Annex A

Statement of Requirements

1. Introduction

1.1.   As part of the long term conservation project for HMS Victory being Project Managed by the National Museum of the Royal Navy (NMRN), a full structural analysis and assessment of the ship has been undertaken. This identified movement and distortion of the hull, and has resulted in the design and introduction of the new Hull Support System to give the ship improved support.

1.2.   The Hull Support System consists of a series of 134 'smart props' each with an embedded load monitoring cell that reports the individual prop load in real time to a web-enabled central reporting point in the NMRN through the IMES International Ltd supplied system, referred to in this tender as 'IMES.

1.3.   The modelling process used for this work is an 'Intelligent Model', a structural model that incorporates historic repair data, survey condition data, materials, types, dates, fixings used, and archaeological details, and incorporation of 3D surveying. This has led to the production of an Analytical Model, to provide a picture of the structural behaviour of the ship.

1.4.   The Analytical Model itself consists of two models, the 'perfect ship' and the 'degraded ship'. The 'perfect ship' represents a dimensionally accurate model of the complete ship. The 'degraded ship' represents inputs from surveys, etc., that allow for modelling for the effects of degradation (e.g. rot) or missing/removed elements on the structural performance of the ship. These models are being finalised as part of the handover process of the Hull Support System, but should be seen as live models. It can be both updated with information as it becomes available through survey, and can also model the effects of element removal (e.g. planking) during planned conservation work.

1.5.   Future modelling will involve both assessing the measured movement of the ship against predicted performance, and measuring the effects of

planking and element removal for conservation work to assess the structural stability of the ship and establish safe working limits.

1.6.   Structural modelling is undertaken using the Rhino System (.3dm) format (Version 5). It can be outputted to Autodesk Inventor for use in the Victory Information Model (VIM), or used within Rhino for the VIM. Currently NMRN run the VIM using Rhino (Version 5). ANSYS14 is used as the specification for software used.

1.7.   The VIM model supports the archaeological knowledge base for HMS Victory, and is required to be kept up to date and in synchronisation with the structural modelling.

1.8.   The current state of the ship is updated as a result of survey, and will be further updated as the conservation programme is undertaken, which conserves, or replaces, the outer and inner planking, and key structural timbers within the ship. It will also be used to model the re-instatement of the full masts and rigging, including materials evaluations for mast construction.

1.9.   As well as the model, the ship has reference points for deflection measurements, currently undertaken by a separate contractor, to assess the actual movement of the ship. These results can therefore also be used to inform the development of the intelligent model and should serve to increase the accuracy of the model, and modelled movement should therefore show increasingly close correlation with observed results. Readings are normally undertaken bi-monthly, and/or as required.

1.10.   The structural model therefore is used to assess:

- The effects of movement upon the ship from either variation in measured load or physical deflection measurement.
- The determination of loads that must be applied at each smart prop to maintain the ship within safe structural limits.
- Determine the effects of removal of sections of planking and/or support elements such as beams or knees, and rigging, to make a

structural assessment and informed decision that planned work does not exceed structural safety limits.

1.11.   It is anticipated that planking will be removed in sections, and that as each section is conserved and re-instated, the models will be updated and a structural re-assessment made, along with recommendations for smart prop loading adjustment.

1.12.   It should be noted that HMS Victory will be re-planked in a different format (and not like for like) to the current scheme; this is to restore her to the state at the time of the Battle of Trafalgar in 1805. On completion of each section of work, therefore, both models must be updated (including 3D scanning that may be undertaken by another contractor), and both the models and the VIM updated to ensure common referencing for the archaeological knowledge base.

1.13.   The work package for conservation, including plank replacement, will be planned and executed in a separate package, CAFM (Computer Aided Facility Management). This package identifies each individual object from the model (referred to as an asset) and therefore there needs to be a common referencing system between the models, VIM and CAFM. Transfer to CAFM is via an MS Excel worksheet. Equally, as planks etc. are replaced, this will be recorded in CAFM and exported as an Excel worksheet (pre-defined format), which is to be used to update the models.

1.14.   The Conservation work will be undertaken in 4 Stages. Stage 1 covers the starboard side, midships section; Stage 2 the bow, Stage 3 the port side midships and Stage 4 the stern and transom.

1.15.   Updated models produced as part of completion of the Hull Support System will be supplied to the selected contractor after contract start.

1.16.   As a response to tender, bidders are asked to consider the effects of removing planking elements, to demonstrate their capability and understanding of the requirements.

1.17.   A technical description of the model and current version of the model in Rhino (.3dm) is available on request from tenders@nmrn.org.uk and subject to completion of the Confidentiality Agreement disclaimer as detailed at Paragraph 2.9.

1.18.   Intellectual property rights for the model are held by the NMRN, and all work completed under this tender will remain within NMRN's Intellectual Property at the completion of the Contract.

1.19.   This tender is for the structural analysis support of HMS Victory during Stage 1 and 2 of the Conservation Programme (total duration estimated at 6 years), with options for Stage 3 and Stage 4 support, each of which is anticipated to last up to 3 years.

2.   Essential Requirements

2.1.   The purpose of this Tender is to seek a contractor to undertake the continued support, operation, and maintenance of the Intelligent and Analytical models (degraded and perfect), alignment and synchronisation with the VIM, and output to/input from CAFM in digital format (Excel workbook format to be sullied by NMRN) for the first two Stages of the conservation programme, with options for two further extensions for each stage. The response to tender is to include a breakdown of the annual cost of maintaining the model and software packages, and a proposal for payment of fees associated with it (e.g. monthly, quarterly). It should be noted that the final version of these models is now being completed. A working version for the purposes of this tender may be supplied on request (see Paragraph 2.9).

2.2.   The contractor is required to update the models (including VIM) as the conservation work progresses, and provide a monthly assessment of structural stability, incorporating bi-monthly deflection readings and load cell monitoring via IMES and inputs form the movement monitoring system outlined in Paragraph 2.3 below. The response to tender is to include a breakdown of the cost of each monthly report.

2.3.   As a response to tender, the contractor is to review Section C Paragraph 3.7 (page 66) of Modelling and Analysis of HMS Victory Volume 1 and propose, with costs, the installation and maintenance of a movement monitoring system. A system technical description and proposed method of operation and procedure to incorporate data as part of structural analysis is to be included as a response to tender.

2.4.   Review As a response to tender, a potential contractor may propose alternative periodicity for deflection readings, with written justification.

2.5.   Provision of modelling to asses structural implications up to six (6) 'phases or slices' of planking removal per conservation stage, and provide 'go/no-go' recommendations in a format to be agreed with NMRN. The response to tender is to include a breakdown of the cost of an individual 'phase or slice' of modelling and a separate cost for attendance (day rates) at NMRN to assist the project team to plan the project in terms of planking replacement.

2.6.   The contractor will be required to agree the process of update of the model, and data conformity with the NMRN Data Manager, who is to be the deciding authority for the process and formats. An indicative format, for development with the successful contractor post contract award is at Appendix 1.

2.7.   <u>Masts and Rigging</u>. The Intelligent Model is also to be used for re-planning the full re-instatement of masts and rigging of the ship. The cost of running the model for a single rigging iteration (and for subsequent iterations) for all three masts and bowsprit is to be included in the response to tender.

2.8.   As costed options:

2.8.1. <u>Costed Option 1</u> - Provision of 3D scanning and post-processing work associated with the modelling, based on:

- Cost to update the models at the end of a stage.
- A cost to undertake an individual scan and update models of a stage whilst work is in progress.
- Provision of 3D scan data in a format suitable for digital interpretation/presentation.

2.8.2. <u>Costed Option 2</u> - Provision of deflection measurement services, for bi-monthly readings and with further options for additional readings onsite as required (Day rates).

2.8.3. <u>Costed Option 3</u> – Obsolescence management of NMRN hardware and software to ensure compatibility of VIM and CAFM with the Contractor supported models, for the duration of this contract, including any extension period. If this option is not taken up by NMRN, then the appointed contractor is to alert NMRN to potential hardware and/or software obsolescence/upgrade needs.

2.9.   It will be for NMRN to decide if options are taken, prospective Tenderers should identify any separate cost for incorporation of data from options 1 and 2 above if an independent company or body is employed to undertake the work.

2.10.   A detailed technical description of the ideal and degraded model and Rhino version of the working model is available by request (to: tenders@nmrn.org.uk). Prospective Tenderers are to note that this description or model is not to be copied, retained, including the information within it, or divulged to third parties. The supply of information and model is only for the purposes of this tender. All supplied information is to be returned to NMRN at the end of the Tender Process, and a signed Confidentiality/Non-Disclosure Agreement must be returned prior to issue (see Appendix 1 to Statement of Requirements). The information will be made available via individual Microsoft

'One Drive' folders. Access to these folders will be suspended at close of the tender assessment period.

2.11.   **RESPONSE TO TENDER** – Modelling Demonstration. The tenderer is to demonstrate their ability to model the performance of the ship using the supplied information below:

Number	Title	Reference
1	Ship Planking Drawing – 'For Tenderers UGD Wales'	20200731 (pdf and CAD.dwg)
2	Ship VIM Model (.3dm Rhino Format))	
3	Fenton Holloway Report Modelling and Structural Analysis of HMSV VOL 1 Full Report Version 1.3	Version 1.3 Dated 14 February 1014
4	Fenton Holloway Report Modelling and Structural Analysis of HMSV VOL 2 Appendices Version 1.3	Version 1.3 Dated 14 February 2014

The supplied drawing shows two scenarios for planking removal (coloured orange and blue), considered to represent typical scenarios for a planking phase removal. The response to tender is to include a short assessment of the two scenarios, including recommendations on suggested structural stability and the methodology to be followed to undertake such work. Any data modelling submitted must be in the same Rhino (.3dm) format.

Appendix 1. Confidentiality/Non-Disclosure Agreement.