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Explosive Ordnance Threat Assessment in respect of Neart Na Gaoithe Offshore Wind Farm for Emu Limited

3165TA_Rev1

27th January 2011

BACTEC

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This Report has been produced in compliance with the Construction Industry Research and Information Association guidelines for the preparation of Detailed Risk Assessments in the management of UXO risks in the construction industry.

Glossary of Terms

AAA	Anti-Aircraft Artillery
ARP	Air-raid Precautions
BDO	Bomb Disposal Officer
EOD	Explosive Ordnance Disposal (current term for "bomb" disposal)
HE	High Explosive
HG	Home Guard
IB	Incendiary Bomb
kg	Kilogram
LCC	London County Council
LM	Land Mine
LSA	Land Service Ammunition (includes grenades, mortars, etc.)
Luftwaffe	German Air Force
m bgl	Metres Below Ground Level
MoD	Ministry of Defence
OB	Oil Bomb
PM	Parachute Mine
RAF	Royal Air Force
SI	Site Investigation
SAA	Small Arms Ammunition (small calibre cartridges used in rifles & machine guns)
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	"Doodlebug" the first cruise type missile, used against London from June 1944. Also known as 'Flying Bomb'.
V-2	The first ballistic missile, used against London from September 1944
WWI	First World War (1914 -1918)
WWII	Second World War (1939 – 1945)

Executive Summary

The Site: The site is located in the North Sea, approximately 15km east of the coast of Fife Ness, Scotland. The site's southern extents encroach onto a modern Firing Practice Area (X5641). The site is an irregularly shaped body of water covering an area of approximately 100km² and proposed to house up to 75 wind turbines.

Proposed Works: A detailed scope of works was not available at the time of the production of this report; however initial plans indicate the wind farm is to comprise 75 turbines, with a proposed cable route running south-west of the site to the coast of Cockenzie and the dual Thortonloch and Skateraw cable route running south to Torness. Emu Limited has noted that such plans are highly indicative and may be subject to change following the issue of this report.

Risk Assessment Methodology: In accordance with CIRIA guidelines this assessment has carried out research, analysed the evidence and considered the risks that the site has been contaminated with unexploded ordnance; that such items remained on site; that they could be encountered during the proposed works and the consequences that could result. Appropriate risk mitigation measures have been proposed.

Explosive Ordnance Risk Assessment: BACTEC concludes that there is a risk from unexploded ordnance at the site of the proposed development. This is based on the following factors:

- The site is located in the North Sea, approximately 15km east of the coast of Fife Ness, Scotland. Several potential sources of explosive ordnance contamination have been identified in this region including historic/modern Army and Naval firing ranges in the area, British and German sea mines, unexploded air-delivered bombs, and anti-aircraft artillery projectiles.
- Extensive minefields were laid around the coast of the UK as a defensive measure against attacks on shipping and in the early period of WWII as a precaution against possible invasion. This included the North Sea, however is not known to have included any waters in relative proximity to the wind farm site with the exception of a British declared area lying 5km to the east which is likely to account for the East Coast Mine Barrage of 1939 which in total comprised up to 100,000 mines along the entire eastern coast of the UK. Additional information provided by the UKHO details a mine lay of approximately 2330 mines approximately 23.5km due east of the wind farm site as part of this operation. Secondary sources also detail extensive mining of the Firth of Forth and Forth Estuary from August to November 1940 and a wreck recorded within the boundary of the wind farm site is detailed to have been sunk by a mine in March 1941, indicative that a mine barrage was located in proximity to the site area. A number of mines have been found in the Firth of Forth in recent years and the Royal Navy believes that there are still "tens of thousands" of mines in the area.
- Assessing the risks posed by mines along specific sections of the UK coast can be problematic. Establishing the locations of all mines at a research stage is not wholly possible since offensively laid mines, in particular, were not generally laid in declared barrages and sometimes singularly or in very small numbers. Furthermore, records assessed for this report are known to be incomplete. For these reasons, the possibility that mines may have been deployed in the area of the wind farm cannot be entirely discounted.
- The western and southern extents of the site lie within historic and modern Army and Navy firing ranges which were in operation prior to, during and post-WWII. The proposed wind farm cable routes also pass through such areas. According to 1939 War Department bye-laws various types of ordnance were permitted, and indeed are likely to have been fired from these ranges, including anti-aircraft and anti-tank artillery projectiles and mortars. Consequently the area of the wind farm and cable routes are likely to have been contaminated by such items.
- Two ammunition dumping grounds are mapped within approximately 12km of the site to the south-west, which would have been used to dispose of a range of munitions post-WWII. There is a risk that dumped munitions may have either been deposited outside the designated areas (i.e. within or closer to the wind farm area) or have moved over time due to tidal currents. It should be noted that the Cockenzie cable route also runs through or in immediate proximity to these dumping grounds. The detonation of larger items would pose a significant threat to any proposed works.
- The UKHO database of shipwrecks does not hold any record of any official military wrecks within the confines of the proposed wind farm. However, a number of the listed wrecks date from WWI or WWII and consequently the risk of explosive ordnance originating from historic wrecks cannot be discounted. The reason for the sinking of many of these vessels is also not documented yet could be related to mines and torpedoes present in such waters.
- Torpedoes and depth charges were both deployed around the UK during WWI and WWII, however not in high numbers and more commonly along the east and south coast. Such items are not commonly encountered however wreck data sheets for the area of the wind farm site detail a WWI-era submarine to have been sunk by a torpedo in April 1917, indicating that such weapons were deployed on or in proximity to the site.
- Occasionally air-delivered weapons such as high explosive bombs are encountered around the coast of the UK. Such items are generally present as a result of attacks on shipping, crashes, 'tip and run' or jettisoning bombs in open water prior to landing. There are records of a number of attacks on shipping in the Firth of Forth and Forth Estuary and the risk of air-delivered weapons having been deployed in the area and failing to explode during such attacks cannot therefore be discounted.

Risk Mitigation Measures: The following risk mitigation measures are recommended to support the proposed redevelopment works:

All Works

- Explosive Ordnance Safety and Awareness Briefings to all personnel.
- The Provision of Unexploded Ordnance Site Safety Instructions.

Area of Proposed Wind Farm & Cabling Routes

- High Resolution Non-Intrusive ROV Magnetometer Survey: This method will be used to identify and clear/avoid items of UXO such as sea mines and torpedoes

Area of Known Ammunition Dumping Grounds in Proximity to Cockenzie Cable Route

- High Resolution Non-Intrusive ROV Magnetometer Survey: This method will be used to identify and avoid the outermost extents of the charted ammunition dumping grounds in proximity to the Cockenzie cable route.

In making this assessment and recommending these risk mitigation measures, the proposed works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, BACTEC should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

Contents

Annexes

Explosive Ordnance Threat Assessment

In Respect of

Neart Na Gaoithe Offshore Wind Farm

1. Introduction

1.1. Background

Emu Limited has commissioned BACTEC International Limited to conduct an Explosive Ordnance Threat Assessment for the proposed works at the Neart Na Gaoithe Offshore Wind Farm site.

The purpose of this report is to examine the potential risk to the proposed works at the wind farm site from a variety of weapons and items of unexploded ordnance known to have historically been deployed, utilised and discarded off the coast of the UK.

As a result of a generally increased risk awareness amongst professionals involved in offshore engineering works and proactive health and safety measures, the threat to life and limb from unexploded ordnance has been minimised. However even the simple discovery of a suspected device during ongoing works can cause considerable disruption to production and cause unwanted delays and expense.

Such risks can be more fully controlled by a better understanding of the site-specific threat and the implementation of appropriate risk mitigation measures.

2. Construction Industry Duties and Responsibilities

2.1. The UK Regulatory Environment

There is no specific legislation covering the management and control of the UXO risk in the UK construction industry but issues regarding health and safety are addressed under a number of regulatory instruments, as outlined below.

In practice the regulations impose a responsibility on the construction industry to ensure that they discharge their obligations to protect those engaged in ground-intrusive operations (such as archaeology, site investigation, drilling, piling or excavations) from any reasonably foreseeable UXO risk.

2.2. The Health and Safety at Work Act, 1974[1]

The Act places a duty of care on an employer to put in place safe systems of work to address, as far as is reasonably practicable, all risks (to employees and the general public) that are reasonably foreseeable.

2.3. Construction (Design and Management) Regulations 2007

This legislation defines the responsibilities of all parties (primarily the Client, the CDM Co-ordinator, the Designer and the Principal Contractor) involved with works.

Although UXO issues are not specifically addressed the regulations effectively place obligations on all these parties to:

- Ensure that any potential UXO risk is properly assessed
- Put in place appropriate risk mitigation measures if necessary
- Keep all parties affected by the risk fully informed
- Prepare a suitably robust emergency response plan

2.4. Other Legislation and Guidance

Other relevant legislation includes the "Management of Health and Safety at Work Regulations 1999" and "The Corporate Manslaughter and Corporate Homicide Act 2007".

RenewableUK, the Trade and Professional body for the UK Wind and Renewable Industries also mentions unexploded ordnance as one of the health and safety considerations to take into account when planning installations. See their "Guidelines for onshore and offshore wind farms", August 2010.

3. The Role of the Authorities and Commercial Contractors

3.1. The Authorities

3.1.1. At Sea

If an item of unexploded ordnance is discovered at sea within UK waters the find must be reported to the Coastguard who will report the incident to the military authorities (JSEODOC - Joint Services Explosive Ordnance Disposal Operations Centre).

3.1.2. On Land

The Police have the responsibilities for co-ordinating the emergency services in the case of an ordnance-related incident on a construction site. They will make an initial assessment (i.e. is there a risk that the find is ordnance or not?) and if they judge necessary impose a safety cordon and/or evacuation and call the military authorities (JSEODOC - Joint Services Explosive Ordnance Disposal Operations Centre) to arrange for investigation and/or disposal. In the absence of an EOD specialist on site many Police Officers will use the precautionary principle, impose cordon(s)/evacuation and await advice from the JSEODOC.

3.1.3. JSEODOC Support

The priority given to a request by JSEODOC will depend on their judgement of the nature of the threat (ordnance, location, people and assets at risk) and the availability of resources. They may respond immediately or as resources are freed up. Depending on the on-site risk assessment the item of ordnance may be removed or demolished (by controlled explosion) in-situ. In the latter case (on land) additional cordons and/or evacuations may be necessary.

[1] *Full title: Health and Safety at Work etc. Act 1974 (application outside Great Britain) Order 2001 (as amended by the Health and Safety at Work etc. Act 1974 (application outside Great Britain) Variation) Order 2009)*

Note that the military authorities will only carry out further investigations or clearances in very high profile or high risk situations. If there are regular ordnance finds on a site the JSEODOC may not treat each occurrence as an emergency and will encourage the construction company to put in place alternative procedures (i.e. the appointment of a commercial contractor) to manage the situation and relieve pressure from the JSEODOC disposal teams.

3.2. Commercial Contractors

In addition to pre-construction site surveys and clearances a commercial contractor is able to provide a reactive service on construction sites. The presence of a qualified EOD Engineer with ordnance recognition skills will avoid unnecessary call-outs to the authorities and the Contractor will be able to arrange for the removal and disposal of low risk ordnance. If high risk ordnance is discovered actions will be co-ordinated with the authorities with the objective of causing the minimum possible disruption to site operations whilst putting immediate, safe and appropriate measures in place.

4. This Report

4.1. Aims and Objectives

The aim of this report is to examine the possibility of encountering any explosive ordnance during the proposed works at the Neart Na Gaoithe Offshore Wind Farm site. Risk mitigation measures will be recommended, if deemed necessary, to reduce the threat from explosive ordnance during the envisaged works. The report follows the CIRIA Guidelines.

4.2. Risk Assessment Methodology

The following issues will be addressed in the report:

- The risk that the site was contaminated with unexploded ordnance.
- The risk that unexploded ordnance remains on site.
- The risk that ordnance may be encountered during the proposed works.
- The risk that ordnance may be initiated.
- The consequences of initiating or encountering ordnance.

Risk mitigation measures, appropriate to the assessed level of risk and site conditions, will be recommended if required.

4.3. Approach

In preparing this Explosive Ordnance Threat Assessment Report, BACTEC has considered general and, as far as possible, site specific factors including:

- Military history of the area.
- Official and unofficial munitions dumping sites.
- Official and unofficial weapon ranges.
- Wrecks of Military warships/submarines.
- Wrecks of merchant ships possibly carrying munitions as cargo.
- Defensive or offensive minefields.
- Evidence of aerial bombing.
- Torpedoes and depth charges.

4.4. Sources of Information

BACTEC has carried out detailed historical research for this Explosive Ordnance Threat Assessment including accessing military records and archived material held in the public domain and in the MoD.

Material from the following sources has been consulted:

- The National Archives, Kew.
- United Kingdom Hydrographic Office (UKHO), Taunton.
- Relevant information supplied by Emu Limited.
- BACTEC's extensive archives built up over many years of research and hands-on Explosive Ordnance Disposal activities in the UK.
- Open sources such as published books, local historical records and the internet.

4.5. Reliability of Historical Records

4.5.1. General Considerations

This report is based upon research of historical evidence. Whilst every effort has been made to locate all relevant material BACTEC cannot be held responsible for any changes to the assessed level of risk or risk mitigation measures based on documentation or other information that may come to light at a later date.

The accuracy and comprehensiveness of wartime records is frequently difficult or impossible to verify. As a result conclusions as to the exact location, quantity and nature of the ordnance threat can never be definitive but must be based on the accumulation and careful analysis of all accessible evidence. BACTEC cannot be held responsible for inaccuracies or gaps in the available historical information.

5. The Site

5.1. Site Location

The site is located in the North Sea, approximately 15km east of the coast of Fife Ness, Scotland. The site's southern extents encroach onto a modern Firing Practice Area (X5641). The positions of the eight outer lying points of the site are detailed in the table below.

Corner	Latitude	Longitude
1	56° 17.4277 N	2° 20.2317 W
2	56° 19.7488 N	2° 17.8248 W
3	56° 20.3088 N	2° 16.5177 W
4	56° 20.1683 N	2° 14.9090 W
5	56° 15.2680 N	2° 9.8973 W
6	56° 12.7185 N	2° 9.2542 W
7	56° 12.7632 N	2° 16.2922 W
8	56° 15.8237 N	2° 20.0542 W

Site location maps are presented in Annex A.

5.2. Site Description

The site is an irregularly shaped body of water covering an area of approximately 100km² and proposed to house up to 75 wind turbines.

Sea bed conditions are understood to be bedrock, with water depths ranging from 44m to 56m. The area is typified by strong tidal currents.

A recent aerial photograph showing the boundary of the site area is presented in Annex B.

6. Scope of the Proposed Works

6.1. General

A detailed scope of works was not available at the time of the production of this report; however initial plans indicate the wind farm is to comprise 75 turbines, with a proposed cable route running south-west of the site to the coast of Cockenzie and the dual Thortonloch and Skateraw cable route running south to Torness. Emu Limited has noted that such plans are highly indicative and may be subject to change following the issue of this report.

A proposed site plan outlining the scope of works is presented in Annex C.

6.2. Intrusive Ground Works

Detailed information regarding the proposed foundation methodology for the site was not available at the time of the production of this report however one or more from a choice of Monopile, Tripod, Gravity or Suction Caisson foundations are likely to be utilised for the stabilisation of the turbines.

7. Area History

7.1. First World War

During WWI the waters of the North Sea were traversed by large numbers of German submarines which successfully operated in the area. Several of these were wrecked in the North Sea, although none are known to be in the vicinity of the study site.

From 1917, the threat from U-boats diminished when the United States entered the war and attention was focused on the main shipping routes of the North Atlantic.

7.2. Second World War

As with all coastal waters around the British Isles, the north-east coast and the North Sea were subject to varying levels of military activity during WWII.

The Royal Navy had laid extensive minefields along most of the north-eastern coastline of Great Britain, as a defence against German warships and u-boats. Such minefields included an extensive British declared area of 'Rosyth' to the east of the wind farm site. In response, the Luftwaffe, under cover of darkness, attempted to close the Firth of Forth to shipping by dropping acoustic and magnetic mines by parachute. They also bombed and machine gunned both merchant shipping and fishing vessels. Consequently, most shipping to and from the Forth was in the form of escorted convoys. Ships from Granton, Leith and Grangemouth assembled off Methil in large numbers, to await their Royal Navy escorts. For further information on U-boat activity, see section 8.2.

The coastal areas of Scotland to the west of the proposed wind farm site were also subject to significant bombing activity, with prominent Luftwaffe bombing targets Including Granton Harbour, Edinburgh Gas Works and the Royal Naval Base at Rosyth in the Forth Estuary; the latter of which is known to have been attacked in October 1939 by twelve Junkers Ju-88 bombers. A Luftwaffe target photograph highlighting Granton Harbour and Edinburgh Gas Works is presented in Annex D.

8. Mining of the North Sea

8.1. General

The North Sea is known to have been mined during both WWI and WWII by the UK and Germany, however it is likely that unrecorded German mine laying activities also took place across this area, delivered either by air, submarines or E-Boats. Mines are still encountered by dredgers and fishermen around the British coastline.

Recent examples of such finds in the Firth of Forth include:

- 1998. M/V Shalimar trawled a reported "2000lb mine" off Largo Bay
- 2006. M/V Methil suspected WWI mine in the Firth of Forth
- 2008. Royal navy disposed of suspected WWII mine 3 miles of Edinburgh after it was found by a fishing vessel
- 2009. Trawler brought up a WWII British Mk 9 mine which was disposed of by the Royal Navy off Port Seton
- 2010. 12ft long mine or torpedo netted by a trawler off Inchkeith Island

Articles describing these incidents are presented in Annex E.

A naval mine is a self-contained explosive device placed in water to destroy ships and/or submarines. Like land mines, they are weapons laid and left until they are triggered by the approach of an enemy ship. Naval mines can be used offensively, to hamper enemy shipping and lock it into its harbour, or defensively, to protect friendly shipping and create "safe" zones. Although attempts were made to remove all the mines from the sea following WWII some sources state that up to 70% of sea mines were not recovered. Consequently, the possibility of encountering a British or German sea mine in the area of the proposed works cannot be discounted and would cause considerable damage if such a device functioned.

8.2. U-Boats

Untersee-boots, or U-boats as they are more commonly known, were German military submarines operated in WWI and in WWII. They are known to have extensively operated in the North Sea throughout both World Wars, conducting anti-shipping operations, which included the laying of sea mines. The primary targets of the U-boat campaigns in both wars were the merchant convoys bringing supplies to Great Britain.

The collapse of France in June 1940 did a great deal to change submarine warfare which had until this point been largely concentrated in the North Sea. U-boats which previously had to move either through this area or the English Channel to get to the Atlantic now had open access to the Atlantic from bases on the western coast of France. This led to the 'Battle of the Atlantic', which from 1941 saw an escalation of the U-boat campaign against the Transatlantic shipping routes vital to the British war effort.

The mining of the area had some success with three U-boat losses in the region of the site (U-714, U-13 and U-1274) and two missing U-boats at unknown locations in the North Sea (U-54 and U-702). The locations of these losses are shown on a map in Annex F; however none are known to be within the area of the wind farm or cabling routes.

8.3. Generic Types of Mines

A wide range of different types of sea-mines were deployed by German Forces using delivery by float planes, submarines, surface vessels and air delivery, either with or without parachute retarders. Mines can be broadly categorised into four classes – ground, moored, control and drifting, with the main initiation mechanisms being impact and influence. The impact/contact mines contained a fuzing system which was activated by direct contact with the hull of a vessel. Influence mines were detonated by detecting changes in the earth's magnetic field, noise or sea-water pressure effects caused by the passage of a vessel. Some mines were also fitted with timed fuzes. Examples of mines deployed during WWII are presented in Annex G.

- *Contact Mines:* These came in a number of different designs but mostly were initiated by "Hertz horns", comprising a soft lead tube containing a glass vial of electrolyte which broke when the horn was bent by contact. The electrolyte completed an electrical circuit which detonated the device. Others used a switch system initiated by direct contact or via a snag-line. Explosive charges were up to 300kg. When deployed the mines floated (on the surface or at depth) in position on a cable or chain attached to a sinker.
- *Influence Mines:* Again there were a number of variants of these mines which were laid on the sea-bed and activated by the passage of a vessel. They were typically larger than the contact variety with high explosive charge weights of up to 900kg.

- *The "mine-bomb":* This device was designed by the Luftwaffe due to the difficulty in the precise delivery of parachute mines. It had a robust influence mechanism which could withstand the impact of being dropped in water without retardation but could also be fitted with an impact fuze for use against shipping - in this configuration it functioned as a conventional high explosive bomb. Charge weight was 725kg.

8.4. British Defensive Mine Fields

Defensive minefields, typically deployed around UK coastal waters by British forces, would have been laid for specific periods of time. Buoyant types were often designed to sink and ground types to become inactive.

Reference to historical WWII chart data held by the UKHO Research Section (Chart number M6500B, titled 'British Islands & Adjacent Waters Minefields', 17th August 1945), presented in Annex H does not highlight any specific British or German minefields in proximity to the wind farm site, however an extensive 'British Declared Area' lies adjacent approximately 5km to the east, which appears to be part of the East Coast Mine Barrage as explored in more detail below. British declared areas are locations known to have been mined during WWII and therefore pose a risk from related UXO. It is likely that the boundary shown is only broadly indicative of the area in which mines may have been laid. It should also be noted that the chart may not be indicative of all mined areas in proximity to the site, especially those deployed by the German Military and in particular by German U-boats which may easily have gone unnoticed.

Further information supplied by the UKHO following internal searches of their archived material found nothing to suggest that there were any UK defensive mine lays in the vicinity of wind farm or the associated cable route running to the south-west at Cockenzie. However, evidence was located detailing a concentration of approximately 2330 mines 23.5km due east in mine lay SN17ii. The mine lay formed *part* of East Coast Mine Barrage[2], undertaken between September and December 1939 and running approximately between 56º 10' 24.9'' N 002º 46' 13.5'' W to 56º 15' 55.5'' N 001º 39' 1.8'' W. The operation is also known to have included the laying of a number of dummy mines on passage to Rosyth.

In addition to the East Coast Mine Barrage, secondary sources detail 'considerable mine laying', 'suspected mine laying' and 'extensive mine laying' in the Firth of Forth estuary between August and November 1940.

8.4.1. Post War Mine Clearance Operations

A series of 'searched channels' are depicted on the minefield map, showing the locations of post-war mine clearance activities conducted by the Royal Navy in the region of the wind farm. The map demonstrates that many of the shallower areas of the North Sea were subjected to extensive mine clearance operations with large areas of open sea swept and reopened to ships along the major shipping routes. The chart shows the centre lines of these sweeps, one of which passes directly past the north-western extents of the wind farm site in a north-east to south-west alignment. It is not clear if this includes the area of the study site, as the exact extent of areas covered from the centre sweeps is not documented.

Assessing the risks posed by mines in specific sections of the North Sea can be problematic. Establishing the locations of all mines at a research stage is not wholly possible since offensively laid mines, in particular, were not generally laid in declared barrages but sometimes singularly or in very small numbers. Known mine barrages were swept at the end of both world wars, although it cannot by any means be guaranteed that all of the mines in a barrage were successfully removed. Furthermore, some of the WWII-era mines were fitted with scuttling circuits which caused them to sink after a specified period of time, often before being swept.

[2] *The East Coast Mine Barrage as a whole extended from Kinnairds Head, Scotland, almost to the mouth of the River Thames and is documented as the most extensive field ever laid with between 25,000 and 100,000 mines estimated to have been deployed.*

8.5. Deductions

During both World Wars, both U-boats and Luftwaffe bombers are known to have conducted anti-shipping operations in the North Sea, including the laying of mines and it is known/charted that a British Declared Area lie approximately 5km to the east of the wind farm.

Extensive minefields were also laid around the coast of the UK as a defensive measure against attacks on shipping and in the early period of WWII as a precaution against possible invasion. This included the North Sea, however is not known to have included any waters in relative proximity to the wind farm site. Information provided by the UKHO does however detail a mine lay of approximately 2330 mines approximately 12.7km due east of the wind farm site as part of the East Coast Mine Barrage which in total comprised up to 100,000 mines along the entire eastern coast of the UK.

A series of post-war Royal Navy mine clearance activities were conducted in the shallower areas of the North Sea to the west of the wind farm, including some immediately adjacent its north-western boundary. Such areas of open sea were swept and reopened to ships along the major shipping routes, however the full extents of areas searched are not known as only centre lines of the searched channels are depicted.

The possibility that sea mines may remain in the area of the site and that such items may now be located in rock crevices and outcrops as a result of current and tidal action cannot be entirely discounted. Furthermore, now that fishermen do not receive a reward for recovering mines they tend to drop them back in the water which could be some way from where they were found. The detonation of such items would pose a significant threat to any proposed works.

It should also be noted that although no records could be found of mines having been deployed in the area of the wind farm specifically, information obtained from the UKHO may be incomplete as significant quantities of the information they hold is understood to require archiving and is currently undergoing digitisation. Consequently much of the material held is currently inaccessible.

9. Coastal Armament Training Areas

9.1. General

There are several historic armament firing ranges located along the north-east coastline, many of which were in operation prior to WWII. Such ranges will have left a legacy of UXO contamination along the coast which may pose a threat to offshore intrusive works and dredging.

9.2. Army and Navy Firing Ranges

A map showing the location of Army and Naval armament training areas in 1945 is presented in Annex I.

The map extract shows fifteen armament firing areas in the coastal region of the proposed wind farm and cable routes, the closest of which (N267) was an offshore naval armament training area that encroached onto the western extents of the wind farm site. Anecdotal accounts[3] confirm the levels of such activity in the region by detailing gunnery practice off the Isle of May to the south-west of the wind farm site during WWII. These training areas were used for the following activities:

- Coast Artillery.
- Gun and Heavy and Light Anti-Aircraft Ranges.

It should be noted that the 1935 bye-laws of these ranges state that no member of the public "shall trawl, dredge, search for or otherwise interfere with any shot, shell or other projectile

[3] *http://www.grantonhistory.org/grantonlite/litewartime2.htm*

within the sea area". If, when trawling or dredging in the vicinity, a vessel comes into possession of an item of ordnance, the byelaws state that it should be returned to the water.

Unexploded munitions which come to rest on the seabed can migrate significant distances due to currents, tides and fishing activities. As a consequence, it is conceivable that items of ordnance from these ranges and Naval training activities may have traversed into the proposed area of the wind farm. The section below details the types of artillery that may have been utilised at the armament training ranges close to the site.

9.3. Types of British Range Projectiles

Within the series of coastal ranges in proximity to the wind farm, various types of range projectiles would have been deployed historically. The projectiles explored fall into two categories – Shot and Projectile, as described below.

9.3.1. Shot

- Practice shot – Used over sea ranges. These projectiles are usually solid cast iron of the same weight as the service projectile.
- Proof shot – For the proof of guns, howitzers and charges. They are made of forged steel of the same weight as the corresponding service projectile.
- Paper shot – Used to test the mounting of guns which cannot fire service projectiles owing to their position (i.e. close to occupied areas).
- Case shot - Generally consisting of three or more long steel segments held in position and filled with bullets allowing them to escape during firing.

9.3.2. Projectile

- HE – Designed to cause damage to material by the force of their burst or to personnel and aircraft by fragmentation.
- Smoke – Used for the production of smoke screens, various fillings are used, the commonest being white phosphorus.
- Shrapnel – Designed to be used primarily against personnel these are filled with the maximum amount of bullets possible.
- Star - Designed to illuminate an area or target.
- Practice – Commonly a solid shot filled with a spotting charge which gives an indication of where it lands.

9.4. Fuzes

The fuzes used with munitions fired on ranges are mainly of the direct impact action variety. This means that if they failed to function on impact a needle/pin may have been driven into the detonator or a very sensitive explosive compound leaving the fuze in a dangerous state. An inadvertent impact on the fuze or munition could cause the munition to detonate.

9.5. Deductions

The area of the proposed wind farm lies within the confines of an extensive historic Naval firing range (N267) as well as being within proximity to fourteen further ranges in the region during the WWII-era. It also currently overlays both a modern Firing Practice Area (X5641) and a Submarine Exercise Area to the south. Consequently, it is likely that related munitions will be present within the boundary of the wind farm site and along the proposed cable routes. It is also likely that many such munitions may have migrated in and out of the area given the strong currents in the area.

Items of ordnance do not become inert or lose their effectiveness with age. Time can cause items to become more sensitive and less stable. This applies equally to items submerged in water or embedded in silts, clays or similar materials. The greatest risk occurs when an item of ordnance is struck or interfered with. This is likely to occur when mechanical equipment is used or when unqualified personnel pick up munitions.

The calibre of projectiles fired in these historic range areas is not entirely clear, however the majority of items fired are likely to have been relatively small and are therefore not likely to pose a significant risk to construction works within the wind farm boundary. Such items may however pose a risk to cable laying operations and dredging where they may come into closer contact with personnel.

10. Shipwrecks

10.1. General

It is known that many vessels (both Military and Merchant Navy/civilian) were sunk in British waters during WWI and WWII, predominantly as a result of U-boat activity[4] and offensive/defensive mining. Many vessels, particularly those in use by the military and responsible for the transportation of ordnance and live explosives, can still pose a threat to modern-day intrusive works.

In general, the risk of munitions contamination is somewhat less in the vicinity of military related wrecks than for dump sites and weapons ranges, since the munitions tend to be enclosed and immobile within the wrecks, and typically unfuzed during transportation. Furthermore, weapons stored in ships' magazines which have not been through the firing sequence are inherently safer than those which have been fired but failed to detonate. It is possible that some munitions would have been thrown clear of the vessel as it sank, or that they may become exposed as the wrecks gradually break up.

10.2. Site Specific Wrecks

Records held by the United Kingdom Hydrographic Office (UKHO) Wrecks Section were requested as part of this Explosive Ordnance Threat Assessment, returning a result of eight recorded wrecks within the boundary of the wind farm site. A recent aerial photograph plotting the locations of the wrecks, as well as the accompanying data sheets for the vessels are presented in Annex J.

The data sheets document seven of the eight wrecks to be 'non-dangerous', however two of these are submarines, which may have contained various items of UXO. Also worthy of note is that one of the wrecks (number 2969) remains 'undefined'. The data sheet pertaining to this wreck provides minimal information regarding the nature and contents of the ship, however it should be noted that the wreck is neither detailed as historic, nor military related. As a result the possibility of UXO being contained within the vessel is considered to be low and it is considered unlikely to comprise anything more than a seabed feature.

10.3. Deductions

It should be noted that whilst none of the listed wrecks are documented as dangerous or military vessels, five of the eight records date from the WWI or WWII-era and include references to two British submarines. Consequently, the likelihood of any such wrecks containing items of UXO cannot be entirely discounted, yet is considered to be minimal.

The data sheets indicate that two vessels (the Ballochbuie and the Einar Jarl) were sunk by munition - a torpedo and mine respectively. This indicates that a mine barrage is highly likely to have been present in close proximity to the wind farm, and that torpedoes were deployed in the area (even though such weapons were historically used in low numbers).

Another wreck is HMS Rockingham, one of the fifty American First World War four-funnelled destroyers sent to Britain as part of the Lend Lease Agreement which gave the U.S.A. military bases throughout the British Empire. Anecdotal accounts refer to HMS Rockingham carrying out two types of training in the Firth of Forth. The first involved an aircraft, towing a drogue, enabling the ships' crews the chance to practice anti-aircraft firing from the decks, or often the vessel was "attacked" by Barracuda aircraft dropping torpedoes (genuine but without explosives).

[4] *See section 11.2.*

The presence and location of each wreck may need to be taken into account in terms of the proposed turbine layout design.

11. British and German Torpedoes and Depth Charges

11.1. General

During WWII, all classes of ship (including submarines) and aircraft could be armed with torpedoes. There was concern torpedoes would be ineffective against warships' heavy armour. This was solved by enabling torpedoes to detonate underneath a ship, badly damaging its keel and the other structural members in the hull, commonly called "breaking its back". A current was produced in a coil on a mu-metal rod as the torpedo passed under a ship and fired the warhead. Germany, Britain and the US independently devised ways to do this; German and American torpedoes, however, suffered problems with their depth-keeping mechanisms, coupled with faults in magnetic fuzes, which were subsequently abandoned in some torpedoes by 1943[5].

Failed torpedoes sink to the seabed with their warheads intact when they run out of fuel and several have been recovered from the waters around the UK in recent years (an example of a torpedo recovered by BACTEC in the North Sea is presented in Annex K-1). Such devices have the potential to be present within the proposed wind farm area. However, the risk of encountering unexploded torpedo warheads is not considered to be high as they were commonly deployed in relatively small numbers. Typically, the warheads would contain around 300-500kg of explosives; however taking into consideration the presence of the submarine exercise area to the south of the wind farm, there is an increased possibility of encountering dummy warheads which are free of such explosives. Photographs of WWII torpedoes are presented in Annex K-2.

Depth charges were also used defensively off the coast of Britain during WWII, but to a much lesser extent than torpedoes. They were basically a large metal drum filled with explosives initiated by a barometric fuze. Up to the middle of 1944, depth charges were the principal anti-submarine weapon for surface ships. Anti-submarine spigot mortars were also deployed by the UK in WWII from 1942. The "hedgehog" mortar had contact fuzing and was fired in batches of 24; charge weights were 16kg. The larger "squid" mortar was fired in salvoes of three and had a charge weight of 45kg. These devices accounted for more U-boat losses than depth charges and their ratio of successes to attacks was much better. More information regarding these weapons is provided in Annex L.

The main developments in depth charges during WWII were to increase the speed of sinking and the maximum depth setting of the hydrostatic pistol. The usual depth settings by late 1943 against a U-boat that had gone deep were between 153 and 226m. More powerful explosives were introduced as available, and the number of devices deployed was greatly increased, with often up to 26 depth charges being used in a single attack.

11.2. Deductions

As with mines, the consequences of the detonation of a torpedo or depth charge are potentially severe. The possibility that such items were deployed in the North Sea cannot be discounted and therefore pose a potential risk to marine based intrusive works. The risk is not however considered to be high.

12. Ammunition Dumping Grounds

12.1. General

Following the end of WWII, Britain was faced with the need to dispose of an enormous quantity of surplus munitions. This process had to be completed quickly and safely. However, given the technological limitations of the time, it soon became clear that sea dumping was likely to be the only practical method of disposing of the bulk of the munitions. Other nations

[5] *Campbell, J 'Naval Weapons of World War Two' pp 80-83.*

arrived at the same conclusion and sea dumping became the internationally accepted method of munitions disposal during the 1940s.

The main disposal site in the UK was Beaufort's Dyke, a long narrow trench in the northern channel of the Irish Sea between south-west Scotland and Northern Ireland. Beaufort's Dyke may have been used for sea dumping of munitions as early as 1920. It is estimated that a million tonnes of conventional munitions ranging from small arms ammunition to HE bombs were dumped there between 1945 and 1973. Sea dumping was effectively ceased by this time following the UK's adoption of the London Convention on the Disposal of Wastes at Sea and the Oslo Convention on the Prevention of Marine Pollution in the North East Atlantic.

12.2. Ammunition Dumping Grounds in the North Sea

An Admiralty chart (No. 190) entitled 'Scotland – East Coast, Montrose to Fife Ness including the Isle of May' was consulted as part of this report. The chart shows both an *Ammunition Dumping Ground (Disused)* and *Ammunition & Boom Gear Dumping Ground (Disused)*, approximately 12-13km to the south-west of the site. The areas partially overlap and lie approximately 2km east of the Isle of May in proximity to the Firth of Forth. Official MoD sources document the sites to lie at 56 11 24N 02 29 00W and 56 10 45N 02 30 15W respectively. The locations of both sites are in very close proximity to the proposed Cockenzie cable route associated with the wind farm.

An extract of this map is presented at Annex M.

12.3. Deductions

Ammunitions dumping grounds such as those located to the south-west of the wind farm site would have been utilised for the disposal of a wide range of UXO in the post-WWII period.

Whilst both charted dumping sites lie at significant distances from the proposed wind farm site, one of the associated cables routes (to Cockenzie) passes either through or in close proximity to these areas. Furthermore, the possibility cannot be discounted that items of UXO may have been dumped outside the designated boundaries of the dumping areas and/or migrated into the wind farm area as a result of current and tidal action. It is known historically that the disposal of munitions was often imprecise or poorly regulated with items disposed of shortly after dumping vessels left shore.

The detonation of larger items would pose a significant threat to any proposed works.

13. The Threat from Aerial Bombing

13.1. General Bombing History of Scotland

13.1.1. First World War

A WWI bomb census map for the UK is presented in Annex N. Whilst the plot does not extend to cover the areas in closest proximity to the wind farm site, the map does demonstrate that the highest densities of bombing were concentrated on London and the south-east. Only a handful of attacks are noted to Scottish towns and cities with the nearest occurrences to the site being two Zeppelin strikes to Edinburgh and Leith. Any ordnance falling into sea-based areas such as those occupied by the wind farm site would not be recorded on this map.

Taking into consideration the relative infrequency of attacks and an overall low bombing density, the threat from WWI UXBs is considered low and will not be further addressed in this report.

13.1.2. Second World War

At the start of WWII, the Luftwaffe planned to destroy key military installations, including RAF airfields and Royal Navy bases, during a series of daylight bombing raids. Targets included dock facilities, railway infrastructure, power stations, weapon manufacturing plants and gas works. As a result of aircraft losses, daylight raids were reduced in favour of attacking targets under the cover of darkness.

Aerial attacks on shipping (both naval and armed merchant) were carried out in the North Sea and in particular the Firth of Forth area in proximity to the site during WWII by both the German and Allied air forces. A proportion of the bombs would have failed to function as designed (the typical failure rate was 10%) and may be encountered on the seabed in the area of the proposed wind farm. However, the total quantity of weapons dropped would not have been high.

Unexploded high explosive bombs are occasionally encountered at sea off the UK coastline and if present within the proposed wind farm area, could pose a significant threat to works. A recent example is a 500kg high explosive bomb which washed up on a beach at Felixstowe on the east coast of the UK (see Annex O).

13.2. Aerial Delivered Ordnance in the Second World War

13.2.1. Generic Types of WWII German Air-delivered Ordnance

The nature and characteristics of the ordnance used by the Luftwaffe allows an informed assessment of the hazards posed by any unexploded items that may remain today. Detailed illustrations of German air delivered ordnance, likely to have been utilised during attacks on shipping in the Firth of Forth are presented at Annex P and described below.

In terms of weight of ordnance dropped, HE bombs were the most frequent weapon deployed. Most bombs were 50kg, 250kg or 500kg (overall weight, about half of which was the high explosive) though large bombs of up to 2000kg were also used. HE bombs had the weight, velocity and shape to easily penetrate the ground intact if they failed to explode. Unexploded HE bombs therefore present the greatest risk to present–day intrusive works.

13.2.2. German Air-delivered Ordnance Failure Rate

It has been estimated that 10% of the German HE bombs dropped during WWII failed to explode as designed. This estimate is probably based on the statistics of wartime recovered UXBs and therefore will not have taken account of the unknown numbers of UXBs that were not recorded at the time, and is probably an underestimate.

The reasons for failures include:

- Fuze or gaine malfunction due to manufacturing fault, sabotage (by forced labour) or faulty installation.
- Clockwork mechanism failure in delayed action bombs.
- Failure of the bomber aircraft to arm the bombs (charge the electrical condensers which supplied the energy to initiate the detonation sequence) due to human error or equipment defect.
- Jettison of the bomb before it was armed or from a very low altitude. Most likely if the bomber was under attack or crashing.

13.3. Bombing of Crail and Edinburgh

13.3.1. Second World War Overview

During WWII, the Scottish coastal regions as a whole were considered to be safe from large scale bombing raids due their remote location and rural nature. Several 'Tip and Run' raids[6] were recorded over the region throughout the course of the war (whereby a bomber, not being able to reach its intended target would jettison its bomb load indiscriminately before returning to base); however, heavy, prolonged bombing did not frequently occur.

The coastal areas in closest proximity to the wind farm site were however home to a number of key Luftwaffe bombing targets including the Royal Naval base at Rosyth, Granton Harbour, Edinburgh Gas Works and the Firth of Forth which itself was a key shipping channel vital to the British war effort. Attacks on shipping preoccupied the Luftwaffe in the early months of the war and along with the Shetlands and Orkneys, Scotland saw most of the action.

[6] *See section 13.5*

Many of the islands along the Forth were fortified in order to defend Edinburgh-Leith and the naval base at Rosyth which was itself attacked by twelve Junkers Ju88 aircraft in October 1939. Such targets in the region were located on shore, at significant distance from the proposed wind farm which being in an offshore location, was not in immediate proximity to any viable Luftwaffe bombing targets.

13.3.2. Second World War Bombing Statistics

The following table summarises the quantity of German bombs (excluding 1kg incendiaries and anti-personnel bombs) falling on onshore areas of the County Boroughs of Crail and Edinburgh respectively between 1940 and 1945. These areas were geographically the nearest borough and closest major City in proximity to the site during WWII. It should be noted that statistics relating to offshore bombing or attacks on shipping are not known to exist, however the following figures serve to demonstrate levels of enemy bombing activity in the nearby areas.

Record of German Ordnance Dropped on the County Boroughs of Crail and Edinburgh		
	Crail	Edinburgh
Area Acreage	129	32401
High Explosive Bombs (all types)	3	45
Parachute Mines	0	2
Oil Bombs	2	0
Phosphorus Bombs	0	0
Pilotless Aircraft (V1)	0	0
Fire Pot	0	0
Long Range Rocket (V2)	0	0
Total	5	47
Items Per 1000 Acres	38.8	1.5

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. Although the incendiaries are not particularly significant in the threat they pose, they nevertheless are items of ordnance that were designed to cause damage and inflict injury and should not be overlooked in assessing the general risk to personnel and equipment. The anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous.

This table does not include UXO found during or after WWII.

13.4. Area Specific WWII Bombing Records

13.4.1. Written ARP Bombing Incident Records

Written ARP reports were obtained from secondary sources including books and the internet and the table below details all incidents on and around the region during WWII.

Date	Weapon	Location	Remarks
16/10/1939	HE Bombs	Firth of Forth	Raid was directed at coastal objectives. Raiders which attacked Naval vessels off Queensferry penetrated some 10 miles westwards and southwards. Anti-aircraft fires reported from Edinburgh and Dunfermline. One enemy plane brought down near Firth Bridge and another in the sea of Port Seton.
03/08/1940	11 x HE Bombs	Edinburgh, Portobello, Crewe	Eleven HE bombs dropped. Ten failed to explode.
11/10/1940	n/k	Aberdeen & Firth of Forth	Enemy aircraft reported over area.
18/10/1940	HE Bombs	Forth Estuary & Crail	A single aircraft raided the Forth Estuary dropping several bombs both there and at Crail. Little damage

Date	Weapon	Location	Remarks
			was reported.
11/11/1940	HE Bombs	Firth of Forth	
24/01/1941	HE Bombs & Machine Gunning	Edinburgh	Edinburgh bombed and Machine Gunned by a single aircraft.
06/08/1942	HE Bombs	Edinburgh	
14/05/1944	Machine Gunning	Edinburgh	

13.5. Tip and Run

Records indicate that if a Luftwaffe pilot did not find his intended target or came under fighter or AAA attack, he would often drop his bomb load before returning to base – an occurrence known as a 'tip and run'. The North Sea, within which the proposed wind farm is located, lay in proximity to the flight path for bombers aiming for industrial targets such as Granton Harbour, Edinburgh Gas Works and the Royal Naval Base at Rosyth in the Forth Estuary. It is possible that the site could have been an area at risk from such 'tip and run' incidents.

13.6. Deductions

The quantities of HE bombs dropped over the area of the wind farm and proposed cable routes during WWII were not significant in number (when compared to areas of south-east England and the Thames Estuary for example). However, attacks on shipping did occur in the area and the possibility that UXBs may be present cannot be discounted, though the likelihood is not considered to be high.

14. Aircraft Activity and Crashes in the North Sea

14.1. General

Luftwaffe bomber crews on route to coastal industrial targets off the Scottish coast were engaged by the Hurricanes and Spitfires of Fighter Command; these in turn were engaged by Luftwaffe fighters defending the bomber crews. During such battles numerous aircraft were shot down and crashed into the North Sea, some with their bomb loads intact. It is difficult however, to ascertain the exact numbers or locations of aircraft which crashed in such areas, however those events detailed among various secondary sources are detailed in the table below:

Date	Location	Remarks
16/10/1939	Firth of Forth and Port Seton	Two enemy aircraft shot down.
07/12/1939	Firth of Forth	Two enemy Heinkels brought down by six Spitfires.
04/02/1940	Firth of Forth	Heinkel aircraft brought down on land near Firth of Forth.
24/07/1941	Off May Island (Firth of Forth)	Junkers Ju 88D-2 (0860) shot down by Hurricanes of No. 43 Squadron.
24/11/191	Firth of Forth	Two aircraft (Dornier Do 217 and a Heinkel He 111) lost over the Firth of Forth.
24/03/1943	Firth of Forth	Junkers Ju 88 aircraft crashed on a sandbank in the Firth of Forth.

14.2. Deductions

The possibility of a threat from the potential presence of wrecked aircraft complete with their bomb loads as well as from the many thousands of rounds of ammunition fired in aerial combat cannot be discounted, although the probability of wreckage being located in the works area is considered to be very low.

15. Offshore Incidents Involving Munitions

15.1. General

Historically it is fishing and dredging activities that are most likely to come into contact with sea-bed ordnance and there are records of a number of such incidents over the last 25 years, as mentioned in previous parts of the report. Annex Q contains examples of ordnance recovered by BACTEC during dredging operations in the Thames Estuary during 2006. Such types of ordnance may be present within the area of the proposed wind farm, especially given the number of firing ranges both on and in close proximity to the site.

15.2. Explosive Munition Incidents

The following is a list of some incidents involving direct physical contact with munitions offshore in the coastal waters of the UK:

08/04/1980 – An explosion occurred on a dredging vessel in the Thames Estuary which encountered aircraft parts and bombs during dredging operations.

01/10/1991 – 30/09/1992 – 12 x German GC mines were recovered by fishing vessels in the Thames Estuary and English Channel.

31/12/1991 – Fishing vessel *Shelandra* netted 23kg of guncotton in blocks which were brought ashore at Ramsgate for disposal.

March 2002 – WWII-era mine recovered by trawler in English Channel near Plymouth

June 2002 – 2 x WWII 1,000lb bombs recovered in the nets of a fishing vessel off the Essex Coast.

2003 – 2 German WWII parachute mines and a German Ground Mine recovered in the Thames Estuary.

04/02/2003 – Eight UXBs located in Bristol Channel during search for modern British munitions.

06/04/2005 – Three Dutch fishermen killed when the trawler *Maarten Jacob* hauled a bomb on board which then exploded off the coast of Lowestoft.

11/10/2007 – A one ton German parachute mine recovered in the nets of a trawler off the Margate Coast. (see Annex F).

April 2008 – 10ft, 700kg German unexploded mine recovered on foreshore of Burnham-On-Sea.

30/04/2008 - German 500kg HE bomb was found by a contractor whilst working on sea defences on Felixstowe beach. The bomb was recovered by Royal Navy Bomb experts and detonated approximately a mile off the Felixstowe seafront.

The Advisory Committee on Protection of the Sea (ACOPS) report dated 2003 states:

"Overall, explosive ordnance of WWII origin still accounts for a significant proportion of reported finds…The evidence suggests that substantial quantities still remain to be discovered and hence the services of the RN Diving Teams will continue to be required for many years to come."

15.3. Deductions

It can be seen from the above that the risk of encountering UXO during offshore operations along the UK coast is very real. Of still greater concern is evidence that such items can function when handled, demonstrating their potential instability.

16. The Overall Explosive Ordnance Threat Assessment

16.1. General Considerations

Taking into account the quality of the historical evidence, the assessment of the overall threat to the proposed works from unexploded ordnance must evaluate the following risks:

- That the site area was contaminated with unexploded ordnance
- That unexploded ordnance remains on site
- That such items will be encountered during the proposed works
- That ordnance may be activated by the works operations
- The consequences of encountering or initiating ordnance

16.2. Quality of the Historical Record

The research has located and evaluated a 1945 armament training areas map and several sources obtained from the UKHO including a minefield chart, admiralty charts and wreck data sheets as well as written secondary accounts of bombing records for the region. It should be noted that complete records pertaining to minefields laid in the North Sea as well as u-boat activities were not available due to archiving and digitisation of material held at the UKHO in Taunton. Consequently the possibility cannot be discounted that mines relating to such activities may remain in the vicinity.

16.3. The Risk that the Site was Contaminated with Unexploded Ordnance

BACTEC believes that there is a risk that the site is contaminated with UXO.

- The site is located in the North Sea, approximately 15km east of the coast of Fife Ness, Scotland. Several potential sources of explosive ordnance contamination have been identified in this region including historic/modern Army and Naval firing ranges in the area, British and German sea mines, unexploded air-delivered bombs, and anti-aircraft artillery projectiles.
- Extensive minefields were laid around the coast of the UK as a defensive measure against attacks on shipping and in the early period of WWII as a precaution against possible invasion. This included the North Sea, however is not known to have included any waters in relative proximity to the wind farm site with the exception of a British declared area lying 5km to the east which is likely to account for the East Coast Mine Barrage of 1939 which in total comprised up to 100,000 mines along the entire eastern coast of the UK. Additional information provided by the UKHO details a mine lay of approximately 2330 mines approximately 23.5km due east of the wind farm site as part of this operation. Secondary sources also detail extensive mining of the Firth of Forth and Forth Estuary from August to November 1940 and a wreck recorded within the boundary of the wind farm site is detailed to have been sunk by a mine in March 1941, indicative that a mine barrage was located in proximity to the site area. A number of mines have been found in the Firth of Forth in recent years and the Royal Navy believes that there are still "tens of thousands" of mines in the area.
- Assessing the risks posed by mines along specific sections of the UK coast can be problematic. Establishing the locations of all mines at a research stage is not wholly possible since offensively laid mines, in particular, were not generally laid in declared barrages and sometimes singularly or in very small numbers. Furthermore, records assessed for this report are known to be incomplete. For these reasons, the possibility that mines may have been deployed in the area of the wind farm cannot be entirely discounted.
- The western and southern extents of the site lie within historic and modern Army and Navy firing ranges which were in operation prior to, during and post-WWII. The proposed wind farm cable routes also pass through such areas. According to 1939 War Department bye-laws various types of ordnance were permitted, and indeed are likely to have been fired from these ranges, including anti-aircraft and anti-tank artillery projectiles and mortars. Consequently the area of the wind farm and cable routes are likely to have been contaminated by such items.

- Two ammunition dumping grounds are mapped within approximately 12km of the site to the south-west, which would have been used to dispose of a range of munitions post-WWII. There is a risk that dumped munitions may have either been deposited outside the designated areas (i.e. within or closer to the wind farm area) or have moved over time due to tidal currents. It should be noted that the Cockenzie cable route also runs through or in immediate proximity to these dumping grounds. The detonation of larger items would pose a significant threat to any proposed works.
- The UKHO database of shipwrecks does not hold any record of any official military wrecks within the confines of the proposed wind farm. However, a number of the listed wrecks date from WWI or WWII and consequently the risk of explosive ordnance originating from historic wrecks cannot be discounted. The reason for the sinking of many of these vessels is also not documented yet could be related to mines and torpedoes present in such waters.
- Torpedoes and depth charges were both deployed around the UK during WWI and WWII, however not in high numbers and more commonly along the east and south coast. Such items are not commonly encountered however wreck data sheets for the area of the wind farm site detail a WWI-era submarine to have been sunk by a torpedo in April 1917, indicating that such weapons were deployed on or in proximity to the site.
- Occasionally air-delivered weapons such as high explosive bombs are encountered around the coast of the UK. Such items are generally present as a result of attacks on shipping, crashes, 'tip and run' or jettisoning bombs in open water prior to landing. There are records of a number of attacks on shipping in the Firth of Forth and Forth Estuary and the risk of air-delivered weapons having been deployed in the area and failing to explode during such attacks cannot therefore be discounted.

16.4. The Risk that Unexploded Ordnance Remains on Site

BACTEC are not aware of any post-war dredging or clearance operations in the area of the site which may have reduced the risk of WWII-era unexploded ordnance remaining in situ. Heavy items such as unexploded air-delivered high explosive bombs may have had some penetration capability into soft material on the seabed and may have remained undisturbed. Photographs of HE bombs found by BACTEC in marine environments are presented in Annex R.

There are several conditions which could have resulted in explosive ordnance remaining within the boundary of the proposed wind farm or cable route:

- Ordnance remaining in situ on the sea-bed over the last 70 years.
- Mobile ordnance – due to the currents in the area, explosive ordnance could potentially be in a state of transit through the area of the wind farm (demonstrated by the recovery by BACTEC of a 1000lb British bomb in transit in the North Sea, see Annex S).

For these reasons it is still considered possible that unexploded ordnance (primarily sea mines and projectiles) could remain in the area of the proposed wind farm, particularly given the evidence of mining in the region and the fact that these records are incomplete.

16.5. The Risk that Ordnance may be Encountered during the Works

BACTEC has identified the potential for encountering various types of explosive ordnance within the area of the proposed wind farm (sea mines, torpedoes, depth charges, projectiles, high explosive bombs).

BACTEC believes a range of UXO may be encountered during the proposed works, however of greatest concern are mines and torpedoes.

This is primarily due to evidence of mining in the region, particularly in the Firth of Forth to the south-west of the site. Furthermore, the sinking of both a submarine by a torpedo in 1917 and the Einar Jarl vessel by a mine in 1941 (both within the wind farm boundary) indicate the presence of such weapons in waters within or in proximity to the wind farm and cabling routes.

Smaller items such as projectiles are only likely to be encountered and pose a risk if they are dredged up or become attached to equipment deployed on the sea floor.

16.6. The Risk that Ordnance may be Initiated

The risk that UXO could be initiated if encountered will depend on its condition, how it is found and the energy with which it is struck. Most unexploded munitions do not become less dangerous with age and could still function as designed if disturbed. Furthermore, it is possible that seawater may have degraded certain types of munition over time leaving them in a more sensitive state.

The movement of vessels and implementation of non-intrusive surveys would not result in the initiation of ordnance through influence alone. Initiation would only result from either direct impact or shock/vibration. This is evidenced by the detonation of a sea mine off the Norfolk/Suffolk coast of the UK in 2005, killing three fishermen (see Annex T).

Unexploded munitions do not spontaneously explode. All high explosive requires significant energy to create the conditions for detonation to occur. In the case of unexploded munitions discovered within the marine environment, there are a number of potential initiation mechanisms:

- Direct impact onto the main body of the munition: Unless the fuze or fuze pocket is struck, there needs to be a significant impact (e.g. from piling) to initiate an iron bomb or projectile. Such violent action can cause a munition to detonate.
- Shock or vibration re-starting the clock timer in the fuze or other mechanical device: Weapons such as German WWII bombs and some sea mines employed clockwork fuze systems. It is probable that significant corrosion will have taken place within the fuze mechanism over the last 60 years that would prevent clockwork mechanisms from functioning. Nevertheless it was reported that the fuze in a UXB dealt with by the British Army Explosive Ordnance Disposal Regiment in Surrey in 2002 did re-commence.
- In principle WWI and WWII contact mines could still be initiated through impact with chemical horns. If the firing circuit was intact the release of electrolyte could theoretically activate the battery and detonate the mine.

It is highly unlikely that magnetic or acoustic sea mines would function as originally designed, primarily due to power supply failure[7]. A significant amount of marine traffic utilises the North Sea, and there have been no known reports in recent history of an influence mine initiating due to the proximity of a vessel alone. However there is a risk that such mines could be initiated due to direct or adjacent shock/impact.

16.7. The Consequences of Encountering or Initiating Ordnance

The initiation of a small item of ordnance such as a small calibre projectile at depth during intrusive works is likely to result in damage to plant and potentially injury of personnel. The initiation of a larger weapon such as a high explosive bomb or sea mine during borehole or piling works could have severe consequences in terms of both damage and loss of life and limb.

Unlike borehole operations where the initiation of an item of ordnance is likely to be at depth and at distance from operatives, the initiation of even a small item of ordnance during dredging operations has the potential to be severe as personnel are likely to be in closer proximity. Even if an item of ordnance does not function, encountering an item or potential item of ordnance during dredging operations may result in significant loss of time.

16.8. BACTEC's Assessment

Taking into consideration the findings of this study, BACTEC considers there to be a **Medium-High** risk from unexploded ordnance during any proposed works at Neart Na Gaoithe Offshore Wind farm site:

[7] *The last incident believed to have been due to an influence mine initiating as designed was in 1955 when the Soviet Battleship the Novorossysk sank in Sebastapol harbour with the loss of 608 officers and men*

	Level of Risk			
Type of Ordnance	**Negligible**	**Low**	**Medium**	**High**
German and British Sea Mines			*	
Allied & German HE UXBs		*		
German incendiaries and anti-personnel bombs		*		
British Army/Navy Range Projectiles				*
Torpedoes and Depth Charges			*	
Other Items Including LSA & SAA		*		

Dredging / Cable Installation Works

Note that the risk to any preliminary dredging works which may be undertaken will depend on the dredging methodology employed. Once full details of any such methodology are available, a respective work specific risk matrix can be prepared.

17. Proposed Risk Mitigation Methodology

17.1. General

BACTEC believes the following risk mitigation measures should be deployed to support the proposed works at the Neart Na Gaoithe Offshore Wind farm site.

17.2. Recommended Risk Mitigation Measures

All Works

- ***Explosive Ordnance Safety and Awareness Briefings to all personnel:*** A specialised briefing is always advisable when there is a possibility of explosive ordnance contamination. It is an essential component of the Health & Safety Plan for the project and conforms to requirements of CDM Regulations 2007. All personnel working on the windfarm project should be instructed on the identification of UXO, actions to be taken to alert site management and to keep people and equipment away from the hazard. Posters and information of a general nature on the UXO threat should be held in the site office for reference and as a reminder.
- ***The Provision of Unexploded Ordnance Site Safety Instructions:*** These written instructions contain information detailing actions to be taken in the event that unexploded ordnance is discovered. They are to be retained and will both assist in making a preliminary assessment of a suspect object and provide guidance on the immediate steps to be taken in the event that ordnance is believed to have been found.

Area of Proposed Wind Farm & Cabling Routes

- ***High Resolution Non-Intrusive ROV Magnetometer Survey:*** This method will be used to identify and clear/avoid items of UXO such as sea mines and torpedoes which may be present and cause a significant threat to intrusive works associated with the installation of the wind turbines on the site.

Area of Known Ammunition Dumping Grounds in Proximity to Cockenzie Cable Route

- ***High Resolution Non-Intrusive ROV Magnetometer Survey:*** This method will be used to identify the outermost extents of the charted ammunition dumping grounds in proximity to the Cockenzie cable route to the south-west of the wind farm. It is recommended that a Construction Exclusion Zone should be placed around this area with any cabling works in proximity to its surveyed extents re-routed to avoid the possible initiation of UXO.

In making this assessment and recommending these risk mitigation measures, the proposed works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, BACTEC should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

BACTEC International Limited 27th January 2011

Bibliography

The key published documents consulted during this assessment are listed below:

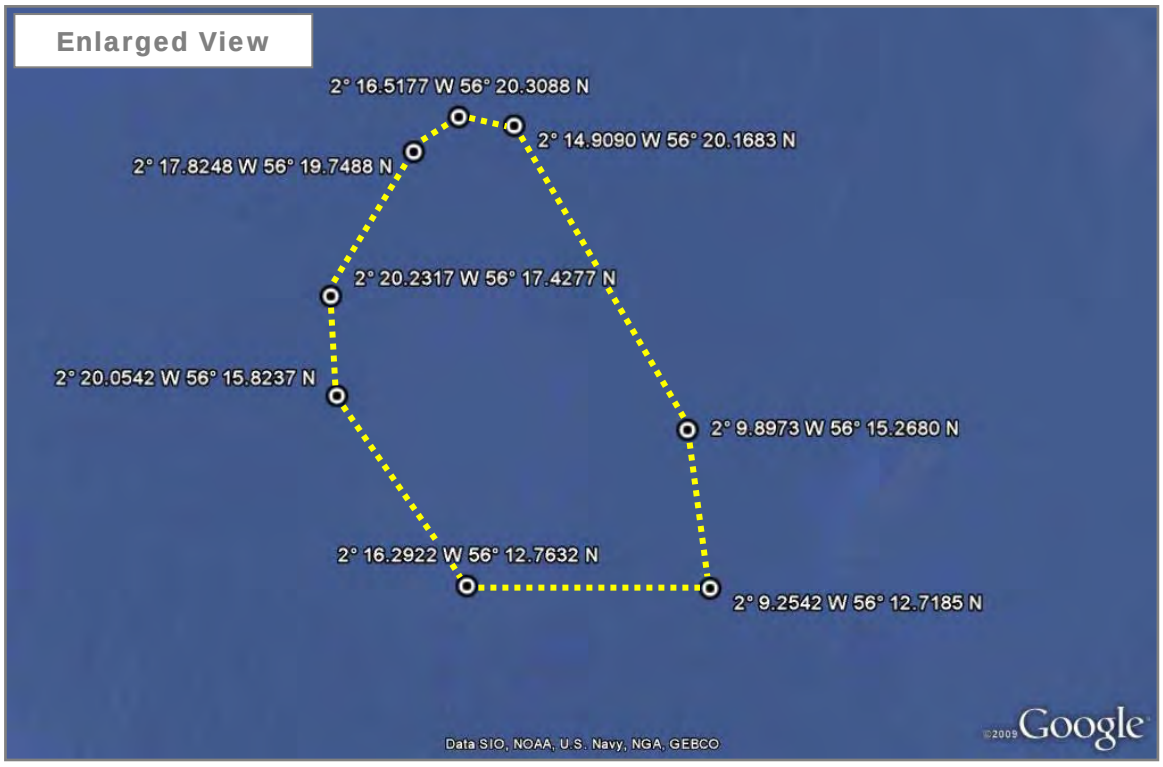
- Bates, H, E., *Flying Bombs over England*, Frogletts Publications Ltd. 1994.
- Campbell, J., *Naval Weapons of World War Two*, Conway Maritime Press. 2002.
- Dobinson, C., *AA Command: Britain's Anti-Aircraft Defences of the Second World War*, Methuen. 2001.
- Fegan, T., *The Baby Killers': German Air raids on Britain in the First World War*, Leo Cooper Ltd. 2002.
- Fleischer, W., *German Air-Dropped Weapons to 1945*, Midland Publishing. 2004.
- Jappy, M. J., *Danger UXB: The Remarkable Story of the Disposal of Unexploded Bombs during the Second World War.* Channel 4 Books, 2001.
- Price, A., *Blitz on Britain, The Bomber Attacks on the United Kingdom 1939 – 1945*, Purnell Book Services Ltd. 1977.
- Ramsey, W., *The Blitz Then and Now, Volume 1*, Battle of Britain Prints International Limited. 1987.
- Ramsey, W., *The Blitz Then and Now, Volume 2*, Battle of Britain Prints International Limited. 1988.
- Ramsey, W., *The Blitz Then and Now, Volume 3*, Battle of Britain Prints International Limited. 1990.
- Whiting, C., *Britain Under Fire: The Bombing of Britain's Cities 1940-1945*, Pen & Sword Books Ltd. 1999.

Annex A: Site Location Maps

Report Reference:	Client:	
3165TA	Emu Limited	BAC TEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Annex B: Recent Aerial Photograph of the Site

North



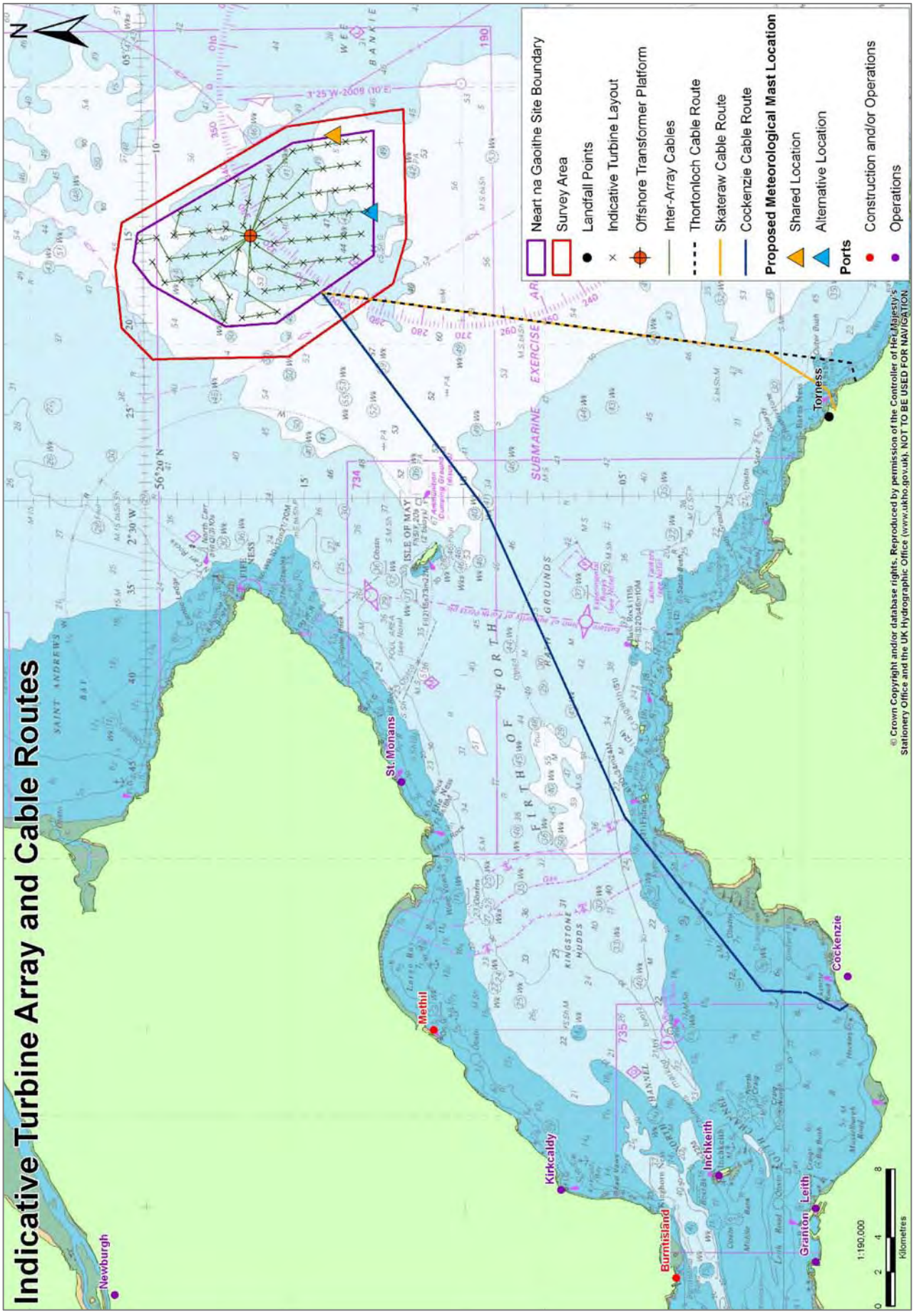
Approximate Wind Farm Boundary

Outlying Points

Report Reference:	Client:	
3165TA	Emu Limited	BACTEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: Google Earth ™ Mapping Services

Annex C: Proposed Site Plan



Report Reference:	Client:	
3165TA	Emu Limited	BAC TEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: Emu Limited

Annex D: Luftwaffe Reconnaissance Target Photograph

The photograph highlights the two main targets in the vicinity; Edinburgh Gas Works (A) and Granton Harbour (B)

Annex E: Articles on Ordnance Finds in the Firth of Forth

Tuesday, December 9th, 2008 | Posted by michaelmacleod1

Francis' WWII catch has an explosive ending

By Michael MacLeod

A FISHERMAN is lucky to alive – after reeling in a car-sized live World War II bomb.

Francis Greig, 60, was almost washed out to sea as battled for six hours to try to detangle the eight-foot mine from his fishing net.

The quick-thinking trawler usually reels in scampi to sell on – but still thought to trawl the bomb rather than let it go when he found it on Monday morning.

That meant that members of the Royal Navy bomb disposal unit could carry out a controlled explosion in the Firth of Forth yesterday just three miles from Edinburgh.

A Royal Navy spokesperson said: "There's no saying for sure it would have killed the fisherman but he certainly did the right thing by getting rid of it.

"In its day this bomb was designed to wipe out ships and there would have been a plume of water big enough to see from both coasts.

"There are still tens of thousands of these in the Forth from the war but what we don't know is whether it was an Allied of German bomb because it was in such a bad state."

Short URL: http://www.deadlinenews.co.uk/?p=2114

BBC NEWS

News Front Page

LIVE BBC NEWS CHANNEL

Last Updated: Monday, 25 September 2006, 14:16 GMT 15:16 UK

E-mail this to a friend Printable version

War mine found in Firth of Forth

Royal Navy explosives disposal experts have been called in to examine what is suspected to be a World War II mine found in the Firth of Forth.

Coastguards alerted the Navy team after the crew of a fishing vessel reported snagging the ordnance in its gear, off Methil in Fife.

It is understood the mine will be blown up in the sea if it is found to be live.

The Forth Coastguard said the mine had to be dealt with "very carefully".

eastlothiancourier

Published: **Thursday, 14th January, 2010 6:00am**

Fisherman nets 'torpedo'

A PORT Seton fisherman snagged an unusual catch last week after he dragged aboard a 'torpedo'.

Fisherman Robert Thomson dragged the 12-foot-long device onto his boat, the Emma Jane, before calling out the Royal Navy's Northern Diving Unit to safely dispose of what turned out to be a practice bomb.

And although the torpedo-shaped mine (pictured) was filled with concrete and did not contain any live ordnance, the four-strong bomb disposal team was forced to carry out a controlled explosion to avoid it causing a hazard to shipping.

The mine, a Royal Navy training device thought to date from the 1970s, was pulled up approximately one mile east of Inchkeith island on Monday, January 4, with the disposal of the device taking place the following day.

Chief Petty Officer Lee Yates, leader of the duty bomb squad, said: "It was pretty straightforward stuff. The boat had netted what the fisherman initially thought was a torpedo and we were called out to investigate.

"On further inspection it turned out to be an old practice mine - perfectly harmless, but still quite a sizeable object.

"The fisherman had originally landed the mine onto the deck of his boat - which is not something we would recommend - and we asked that he put it back into the water at a marked location in Gosford Bay, where we would inspect it."

Robert Thomson, 42, said: "The net got snagged around it on the sea bed and I wasn't able to haul it in. It was quite a struggle - maybe three quarters of an hour. At one point I thought we might have to cut the net.

"And then we had to bring it onto the boat to clear it from the net. It was only later that I found out these exercise mines are filled with concrete which explains why it was so heavy.

"Quite a lot of these things appear round here and we all know what to do. I called the Coastguard which then alerted the bomb disposal guys at Faslane."

The Northern Diving Group is part of the Fleet Diving Squadron which operates throughout northern England, Northern Ireland and Scotland. A four-strong team is on constant emergency standby every day of the year.

Lieutenant Commander Jason White, Northern Diving Group commanding officer, said: "The team has done a great job on this. In this case, whether the mine turned out to be live or not, the operation still involved diving in challenging and very cold conditions, to conduct a controlled explosion with a diver-placed charge.

"It is only straightforward because of the professionalism of the team and their experience.

"If anyone finds any historic ordnance on a beach or if a fishing boat does drag up such a thing, they should immediately report it to the Coastguard or police, who will then call us out.

"If it is on a beach we recommend that people do not tamper with it and keep well clear.

"If it is brought up in nets, we strongly advise that it should be reported - again to the Coastguard or police, who will then contact us.

"We can then have a conversation with the crew to find out their location and advise on where it is safe to place the object and in what depth of water. It's not advisable to bring the object back to port or to land it within the boat."

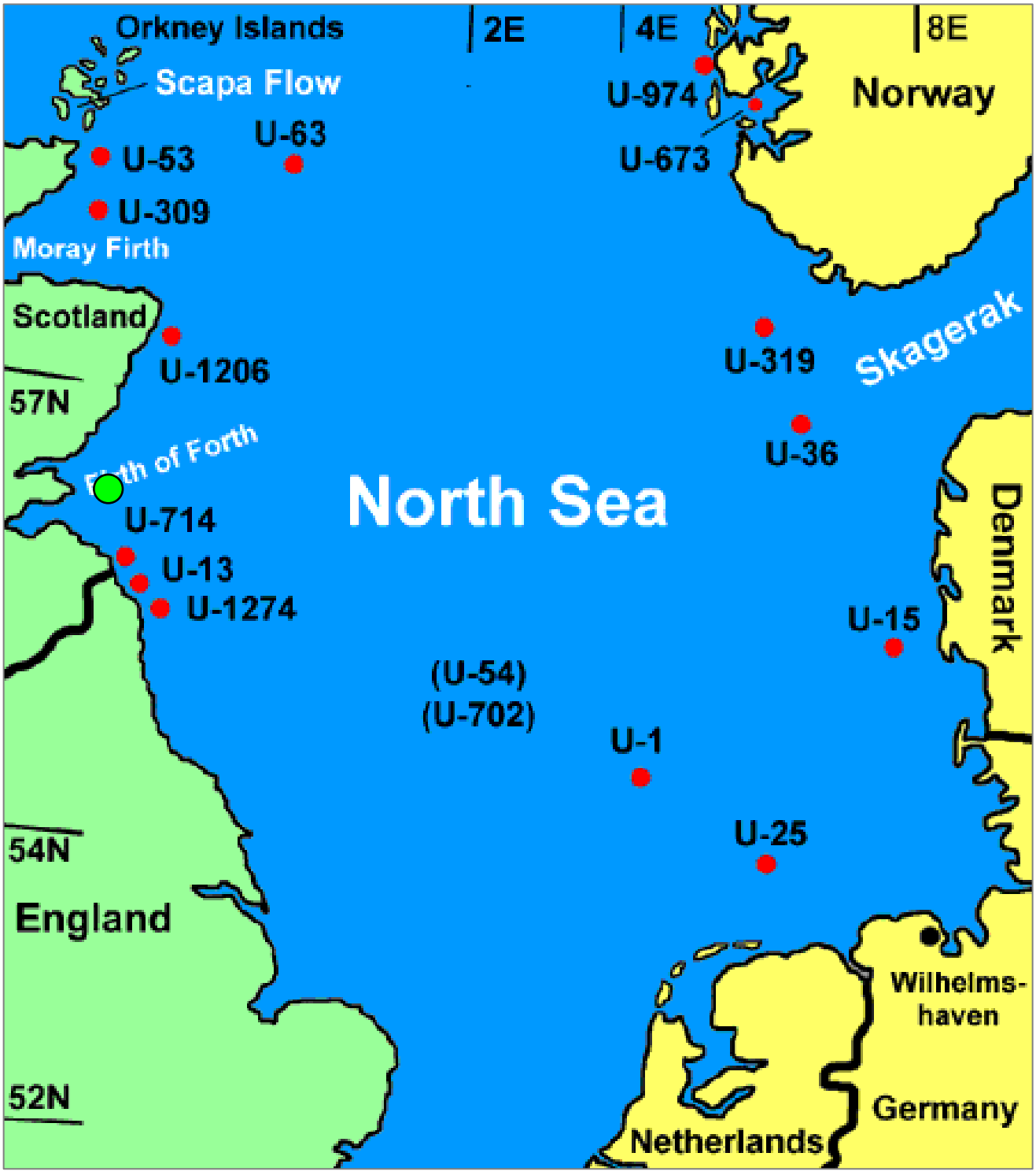
UXOINFO.com The Authority on Unexploded Ordnance Technology, News, and Information

Fishing Trawler Nets Unexploded Sea Mine

Posted At : October 13, 2009 8:13 AM | Posted By : Admin
Related Categories: WWII Era UXO Finds, WWII Era UXO Finds - Underwater Related

Port Seton, Scotland The captain of a fishing trawler brought up an old sea mine in his nets while fishing approximately three miles from Inchkeith island. The captain reportedly dragged the sea mine closer to shore before calling the Coastguard to report the find. The Coastguard responded with a Royal Navy EOD Dive team based out of Faslane Naval Base for technical support. EOD identified the sea mine as a live WWII era British Mark 9 bottom mine. EOD setup a counter charge to detonate the sea mine about a mile off shore from Port Seton. Following the safe detonation of the sea mine the Coastguard issued a reminder notice to mariners of potential for WWII era UXO in the area and instructed boaters to report any munitions finds to the Coastguard.

Annex F: Map of WWII U-Boat Losses in the North Sea



U-Boats listed in brackets are those known to have gone missing within the North Sea. Their exact locations are not known.

U-Boat Losses

Approximate Wind Farm Location

Report Reference:	Client:	
3165TA	Emu Limited	BAC TEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: http://www.uboat.net/maps/north_sea.htm

Annex G: Sea Mines

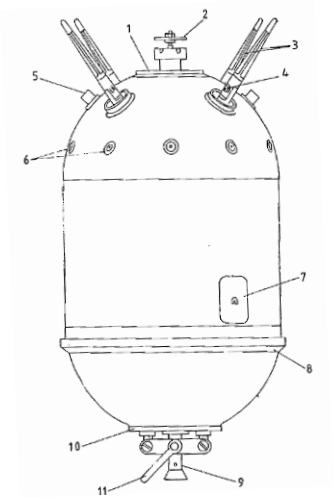
Contact Mine. Code EMA / EMB
British Designation: GU

Type:	Moored contact
Shape:	Ovoid
Dimensions:	EMA:1.6 x 0.8m EMB was smaller, 0.9m high
Charge Weight:	EMA:220kg EMB:150kg
Delivered by:	Surface craft
First Deployed:	1939
Remarks:	Could be moored in waters of 100 or 150m depth. Equipped with five Hertz Horns.

This photograph shows the base mooring unit and the mine

Contact Mine. Code BMC
British Designation: GM

Type:	Moored contact
Shape:	Cylindrical with hemispherical top and bottom
Dimensions:	1.0m high, 0.66m diameter
Charge Weight:	50kg
Delivered by:	Aircraft (float planes?)
First Deployed:	1943
Remarks:	Delivered without parachute. Equipped with four Hertz Horns.

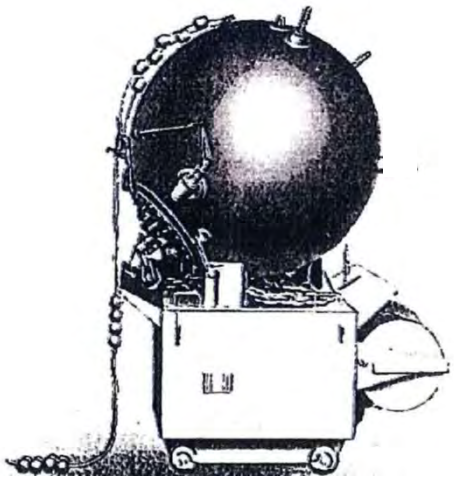


1. Cover plate carrying master switch
2. Horn release plate
3. Four push-rod horns
4. Hinge
5. Tapped bosses
6. Welded projections
7. Plate covering detonator pocket
8. Seating band for sinker
9. Mechanism plate
10. Mooring shackle

Contact Mine. Code EMC
British Designation: GY

Type:	Moored contact
Shape:	Spherical
Dimensions:	1.12m diameter
Charge Weight:	300kg
First deployed:	September 1939.
Delivered by:	Surface craft
Remarks:	Equipped with a seven Hertz Horns. There were a number of variants with different charge weights, horns and chain & snagline devices

An example pictured on sea-bed in 2008



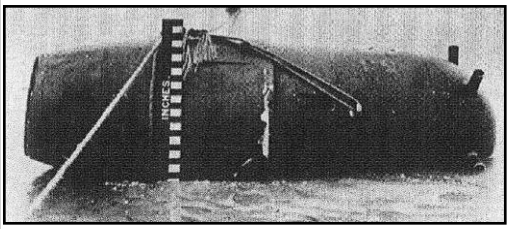
Contact Mine. Code KMA
British Designation: GJ

Type:	Moored contact
Shape:	Spherical
Dimensions:	0.38m diameter
Charge Weight:	12kg
Delivered by:	Surface craft
First deployed:	September 1939.
Remarks:	Equipped with a single Hertz Horn.
	This is a beach mine

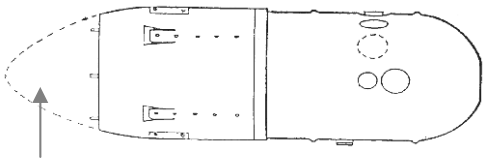
G

Influence Mine. Code KMA
British Designation: GA /GD

Type:	Ground, Magnetic
Dimensions:	Cylindrical, with hemispherical nose and rear parachute housing 1.8m long x 0.66m diameter
Charge Weight:	300kg
Delivered by:	Aircraft, retarded by parachute.
First deployed:	September 1939
Remarks:	The mine had 6 anti-rolling (not Herz) horns
	A later version, designated GD in Britain, was later also equipped with acoustic detectors. It did not have anti-rolling horns



GA Version

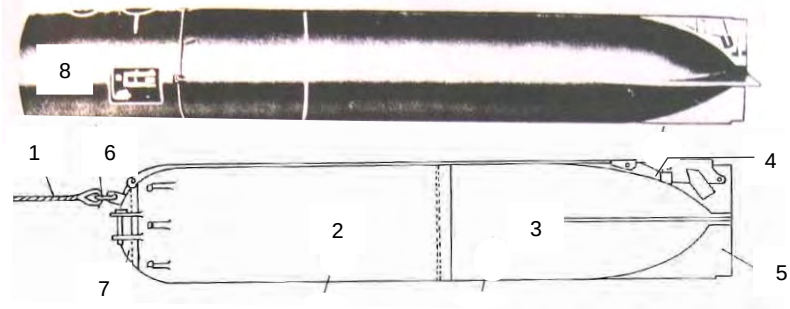


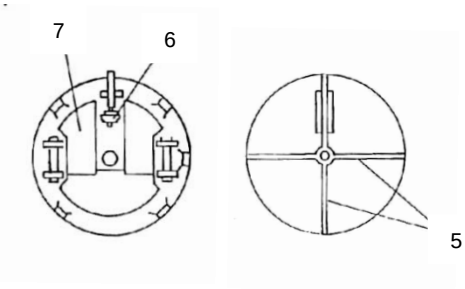
Parachute housing

Later GD Version

Influence Mine. Code LMF
British Designation: GT

Type:	Moored magnetic
Shape:	Cylindrical, finned
Dimensions:	0.53m diameter, 2.7m long
Charge Weight:	230kg
Delivered by:	Surface craft, U-boats and float planes
Deployment:	Proved unreliable and was withdrawn in 1941
Remarks:	Used at 150m or 270m depths





1 Mooring rope
2 Buoyancy chamber
3 Charge
4 Bowden wire
5 Fins
6 Mooring shackle
7 Mechanism, covered by light casing
8 Anchor system, before deployment

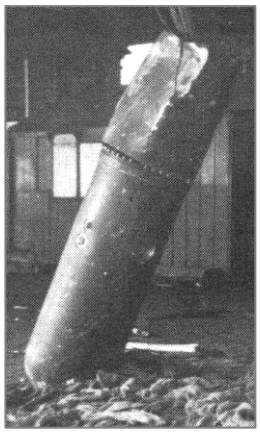
Report Reference:	Client:	
3165TA	Emu Limited	BACTEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: BACTEC International Limited and various historical sources

Influence Mine. Type LMB
British Designation: GB / GC

Type:	Ground Magnetic
Dimensions:	Cylindrical, with hemispherical nose and rear parachute housing Overall up to 3.2m long x 0.66m diameter
Charge Weight:	700kg
Delivered by:	Aircraft, retarded by parachute.
Remarks:	This is a larger version of the LMA mine.
First deployed:	September 1939
Remarks:	The earlier version had 6 anti-rolling (not Herz) horns A later version, designated GC in Britain, also used acoustic detectors. It did not have anti-rolling horns This mine was also dropped on land, when it used a an impact fuze, and was known colloquially as the "land mine"

GC "land-mine" part of the parachute visible

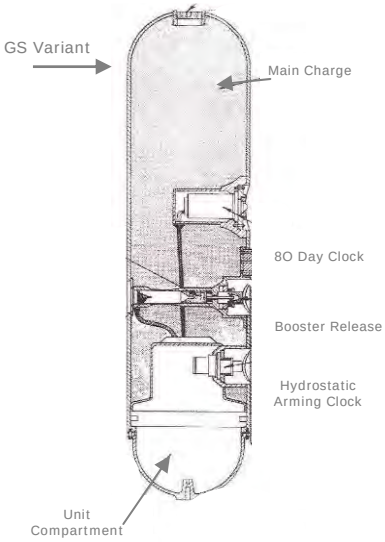


GC mine caught in fishing gear. Note the parachute housing still intact

Influence Mine. Type TMB
British Designation: GN & GS

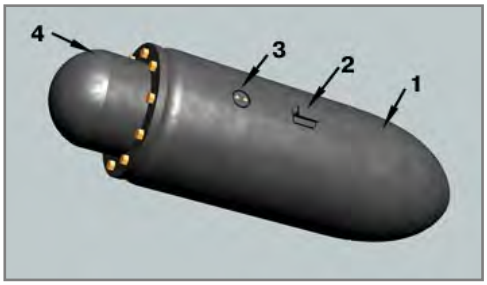
Type:	Ground Magnetic Influence Mine (later acoustic/magnetic)
Dimensions:	Cylindrical with hemispherical ends. GN 0.53m diameter 3.1m long GS 0.53m diameter, 2.3m long
Charge Weights:	GN 900kg. GS 420 to 560kg
Delivered by:	Submarines
Deployed:	1939
Remarks:	Shell made from aluminium alloy. Mine was normally laid in waters of 22m-27m.

GN Variant



"Mine-bomb". Type BM1000
British Designation: GG

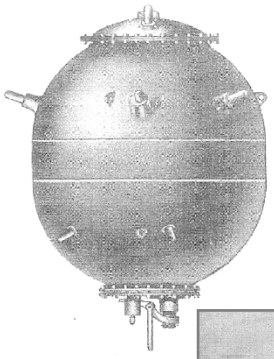
Type:	Magnetic and acoustic (later also pressure) and impact
Dimensions:	Cylindrical 0.66m diameter, ~2.0m long, depending on tail unit
Charge Weight:	725kg
Delivered by:	Aircraft
First deployed:	May 1941
Remarks:	Dropped as a conventional high explosive bomb normally without parachute. Unlike other mines designed by the German Navy this mine was designed by the Luftwaffe with the objective of allowing more accurate positioning than could be achieved with a parachute retarded mine. When deployed against shipping it could be used as an impact bomb or influence mine. Casing has low magnetic signature, manufactured from austenitic steel

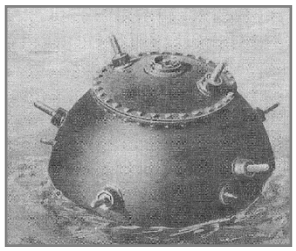


1. Casing 2. Suspension lug
3. bomb fuse 4. Influence fuzing mechanism

Contact Mine Mk XIV & XV

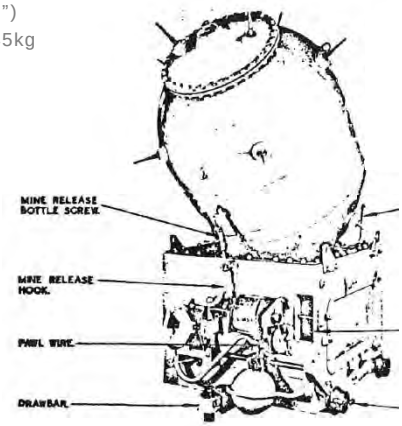
Type:	Moored contact
Shape:	Ovoid
Dimensions:	Diameter 1016mm (40”)
	Charge Weight: 145kg or 295kg
Initiation:	initially 11 Hertz horns, later switch horns
Delivered by:	Surface craft
Dating from:	1920’s
Remarks:	Designed for laying in 200 – 1000 fathoms (365 to 1830m) but also used as a general purpose mine in tidal waters



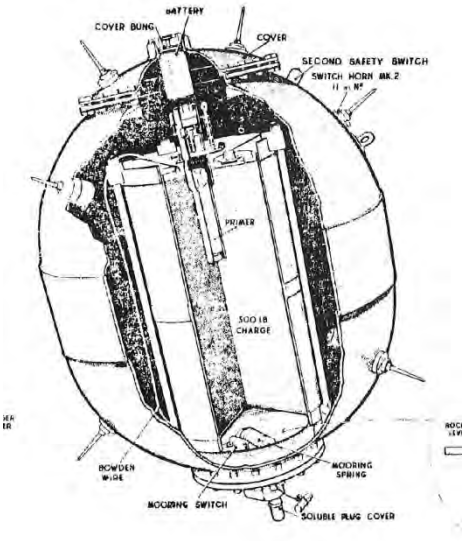


Contact Mine. Mk XVII

Type:	Moored contact
Shape:	Ovoid
Dimensions:	Diameter 1016mm (40”)
	Charge Weight: 145kg
Initiation:	11 switch horns
Delivered by:	Surface craft
Dating from:	early 1940’s
Remarks:	Designed for laying in 500 fathoms (925m) There was also an influence (acoustic) version

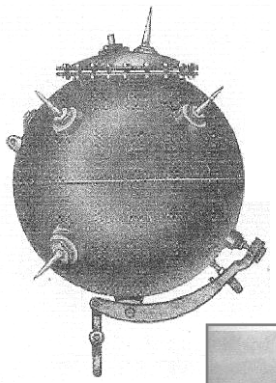


Mk XVII on sinker, before deployment



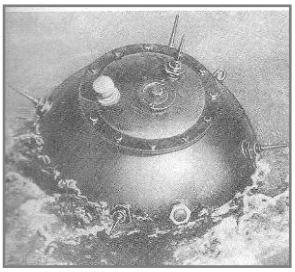
Contact Mine. Mk XIX & XIXS

Type:	Moored contact
Shape:	Spherical
Dimensions:	790mm (31”) diameter
Charge Weight:	45kg
Initiation:	initially 8 switch horns
Delivered by:	Surface vessel
Remarks:	Originally designed to be laid as anti-submarine barrage. The “S” variant was for use against shallow draft vessels



Left Mk XIXS

Below: Mk XIX



Report Reference:	Client:	
3165TA	Emu Limited	BACTEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: BACTEC International Limited and various historical sources

Annex H: Map Showing Minefields in Proximity to Site

North

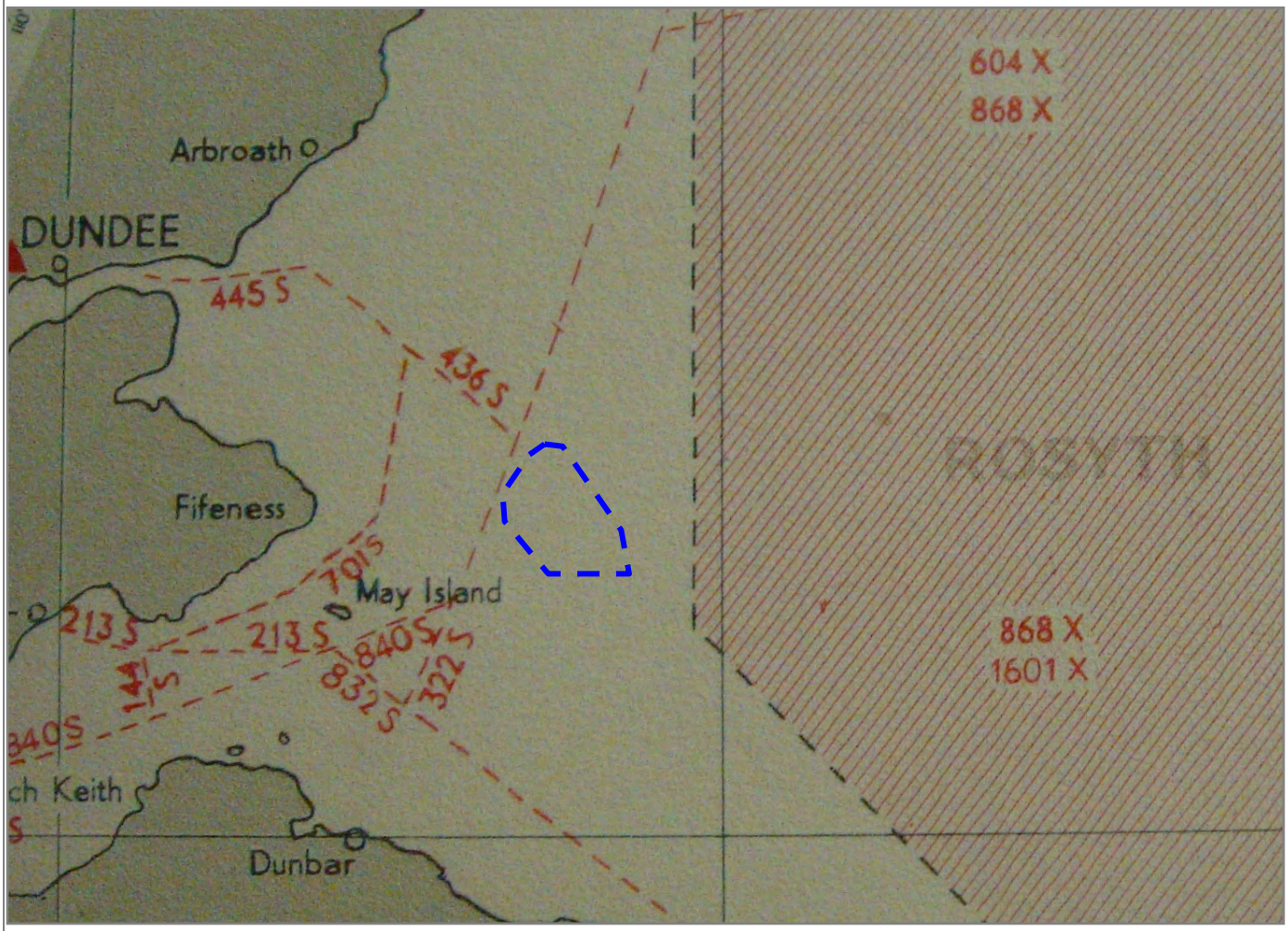
SERIAL Nº102

NOT TO BE USED FOR NAVIGATION

BRITISH ISLANDS AND ADJACENT WATERS

MINEFIELDS

INDEX CHART OF QZX, QZY, QZL, QZS MESSAGES AND CERTAIN NOTICES TO MARINERS



H.D. 352, issued weekly, contains a list of all Temporary and Preliminary Notices to Mariners, Special (5000 series) Notices to Mariners, and QZH and WZ Messages in force, affecting the area covered by this Chart and by Chart M. 06500[A]

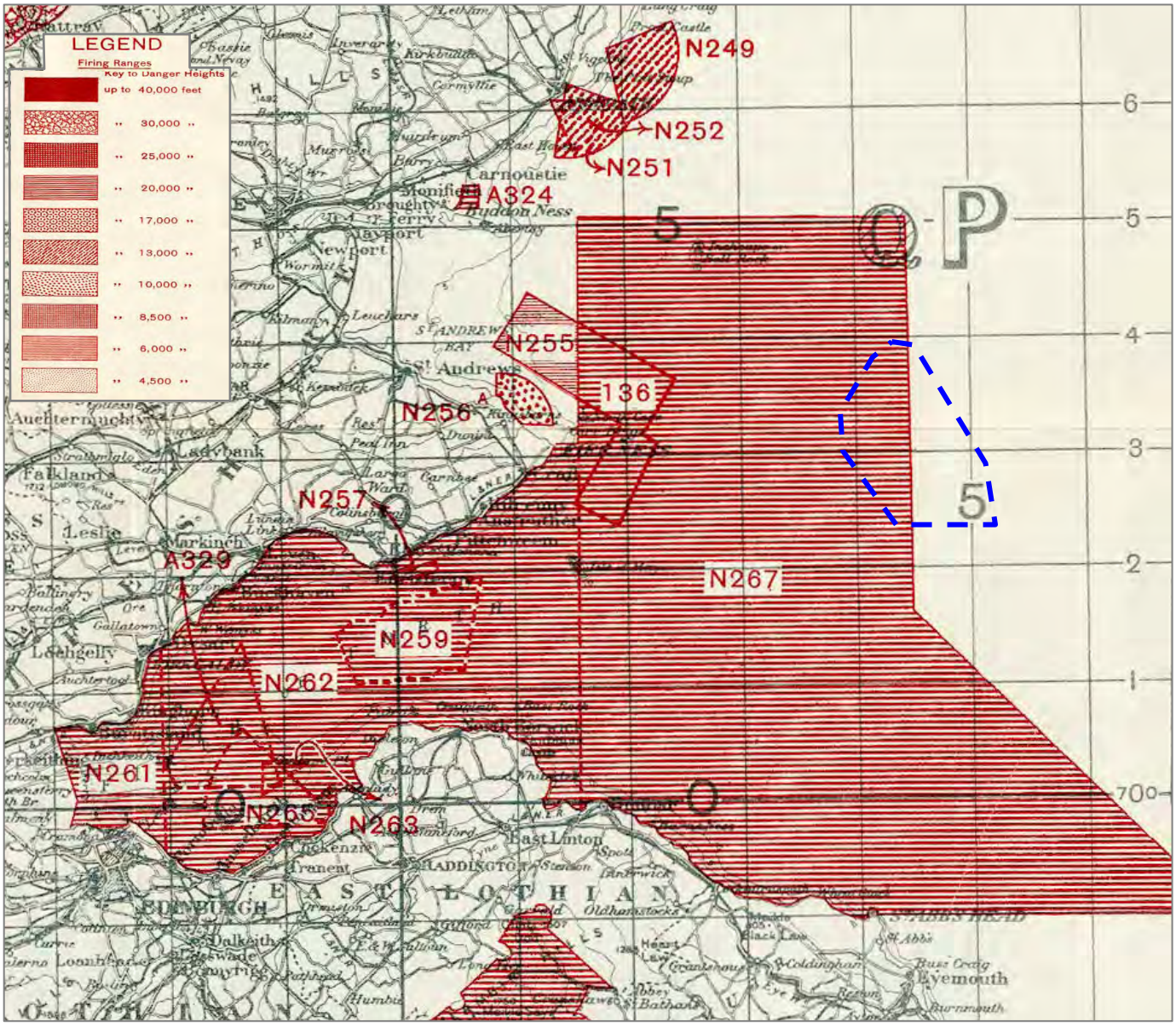
- British declared Areas
- British Minefields
- Enemy Minefields
- Searched Channels
- Standard Traffic Routes
- Naval Command Headquarters (C. in C.)
- Naval Sub-Command Headquarters (F.O.I.C.) or (N.O.I.C.)
- Naval Officer in Charge (N.O.I.C. unless otherwise shown)

Approximate Windfarm Boundary

Report Reference:	Client:	
3165TA	Emu Limited	BAC TEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: UK Hydrographic Office (UKHO)

Annex I: 1945 Army & Naval Armament Training Areas Map



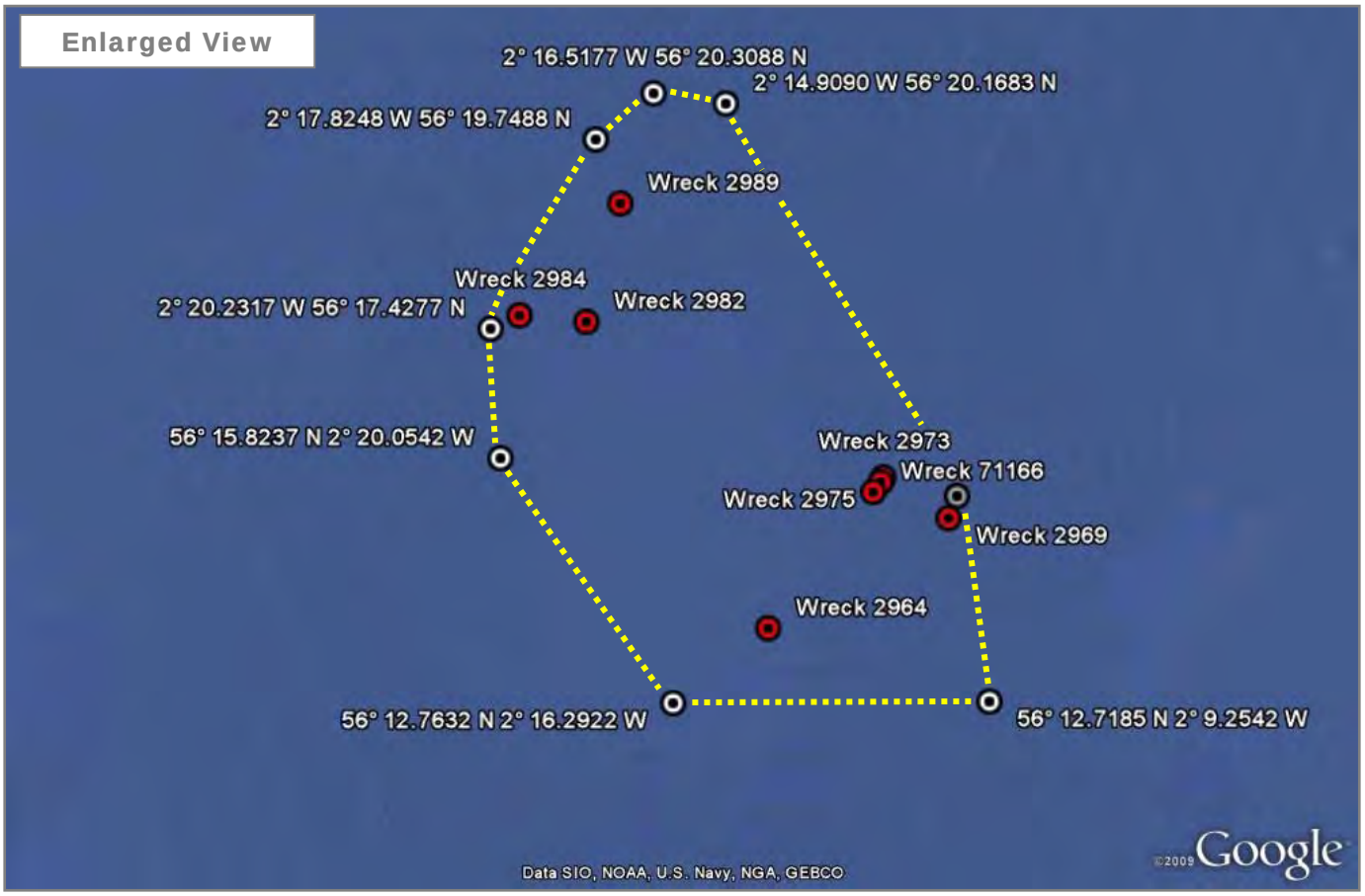
Approximate Wind farm Boundary

Report Reference:	Client:	
3165TA	Emu Limited	BAC TEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: National Archives

Annex J: Wreck Location Map & Data Information Sheets

North



Approximate Windfarm Boundary Approximate Wreck Locations Outlying Points

Report Reference:	Client:	
3165TA	Emu Limited	BAC TEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: Google Earth ™ Mapping Services

Latitude = 56 18'.953 N **Longitude** = 002 17'.297 W [EUT] **Square Number** = 52 **State** = LIVE

Wreck Number	2989	**Classification**	= Unclassified
Symbol	WK 44.0	**Largest Scale Chart**	= 175, 190
Charting Comments			
Old Number	005201299		
Category	Non-dangerous wreck		
WGS84 Position	**Latitude** = 56 18'.953 N	**Longitude** = 002 17'.297 W	
WGS84 Origin	Original		
Horizontal Datum	EUT ETRS 1989		
Position Method	Differential Global Positioning System		
Position Quality	Surveyed		
Position Accuracy	3.0		
Area at Largest Scale	No		
Depth	44.0 metres		
Drying Height			
Height			
General Depth	53 metres		
Vertical Datum	Approximate lowest astronomical tide		
Depth Method	Found by multi-beam		
Depth Quality	Least depth known		
Depth Accuracy			
Conspic Visual	NO	**Conspic Radar**	NO
Historic	NO	**Military** NO	**Existence Doubtful** NO
Non Sub Contact	NO		
Last Amended	19/06/2008		
Position Last Amended	19/06/2008		
Position Last	**Latitude** = 56 18'.967 N	**Longitude** = 002 17'.183 W	
Name	EINAR JARL (PROBABLY)		
Type	SS		
Flag	NORWEGIAN		
Dimensions	**Length** = 80.8 metres	**Beam** = 12.8 metres	**Draught** = 5.4 metres
Tonnage	1858 Gross		
Cargo	BALLAST		
Date Sunk	17/03/1941		
Sonar Dimensions	**Length** = 89.0 metres	**Width** = 21.0 metres	**Shadow Height** = 8.3 metres
Orientation	165/345		
Magnetic Anomaly	Strong		
Debris Field	CLOSE TO WK		
Scour	**Depth** = 1.5 metres	**Length** = 10.0 metres	**Orientation** =
Markers			
General Comments	INTACT, ON STBD SIDE, COLLAPSING, SCOUR SURROUNDS		

Circumstances of Loss

**BUILT 1921 WITH ONE BOILER, TRIPLE EXPANSION ENGINE, SINGLE SHAFT. PASSAGE HULL FOR HALIFAX. MINED. ONE MAN LOST. (WW2SL & SIBI).
**BUILT IN FREDRIKSTAD FOR DET NORDENFJELDSKE DAMPSKIPSSELSKAP, TRONDHEIM. STRUCK A MINE 9.75M E OF FIFE NESS AFTER LEAVING METHIL IN CONVOY EN86A. VESSEL WAS ABANDONED & SANK IN 10 MINUTES SE OF BELL ROCK, APPROX 3M FROM ISLE OF MAY. 23 OF 24 CREW SAVED. (B BAIRD, E-MAIL 1.8.08)

Surveying Details

**H3609/64 22.4.65 WK IN POSN 561848N, 021630W [OGB]. (HMS DUNCAN, 10.12.64). NCA.
**H2205/66 17.6.66 LEAST E/S DEPTH 28.5FMS. LENGTH 372FT, HEIGHT 17FT. MAX RANGE OF CONTACT 2000YDS. LYING 130DEGS/310DEGS. SLIGHT SCOUR SE OF WK. (HMS MALCOLM, 5.3.64). POSN BY DECCA. ACCEPT WK 25FMS. INS AS NDW PA. BR STD.
**30.7.68 SHOWN AS WK 28FMS. (AUTHORITY NOT STATED) BA 2182B.
**6.11.72 AMEND TO WK 25FMS. NE 1407.
**H4818/75 26.8.77 LOCATED 13.8.76 IN 561858N, 021711W [OGB] USING HIFIX [2 LOP]. LEAST E/S DEPTH 45 IN GEN DEPTH 54MTRS. SCOUR 1MTR. DCS3 HEIGHT 11.6MTRS. LENGTH 95MTRS. LYING 176/356DEGS. (HMS SHIPHAM, 7.12.76). AMEND TO WK 41MTRS. BR STD.
**5.9.96 POSITIVELY IDENTIFIED AS HMS ROCKINGHAM. WK IS COLLAPSED BUT INTACT, LYING ON ITS STARBOARD SIDE. STARBOARD PROP IS MISSING. HIGHEST POINT ARE THE BOWS WHICH STAND 10MTRS PROUD OF SEABED AND ARE COVERED WITH NETS. (D L ORMSTON, LTR DTD 15.8.96). NCA.

POSITIONS BELOW THIS POINT ARE IN DEGREES, MINUTES AND DECIMALS OF A MINUTE
**HH091/152/01 & SEP 2008/000080688 19.6.08 EXAM'D 31.12.07 IN 5618.953N, 0217.297W [WGD] USING DGPS. LEAST M/B DEPTH 44.8 IN GEN DEPTH 53.1MTRS. SCOUR 1.5MTRS DEEP SURROUNDS WK. LENGTH 89MTRS, WIDTH 21MTRS, HT 8.3MTRS. LIES 165/345 DEGS. STRONG MAGNETIC ANOMALY. LARGE, COLLAPSED WK. (GARDLINE HYDRO, HI 1152). AMEND WK 44MTRS IN REVISED POSN. BR STD.

**6.8.08 WRECK HAS BEEN DIVED & FOUND TO BE A FAIRLY LARGE BROKEN UP SS, WITH 1 PROPELLER & 1 LARGE BOILER, THEREFORE NOT HMS ROCKINGHAM AS PREVIOUSLY REPORTED. WK IS PROBABLY "EINAR JARL". PHOTO SUPPLIED. (B. BAIRD, E-MAIL DTD 31.7.08)
**7.8.08 FURTHER CONFIRMATION THAT THIS WRECK IS NOT HMS ROCKINGHAM. DIVED IN RECENT WEEKS, VESSEL HAS SINGLE PROPELLER WITH RUDDER BEHIND IT, ROCKINGHAM HAD TWIN OPEN STYLE PROPELLERS WITH RUDDER MIDSHIPS. STERN IS SCALLOP SHAPED WHERE AS ROCKINGHAM'S STERN WOULD HAVE BEEN POINTED. ONLY ONE BOILER WAS SEEN. WRECK IS POSSIBLY "EINAR JARL". (S HADDOW, E-MAIL DTD 7.8.08)

Latitude = 56 17'.587 N **Longitude** = 002 19'.584 W [EUT] **Square Number** = 52 **State** = LIVE

Wreck Number	2984	**Classification**	= Unclassified
Symbol	WK 46.0	**Largest Scale Chart**	= 175, 190
Charting Comments			
Old Number	005201238		
Category	Non-dangerous wreck		
WGS84 Position	**Latitude** = 56 17'.587 N	**Longitude** = 002 19'.584 W	
WGS84 Origin	Original		
Horizontal Datum	EUT ETRS 1989		
Position Method	Differential Global Positioning System		
Position Quality	Surveyed		
Position Accuracy	3.0		
Area at Largest Scale	No		
Depth	46.0 metres		
Drying Height			
Height			
General Depth	53 metres		
Vertical Datum	Lowest astronomical tide		
Depth Method	Found by multi-beam		
Depth Quality	Least depth known		
Depth Accuracy			
Conspic Visual	NO	**Conspic Radar**	NO
Historic	NO	**Military** NO	**Existence Doubtful** NO
Non Sub Contact	NO		
Last Amended	20/06/2008		
Position Last Amended	20/06/2008		
Position Last	**Latitude** = 56 17'.610 N	**Longitude** = 002 19'.480 W	
Name			
Type			
Flag			
Dimensions	**Length** =	**Beam** =	**Draught** =
Tonnage			
Cargo			
Date Sunk			
Sonar Dimensions	**Length** = 45.0 metres	**Width** = 10.0 metres	**Shadow Height** = 7.1 metres
Orientation	040/220		
Magnetic Anomaly	Moderate		
Debris Field	ITEM OF DEBRIS CLOSE TO PORT SIDE		
Scour	**Depth** = 1.5 metres	**Length** = 30.0 metres	**Orientation** = 020
Markers			
General Comments	INTACT, UPRIGHT, BOWS NE, SCOUR RUNS 020/200 DEGS		
Circumstances of Loss			

Surveying Details

**H454/67 21.3.77 WK 46.9MTRS IN GEN.DEPTH 53MTRS LOCATED IN 561736.6N, 021928.8W [OGB]. (HMS FOX, SIGNAL DTD 28.2.77). INS AS WK 25FMS (47MTRS). - NM 845/77.
**H4818/75 3.8.77 EXAM'D 24.2.77 IN 561735N, 021929W [OGB] USING HIFIX/6 [2 LOP]. LEAST E/S DEPTH 46.9 IN GEN.DEPTH 53MTRS. DCS3 HEIGHT 7MTRS. LENGTH 40MTRS. LYING 045/225 DEG. WK COMPLETE EXCEPT SMALL DETACHED PART CLOSE SW. (HMS FOX, HI 34A/77). NCA.

POSITIONS BELOW THIS POINT ARE IN DEGREES, MINUTES AND DECIMALS OF A MINUTE
**HH091/152/01 & SEP 2008/000080688 20.6.08 EXAM'D 31.12.07 IN 5617.587N, 0219.584W [WGD] USING DGPS. LEAST M/B DEPTH 46.6 IN GEN DEPTH 53.3MTRS. SCOUR 1.5MTRS DEEP EXTENDS 30MTRS ALONG 020/200 DEGS. LENGTH 45MTRS, WIDTH 10MTRS, HT 7.1MTRS. LIES 040/220 DEGS WITH BOWS NE. MODERATE MAGNETIC ANOMALY. UPRIGHT AND INTACT. SCOURING MAINLY AT THE BOW. ITEM OF DEBRIS LIES CLOSE TO PORT SIDE MIDSHIPS. (GARDLINE HYDRO, HI 1152). AMEND WK 46MTRS IN REVISED POSN. BR STD.

Latitude = 56 15'.513 N **Longitude** = 002 11'.533 W [EUT] **Square Number** = 52 **State** = LIVE

Wreck Number	2973	**Classification**	= Unclassified
Symbol	WK 43.0	**Largest Scale Chart**	= 175, 190
Charting Comments	SHOWN IN CONJUNCTION WITH WK CLOSE S		
Old Number	005201123		
Category	Non-dangerous wreck		
WGS84 Position	**Latitude** = 56 15'.513 N	**Longitude** = 002 11'.533 W	
WGS84 Origin	Original		
Horizontal Datum	EUT ETRS 1989		
Position Method	Differential Global Positioning System		
Position Quality	Surveyed		
Position Accuracy	3.0		
Area at Largest Scale	No		
Depth	43.0 metres		
Drying Height			
Height			
General Depth	50 metres		
Vertical Datum	Lowest astronomical tide		
Depth Method	Found by multi-beam		
Depth Quality	Least depth known		
Depth Accuracy			
Conspic Visual	NO	**Conspic Radar**	NO
Historic	NO	**Military** NO	**Existence Doubtful** NO
Non Sub Contact	NO		
Last Amended	19/06/2008		
Position Last Amended	19/06/2008		
Position Last	**Latitude** = 56 15'.467 N	**Longitude** = 002 11'.583 W	
Name	HMSM K4 (PROBABLY)		
Type	SUBMARINE		
Flag	BRITISH		
Dimensions	**Length** = 101.8 metres	**Beam** = 8.2 metres	**Draught** =
Tonnage	2650 Displacement		
Cargo			
Date Sunk	31/01/1918		
Sonar Dimensions	**Length** = 89.0 metres	**Width** = 15.0 metres	**Shadow Height** = 6.9 metres
Orientation	040/220		
Magnetic Anomaly	Strong		
Debris Field	NIL		
Scour	**Depth** = 1.0 metres	**Length** = 3.0 metres	**Orientation** =
Markers			
General Comments	UPRIGHT, INTACT, DEEP RENT AFT OF TOWER, SCOUR AT BOW/STERN		

Circumstances of Loss

**SANK FOLLOWING A COLLISION WITH BRITISH SUBMARINE K6.

Surveying Details

**SANK OFF MAY ISLAND. (COLLEDGE).
**H2905/62 14.8.62 WK LOCATED IN 561521N, 021141W USING 2 RANGE DECCA. LEAST E/S DEPTH 152FT IN GEN DEPTH 169FT. (HMS SCOTT, HI 14/62). INS AS NDW. - NM 2746/62.
**30.7.68 AMEND TO WK 25FMS. NE 1407.
**22.8.77 AMEND TO WK 46MTRS. NC 175.
**H1310/86/14 12.6.86 LOCAL DIVERS STATE WK OF K4 LIES CLOSE TO THAT OF K17 AT A DEPTH OF 46MTRS ABOUT 10M E OF MAY ISLAND. (LT SCC) A KNOX, RNR, 2.6.86).
**24.6.94 LOCATED IN 561528N, 021135W [WGD]. DEPTH 48 IN GEN DEPTH 56MTRS. NO SCOUR. COMPLETE HULL, BOWS TO STERN. UPRIGHT. PROPELLORS BURIED. DEEP RENT ACROSS HULL AFT OF REAR GUN MOUNT. CONNING TOWER FORCED OVER TO STBD BUT STILL ATTACHED AT 90 DEGS. FWD PERISCOPE DAMAGED. NET ON GUN AND CONNING TOWER. (P P G WADSWORTH).

POSITIONS BELOW THIS POINT ARE IN DEGREES, MINUTES AND DECIMALS OF A MINUTE
**20.10.03 RECORD REVIEWED. AMEND POSN TO 5615.467N, 0211.583W [WGD]. BR STD.
**29.10.07 POSN 5615.456N, 0211.594W [WGD]. (B BAIRD VIA K HEATH, TELECON 26.10.07). SHOWN IN CONJUNCTION WITH K17 [SEE 2975] CLOSE S ON BA 175 [SEP '05 EDN]. NCA.
**HH091/152/01 6 SEP 2008/000075801 19.6.08 EXAM'D 11.2.08 IN 5615.513N, 0211.533W [WGD] USING DGPS. LEAST M/B DEPTH 43.8 GEN DEPTH 50.8MTRS. SCOUR 1MTR DEEP EXTENDS 3MTRS FROM BOW AND STERN. LENGTH 89MTRS, WIDTH 15MTRS, HT 6.9MTRS. LIES 040/220 DEGS. STRONG MAGNETIC ANOMALY. INTACT. (GARDLINE HYDRO, HI 1152). AMEND WK 43MTRS IN REVISED POSN. BR STD.

Latitude = 56 15'.453 N **Longitude** = 002 11'.593 W [EUT] **Square Number** = 52 **State** = LIVE

Wreck Number	2975	**Classification**	= Unclassified
Symbol	WK 41.0	**Largest Scale Chart**	= 175, 190
Charting Comments	DANGER LINE COVERS [2793] CLOSE N		
Old Number	005201147		
Category	Non-dangerous wreck		
WGS84 Position	**Latitude** = 56 15'.453 N	**Longitude** = 002 11'.593 W	
WGS84 Origin	Original		
Horizontal Datum	EUT ETRS 1989		
Position Method	Differential Global Positioning System		
Position Quality	Surveyed		
Position Accuracy	3.0		
Area at Largest Scale	No		
Depth	41.0 metres		
Drying Height			
Height			
General Depth	49 metres		
Vertical Datum	Lowest astronomical tide		
Depth Method	Found by multi-beam		
Depth Quality	Least depth known		
Depth Accuracy			
Conspic Visual	NO	**Conspic Radar**	NO
Historic	NO	**Military** NO	**Existence Doubtful** NO
Non Sub Contact	NO		
Last Amended	19/06/2008		
Position Last Amended	19/06/2008		
Position Last	**Latitude** = 56 15'.436 N	**Longitude** = 002 11'.636 W	
Name	HMSM K17		
Type	SUBMARINE		
Flag	BRITISH		
Dimensions	**Length** = 101.8 metres	**Beam** = 8.2 metres	**Draught** =
Tonnage	2650 Displacement		
Cargo			
Date Sunk	31/01/1918		
Sonar Dimensions	**Length** = 100.0 metres	**Width** = 10.0 metres	**Shadow Height** = 8.3 metres
Orientation	130/310		
Magnetic Anomaly	Strong		
Debris Field	NIL		
Scour	**Depth** = 1.0 metres	**Length** = 5.0 metres	**Orientation** = 130
Markers			
General Comments	UPRIGHT, BOW LIES ON PORT SIDE		

Circumstances of Loss

**BUILT IN 1917 BY VICKERS, BARROW-IN-FURNESS. TWO BOILERS, TWIN SHAFT. PASSAGE ROSYTH FOR NIGHT EXERCISES AND RETURN. RAMMED AND SUNK BY HMS FEARLESS. (SIBI).

Surveying Details

**POSN 561530N, 020930W, APPROX. (FEARLESS- ADM 53-41566, PUBLIC RECORDS OFFICE).
**H2905/62 14.8.62 WK LOCATED IN 561532N, 021124W USING 2 RANGE DECCA. LEAST E/S DEPTH 152FT IN GEN DEPTH 176FT. (HMS SCOTT, HI 14/62). INS AS NDW. - NM 2748/62.
**30.7.68 AMEND TO WK 25FMS. BR STD.
**22.8.77 AMEND TO WK 46MTRS. NC 175.
**H1310/86/14 12.6.86 LOCAL DIVERS STATE WK OF K17 LIES CLOSE TO THAT OF K4 AT A DEPTH OF 46MTRS ABOUT 10M E OF MAY ISLAND. (LT (SCC) A KNOX RNR, 2.6.86).
**H1310/87/13 18.3.87 POSNS 561520N, 021230W & 561600N, 021000W REFERRED TO IN DAILY LOGS FOR 8.5.1918 OF HMS URSULA & AIRSHIP NS3, RESPECTIVELY, FOR THE WRECK OF K17. (LT (SCC) A KNOX, 7.3.87).
**24.6.94 DIVED IN 561531N, 021131W (STERN); 561520N, 021147W (BOWS) [WGD]. STERN HAS DEPTH OF 52 IN GEN DEPTH 56MTRS. SCOUR DEPTH 58MTRS. LIES E/W, UPRIGHT. PROPELLORS PROTRUDING FROM SEABED. STERN, AFT GUN, CASING, OPEN VENTS AND FUNNELS INTACT. CONNING TOWER NOT SEEN. HULL SLICED OFF FWD OF CONNING TOWER SITE. IMPACT WAS FROM STBD. OIL IS PRESENT ON SURFACE AT THIS SITE. BOW HAS DEPTH OF 48MTRS. NO SCOUR. LIES ON PORT SIDE. COMPLETE BOW SECTION AFT TO OFFICERS' QUARTERS CLEAN CUT AT THIS POINT. (P P G WADSWORTH). NCA.

POSITIONS BELOW THIS POINT ARE IN DEGREES, MINUTES AND DECIMALS OF A MINUTE
**20.10.03 RECORD REVIEWED. AMEND POSN TO 5615.430N, 0211.556W [WGD]. BR STD.
**29.10.07 MAIN SECTION IN 5615.528N, 0211.494W [WGD], BOW IN 5615.345N, 0211.778W [WGD]. (B BAIRD VIA K HEATH TELECON 26.10.07) NCA, SHOWN IN CORRECT CENTRAL POSN 5615.436N, 0211.636W [EUT] ON BA 175 [SEP '05 EDN].
**SEP 2008/000005954 18.1.08 WK LOCATED IN 5615.458N, 0211.601W [WGD] USING DGPS. GEN DEPTH 50.1MTRS. LENGTH 97MTRS, WIDTH 10MTRS, HT 7MTRS. LIES 120/300 DEGS. (GARDLINE, HN FOR HI 1152). WAIT SURVEY DATA. NCA.
**HH091/152/01 & SEP 2008/000075801 19.6.08 EXAM'D 11.2.08 IN 5615.453N, 0211.593W [WGD] USING DGPS. LEAST M/B DEPTH 41.6 IN GEN DEPTH 49.9MTRS. SCOUR 1MTR DEEP EXTENDS 5MTRS TOWARDS 130 DEGS FROM SE END. LENGTH 100MTRS, WIDTH 10MTRS, HT 8.3MTRS. LIES 130/310 DEGS. STRONG MAGNETIC ANOMALY. MAINLY INTACT. (GARDLINE, HI 1153). AMEND WK 41MTRS IN REVISED POSN. BR STD. - PNM 5771/08.
**SEP 2008000097474 6.1.09 RE-ISSUED AS PNM 250/09.
**SEP 2009000049721 13.7.09 RE-ISSUED AS PNM 3955/09.
**SEP 2009000096591 6.8.09 RE-ISSUED AS PNM 4532/09.
**SEP 2009000128360 28.9.09 RE-ISSUED AS PNM 5502/09.
**SEP 2010000027978 16.3.10 RE-ISSUED AS PNM 1557/10.

Latitude = 56 15'.335 N **Longitude** = 002 11'.764 W [EUT] **Square Number** = 52 **State** = LIVE

Wreck Number	71166	**Classification**	= Unclassified
Symbol	WK 45.0	**Largest Scale Chart**	= 175, 190
Charting Comments			
Old Number			
Category	Non-dangerous wreck		
WGS84 Position	**Latitude** = 56 15'.335 N	**Longitude** = 002 11'.764 W	
WGS84 Origin	Original		
Horizontal Datum	EUT ETRS 1989		
Position Method	Differential Global Positioning System		
Position Quality	Surveyed		
Position Accuracy	3.0		
Area at Largest Scale	No		
Depth	45.0 metres		
Drying Height			
Height			
General Depth	49 metres		
Vertical Datum	Lowest astronomical tide		
Depth Method	Found by multi-beam		
Depth Quality	Least depth known		
Depth Accuracy			
Conspic Visual	NO	**Conspic Radar**	NO
Historic	NO	**Military** NO	**Existence Doubtful** NO
Non Sub Contact	NO		
Last Amended	18/06/2008		
Position Last Amended	18/06/2008		
Position Last	**Latitude** = 56 15'.335 N	**Longitude** = 002 11'.765 W	
Name			
Type			
Flag			
Dimensions	**Length** =	**Beam** =	**Draught** =
Tonnage			
Cargo			
Date Sunk			
Sonar Dimensions	**Length** = 24.0 metres	**Width** = 10.0 metres	**Shadow Height** = 4.0 metres
Orientation	030/210		
Magnetic Anomaly	Moderate		
Debris Field	NIL		
Scour	**Depth** = 0.5 metres	**Length** =	**Orientation** =
Markers			
General Comments	SMALL WK, ?PART OF [2973] OR [2975]		

Circumstances of Loss

Surveying Details

**SEP 2008/000005954 18.1.08 WK LOCATED IN 5615.335N, 0211.765W [WGD] USING DGPS. GEN DEPTH 49.5MTRS. LENGTH 20MTRS, WIDTH 6MTRS, HT 4MTRS. LIES 035/215 DEGS. (GARDLINE, HN FOR HI 1152). INS AS WK 45MTRS. BR STD.
**HH091/152/01 & SEP 2008/000075801 18.6.08 EXAM'D 11.2.08 IN 5615.335N, 0211.764W [WGD] USING DGPS. LEAST M/B DEPTH 45.6 IN GEN DEPTH 49.6MTRS. SCOUR 0.5MTR DEEP. LENGTH 24MTRS, WIDTH 10MTRS, HT 4.0MTRS. LIES 030/210 DEGS, MODERATE MAGNETIC ANOMALY. SMALL WK. ?PART OF [2973] OR [2975]. (GARDLINE HYDRO, HI 1152). RETAIN WK 45MTRS IN REVISED POSN BR STD.

Latitude = 56 15'.000 N **Longitude** = 002 10'.000 W [OGB] **Square Number** = 52 **State** = LIVE

Wreck Number	2969	**Classification**	= Unclassified
Symbol		**Largest Scale Chart**	= 175, 190
Charting Comments			
Old Number	005201068		
Category	Undefined		
WGS84 Position	**Latitude** = 56 14'.995 N	**Longitude**	= 002 10'.095 W
WGS84 Origin	3-D Cartesian Shift (BW)		
Horizontal Datum	OGB ORDNANCE SURVEY OF GREAT BRITAIN (1936)		
Position Method			
Position Quality	Approximate		
Position Accuracy			
Area at Largest Scale	No		
Depth			
Drying Height			
Height			
General Depth	51 metres		
Vertical Datum	Lowest astronomical tide		
Depth Method			
Depth Quality	Depth unknown		
Depth Accuracy			
Conspic Visual	NO	**Conspic Radar**	NO
Historic	NO	**Military** NO	**Existence Doubtful** NO
Non Sub Contact	YES		
Last Amended	20/10/2003		
Position Last Amended	20/10/2003		
Position Last	**Latitude** = 56 15'.000 N	**Longitude**	= 002 10'.000 W
Name			
Type	NON-SUB CONTACT		
Flag			
Dimensions	**Length** =	**Beam** =	**Draught** =
Tonnage			
Cargo			
Date Sunk			
Sonar Dimensions	**Length** =	**Width** =	**Shadow Height** =
Orientation			
Magnetic Anomaly			
Debris Field			
Scour	**Depth** =	**Length** =	**Orientation** =
Markers			
General Comments			

Circumstances of Loss

Surveying Details

**H0276/39 NSC IN POSN 561500N, 021000W. (HMS SOMALI, HN 19,12.39).

**H0276/39 9.5.60 GOOD A/S CONTACT. SMALL PATCH OF OIL ON SURFACE NEARBY. E/S GAVE FAINT INDICATION OF OBJECT ON BOTTOM. CONSIDERED WK. (HMS SOMALI, 23.12.39).

Latitude = 56 13'.675 N **Longitude** = 002 14'.056 W [OGB] **Square Number** = 52 **State** = LIVE

Wreck Number	2964	**Classification**	= Unclassified
Symbol	WK 43.0	**Largest Scale Chart**	= 175, 190
Charting Comments			
Old Number	005201019		
Category	Non-dangerous wreck		
WGS84 Position	**Latitude** = 56 13'.670 N	**Longitude** = 002 14'.150 W	
WGS84 Origin	Original		
Horizontal Datum	OGB ORDNANCE SURVEY OF GREAT BRITAIN (1936)		
Position Method	Global Positioning System		
Position Quality	Precisely known		
Position Accuracy	15.0		
Area at Largest Scale	No		
Depth	43.0 metres		
Drying Height			
Height			
General Depth	51 metres		
Vertical Datum	Lowest astronomical tide		
Depth Method	Found by echo-sounder		
Depth Quality	Least depth known		
Depth Accuracy			
Conspic Visual	NO	**Conspic Radar**	NO
Historic	NO	**Military** NO	**Existence Doubtful** NO
Non Sub Contact	NO		
Last Amended	28/05/2002		
Position Last Amended	28/05/2002		
Position Last	**Latitude** = 56 13'.667 N	**Longitude** = 002 14'.067 W	
Name	BALLOCHBUIE (POSSIBLY)		
Type	SS		
Flag	BRITISH		
Dimensions	**Length** = 61.0 metres	**Beam** = 9.5 metres	**Draught** = 3.8 metres
Tonnage	921 Gross		
Cargo	BALLAST		
Date Sunk	20/04/1917		
Sonar Dimensions	**Length** = 60.0 metres	**Width** = 8.0 metres	**Shadow Height** = 5.9 metres
Orientation	135/315		
Magnetic Anomaly			
Debris Field	NIL		
Scour	**Depth** =	**Length** =	**Orientation** =
Markers			
General Comments	UPRIGHT & INTACT, COLLAPSED, BOWS SE, WIDTH BY DIVER		

Circumstances of Loss

**BUILT IN 1905 BY JOHN DUTHIE SB CO, ABERDEEN. OWNED AT TIME OF LOSS BY THE ABERDEEN LIME CO LTD. ONE BOILER, TRIPLE EXPANSION ENGINE OF 153HP FOR 9.5 KNOTS, SINGLE SHAFT. MACHINERY BY J ABERNETHY & CO, ABERDEEN. PASSAGE ABERDEEN FOR SUNDERLAND. IN BALLAST. TORPEDOED BY UC-41. THREE MEN LOST.

Surveying Details

**20.4.17 POSN 561300N, 021800W.
**H8203/19 7 MILES E FROM MAY ISLAND. (WW1 SL).
**H2905/62 14.8.62 WK IN 561341N, 021400W. LEAST E/S DEPTH 150FT IN 178FT. (HMS SCOTT, MAY 1962). INS AS NDW. - NM 2748/62.
**30.7.68 AMEND TO 25FMS. NE 1407.
**H4818/75 3.8.77 EXAM'D 12.3.77 IN 561340N, 021404W [OGB] USING HIFIX [2 LOP]. LEAST DEPTH 43.6MTRS IN GEN DEPTH 51MTRS. DCS3 HT 5.9MTRS. LENGTH 60MTRS. LYING 065/245DEG. ABOUT 700MTRS NW OF 41.8MTR PEAK. APPEARS UPRIGHT & INTACT. (HMS FOX, HI 34A/77). AMEND TO WK 43MTRS. BR STD.

POSITIONS BELOW THIS POINT ARE IN DEGREES, MINUTES AND DECIMALS OF A MINUTE
**HH100/351/18 28.5.02 DIVED IN 5613.67N, 0214.15W [WGD] USING GPS. STANDS 7MTRS HIGH BY E/S. LENGTH 55MTRS, WIDTH 8MTRS. LIES 135/345 DEGS WITH BOWS SE. S CARGO VESSEL WITH TWO HOLDS FWD & 2 HOLDS AFT. FOUR BLADED PROP. POSSIBLY A COLLIER. NOT MUCH REMAINS OF WHEELHOUSE, MOSTLY COLLAPSED BACK INTO THE BOILER SECTION. STERN DAMAGED AND APPARENT REASON FOR LOSS. NO DEBRIS. SEABED SAND & GRAVEL. (D GREIG). AMEND POSN. BR STD.

Latitude = 56 17'.495 N **Longitude** = 002 18'.094 W [EUT] **Square Number** = 52 **State** = DEAD

Wreck Number	2982	**Classification**	= Unclassified
Symbol	WK USC PA 35.0	**Largest Scale Chart**	= 175, 190
Charting Comments			
Old Number	005201214		
Category	Non-dangerous wreck		
WGS84 Position	**Latitude** = 56 17'.495 N	**Longitude** = 002 18'.094 W	
WGS84 Origin	Block Shift		
Horizontal Datum	EUT ETRS 1989		
Position Method			
Position Quality	Approximate		
Position Accuracy			
Area at Largest Scale	No		
Depth	35.0 metres		
Drying Height			
Height			
General Depth	50 metres		
Vertical Datum	Lowest astronomical tide		
Depth Method			
Depth Quality	Least depth unknown, safe clearance at value shown		
Depth Accuracy			
Conspic Visual	NO	**Conspic Radar**	NO
Historic	NO	**Military** NO	**Existence Doubtful** NO
Non Sub Contact	NO		
Last Amended	18/04/2005		
Position Last Amended	18/04/2005		
Position Last	**Latitude** = 56 17'.500 N	**Longitude** = 002 18'.000 W	
Name	EINAR JARL		
Type	SS		
Flag	NORWEGIAN		
Dimensions	**Length** = 80.8 metres	**Beam** = 12.8 metres	**Draught** = 5.4 metres
Tonnage	1858 Gross		
Cargo	BALLAST		
Date Sunk	17/03/1941		
Sonar Dimensions	**Length** =	**Width** =	**Shadow Height** =
Orientation			
Magnetic Anomaly			
Debris Field			
Scour	**Depth** =	**Length** =	**Orientation** =
Markers			
General Comments			

Circumstances of Loss

**BUILT IN 1921. ONE BOILER, TRIPLE EXPANSION ENGINE, SINGLE SHAFT. PASSAGE HULL FOR HALIFAX. MINED. ONE MAN LOST. (WW2SL & SIBI).

Surveying Details

**H0423/41 POSN 561730N, 021800W.
**H066/41 & H01166/41 15.8.41 INS AS NDWPA. - NM 1930/41.
**H(W)0202/50 24.6.55 CONFIRMED BY A/S. (HMS WELCOME).
**H4818/75 25.8.77 NOT LOCATED. (HMS SHIPHAM, HI 42/76). AMEND TO WK USC PA 28MTRS. BR STD.

POSITIONS BELOW THIS POINT ARE IN DEGREES, MINUTES AND DECIMALS OF A MINUTE

**H4818/75 18.4.05 SHOWN AS WK USC PA 35MTRS IN 5617.495N, 0218.094W [EUT] ON BA 175 & 190 [DEC'04 EDNS], BA 1407 [OCT'02 EDN], & BA 2182B [AUG'03EDN]. RECORD REVIEWED, ORIGINAL REPORT OF SURVEY BY HMS SHIPHAM HI 42/76 SEEN, WK DEFINITELY NOT LOCATED. DELETE. BR STD.
**HH091/152/01 & SEP 2008/000068447 16.6.08 NOT LOCATED BY M/B. (GARDLINE HYDRO, HI 1152). NCA.

Annex K: WWII Torpedoes

Torpedo against the 24” pipe

View of front of torpedo showing collapse of outer case and partial separation of warhead from pressure vessel

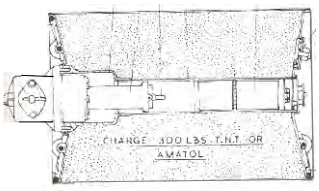
Preparing a torpedo aboard HMS Vanoc in August 1941
This is probably a Mark II or Mark IV torpedo

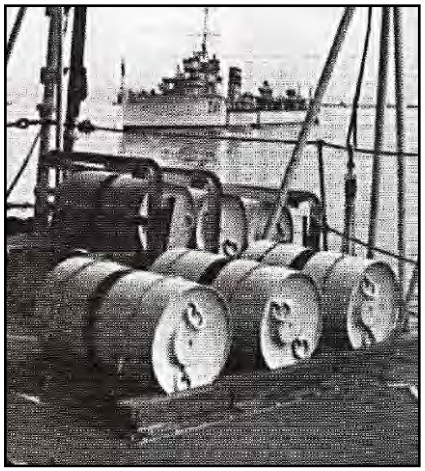
21" (53.3 cm) Mark V torpedo being hoisted aboard HMS York

Annex L: British Anti-Submarine Weapons

Depth Charge. Mk VII

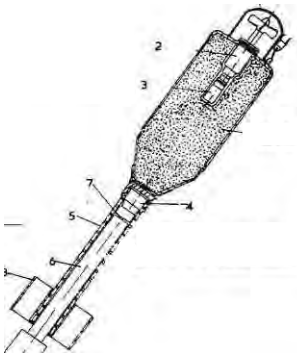
Type:	Standard
Shape:	Cylindrical, drum shaped
Dimensions:	700mm long, 450mm diameter
Charge Weight:	132kg
Delivered by:	Surface vessel
First Deployed:	1939
Remarks:	The Mk VII was little changed from the WWI Type D. Initially the depth charge was simply dropped from the attacking vessel but from late 1940 /early 1941 a launcher was used which projected the weapon some 35m





"Hedgehog" Spigot Mortar

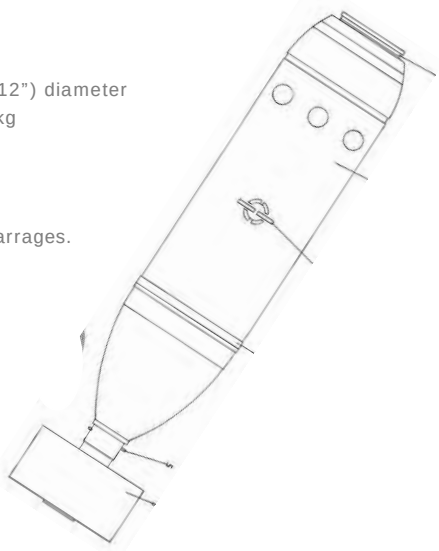
Dimensions:	Diameter 178mm (7") diameter Charge Weight: 16kg
Initiation:	Contact fuze
Delivered by:	Surface craft
Dating from:	1942
Remarks:	Fired in 24 mortar barrages. The contact fuze was only activated if it struck a submarine

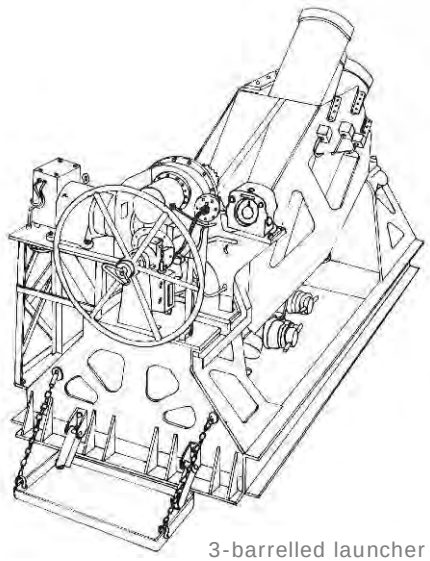


24 Mortar launcher

"Squid" Mortar

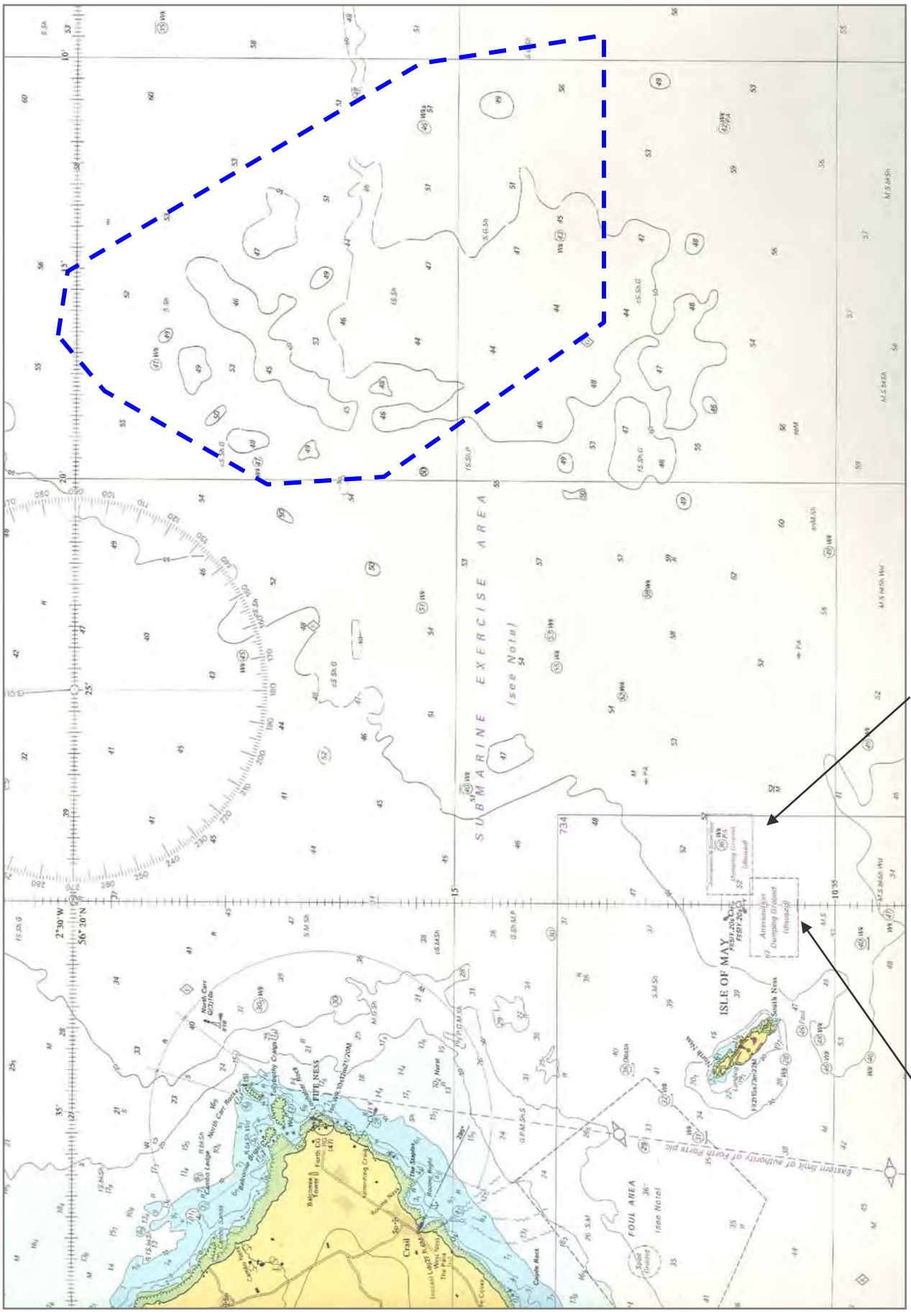
Dimensions:	Diameter 305mm (12") diameter Charge Weight: 94kg
Initiation:	Timer fuze
Delivered by:	Surface craft
Dating from:	1943
Remarks:	Fired in 3 mortar barrages.





3-barrelled launcher

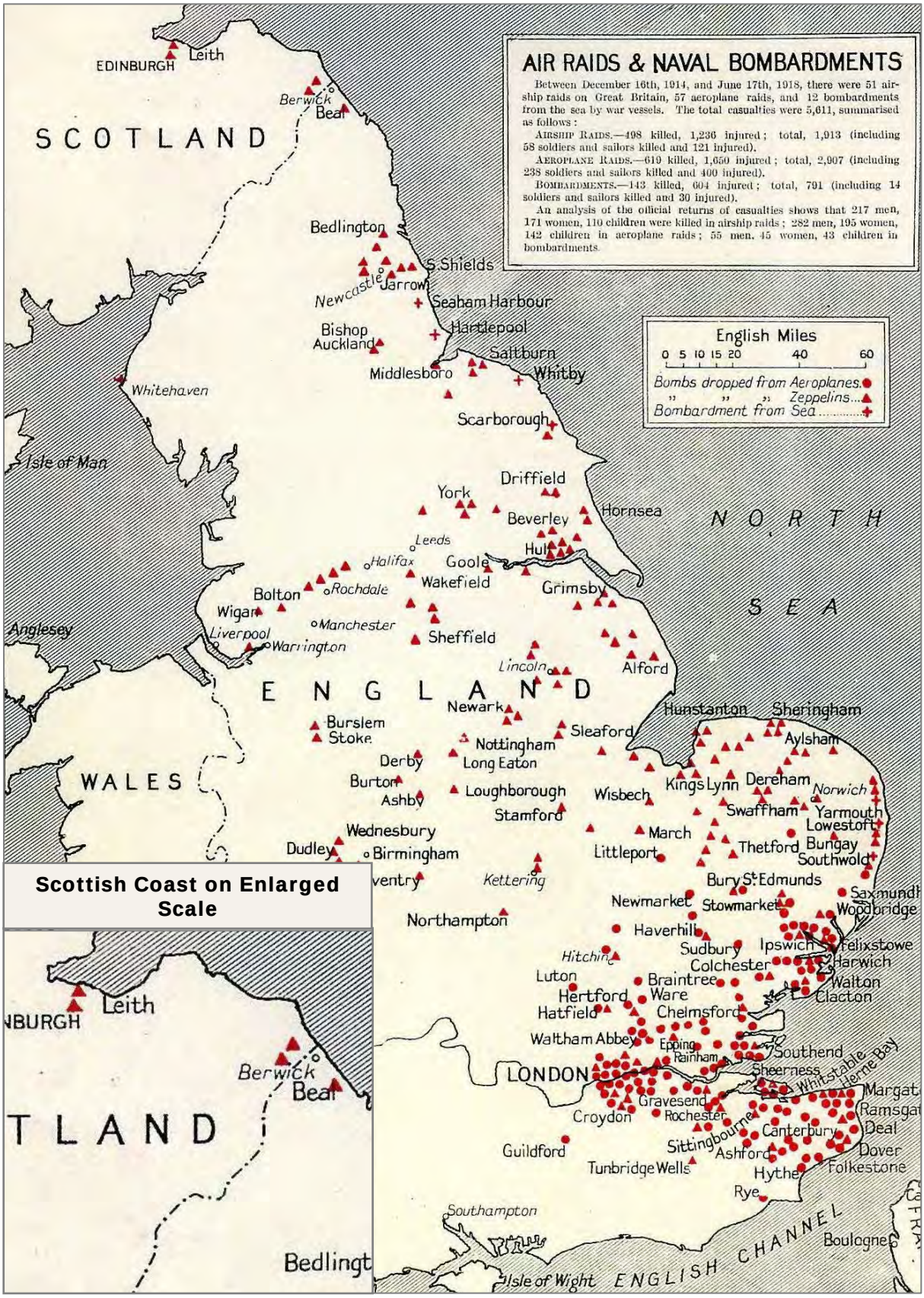
Annex M: 2005 Admiralty Chart Showing Sea-Based Features in Proximity to Site



Report Reference:	Client:	
3165TA	Emu Limited	BAC TEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: UK Hydrographic Office (UKHO)

Annex N: WWI Air Raids & Naval Bombardments Map



The approximate area of the wind farm lies outside the area covered by the map

Report Reference:	Client:	
3165TA	Emu Limited	BAC TEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: National Archives

Annex O: WWII Bomb at Felixstowe Beach, 2008

Felixstowe rocked as Navy detonates wartime bomb
30 Apr 08

A team of Royal Navy divers and explosive ordnance experts has successfully detonated a World War II bomb off the Suffolk coast. Report by Leigh Morrison.

The 11-man team confirmed the location of the explosive using the unique searching capabilities of the Remus unmanned submersible vehicle yesterday evening, Tuesday 29 April 2008. The data gained from the side-scan sonar onboard the Remus submersible indicated that the bomb was 1.15 miles [1.85km] off the Felixstowe seafront.

The recent extreme weather conditions resulted in the necessary resetting of the fuse connected to the bomb before the Navy team could progress with the explosion. A one mile [1.6km] exclusion zone was set up and, after a short wait until a tidal window was available, divers detonated the bomb at 1940hrs.

After the bomb was detonated, vibrations are said to have been felt up to two -and-a-half miles [4km] away from the site, with some residents reporting slight shaking in their homes. The exercise was carried out safely and nobody was hurt. With the bomb being in nine metres of water the explosion caused a plume between 150 and 200 feet [45.7-60.9m] high to rise into the air.

The 500kg device, which was identified as a German bomb left over from the Second World War, is thought to be one of the largest ever washed up on the British coastline. It was found on Monday 21 April 2008 when a contractor working on sea defences in the area accidentally scooped the hefty shell up with his digger.

Around 1,200 Felixstowe residents were initially evacuated from their homes and a half mile exclusion zone was cordoned off by police around the area. The cordon was lifted at midday on Tuesday 22 April 2008 when a team of Royal Navy bomb disposal specialists towed the bomb out to sea and to safety. A sea exclusion zone was then set around the bomb to protect local shipping.

The Navy team had originally planned to carry out a controlled explosion last week, but strong tidal currents made it impossible for divers to attach a charge. Heavy rain and fog furthered hampered the team's efforts to reach the bomb making it necessary to delay the operation until yesterday.

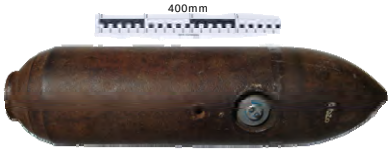
The Royal Navy team made a total of 50 dives in arduous conditions throughout the operation to secure the safety of residents living nearby.

Annex P: German Air Delivered Ordnance

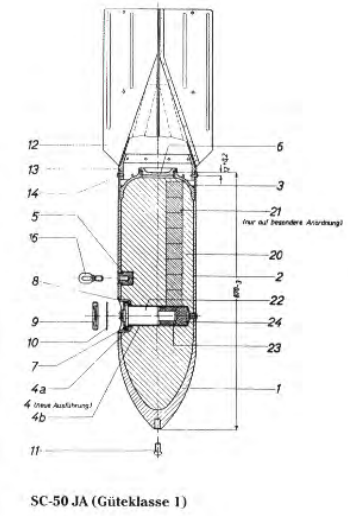
SC 50

Bomb Weight:	40-54kg (110-119lb)
Explosive Weight:	c25kg (55lb)
Fuze Type:	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions:	1,090 x 280mm (42.9 x 11.0in)
Body Diameter:	200mm (7.87in)
Use:	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks:	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.

50kg bomb, London Docklands



Minus tail section

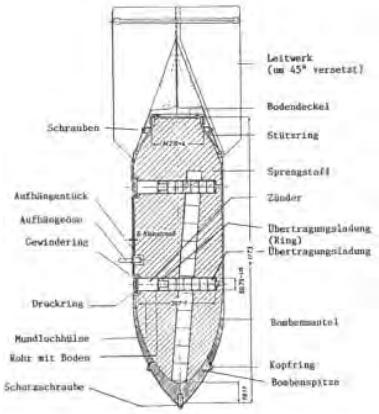


SC-50 JA (Güteklasse 1)

SC 250

Bomb weight:	245-256kg (540-564lb)
Explosive weight:	125-130kg (276-287lb)
Fuze type:	Electrical impact/mechanical time delay fuze.
Bomb dimensions:	1640 x 512mm (64.57 x 20.16in)
Body diameter:	368mm (14.5in)
Use:	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.

250kg bomb, Hawkinge



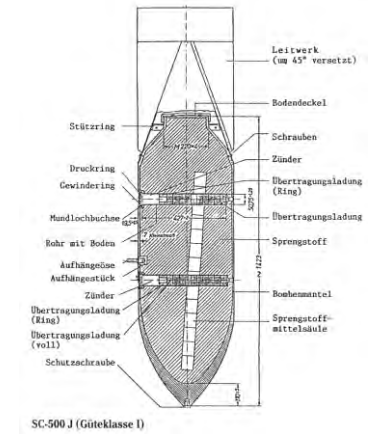
SC-250 JA (Güteklasse I)

SC 500

Bomb weight:	480-520kg (1,058-1,146lb)
Explosive weight:	250-260kg (551-573lb)
Fuze type:	Electrical impact/mechanical time delay fuze.
Bomb dimensions:	1957 x 640mm (77 x 25.2in)
Body Diameter:	470mm (18.5in)
Use:	Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.

50kg bomb included for size comparison (see above)

500kg bomb, Felixstowe beach, April 2008



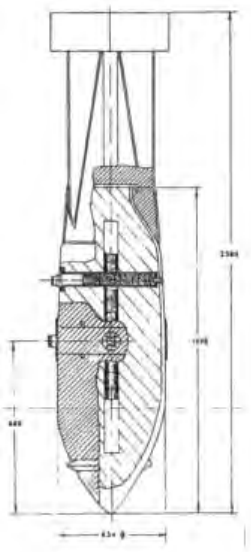
SC-500 J (Güteklasse I)

Report Reference:	Client:	
3165TA	Emu Limited	BAC TEC
	Project: Neart Na Gaoithe Offshore Wind Farm	

Source: BACTEC International Limited and various historical sources

SC 1000

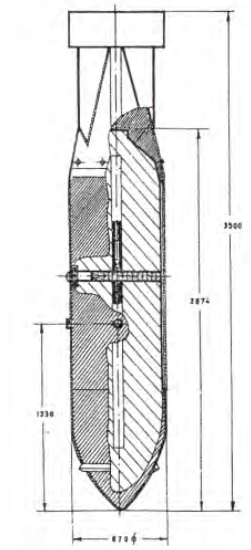
Bomb weight:	993-1,027kg (2189-2,264lb)
Explosive weight:	530-590kg (1,168-1,300lb)
Fuze type:	Electrical impact fuze
Bomb dimensions:	2,580 x 654mm (101.6 x 2.5in)
Body diameter:	654mm (25.75in)
Use:	Against unarmoured sea and land targets
Remarks:	Known as the 'Hermann'



SC 1800

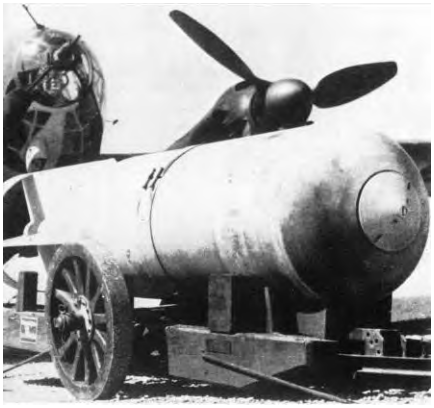
Bomb weight:	1,767-1,879kg (3,896-4,142lb)
Explosive weight:	1,000kg (2,205lb)
Fuze Type:	Electrical impact fuze
Bomb Dimensions:	3500 x 670mm (137 x 26in)
Use:	Against building complexes and large merchant vessels
Remarks:	Known as the 'Satan'

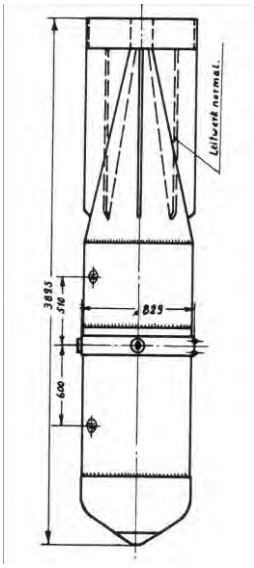
1800kg bomb, Bristol, 1941



SC 2500

Bomb Weight:	Bomb weights have been quoted as 1,950kg (4,300lb) and 2,500kg (5,512lb)
Explosive Weight:	1,700kg (3,748lb)
Fuze Type:	Electrical impact fuze
Bomb Dimensions:	3,895 x 829mm (153.3 x 32.6in)
Body Diameter:	829mm (32.6in)
Use:	Against building complexes and merchant vessels.
Remarks:	The SC 2500 has an aluminium body with a welded head and tailpiece. Known as the 'Max'. Only a limited number were deployed.





Annex Q: Examples of Ordnance Recovered From the Thames Estuary, 2006

PROJECTILE 4”

P.T.T.F LIVE FUZE

PROJECTILE 4” SOLID SHOT

PROJECTILE 3” HE/BLACK POWDER

FUZE COMPONENTS

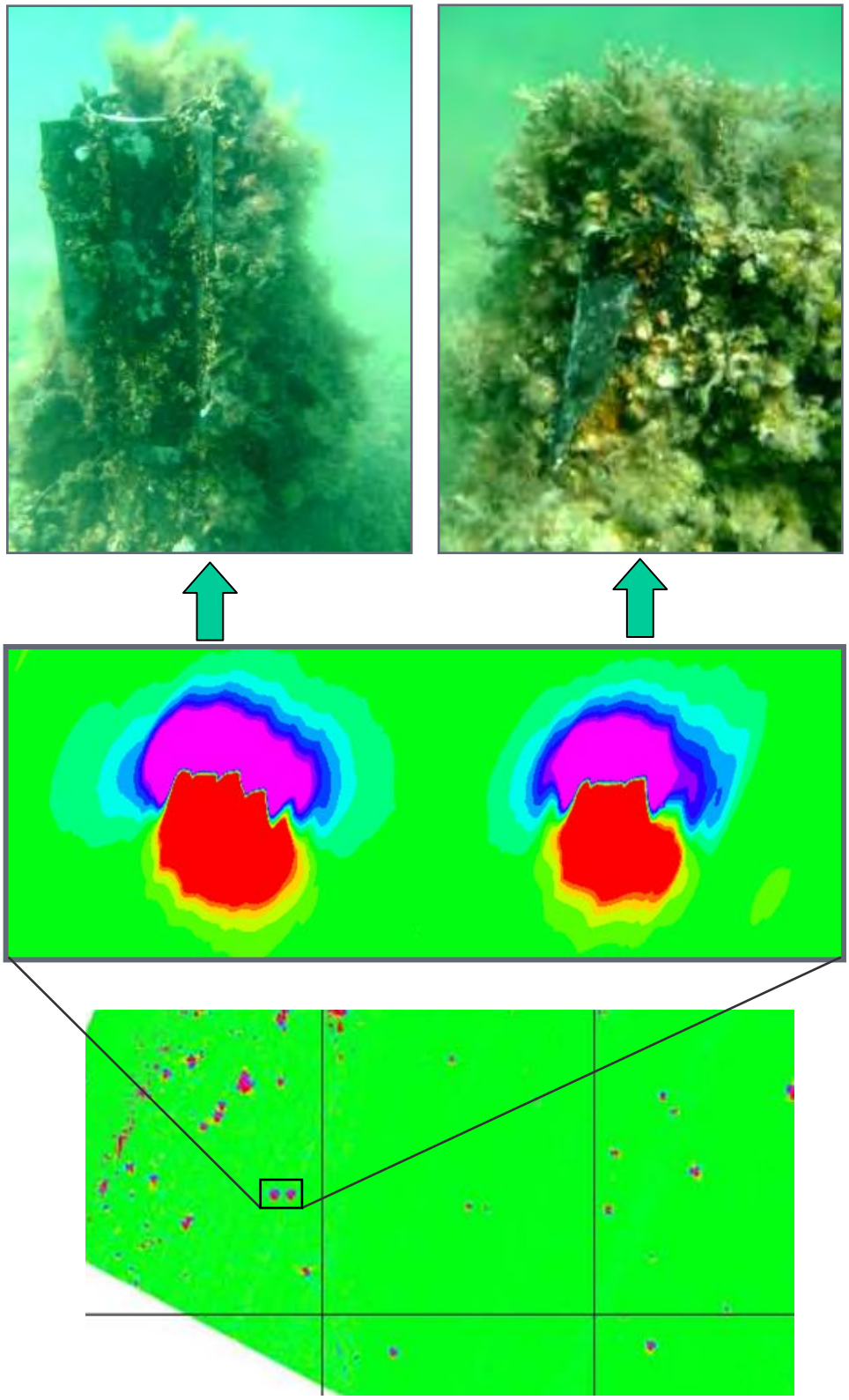
PROJECTILE 5” SOLID SHOT

PROJECTILE 13/4” HE LIVE

SAA

1 ½” HE PROJECTILE

Annex R: Photos of HE Bombs Found in a Marine Environment



This Annex shows photographs of two unexploded US 1000lbs bombs believed to have been in the water for 20years

They were detected by BACTEC's AGS-1 magnetometry survey system and relocated by divers before being demolished by controlled explosion

Annex S: Example of Ordnance in Transit, North Sea, 2006

1000lb British high explosive bomb recovered by BACTEC in the North Sea in 2006

Annex T: Example of Recent Initiation of Sea Mine

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Warning over WWII mines on seabed

Fishermen off the Norfolk and Suffolk coast are being warned about three World War II mines lying on the seabed.

Three crew of a Dutch fishing vessel were killed on Wednesday when a device caught in one of their nets.

The mines are thought to be lying about 40 miles off the coast of Lowestoft, close to the international border with the Netherlands.

Wayne Brunning, from Great Yarmouth coastguard, said the mines were lying 40 metres down on the seabed.

"We contacted Joint Service Explosives Ordnance Disposal Unit and they will assess the situation to see if it is viable for them to go out to detonate these devices," he said.

Maarten Jacob Incident

This Dutch fishing trawler unknowingly hauled a WWII bomb or mine on board and dropped it into the hold. The device exploded, fatally injuring three fishermen, two of whom were blown overboard. The hold and deck were holed. Subsequent mine clearance operations in the vicinity of the incident resulted in the destruction of 23 additional items of ordnance.

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