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# LANDING PLATFORM DOCK (REPLACEMENT) LPD(R)

by

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ABSTRACT

This article is based on the presentational material provided to potential tenderers to familiarize them with some key aspects of the project in the run up to the issue of the LPD(R) Design and Build Invitation to Tender. As such it is very much an appetizer. The article covers:

- Some background material to the current procurement strategy.
- A description of the Indicative Design emerging at the end of the project definition studies.
- A description of the combat system and some important related issues.

## PROCUREMENT STRATEGY

### Background and lessons learnt

The original procurement strategy for LPD(R)'s, approved by the Chief of Defence Procurement (CDP) in 1985, was based on Whole Ship Procurement (WSP) with the Prime Contractor (PC) taking responsibility for all aspects of development and production of the ship and its combat system. In view of the relative simplicity of the LPD(R) design, compared with other warships, procurement was to be in two phases rather than the more usual three for a major project. The first phase was funded competitive design studies by potential PC's, that covered both Feasibility and Project Definition (PD) to develop the design to a stage where fixed prices could be sought for the second phase of Design and Build (D&B). Three study contracts were placed in September 1987 lasting one year.

A separate contract was placed in December 1986 with Swan Hunter Shipbuilders Ltd for a study into modernizing and extending the life of the existing LPD's to achieve the same capability as the new ships. This option compared unfavourably with new build and was eventually dropped by the Equipment Policy Committee (EPC).

The WSP strategy failed to produce a satisfactory outcome for three main reasons:

*Firstly*

Feasibility studies need to draw on MoD specialists and user expertise to interpret and develop the requirement. But the competitive nature of the studies inhibited this.

*Secondly*

The in-house cost estimates were based on limited concept studies and there was no specific provision made for the additional cost of WSP, which in any case would have been very speculative. Again the competitive nature of the studies constrained the freedom to change direction part way through the studies, to carry out cost capability trade off studies, as it became apparent that the contractors' emerging designs were too expensive.

*Thirdly*

Splitting the PD funding three ways to maximize competition meant the depth of the studies was constrained.

In the event, the level of definition achieved by the contractors, particularly in the combat system, gave little confidence that an acceptable solution would emerge if the project were to have proceeded to the next phase.

In January 1990, the Finance and Planning Management Group (FPMG) took into the programme an alternative assumption. This called for two new build LPD's (FIG. 1), with a reduced capability and cash limit for design and build.

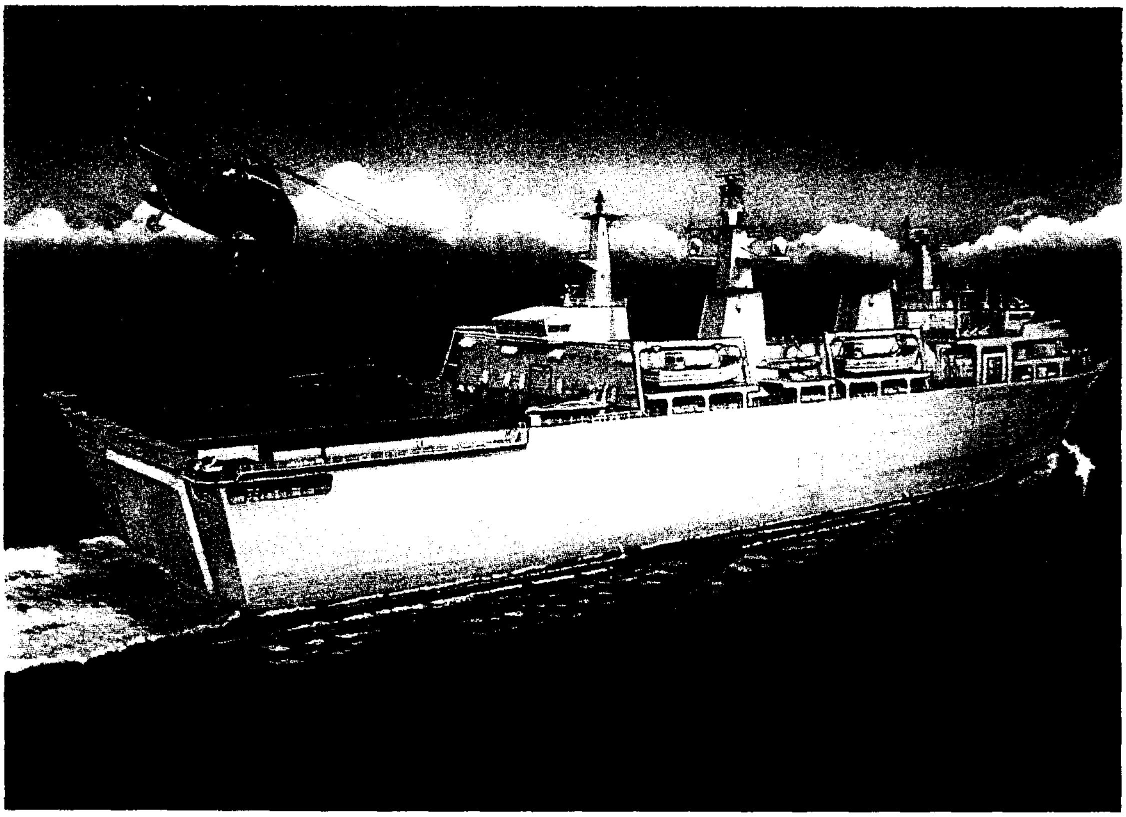

FIG. 1—ARTIST IMPRESSION OF THE LPD

As a result of the failings of the original WSP strategy, CDP approved a substantially revised strategy. There was to be a single warship PD contract for the ship and its combat system, excluding the Combat Management System (CMS). A taut procurement specification and a costed design to confirm that the requirement was affordable, were to be produced. The contractor undertaking this work was to be precluded from participating in the competition for the D&B phase, to avoid unfairness. In addition, two parallel competitive PD contracts for the CMS were proposed, with the outcome forming the basis for selecting the development and production contractor. CMS equipments were to be supplied to the warship D&B PC as Government Furnished Equipment (GFE). Novation[1] of CMS development and production to the warship D&B contract was identified as a possibility at a later stage. The aims of this change in procurement strategy were to facilitate an open exchange between the warship PD contractor and all the MoD authorities involved with the warship design, as well as an interactive dialogue between the MoD and CMS contractors to ensure that the requirement was met.

Subsequent to the EPC meeting on 7 February 1991, the communications system was also separated out from the warship and PD contracts were placed for warship, Internal External Communications System (IXCS) and for the two elements of the CMS, viz. Command System (CS) and Command Support System (CSS). As these studies (known as PD1) proceeded, it became apparent that to meet the full requirements of Staff Requirement SR(S)7045 to full naval standards, would cost substantially more than the cost cap set by the FPMG in January 1990. Additional studies (known as PD2) were therefore endorsed in May 1993.

## OUTCOME OF THE PD2 STUDIES

### CS

A variant of ADAWS 2000 has been selected as the CS for the LPD(R). This system has also been selected by VSEL for the Landing Platform Helicopter (LPH). The contract will be placed at the time of the ship order.

### CSS

The CSS provides facilities for planning and decision-making in support of the deployment, operation and recovery of the amphibious force. (FIG. 2) shows diagrammatically the scale of the task to be managed. In order to reduce technical risks and associated development and production costs, the CSS will be based wherever practicable upon existing commercial hard and software. Two consortia led by EDS Scicon and GEC-Marconi are in competition to produce the system. At the time of writing the assessment of the tenders is underway. The risk of not achieving an adequate military solution within the cost cap was judged negligible and was therefore not a reason for holding up the issue of the warship Invitation To Tender (ITT). The risk of the need to amend the warship ITT, by issuing it in advance of the output of the PD2 studies, was minimized by agreeing key ship fitting parameters. The contract will be placed at time of the ship order.

### IXCS

The IXCS required for the LPD(R) is very substantial but comprises equipments and technologies, either already in-service or available commercially off-the-shelf. The control and reconfigurability for a system of this complexity and size necessitates the introduction of computer-based management and distribution by Local Area Network (LAN) technology. Such systems are available in the market place and software development is being confined to

1 Novation is the legal process of transferring contracts

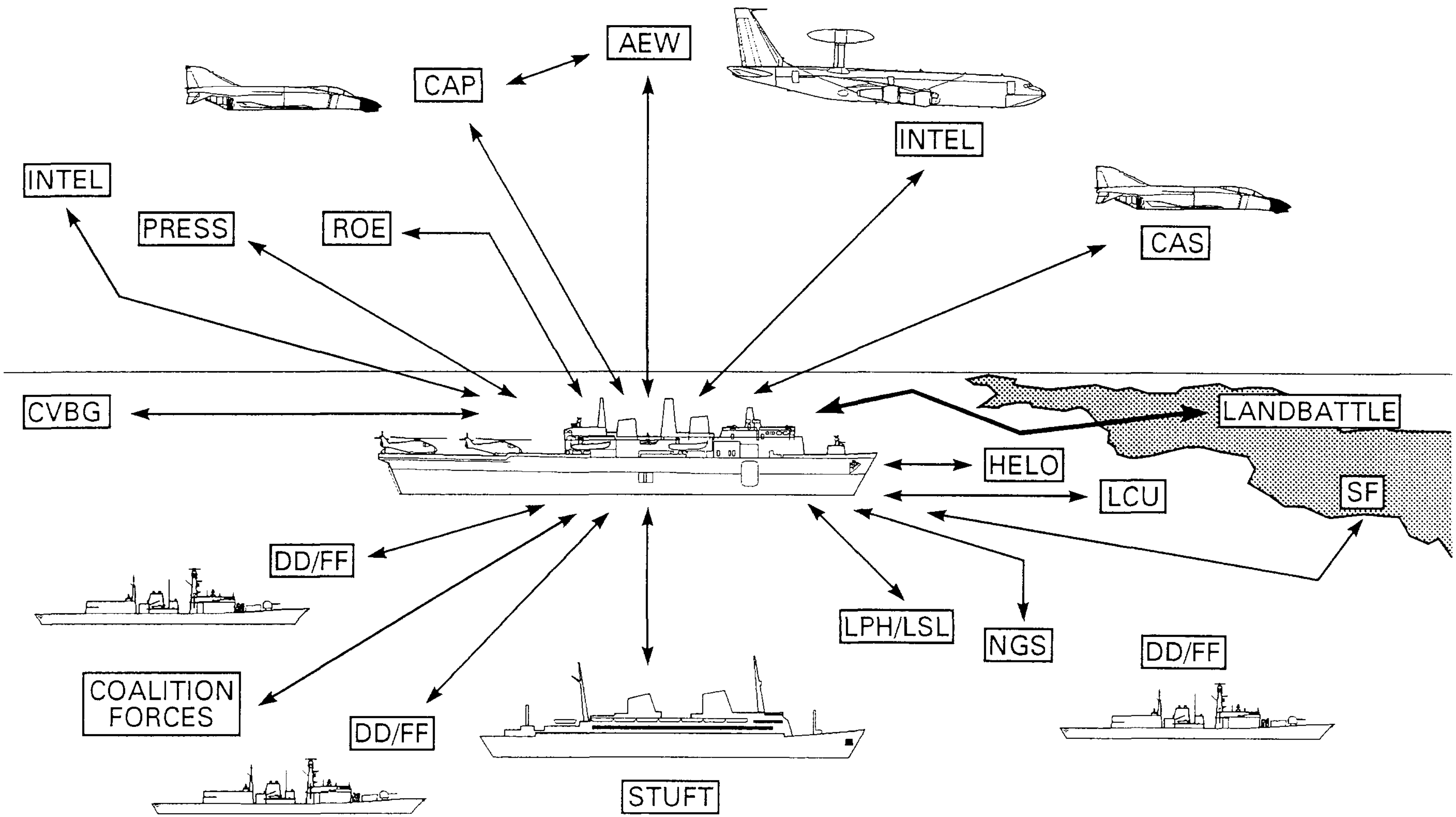


FIG. 2—OPERATIONAL TASK

providing control and user interfaces to suit ship and RN requirements. This automation provides the improvements necessary for lean-complemented ships, compared with current warship communication systems.

The system offered by the consortia led by Redifon was selected and to avoid delay to the LPD(R) programme, the IXCS combined development and production order was placed at the same time as the warship ITT was issued. This includes a commitment to order the minimum essential hardware for development and integration proving, including items for the Land Based Test Site (LBTS), prior to approval to order the ship(s). Approval to proceed with the production of equipments for both LPD(R)s will be sought with approval to order the ship(s). Hardware used in the development programme will be refurbished and form part of the production equipment for the second ship.

### Warship

YARD won the contract for the warship PD study. The ship cost emerging from PD1, at the end of 1992, exceeded the cost-cap by some 30%. Parametric studies were conducted to identify cost savings, associated with reduced military capability and standards, which offered ways of coming within the cost-cap. Landing craft, offices, workshops and complement (and therefore numbers of bunks) were identified as areas where useful cost savings could be made with an acceptable reduction in capability. A seven-month follow-on warship PD study (PD2) completed in February 1994. The Ministry was actively involved in the developing design and, in particular, the identification and agreement to the appropriate mix of naval and commercial standards to meet operational and safety requirements. This was combined with a more pragmatic approach to such issues as:

- Availability Reliability & Maintainability (AR&M).
- Through life cost.
- Human factors.
- Mockups.

This was to be consistent with the large commercial content of the design and to reduce cost, some simplifications were made to the MoD management practices associated with:

- Inspections.
- Tests and trials.
- Acceptance.

## INVITATION TO TENDER

The ITT includes as much risk transfer as is practicable and prudent, requiring the contractor to take full responsibility for the proper execution of these tasks under his control.

### Indicative Design (ID)

The ID, developed by YARD during PD2, was issued with the ITT as part of the Procurement Specification (PS). Tenderers will be required to validate the ID as part of their tender proposal and take responsibility for the ship design, developing the ID rather than starting afresh. This approach significantly reduces the risks of non-compliant responses and in the D&B phase, because the ID has been worked up to a much greater level of detail across the board than one would expect from a normal D&B tender response. Tenderers may propose changes so long as they can demonstrate that the requirements of the PS are met and costs are not increased.

### Combat system

The PC will be responsible for procuring combat system equipments (excluding GFE's) to modification states and software issues for which integration has been proven in the Type 42 system and also for:

- Installation.
- Setting to work.
- Linking.
- Presenting integration.
- Acceptance trials.

The warship D&B contract will cover both Stages 1 and 2 acceptance, that is to the end of Part IV combat system demonstration trials, as well as collection and analysis of AR&M data for the first year in-service. Further details of how the PC is expected to manage the combat system installation, setting to work and acceptance are given later in this article, together with details of the measures taken to minimize risk to the MoD.

### Novation

Management of the interfaces between the CS, CSS, IXCS and the warship D&B contract will be difficult and expose the MoD to some risk. Novation of the CS, CSS and IXCS into the warship contract, at the time of ship order, provides an opportunity to transfer programme and physical integration risks to the PC; but probably not performance and integration risks because of the previous development work done under the direction of MoD. All contracts will, therefore, give the MoD an option to novate, and the warship ITT will seek the premium for doing this. The benefits of novation compared with the additional risks and costs will be assessed prior to ship order.

### Programme

The warship D&B ITT was issued in August 1994. A separate ITT for warship support was issued in September 1994. The contracts will be awarded to the contractor who offers the best overall value for money. At the time of writing it is expected that these contracts will be placed towards the end of 1995.

## SHIP DESIGN

### Design development

The development of the LPD(R) ID was driven by three factors:

(*a*) The requirement to transport and deliver the embarked military force and its equipment.

(*b*) The requirement to provide the command and control of the amphibious task group and of the landing force, until the landing force commander moves ashore.

(*c*) The need to meet the cost cap in a manner that struck the correct balance between military capability, survivability and through life costs.

Whilst developing the design to meet the operational requirement the detailed equipment design and material standards and system configurations were developed with close regard to first and through life cost implications. The key issues considered, besides the operational requirement, were:

- Safety.
- Operability.
- Supportability.
- Survivability.

The order of priorities and degree of attention paid to each depended on the risks associated with the equipment or system and its contribution to meeting the operational requirement and through life costs.

The Key Particulars of the payload and combat system are given in Tables 1 and 2.

TABLE 1—*Payload and aircraft*

| | |
|---|---|
| High vehicles | 31 |
| Low vehicles | 36 |
| Ro-Ro LCUs | 4 |
| LCVPs | 4 |
| War maintenance reserve | 30 tonnes |
| Flight deck | 2 Spot |

TABLE 2—*Combat system*

Type 42 Command System Variant ADAWS2000
CSS
IXCS
2 x GOALKEEPER CIWS
4 x 30mm Guns (FTR)
4 x 7.62mm GPMG
2 x SEA GNAT
2 x Passive Decoy
Surveillance Radar Type 996
IFF Mk 12
2 x Radar Type 1007/RRB
Thermal Imager/EO System (IPMD)
UAT ESM

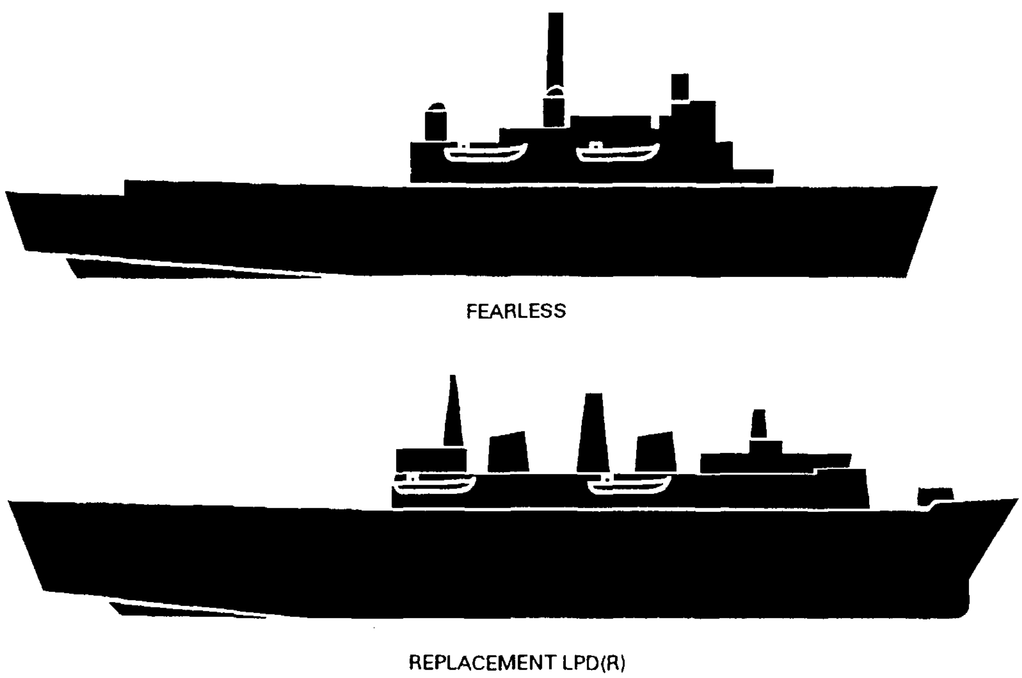


FIG. 3—PROFILE COMPARISON BETWEEN LPD AND H.M.S. 'FEARLESS'

## Overall configuration

(FIG. 3) provides a profile comparison of the replacement LPD with H.M.S. *Fearless*, with the LPD(R) being a little larger. (FIG. 4) shows an arrangement profile, giving the disposition of the key functional areas and the key particulars of the design are in Table 3.

TABLE 3—*Key particulars*

| | |
|---|---|
| Displacement | 14,200 tonnes |
| LBP | 155 metres |
| LOA | 171 metres |
| Max Beam | 31 metres |
| Complement | 325 |
| Accommodation | 630 |

The LPD(R) landing craft arrangements shown in (FIG. 5) are similar to the existing LPDs, but with 4 Roll on-Roll off (Ro-Ro) Landing Craft Utility (LCU's) in a totally covered well dock. 4 Landing Craft Vehicle or Personnel (LCVP's) are carried on davits alongside the superstructure. The vehicle deck is forward of the well dock and the 2 spot flight deck is aft of the superstructure.

The Ro-Ro LCUs (FIG. 6) significantly speed the loading and turn round process by avoiding the need for vehicles to reverse on to the LCU. The single vehicle deck with a half deck at one side provides flexibility and ease of movement for vehicles and cargo. A monorail system is fitted within the vehicle deck and a gantry crane covers the well dock to provide rapid movement of cargo. There is also access from the vehicle deck to the main stores and magazines. Pallet ports and a starboard side vehicle ramp provide for loading and offloading vehicles from a quay and pallets to Mexeflotes. These facilities will also aid refits, with soft patches in the vehicle deck leading to the machinery spaces.

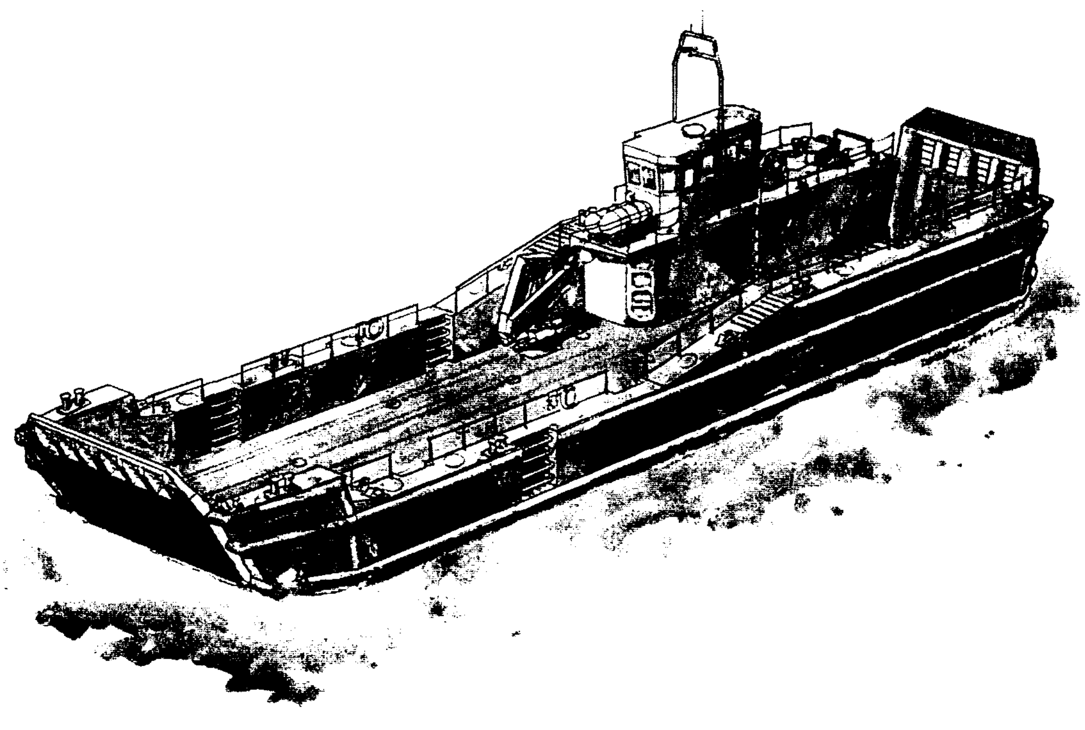

FIG. 6—ARTIST IMPRESSION OF RO-RO LCU

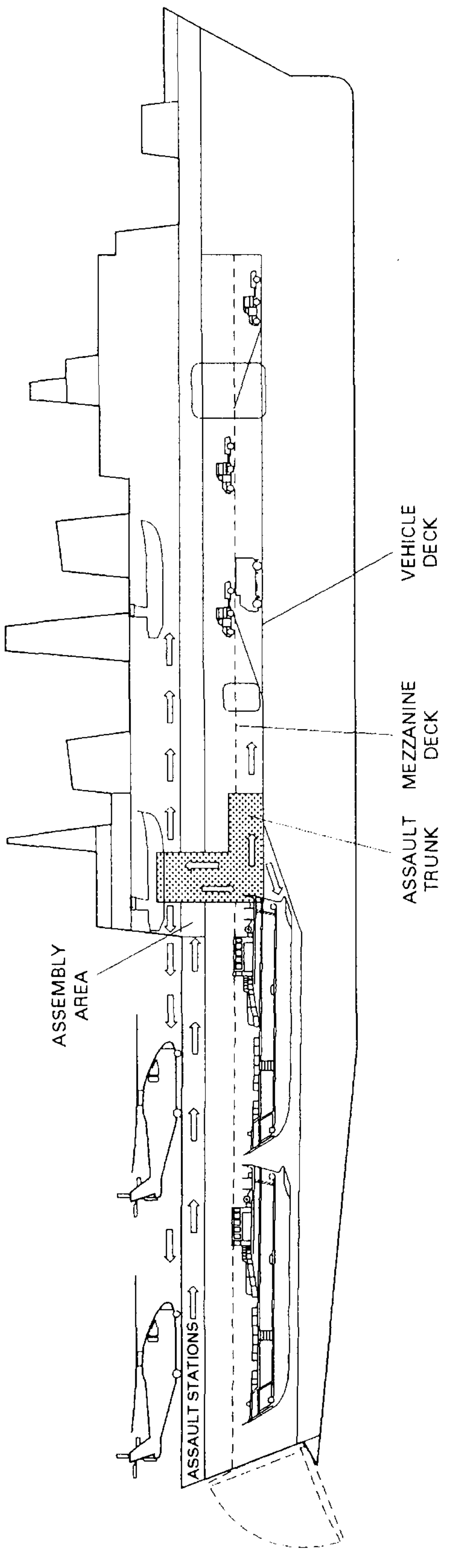


FIG. 7—ASSAULT ROUTES

The continuous deck over the well dock provides a large area for accommodation. This permits rapid and efficient movement of troops, with their personal equipment, from their mess decks to the helicopters or landing craft. Troops move forward to an assembly area and then up or down to the forward end of the flight deck or well dock (FIG. 7). The assault route is carefully sized and configured to minimize any potential bottle-necks. A particular feature is the assault trunks, port and starboard, with wide gently sloping stairways between the assembly area on 2 deck and the well dock and flight deck. The trunk can operate as a 30 man airlock if required.

With the well dock and vehicle deck taking up the heart of the ship with the machinery spaces beneath them, the large operational spaces, required to meet the command and control requirement, are located in the superstructure. They are generally surrounded by lower value compartments or passageways to provide protection.

The extensive communications requirement dominates the upper deck layout. Three masts are fitted. The receiving aerials are generally located on the forward mast and superstructure. The transmitting aerials are on the main and aft masts and aft superstructure. This eases the problem of achieving a good communications system performance whilst meeting RADHAZ and EMC requirements within the limited space available. The detailed arrangement of guns, decoys, boats and LCVP's will require careful development by the PC in consultation with the IXCS contractor to achieve the best overall arrangement from an operational and safety point of view.

The ship is divided into three autonomous zones (FIG. 8) which are themselves divided into fire zones based on the main watertight bulkheads. The well dock and vehicle deck together constitute a further zone which can be further sub-divided by a fire curtain.

There are five machinery spaces comprising forward and aft engine rooms with three auxiliary machinery rooms, one aft of the aft engine room, one between the two engine rooms and one forward of the forward engine room. This provides separation of key equipments and systems to reduce vulnerability to damage.

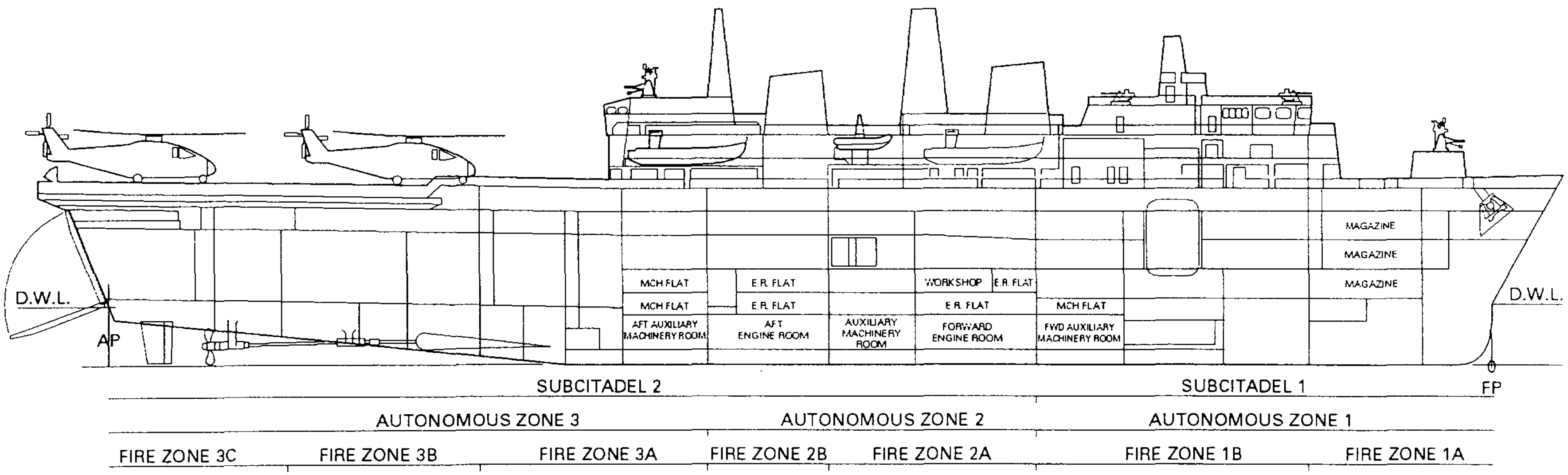


FIG. 8—LPD ZONES

## Propulsion machinery arrangement

Some 16 different propulsion systems were considered before reaching the final selection. Initial and through life costs were considered in the selection process. The key driver in selection was the need to operate for extended periods at slow speed (2 to 6 knots). The final selection was between a full diesel electric arrangement and a system with separate motors for the slow speed operations. The latter proved cheaper.

The selected propulsion system configuration is shown in (FIG. 9). It consists of two unidirectional medium speed diesels driving fixed pitch propellers through separate reversing gearboxes. Electric motors driving into the gearbox provide the low speed capability and are sized to give a degree of overlap with the bottom minimum speed of the diesels.

A tunnel bow thruster is fitted to assist slow speed manoeuvring.

## Electrical machinery

There are two groups of two 1.4 MW Diesel Generator (DG) sets and associated switchboards, with at least two watertight compartments between each generator and switchboard group. One dedicated generator in each group is capable of providing power for the loiter drive. For these generators, connection to their switchboards is via two interlocked breakers, one for ship service duty and one for loiter drive, thus ensuring that any harmonics generated by the loiter drive are isolated from the ship system. (Only one generator is needed for loiter at any one time).

An emergency generator is fitted on 1 Deck in a different zone to the main generators.

## Ballast system

To enable the ship to go from its normal operating draught to pre-action draught, the ballast system pumps into ballast tanks high in the wings of the well dock and trim tanks forward. Action draught is then achieved rapidly by flooding the ballast tanks below the water-line. Dumping water from the high ballast tanks, combined with some pumping, enables rapid return to pre-action draught. Although this leaves the ship in a different pre-action condition, it can still pump in ballast to achieve an acceptable return to action condition without first adjusting all the ballast tanks.

The use of 'dumping' enables the system to be limited to 4 x 700m$^3$/hr reversible axial ballast pumps and a 400mm bore ring main. The ballast system will have GRP pipework.

Remote control will be available from the Platform Management System (PMS) in the Ship Control Centre (SCC) or HQ2 alongside dock control. A computerized system will be fitted to provide loading and stability advice.

## Chilled water system

The system is separated into so-called essential and non-essential systems with different survivability requirements applying to each system to reduce cost.

The essential system supplying combat system equipments and air conditioning of key operational spaces consists of two essential chilled water plants located on No 1 deck. One adjacent to the Operations Room complex to serve that area and one under the main mast to serve combat systems in that area. The two GOALKEEPERS, HQ2 and the SCC, which also require essential chilled water/air conditioning, are remote from the two essential chilled water plants and will have local packaged chilled water/air conditioning units. Cooling water supplies for these units is taken from the High Pressure Sea Water (HPSW) system.

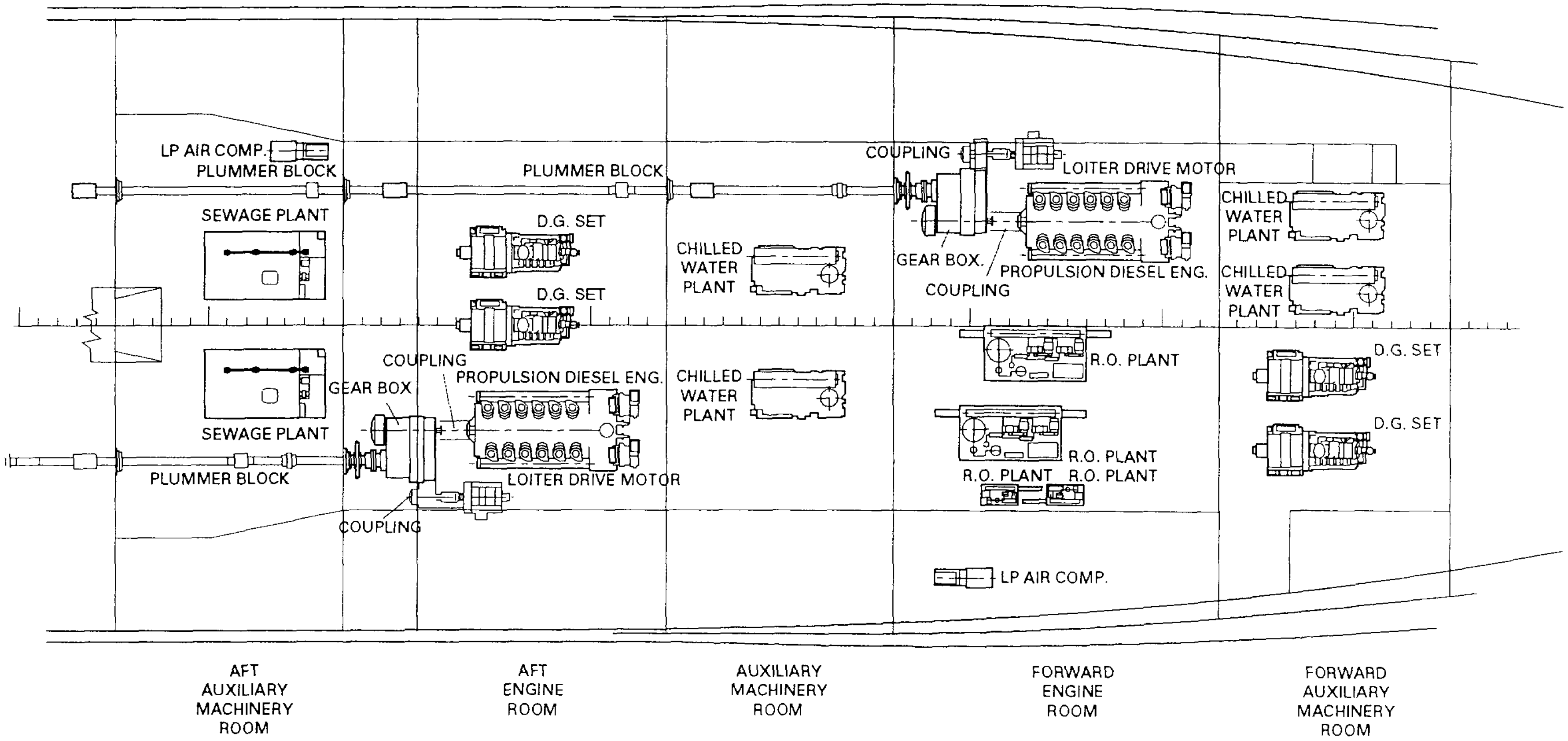


FIG. 9—PROPULSION SYSTEM

Each essential chilled water plant will have one sea-water pump, with back-up sea water from the HPSW main. If the plant fails then the chilled water in the circuit is cooled via a plate heat exchanger fed from the non essential chilled water system. At maximum load this will require shedding of some non-essential loads.

The non-essential system is sized to provide for the maximum activity load with all plants working. It consists of two pairs of plants. Normally each chilled water plant would have two sea-water pumps, one running and one standby and two chilled water circulating pumps, one running and one standby. To reduce cost two sea water pumps will be fitted per pair of plants, with the pumps sized such that one pump can serve both plants, i.e. one running one standby per pair of plants. For chilled water circulation each plant has one circulating pump and each pair of plants has one standby pump which can be connected into either plant as necessary following the failure of one pump. This arrangement provides an appropriate level of redundancy noting the systems supplied and the likely loadings at most times.

## Air conditioning and ventilation

The number of air filtration units and the citadel volume has been kept to a minimum to reduce cost. Dangerous areas are not included within the citadel unless it was cost effective to do so.

The air conditioning and ventilation system is autonomous in each of the three main longitudinal autonomous zones, with no trunking crossing the boundaries. Wherever possible, compartments within a fire zone will be served by Air Treatment Units (ATUs) sited within the same fire zone. When trunking penetrates fire zone boundaries, isolation facilities will be provided.

In the past Heating, Ventilation and Air Conditioning (HVAC) systems have been designed for the maximum occupancy in all spaces and this leads to oversized systems. Utilization factors have been used to reduce the size of the system at the expense of some degradation in some compartments of high variation in usage during periods of full occupancy.

The air conditioning and ventilation system is capable of being reconfigured to use the ATUs to remove smoke from the ship.

Ventilation of the vehicle deck and well dock is designed to provide 25 air changes per hour through supply trunks to port and exhausts to starboard. Within the vehicle deck and well dock the air will be circulated by a system of high pressure jets in order to avoid any local build up of dangerous fumes. With this system it is expected that the problems encountered on the current ships, when the vehicles and LCUs start up, will be avoided.

## HPSW

The HPSW system is sized to cope with a worst case credible incident involving:

- Fires in the vehicle deck and elsewhere.
- Boundary cooling.
- Eductors to remove firefighting water.
- Essential cooling loads.

An allowance is also made for non availability of pumps through damage and maintenance. The demand is met by 9 x 200 $m^3/hr$ HPSW pumps. In addition two pressurising pumps are fitted and two diesel driven emergency pumps are provided. In a ship size of LPD(R) it is impossible to achieve a location where an emergency pump will maintain suction at all angles of heel whilst ensuring that the coupled diesel prime mover always remain above the water-line. The solution adopted is to use commercial submersible electric pumps with dedicated DGs (one for each pump) installed on No 2 deck. This also has the advantage of ready access to the prime mover in an emergency and simple routes for induction air and exhaust gas.

The system is generally configured to full naval standards with a ring main below No 2 deck capable of subdivision and cross connection in the event of damage. The benefits of a low level dry main compared with the cost and difficulty of finding a protected route are marginal and it has not been included. Pipework and valve materials will be to commercial standards equivalent to Naval standards.

### PMS

The PMS will include:

- Machinery Control And Surveillance (MCAS).
- Electrical generation and distribution control and surveillance.
- Ballast control and stability analysis.
- Damage Surveillance And Control (DSAC).

The degree of integration between these elements and other systems, such as fire and flood detection, will be determined by the PMS design contractor.

### DSAC

The LPD(R) is a lean manned ship (complement of 325, compared to 550 on the current ships). This leads to a shortage of manpower for Nuclear Biological and Chemical Defence (NBCD) duties in NBCD state 1 compared to current practice. Fire and repair parties will enter reports into a DSAC system and the information will instantaneously be displayed in HQ1 and HQ2 and be available to other fire and repair party posts. This removes the need for section bases and some communications personnel. Information display will be in the familiar form of incident boards albeit on workstation screens or other electronic displays.

The system also provides rapid access to all the information required for damage control purposes (eg. damage control check lists, jettison bill, compartment information etc.). A play back and report generation facility will also be included.

Whilst most systems will be controlled by the MCAS elements of the PMS, the HPSW and HVAC systems will be controllable direct from DSAC work stations. The degree of integration between DSAC, MCAS and the ballast and stability computer will be determined by the PMS design contractor.

Other features aimed at easing the problems associated with lack of manpower include:

- Fixed boundary cooling systems.
- Wider use of centre feed hose reels.
- Dry spray grids in some compartments.
- Extensive use of fire barrier insulation.

## COMBAT SYSTEM

### Combat system composition and integration

To reduce integration risks and costs, the composition of the combat system, (Table 2) has been based largely upon a sub-set of the proven Type 42/CVSG combat system. The CS is a variant of ADAWS 2000, the CSS will be a new development system, as will be parts of the IXCS. A small number of the equipments to be supplied by the contractor will be variants of in-service equipments. One equipment—the Operational Information System (OIS) is left to the selection of tenderers. This system will display a combination of dynamic ship and systems information and non dynamic operational information, superseding traditional stateboards and some versatile console system displays.

The warship contractor is required to establish an LPD(R) SDF by configuring the LBTS equipments, and ensuring that hard and software states are fully representative of the final warship fit. He is to provide any items of equipments covered by the prime contract not already at the LBTS. The warship contractor must also provide an LPD(R) Combat System Highway. Partial new-to-service GFEs will be provided by the GFE equipment project managers.

Testing at the LPD(R) SDF will be divided into two distinct types:

1. New-to-service equipment and interface proving.
2. Combat system tests.

The programme agreed with GFE project managers requires new-to-service equipments to be proven prior to commencement of combat system tests. It is anticipated that testing of new-to-service GFEs will comprise mainly of interface proving. In-service equipments already successfully trialled by other platforms need not be retested for the LPD(R), although evidence of the success of those trials has to be provided by the warship PC. Similarly the warship tenderers are being encouraged to examine the entire trials requirement and suggest reductions, where they can be justified.

Combat system trials will be designed, planned, programmed, undertaken and presented by the warship contractor. Limited assistance will be given by the LBTS staff and the GFE contractors. During this period the warship contractor will also produce the test specifications for the later sea trials, since the SDF results will help define the acceptance criteria.

## Cohesion between PC and GFE contractors

It is essential that the warship contractor establishes and maintains effective and cooperative working relationships with the GFE equipment contractors. MoD project managers have established a workable and cohesive basis for this and have embedded within specifications, and the contracts already placed, joint agreements on issues such as programmes and responsibilities. This process will need to continue and be developed with the warship contractor taking the lead.

## Maintenance of agreed composite trials programmes

A key issue is the development and maintenance of agreed composite programmes. The warship project have made a start on this and included the programmes produced so far in the ITT package. Past warship procurement programmes provide ample evidence that harmonizing the trials phase to meet the corporate need calls for careful attention and consultation as well as rigorous management by the project.

## Configuration management

The combat system is subject to evolution to meet the needs of other warship programmes. Some improvements in interfacing and equipment performance are under active development and the procurement strategy for the LPD(R) is to track these developments. The various project programmes have been analysed and the warship ITT specified equipment hard and software states. The warship contractor will have to continue to track equipment developments and there will need to be agreement on what other future equipment developments should be adopted in the LPD(R) combat system.

## Combat system acceptance and agreed characteristics

The PS and related documents give considerable attention to the issue of overall combat system acceptance, and the path to off-contract acceptance has been specified in the ITT. The warship project, not the warship contractor, will be responsible for obtaining naval acceptance. The warship contractor will, however, be responsible for obtaining from the Captain Weapon Trial Acceptance, Fleet Weapon Acceptance of any new-to-service equipments procured by him. For variants of in-service equipments, special category Fleet Weapon Acceptance will be required.

A set of draft combat system agreed characteristics has been produced. Tenderers are required to consider these and propose any modifications considered to result in significant cost savings. The procedure for subsequent agreement and endorsement has been specified.

### Security accreditation

The LPD(R) will be one of the first warships to have the security of its combat system accredited. Because of the novelty of this practice, considerable effort has been put into the production of a combat system policy paper. This is a sound basis for both tenderer and contractor. It is expected that tenderer and contractor will need to obtain the assistance of a CLEF—the acronym for Comercially Licensed Evaluation Facility.

## CONCLUSION

The project have produced a low technical risk design solution and have sought to minimize management risks by defining comprehensively tasks, responsibilities and authorities of all those involved. Whatever the project may do, the success of the project will depend a great deal on the experience and competence of the PC.

### Postscript

Subsequent to writing this article, VSEL has emerged as the sole tenderer.