**SSC Project Recommendation for FY 2018**

# Guide for Application: FEA in Design and Assessment of Ship Structures

## 1.0 OBJECTIVE

The objective of this project is to develop a guidance note for the application of finite element analysis in the design and assessment of ship structures. Current design and assessment practice includes extensive use of powerful numerical modeling techniques which if improperly applied can lead to analysis results with wide variation in quality and reliability. The objective of this project would be to provide guidance on aspects relating to quality assurance (QA) of FEA are reviewed, including the procedures used in conducting FEA, software, and the human element.

## 2.0 BACKGROUND

2.1 The Ship Structure Committee (SSC387) dealt with this issue in 1996, however, in the past 15 years the use of finite element modeling has advanced in terms of:

- Tools available (e.g. automated meshing, interaction with drafting/solid modeling tools),
- Materials considered (steel, aluminum, plastic, composites, non-linear (post yield) behavior),
- Load conditions (e.g. fluid structure interaction, collision, blast simulation),
- Analysis types (implicit versus explicit (time domain) modeling),
- Element formulations (non-linear, hybrid and contact elements), and
- Structural geometries (crack tip elements, connection and weldments, contact/sliding component fit-up).

2.2 The previous SSC treatment of this topic and guidance provide by other industry guidelines focus on:

- Linear elastic analysis of ship structures,
- Dynamic analysis limited to natural frequency (modal) analysis,
- Structural assemblies rather than connections and whole ship models, without treatment of sub-structuring,
- Isotropic materials,
- Local loads rather than whole ship loading,
- Benchmarking modeling tools, and
- Development of error checking procedures.

2.3 In order to produce high quality finite element analysis results, guidance on model preparation and interpretation are required to develop a consistent level of quality from current advanced numerical modeling tools. This guidance could consider:

- Planning and preparation,
- Development of the engineering model,
- Construction of the finite element model,
- Exercising the finite element model, and
- Interpreting the results

## 3.0 REQUIREMENTS

3.1 Scope

The Contractor shall conduct the work required by this project in three phases:

3.1..1 Data Collection - Literature review and definition of best practice demonstration examples

3.1..2 Guidance Assembly - Compilation of best practice guidelines

3.1..3 Demonstration of Concepts - Completion of best practice guideline examples

3.2 Tasks

In Phase 1, the Contractor shall undertake a comprehensive literature review and develop a proposed plan for the work in Phase 2 including the following tasks:

3.2..1 Project Kick Off Meeting – Review project objective, scope and administration to ensure a common understanding of the project is held by the Contractor and the Project Technical Committee.

3.2..2 Literature Review – A review of large structure safety assessment literature with the objective of identifying state of practice treatment of structural redundancy or reserve capacity in analytic and numerical approaches. The literature review shall consider information from complimentary industry applications (e.g. aerospace, machine design, offshore structures).

3.2..3 Planning the Review and Update of Existing Guidance Manual – The contents of the existing manual will be reviewed for relevance to the state of practice in today's finite element modeling environment. The elimination, modification and addition of best practice items will be considered in the development of a plan for updating the guide.

In Phase 2, the Contractor shall assemble the best practice guide through completion of the following tasks:

3.2..4 Numeric Analysis Platforms Review and Comparison – Three numerical modeling tools will be considered as representative of current analysis tools (e.g. Maestro, Ansys and LS Dyna). Best practice and guidance and modeling techniques will be considered based upon these tools, as such their treatment of typical analytic problems (design and analysis) will be considered.

3.2..5 Advanced Analysis Guidance – The requirements and guidance on reference materials to support advanced analysis problems including: Fatigue and fracture, Structural plasticity, Collision and impact, and Composite structures, will be identified. This information will be used to develop best practice guidance on these topics.

3.2..6 Review and Update of Existing Guidance Manual – The contents of the existing manual will be updated to consider the results of the previous three tasks and define the needs of demonstration examples completed in Phase 3.

In Phase 3, the Contractor shall add demonstration examples to the best practice guide through completion of the following tasks:

3.2..7 Sample Application Development – Sample structural models will be developed to demonstrate the four advanced analysis topics. Not all concepts will be developed in of the all modeling tools considered in Phase 2.

3.2..8 Sensitivity of Results - The effect of differing assumptions or interpretation of analysis results will be demonstrated using the sample models. These results will be used to demonstrate best practice in the advanced analysis areas of interest.

3.2..9 Documentation in the Guidance Manual - The results of these examples with discussion of the significance of good and poor practice will be added to the guidance manual.

3.3 Project Timeline: the anticipated duration of this project is twelve (12) months. This includes three (3) months for Phase 1, approximately six (4) months for Phase 2, three (3) months for Phase 3 and two (2) months for a review of the final deliverable.

**4.0 GOVERNMENT FURNISHED INFORMATION.**

4.1 Standards for the Preparation and Publication of SSC Technical Reports.

**5.0 DELIVERY REQUIREMENTS.** (Identify the deliverables of the project).

5.1 The Contractor shall provide quarterly progress reports to the Project Technical Committee, the Ship Structure Committee Executive Director, and the Contract Specialist.

5.2 The Contractor shall provide an interim report at the end of Phase 1, including a preliminary version of the results of the literature survey and final proposals for the sample applications in Phase 2

5.3 The Contractor will provide technical status reports at the end of each task in the project. This will include SSC technical committee request for comment on the Phase1 and Phase 2 recommendation for the details of the following phase:

- Phase 1 Deliverable – Guidance Manual Update Plan
- Phase 2 Deliverable – Guidance Manual Sample Application Plan

5.4 The Contractor shall provide a print ready master final report and an electronic copy, including the above deliverables, formatted as per the SSC Report Style Manual.

**6.0 PERIOD OF PERFORMANCE.**

6.1 Project Initiation Date: June, 2018

6.2 Project Completion Date: 12 months from the date of award.

**7.0 GOVERNMENT ESTIMATE.** These contractor direct costs are based on previous project participation expenses.

7.1 Project Duration: 12 months.

7.2 Total Estimate: $120,000

7.3 The Independent Government Cost Estimate: To be provided with full proposal.

**8.0 REFERENCES.**

8.1 SSC Reports

8.2 H. Hope, “Goal Based Standards - A New Approach to the International Regulation of Ship Construction”, Maritime Safety Division, International Maritime Organization.

**9.0 SUGGESTED CONTRACTING STRATEGY**

9.1 GSA’s eBuy solicitation system, or directly to contractors according to governing agency procedures. Special Item Number (SIN) 871-1 (Strategic Planning for Technology Programs/Activities) or SIN 871-2 (Concept Development and Requirements Analysis) would be appropriate classifications for the proposed project.