6402) illustrates the boundaries of a naval practice firing area (Ardglass), an estimated 5.5 km northeast of the site.

RPS EES understand that the exercise boundaries encompass an area of approximately 41,500.00 Hectares (ha). It is recorded that air general, HM ships and submarine exercises have taken place at the stipulated area.

In 1942, a company of the 3rd Battalion, 6th Armoured Infantry, 1st Armoured Division (USA) executed practice firing exercises in the area.

The position of the naval exercise area (Ardglass), in relation to the bounds of the AOI, has been presented at Appendix 007.

3.6.2 Gormanston Aerodrome

In 1917, the aerodrome (Gormanston Camp) was utilised as a Royal Flying Corps (RFC) training depot.

At the conclusion of WWI (1914-1918), RFC Gormanston was merged with the Royal Naval Air Service to establish Royal Air Force (RAF) Station Gormanston.

In the inter-war period, a significant reduction in the quantities of aircraft at Gormanston site was experienced. By 1920, the remaining aircraft were transferred to RAF Baldonnel Aerodrome and the station was placed under care and maintenance.

Throughout WWII (1939-1945), limited UXO-related activities were experienced at Gormanston Camp (airfield), with the site primarily utilised as a detention centre for air crews of crashed aircraft. In 1945, Air Corps occupied the camp on a permanent basis, with NO.1 Fighter Squadron stationed at the installation in 1944. The squadron are known to have had Hawker Hurricanes, capable of carrying ordnance. Post-war, the Hawker Hurricanes were replaced with spitfires (in 1947).

In 1956, the Fighter Squadron was transferred to Baldonnel Aerodrome; although, an Air Corps training facility remained active at the installation.

As a consequence of civil strife in Northern Ireland (1969), the Gormanston installation was designated as a refugee camp. At the close of October (1971), 12,000 civilians had used the camp. The airfield was officially closed in 2002.

3.6.3 Gormanston Danger Area D1

Multiple sources provide a series of alternate measurements with regards to the extent of the Gormanston Danger Area D1; however, the US National Geospatial-Intelligence Agency (2015) indicates that the area extends 10 nautical miles (offshore) east of Benhead (53°39N., 6°13’W).

No evidence has been found to indicate that active military activities have ceased at the Gormanston Danger Area D1.

Anecdotal evidence in a local publication (26 June 2009) indicates that the army have utilised rapid-fire, radar-controlled Bofor EL70 40mm guns to attack targets towed out to sea by the Air Corps.

On the 29 August 2017, Exercise Terra Nova 2017 commenced at the Gormanston Danger Area D1. Records state that Pilatus PC-9M aircraft, armed with 0.5” FN heavy machine guns and 70mm FZ folding fin rockets were utilised to conduct Air-to-Ground firing on targets. The exercise concluded on the 8 of September (2017).

Given the estimated 4.5 km distance between Gormanston Danger Area D1 and the AOI, RPS EES believe it would be prudent to maintain an awareness of the potential UXO-related risk associated with this source.

3.6.4 RAF Greencastle

On the 12 January (1942), construction of the aerodrome commenced. The installation was designed to be employed as an RAF bomber Operational Training Unit (OTU); however, in April (1942), the airfield was reassigned to the United States Army Air Force (USAAF) and renamed AAF Station 237.

In 1944, the USAAF 4th Gunnery and Tow Target Flight were located at the installation, with Douglas A-20 Havocs, Westland Lysanders and Vultee Vengeance A-35B’s in the Consolidated B-24 Liberator gunnery school.

In 1945, the airfield was returned to RAF control; although, the installation was immediately closed.

3.6.5 Aitken Barracks and Dundalk Rifle Range

On the 14 August (1922), Dundalk Military Barracks sustained an attack from anti-Treaty IRA guerrillas, a consequence of the ratified Anglo-Irish Treaty (1921). At the onset of the attack, a series (x4) of homemade

bombs/mines detonated on the periphery of the barracks. In addition, anecdotal evidence indicates that there were outbreaks of machine-gun fire throughout the assault.

RPS EES are confident that the UXO-related devices associated with this incident will have had a non-existent influence on UXO contamination at the AOI.

At present, the 27th Infantry Battalion are billeted at the Aitken Barracks. The battalion conduct practice firing exercises at the Dundalk Rifle Range, an estimated 1.2 km southeast of the barracks. RPS EES are confident that the ordnance fired from this source would not have an influence on the UXO-related risk experienced at the site.

3.7 Anti-Aircraft Artillery (AAA)

RPS EES has identified a series of AAA batteries within the general environment of the AOI although given their distance to the site, they are considered unlikely to have a direct impact on the site. It should be noted however that munitions once fired from these locations could have migrated to within the AOI.

Selected information identified from research, in relation to the above-mentioned AAA batteries, has been presented in the table below and the geographic extent of the firing fans attributed to the alternate batteries has been presented at Appendix 007.

Table 3-1: Details pertinent to AAA batteries identified within the immediate environment of the AOI, Source: Armament Training Areas (1945) maps.

Location of AAA position	Type of battery utilised	Firing fan distance/direction from the AOI
St John's Point (NI)	HAA and LAA	23.7 km (NE of the AOI)
Hilltown (NI)	Unspecified	22.2 km (N of the AOI)
Ringsallin (NI)	LAA	30.2 km (NE of the AOI)
Ballykinlar (NI)	AA (MG)	34.7 km (NE of the AOI)

3.8 Munitions Dumping

Having reviewed records of munitions dumpsites in the vicinity of the site and the wider area, it is evident that a chemical weapons dumpsite exists in the Irish Sea, an estimated 30 km southeast of the AOI.

As a general postulation, in excess of 71,000 bombs equipped with nerve agents, unspecified chemical weapons and 'seed dressing', containing bacillus anthracis spores have been dumped in the Irish Sea, in various locations.

At this juncture, RPS EES believe that the distance between the aforementioned chemical weapons dumpsite and the AOI is too great to have a significant influence on UXO-related risk.

3.9 UXO Finds/Incidents

Post-consultation of OSPAR datasets and anecdotal evidence, it is evident that natural processes transport conventional munitions from the Irish Sea, onto the shoreline. On the 22nd of November (2005), a conventional munition (unspecified) was identified onshore, an estimated 12 km from the AOI. OSPAR data indicates that the device was detonated in a controlled environment.

In addition, anecdotal evidence from a BBC News publication indicates that a WWII-era UXB washed ashore in the harbour at Warrenpoint (NI), an estimated 21 km north of the AOI.

At these distances, the UXO will have had a negligible influence on the UXO-related risk within the bounds of the site; however, these discoveries highlight a potential for ordnance to migrate along the seabed.

4 MARINE UXO MIGRATION / DRIFT AND BURIAL

4.1 Migration / Drift

A plethora of academic studies have documented that munitions can migrate across the seafloor. The principal force behind this movement is tidal currents. Research by Wilson et al. (2008) indicates that the migration of munitions decreases with depth and that munitions in a minimal burial state are particularly susceptible to movement when influenced by a large wave or strong current.

Importantly, Wilson's report states that once a munition is completely buried, no further migration occurs unless bottom profile variation allows for re-exposure or there is scour. As mentioned in Section 2.3, scour is considered to be relatively weak and easily mitigated in the region.

The greater the velocity of the tides and currents, the greater the likelihood and rate at which UXO-related items can migrate. However, larger items of UXO such as mines, torpedoes and larger categories of iron bombs, are unlikely to migrate as far and frequently as smaller items, unless significant tidal / current velocities exceed the minimum energy required for them to move. Smaller items of UXO, such as AA artillery projectiles and Small Arms Ammunition, are more likely to migrate when subjected to lower levels of energy generated by more benign tides and currents.

4.2 Depth of Burial

4.2.1 Burial Via Initial Penetration

When a munition is fired/dropped from height, its velocity upon initial impact provides the potential for the item to penetrate the seabed. In situations where a device impacted into >10 m depth of water, which would be the case for this site, it is likely that penetration would have been retarded significantly by the water and the ordnance would come to rest on or very near the seabed (within the top 2 m). Given the water depths located on site, it is considered unlikely munitions would have become buried when coming to rest on the seabed.

Certain munitions, including those that have either been dumped, placed (e.g. sea mines) or have migrated from elsewhere, are likely to have landed on the surface of the seabed rather than penetrating.

4.2.2 Burial Via Natural Processes

It is assumed that within the AOI, the seabed mainly consists of sands, muds and gravels. In the softer sediments, it is possible for munitions to be covered by shifting sediments on the seabed and subsequently become buried. This is dependent on the mass, dimensions/shape of the item and the sediments upon which it came to rest as well as the currents affecting the area.

As outlined in Section 2.3, "*sediment migration was recognised in the area, but the current velocities in the area were discounted as being significant enough to cause an issue, particularly with relation to scour which could easily be mitigated against".* This said, as demonstrated by the reports of munitions being found along the coastline, the migration of munitions along the seabed is a process that needs to be considered in the AOI.

5 POTENTIAL ORDNANCE DETAILS

5.1 General

Based on the information collated, RPS EES considers that the following types of ordnance have the potential to have been utilised on/within the vicinity of the proposed route:

- **Small Arms Ammunition:** Description and examples are presented at Appendix 008
- **Land Service Ammunition:** Description and examples are presented at Appendix 009
- **Projectiles:** Description & examples are presented at Appendix 010
- **Aerial Delivered Bombs:** Description and examples are presented at Appendix 011
- **Sea Mines:** Description and examples are presented at Appendix 012
- **Torpedoes:** Description and examples are presented at Appendix 013
- **Depth Charges:** Description and examples are presented at Appendix 014
- **Rockets:** Description and examples are presented at Appendix 015
- **Missiles:** Description and examples are presented at Appendix 016
- **Conventional and Chemical Dumped Munitions**

Importantly, whilst the technology in some of these munitions has altered significantly over the years, the composition of the explosives within them generally has not changed. It is the explosives within the devices that pose the risk; therefore, historic munitions can pose as significant of a risk today as more modern devices, especially as bulk explosives may not have degraded since the time the device was assembled.

It should be considered that WWI and WWII munitions have been identified on or below the sea floor that are still hermetically sealed; with no water ingress having been observed. Other devices are found to have cracked; with the outer casings of some mines for example having been worn away over time. Therefore, it is not possible to state with any certainty that historic munitions pose less of a risk based on their degradation over time.

6 RPS EES UXO ANALYSIS AND ASSESSMENT

6.1 General

Risk Assessment is a formalised process for assessing the level of risk associated with a particular situation or action. It involves identifying the hazards and the potential receptor that could be affected by the hazard. The degree of risk is associated with the potential for a pathway to be present, linking the hazard to the receptor. This relationship is usually summarised as the Source – Pathway – Receptor.

This review has utilised information from research carried out by RPS EES and considered the proposed intrusive activities to design a more specific and detailed mitigation methodology. In the following sections, RPS EES will review the assessment made and where applicable, make further recommendations.

6.2 Sources / Hazards

The RPS EES research has resulted in the following items having been deemed possible contaminants within the proposed route:

- SAA
- LSA
- Projectiles
- Aerial Delivered Bombs
- Sea Mines
- Torpedoes
- Depth Charges
- Dumped Munitions (Conv. And Chem.)
- Missiles/Rockets

6.3 Pathway

The pathway is described as the route by which the hazard reaches the site personnel. Given the nature of the proposed route the only pathways would be during:

- Cable Laying on surface of seabed
- Ploughing
- Jetting
- Trenching
- Piling
- Drilling
- Snag on Vessel – e.g. entanglement in equipment being brought aboard
- Support Vessel – e.g. carrying out installation works from surface

6.4 Receptors

Sensitive receptors applicable to this proposed route would be:

- People (Workers / Engineers and General Public)
- High Value Equipment
- Infrastructure
- Vessels (Applicant and Public)
- Environment

6.5 Risk Evaluation

The following sections contain the Risk Evaluation for the proposed route, prior to the implementation of any risk mitigation measures. For the risk to be properly defined, several factors must be taken in to account, including the consequences of initiation, the probability of encountering UXO on the proposed route and the probability of detonating munitions during intrusive activities. The technique used to evaluate level of risk is outlined in the following diagram:

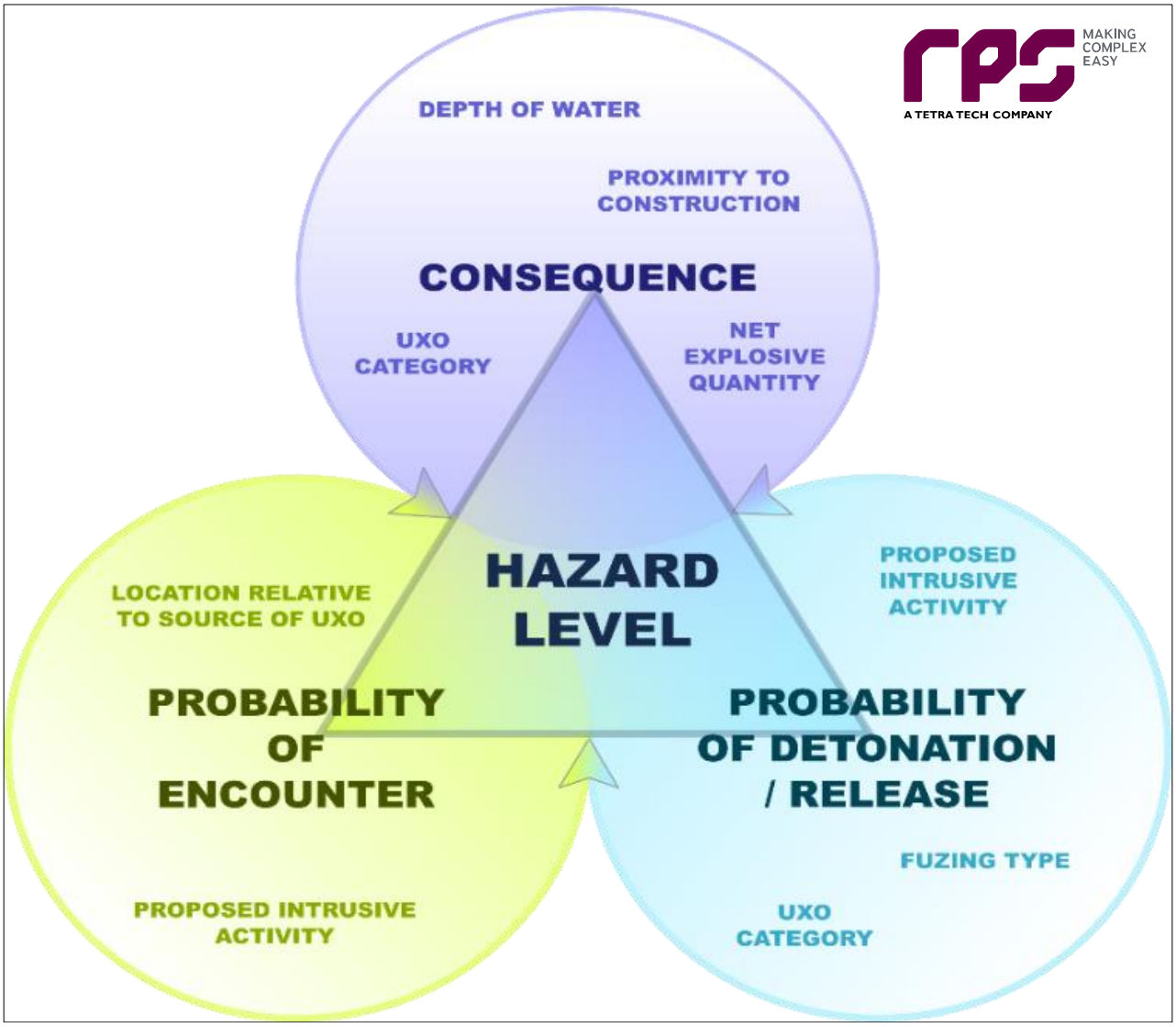


Figure 6-1: Hazard Level Considerations.

Risk level = Probability of Encounter x (Probability of Detonation or Release x Consequence)

In order, to identify an appropriate risk mitigation strategy for the works it is now necessary to complete a semi-quantitative assessment of the identified risk.

6.6 Probability and Consequence Assessment

For the purpose, of this assessment RPS EES has examined the probability of encounter and detonation and the potential subsequent consequence for the specific proposed works to be undertaken during the

project. Only the following main categories of munitions have been included to provide a range of assessment data and it should be noted that other munition types may remain in the area.

The assessment is presented at Appendix 017 and the process detailed below. Based, on the factors detailed above the probability of each engineering activity causing each munition type to detonate is assessed and ranked A – F:

A. Highly Probable
B. Probable
C. Possible
D. Remote
E. Improbable
F. Highly Improbable

This is based on the estimated disturbance caused by the installation activity and the likelihood for this to cause a detonation of specific munitions (which is based on the items initiation systems).

The consequence level for each activity and munition type is then obtained from the table presented in Appendix 018, which provides a consequence rating from one to five, depending upon the severity. The detonation consequence assessment assigns a site-specific consequence level to any potential UXO that may be encountered at the proposed route. This is achieved by combining the UXO impact ranking and the depth of water across the proposed route. A rating system for assigning consequence levels has been derived based on the expected effects of a detonation event during each of the engineering activities, both on the seabed and on the vessel.

Finally, the estimates of the extent of intrusive works can be combined with the estimate of the likelihood of a UXO risk being present within each route segment to assess the probability of encounter, which are additionally ranked A – F, as above.

The result for each activity, munition type and segment are then presented as:

I^1 (I^2 – n)*;* where:

- I^1 is the Probability of Encounter level, (*A – F*)
- I^2 is the Probability of a Detonation level (*A – F*)
- *n* is the Consequence of a Detonation level (*1 – 5*)

The probability of encounter, probability of detonation/release and consequence of a detonation/release levels are then multiplied to give a risk level for each munition type, segment and engineering activity.

This was determined by assigning the values in the following table to the above results, which were then multiplied to provide a final risk level ranging between Negligible and High.

Table 6-1: Probability and consequence levels.

Prob. of Encounter (*1*)		Prob. of Detonation (*2*)		Consequence (*3*)	
A	Highly Probable (*1 in 1*)	**A**	Highly Probable (*1 in 1*)		
B	Probable (*1 in 10*)	**B**	Probable (*1 in 10*)	**1**	Catastrophic (*1 in 1*)
C	Possible (*1 in 100*)	**C**	Possible (*1 in 100*)	**2**	Major (*1 in 10*)
D	Remote (*1 in 1,000*)	**D**	Remote (*1 in 1,000*)	**3**	Moderate (*1 in 100*)
E	Improbable (*1 in 10,000*)	**E**	Improbable (*1 in 10,000*)	**4**	Minor (*1 in 1,000*)
F	Highly Improbable (*1 in 100,000*)	**F**	Highly Improbable (*1 in 100,000*)	**5**	Insignificant (*1 in 10,000*)

Table 6-2: Final Risk Scores.

Probability (Encounter x Detonation) X Consequence

			Probability					
			A Highly Probable	**B** Probable	**C** Possible	**D** Remote	**E** Improbable	**F** Highly Improbable
Consequnece								
1	Catastrophic	1	1.E+00	1.E-01	1.E-02	1.E-03	1.E-04	1.E-06
2	Major	0.1	1.E-02	1.E-03	1.E-04	1.E-05	1.E-06	1.E-08
3	Moderate	0.01	1.E-04	1.E-05	1.E-06	1.E-07	1.E-08	1.E-10
4	Minor	0.001	1.E-06	1.E-07	1.E-08	1.E-09	1.E-10	1.E-12
5	Low	0.0001	1.E-08	1.E-09	1.E-10	1.E-11	1.E-12	1.E-14

Risk Score
Negligible
Low
Moderate
High

7 UXO RISK LEVELS

7.1 UXO Risk

Based on the conclusions of the research and the risk assessment undertaken, RPS EES has found there to be a low risk of encountering UXO during the proposed operations. This is primarily due to the assessed low probability of encountering an item of UXO within the AOI. As a blanket risk has been assigned to the project area, no risk zone mapping has been created.

It should be noted that potential sources of UXO do exist in the wider area although they are at such a distance that they are deemed unlikely to have a direct impact on the site.

Migration appears to be unlikely based on reports provided to RPS although encounters with munitions along the coastline have been identified. As such, the possibility that munitions may have migrated to within the AOI cannot be entirely dismissed.

The assessed risks on site have been presented in the table below with the facets presenting possible sources of UXO presented in the mapping at Appendix 007:

Table 7-1: Risk Levels Per Activity.

Ordnance Variant		Activity						
		Seabed Activities					Surface Activities	
		Cable Lay on Seabed	Plough	Jetting	Trenching	Drilling	Support Vessel	Snag on Vessel
Small Arms Ammunition		Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Land Service Ammunition		Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
≤ 155mm Projectiles		Low	Low	Low	Low	Low	Low	Low
>155mm Projectiles		Low	Low	Low	Low	Low	Low	Low
HE Bombs	Allied Origin	Low	Low	Low	Low	Low	Low	Negligible
	Axis Origin	Low	Low	Low	Low	Low	Low	Negligible
Sea Mines	Allied Origin	Low	Low	Low	Low	Low	Low	Negligible
	Axis Origin	Low	Low	Low	Low	Low	Low	Negligible
Torpedoes		Low	Low	Low	Low	Low	Low	Negligible
Depth Charges		Low	Low	Low	Low	Low	Low	Negligible
Dumped Munitions (Conv.)		Low	Low	Low	Low	Low	Low	Low
Dumped Munitions (Chem.)		Low	Low	Low	Low	Low	Low	Low
Missiles/Rockets		Low	Low	Low	Low	Low	Low	Negligible

8 RISK MITIGATION STRATEGY

8.1 Mitigation Strategy Rationale

RPS EES' Risk Assessment for Potential UXO contamination has identified a Low risk from UXO across the proposed AOI.

8.2 Recommendations

Based on the identified risk levels, it is recommended that appropriate mitigation is implemented prior to and/or during the scheduled operations.

The methods of mitigation that are recommended for the site consist of reactive methodologies and are outlined in the following sections.

8.3 Explosives Safety Awareness

As Explosives Safety Engineer Supervision is not deemed to be required during installation operations, Explosives Site Safety Guidelines should be implemented.

A set of *Explosives Site Safety Guidelines (ESSG)* would be produced, which would be provided to the Applicant along with training at the start of the project. The guidelines are designed to aid the project team to plan the proposed works and potentially deal with the event of a suspicious item / UXO discovery incident. The guidelines would address the risk to all of the specific proposed works and will inform all personnel how to undertake the works safely and will refer to the specific risk items/hazards that have been identified for the site and the mitigation that has been completed to reduce the risk.

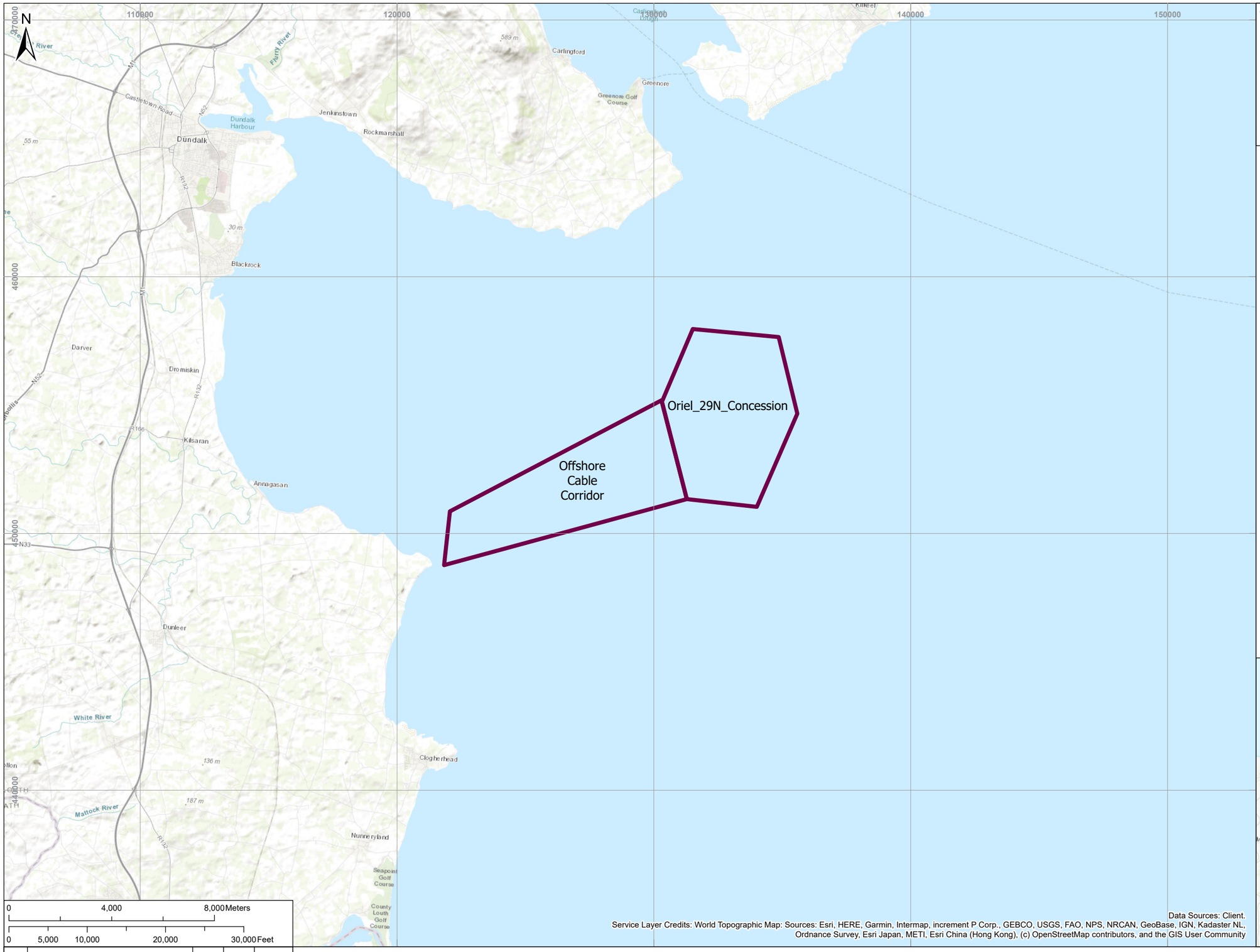
The guidelines would typically be provided to the Applicant in the form of a '*Guidelines Document'* along with a supporting PowerPoint Slideshow. Safety and Awareness Training would be provided to key personnel and offshore teams.

RPS EES would specifically recommend that these be delivered to personnel involved in intrusive works on the seabed. Training on how to recognise UXO for these personnel would be considered most prudent given the risks in the area.

APPENDICES

APPENDIX 001

Site Location Map



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Legend

Area of Interest (AOI)

Data Sources: Client.
Service Layer Credits: World Topographic Map: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

00	INITIAL ISSUE	GD	RP	15/08/19
Rev	Description	By	CB	Date

Figure Number **EES1022-F-001** | Rev **00** | Page **1 of 1**

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Client: Parkwind

Project: Oriel Wind Farm, Irish Sea

Title: Site Location

Status	Drawn By	PM/Checked By	Geodetic Information:
INITIAL ISSUE	GD	RP	CRS: British National Grid Datum: OSGB 1936 EPSG Code: 27700
Project Number	**Scale @ A3**	**Date Created**	
EES1022	1:150,000	15/08/19	

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APPENDIX 002

Terminology

Terminology

High Explosive (HE) - An explosive that normally detonates rather than burns; that is, the rate of detonation exceeds the velocity of sound.

Initiation - A physical process that sets in motion a cascade of chemical reactions of ever increasing energy (the explosive chain) that will eventually generate sufficient energy (the velocity of detonation) to allow the main charge to detonate in a violent, explosive chemical reaction, releasing energy in the form of heat and blast.

Unexploded Bomb (UXB) -The term UXB refers to any WWII aerial-delivered unexploded bomb, torpedo, projectile or mine consisting of a complete ferrous casing (without tailfins) weighing 50kg or greater.

Unexploded Ordnance (UXO) - Explosive Ordnance that has been primed, fuzed, armed or otherwise prepared for action, and which has been fired, dropped, launched, projected or placed in such a manner as to constitute a threat to the safety and/or security of people, animals, property or material and remains unexploded either by malfunction or design or for any other reason.

UXO Contamination - UXO that is present, within any given physical context that is considered to be an impediment to the safe on-going or intended use of a facility, including geological features. Safety in this instance is measured against an acceptable level of exposure to the potential risks that UXO present.

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Glossary

AAA	Anti-Aircraft Artillery
ALARP	As Low As Reasonably Practicable
Allied Forces	The Allies of World War II were the countries officially opposed to the Axis powers during the Second World War
ARP	Air-raid Precautions
BD	Bomb Disposal (historic term for EOD)
BDO	Bomb Disposal Officer
bgl	Below Ground Level
BSH	Federal Maritime and Hydrographic Agency of Germany
dGPS	Differential Global Positioning System
EEZ	Exclusive Economic Zone
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
GPS	Global Positioning System
HAZOP	Hazard and Operability Study
HE	High Explosive
HOID	Hydrographic Office Identification
HVAC	High Voltage Alternating Current
IB	Incendiary Bomb
KMBD	Kampfmittelbeseitigungsdienst - Explosive ordnance disposal services of Germany also abbreviated to KBD
kg	Kilogram
Km	Kilometre
KP	Kilometre Point
LAT	Lowest Astronomical Tide
LMB	Luftmine 'B' - German Ground Mine, British Designation GC Mine
LSA	Land Service Ammunition
Luftwaffe	German Air Force
MBES	Multi Beam Echo Sounder
mbgl	Metres Below Ground Level
Mm	Millimetre
NEQ	Net Explosive Quantity
nm	Nautical Mile
OB	Oil Bomb

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Glossary

ROV	Remotely Operated Vehicle
RPL	Route Position List
RPS	RPS Group Plc
RTK	Real Time Kinematic
SAA	Small Arms Ammunition
SBP	Sub-Bottom Profiler
SC	Sprengbombe-Cylindrisch, thin cased General Purpose Bomb
SD	Sprengbombe-Dickwandig, Semi-Armour-Piercing Fragmentation Bomb
SJA	Safe Job Analysis
Sqm	Square Metres
SSS	Side Scan Sonar
TDEM	Time Domain Electro Magnetic
TMB	Torpedomine 'B' - German Ground Mine, British Designation GS Mine
UKHO	United Kingdom Hydrographic Office
USAAF	United States Army Air Forces
USBL	Ultra Short Base Line
WWI	First World War (1914 -1918)
WWII	Second World War (1939 – 1945)

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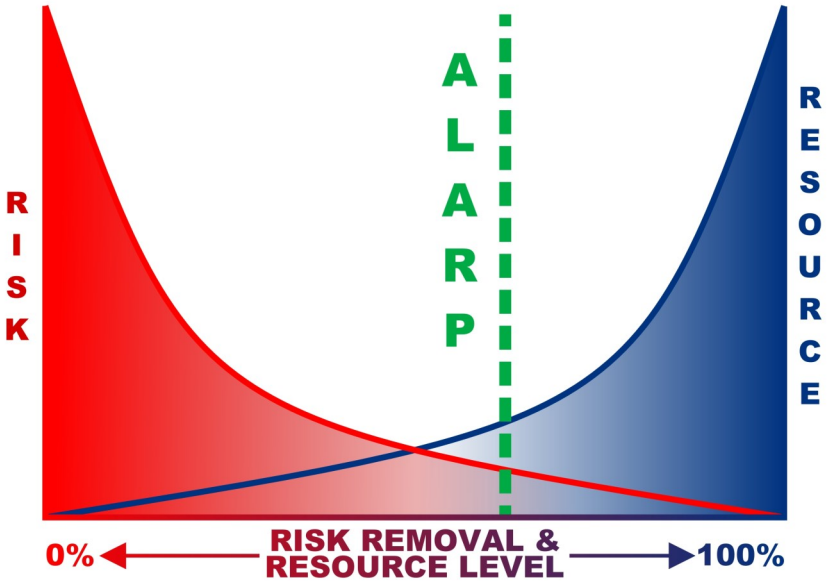
APPENDIX 003

'ALARP' Principle

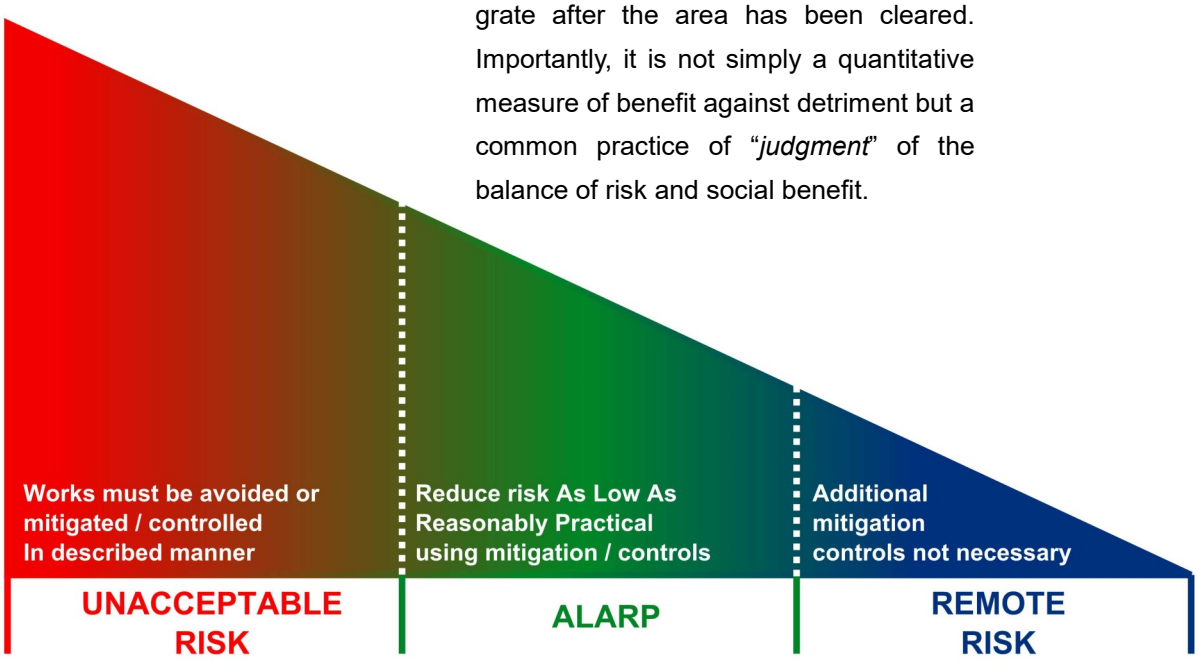
'ALARP PRINCIPLE'

ALARP has particular connotations in UK Health and Safety law and the core concept of what is "*reasonably practicable*". This involves weighing a risk against the effort, time and costs needed to control it, which will vary greatly dependent upon the level of UXO Hazard and the environment within which it is associated.

For a risk to be reduced in line with ALARP it must be possible to demonstrate that the cost involved in reducing the risk further would be "*grossly disproportionate*" to the benefit gained. The ALARP principle arises from the fact that it would be possible to spend infinite time, effort and money attempting to reduce a risk to zero, which may never be achievable. This is particularly true of UXO risk, where there will always remain a residual (albeit low) risk, for example from smaller UXO that is not easily detectable, or due to the limitations of survey equipment, and particularly in the marine environment where UXO can migrate after the area has been cleared. Importantly, it is not simply a quantitative measure of benefit against detriment but a common practice of "*judgment*" of the balance of risk and social benefit.



ALARP Resource Graph



ALARP Diagram Approach

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APPENDIX 004

Legislation

Whilst undertaking this desk study the requirements of a number of legislations has been borne in mind, as presented following:

UK Legislation	Corresponding ROI Legislation
Manufacture and Storage of Explosives Act 2005.	Stores for Explosives Order 2007, S.I. No. 804 of 2007
Health & Safety at Work etc Act 1974.	The Safety, Health and Welfare at Work Act, 2005.
Construction (Design & Management) Regulations 2015.	The Safety, Health and Welfare at Work (Construction) Regulations, 2013. S.I. No.291 of 2013
Control of Substances Hazardous to Health (COSHH) Regulations 2002. (European law covered in Ireland by the Legislation listed to the right.	Chemicals Act 2008 (No. 13 of 2008) and Chemicals (Amendment) Act 2010 (No 32 of 2010)
Personal Protective Equipment at Work Regulations 1992.	The Safety, Health and Welfare at Work (General Application) Regulations 2007-2016

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APPENDIX 005

Geology and Bathymetric Map

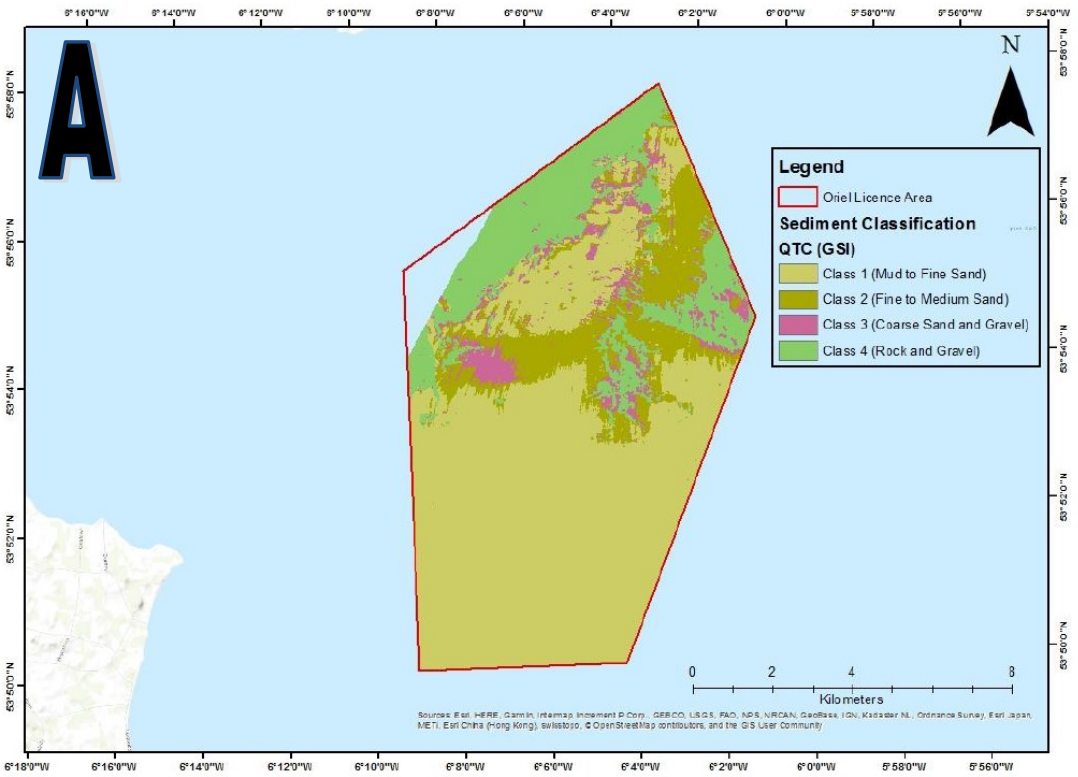


Figure A: The various geological sediments identified within the bounds of the site.

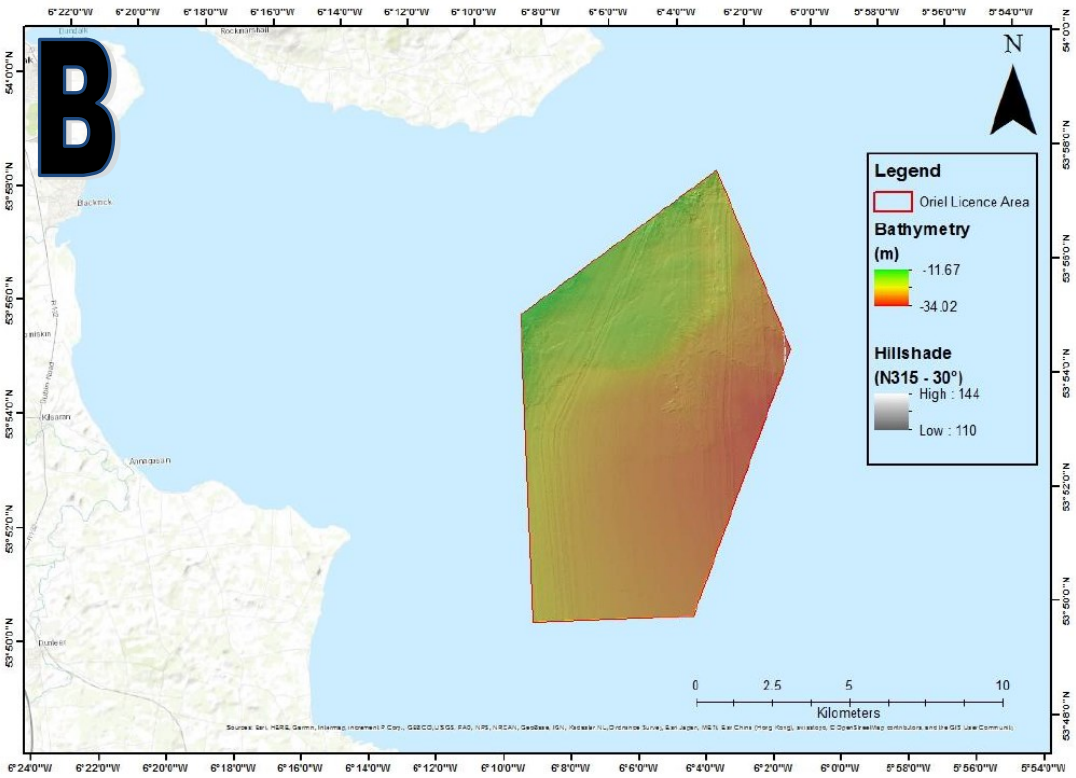
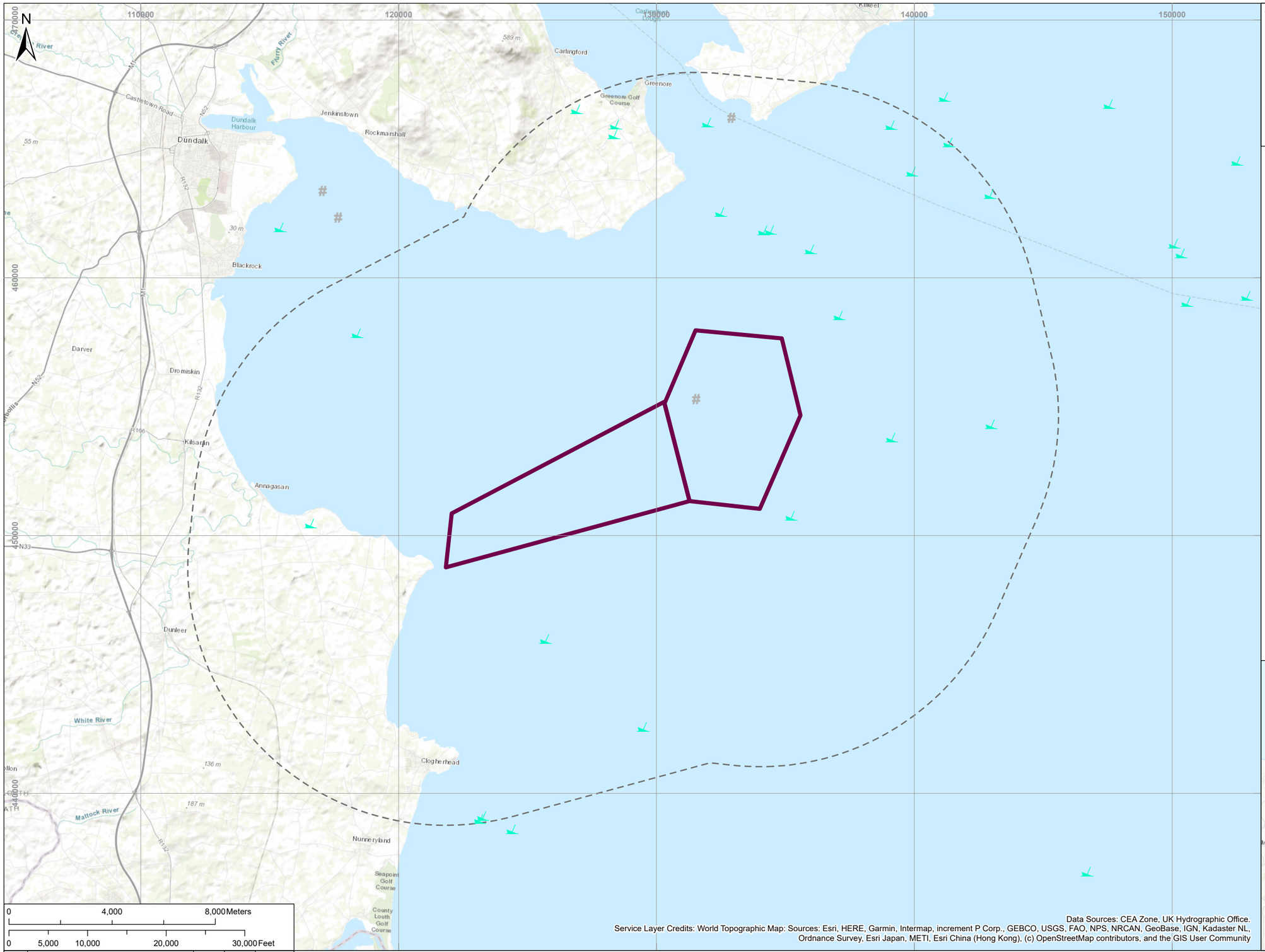


Figure B: The approximate bathymetry observed within the bounds of the site.

APPENDIX 006

Shipwrecks and Obstructions Map



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Legend

- Area of Interest (AOI)
- AOI_Buffer_10km
- Wreck
- Foul / Obstruction

Overview

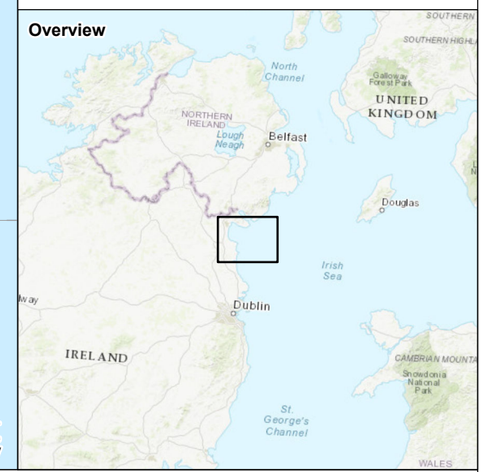

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Figure Number **EES1022-F-003** | Rev **00** | Page **1 of 1**

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Client: Parkwind

Project: Oriel Wind Farm, Irish Sea

Title: Wrecks and Obstructions

Status	Drawn By	PM/Checked By
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Project Number	**Scale @ A3**	**Date Created**
EES1022	1:150,000	15/08/19

Geodetic Information:
CRS: British National Grid
Datum: OSGB 1936
EPSG Code: 27700

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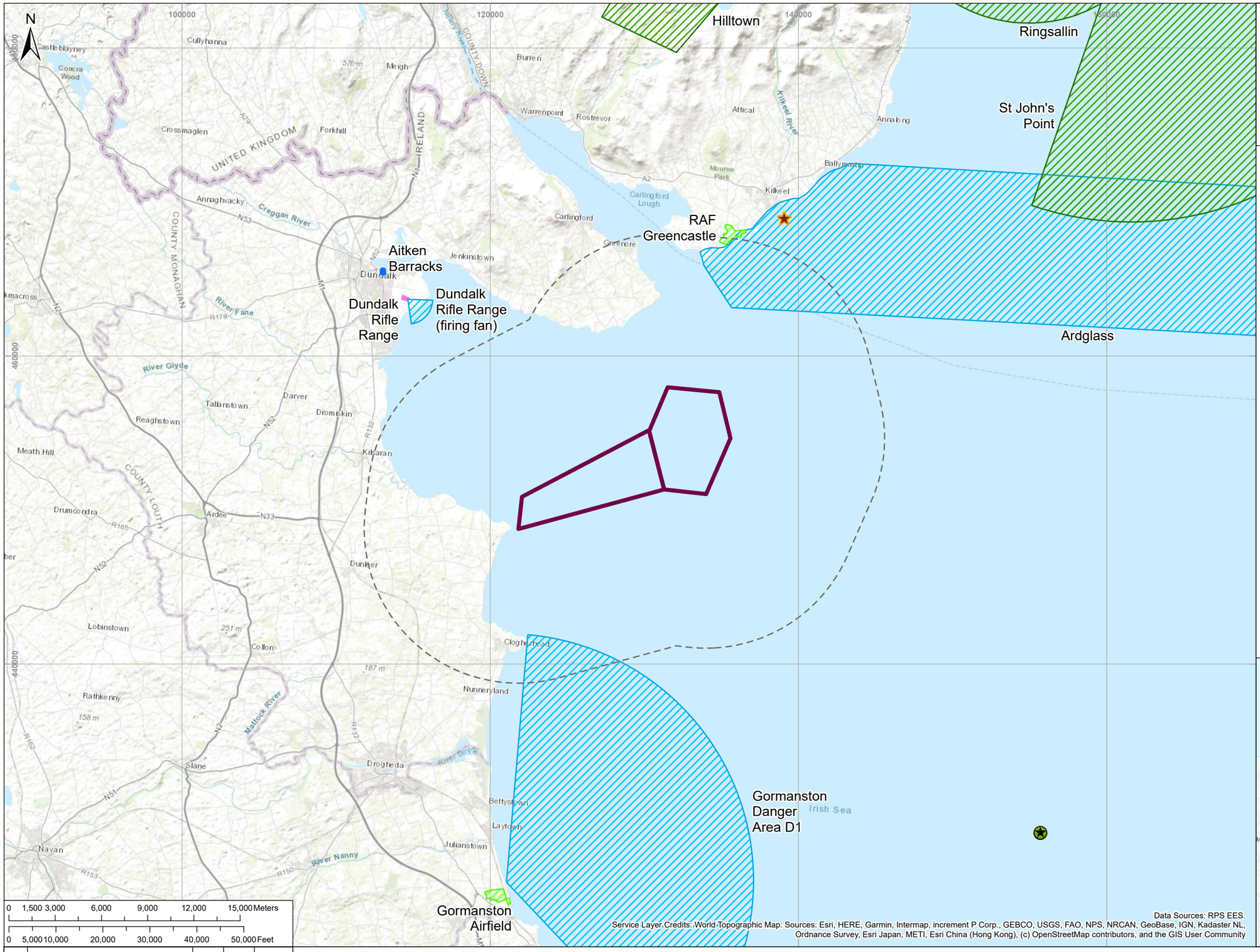
APPENDIX 007

UXO Features Map



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Legend

- Area of Interest (AOI)
- AOI_Buffer_10km
- Chemical Weapon Munitions Dump
- OSPAR Munition Encounters (up to 2014)
- Military Firing Range
- Military Installation
- Airfield
- Firing (Air, Sub, Sur)
- Artillery

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Figure Number **EES1022-F-002** | Rev **00** | Page **1 of 1**

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Client: Parkwind
Project: Oriel Wind Farm, Irish Sea
Title: UXO Features

Status: INITIAL ISSUE
Drawn By: GD
PM/Checked By: RP
Project Number: EES1022
Scale @ A3: 1:250,000
Date Created: 15/08/19

Geodetic Information:
CRS: British National Grid
Datum: OSGB 1936
EPSG Code: 27700

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APPENDIX 008

Examples of Small Arms Ammunition

Project: Oriel Wind Farm, Irish Sea

Project Ref: EES1022

Appendix 008A: Examples of Small Arms Ammunition

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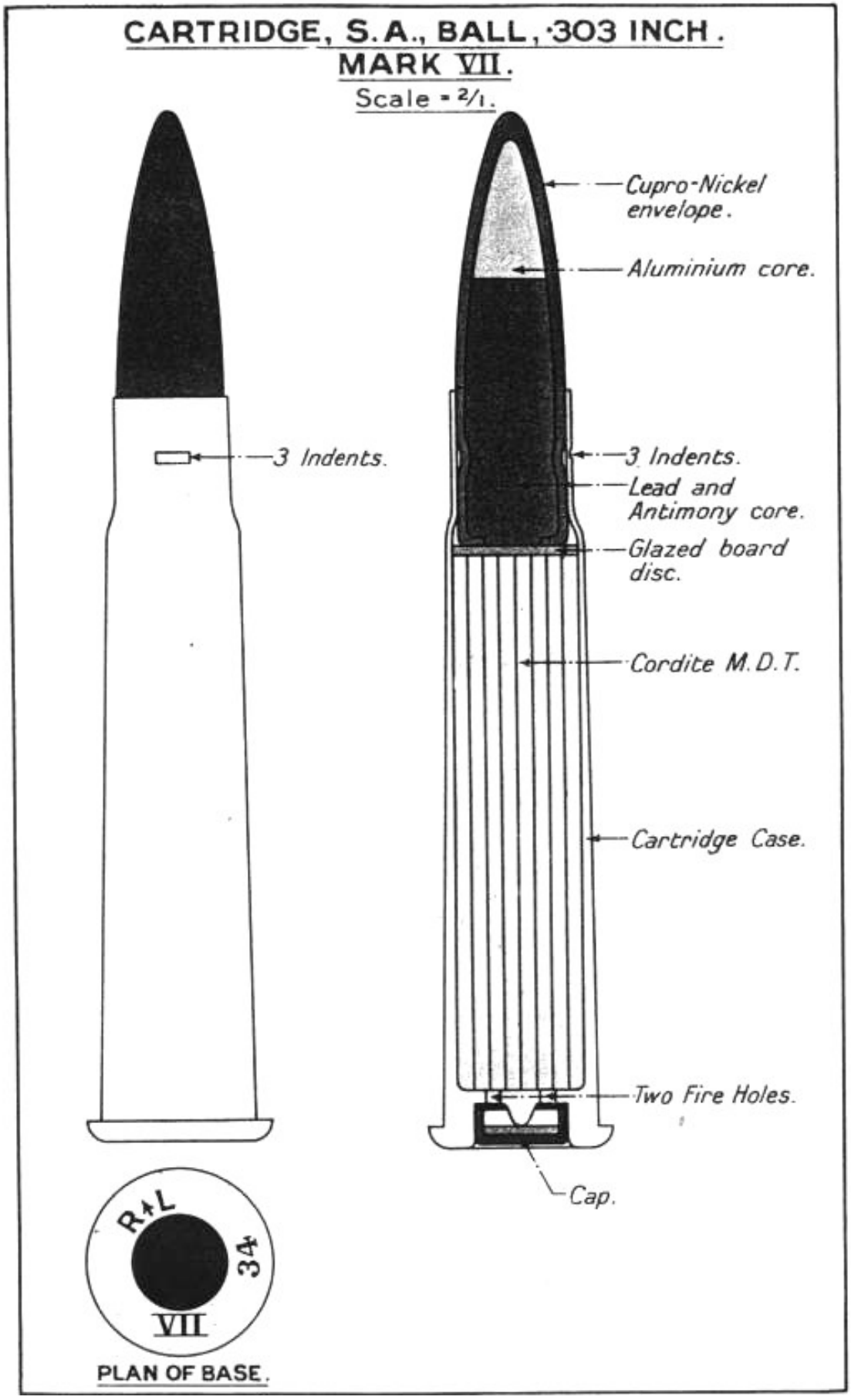

Project: Oriel Wind Farm, Irish Sea

Project Ref: EES1022

Appendix 008B: Examples of Small Arms Ammunition

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APPENDIX 009

Examples of Land Service Ammunition

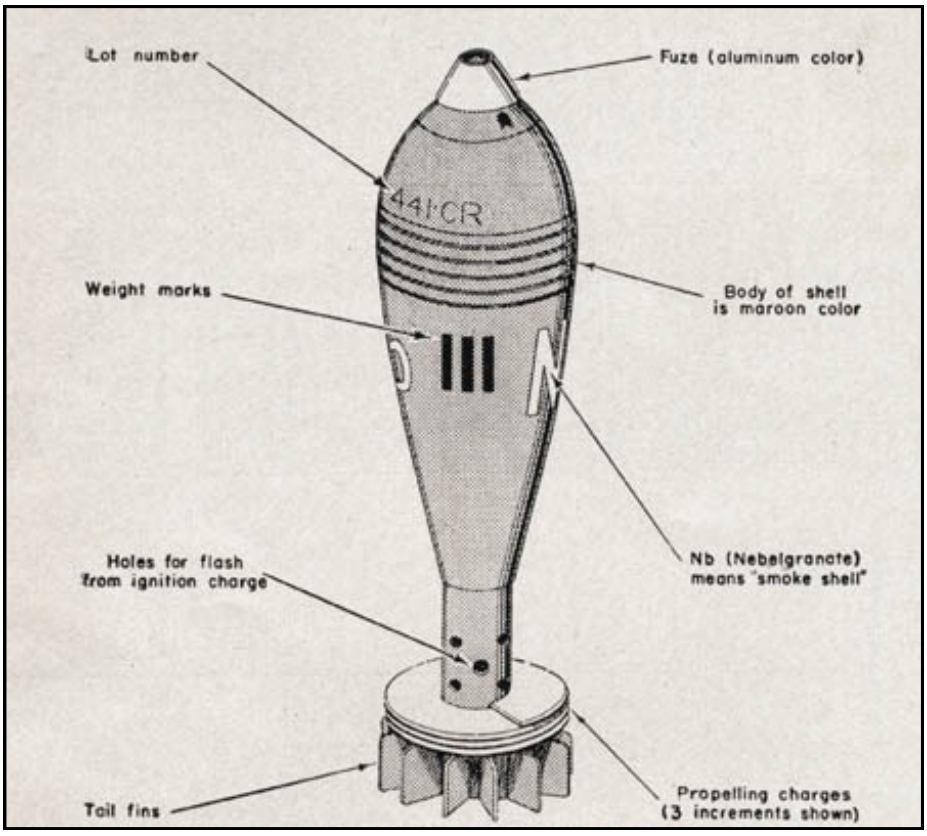

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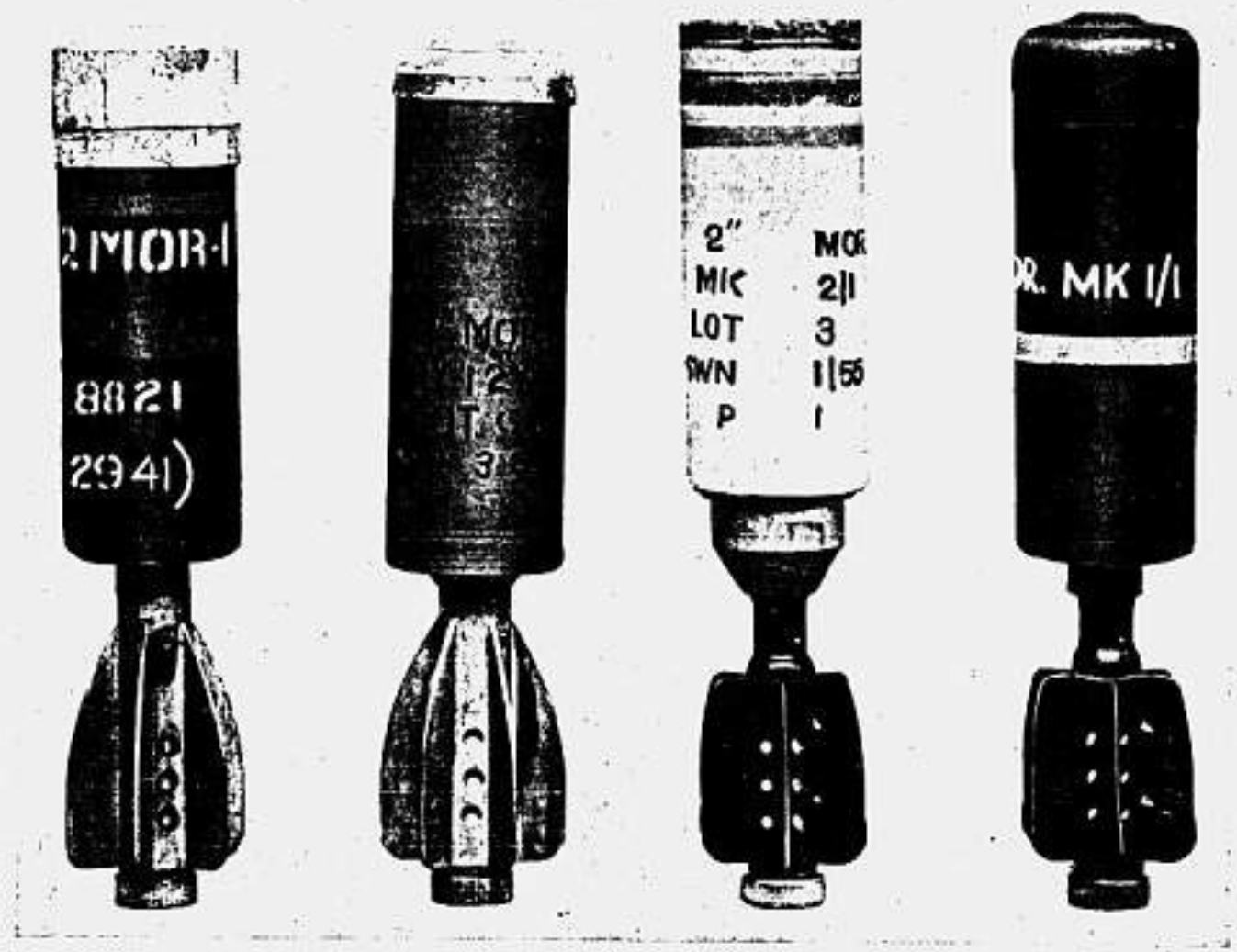
Fig. 9
BOMBS, M.L., 2-in. MORTAR



H.E. | Smoke | Illuminating with parachute | Practice

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APPENDIX 010

Examples of Projectiles

Anti Aircraft Artillery Projectiles

During WWII, the munitions commonly used by the British AAA were the 4.5” and 3.7” varieties. An artillery munition generally consists of four main sections:

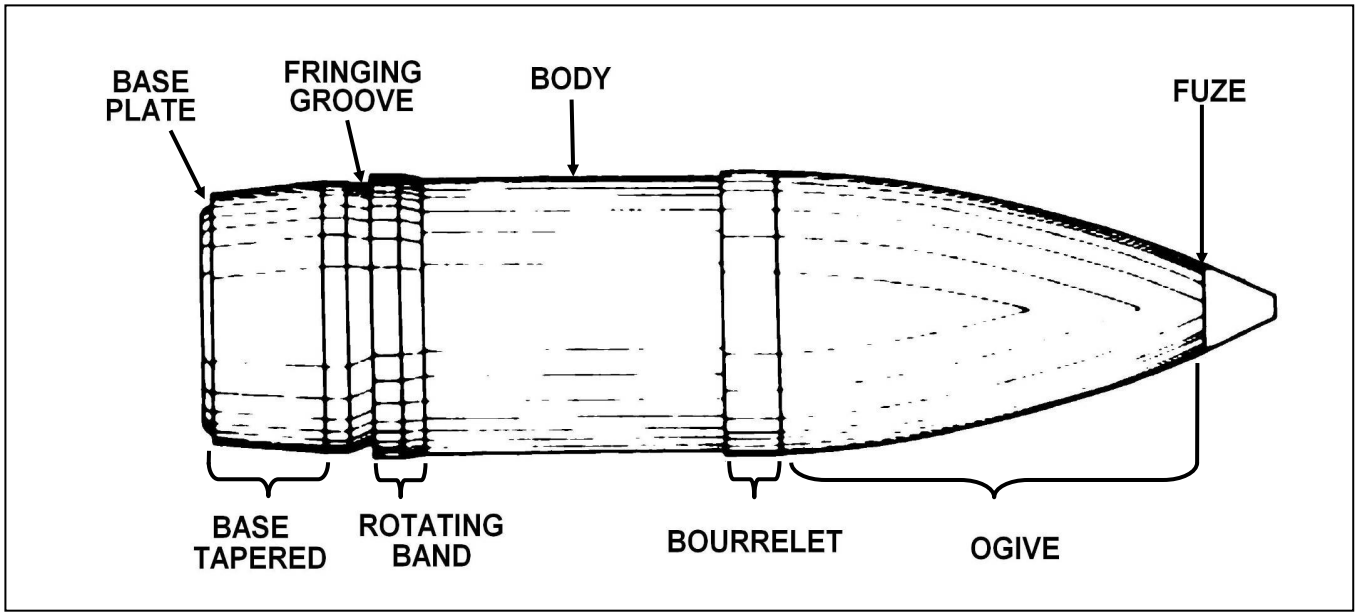
- ***Fuze –*** The part of the device which initiates the detonation of the payload. Usually artillery munitions have nose fuzes, although some do have base fuzes. When used with HE shells, ‘airburst’ fuzes usually have a combined airburst and impact function.

- ***Projectile –*** This is the part of the munition that generally contains the main payload, and will be ejected from the main munition during firing. Artillery shell projectiles can range between bursting, base ejection or nose ejection.

- ***Propellant –*** Propellant in artillery munitions is always low explosive.

- ***Primer –*** The primers purpose is to initiate the propellant upon firing.

In most cases, the part of the munition that is likely to remain as UXO, as a result of malfunction during firing, is the Projectile (potentially with fuze), as this is the part of the device that is fired through the air.



TYPICAL PROJECTILE COMPONENTS

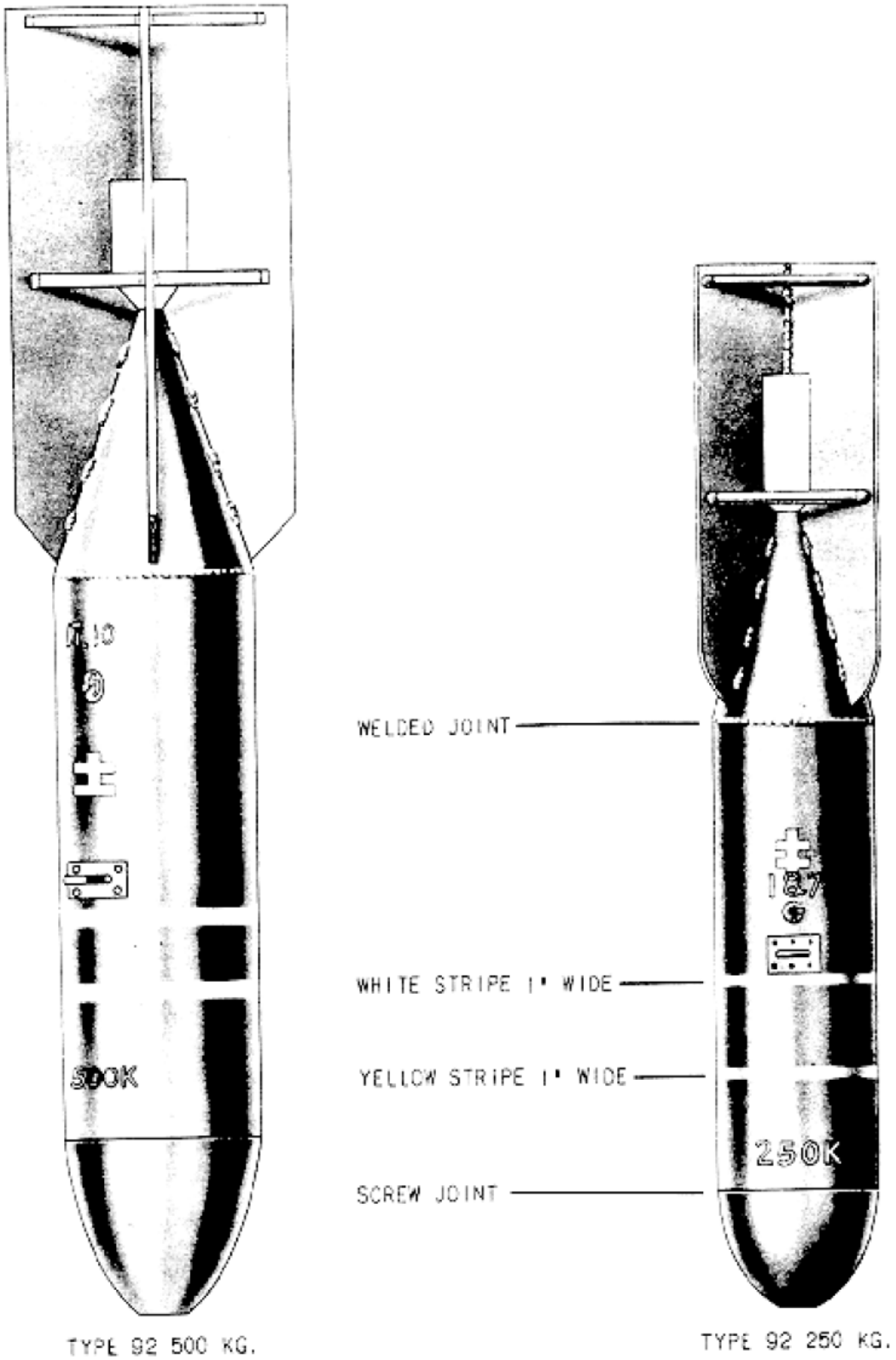
“Z” Batteries, often manned by Home Guard units fired Rockets as part of the integrated aerial defences. These ‘projectiles’ were essentially fin stabilised rockets which contained a small propellant charge to ignite the rocket motor. Throughout WWII two variations of the rocket were utilised, the first being a 2” rocket which was later replaced by a 3” rocket after being discovered that it was far more effective.

20x70RB (Becker), 20x72RB (Oerlikon FF - aka IJN Type 99-1), 20x80RB (German MG-FF/M), 20x82 (Mauser MG 151/20), 20x94 (IJA Ho-5), 20x99R (ShVAK),20x101RB (Oerlikon FFL- aka IJN Type 99-2), 20x105B (Solothurn S18-350), 20x105(German MG 204), 20x110RB (Oerlikon FFS and HS.7, H.S.9 variants), 20x110(HS.404 - Hispano)

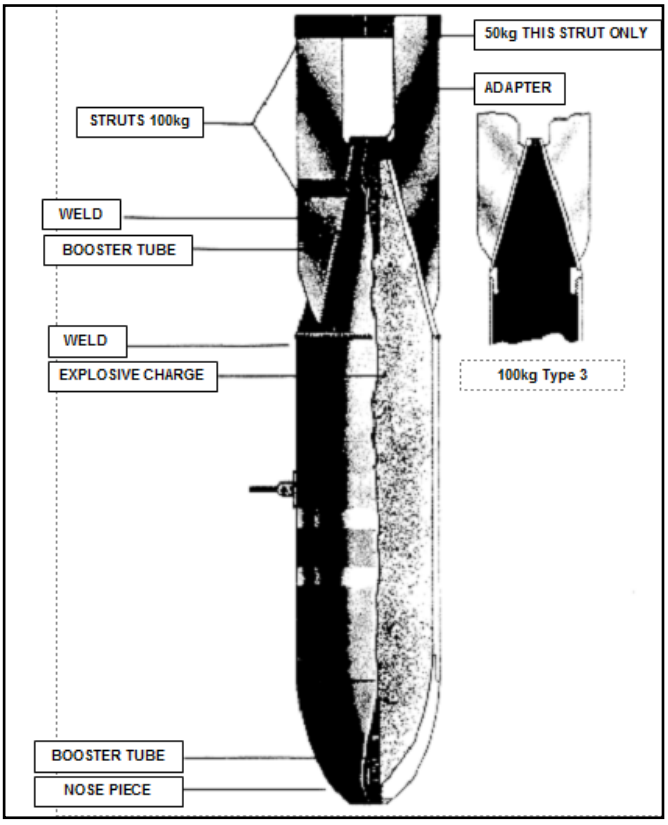
19x114R (WW1 Szakats), 20x110 (for scale), 20x72RB(E) (WW1 Ehrhard), 20x120RBSimonetta (1930s), 20x135 Polte (German pre-WW2: replica), 20x138RB (German WW2 unknown: replica), 20x122 case (post-WW2 French AA 5CG series), 20x126B(post-WW2 French AA 5CG series - used German projectiles), 20X158RB (US T5, for post-WW2 T33 aircraft gun)

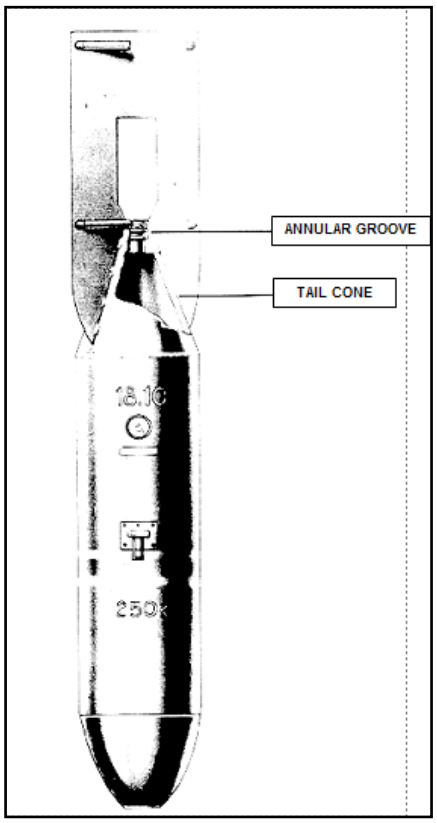
APPENDIX 011

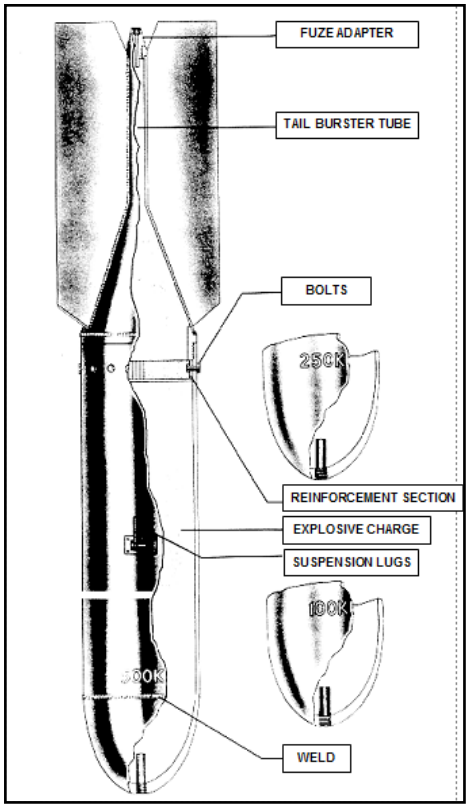
Examples of Aerial Delivered Bombs



Type 92 250-kg. and 500-kg. High-Explosive Bombs.







1- Type 94 50kg, Type 94 & Type 3 100kg HE 3- Bomb

2- Type 1 - 250kg HE Bomb

3- Type 4 - 100KG, 250kg & 500kg Anti-shipping Bombs

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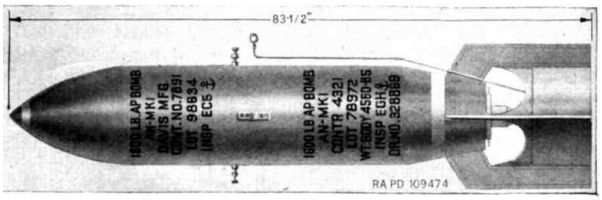
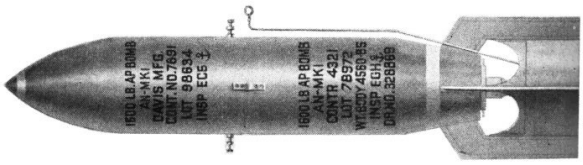
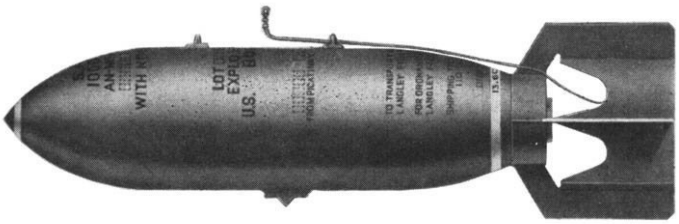
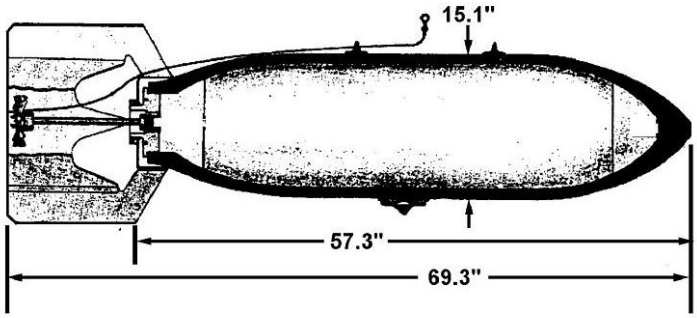


Bomb, AP, 1,600-lb, AN-MK 1.

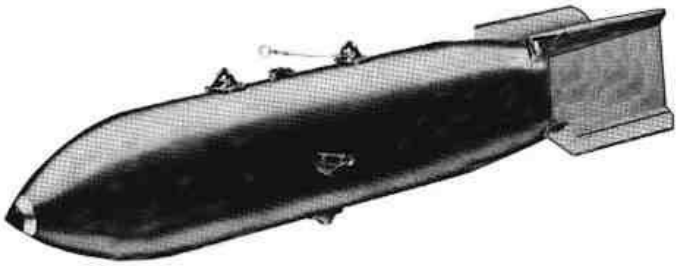


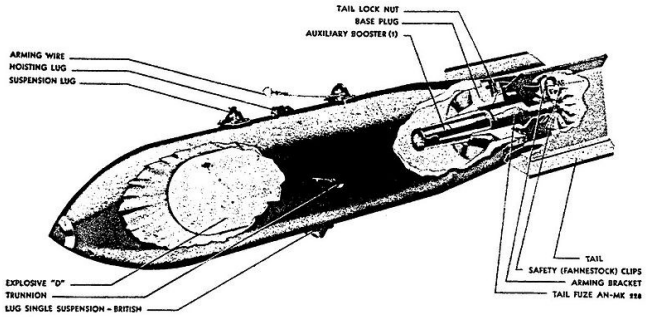
American - AN-MK 1 Armoured Piercing Bomb. 1600lb



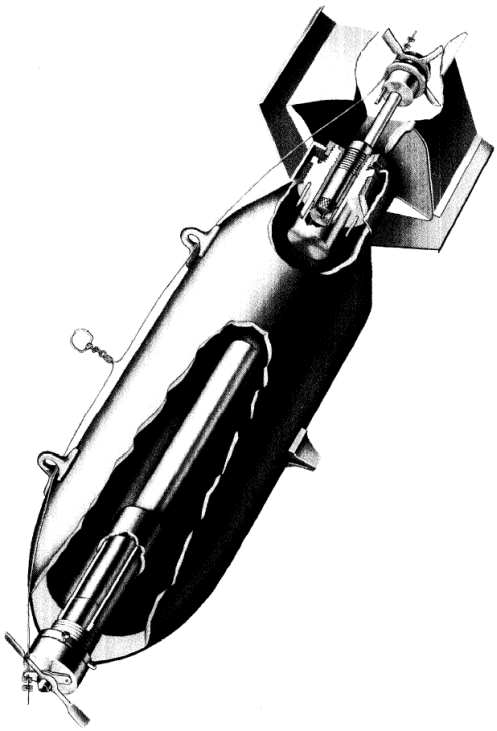


American - AN-M29 Semi-Armoured Piercing Bomb. 1000lb

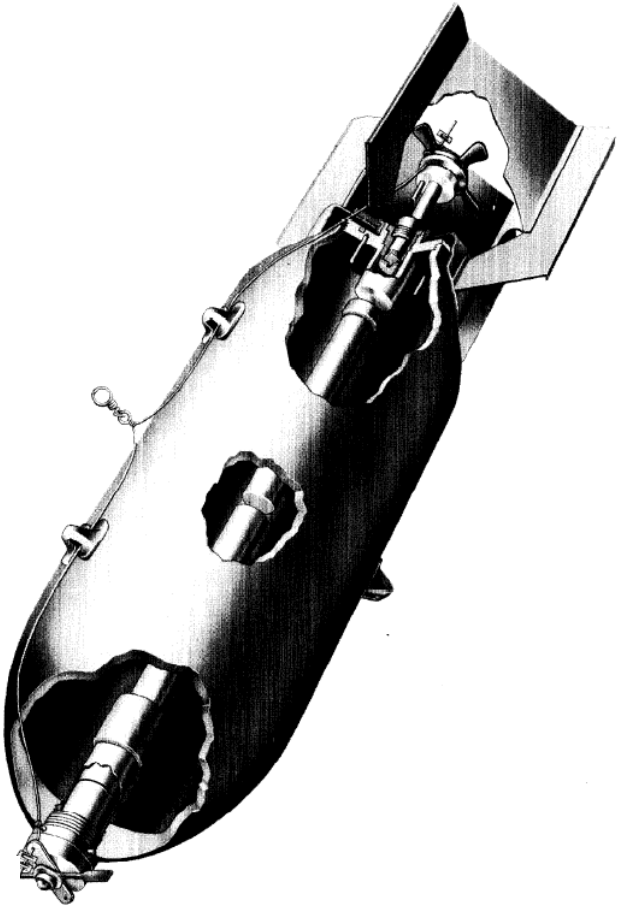




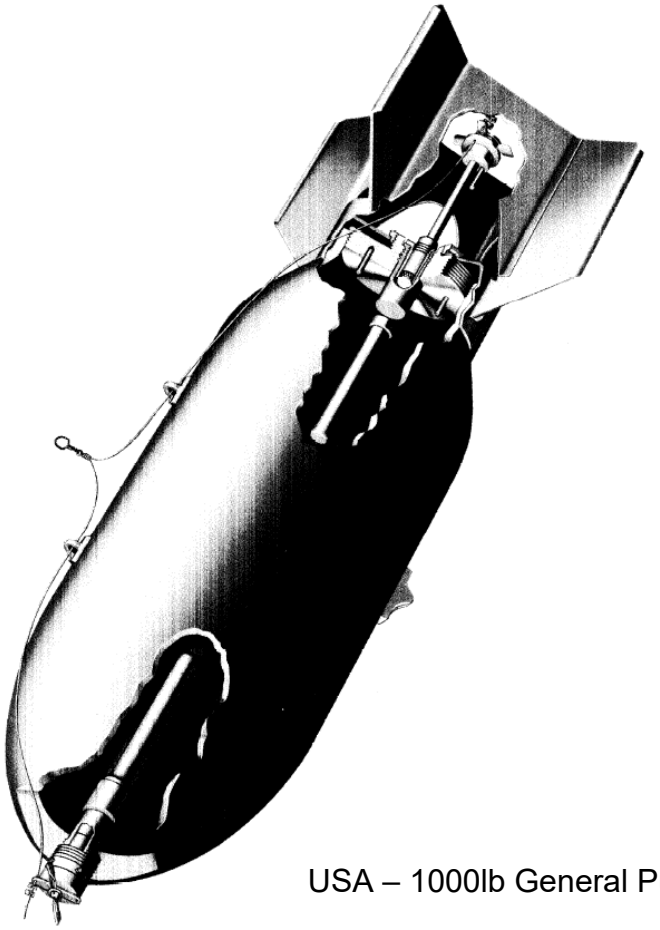
American - MK-33 Armoured Piercing Bomb. 1000lb



USA – 100lb General Purpose Bomb



USA – 250lb General Purpose Bomb



USA – 1000lb General Purpose Bomb

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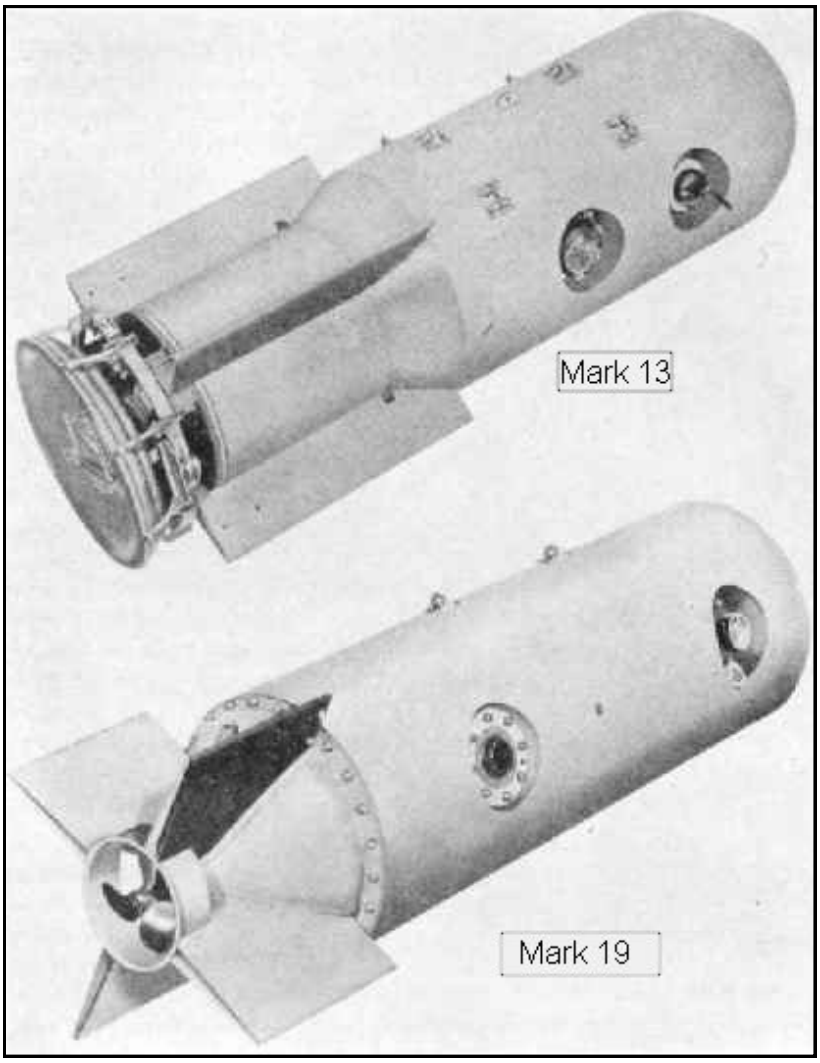
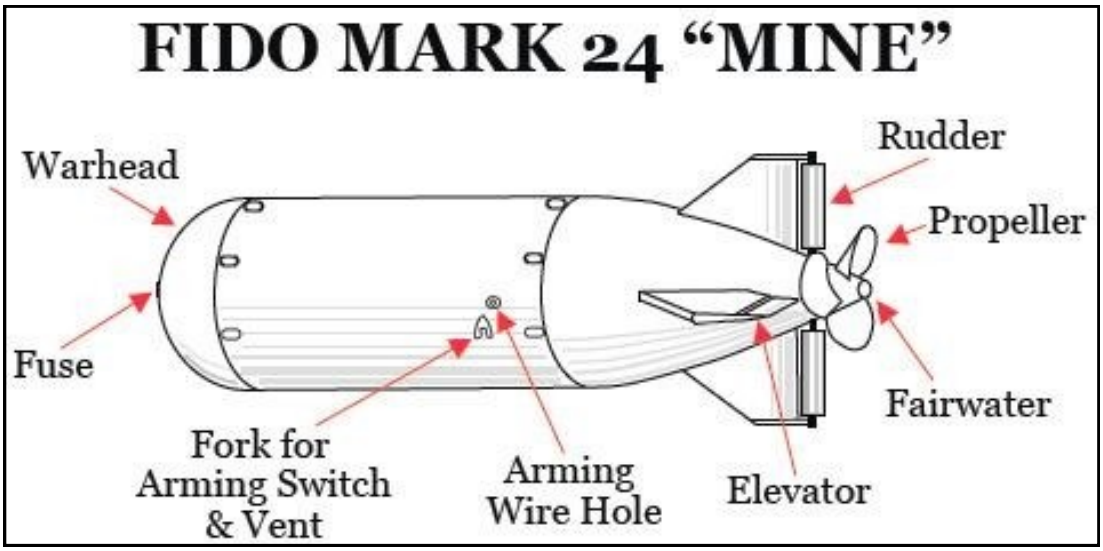
APPENDIX 012

Examples of Sea Mines

US Mines Mark 13, Mark 14 and Mark 19





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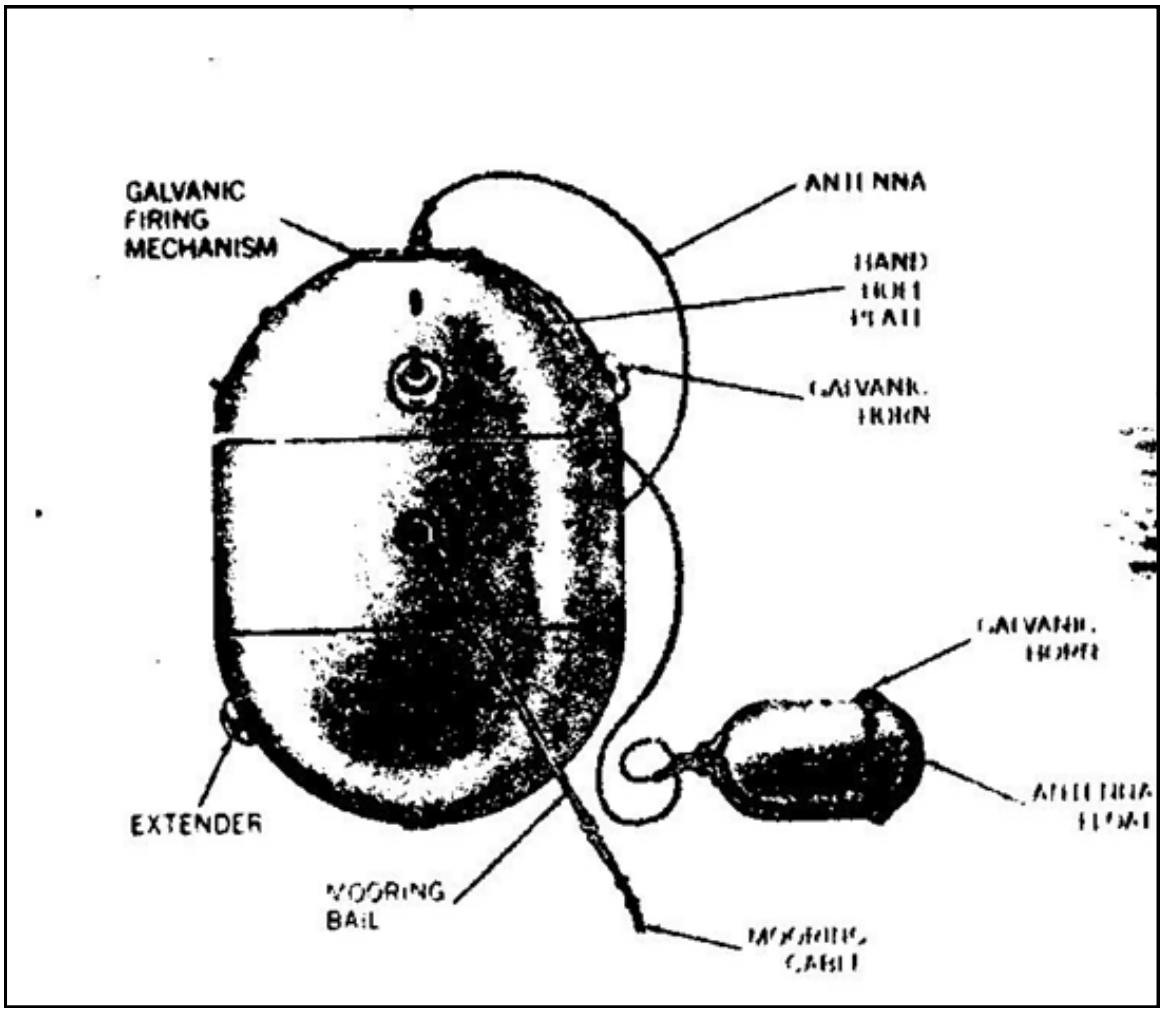
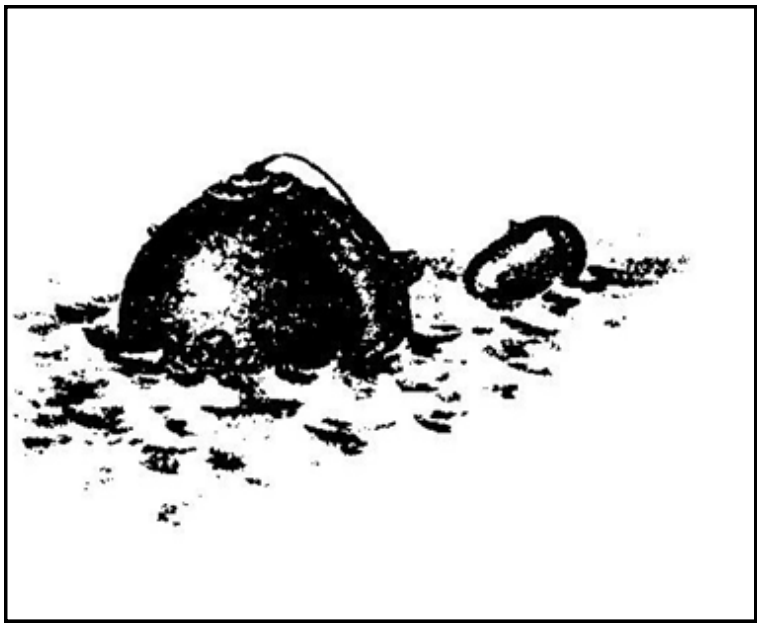
US Mines Mark 11-1





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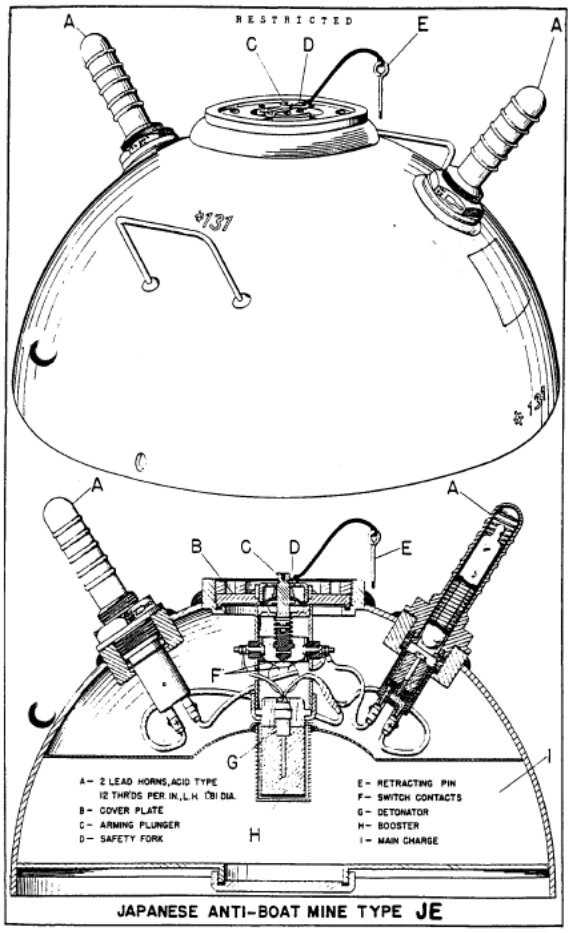
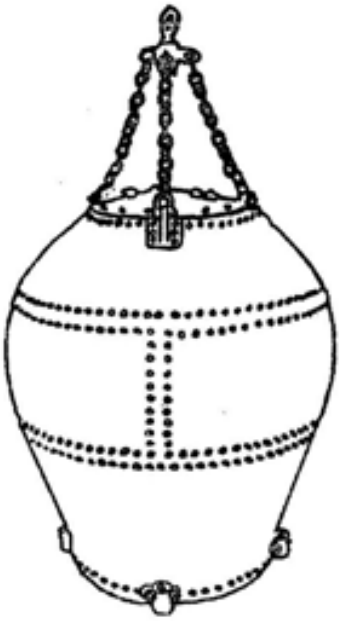
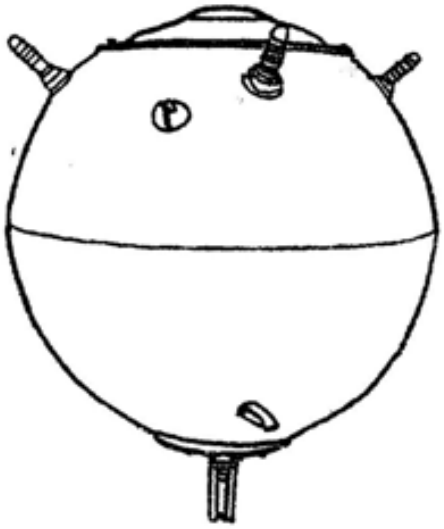


JAPANESE ANTI-BOAT MINE TYPE JE

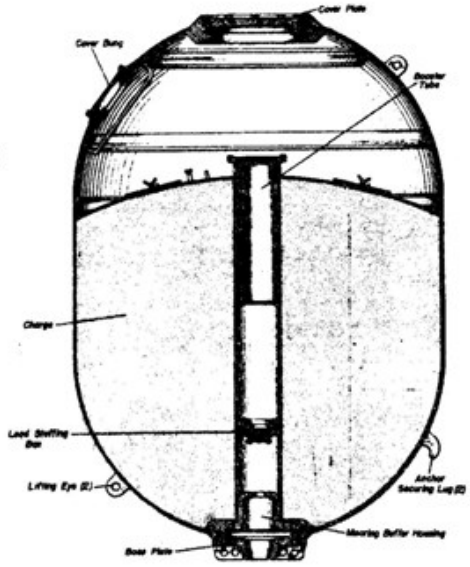
CONFIDENTIAL	PUBLICATION DATE Sept. 1944	JAPANESE ANTI-BOAT MINE TYPE JE
DIAMETER	20¼ in.	
HEIGHT	10.62 in.	
THICKNESS OF WALL	3/16 in.	
MATERIAL OF WALL	Steel	
WEIGHT, LESS HORNS, DETONATOR BOOSTER & WIRING	106.5 lb.	
WEIGHT OF FILLING	46.5 lbs.	
TYPE OF FILLING	Type 98 Explosive (END/TNA 40/60) with a picric acid booster and tetryl detonator.	
DESCRIPTION	This is a hemispherical, chemical-horned, all-welded mine. The outer body forms a hemisphere and has two (2) handles on its upper portion, a central opening on top to take the booster and safety switch, and two (2) horn openings 180° apart. The mine is divided internally into an explosive chamber and a chamber containing booster, wiring, safety switch, and horn electrodes. The division is made by a shallow, saucer-shaped steel section, which forms less than a hemisphere which is pressed into the outer body from the bottom and is welded in place. A plate is then fitted into the bottom of the mine and is also welded in place. This last-mentioned plate carries a filling plug in its center and is inset 13/16 of an inch to allow clearance for the plug. The horns, two in number, appear to be standard lead-acid mine horns. They are set at an angle of about 65° and project above the level of the mine top; threads are left hand. In the firing circuit is a spring-loaded plunger whose upper end projects through the safety-switch cover. A rubber diaphragm in the top of the cover insures watertightness but allows the plunger to move. There is a tapered, threaded hole in the center of the top of the plunger and a groove around the plunger near the top. Until the mine is in position a safety fork engages this groove and holds the plunger up against its spring. The inner end of the plunger is thus withdrawn from between two contacts in the electrical firing circuit and the circuit is incomplete.	
EMPLOYMENT	Used on beaches as an anti-boat mine. It can also be used on land as an anti-tank mine by burying or otherwise concealing it.	
OPERATION	After the mine is laid the safety fork is removed. The contact plunger moves down under spring pressure and closes the electrical contacts, thus completing the electrical circuit and the mine is armed. When a horn is crushed an acid vial inside is broken, allowing the acid to drain down onto two plates of a small battery which generates sufficient amperage to fire the detonator. As the wiring is series-parallel, either horn on being bent will act independently to fire the mine.	
TO RENDER SAFE	To make the mine safe, pull up on plunger on top of the mine and wedge out with safety fork. With a spanner wrench or a drift pin and hammer, remove the keep ring over the arming mechanism. Pull out arming mechanism and cut white or yellow leads to detonator. Unscrew blue or black leads to safety switch. Either of these two operations will break the circuit. The mine is now safe. Unscrew booster from lower inside of arming mechanism and remove detonator from booster. (NOTE: Wooden centering ring for detonator has been found to swell and stick. Use a screw driver to break it out.) A booby trap could be incorporated so that when the plunger is retracted, the mine would fire. Precautions should be observed. The mine may be detonated by taping a blasting cap to one horn and firing the cap. The former U.S. designation was : JXIII The Japanese designation is : Small Type Land Mine	



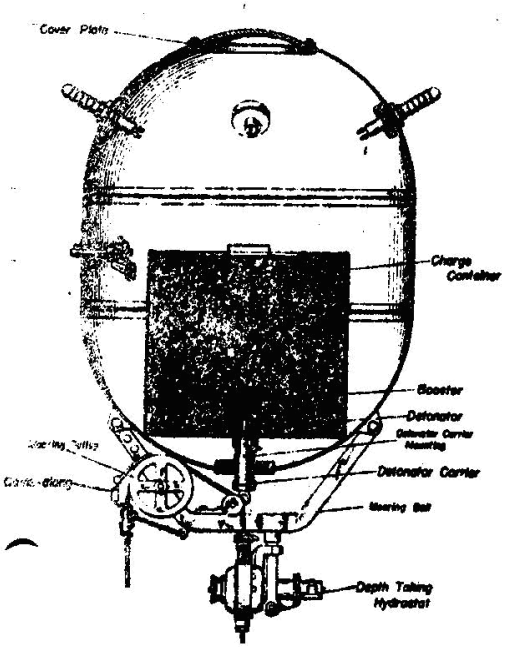
Type: Moored, Contact Mine
Dimensions: Diameter 32.5”
Firing System: Impact Inertia
Charge: 110lb Shimose



Type: Moored, Contact Mine
Dimensions: Diameter 41.4”
Firing System: Chemical Horn
Charge: 440lb Cast Shimose



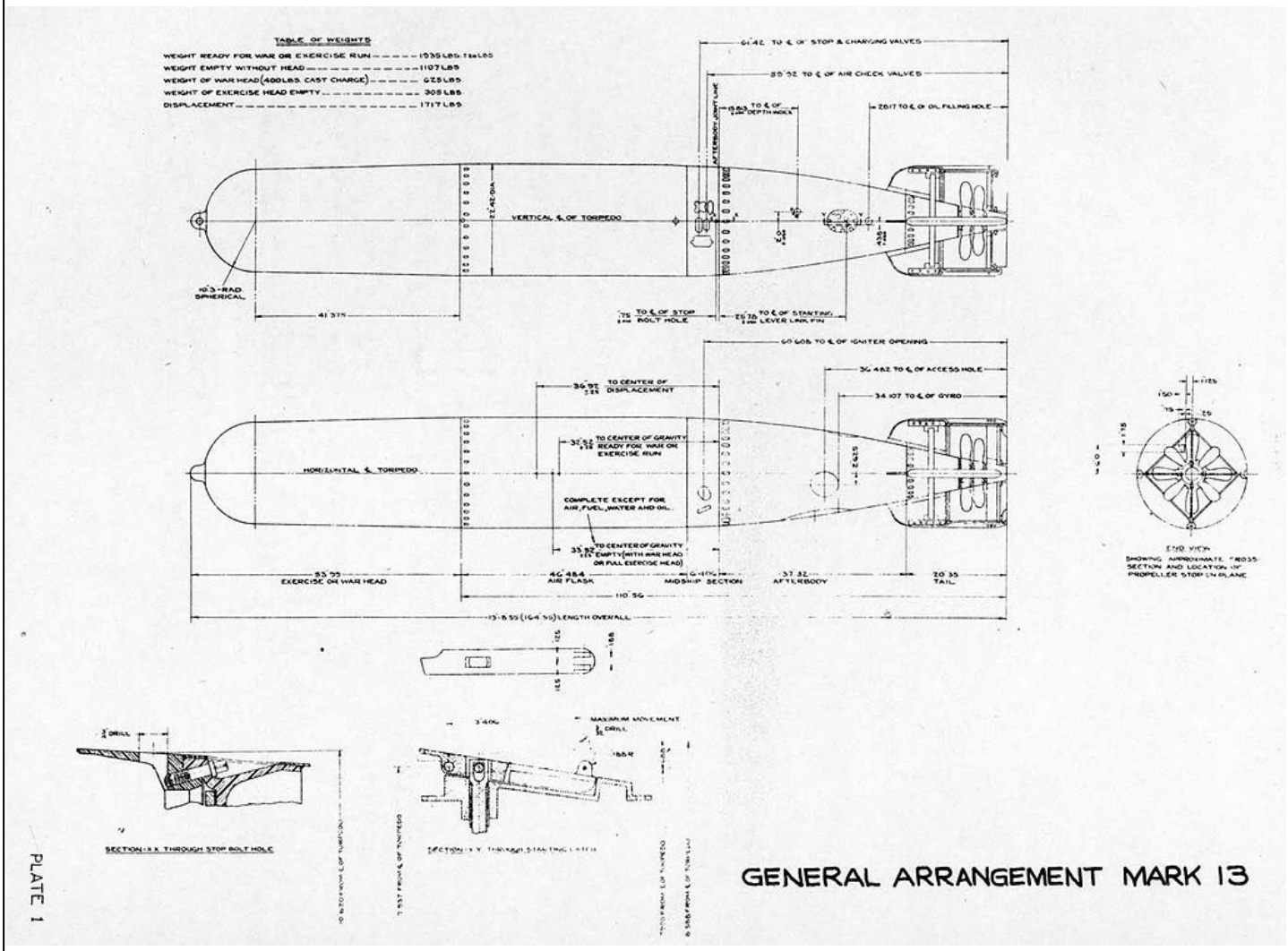
Type: Moored, Contact Mine
Dimensions: Diameter 41.5”, Length 55”
Firing System: Magnetically monitored, Controlled
Charge: 1,100lb Temporary Type I explosive



Type: Moored, Contact Mine
Dimensions: Diameter 33.9”, Length 45.8”
Firing System: Chemical Horns
Charge: 369lb Shimose (Black Filled)

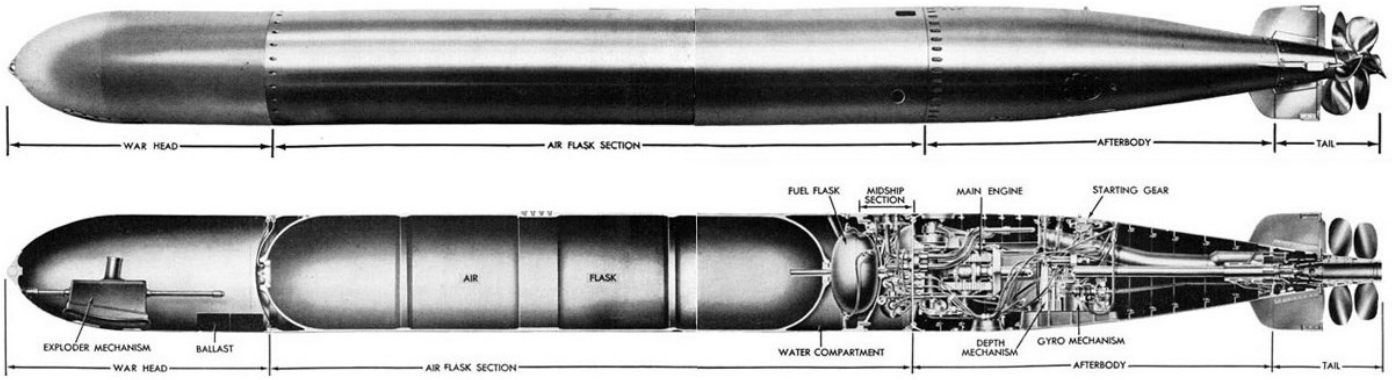
APPENDIX 013

Examples of Torpedoes



Mark 13

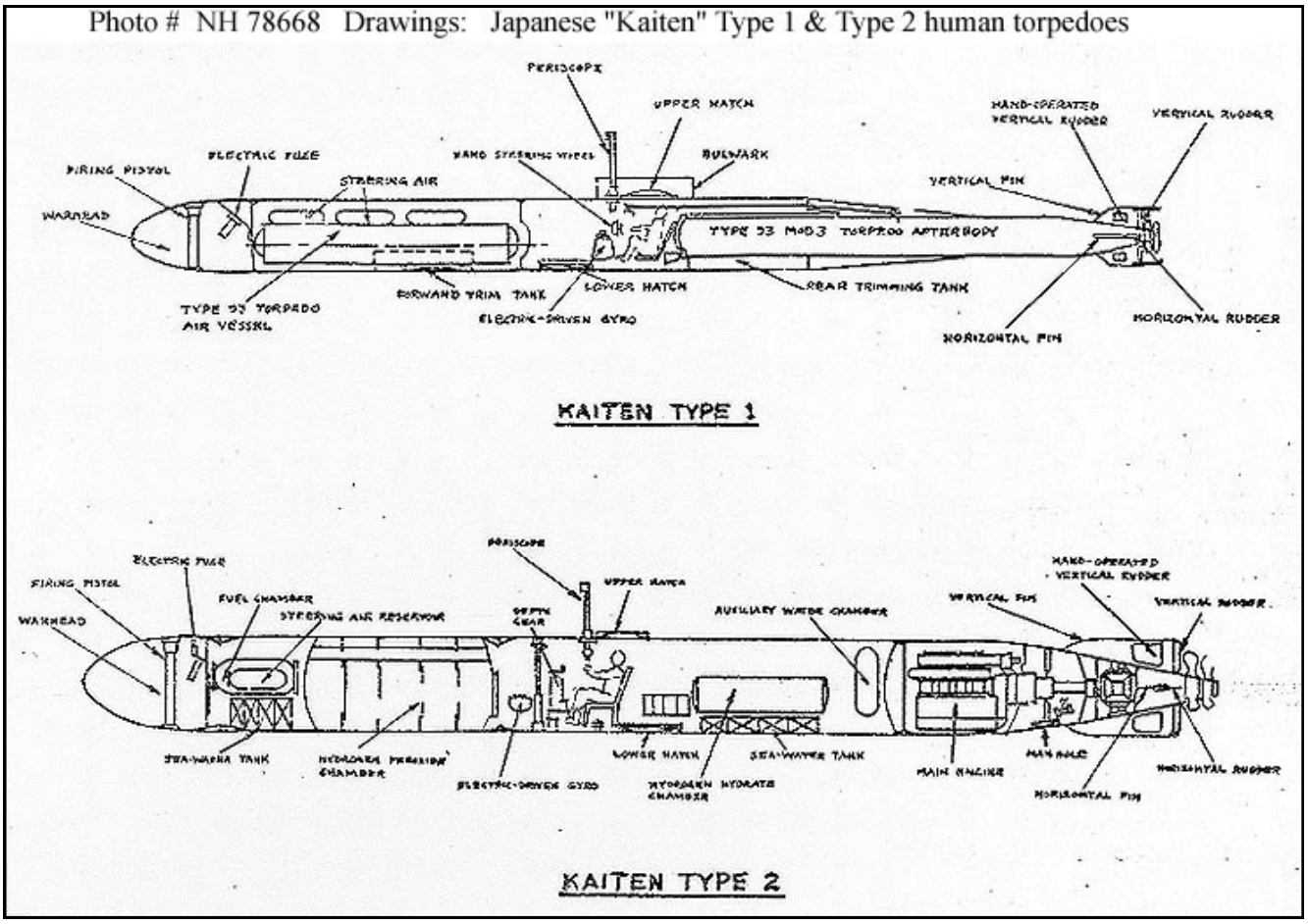
This was the standard American aerial delivered torpedo of WWII. The Mark 13 was short, fat, slow and long-ranged. It was also initially highly unrealisable, even so 17,000 where produced during the war.



Mark 14

This was the standard weapon on the more modern US submarines by 1941. However the weapon has a tendency to fun approximately 10 ft to deep meaning the magnetic detector didn't trigger resulting in the weapon not detonating. This problem was not even officially identify and resolved until 1944.

Photo # NH 78668 Drawings: Japanese "Kaiten" Type 1 & Type 2 human torpedoes



Project: Oriel Wind Farm, Irish Sea

Project Ref: EES1022

Appendix 013B: Examples of Torpedoes

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APPENDIX 014

Examples of Depth Charges

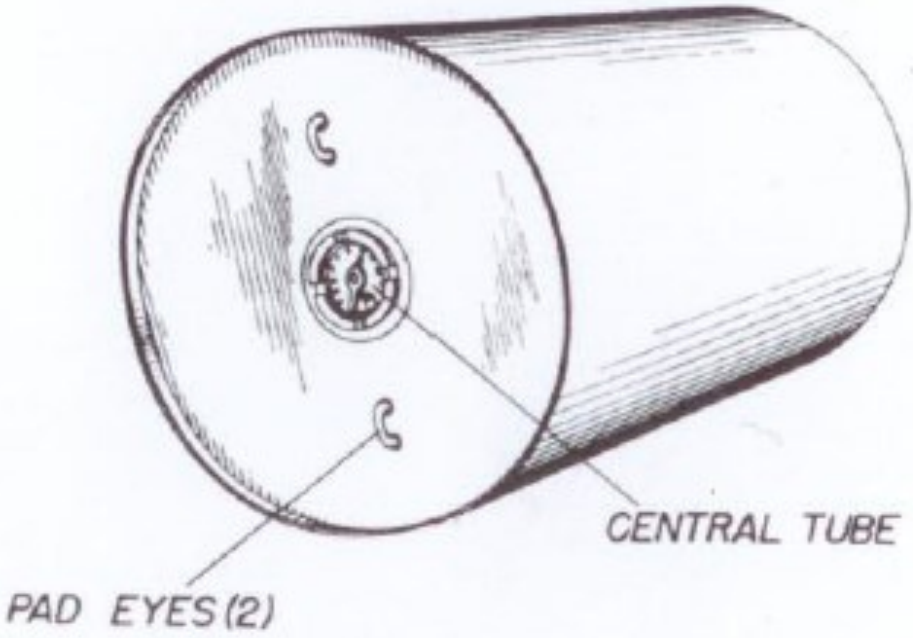
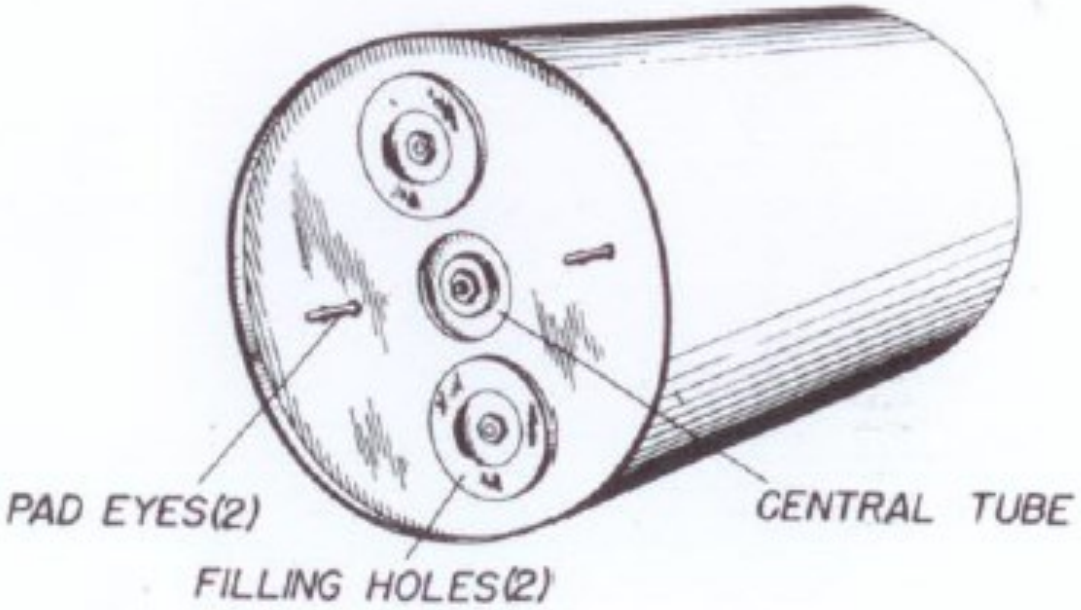
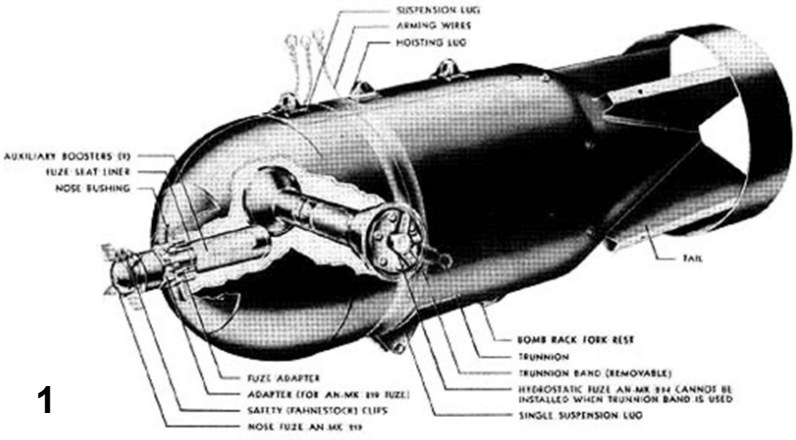


Fig. 8-- Type 2, Modification 1 Depth Charge, Pistol End



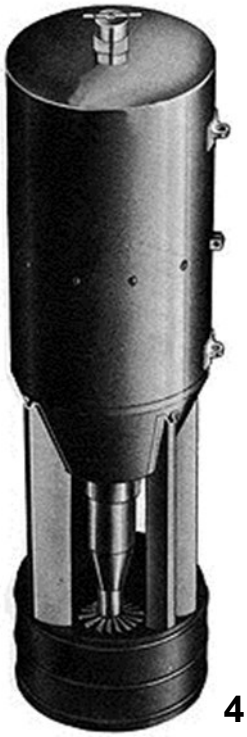


1

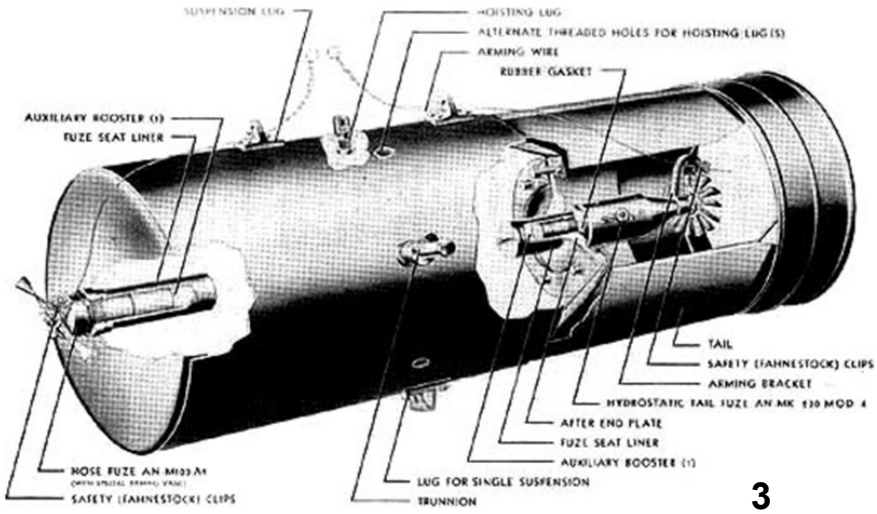
2

American - Aerial Dropped Depth Charges

1. AN - MK 17 Mod 2, 325lb
2. AN - MK 41, 350lb
3. AN - MK 53, 330lb
4. AN - MK 54, 325 - 350lb



4



3

Project: Oriel Wind Farm, Irish Sea

Project Ref: EES1022

Appendix 014C Examples of Depth Charges

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APPENDIX 015

Examples of Rockets

AIR-2 Genie

Mighty Mouse

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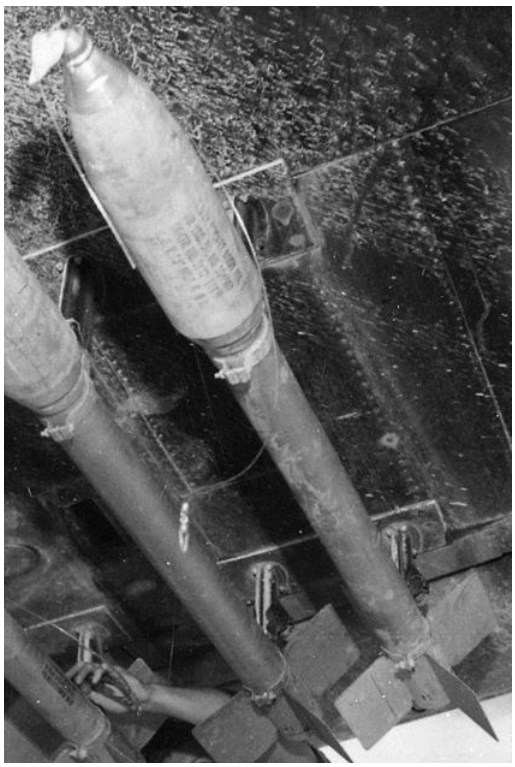
High Velocity Aircraft Rocket (HVAR)

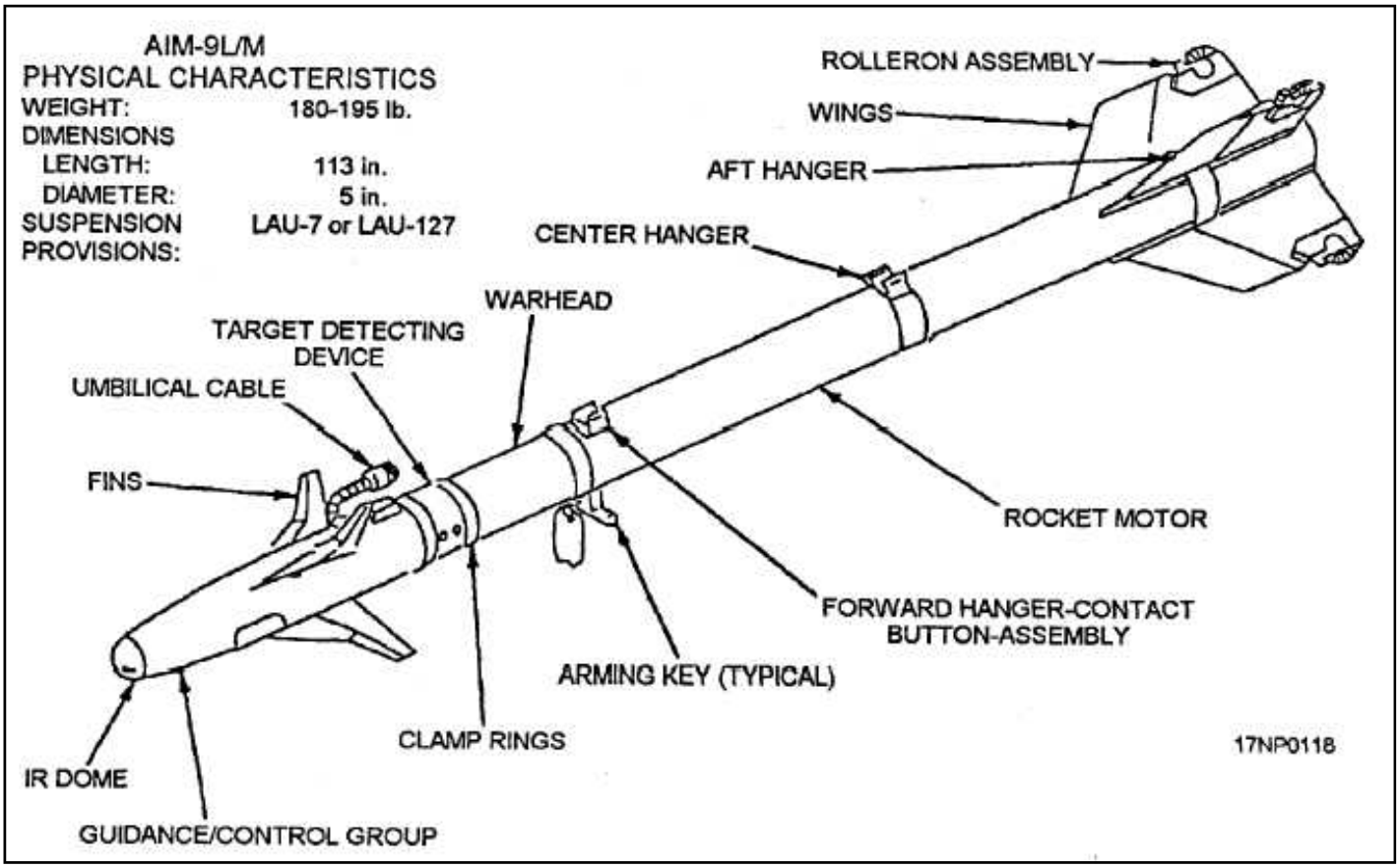
Mousetrap Anti-Submarine Rocket



5” Rocket

APPENDIX 016

Examples of Missiles



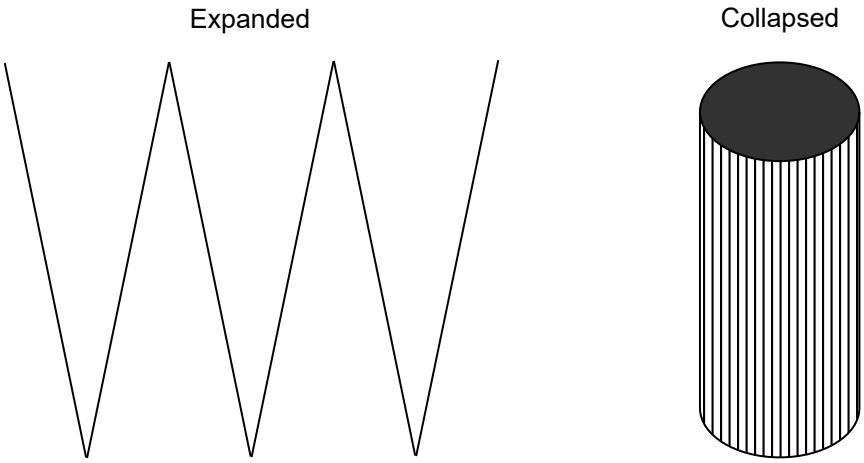
Above: AIM-9LM Sidewinder Missile

Below: BAE SkyFlash Missile

Missiles

Modern air to air missiles are typically constructed of aluminium or composite materials, however; they incorporate components such as a steel continuous expanding rod to disable an aircraft rather than using an explosive to directly damage the intended target.

The device is comprised of an even number of steel rods with ends welded together in such a way that they can collapse into a cylindrical ring as shown in the image below:



This ring is then placed inside the missile. When the target is in the vicinity, explosives within the missile cause the ring to expand into an ever growing circle until the rods form a single plane at full extension.

It is the expanding ring that brings down the aircraft by cutting through the skin of the aircraft and crucial features such as the structure, cables, hydraulics.

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APPENDIX 017

Hazard Evaluation Matrix

Regular Munitions		Activity / Pathway: Cable Lay	Ploughing	Jetting	Trenching	Drilling	Snag on Vessel	Activity Pathway: Cable Lay – Water Depth: Surface	Cable Lay: 0m - 10m	Cable Lay: >10m	Ploughing: Surface	Ploughing: 0m - 10m	Ploughing: >10m	Support Vessel: 0m - 10m	Support Vessel: >10m	Jetting: Surface	Jetting: 0m - 10m	Jetting: >10m	Trenching: Surface	Trenching: 0m - 10m	Trenching: >10m	Drilling: Surface	Drilling: 0m - 10m	Drilling: >10m	Snag on Vessel: Surface
		Probability of Detonation						Consequence / Impact Level																
Small Arms Ammunition		F	E	E	E	E	E	3	5	5	3	5	5	5	5	3	5	5	3	5	5	3	5	5	3
Land Service Ammunition		E	D	D	D	D	D	2	5	5	2	5	5	5	5	2	5	5	2	5	5	2	5	5	2
≤155mm Projectiles		E	D	D	D	D	D	2	5	5	2	5	5	5	5	2	5	5	2	5	5	2	5	5	2
≥155mm Projectiles		E	D	D	D	D	D	2	4	5	2	4	5	5	5	2	4	5	2	4	5	2	4	5	2
HE Bombs	Allied Origin	E	C	C	C	C	C	2	3	4	2	3	4	4	5	2	3	4	2	3	4	2	3	4	2
	Axis Origin	E	C	C	C	C	C	2	3	4	2	3	4	4	5	2	3	4	2	3	4	2	3	4	2
Sea Mines	Allied Origin	D	C	C	C	C	C	2	2	3	2	2	3	3	4	2	2	3	2	2	3	2	2	3	2
	Axis Origin	D	C	C	C	C	C	2	2	3	2	2	3	3	4	2	2	3	2	2	3	2	2	3	2
Torpedoes		E	C	C	C	C	C	2	2	3	2	2	3	3	4	2	2	3	2	2	3	2	2	3	2
Depth Charges		E	C	C	C	C	C	2	2	3	2	2	3	3	4	2	2	3	2	2	3	2	2	3	2
Conventional Dumped Munitions		E	D	D	D	D	D	2	2	3	2	2	3	3	4	2	2	3	2	2	3	2	2	3	2
Chemical Dumped Munitions		E	D	D	D	D	D	2	2	3	2	2	3	3	4	2	2	3	2	2	3	2	2	3	2
Missiles/Rockets		E	D	D	D	D	D	2	2	3	2	2	3	3	4	2	2	3	2	2	3	2	2	3	2

Source: UXO
Potential Pathway: Cable Lay Operations - Cable Lay, Ploughing, Support Vessel, Jetting, Snag on Vessel
Potential Receptor: People, Equipment, Ifrastructure, Vessels, Environment

Probability: A = high probability to E = Low probability
Consequence: 1 = High to 5 = Low

Assumptions: Probability of detonation is based on a encountering a single item
Consequence/Impact levels are based on the worst case consequence/impact for each tier level

APPENDIX 018

Consequence Levels

CONSEQUENCE LEVEL		EXPECTED CONSEQUENCES / IMPACTS			
		Human Health/Safety	Environment	Financial Impact	
				Plant and Equipment	Structures
	1	Fatalities Over Extended Area	Major – Full Scale Response Required	Multiple Unit Destruction	Widespread Structural Collapse
	2	Localised Fatalities	Major – Full Scale Response Required	Unit Destruction	Localised Structural Collapse
	3	Serious Injury	Serious Resource Required	Component Replacement / Repairs Required	Structural Damage
	4	Injury Requiring Medical Treatment	Moderate/Limited Response Required	Superficial Damage	Non-Structural / Superficial Damage
	5	Minor Impact/First Aid	Minor Response Required	Minor/ No notable effect	Minor/ No notable effect

Probability Level	
A	Highly Probable
B	Probable
C	Possible
D	Remote
E	Improbable
F	Highly Improbable

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