Final report on research carried out during FY 14/15 in support of managing the wreck of the SS Richard Montgomery

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Background

The SS Richard Montgomery is a wartime wreck located 3.1km offshore from Sheerness containing munitions, mostly aircraft bombs, with a total explosive content of 1400 tonnes. In 2014 the Defence Science and Technology Laboratory (Dstl) was requested to assist the Department for Transport (DfT) by providing technical advice to support the development of their strategy for managing the SS Richard Montgomery.

The aim of this report is to summarise the work carried out by Dstl during FY 14/15 and to describe potential future research tasks and associated considerations.

Key findings

A considerable body of work had been carried out since the vessel grounded in 1944. A detailed analysis of that work was conducted by Dstl, primarily through the review of reports which had been produced. That analysis identified a number of areas of uncertainty and information gaps originating from a variety of causes.

Following the analysis, a strategy was developed which articulated the most important questions to be addressed:

- *What is the probability of detonation for a range of courses of action?* Being able to quantify the probability of detonation for the range of courses of action, including “do-nothing”, is key to managing the wreck.
- *How is the vessel’s structure degrading and when is it likely to break up?* This area is key to understanding how much time is available to deal with the vessel. It would also provide information on likely failure modes which would assist with determining the probability of detonation.
- *What would be the impact on the environment should the vessel’s cargo detonate?* The effects on the environment of blast, fragmentation, water wave generation and contaminants are important considerations which impact public safety, commercial considerations and the security and protection of infrastructure.

Probability of detonation

A methodology was developed for determining the probability of mass detonation of the munitions on board the SS Richard Montgomery for a range of courses of action and a range of timescales. The courses of action included doing nothing, removing the munitions and containment, the timescales considered were now and in 10 and 30 year's time.

This task was the most difficult of the three due to an almost complete lack of knowledge of the condition of the munitions on the vessel; very little knowledge exists on the long term effects on munitions of immersion in sea water and no munitions have been recovered from the Richard Montgomery. This task was also critical since understanding the probability of detonation is fundamental to any physical intervention measure. For this reason it is essential that there is adequate confidence in the answer obtained.

The analysis comprised the following activities:

- Visualisation of the munition initiation and consequence sequences for each of the scenarios under consideration.
- Development of fault trees which will enable the probability of mass detonation to be calculated once inputs to the fault trees are known.
- Identification of future activities which, when completed, will enable a probability assessment to be made.

Vessel structure

Previous work relating to corrosion and break up of the vessel was reviewed to assess its validity and recommendations made for future work which will enable accurate prediction of corrosion and break up.

A number of reports were reviewed, these reports described dive surveys carried out and provided structural assessments of the vessel. Approaches to the management of other wrecks around the world were also examined. These included the USS Arizona at Pearl Harbor and the submarine HMAS AE2 in the Dardanelles Straits.

It was concluded that the structure of the vessel is deteriorating faster than previously estimated although further work is required to accurately quantify this.

Impact on the environment

Previous work carried out on the environmental impact of the vessel and its cargo was reviewed, the validity of the work was assessed and recommendations made for future work which will enable accurate prediction of the environmental impact.

Previous predictions of the blast, fragmentation and water wave effects likely to be generated by a mass explosion were technically reviewed. It was concluded that further analysis should be carried out to take advantage of improvements in modelling capability and to reflect changes to the environment.

An Environmental Impact Screening and Scoping Study (EISS) was completed, this is the initial process carried out before conducting an Environmental Impact Assessment (EIA). The EISS

considered potential environmental impacts from the wreck under two scenarios. The first scenario considered the wreck and its cargo as it currently resides within the environment and how it interacts with the local infrastructure and marine, coastal and terrestrial receptors ("baseline scenario"). The second scenario considered the environmental impacts on the receptors from a detonation of the cargo ("detonation scenario"). It was concluded that some areas relating to hydrography, water and sediment quality, marine ecology and socio-economics were out of date and should be reviewed through the commissioning of a full Environmental Impact Assessment.

Recommendations

There are a large number of potential future activities which will improve knowledge of the situation pertaining to the Richard Montgomery and facilitate effective management of the wreck. Some tasks are very costly and, given a finite budget, decisions will need to be made on which activities should be undertaken, those decisions will depend on:

- Cost. The costs associated with the tasks range from a few thousand pounds for a small scale study to millions of pounds for large scale experiments involving explosives.
- The extent of current knowledge. The difference between our current knowledge and the desired end state varies between tasks. Tasks with the largest differences tend to be the most intractable.
- The contribution which any increased knowledge will make to public safety and infrastructure security. Some tasks will only contribute to public safety and the protection of infrastructure by a small amount. Those that will contribute the most tend to be more costly and difficult
- The availability of suitable resources to undertake the work. The knowledge and expertise required to complete some tasks is widely available whilst in the case of other tasks requiring more specialised knowledge, notably those involving explosives, resources are much more limited

It is recommended that the following activities are carried out in the next phase of work:

- Prioritisation of the activities associated with establishing the probability of detonation. This will require a working group with munitions expertise to be maintained.
- Construction of a spatial model of the vessel and its cargo to establish the disposition of munitions in the vessel and the distances between munitions/munition stacks.
- Technical details of possible courses of action should be obtained in order to inform the prioritisation of activities relating to the probability of detonation.
- A full Environmental Impact Assessment.
- A more refined engineering analysis to more accurately quantify the blast, fragmentation and water wave effects.
- The development of a Corrosion Risk Management Strategy