

INDEPENDENT SAFETY ASSURANCE

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ABSTRACT

Warships have always been exempt from Merchant Shipping Legislation and are excluded from many International Maritime Organization conventions such as Safety of Life at Sea. The MoD has therefore been required to act responsibly and self-regulate its own shipping. In the past, the MoD was directly involved in all aspects of shipping from design and build through to refit, repair and operation. An infrastructure existed with adequate resources to maintain standards, such as Naval Engineering Standards and to apply them.

Over the years, the procurement and management of warships and auxiliaries has evolved with many aspects of shipping activities traditionally undertaken by the MoD being contracted out to industry. At this time, the impact of the latest acquisition initiatives is being felt. MoD new ship projects depend on industry to identify suitable standards, undertake design work, build ships, and more recently, to maintain them in-service. In these circumstances, it is increasingly difficult for the MoD to self-regulate its own shipping.

Recognizing these trends, the MoD has begun to harmonize its practices and requirements with merchant shipping. 'Naval Authorities' have been established to mirror 'Statutory Authorities' and to regulate certain ship hazards such as stability, structure and magazine construction. The implementation of Naval Authority regulation has, as expected, been faced with many obstacles, predominantly associated with the interactions between the various organizations involved in safety regulation. This article summarizes arguments for pursuing the Naval Authority concept, progress in the early days for surface ship naval architecture, the issues as seen from the MoD point of view and from industry, and what the future might hold.

This article presents the experience and opinion of two key participants in Naval Authority regulation; that of the MoD Sea Technology Group surface ship stability section and that of BMT Defence Services Ltd, an independent consultant and delegated Naval Authority.

Introduction

The MoD has traditionally, for reasons of national security, been exempt from UK health and safety law. It has however operated an internal safety management system to maintain an adequate level of safety of those engaged in and affected by MoD shipping activities. Naval Vessels during this period (pre 1990) were in the main designed and built to Naval Engineering Standards (NES's) that encompassed both safety and best practice from many years of experience. Additionally the MoD had the resources to maintain such standards and apply them in the design of warships. The climate during the 1990's saw activities being contracted out to industry. In striving to obtain value for money NES's were regarded as 'gold plating' and the trend started towards the adoption of commercial standards and practice. In tandem the MoD was shrinking in size and more responsibility and risk was being placed with Industry.

Recognizing this move and need to demonstrate its management of safety to not only the government but also the public at large the MoD introduced the safety case to justify safety for all its shipping activities. Although certain, areas such

as stability and structural strength already received certification, the concept of Key Hazard safety certification was introduced. Areas such as stability, structure, magazine construction and fire where there was a catastrophic consequence to the ship, the personnel on board and the environment would receive safety certification. A Warship Project Manager would submit a case for certification to an independent MoD authority for review and, subject to the case being satisfactory, the independent authority would make a recommendation for the Warship Project Manager to sign the certificate.

The move to a performance based system of procurement instead of that based on purely technical requirements led to fewer standards being stipulated. The onus and dependence was thus placed upon industry to select standards (if any) to satisfy the performance specification. The traditional approach to naval shipping was fundamentally changing not only in the procurement but also the upkeep of ships with the transfer of the Royal Dockyards to the private sector. This is perhaps particularly illustrated more recently in the move to transfer ownership of assets to the commercial sector in return for a leasing arrangement. This provision not only extends to capability but also the availability of the asset where the ships are procured with whole life logistic support arrangements.

The implementation of SMART Procurement in the MoD brought changes to the internal structure and the way it did its business. Integrated Project Teams were set up and one of the many benefits of the system was the identification of one person empowered to deliver functional and safety performance. However, it also meant that there was greater risk of inward focus and the possibility of projects acting independently with a subsequent loss of commonality of approach, standards and safety across the fleet.

Most Integrated Project Teams are now using industry to support their demonstration of safety objectives and delivery of safety policy. It is recognized that this could, in the future, lead to a loss of continuity of MoD corporate knowledge and expertise in key hazard areas.

The MoD operates ships with a diverse range of activities ranging from ships with no military role to battle ready front line warships. In the procurement of new capability there has been a move for some time to adopt pure commercial standards or a mix of commercial and military standards where they are appropriate to the role of the ship. The selection of appropriate standards in the key hazard areas for the many and varied roles of MoD ships requires a much more influential role of the independent safety authority early in the project life. The certification system as it stood did not accommodate this.

The MoD is the largest ship operator in the UK and as such can find itself alongside commercial owners being scrutinized by the government and the public. Whereas UK registered merchant ships are required by law to comply with the Merchant Shipping Acts, ships operated by or on behalf of the Crown are not.

The Secretary of State for Defence states that the MoD must put in place arrangements for safety that are 'so far as reasonably practicable', at least as good as those required by statute. Change was required to the certification system to reflect the way business was now being conducted and to provide the government and the public with an independent safety assurance system at least as good as merchant regulatory practice.

Implementation

The many contributing factors to the way in which the MoD conducts its business led to the endorsement by the Ship Safety Board in 2000 for the creation of Naval Authorities.

One of the underlying principles underpinning the regulatory system was that the issue of a Certificate would provide the MoD with assurance that a specific element of its 'Duty of Care' to the safety of the ship, its crew, third parties, property and the environment is discharged.

In setting up the Naval Authority regulatory system it was recognized that certification has an integral role to play in the justification of safety within the Ship Safety Case as defined by JSP430 *MoD Ship Safety Management Code*. The relationship with the safety case is illustrated in (FIG.1).

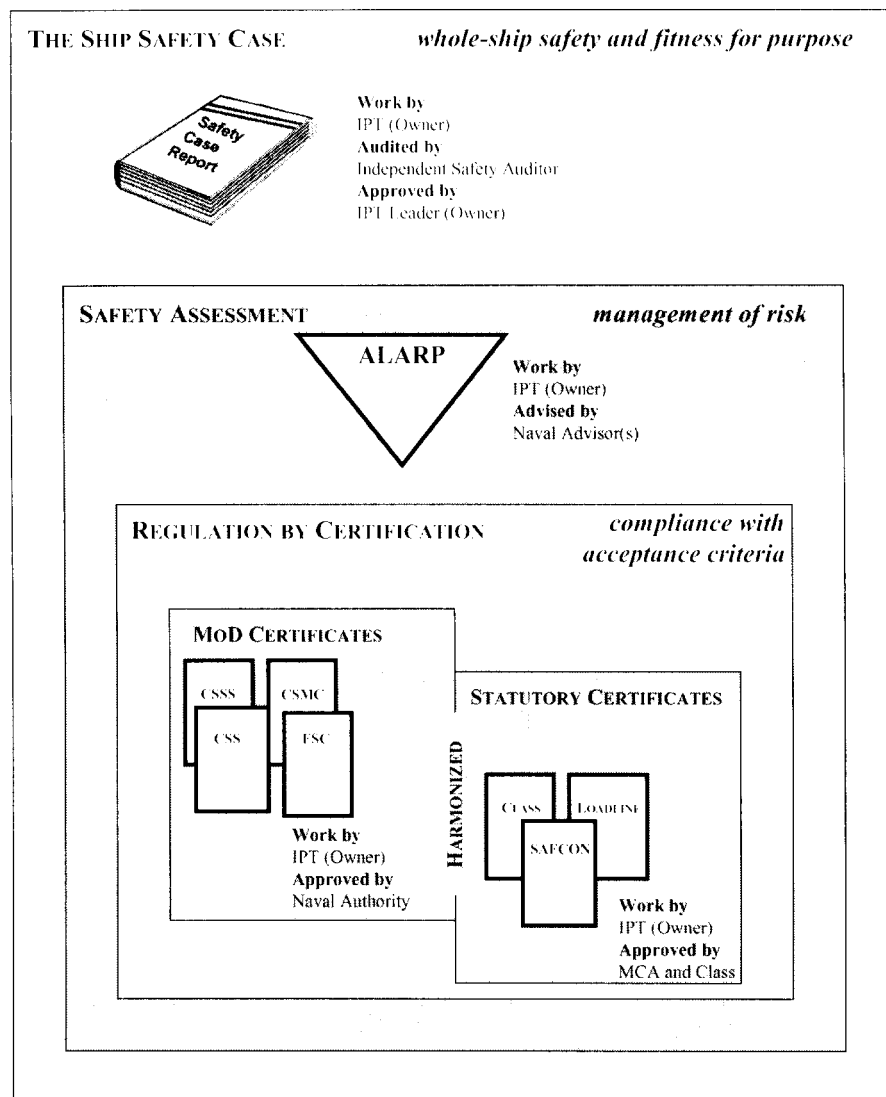


FIG.1 REGULATION AND THE SAFETY CASE

For conventional vessels where appropriate robust and mature standards exist the proportion of risk safeguarded through certification is greater than that for a complex novel vessel where more risk assessment is appropriate.

To be a Naval Authority that is harmonized with statute, the Naval Authority regulatory system must possess a number of fundamental attributes.

Creating the first Naval Authorities (surface ship stability and structure) was essentially a new endeavour by the MoD. As such, the approach was as structured as possible but there was a degree of addressing challenges as they emerged. To be a Naval Authority that is harmonized with statute, the Naval Authority must possess a number of fundamental attributes in order to provide robust and efficient regulation. The attributes identified to date and the supporting activities are shown in (FIG.2).

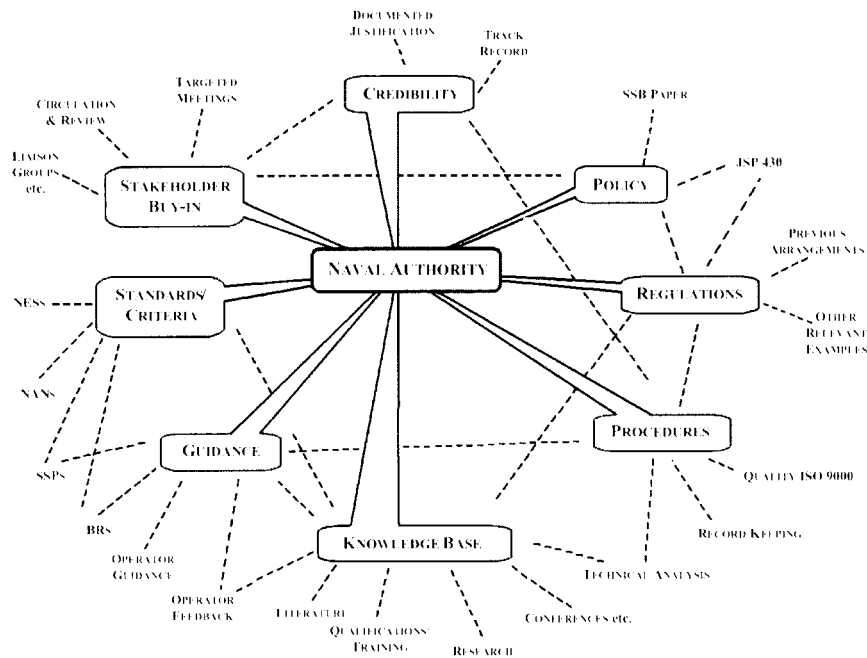


FIG.2 NAVAL AUTHORITY ATTRIBUTES

Across the Naval Authorities, these attributes combine with some emerging common themes:

- A format based on civil practice (providing society with visibility of naval safety processes benchmarked against civilian shipping).
- Robustness, i.e. a common approach for all vessels new and in-service with the only difference being for in-service ships being a different starting point in the design disclosure.
- Generic requirements, procedures and certificate format common for all Naval Authorities.
- Procedures that are flexible and allow for 'Ownership' to be delegated outside of MoD.
- Certificates that are issued on a periodical basis that is harmonized with statute.
- Cohesion with other Naval Authorities.
- Positive engagement with the Duty Holder on certification issues.
- Technical Expertise and Competence to act as both regulator and advisor.

Key elements

The attributes and common themes are discussed in the following sections as key elements of a Naval Authority system:

- Regulations.
- Certificates and defects.
- Advice.
- Standards.
- Accountability.
- Cohesion.
- Responsibilities.
- Awareness.
- Delegation.

Regulations

The guiding principles of regulation would be common for all key hazard areas and equally applicable to all types of ships and submarines addressing such aspects as principles of certification, delegation and management of non-compliance. Naval Authority contribution commenced with the production of Regulations for Surface Ships published in January 2001 addressing not only the regulatory system but also the requirements for Stability and Structural Strength safety certification.

The common regulations for certification are contained in the first three chapters that in turn are followed by the dedicated requirements specific to each certificate i.e. Chapter 4 Certificate of Safety-Stability and Chapter 5 Certificate of Safety-Structural Strength. This will in the future be followed by chapters containing the requirements for Certificates of Safety for Fire, Explosives and the Submarine Certificates of Safety for Stability, Structural Strength, Manoeuvrability, Watertight Integrity and Atmosphere Control. Together, the requirements for all Naval Authorities will form one cohesive document.

The philosophy of the Regulations is to provide assurance that the ship complies with agreed standards or criteria. Such criteria for certain certificates may be based purely on the safety case approach or a combination of both standards and risk assessment. Implicit in the regulatory function is the fact that a Certificate must be determined on the basis of the ship role, the design, the material state and operator guidance and the approach for each ship captured in the certification plan. This process, the 'Circle of Certification', is illustrated in (FIG.3).

The key elements of the 'Circle of Certification' are:

- Operational Requirement will state the type of vessel, its role and area of operations. It is at this stage that the standards or criteria applicable to the role are selected that will form the basis of certification.
- Design Disclosure provides the evidence that the vessel is designed to comply with the selected standards or criteria.
- Material State survey will confirm that the vessel reflects the design.
- Operator Guidance will demonstrate that clear instructions have been developed for the operator.
- Certification is appropriate if a complete case is presented.

- Re-certification restarts the cycle once more.

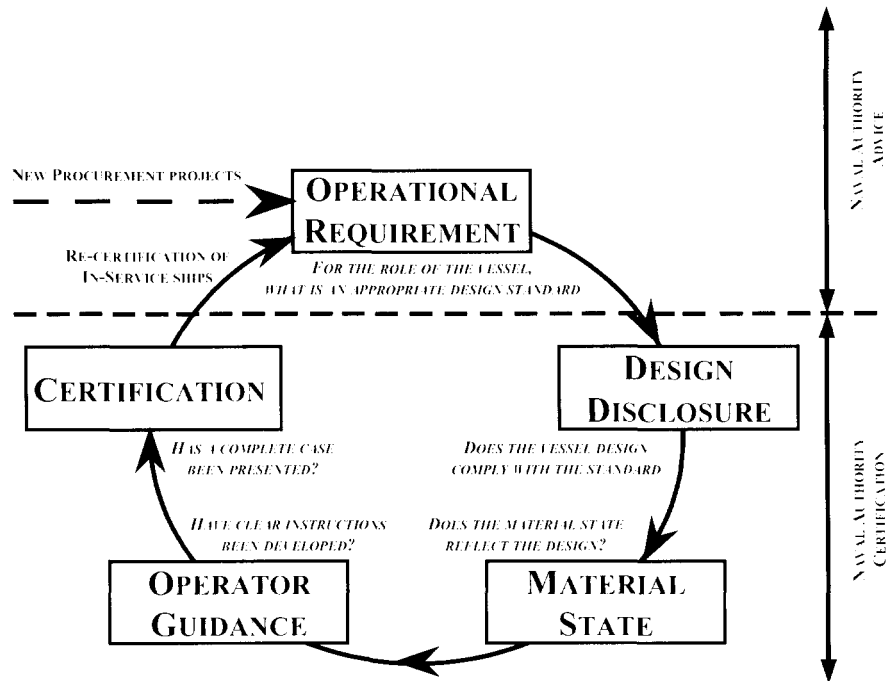


FIG.3 THE CIRCLE OF CERTIFICATION

Certificates and Defects

The safety policy contained in JSP 430 requires all ships operated by or on behalf of the MoD to have Naval Authority certification before proceeding to sea. Three types of certificate may be issued.

Certificate

A Certificate informally known as a 'full certificate' may only be issued when the full audit process is complete and the safety of the ship has been demonstrated as adequate for the role and the performance can be maintained over the period of the Certificate.

Interim Certificate

An Interim Certificate may be issued where the ship is required to hold certification without full evidence of compliance and that some justification that the more fundamental issues have been addressed and that there is no other reason to believe that the safety of the ship or personnel on board is in doubt.

Exemption Certificate

An exemption certificate may be issued when a ship is not required to hold a certificate. Such certificates are only issued on the basis that alternative and suitable certification is held. This differs slightly from the use of statutory exemption certification and in general is used where the issue of a MoD Certificate does not increase the level of safety assurance provided by the alternative regime. A harbour

tug with no military role would be a prime example for application of the exemption arrangements.

Defects occur on ships from time to time be it at build or in-service and a robust certification regime must have arrangements in place to manage such eventualities. In a similar manner to the merchant Classification Societies where a Condition of Class is raised when a defect affects compliance with the requirements of certification, the Naval Authority will raise a Condition of Certification. The time allowed for rectification will obviously depend upon the severity of the defects. The Naval Authority will decide on the date by which it must be rectified and in doing so they will seek the agreement of the Duty Holder. In extreme circumstances non-compliance may result in the issue of certification being withheld.

Advice

The MoD operates a very diverse range of vessels from canoes to aircraft carriers and from high-speed intercept craft to harbour tugs. The selection of standards is critical in providing the right degree of safety assurance appropriate to the role as safety is inextricably linked to capability for both peacetime and war. The role of the Naval Authority differs in some ways from its civil counterparts, as there is an additional role of advisor to both Duty Holders and Industry during the process of certification, which compromises pure independence. This role is most prevalent during the selection of standards or criteria however advice and guidance in some form is provided through the certification process if required. Therefore in discharging this important role, the Naval Authority must make it clear when it is acting as an advisor and not as a regulator and vice versa.

Standards

The Naval Authority will in general sponsor their own standards that in most instances will be focused towards the military role of MoD ships. Research and development will support the maintenance of such standards in order to ensure the level of safety assurance and capability provided is adequate. The knowledge should however ideally extend to other sectors in order to fulfil their role in the selection of standards. As it is recognized that the Naval Authority may not have the technical expertise to address all eventualities, advice will be sought from the appropriate authorities that may exist outside of the MoD.

Modelled on the concept of Merchant Shipping Notices, Naval Authority Notices were introduced to support both the maintenance of standards and the Regulations and to facilitate prompt distribution of information or changes to requirements to all concerned. Consultation with the Duty Holders and Industry in the development of new requirements is an important feature of the management system. Naval Authority Notices are formally presented to stakeholders at liaison groups such as the Hydromechanics and Structures Liaison Group and then issued for a period of consultation before being formally approved and implemented.

Accountability

The accountability for the safety of MoD shipping activities originates with the Secretary of State for Defence. In turn, authority is formally given to the Controller of the Navy by the 2nd Permanent Under Secretary. The Controller of the Navy through his responsibilities as Chairman of the Ship Safety Board then delegates authority to individuals to act as Naval Authorities. To allow the system to function efficiently subordinate officers are thence audited and receive individual delegation to act on behalf of the Naval Authority.

To support this structure and to ensure the regulatory system has a consistency of approach, the Naval Authorities formed the Naval Authority Council. The other members of the Council include the Head of the Ship Safety Management Office and representation from Duty Holders and Operating Authority. The Council exists to coordinate the Naval Authority regulatory regime, set ship safety policy, approve the Regulations and provide high level direction on safety matters for all MoD shipping activities. The Council reports directly to the Ship Safety Board (SSB) as illustrated in (FIG.4).

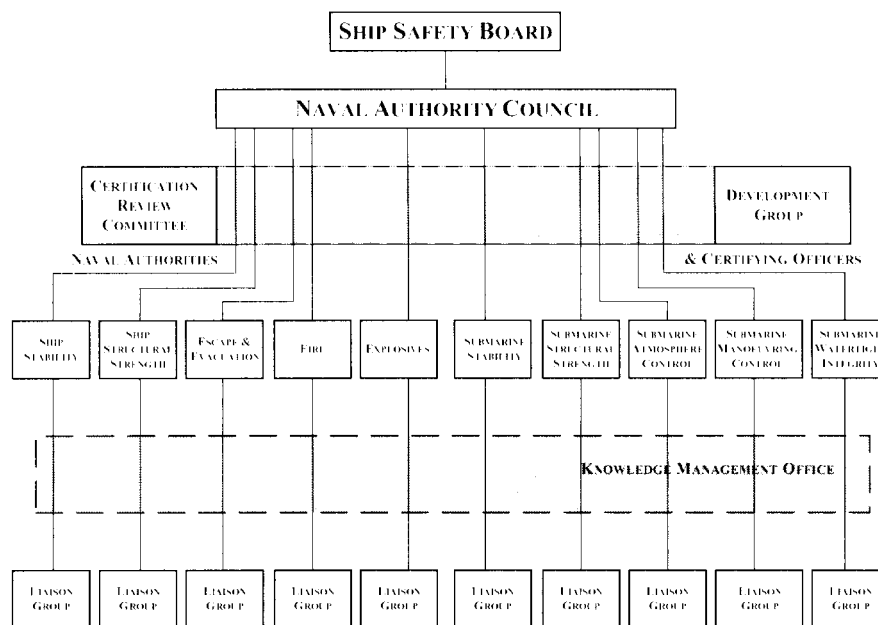


FIG.4 NAVAL AUTHORITY AND COMMITTEE STRUCTURE

The governing functions of the Council are:

Assurance

To report assurance to Ship Safety Board Chairman on the integrity of the MoD Naval Authority Regulatory Regime.

Co-ordination

To ensure that Naval Authority Regulations are created and operate in a consistent, coherent and coordinated manner.

Development

To develop the elements and organizations of the Naval Authority Regulatory Regime.

The accountability chain provides an important element of the MoD safety management system for the resolution of serious issues where difficult decisions are required to achieve an appropriate level of safety and in some instances a balance with military capability.

Cohesion

As new Naval Authorities develop there is a particular need to ensure a commonality of approach and cohesion. The interfaces between key hazard areas

are complex and multi-relational. It is possible to repeat this in a two-dimensional model (FIG.5).

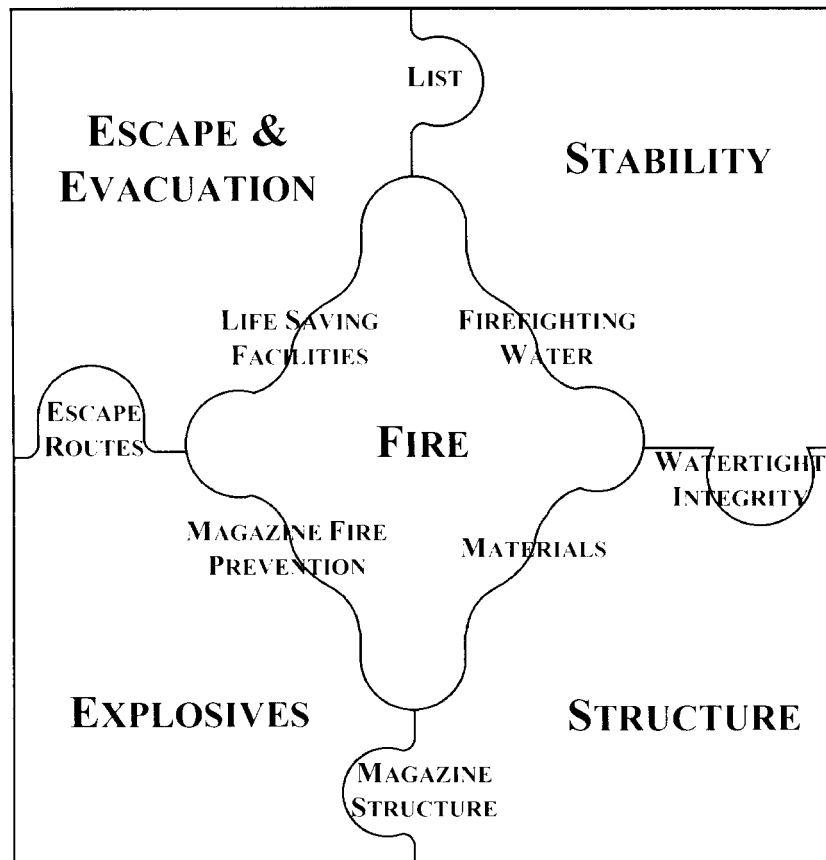


FIG.5 EXAMPLE INTERFACES WITH THE FIRE NAVAL AUTHORITY

The Naval Authority Development Group has the responsibility for promoting the cohesion of the certification areas as Naval Authorities develop and mature. For those Naval Authorities already operating there is a need to continually review progress, policy and issues regarding certification. The Naval Authority Certification Review committee (FIG.4) meets regularly to review certification issued across areas and debate and formally share any problems associated with individual cases. Furthermore it ensures interfaces between each certificate areas receive appropriate attention.

Responsibilities

The MoD is a complex organization and many parties are involved in contributing to the safety assurance shipping activities. With regard to Key Hazards the primary parties with responsibility for safety are the Duty Holder, Naval Authority and the Operating Authority. Their individual responsibilities relating Key Hazard Certification and the provision of the safety provided are outlined below.

The Duty Holder is primarily responsible for:

- Selection of standards or criteria.
- Demonstrating compliance with standards or criteria.
- Production of satisfactory operator guidance.
- Satisfactory upkeep of the ship.
- Maintaining professional competence.
- Submission for certification.
- Informing the Naval Authority and Operating Authority of issues affecting compliance.

The Naval Authority is primarily responsible for:

- Providing advice on standards and criteria selection.
- Maintaining regulations, guidance information and sponsored standards.
- Maintaining professional competence.
- Audit of certification submissions.
- Issue of certification.
- Informing the Duty Holder of non-compliance.

The Operating Authority is primarily responsible for:

- Operating the ship in a safe manner and in accordance with guidance provided.
- Maintaining professional competence.
- Performing appropriate maintenance.
- Informing the Duty Holder of issues affecting certification.

Awareness

As with any new system when introduced it is important the stakeholder i.e. Duty Holders, Industry and Operators are fully briefed on the new system, how it would operate, their responsibilities and how it would impact them. The Regulations received wide distribution for consultation and were followed by extensive briefings around the country once formally endorsed.

Promotion of the Naval Authority regulatory system maintained through life to ensure new stakeholders are exposed to the principles and the requirements.

Delegation

It may be appropriate on occasions to delegate authority to another organization where for example a Naval Authority does not have the necessary expertise or resource to be able to discharge some of its duties. The process of justifying the suitability of a Recognized Organization (or 'delegated Naval Authority') involves a formal assessment by the Naval Authority and formal acceptance by the Recognized Organization.

Delegation follows the same broad principles as those recommended by the International Maritime Organization (IMO) where three types authorization are available Limited, Partial and Full as defined in Table 1 below.

TABLE 1 *Levels of Delegation*

Level of Delegation	Authorization
Limited Authorization	The Recognized Organization is authorized to undertake specified activities for a specified ship or vessel on a case-by-case authorization basis (e.g. due to time constraints or geographical limitations).
Partial Authorization	The Recognized Organization is authorized to undertake specified activities to assess compliance against the agreed standard or criteria for specified classes of ships or vessels (e.g. watertight integrity surveys of a particular class of vessel).
Full Authorization	The Recognized Organization is authorized to undertake specified activities for specified classes of ships or vessels and to issue Certificates on behalf of the MoD Naval Authority, Equivalence. The Recognized Organization is authorized to assess and accept non-compliance with the standard or criteria raising a Condition of Certification in the normal manner.

In any of the above levels of delegation if for whatever reason the Recognized Organization, or delegated Naval Authority, cannot accept arrangements then they are formally reported to the Naval Authority.

The MoD Naval Authority does not diminish the Duty Holders responsibility to manage ship safety with which they are charged. Similarly it does not seek to prohibit the use of consultants in design, construction or repair selected by the Duty Holder; though if used for surveys to support certification then they will need to be assessed by the Naval Authority or an appropriate Recognized Organization acting on behalf of the Naval Authority.

The process of delegation to Recognized Organizations involves in the first instance the selection of prospective candidates. The implementation of Naval Authority regulation had to consider the impact on the MoD shipping community and hence one of the primary drivers in delegating authority was to firstly select the major industrial players involved in the material state survey of MoD vessels. Babcock Rosyth Engineering Ltd, Devonport Royal Dockyard Ltd and Fleet Support Ltd, Lloyd's Register of Shipping, Det Norske Veritas and British Maritime Technology Defence Services Ltd have all been offered and accepted some form of delegation.

TABLE.2 *Typical Degrees of Authorization*

Functional Activity			
	Limited¹	Partial	Full²
Operational Requirement	No delegation	No delegation	No delegation ³
Design Disclosure	✓	✓	✓
Material State	✓	✓	
Operator Guidance	✓	✓	
Certification	No delegation to issue Certification	No delegation to issue Certification	
Notes:			
1. Delegated on a case by case basis.			
2. Full authorization to issue a Certificate will only be granted if the organization has demonstrated competence in all activities.			
3. Although not formally authorized, the organization shall take due recognition of the Operational Requirement.			

By definition the assessment for full delegation is more demanding than for partial or limited as it requires much greater scrutiny of competence, internal management systems and processes.

The process of assessment for delegation takes place in two stages, firstly a self-assessment form is issued to the candidate organization and secondly dependent upon a review of this a more in-depth assessment will take place, possibly with third party assistance. The self-assessment enables the organizations to gain an awareness of the requirements of authorization, to identify and gather evidence and for the organization to make a preliminary judgement as to the appropriate degree of authorization. The assessment can also differentiate between types of ships such as a Warship or an Auxiliary.

The main areas of the assessment cover:

- Corporate Competence.
- Procedures.
- Specialist Skills.
- Staff Competence.
- Infrastructure.
- Administration.

After the delegation offer has been formally accepted the Recognized Organization can expect to be audited at appropriate intervals during the period of authorization.

Impact on the MoD

Prior to Naval Authority regulation certain Key Hazards received certification such as Surface Ship Stability and Structural Strength. The changes in the approach to certification did not have a significant impact on Duty Holders for those that were already proficient in the previous system. For those that were not, then there was perhaps more of a learning curve and a greater impact on resources to satisfy the new requirements. The main impacts on each of the three main parties are described in the following paragraphs.

Duty Holders

As expected for new areas of certification that had not previously existed then there can be considerable impact on Duty Holders. Therefore all Duty Holders and Industry are openly encouraged to have dialogue with the Naval Authority in order to fully comprehend the requirements and the impact they will have.

There were however some new requirements that were introduced to areas that already received certification. These were mainly associated with improvements to the old system and providing a more integrated certification system. An example of this was improving the robustness of the link between surface ship structure, watertight integrity and stability. This involved new requirements for evidence of the state of watertight integrity both internally and externally. These surveys in most instances identified defects that had to be rectified which had been in existence under the previous regime.

Where defects exist that require rectification, these will be recorded as Conditions of Certification in a similar vane to the Merchant Classification Society Conditions of Class. Failure to adequately rectify conditions will result in the Certificate becoming invalid. This new system has meant a greater workload on projects in order to action Conditions of Certification and has led the Naval Authority providing some 'soft policing' to warn projects of impending deadlines.

The MoD has relied for many years on the support of industry for assistance in inclining experiments and this trend is set to continue. The basic ship derived from the experiments forms the cornerstone of the data for demonstration of compliance with the standard. It is therefore crucial that the Naval Authority confirms that it is performed under controlled conditions and to a level of accuracy that can be acceptable for as the basis for certification. The Naval Authority or a Recognized Organization must be in attendance and the Inclining Officer must therefore take account of this when conducting the experiment.

The attention to material state has received continuing scrutiny following the gestation of the first Naval Authorities and as from 1 January 2003, all surveys that are conducted in support of Naval Authority regulation must be performed by the Naval Authority or a Recognized Organization.

Operating Authority

Prior to the Naval Authority regime the Operating Authority had previously received certification. As a matter of routine Ships Staff report defects in the material state for all manner of aspects. It is now incumbent upon the Duty Holder to notify the Naval Authority of relevant defects. This important element of the safety management system now has a direct affect on the validity of certification and the Operating Authority can now have greater confidence in robust and comprehensive certificates.

Naval Authority

The impact on the Naval Authority has clearly been significant as a robust and auditable management system and supporting structure is required to discharge its responsibilities. The key elements that have to be put in place to support the function of the Naval Authority are:

- Maintenance of Regulations.
- Maintenance of Standards.
- Management and Audit of Delegation.
- Maintenance of Procedures.
- Submission Audit.
- Certification Issue.
- Monitoring Certification.
- Monitoring Conditions of Certification.
- Configuration Control.
- Documentation Management.
- Maintenance of Technical Competence.

As expected when serving the largest UK shipping operator, auditing submissions is a time consuming and manpower intensive occupation. Around 60 ships have received certification and 80 conditions of certification were issued in the first 18 months of operation. One of the main reasons for the apparent large number of Conditions of Certification is that the new Naval Authority regime exposed areas that had been previously overlooked. Conditions of Certification were raised and action taken to rectify these shortfalls which has now improved the level of safety.

Impact on Industry

Industry exposure to MoD self-certification may fall under one of two descriptions:

Either

As a customer of MoD certification when acting on behalf of the MoD ship projects, i.e. as the 'owner'.

Or

In providing technical or managerial assistance directly to the Naval Authority in support of MoD certification.

The following paragraphs describe the experience of one delegated Naval Authority, BMT Defence Services Ltd.

BMT Defence Services Ltd has provided technical and managerial consultancy to the MoD since 1986. In this time, the company has grown to approximately 240 staff and the range of skills has expanded. Originally the company specialized in performing small Naval Architecture and Marine Engineering tasks under enabling contracts and is now covering a wide range of activities in ship and submarine design and support. In addition to a whole ship design capability, expertise can be directed to resolving specific problems at equipment, system or whole ship level. Supporting these activities, and other areas outside the naval sector, the company offers specialist programme management skills in formal safety assessment, safety and risk management.

With specific reference to Naval Authority regulation, BMT Defence Services Ltd has undertaken a variety of tasks in support of MoD Naval Authority. These include numerous watertight integrity surveys on Type 42 destroyers and CVS

aircraft carriers in support of the Certificate of Safety – Stability, and many fire assessments of ships and submarines to support the Certificate of Safety – Fire. Furthermore, BMT Defence Services Ltd has undertaken a variety of consultancy tasks to support the development of Naval Authority regulation including:

- Developing regulations and procedures for surface ship escape and evacuation.
- Developing internal procedures for five submarine key hazards (structure, stability, manoeuvring and control, atmosphere control and watertight integrity).
- Production of material to support raising awareness across the MoD shipping community.

Thus, in the course of working for the MoD, BMT Defence Services Ltd has been exposed to both aspects of MoD self-certification, acting on behalf of the ‘Owner’ and on behalf of the Naval Authority.

It is for this reason coupled with the independence of BMT Defence Services Ltd that lead the MoD to offer delegated Naval Authority status to the company. The delegation offered to BMT Defence Services Ltd initially covered:

- Full Delegation (issuing survey and certification) under the Certificate of Safety – Structural Strength for Landing Craft.
- Partial Delegation (survey only) under the Certificate of Safety Structural Strength and Certificate of Safety – Stability for all MoD surface ships.

So what effect has this had? In order to draw out the lessons learned, it is first necessary to describe the experience of BMT Defence Services Ltd with respect to acting as a delegated Naval Authority. This experience is best outlined under two headings:

- Developing delegated Naval Authority arrangements.
- Demonstrating delegated Naval Authority arrangements.

Developing delegated Naval Authority arrangements

It became apparent shortly after the offer of delegation that there were a number of issues that required clarification and that there were likely to be more challenges emerging in the future. Typical questions that were asked included:

- How will independence be maintained when other consultancy work is undertaken within the company?
- How can we ensure that members of staff identified to undertake delegated Naval Authority work are suitably qualified?
- What is the best way of keeping records?
- How can we provide guidance to Owners and Naval Authorities regarding access to delegated Naval Authority services?
- What is the relationship with the MoD Naval Authority?

It was concluded that the best way of addressing these and many other questions would be to create a sub-organization within BMT Defence Services Ltd to undertake delegated Naval Authority duties; a ‘Naval Authority Service’.

The BMT Defence Services Ltd Naval Authority Service has been created within BMT Defence Services Ltd to provide a coherent and comprehensive service of independent safety assurance to owners and operators of naval vessels.

The Naval Authority Service has been built on the delegation from the MoD Naval Authority and supported by the extensive track record of BMT Defence Services Ltd. It is consistent with the requirements of the MoD Naval Authority with sufficient retained flexibility to allow them to be tailored to meet the requirements of other navies and Duty Holders. The MoD Naval Authority assures quality of service through the continual assessment of the BMT Defence Services Ltd Naval Authority Service.

The attributes and competence of BMT Defence Services Ltd that have been used as a basis cover specialist procedures, staff knowledge, libraries and archives and research and development.

Specialist procedures

These have been developed over the years to support BMT Defence Services Ltd current business areas. Each 'Code of Practice' (CoP) supplements the Company Quality Procedures by providing detailed instruction on the methods of undertaking activities that are commonly performed. A list of some BMT Defence Services Ltd Codes of Practice is provided in Table 3. The CoPs cover technical aspects as well as responsibilities of various staff in terms of implementing the procedures, staff qualifications that are required for the given task and any records that need to be established and maintained. The CoPs are under constant review and it may be necessary to revise existing CoPs or develop additional CoPs as the need arises.

TABLE.3 *Some BMT Defence Services Ltd Codes of Practice*

No	Title
NA-01	Inclining Experiments and Displacement Checks.
NA-02	Naval Architecture Software Tools.
NA-03	Preparation of data for use by clients with proprietary software.
NA-04	Concept and Feasibility Studies.
NA-05	Stability Certification Procedures.
NA-06	Computer Model Definitions.
NA-07	Structural Assessments.
NA-08	Finite Element Analysis.
NA-09	Use of the GODDESS Computer System.
NA-10	Use of PARAMARINE Naval Architectural Software.
NA-11	Watertight Integrity Surveys.
NA-12	Steel Ship Structural Surveys.
DNA-01	BMT Defence Services Ltd Delegated Naval Authority Procedures.

Staff Expertise

BMT Defence Services Ltd recognizes that its' success is highly dependent upon the knowledge and experience of motivated staff. Along with prioritizing staff retention through schemes like the Employee Benefit Trust, BMT Defence Services Ltd targets recruitment to fill skills gaps. To monitor the skills available within the company, BMT Defence Services Ltd maintain staff skills matrices that cover a range of technical areas. Those databases also allow training to be targeted to where it provides maximum benefit.

Libraries and Archives

To supplement individual's knowledge, BMT Defence Services Ltd has a central library. This library includes:

- MoD standards.
- Commercial standards.
- Technical books.
- Technical publications.

In addition, all company produced documents and information (e.g. reports, calculation sheets, quality assurance records) are scanned into an electronic archive system. This information can be searched by title, author or keywords. In addition, staff have the ability to perform text searches through information currently stored on the computer network. All of these searches are limited by the usual 'need to know' rules. The information is used to ensure that best practice is adopted wherever possible.

Research and Development

The BMT Group was formed from merging two research organizations NMI and BSRA. From this firm foundation, BMT Group has developed into an international organization with companies operating in the commercial shipping, oil and gas, defence and environmental markets, as well as such diverse sectors as rail, energy, commercial aviation, aerospace and Formula One. BMT continues to invest approximately 6% of its annual turnover in research, almost double that of comparable organizations. This strong research base means that there is always a steady flow of new, groundbreaking products and services, which BMT can bring to the market.

Access to the Naval Authority Service is shown on (FIG.6). This shows that the requirements of the MoD Naval Authority that relate to assessing the competence of the Delegated Naval Authority require access to the internal arrangements - the Codes of Practice in the case of BMT Defence Services Ltd. The Owner or Duty Holder would need to reference the client procedures that describe the services on offer.

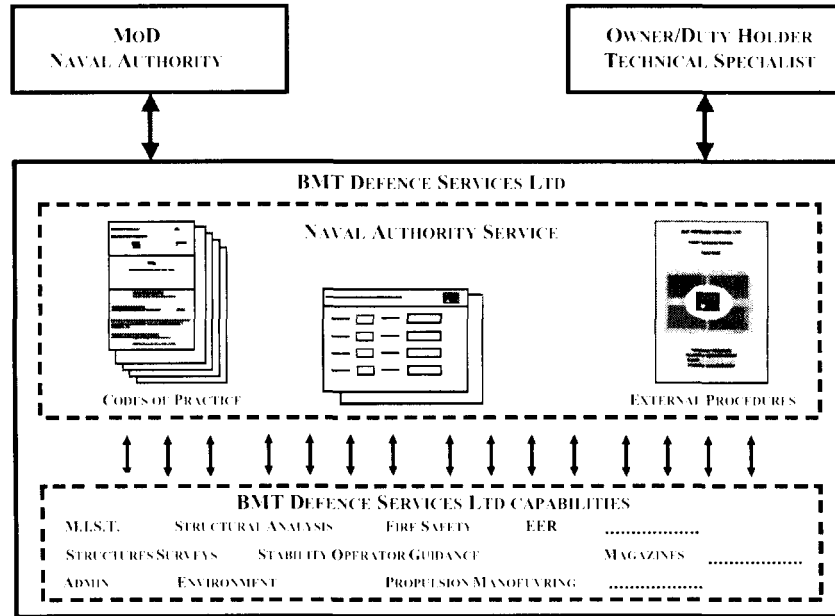


FIG.6 STRUCTURE OF THE BMT DEFENCE SERVICES LTD NAVAL AUTHORITY SERVICE.

These attributes and competences have provided the basis for the BMT Defence Services Ltd Naval Authority Service. The service is structured to consist of four distinct strands:

Certification

Risk-based identification of appropriate standards and criteria, plan appraisal, survey (see below), operator guidance and overall certification for specific hazards such as ship structures.

Survey

Survey of new build ships, in-service ships and ship conversions to obtain evidence that the material state is consistent with maintaining compliance with the design standards and criteria in support of overall safety assurance and certification. Surveys are undertaken by subject and include: structure, watertight integrity, and fire.

Assessment

Assessment of naval architecture and engineering analysis, equivalence, relevance of standards and criteria, degree of compliance with agreed standards and criteria, preparation of evidence in support of certification, preparation of operator guidance manuals, and proposals for defect mitigation. This may include stability, structure, fire arrangements, escape and evacuation arrangements, and magazine design.

Administration

Knowledge management of certification, defects, audits and delegation, based on a dedicated database specifically designed to support MoD Naval Authorities and ship project teams.

Demonstrating delegated Naval Authority arrangements

In order for the MoD Naval Authority to gain assurance that BMT Defence Services Ltd is sufficiently competent to be granted full delegation for the Certificate of Safety – Structural Strength and partial delegation with respect to the Certificate of Safety – Stability, BMT Defence Services Ltd were required to undertake a self-assessment against a defined framework. The findings of this self-assessment are presented in (FIG.7).

SUBJECT	KEY POINTS	SUBJECT
CORPORATE COMPETENCE	<ul style="list-style-type: none"> ● Established in 1985 from a merger between NMI and BSRA ● Long track record of work relevant to the delegation ● Worked closely with other parts of UK industry ● Need for independence in Naval Authority work recognized 	<input type="radio"/> Poor, effort required <input type="radio"/> OK, some work <input checked="" type="radio"/> Good, maintain
PROCEDURES	<ul style="list-style-type: none"> ● BMT DSL to use procedures consistent with MoD ● Electronic records will be kept in a database 	<input type="radio"/> Poor, effort required <input checked="" type="radio"/> OK, some work <input type="radio"/> Good, maintain
SPECIALIST SKILLS	<ul style="list-style-type: none"> ● BMT has an extensive range of specialist skills ● BMT DSL 'specialist procedures: Codes of Practice' ● BMT DSL maintains company libraries 	<input type="radio"/> Poor, effort required <input checked="" type="radio"/> OK, some work <input type="radio"/> Good, maintain
STAFF COMPETENCE	<ul style="list-style-type: none"> ● Specific TORs for Naval Authority staff ● Accredited staff training schemes ● Staff skills matrix ensures appropriate staff selected 	<input type="radio"/> Poor, effort required <input checked="" type="radio"/> OK, some work <input type="radio"/> Good, maintain
INFRASTRUCTURE AND ADMINISTRATION	<ul style="list-style-type: none"> ● Adequate office facilities and location ● Adapted MoD Naval Authority procedures ● Hard and soft records will be held 	<input type="radio"/> Poor, effort required <input type="radio"/> OK, some work <input checked="" type="radio"/> Good, maintain

FIG.7 BMT DEFENCE SERVICES LTD DELEGATED NAVAL AUTHORITY SELF-ASSESSMENT

The UK MoD Naval Authority reviewed this self-assessment and concluded that delegating Naval Authority duties to BMT Defence Services Ltd was appropriate subject to a full assessment based on a formal demonstration of the service.

The aim of the full assessment by the MoD Naval Authority based on a formal demonstration was to gain assurance that all the necessary procedures and arrangements were in place. This could either be achieved through a cautious step-by-step approach or else the whole process could be tried out in anger leading to the issue of a Certificate of Safety under full delegation of Naval Authority responsibilities.

It is only the latter approach that would involve all aspects of regulation from high-level policy to technical detail and that would test all four strands of the BMT Defence Services Ltd Naval Authority Service; certification, survey, assessment and administration. As such the MoD Naval Authority full assessment was based on this approach. This might be viewed as somewhat ambitious, and so to address any concerns, sufficient checks and balances were put in place by both the MoD Naval Authority and BMT Defence Services Ltd to control any potential risks.

This approach has subsequently proved effective and the issue of a Certificate of Safety – Structural Strength was achieved on the 7 August 2002, a year and five days after the initial offer of delegation from the MoD.

The case example selected to test the ability of BMT Defence Services Ltd to provide certification under Full Delegation from the MoD Naval Authority was the Landing Craft Utility (LCU) Mk9(S) 701. This particular LCU was built by Brooke Marine Ltd in 1965. Very similar to the other LCU Mk9(S) craft, it has a deep displacement of around 180 tonnes at about 1.5m draught and has a length of approximately 27.5m. As such, it is not a full ocean-going warship and does not exhibit the same degree of complexity of design and construction apparent in an aircraft carrier or destroyer. Despite this, the LCU Mk9 craft pose the same challenges to certification and offered an ideal opportunity to test the BMT Defence Services Ltd internal procedures developed to support the delegated Naval Authority role.

The audit followed the same principles outlined in the MoD Regulations, i.e. the issue of a certificate was conditional open the satisfactory demonstration by the Duty Holder that the Operational Requirement, the Design Disclosure, the Material State and the Operator Guidance were consistent and satisfactory. These are discussed in turn.

Operational Requirement

The role of the LCU Mk(9S)) is to operate from assault ships to transfer tracked army fighting vehicles, wheeled vehicles, stores and military personnel to and from the beach. They are required to operate independently over long distances for many days to provide military and logistic support for landing forces. The LCU Mk9's are designed for limited sea states, and this needed to be captured in the subsequent Operator Guidance. The craft are operated with a crew of approximately 6 and with up to about 90 embarked forces.

With respect to the acceptance criteria for structural certification, no comprehensive record exists to state what standards were used to design the landing craft. Documents that existed around the time of their design consist of the General Hull Specification and the Structural Manual (dated March 1973). However these do not state Factors of Safety, Corrosion Margins, Fatigue Requirements etc. In recent years, the craft have been surveyed to NES 155 hence it would be consistent to assess the design of the structure against NES 110 or 154 or similar.

Although the survey standards address local deformation, these core design standards do not specifically address local deformations resulting from regular collision or beaching. Other than considering robustness of the design, this matter can only then be addressed by survey under the Material State survey.

In addition to these considerations, it was also necessary to consider the link between the Certificate of Safety-Structural Strength and the Certificate of Safety-Stability. The latter requires the craft to survive following damage and subsequent flooding.

Design Disclosure

The original Book of Calculations was developed in 1960. It assessed the limiting case of 2 x 50 ton Tanks positioned on the well deck with the craft beached. The calculations assessed longitudinal strength and the strength of the well deck and showed the structure to be more than adequate against the design criteria specified (which was a stress in terms of tons per square inch). However, since 1960 the structural configuration has changed (the side structure was raised and there is a new well deck) and the typical payloads have inevitably changed.

Thus, to support this audit, the BMT Defence Services Ltd Naval Authority Service have reassessed the strength of the craft to gain an understanding the loads

and factors of safety. Together with the tens of years of vessel experience, these can then be used to consider the significance of defects and enable a logical assessment of the material state. These recent calculations covered global loads, hydrostatic pressure and vehicle deck loading are summarized below.

Based on the known role and operating philosophy, the following load cases were defined as being representative of typical loads:

- Global loads based on the craft being supported at the fore and aft cutups.
- Loads resulting from the payloads based on one Main Battle Tank.
- Hydrostatic loads arising from saltwater ballast.
- Flooding resulting from damage or external environment.

These loads are depicted in (FIG.8).

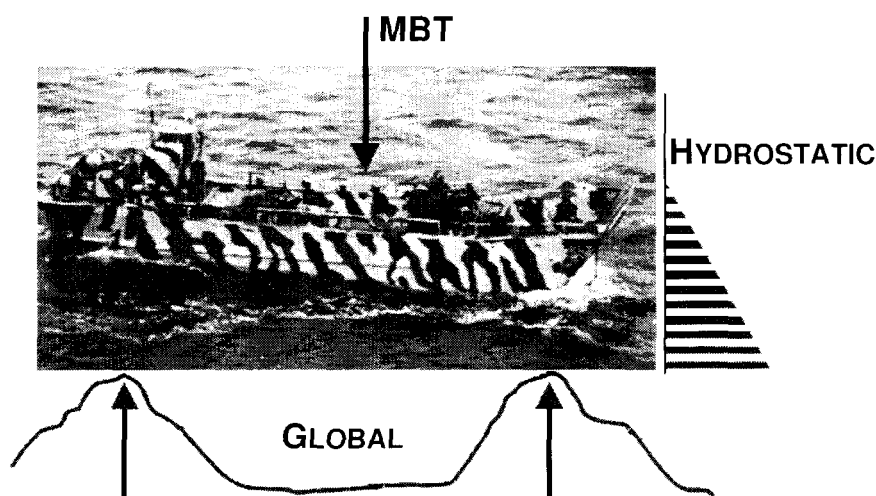


FIG.8 LOADS CONSIDERED FOR DESIGN DISCLOSURE

These loads have been applied to various parts of the ship's structure as appropriate: the vehicle deck main and intermediate stiffeners, all watertight bulkheads, the side shell and the outer bottom. The failure modes for which calculations were undertaken included stiffener tripping, overall grillage flexural buckling, plate/stiffener interframe collapse and plate failure.

With respect to global loads, the overall bending moment resulting from the LCU being supported on two points (as in the original 1960 design disclosure) induces compressive stresses above the neutral axis and tensile stresses below. In all cases the induced stresses are well below yield stress and critical stresses in the vehicle deck main and intermediate longitudinals and in the outer bottom.

The loads resulting from the weight of the Main Battle Tank on the deck grillage are significant, particularly with respect to the stress in the longitudinal deep girders. The load in the longitudinal girders is partially supported by vertical pillars and so the integrity of these pillars is crucial to the strength of the well deck when subjected to large vehicle loads. The in-plane loads in transverse bulkheads are less significant but attention should be paid to potential plate buckling due to in-plane compression.

Hydrostatic loads were assessed with various heads of water. Firstly, the ballast tank bulkhead is subjected to a large head (0.5m over the side deck) as this forms part of the ballast tank boundary. With this head of pressure the stress in the flange of the vertical stiffeners was found to be high. The other watertight bulkheads have been assessed with a lower head (up to the well deck). The capability of these bulkheads with respect to hydrostatic head is less than that in the ballast tank bulkhead. This is understandable, as the hydrostatic head in the remaining watertight bulkheads should only occur following damage and flooding when a degree of plastic deformation would be acceptable. The hydrostatic pressure acting on the side shell and outer bottom was taken as 1m above the well deck. The resultant stresses were found to be moderate but are within acceptable limits.

To summarize the Design Disclosure, the overall strength of the LCU Mk9 design is more than adequate. The review by the BMT Defence Services Ltd Naval Authority Service concluded that when interpreting survey reports, attention should be paid to watertight integrity, overall budding and budding in plating in ballast tank bulkhead, buckling in plating in other bulkheads, and the integrity of the under well deck pillars.

Material State

The Survey Procedures were in accordance with DefStan 02-155 Part 2 supplemented by the BMT Defence Services Ltd Code of Practice NA/12 Structural Surveys of Steel Ships.

The LCU Mk9 craft are very prone to damage during routine beaching operations. To reflect this, the Duty Holder recommended that the CSSS be issued every 2 years to usually coincide with a Refit Period. In addition to this two-year survey and certificate, a yearly inspection survey is made to assess the structural state of the craft and whether it can still support the issued CSSS.

Recognizing that this certificate was to be issued for the first time by the BMT Defence Services Ltd Naval Authority Service it was considered very necessary for the 2002 survey to be undertaken by the BMT Defence Services Ltd Naval Authority Service. Once tasked by the Duty Holder, the survey was conducted on the 1 August 2002 at Portsmouth Naval Base and the findings recorded in the BMT Defence Services Ltd Naval Authority Service database.

Operator Guidance

The principal document is BR 1756(2) *Handbook for Landing Craft Utility Mk 9(S)*. This was reviewed and found to be clear and concise in defining the operational limits of the craft. BMT Defence Services Ltd Naval Authority Service prepared a Structural Statement, which supplemented the BR and addressed a few remaining issues.

Certification

In accordance with the delegated Naval Authority procedures, the BMT Defence Services Ltd Naval Authority Service core team presented the case for the issue of a Certificate of Safety – Structural Strength to the BMT Defence Services Ltd Naval Authority Certification Committee. The committee recognized that the vessels are unusual in many respects and that their operation subjected them to routine damage; consequently their structure is over-designed for normal ship type loads. History has demonstrated that the structure to be adequate for the role, this comes down to ensuring that material state is maintained through the identification of defects, rectification being conducted by a reputable organization and inspected

to an appropriate level after repair. This survey demonstrates continued compliance with the selected standards and hence supports the CSSS.

The committee reviewed the audit and the survey findings and concluded that the issue of a Full CSSS was appropriate to be valid for 2 years. This was signed and issued on the 7 August 2002.

What the future may hold

The focus of the MoD in the short term is both on consolidation and maturing of the current system combined with the necessary development needs. A Naval Authority Knowledge Management Office is planned to provide support arrangements to the Naval Authority and an information system available to the wider community of Recognized Organizations, IPTs, Operators and Industry.

The development of new Naval Authorities continues which brings with some immediate short term issues to address:

- Risk-based vs standards-based.
The two leading Naval Authority areas are surface ship stability and surface ship structural strength. Both are biased towards a more standards based approach. However, many of the key hazard areas where Naval Authority regulation is being implemented (fire and submarines in particular) require a more risk-based approach. The regulatory process therefore needs to be modified to enable a blend of standards and risk without compromising either approach. This work is now in hand.
- Scope of Certification.
Key Hazards represent a significant danger to the lives of several persons and whose consequences may cause the loss of the ship or significant damage to the environment. In developing certification each Naval Authority has had to in turn define the scope of certification. This work is in hand and subsequently the scope may be seen to develop as the process matures. The expansion of the scope can also be at the bequest of the Duty Holder who may wish to have additional areas included in certification as 'Owners' Requirements thus strengthening the demonstrable evidence for the safety case.
- Naval Class.
The concept of Naval Class started with the classification of the structure of ships. With time, this is developing into the other areas of propulsion and lifesaving. It provides a convenient and structured model in which to incorporate both military and commercial standards and in particular the naval equivalence to statutory standards. Should such a system mature then it would be a natural progression for Naval Authority Certification to be based on compliance with the standards or criteria of Naval Class.

In the long term, some areas where developments are likely, be they from UK MoD or industry or other navies include:

- Naval IMO.
In the commercial shipping world, Class Societies conduct statutory duties under delegation from Flag States. The MoD Naval Authority delegation is based closely on this format although it this is of course only on a national basis rather than international. There may well be an appropriate time in the future to create an 'International Naval

Organization' to mirror the IMO. This would allow navies to more effectively and efficiently develop baseline safety standards. The 'Military Flag State' (in the case of the MoD this would be the Ship Safety Board) would operate the Naval Authorities (Statutory Authority equivalent) to provide the essential safety certification.

- Naval equivalence of statutory standards

Naval Authorities within the MoD are being established to cover the various ship key hazards. Ultimately it is quite possible that a number of Naval Authorities will exist in parallel. Economies of scale would suggest that other than sharing common arrangements for regulatory processes, there may be sufficient justification for combining standards or acceptable criteria. At the very least, there will certainly be a need to carefully map the scope of Naval Authority certificates to make sure there are no shortfalls or overlaps.

Conclusions

The changing state of MoD shipping has meant that the traditional manner in which certification was issued was no longer appropriate. The MoD is a large organization and the Naval Authority regime now provides a distinct body for independent safety assurance. Just as the Maritime and Coastguard Agency provides certification for merchant shipping, Naval Authority certification provides an additional degree of demonstrable assurance that the MoD has taken all reasonable steps to assure the safety of the fleet.

One of the benefits of implementing the system is that the differing roles of acting on behalf of the Duty Holder and acting on behalf of the Naval Authority have been very much clarified at all levels from MoD senior management to the surveyor at the ship. In the past under the old MoD arrangements for safety certification, the distinction between the two was blurred.

In developing the new regulatory system Industry has received varying degrees of delegation to act on behalf of the Naval Authority. This process is now beginning to mature and a number of Certificates have been issued by Recognized Organizations with full delegation. BMT Defence Services Ltd, an independent engineering consultancy with an extensive track record of work in support of MoD ship safety, is one such organization that has been offered and accepted delegation. In order to provide a coherent service to the MoD with respect to Naval Authority regulation, BMT Defence Services Ltd has created a Naval Authority Service. Based on a self-assessment and a subsequent full assessment by the MoD Naval Authority against a case example, the MoD Naval Authority has authorized the BMT Defence Services Ltd Naval Authority Service to act on its behalf as follows:

- Full delegation under the Certificate of Safety Structural Strength.
- Partial delegation under the Certificate of Safety Stability.

To date, the implementation of Naval Authority regulation has not placed too great a burden on the already limited resources. Independent safety assurance under Naval Authorities is robust, efficient and effective. With developments continuing and interest increasing within the MoD, in industry and in other navies, the future for Naval Authority regulation is extremely promising.