ADVANCES IN STRUCTURAL SAFETY CERTIFICATION

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ABSTRACT

The Certificate Safety–Structural Strength programme is a formal process designed to focus attention on Royal Navy ship structural or material condition at regular intervals. The programme and advances since its introduction are discussed.

Introduction

Warship losses due to causes other than those directly associated with battle damage are an extremely rare occurrence. Large merchant vessels are lost at a rate of 20 per year on average. Is this due to differences in design standards, maintenance practices, or the quality of crew who operate the vessels? Direct comparison is not valid since intended operational roles are so vastly different. However, it does serve to highlight the unforgiving environment which RN ships and sailors must endure.

In response to technological change and ever-tightening fiscal policies, improvements in the structural maintenance and reporting processes are being implemented to ensure continued structural safety of RN ships in all operational roles.

Fundamental to successful operations is a ship which is structurally sound. This article describes the Certificate Safety—Structural Strength (CSSS) programme designed to provide assurance to Commanding Officers and other responsible authorities that the ship in question is fit for purpose. Programme advances since 1983 are discussed and development work is described. Thus it updates the two earlier articles on this subject in the *Journal*[1,2].

Background

Machinery and weapon systems operate as intended only if they are well maintained. Similarly, a well designed warship structure requires frequent in-service attention. A CPO(MEA) knows by the sound and touch when his diesel is vibrating beyond acceptable limits. Ship's structures are regularly monitored by surveys at DEDs and Refits. Unacceptable corrosion and cracking (the major cause of structural distress), like shaft imbalance, can be tolerated to a certain extent to complete high priority operations. The cost, of course, is increased work at maintenance periods and possible wholesale equipment changes or large sections of ship structure replacement.

Corrosion and cracking are a fact of life for warships even in peacetime. Any sailor on exercise in the North Atlantic or doing towed array duties can testify that there is much pride at stake; missions are not often aborted simply due to adverse conditions. Towed array LEANDERS forced to maintain course and station under less than desirable sea states are subject to severe conditions during peacetime. Remaining ship hull fatigue life is reduced considerably more quickly. In short, warships absorb significant punishment which is accepted but which must be accounted for when considering structural maintenance.

Decommissioning of warships occurs due to cost, capability and political considerations. Occasionally, a ship's capability may be considered inadequate on the basis of extensive corrosion and fatigue cracking. When corrosion has taken hold beyond the bounds of economical repair or the ship's structure reaches a state where cracking reappears shortly after expensive repairs, a tough decision on the ship's future must be taken.

On occasion re-analysis of an existing vessel's structural integrity takes place; particularly when significant defects arise. For example, in 1989 the Royal Navy (RN) ice patrol vessel HMS *Endurance*, while operating in South Atlantic ice conditions, sustained significant damage. Serious cracking resulted. Upon review, the options were:

(*a*) to limit operations severely with caveats to the CSSS and increase survey frequency;

(*b*) to replace major structural scantlings with notch tough plating and stiffeners. This was costed at £5 million and represented the bare minimum acceptable to enable continued cold weather operations; or

(*c*) to decommission.

HMS *Endurance* was decommissioned in October 1991 and replaced by MV *Polar Circle*.

In today's climate of fiscal constraint, decision-makers face a very real temptation to postpone expensive and time-consuming ship repairs. Maintenance cycles are being extended such that time between surveys is increased; defects will therefore on average not be detected quite so early.

Engineering by its very nature is peppered with trade-offs. A balance between maintenance efforts and continued structural safety is therefore essential to the well-being of each ship, and to continued minimal unplanned downtime (the problem of every operational commander). Innovative maintenance planning becomes more important than ever.

The CSSS Programme

The Certificate of Safety—Structural Strength (CSSS) was introduced with the re-organization of the Sea Systems Controllerate in 1983, in part to focus the attention of ship maintainers at all levels, on ship structural condition at regular intervals. Secondly, the Commanding Officer is apprised of the current structural condition of his ship by way of a professional assessment made by both repair and design authorities.

CERTIFICATE OF SAFETY - STRUCTURAL STRENGTH

HMS NONSUCH

VALID UNTIL RFSD + 4 YEARS

1. The structural strength of HMS NONSUCH is considered adequate to meet operational requirements without danger to the safety of the vessel or to personnel on board.

2. A margin of safety to allow for normal degradation of structure is included. Any abnormal change or defect should be immediately reported to the Operating Authority and MOD (PE).

3. This certificate supersedes all previous issues for this ship and is based on the Report of Structural Survey conducted at some shipyard and dated 1 October 199-

Dated November 199-	Director General Surface Ships

Notes:

Nil.

FIG. 1—A TYPICAL CSSS. ONES FOR REAL SHIPS ARE RESTRICTED

All RN ships must now be issued with CSSSs (FIG. 1) after each DED or Refit, as laid down in CNA Technical Memorandum 1/92[3]. Queen's Regulations (QRRN)[4] state:

> In addition to a Stability Statement, HM surface ships are issued with a Certificate of Safety—Structural Strength. The purpose of this certificate is to assure the Commanding Officer that his ship, in its undamaged state, meets satisfactory structural safety standards and can safely perform her operational duties. Specific structural shortcomings will be noted on the certificate along with any operating restrictions deemed to be necessary. The Commanding Officer may authorise the operating restrictions to be exceeded only when he deems it imperative in an emergency.

The overall programme broadly consists of provision of adequate design and

build standards, maintenance standards, regular survey and repair, reporting practices, professional assessment, and issue of a CSSS.

RN warships are categorized as A, B or C for the purposes of structural certification. Essentially, category A ships are major warships and those required to withstand shock and/or cold weather operations. Other vessels over 50 metres in length are assigned category B status; the remainder of MOD-owned vessels are category C. Category A ship's CSSSs are approved by DGSS while B and category C ships are signed at the Director level.

To cover ships just out of upkeep, an interim certificate is issued when the structural condition of the ship is known to be satisfactory yet the ship operational commitments precede final completion of survey and repair reports.

Caveats are used to inform the ship's Captain and other responsible agencies of any operational restrictions. The use of caveats is very limited since in most cases routine maintenance brings the ship back to a condition very similar to original design intent, that is without any operational restrictions.

The certification programme is a comprehensive process of survey, repair, reporting and professional assessment. This culminates in the recommendation and issue of a certificate. Director General Surface Ships (DGSS) ship project sections participate closely in the process, in particular when significant defects are discovered. Midway through the work period a Hull Survey assessment meeting is convened to discuss any outstanding items. At this stage, most if not all survey work should be nearing completion and repair work well underway.

A primary aim of the CSSS programme is to link certificate validity period to the design and material condition of the ship. The certification programme has thus far coincided generally with historically based maintenance cycles; DEDs and Refits. It is envisaged that improved accounting and information handling will in future result in enhanced planning and reporting practices. Improved risk analyses and optimized maintenance cycles will produce cost savings without sacrifice to structural safety. Improved understanding of current status and historical records will enable early response (repair action) and better expose trends.

Current CSSS Status

All category A vessels and approximately 50% of the category B vessels have been issued with certificates. The remainder of category B and C vessels will receive certificates at the earliest opportunity.

Progress is being made in updating the appropriate standards. NES 155 part II[5] and NES 752 part I[6], survey and repair standards for steel and GRP vessels respectively, have recently been promulgated.

Structural Inspection Database

The structural maintenance programme, which aims to provide timely repair activity, relies heavily upon regular and thorough surveys. This includes early warning of perceived structural distress by ship's crews. A computerized database to assist with survey planning, and to record and report defect and repair activities is being investigated as a means of enhancing efficiency.

Ship structural inspection software has the potential advantages of standardized survey reporting. This in itself will enable rapid sorting and highlighting of significant defects, feedback on repair actions, and reduced vetting effort. Historical records can be obtained from which finance branches or ship designers can draw information for cost or defect trend analyses and through-life costing. Further, an up-to-date ship structural status report will be available at any time during the ship's life for safety decision-making purposes.

A trial in HMS *Brazen* during her May 1993 DED is planned using the Structural Inspection database (SID) in use by the Canadian Navy. The purpose of this trial is to investigate the utility of a database tool within the MOD UK ship structural maintenance working environment.

Should the database approach prove to be effective, such a system will be introduced for use by contractors and ship project sections.

It is envisaged that the UK database could be extended to utilize graphical means to further enhance the reporting of defects and repair information.

Design Disclosure information specifically stating the extent of primary structure and expected problem areas (e.g. fatigue at areas which will see significant cycles of relatively high stress and which have less favourable geometry) may eventually become integrated into the database. The impact of defect information would then assessed in light of the relevant structural member importance to the ship and it would provide a further aid to designers and maintenance authorities.

Concluding Remarks

Maintaining RN ships in a structurally safe condition is a complex and costly business. The CSSS programme effectively causes the entire ship support community to focus on the condition of each vessel at regular intervals. As a result, responsible authorities are well informed with regard to the material status of a given ship. Defects are given the appropriate level of visibility so that timely repair action will occur in context with the operational and financial considerations.

Advances in the CSSS programme are predominantly related to certification of HM ships currently without CSSSs (50% category B and nearly all category C vessels), upgrading standards and developing new methods of information handling. The database approach shows significant promise as a means to improving information processing efficiency and quality of ship structural condition reviews. As a result, RN ships will continue to be safe platforms to operate despite the potential pitfalls of fiscal contraint and organizational change.

References

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3. CNA Technical Memorandum No. 1/92: Certificate of Safety—Structural Strength.
4. *The Queen's Regulations for the Royal Navy*; BR 2, 1989.
5. Requirements for structural practices in steel surface ships; NES 155, part 2, issue 3, 1992.
6. GRP survey and repair requirements HM ships, boats, craft and structures; NES 752, part 1, issue 3, 1993.