THE WHAT, WHY, WHO AND HOW OF SUBMARINE COMBAT SYSTEMS INTERFACE MANAGEMENT

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ABSTRACT

With the onset of data highway technology and combat systems capable of processing vast amounts of information, definition of system interfaces (using NES 1013 part 2) and their on-going control (SSCP 38 chapter 414 procedures) are essential to establishing and maintaining system integrity. This article describes how interface management is coordinated on a cross-class basis for submarine combat systems.

What *(is the scope)*?

Interface documentation is the essential tool of interface management and is encompassed in Naval Engineering Standard (NES) 1013 part 2. The NES's title of 'Interface Documentation' sells it short as the NES deals not only with formal interface definitions, but shows how the structure of a system's interfacing components can be used as the basis for on-going system management.

The basis for exercising this coordinated management, is the interface coding system embracing all submarine combat systems. To operate successfully, the interface coding mechanism has to:

- Encompass both system and equipment level information.
- Be coordinated across systems, identifying where common equipments or services are involved.

The intention to manage the system using interface documentation must be established at the outset of a project.

Why (*do we need interface documentation*)?

The interface control initiative originated in the United States with the POLARIS programme in the late 1950s. The adoption of configuration management and interface control techniques were vindicated by the successful firing of the first POLARIS missile from a submarine, only 5 years after the project had started. When the U.K. POLARIS programme was instigated in the mid 60s the U.S. system definition and control aspects were incorporated into the U.K.'s Procurement Executive Plans (PEPLANs). Further demonstration of the need came in the 1970s when some rather traumatic system interface problems were experienced when interfacing the Amercian Mk46 Mod2 torpedo into service with the Royal Navy. The demand was seen for formal system interface definition to ensure that remote projects could work to agreed boundary conditions, which could not be changed without mutual and system-level concurrence.

In the past, the fighting system performance was determined by the human interfacing links. Over the last 10 years combat systems have become much more complex and interactive, with data highway technology facilitating increased automation to handle the growing level of exchanged data between equipments. This evolution has heightened the need for interface documentation to establish a formal structure describing intercommunication between equipments.

A 'bottom-up' approach to systems integration was initially the only option, as the Weapon System Manager (WSM) was given control of all the disparate elements (new and existing equipments) which contributed to the ships fighting capability. Modern combat system design adopts a 'top down' approach, partitioning the system into component subsystems (areas for separate development-sensors, communications etc), using interface documentation to set the subsystem boundary conditions and control the integration of the partitioned parts into a complete combat system.

Who (*coordinates this interface control*)?

Weapon system management is a 'platform class' responsibility, but for submarines the preparation and control of interface documentation is coordinated, across all classes, by the Director Submarines' System Documentation section (SM821).

A natural flow of information is wanted from system design, through integration and implementation to in-service operation. Early details from design documentation are needed for onboard vetting of draft amendments to system user handbooks. The preparation of draft and final onboard weapon system handbooks is also the responsibility of SM821. Grouping the work together like this (Table I), promotes a consistent application of system design information (including interface changes) right to the users in the submarine flotilla.

TABLE I—*SM821 Group*

Combat System Documentation **SM821**	
System Design Documentation **SM821A/B**	System Information for On-Board Users **SM821N**
Interfaces Electrical Links Installation	Operating Procedures Training Aids Command Guidance System Handbooks

How (*is the Interface Management Achieved*)?

In this market orientated world the interface documentation and management tool needs to satisfy the following 'customer' aspirations:

(*a*) WSM

Needs to see the system broken down into its constituent parts and to identify the interfaces to be controlled.

(*b*) Equipment Project Manager (EPM)

Wants definition of all his equipment's external interfaces across the flotilla (including shore installations, which for system control purposes are treated as extra platforms).

(*c*) Coordinator

Has to identify where common equipments (and therefore common interfaces) occur, so that the effects of proposed system interface changes can be assessed across all affected classes and the application of documentation optimised.

Having functionally defined the system, the following criteria generally apply when determining where interface definitions within a combat system have to be established:

(*a*) Where agreement is required between separate contractors and design authorities.

(*b*) Where across platform/class system, change control is to be implemented.

(*c*) The sub system/equipment level, at which the performance upgrading of the overall combat system is to be implemented.

Whilst the WSM has overall control of the combat systems, within a given class, the function of the constituent EPMs is just as vital to the integrity of the combat system. If an individual equipment is unreliable then the effectiveness of part or all of the combat system is jeopardized. Similarly, system configuration control is frustrated, if an equipment project fails to:

- Authenticate its interface specifications and certificates.
- Maintain its interface source information.
- Report proposed interface changes to the systems coordinator.

For this reason the requirements of NES 1013 Part 2 and system change control (SSCP38 Chapter 414) are mandatory for all submarine combat system projects.

Interface control must be an integral part of the equipment design process, so that as an equipment design team struggles to achieve the agreed characteristics for equipment performance they do not forget their obligation to the rest of the combat system. If an equipment's documentation system (Master Record Index (MRI)), has as its top level of information interface drawings/source document (FIG. 1), which describe an equipment's external interface parameters (i.e. form, fit and function), this task will be much simpler. With these external interface drawings fully integrated into the MRIs, change control procedures any change which impacts on these interface drawings can be marked up and presented to the systems coordinator to advise affected EPMs/WSMs across all classes and achieve agreement.

To satisfy the coordination requirement, a consistent nomenclature is required for equipment (e.g. always use Mk24 Mod 2 Torpedo as opposed to Mk24 Consolidated or TIGERFISH) and for equipment generic groupings (e.g. Mk24, SPEARFISH, RNSH are all allocated to the 'Weapons' group whilst DCB, DCC, SMCS are consigned to the 'AI0' category). From this consistent application of generic equipment groups, interface reference codes can be made traceable on an

across class basis. For example, on a very simplified diagram (FIG. 2) we can see that across the platforms where the **common** boundary C-S1 lies, it should be covered by a **single interface** reference code (AH99 say) and specification.

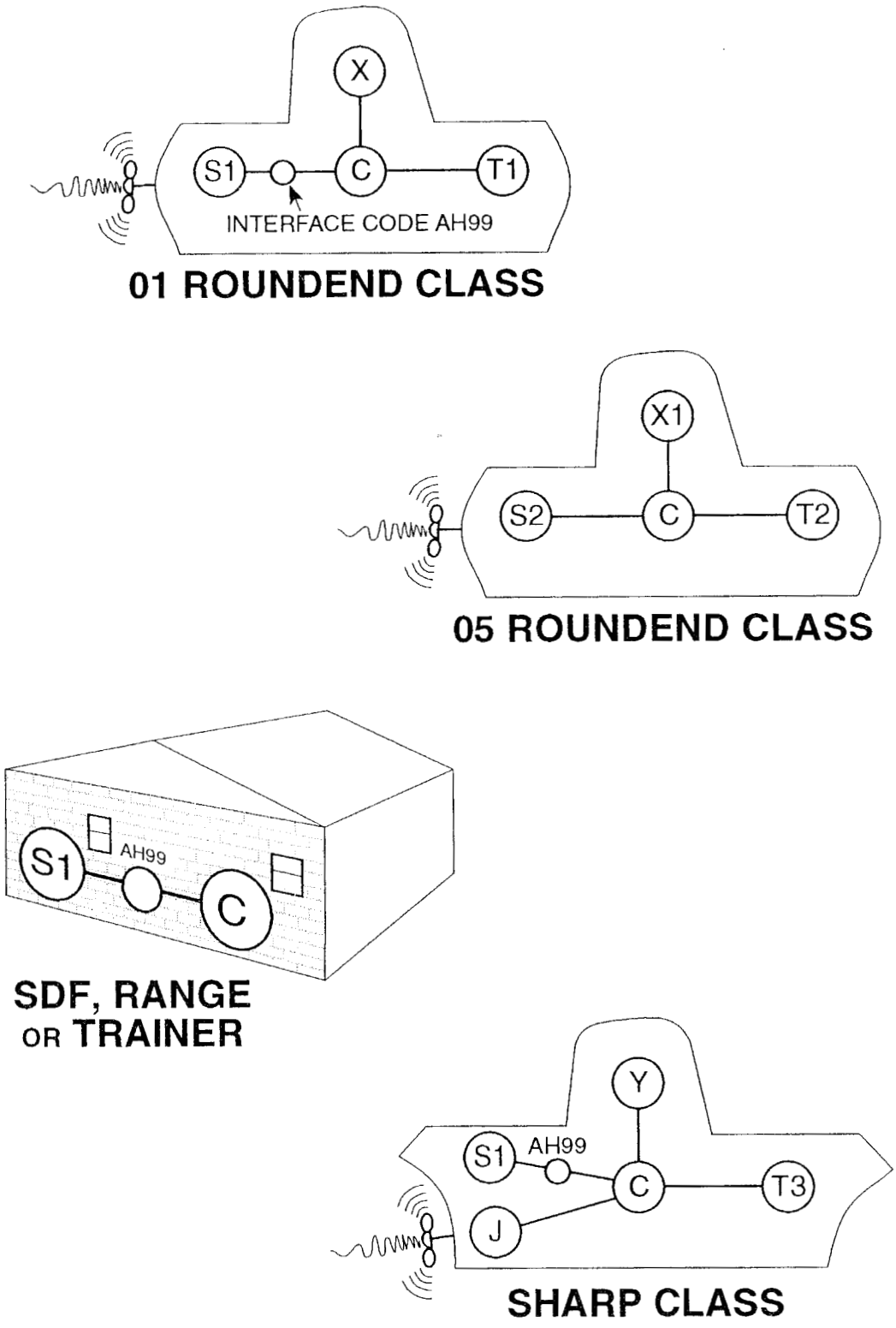

FIG. 2—INTERFACES ACROSS PLATFORMS

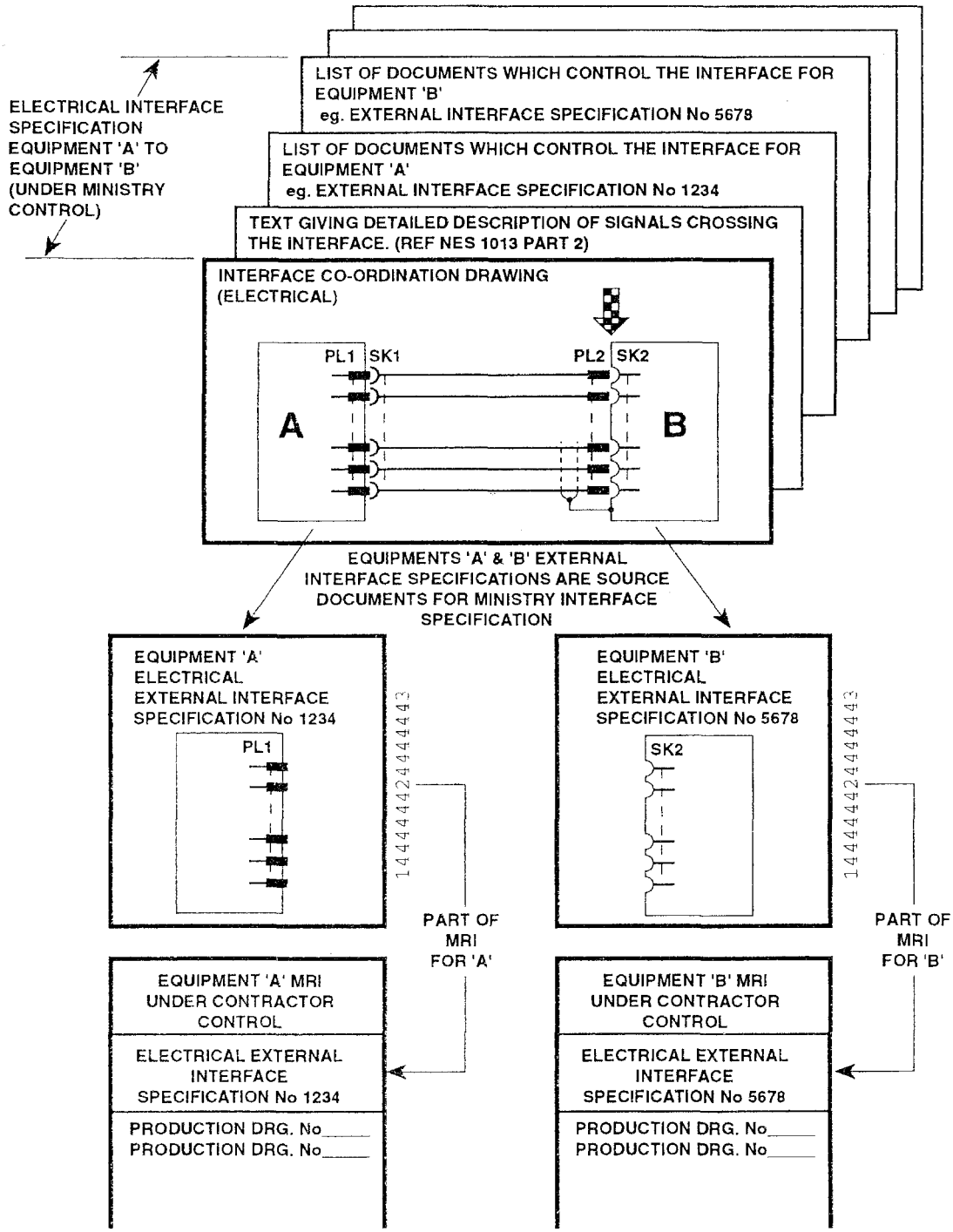

FIG. 1—DIAGRAMMATIC REPRESENTATION OF THE MECHANISM FOR INTERFACE CONFIGURATION CONTROL USING EQUIPMENT MRIS TO IDENTIFY SOURCE DOCUMENTS

Combat system management requires that interfaces are not considered in isolation, but viewed and controlled as part of a total system design. To do this, it is necessary to construct a coded map of all the equipments and interface relationships relevant to the total combat system. This coded map is called a System Interface Diagram (SID).

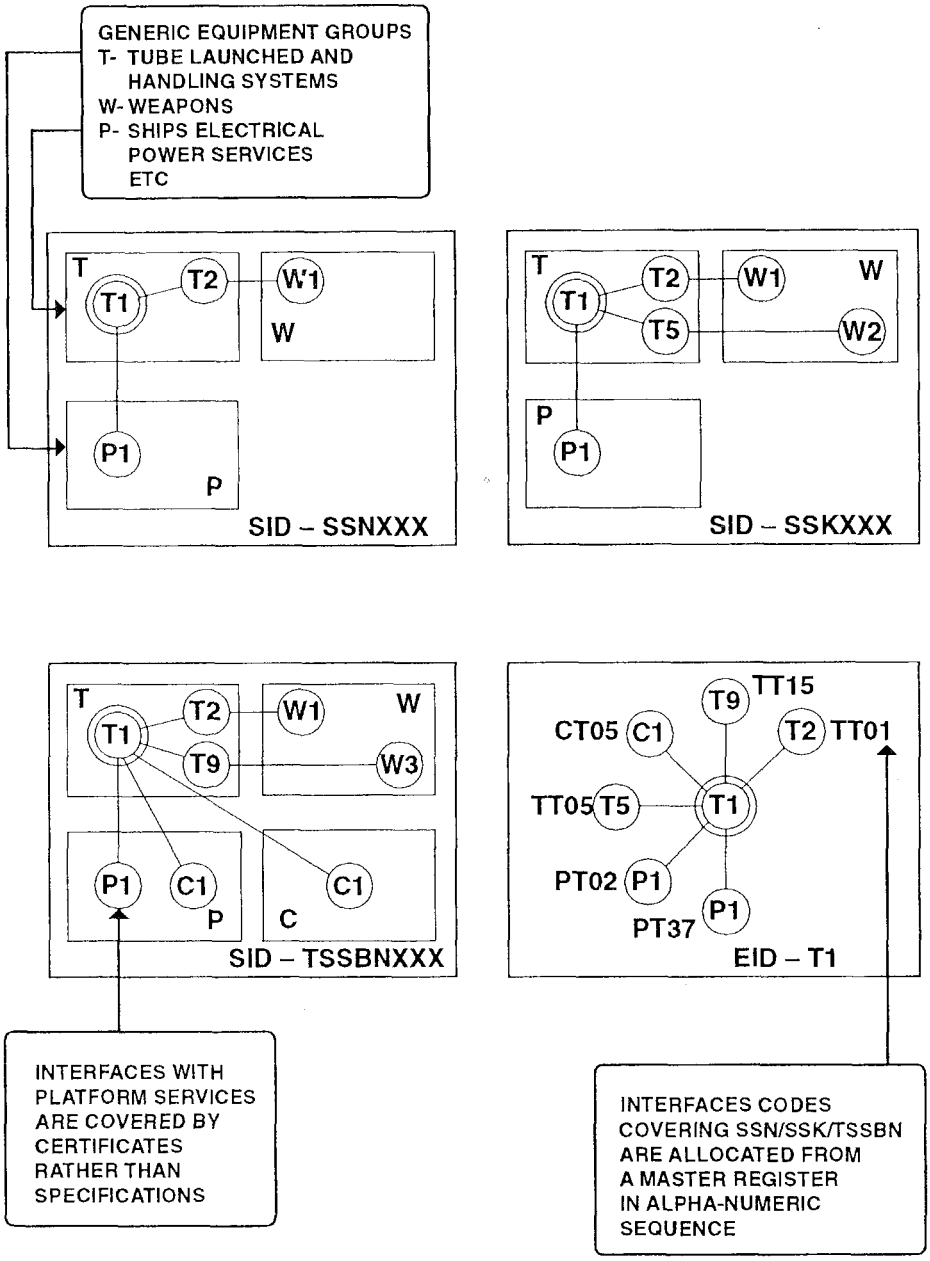

FIG. 3—OPTIMIZE COMMON INTERFACES

SIDs are authenticated by the WSM and are prepared on an individual platform basis with separate electrical, mechanical, platform services (e.g. power, air, water) and structural interface drawings. If information regarding equipments, platforms and interface codes are held on the same relational database then Equipment Interface Diagrams (EIDs), which identify a given equipment's interfaces across all platforms, can be generated concurrently with the SIDs, making the coding system and database doubly useful (FIG. 3). Other associated

lists generated by the database within the family of interface control documents are shown in (FIG. 4). It should be noted that the interface specifications and certificates are normally held outside the database structure as separate text/ graphics files.

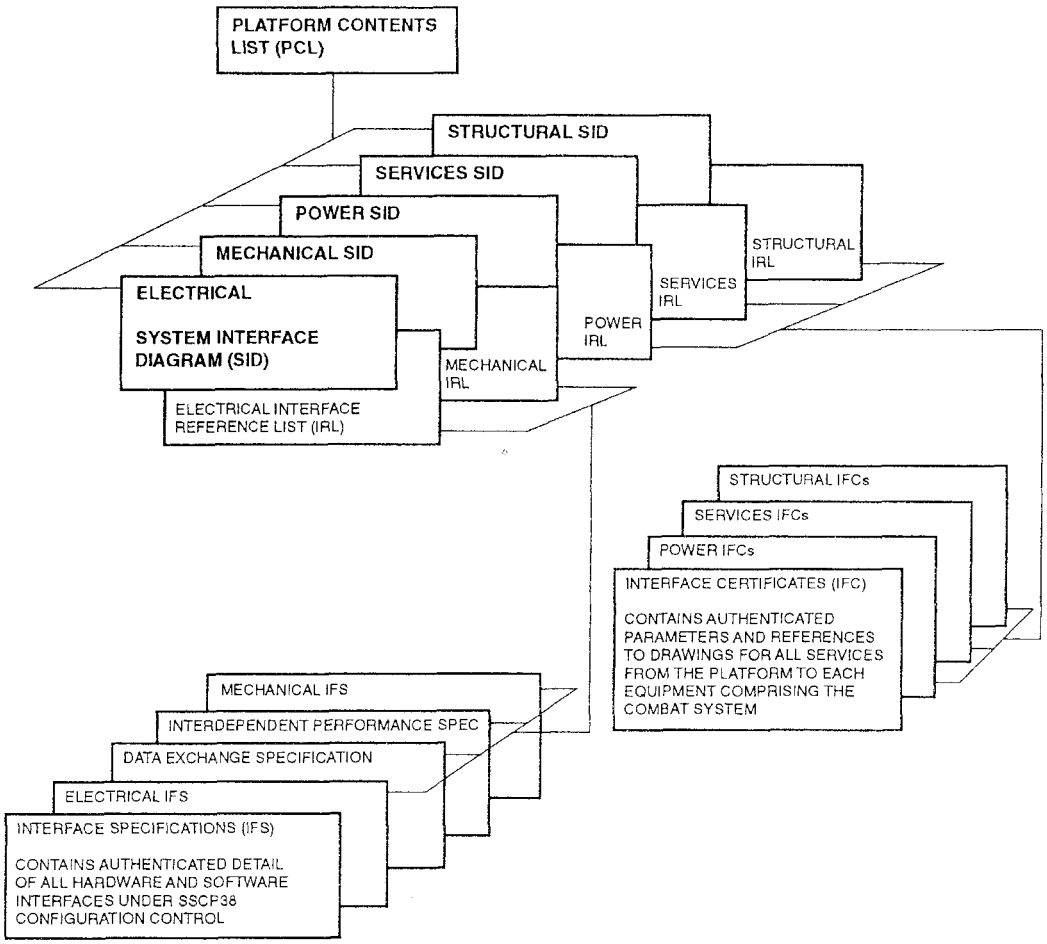

FIG. 4—CS CONFIGURATION CONTROL DOCUMENTS

The role of the systems coordinator, operating across all classes and providing a focal point for WSMs and EPMs, to control all interface documentation and changes is becoming increasingly important. Without such coordination the preparation of documentation and review of system changes across the flotilla would be undertaken in a fragmented manner. On the last occasion that the level of weapon equipment commonality across the submarine flotilla was surveyed, it was found to be 60% and rising. Indications are that the level of combat system equipment commonality for surface ships is even greater! It therefore follows that in more than half the cases where an equipment interface change is mooted, the coordinated assessment and approval from more than one WSM area (via their configuration modification committee) will be required.

The coordinating function involves the following range of tasks:

- Information upkeep.

  Providing the focal point for system interface change control.
  Maintaining information for combat system upgrading and refit planning.

- Interface reference data
  Setting the nomenclature and codes structured for uniform cross-platform referencing, ensuring that compatibility is maintained with the numbering system for link (ships cabling) documentation.
- Documentation control
  Coordinating the documentation preparation task, making sure that common interfaces are not being documented by different authorities, ensuring that only new interfaces are being documented, because existing interfaces are already held in a centrally-maintained library of interface specifications. The library currently consists of:
  2000—Electrical Interface Specifications.
  100 —Data Exchange Specifications.
  200 —Mechanical Interface Specifications.
  200 —Interface Certificates.
- Identity of across-platform and class inconsistencies
  Ensuring information content is consistent from platform to platform.
- Maintaining standards
  Vetting completeness of interface definition and uniformity of presentation. Reviewing and amending the interface documentation standard NES 1013 Part 2.
  Expertise transfer by guiding new documenting authorities (effectively reducing learning time).
- Recommendations to the acceptance authority
  Giving assurance to the submarine acceptance authority that the required standard of interface documentation has been achieved, including traceability to formally controlled source documents.

Summary

Over the last 10 years an increasing level of cross class coordination in interface documentation control has been established in submarine combat system projects using NES 1013 Part 2's structured approach. The pre-eminence of interface documentation as the foundation of modern systems control, is exemplified by its inclusion as part of the contract definition for equipments being introduced under the SWIFTSURE and TRAFALGAR class update programme.

The methodology is based on the simple concept that there needs to be a structured relationship between information presented at both equipment and system level, it does not prescribe which system design technique is to be used.

Properly coordinated interface document preparation greatly streamlines the updating task and the structure gives shape to the task of communicating with all affected interface parties when across-class change is proposed. The coordination has also recently been strengthened by the introduction of system change control procedures (SSCP38 Chapter 414).

Any future system design model must take cognisance of how system design changes will be evaluated and controlled. Since new systems inevitably involve the bringing together of existing equipments with new ones, it is essential to keep equipment external interface definition up to date. Master interface documentation must be fully maintained so that it can be readily applied to systems development on new platforms or capability upgrades on existing platforms.