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Ministry of Defence Roles and Required Technical Resources

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Summary

The United Kingdom's Ministry of Defence (MOD) is currently procuring a new class of nuclear-powered attack submarines, the Astute. For various reasons, the Astute programme has fallen behind schedule and has exceeded early cost estimates. Some of these divergences may stem from the acquisition strategy used for this class, which represented a break from how submarines were historically acquired. Here we determine what MOD institutional resources would be required and how they should be organised and brought to bear to maximise product quality and minimise cost and schedule penalties in submarine acquisition. We base our analyses on extensive interviews with MOD and contractor personnel concerned with submarine acquisition, along with the literature on partnering and on best practices in acquisition.

Overview of Submarine Acquisition To Date

For all classes of nuclear submarines, from Valiant up through Vanguard, the MOD exercised significant authority and responsibility in design and development and performed the integration role for the acquisition programme. It completed the concept definition, managed the design process, and maintained design authority¹ through-

¹ Joint Service Publication 430 defines *design authority* as 'An organisation with the professional competence and authority to specify design requirements, undertake design tasks, apply configuration management to designs and associated documentation, whilst con-

out the life of the submarine. This involved considerable, ongoing investment in programme management and technical skills, which were maintained with the regular introduction of new ship classes and subsequent maintenance and upgrade of in-service submarines.

The MOD by no means performed all the necessary functions required to design a complete submarine in-house. For example, it hired a shipbuilder, Vickers Shipbuilding and Engineering Limited of Barrow-in-Furness, to perform the detailed design work and build the submarine. Various subcontractors designed major systems and sub-systems.

This acquisition structure lasted for three decades, as the United Kingdom established and worked towards a nuclear submarine building programme with a regular production schedule. Two major changes during the 1990s influenced the way the MOD managed its nuclear submarine acquisition programmes. First, the MOD felt pressure to reduce its staffing levels and transfer major programme responsibilities to the prime contractor. This pressure stemmed from the change in national political philosophy, towards a smaller role for government in society, that had been in the process of implementation for a number of years, as well as from criticisms that the administrative infrastructure used to manage defence system acquisition was too large and costly. Whole organisations that played a major role in submarine acquisition were eliminated.

Second, in the latter part of the decade, a new system for defence systems acquisition—now known as Smart Acquisition—was adopted. This system emphasised partnership with industry in requirements generation, the creation of integrated project teams (IPTs) to manage major defence system programmes, and the rotation of personnel to different programmes to broaden their exposure and knowledge.

As a result of these changes, the MOD followed a dramatically different model in acquiring the Astute class. Rather than being

tinuously monitoring the effectiveness of those activities for a given material state' (Ministry of Defence, *MOD Ship Safety Management: Issue 3, Part 1: Policy*, Ship Safety Management Office, July 2004b).

deeply involved in every stage of acquisition, the MOD sought to outsource as much of the work as possible to a prime contractor. The goal was to keep costs low² and to share the risk for any overrun with the prime contractor up to a point, after which the prime contractor would absorb all the cost risk. Also, the MOD gave the contractor more control over costs by conferring on it the authority to make design decisions. The transfer of responsibility to the contractor not only reflected concern about cost growth but also coincided with the loss of technical expertise at the MOD. Unfortunately, that loss, combined with the desire to avoid compromising the risk, resulted in the MOD not fully engaging with the contractor in important design decisions.

Although not the only cause, the new management model for Astute contributed to major cost and schedule problems. Currently, the programme is more than three years behind the schedule set during its initial stages and is approximately £1 billion over the initially approved cost.

The loss of internal submarine expertise, coupled with decreased nuclear submarine procurement rates, raises fundamental issues with respect to MOD capabilities as the ministry seeks to effectively oversee submarine design and production. The initial approach to Astute-class acquisition was an attempt to cope with a new philosophy and budgetary regime in which the MOD's capabilities had been reduced so much that its ability to oversee design and production was significantly affected. Recognising the cost and schedule problems confronting the Astute programme, the MOD proactively enhanced both resource levels and the degree of interaction and oversight in its relationship with the prime contractor. These actions have been effective to some degree; however, it is not clear whether they will be sufficient to handle an increased volume of activity that will occur during the design and build acceptance process in the next few years.

² Outsourcing activities does not, of course, eliminate the activity's cost to the MOD; the theory is that outsourcing lowers costs by increasing the efficiency with which the outsourced activities are accomplished.

Research Objectives and Approach

Given the various advantages and disadvantages of the greatly different models used by the MOD in managing nuclear submarine design and construction over the past few decades, the Attack Submarines Integrated Project Team (ASM-IPT) asked the RAND Corporation to address the following questions:

- What are the appropriate roles and functions for the MOD if it is to be a smart buyer of nuclear submarines?
- What management structure and level of additional resources are needed to perform those roles and functions?
- How could the MOD transition its workforce to the desired end goal?

To address these questions, RAND examined the historical record of UK submarine procurement to look for lessons from experience with the two approaches used to date—the model used through the Vanguard class and the initial model used for the Astute class. We conducted a wide range of interviews with various people in different MOD organisations involved with submarine design and acquisition as well as with private organisations such as BAE Systems Submarine Division, the current owner of the Barrow shipyard. Information and insights were also gathered from similar organisations in the United States.

Towards a New Acquisition Management Model

From the point of view of the economics, economic sociology, and management literatures, the evolution of submarine acquisition might be summarised as follows. Through the Vanguard class, the MOD's approach required large technical organisations and hence high costs in maintaining this internal bureaucracy. In the Astute era of increased outsourcing, a problematic working environment arose from the difficulty of writing a completely specified contract for a product as complex as a nuclear submarine. The MOD's attempt to

seat the management of risk at the contractor rather than manage it in-house has also proved impossible to execute. The MOD is ultimately responsible for obtaining specified military performance, maintaining safety of operations, and delivering on schedule and at cost. Holding the contractor at risk for cost might mean driving it out of business, which would not accomplish the MOD's goal of providing a safe, militarily capable submarine to the flotilla.

To manage these risks, we propose a middle-ground alternative approach between the two acquisition models used in the past—that is, one model marked by a large internal bureaucracy and the other marked by an attempt to outsource key responsibilities. The proposed 'partnership' approach is broadly supported by the management best-practices literature on the benefits of intermediate structures, including joint ventures. While such an approach is one of the stated goals of Smart Acquisition, structures and processes to support a true partnership were not emplaced during the early years of the Astute programme.

The best-practices literature on purchasing and supplier management also suggests such a partnership model for acquisitions that are both high value and high risk—and nuclear submarines meet both of these criteria. Reported benefits from partnering include reduced cost, improved quality, and increased innovation. We describe what such a partnership model means, including the details of enhanced MOD engagement through all the submarine acquisition phases, and we suggest how current capabilities can be improved to support this new model.

Summary of Recommendations

Our recommendations are principally concerned with improving the MOD's ability to manage its risks and responsibilities in submarine acquisition. They are summarised as follows:

- Increase integration amongst MOD components, and increase partnering with industry in submarine design and development.

- Resolve critical safety and technical issues early in the programme by requiring early involvement of the Naval Authorities.
- Increase the ASM-IPT's engagement in design and construction at Barrow to improve the MOD's understanding of the contractor's detailed design and build performance and to facilitate the ministry's active participation in the acceptance process.
- Ensure through-life ship safety, maintenance and postdelivery control of design intent, and the propagation of lessons learned across submarine classes by transitioning design authority back from the prime contractor when the submarine enters service.
- Improve the MOD's management of technical support for nuclear propulsion throughout the fleet by shifting procurement and oversight of future nuclear steam-raising plant (NSRP) components and design services from being contractor furnished to being government furnished.

Note that these principles do not envision a return to a Vanguard-type model of MOD involvement. Design authority can remain with the contractor until the ship enters service. The contractor would still carry out most of the design effort.

These principles should be supported by a moderate growth of approximately 20 to 40 trained and experienced designers and engineers spread throughout the MOD's submarine-related organisations and by changes in the MOD's career management processes to encourage the development of submarine specialists.

In the remainder of this summary, we suggest appropriate roles for the MOD within its partnership with the prime contractor for each of the phases of submarine acquisition. We set out an organisational scheme, consistent with the current plan, by which the MOD might effectively meet its responsibilities under the partnership model. We then turn to other changes that would benefit the MOD, including modest staff increases and revision of the current career management philosophy. Finally, we present some thoughts on the transition to these desired end states.

MOD Roles Through the Phases of Submarine Acquisition

If the MOD is to meet its responsibilities for delivering a militarily capable, safe submarine to the flotilla on schedule and at a reasonable cost, it must fill certain roles during each phase of submarine acquisition, as seen in Table S.1. These roles involve various levels of leadership and partnership with the prime contractor.

The MOD is fully responsible for developing top-level military requirements, as laid out in the User Requirements Document (URD). The Director of Equipment Capability (DEC), also known as Customer 1, currently and appropriately performs this role. Approaches to meet these requirements are then worked out in concept and feasibility studies. The Future Business Group (FBG), working with the DEC, the Royal Navy flotilla (Customer 2), the Nuclear Propulsion IPT (NP-IPT), the Submarine Support IPT (SUB-IPT), and the Naval Authorities, should manage the initial phases of these studies. The FBG should also be supported by study contracts with relevant consulting firms and the shipbuilder(s). Once a new IPT is formed (or an existing IPT is tasked) to oversee the new programme, they should manage specification development, again with input from key stakeholders in the MOD, including the DEC, Customer 2, the SUB-IPT, the NP-IPT, the Naval Authorities, and

Table S.1
Recommended MOD Responsibilities
by Acquisition Phase

Acquisition Role	MOD Role
Requirements generation	Lead
Initial studies	Lead partner
Detailed design	Follow partner
Construction	Follow partner
Acceptance	Lead partner
Support	Lead

industry. This results in the System Requirements Document (SRD). The new IPT should work closely with the shipbuilder and other key suppliers to ensure mutual understanding of the SRD.

During detailed design and construction, the shipbuilder takes the lead. The MOD does not currently have the capability to design or build a submarine, roles that it clearly prefers to leave with industry. The shipbuilder must also lead vendor involvement where needed. However, the MOD should adopt the goal of working closely with—engaging with—the shipbuilder to address design issues and resolve problems as early in the process as possible to minimise cost of any necessary design or construction changes.³

One key to this approach is the development of formal and agreed-on procedures that include early communication with the Naval Authorities and other steps to manage critical, safety-related risks up front, rather than relying on the predelivery certification processes. These procedures should permit keeping the design authority and the majority of the effort at the shipbuilder.⁴ All parties should communicate freely with MOD regulatory bodies.

Finally, when the submarine enters service and the MOD assumes the operational role, design authority should transfer back to the government. The MOD can choose to contract design authority support to private industry, acting as a design agent with formally prescribed roles. Every effort should be made to ensure that, for effectiveness, lessons learned from any class are transferred through the entire submarine fleet and that, for efficiency, fleetwide management practices are used.

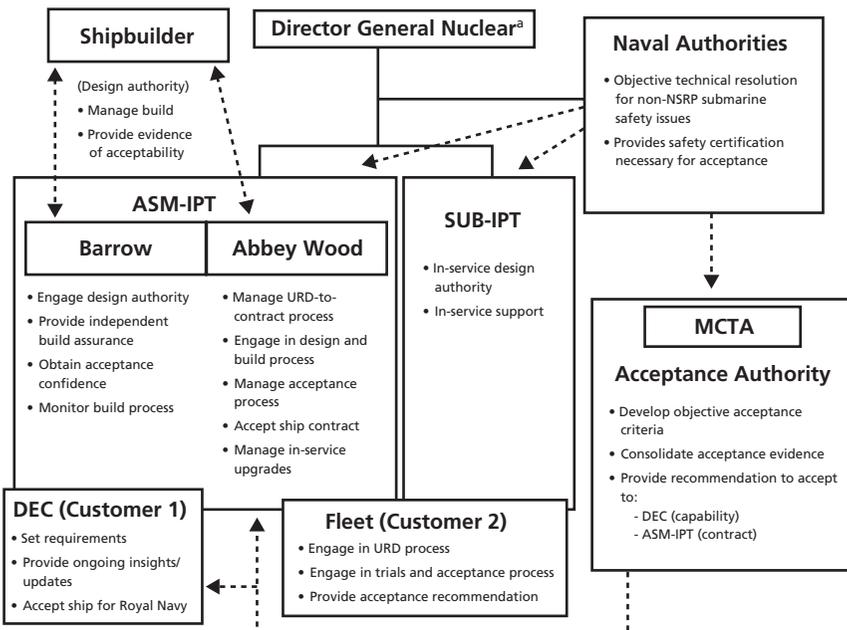
³ The MOD also needs to advise regarding government-furnished equipment, in-service experience with systems, and planned uses of the submarine.

⁴ Some may question whether it is appropriate to let the contractor hold design authority, which lets it make important decisions that could be inappropriately swayed by commercial interests. Engagement between the ASM-IPT representative at Barrow and the contractor's design authority could provide assurance to the MOD that the design authority is exercised independently. Instead of bringing design authority back in-house, the MOD could invest in ensuring that the shipbuilder's processes are functioning correctly.

Revised MOD Organisational Structure

How might the MOD’s organisational structure accommodate the roles discussed above? We agree with the recent establishment of a new nuclear organisation (similar in intent to the former Director General Submarines), which brings under one umbrella the four nuclear-related IPTs: the ASM-IPT, the NP-IPT, the Nuclear Weapons IPT (NW-IPT), and the SUB-IPT. In Figure S.1, we show this new organisation with the specific roles of the various groups involved in submarine programmes.

Figure S.1
Proposed MOD Organisation, Functions, and Interfaces



^a Organizations not shown: NP-IPT and NW-IPT.

Other Changes

Nuclear Steam-Raising Plant as Government-Furnished Equipment

The Astute contract marked the first time procurement and oversight of the NSRP were given to the prime contractor versus retaining them in the MOD. This change would yield benefits if the prime contractor could add value by managing the subcontract for provision of components and information necessary for nuclear regulatory requirements better than MOD had done previously when the NSRP was government-furnished equipment. However, we collected no evidence to show whether the prime contractor had managed Rolls-Royce better as a subcontractor than the MOD had done in the past. Even if BAE Systems were able to get priority in allocation of Rolls-Royce's limited technical resources in support of the Astute programme, this might not be the best allocation of Rolls-Royce resources from an overall MOD standpoint. The MOD also must manage responsibilities and risks with its operating fleet, refuellings, and refits at Devonport Management Limited along with NSRP support in Faslane. Having Rolls-Royce as a subcontractor to one or more MOD prime contractors, in addition to being an MOD prime contractor, invites suboptimisation of Rolls-Royce scarce technical resources and a diminution of the MOD's effectiveness and efficiency at managing its own risks. It appears that it would be a better approach to have the MOD actively involved in the Rolls-Royce technical resource allocation process, considering the MOD's overall nuclear propulsion management responsibilities. To that end, the MOD should shift NSRP components and design services to being government furnished on the Astute.

Increase MOD Staffing

The IPT's presence at Barrow is particularly important for improving MOD-contractor relations and to ensure product quality. Unfortunately, ASM-IPT staffing at Barrow may be insufficient for the impending high volume of work pertaining to the acceptance process in the next few years and should be augmented by possibly five personnel above the levels currently planned. We also recognise that

staffing resources are limited at Abbey Wood, so if it proves impossible to increase the total staff, we recommend the transfer of Abbey Wood personnel to Barrow to the extent sufficient to support the Astute programme.

The staffing of the SUB-IPT, the NP-IPT, and the Naval Authorities should each be increased by approximately five to ten people with submarine expertise to support the increased interactions amongst the various organisations during the design and construction of a new class of submarines.

In summary, the roles and structures outlined above should be supported by an increase of approximately 20 to 40 trained and experienced personnel and by processes to support effective partnering and internal MOD linkages. Thus, the new management approach proposed here also depends on changes in career management and on process improvement and trust building.

Career Management

The MOD needs to aggressively manage its in-house technical expertise as it relates to acquisition and life-cycle management. The MOD's core technical expertise has been eroded through reduction in the ministry's workforce. It has also been depleted through a dual focus on job rotation for skill breadth and on the valuation of generalists, who can manage a contract, over specialists, who have more technical insight into design and construction. Mid-career and senior-level experts are still available, but the formal technical career track was eliminated some time ago. There are some indications that this lack has been recognised, and attempts are being made to remedy it. However, we are not convinced that the MOD has accepted the necessity of investing in the core of technical experts required to manage the responsibilities and risks inherent in submarine acquisition.

To resolve this, we recommend that the MOD reinstate an engineering career track for submarine-related skills. Career management might include further schooling and rotations at the shipyard in Barrow, within the different nuclear-related IPTs, with the Defence Procurement Agency's (DPA's) Sea Technology Group, and with the

Defence Logistics Organisation's submarine equipment IPTs. Currently, DPA staff are more likely to be promoted if they move away from technical roles and into management positions. A separate technical career track would provide room for growth for experts who choose to work as engineers throughout their careers.

Focus on Process Improvement and Building Trust

The relationship between the MOD and the current contractor has not been without its difficulties; each has raised concerns about the other's behaviour. The relationship has been characterised as one that is improving, but continuing problems suggest some residual bitterness and distrust.

While this is not something that can be cured immediately, a focus on the processes by which the shipbuilder and the government engage each other can lead to a climate of increased mutual understanding and eventually to trust. We suggest a task-based approach in which the MOD and the contractor work together to identify and resolve problematic areas.

Making the Transition

It is evident that the MOD faces continual pressure to cut staffing and reduce costs. Our recommendations do not require a significant increase in staffing, but some additions are suggested.

DPA management would need to be involved in any additional staffing and career structure changes. This represents a long-term staff planning issue and would likely require several years before it could effectively be implemented.

Process improvements can be managed from within the new nuclear organisation or at the ASM-IPT, with the engagement of the shipbuilder. This would require a strategic focus above and beyond the day-to-day issues that arise. Improving processes and strengthening the MOD–prime contractor relationship will be key to enhancing programme effectiveness without requiring a large increase in MOD staff.

Change is difficult because it can be threatening: It requires organisations and their members to accept that improvements over the current way of doing things are possible. In this study, we take only the first steps towards change—developing the case for it and indicating a vision for the future. The MOD now needs to further prepare the way forward and, in doing so, to remain conscious of how the organisation's culture, structure, and norms will react.