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DST Strategy 07-01-03

[redacted]
email: [redacted]

4 November 2016

Dear [redacted]

I am writing to update you following our e-mail dated 18 August and our letter of 22 September 2016 which was in response to your email of 20 July 2016, addressed to the Ministry of Defence, requesting the following information:

- *A copy of the report 'The Safety of UK Nuclear Weapons' prepared by Sir Ronald Oxburgh, MoD Chief Scientific Advisor, released in July 1992. Please provide me with a copy of the internal MoD version of the report, redacted as appropriate.*
- *If the report has been transferred to the National Archives I should be grateful if you would give me a copy of the appropriate file reference number within the archives.*

The information you have requested can be found at Annex A, but some of the information falls entirely within the scope of the qualified exemptions provided at section 24 (National Security), Section 27 (International Relations) and also within the absolute exemption provided for at section 40 (Personal Data) of the FOIA and has been redacted accordingly.

Section 24 (1) has been applied to some of the information because it contains sensitive details necessary to safeguard national security. The balance of the public interest was found to be in favour of withholding the information given that, overall, the public interest is best served in not releasing details that would, or would likely to be proliferative.

Section 27 (1) (a) has been applied to some of the information because release would further the public understanding of UK relations with other states. The balance of the public interest was found to be in favour of withholding the information given that release of this information would prejudice the UK's relations with other States that have provided information contained in it, would undermine the UK's reputation for honouring its sharing agreements and would inhibit other States' willingness to share sensitive information with the UK in future.

Section 40 (2) has been applied to some of the information to protect personal information as governed by the Data Protection Act 1998. Section 40 is an absolute exemption and there is therefore no requirement to consider the public interest in making a decision to withhold the information.

Please accept my apologies for the delay in providing this information.

If you are not satisfied with this response or you wish to complain about any aspect of the handling of your request, then you should contact me in the first instance. If informal resolution is not possible and you are still dissatisfied then you may apply for an independent internal review by

contacting the Information Rights Compliance team, 1st Floor, MOD Main Building, Whitehall, SW1A 2HB (e-mail CIO-FOI-IR@mod.uk). Please note that any request for an internal review must be made within 40 working days of the date on which the attempt to reach informal resolution has come to an end.

If you remain dissatisfied following an internal review, you may take your complaint to the Information Commissioner under the provisions of Section 50 of the Freedom of Information Act. Please note that the Information Commissioner will not investigate your case until the MOD internal review process has been completed. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website, http://www.ico.org.uk.

Yours sincerely,
DST-Strategy Secretariat FOI Focal Point

[redacted]

[redacted]

25/6

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R.K. Davies
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Report on the Safety of UK Nuclear Weapons

CSA 42/5/1/1 (46/92)

Copy 11 of 60

Prepared by the Safety Review Group
Chaired by the Chief Scientific Adviser to MoD

12 February 1992

Cover + 36 pages

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Executive Summary

1 This report is the work of a Group set up in mid-1991 by the Secretary of State for Defence "to review in the light of any relevant aspects of the report of the Drell Panel in the United States the safety of the present and prospective United Kingdom nuclear armoury".

2 The procedures for ensuring the safety of the UK nuclear stockpile are numerous and complex. The Group has reviewed the present procedures to the extent possible within the time available, and has concluded that overall they have been effective, well implemented and rigorously inspected. But they are difficult to view as a whole. There is no single coordinating body, and different parts have evolved separately over the years and involved many different organisations. The complexity results in part from successive reorganisations that have not primarily been concerned with safety, and in part from the security that attends all nuclear activities with the associated difficulty of gaining an overview. The organisation has depended on the experienced staff in post who know what has to be done.

3 The New Management Strategy in MoD provides the opportunity to make all responsibilities, including those for safety, clearer. Chains of safety responsibility should be as short as possible - at present they tend to be over-long with little added value in certain parts of the chain. We recommend all nuclear weapon safety responsibilities be specifically delegated by personal letter.

4 A major concern over present arrangements for nuclear weapon safety is that although they are good for the evaluation of individual system elements, they are less good for viewing the safety of the *system as a whole*. System elements that are separately safe may interact in ways not easily foreseen (eg in the case of Trident the *whole system* comprises warhead, missile, submarine reactor, torpedoes, shore facilities, etc). Overview of the whole system is difficult but essential and is made more difficult if staff are inexperienced or spend too short a time in post. An overview must be maintained by individuals with appropriate technical understanding rather than by briefed officials, whether they be administrators, scientists or from the Services.

5 We therefore recommend the appointment of an independent champion for nuclear weapon system safety in MoD who, supported by an appropriate staff, would personally answer for a range of assessment and overview responsibilities with respect to the safety of nuclear weapon systems. This would in no way dilute the responsibility of the Procurement Executive for ensuring that all issues of nuclear safety were addressed, nor the duties of the Ordnance Board, particularly with respect to design assessment. Where the champion and his staff might be best located within the MoD structure would be for the Department to decide, but independence and, ultimately, access to Ministers would be essential.

6 The existing Nuclear Weapons Safety Committee (NWSC) is independent and comprises outside experts with relevant experience. It is free to inquire into any aspect of nuclear weapon safety. It may also respond to requests for advice. The chairman has direct access to the Secretary of State on any matter that he deems necessary. This committee is outside the chain of safety responsibility and it is important that it should remain so. We recommend, however, that arrangements for bringing matters to the attention of the NWSC be reviewed.

[redacted]

7 The weapons in the UK stockpile (the WE177 free-fall bomb and the Polaris-Chevaline missile system) are of elderly but robust design. The present review has not revealed previously unsuspected weapon hazards nor suggested that present handling methods should be modified. There is no reason not to allow the WE177 to continue in service in accordance with present plans, subject to its satisfying periodic system safety reviews as we recommend should be regular practice with nuclear weapon systems.

8 The Polaris-Chevaline system currently deployed in submarines is due to be replaced by Trident. Although the Trident warhead has additional safety features, the overall system safety is in part dependent on the Trident missile itself which is procured from the US. As the Drell report recognised, the most delicate operation is weapon embarkation and disembarkation and much effort has gone into making this operation as safe as possible. Although UK proposed practice is in fact the method preferred by Drell, we recommend that the arrangements for conducting the operation continue to be studied.

9 [redacted]

10 It is planned to replace WE177 early in the next century, and to meet this date preliminary work is already under way on a future nuclear weapon. It is essential that safety issues be fully exposed during the process of specifying this requirement. We recommend that the Ordnance Board revisit its guidelines for the safety assessment of nuclear weapons in time for its views to be taken into account.

11 [redacted]

12 Warheads are carried by road in vehicles that are secure and equipped with satisfactory means of internal containment and protection. The present vehicles themselves, however, are old, unreliable and overdue for replacement. Although this does not add significantly to the hazards of transport, even rare breakdowns in this most conspicuous part of UK nuclear activities can only undermine public confidence in what are otherwise thoroughly professionally run operations. New vehicles are planned to enter service in 1992.

13 We recommend that clear criteria be set for the reporting of incidents involving any part of a nuclear weapon system which affects nuclear weapon safety, and that the list of reported incidents be reviewed annually with a view to recognising any lessons that may be learned and bringing them to the attention of the appropriate authorities.

14 The Atomic Weapons Establishment (AWE) is the sole source of UK expertise in warhead design and the prediction of warhead behaviour in all environments. The past safety of the UK nuclear programme has been dependent in large measure on the

ability of AWE to be proactive as well as reactive, and to collaborate closely with those who handle weapons and are responsible for their custody. AWE staff have also customarily filled nuclear posts in MoD. Although some suitable staff might be recruited from elsewhere, we recommend that the impending contractorisation of AWE should not be allowed to impede these activities.

15 It has been customary to consult AWE on all matters bearing on warhead safety. Because the procedures that are safe with nuclear weapons may in some cases be counter-intuitive to conventional weapons experience, we recommend that there should be an obligation to consult AWE over the planning or modification of all procedures relating to the handling, storage, or movement of nuclear weapons.

16 The UK nuclear weapon programme has been conducted so far without any major incident. This record is a tribute to the efforts of all those involved over the years but offers no grounds for complacency. However unlikely an accident may be, we recommend that as long as the country retains nuclear weapons, high priority continue to be given to the retention of properly trained, equipped and regularly exercised nuclear accident response teams.

17 The safe and responsible ownership of nuclear weapons carries major obligations. It is possible to discharge these only with the support of comprehensive technical expertise of the highest quality and operating procedures that are carefully planned and meticulously executed. We recommend that technical expertise be sustained by a vigorous programme of research at AWE that includes a sharp focus on safety. If underground testing is constrained this process will be more difficult. The achievement of safe operation will in any case depend on the Services maintaining their present high standards.

18 We have analysed the specific recommendations made by the Drell panel and considered their relevance to UK weapons and practices. Most matters are addressed in the main report but, for completeness, a separate section commenting on each of the Drell recommendations is included.

19 Even as this report was being written major changes were taking place in the nuclear plans of the superpowers. Nevertheless the Group believe that their comments and recommendations on the issues they were asked to consider can be read across to any new nuclear posture that the UK may decide to adopt.

20 The Group records its thanks to all who have assisted in the enquiry. The fullest co-operation and attention was received from all of whom it was sought.

Recommendations

1 That more formal arrangements for bringing matters to the attention of the Nuclear Weapons Safety Committee be considered. (Paragraph 2.4.3)

2 That consideration be given to the involvement of UK nuclear weapons design authorities in Weapon Standardisation Team Inspections, Nuclear Weapon Capability Inspections and Missile Technical Proficiency Inspections. (Paragraph 2.5.6)

3 That all those with nuclear responsibilities should review their delegations under the New Management Strategy, to make sure that responsibilities for both promoting and ensuring safety are explicitly stated and acknowledged. (Paragraph 3.2.2)

4 That senior MoD managers ensure that professional views from those with the highest level of technical overview are properly represented, together with the wider view of management in the area concerned. The senior MoD managers should also maintain sufficient direct links with the technical level to satisfy themselves that the procedures are sound. (Paragraph 3.2.4)

5 That arrangements be instituted to define the levels of experience and training that should be associated with all posts in MoD having responsibilities for nuclear weapon safety, and to ensure that these requirements can be and are satisfied. (Paragraph 3.2.5)

6 That MoD should identify a champion for nuclear weapon safety. This individual would need to have the competence, resources and seniority to discharge the following responsibilities:

- to be the independent champion for safety in nuclear procurements who would be involved in nuclear procurements from the earliest stages and who could, if necessary, raise to Ministerial level any conflict between safety and cost, performance or timescale;
- to provide an independent assessment of the completeness and quality of the safety case prepared for any nuclear weapon system, and to promote best practice in this area;
- to keep continuously under review the organisation and management of nuclear weapon safety in all procedures and activities related to present or future nuclear weapon systems, to be satisfied that they are functioning effectively, and to bring to the attention of the responsible authorities any deficiencies or unnecessary duplications;
- to set criteria for the reporting of incidents actually or potentially hazardous to nuclear weapon systems or their critical components, and to receive, maintain, analyse and appropriately disseminate records of such incidents;
- to serve as a centre of experience and best practice in safety matters relating to the ownership of nuclear weapons;

[redacted]

Recommendations (continued)

- to interact with appropriate technical organisations in the formulation of nuclear safety R&D objectives;

- to provide to the EPC(N) and EPC or their successor bodies, assessments of the treatment of system safety in submissions relating to nuclear weapons, and similarly to the other approving bodies or individuals for items too small to be considered by the senior committees.

(Paragraph 3.3.5)

7 That MoD committees with nuclear weapon safety responsibilities should review their roles, and that the way in which they reach and communicate decisions, and the responsibilities of the chairman, should be agreed by the members and those to whom advice or direction is normally offered. (Paragraph 3.4.1)

8 That as long as the country retains nuclear weapons, high priority continue to be given to the retention of properly trained, equipped and regularly exercised nuclear accident response teams. (Paragraph 3.6.4)

9 That the potential linkage of security to nuclear weapon safety be recognised by requiring the Director of Nuclear Policy and Security to report any proposed change in the physical or technical security measures to be applied to an operational nuclear weapon system, whether or not it was yet in operational service, to the relevant procurement authority. The procurement authority, whether for the warhead or the overall system, should conduct a formal assessment of the nuclear safety implications of the proposed change. (Paragraph 3.7.2)

10 That a vigorous research programme be pursued at AWE towards continuing improvements in the safety of warhead designs. (Paragraph 3.8.1)

11 [redacted]

12 That steps be taken to ensure that AWE be consulted over the planning or modification of all procedures relating to the handling, storage, or movement of nuclear weapons. (Paragraph 3.8.4)

13 That the contractorisation of AWE not be allowed to reduce the availability of nuclear expertise to MoD. (Paragraph 3.8.5)

14 That comprehensive assessment methodologies such as those based on the use of probabilistic design criteria continue to be actively pursued for application to the design of nuclear weapon systems. (Paragraph 4.1.3)

15 That approximately every seven years during service there should be a design review of a nuclear weapon system. (Paragraph 4.2.2)

Recommendations (continued)

16 That a design review of the WE177 weapon should be undertaken forthwith, not because we have identified any specific cause for concern, but as a prudent precaution. (Paragraph 4.2.2)

17 That weapons continue to be transported by air as infrequently as possible and that practices relating to the number of weapons transported at one time by air, and how they are contained, should be re-examined with modern risk assessment techniques. (Paragraph 4.2.4)

18 That if it is the intention that surface ships should remain nuclear capable after the withdrawal of the WE177 from deployment at sea, then there should be a safety requirement to ensure that the capabilities of ships and shore facilities are maintained by exercising with training rounds. (Paragraph 4.2.5)

19 That studies continue in order to further understanding of the potential hazard of Trident missile loading and unloading, and to ensure that it is minimised in every situation. (Paragraph 4.4.4)

20 That the Ordnance Board revisit its guidelines for nuclear weapon design assessment on a regular basis, recognising that it is essential that this be done before any new weapon procurement is embarked upon. (Paragraph 4.5.2)

21 That a strategy for the safety justification of any future nuclear weapon system be defined. (Paragraph 4.5.4)

22 Annex G, Paragraph G.2.

23 Annex G, Paragraph G.3.

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1 Introduction

1.1 On 15 October 1991 the Minister of State for Defence Procurement announced in Parliament that a small group, including experts from both inside and outside Government and under the leadership of the Ministry of Defence's Chief Scientific Adviser, had been set up to examine the safety of United Kingdom nuclear weapons. The Group was to take account of a recent report prepared for the House Armed Service Committee of the United States Congress and which had been commissioned from a specially appointed, independent technical panel on the safety of US nuclear weapons. This panel was chaired by Dr Sydney Drell and its report has been made available to the UK. Although the UK nuclear stockpile is smaller, less diverse and different in kind from that in the US, there are nevertheless some important elements in common.

1.2 The Group began work in August 1991 with the remit of reporting around the turn of the year. The terms of reference and membership of the Group are given at Annex A. Although the Group took the Drell report as its point of departure, it has attempted to survey UK nuclear weapon safety issues as a whole.

1.3 The Group recognised that all weapon systems are potentially dangerous; their design and their ultimate certification as suitable for service must represent some kind of judgemental balance between capability, risk and cost. Over time, however, the basis of that judgement may change. New computational and analytical techniques may provide a more thorough understanding of the behaviour of a system than it was possible to derive from the initial development work, including underground tests, and from the methods that were available when it was designed. New technologies and new materials may become available that allow weapons to be designed to higher safety standards than was previously possible. The consequences of component deterioration in mature weapon systems may have to be addressed. Finally public expectations for standards of weapons safety may become more demanding over the years.

1.4 In practice the issues addressed by the Group largely fell into two groups:

- the processes of establishing the requirement, concept and design that lead to the manufacture and to the delivery of a weapons system; here the Group was first concerned with the initiation of safety requirements and secondly with the way in which approvals, and particularly their safety component, were obtained at the various stages in the procurement process up to and including a system's entry into service;

- the management, operation, protection and support of systems once they enter service; here it was a matter of discovering how safe practice was initially established, how it was subsequently revised and whether the arrangements were working as intended.

1.5 Consideration of these issues is complicated by the current practices of procuring major system elements off-shore and by three major changes in the way that MoD conducts its business. First, it has been decided to manage the Atomic Weapons

Establishment (AWE) through an operating contractor who will carry out research, development and production for MoD on an arm's length contractual basis. Second, within MoD, the introduction of the New Management Strategy is designed *inter alia* to give individuals at all levels more control over the staff and resources needed to carry out their work. Third, the reduction in the size of UK armed forces is being matched by a reduction in MoD Headquarters staff, which itself is resulting in some major reorganisations. This HQ reduction goes under the name of PROSPECT. It is not clear how these three changes will affect a safety structure that traditionally placed a heavy reliance on a sense of personal and professional responsibility, but which was essentially conducted in an environment where it was difficult to assign costs separately to the different facets of nuclear weapons procurement and operation.

1.6 Although the Group's terms of reference refer to safety, some attention was paid to security as well. This was partly because there is often little public awareness of a distinction between the two, and partly because security measures can have an important influence on weapon system design and operation, and therefore potentially on safety.

1.7 The Group worked by receiving documents (including some of US origin), holding discussions with key officers and officials with nuclear weapon responsibilities, and visiting a number of sites to meet those responsible for designing, building, handling, maintaining, operating and protecting nuclear weapons (see Annex A). It was also important not only to establish the nature of present safety practices but to see how effective they had been by examining the UK record of nuclear weapons incidents (Annex F).

1.8 The enormous complexity of any nuclear weapon system meant that it would not be possible to establish independently and *ab initio* the compliance of UK nuclear weapons with any particular safety standard. The Group believed therefore that it was most appropriate to review the safety procedures under which UK nuclear weapons are designed, built and operated, to review the organisation and responsibilities by which these standards are established and through which compliance is confirmed, and to identify areas of concern. In doing so it has also reviewed the individual weapon systems to the extent necessary to make informed judgements as to their safety.

1.9 The report that follows is in four main parts. The first is a brief overview of existing weapon systems and procedures both for dealing with them and designing and procuring new systems, with particular emphasis on safety. This section is intended to give no more than a flavour of these activities. The second section deals with our concerns and recommendations about existing procedures, while the third offers comments on the weapons themselves. The fourth covers the impact of the Drell report on UK matters. The report is supported by a number of annexes which elaborate on certain aspects of the main report and contain supplementary factual information.

1.10 We have been seriously constrained by time and given longer would have been able to look into a number of matters in more detail. We do not, however, believe that our main conclusions would have been significantly affected. The principal difference would probably have been an increased number of minor recommendations. We believe that these will in any case emerge if our present recommendations are adopted.

1.11 Even as this report was being written, the major nuclear powers were announcing reductions in their stockpiles and nuclear preparedness that would have been unthinkable even a short time ago. We believe, however, that our comments and recommendations on the issues we were asked to consider can be read across to any new nuclear posture that the UK may decide to adopt.

1.12 In conclusion we must express our thanks to all those who have done so much to assist us in our task. We received the fullest co-operation and attention from all those whom we approached.

[redacted]

2 Overview of UK Nuclear Weapon Systems and Current Requirement and Procurement Procedures

2.1 UK Tactical Weapons

2.1.1 The UK has both tactical and strategic nuclear weapon systems. The current tactical system is the WE177 free fall bomb which exists in three variants. It came into service in 1966 and is deployed with both ships of the Royal Navy and at Royal Air Force stations. The Government has recently announced that the weapon will no longer be deployed at sea under normal circumstances and that stocks maintained abroad in support of NATO will be significantly reduced. Land and air transport of the weapon are the responsibility of the RAF, and sea transport the responsibility of the RN.

2.1.2 All nuclear warheads in service are returned to the Atomic Weapons Establishment (AWE) periodically for maintenance and for the replacement of components that have a limited life. Neither the RN nor the RAF deploys live nuclear weapons in combat aircraft or helicopters in peacetime and in consequence, now that the RN weapons have been withdrawn from ships, tactical weapons will be moved only as necessary for servicing or, rarely, between RAF stations.

2.1.3 Periodically, sample warheads are withdrawn from service and completely disassembled at AWE. Each of the components and subsystems is tested to gain early warning of any component deterioration that might threaten the safety or proper functioning of the weapon. For the same reason, samples of as many original components as possible are stored at AWE in an appropriate environment and periodically tested. [redacted]

2.1.4 Present Government plans envisage the progressive retirement of the WE177 soon after the year 2000. Options are under study for its replacement with an air-launched stand-off weapon known as FTNW (Future Theatre Nuclear Weapon) and sometimes referred to as TASM (Tactical Air to Surface Missile). Weapon systems of this complexity and with the most demanding requirements for safety take a long time to design, test and produce, and to meet the intended in-service date, work on FTNW is under way now.

2.2 UK Strategic Weapons

2.2.1 UK strategic weapons are deployed in submarines and the current system consists of a Polaris missile armed with a UK payload in a configuration known as Chevaline. These missiles are deployed in the four Resolution class submarines. The warheads are manufactured at AWE and are in most cases transported by road (but occasionally by sea) to the Clyde Submarine Base where they are mated to the missiles and embarked on the submarines. The warheads are of a more modern design than the WE177 but do not incorporate the modern safety features mentioned in Paragraph 2.1.3. It is planned to withdraw the Resolution class submarines and their Polaris missiles over the next five years or so and to replace them by the Vanguard class carrying Trident D5

2 *Overview of UK Nuclear Weapon Systems and Current Requirement and Procurement Procedures (continued)*

missiles procured from the United States. The missiles each carry a number of warheads designed and manufactured at AWE. As Chevaline warheads are withdrawn from service they will be returned to AWE for breaking down and recovery of fissionable materials.

2.2.2 The Trident missiles procured from the US will be identical to those deployed by the US in their Trident submarines. Missiles for the UK will be drawn from a common stock held in the US. It is planned that each new Vanguard submarine should call at Kings Bay in the US to embark its complement of missiles and then return to the Clyde where the warheads delivered from AWE would be mounted on the missiles in the submarine. This done, the submarine would enter its operational patrol pattern. Before a major submarine refit the procedure would be reversed.

2.2.3 [redacted]

2.3 The Procurement Process

2.3.1 The following account of the MoD organisation for procuring nuclear weapons can be no more than a snapshot of a structure that is subject to the changes described in Paragraph 1.5. Furthermore, it is important to recognise that the progression of a project from concept to entry into service may take fifteen or more years, in which time MoD arrangements for dealing with important parts of it may have changed more than once, and in minor ways more frequently.

2.3.2 The generation, study and evaluation of proposals for new conventional weapon systems tend to be initiated within groups working for the Deputy Chief of the Defence Staff (Systems) (DCDS(S)). In the case of nuclear weapons, the major role in project initiation is played by the Assistant Chief of the Defence Staff (Policy and Nuclear) (ACDS (Pol&Nuc)) who answers to the Deputy Under Secretary (Policy). In practice there are extensive discussions with the appropriate senior officials in the Procurement Executive (PE) and with senior staff in AWE. Previous to this there is consultation with the Office of Management and Budget and with the Programme staff who have the responsibility for matching plans for future programmes with agreed expenditure limits. Ultimately a proposal for a new nuclear weapon emerges in the form of a Staff Target whose preparation is led by staff of DCDS(S).

2.3.3 Such proposals are also discussed by a relatively new committee, the Senior Nuclear Group, chaired by the Chief of the Defence Staff and the Permanent Secretary. This group fulfils no formal executive role but takes an overarching view of the interaction of nuclear policy and procurement with other aspects of the Department's business. It exercises its influence through the executive authority of its individual members or their membership of other bodies.

2.3.4 The project then begins upon the first of a series of stages, through which all major procurement activities pass, in order to match increasing and staged financial commitment with a managed reduction of risk. Costs, technologies, objectives and contractual handling are progressively refined through the procurement phases known as Feasibility Study, Project Definition, Full Scale Development and Production, and lead to the introduction of a system into service. The Feasibility Study is conducted on the basis of a Staff Target and is designed to provide a number of options offering a range of capabilities; later phases are conducted against a Staff Requirement which is based on the Staff Target and re-endorsed with minor changes as each stage is initiated. In all cases the project is managed and the expenditure controlled by MoD's Procurement Executive (PE). The decision to move from one stage to the next rests with Ministers who will be advised by the Equipment Policy Committee (Nuclear) (EPC(N)). In some cases (eg Trident) the system is very large and may be the subject of separate Staff Targets - missile, submarine and shore facilities, and separately the warhead.

2.3.5 For every project the PE establishes the post of project manager, and this post remains extant as long as the weapon remains in service. Once the weapon is well established in service, the post is usually combined with another, but it retains the responsibility for managing approvals of and overseeing any modifications to the weapon or changes in the way in which it is used. The seniority of the project manager reflects the size of the project and current stage of its development.

2.3.6 Matters of safety arise at every procurement stage. In the case of the warhead, the Staff Target is translated into a formal procurement document by the PE in consultation with AWE, the design authority for the warhead, before work can begin. The principal external arbiter on safety at this stage is the Ordnance Board (OB) which periodically (and most recently in 1984, OB Proc N392) issues formal guidelines for the design and associated assessment of the safety of nuclear warheads. It should, however, be recognised that AWE is the only body in the country with the technical expertise in warhead design that is necessary to undertake the design task and to confirm compliance with these OB guidelines. AWE carries out a research programme within which new safety technologies are an important element, and are the advisers to both the PE and the OB on warhead safety.

2.3.7 The Group felt that, while safety was generally accepted as important during procurement, it was not seen as a key attribute by those who specify the requirement, possibly because it was taken for granted (see the recommendation in Paragraph 3.3.5).

Table 1 Representation of MoD safety authorities on committees with nuclear safety interests

	CSSE /DGSWS	DC(Nuc)	AWE	DGST(N)	OB	CINO
NWSC (SoS)	√	√	√	√		√
TSC (DGSWS)	√	√	√	√	√	√
MSC (DCofN)	√			√	√	√
WSCC (AWE)	√	√	√	√	√	√
RBASC (DC(Nuc))	√	√	√	√	√	√
ESTC		√	√	√	√	√

Committees		Authorities	
NWSC	Nuclear Weapons Safety Committee (advises Secretary of State)	CSSE/ DGSWS	Chief Strategic Systems Executive/Director General Strategic Weapon Systems
TSC	Trident Safety Committee (advises Director General Strategic Weapon Systems)	DC(Nuc)	Deputy Controller (Nuclear)
MSC	Magazine Safety Committee (advises Deputy Controller of the Navy)	AWE	Atomic Weapons Establishment
WSCC	Warhead Safety Coordinating Committee (advises Chief Executive, AWE)	DGST(N)	Director General Supplies and Transport (Navy)
RBASC	Re-entry Body Assembly Safety Committee (advises Deputy Controller (Nuclear))	OB	Ordnance Board
ESTC	Explosive Storage and Transport Committee	CINO	Chief Inspector of Naval Ordnance

2.4 Committees Concerned with Nuclear Safety

2.4.1 The main committees with interests bearing on safety are listed in Annex B, along with their terms of reference and some additional comments. Table 1 indicates cross-membership between these committees. In this section we mention some of the more important committees. Terms of reference and in some cases further comments are given in Annex B.

2.4.2 The Nuclear Weapons Safety Committee (NWSC) comprises individuals who are largely external to MoD. It is constituted to provide independent advice to the Secretary of State for Defence on safety matters pertaining to all aspects of nuclear weapons from design through to operations, but generally works by providing advice to responsible officials and Service officers. The chairman and other external committee members have no direct line responsibility for nuclear safety in MoD, but have high level expertise and wide experience in nuclear safety or radiation protection in other applications (or as former employees in MoD) (see Annex B.6). MoD has a parallel body that advises on reactor safety in warships - the Nuclear Powered Warships Safety Committee.

2.4.3 The NWSC both comments on matters brought to its attention and can itself initiate enquiries. Its standing is such that its advice cannot be ignored. The Group feels, however, that the NWSC's effectiveness owes much to the current members' long experience, and *we recommend that more formal arrangements for bringing matters to the attention of the Nuclear Weapons Safety Committee be considered.*

2.4.4 The Ordnance Board (OB) is a body with broad tri-service responsibility for the safety of munitions. It examines any warhead proposal a number of times in its evolution, and although the Board does not have executive authority, any proposal with which it was not satisfied would not normally be accepted (see Annex B.7).

2.4.5 Within AWE there is a Warhead Safety Coordinating Committee (WSCC) that is separate from and independent of the design team. This committee is headed by the establishment Safety Director and its membership is drawn from a wide range of relevant MoD authorities. It provides advice to the Chief Executive of AWE who has the responsibility for certifying to the PE the performance and safety characteristics of the warhead (see Annex B.9).

2.4.6 The other main committee with broad safety responsibilities is the Explosives Storage and Transport Committee (ESTC). It has formal tri-service responsibility for "classifying" explosives (the explosive classification determines the storage and handling procedures that must be followed) and for prescribing on the safe transportation and storage of weapons or other systems containing explosives (see Annex B.8).

2.4.7 Before being embarked in a vessel, a weapon must have received a magazine safety certificate issued by the Magazine Safety Committee (MSC) on the basis of evidence provided by the responsible project in the form of a Magazine Safety Paper. A safety statement is also provided by the Chief Inspector of Naval Ordnance (CINO), together with information specific to the type of vessel in question. The procedures to be followed onboard for Strategic Weapon Systems, for handling, maintenance, test and launch are provided by the procurement authority, but the responsibility for implementation lies with Flag Officer Submarines. The procedures to be followed on board ships are the responsibility of Commander-in-Chief Fleet following guidance from the MSC (see Annex B.10).

2.4.8 In addition to these standing committees, a project is free to establish its own *ad hoc* committees or working groups that include safety among their remits, an example being the Trident Safety Committee (TSC) set up by Director General Strategic Weapons Systems. Most members of the TSC are representatives of organisations contributing significant effort to safety assessments (see Annex B.11).

2.4.9 It was noted that the EPC(N) (Paragraph 2.3.4) does not address safety as a regular concern or in any systematic way (see the recommendation in Paragraph 3.3.5).

2.5 Weapon Handling Procedures

2.5.1 Although the Services' management of safety is generally outside civil statutory regulation, it is MoD policy that safety standards should be at least as high as those in the civilian world in comparable activities.

2.5.2 Well in advance of a nuclear weapon system's entry into service, the appropriate procurement authority in consultation with the Service or Services responsible will have established procedures for receiving the weapon or warhead, and for its storage, preparation, handling, and deployment. Most recent experience of this kind is in the Trident project where it has also been necessary to build extensive shore facilities at the Clyde submarine base as part of the project. The responsibility for implementing these requirements within the Naval depot rests with the Director General of Supplies and Transport (Naval) (DGST(N)), and the fitness for purpose of the procedures and interfaces with the facilities is verified by a slow run through of all these activities using inert training weapons. The procedures themselves are devised after extensive analysis of a wide range of possible accident scenarios.

2.5.3 Once a weapon has entered service, there is a variety of inspection procedures to ensure that the authorised procedures are followed meticulously. In the case of the RAF, each location at which nuclear weapons are held is subject to a long (one to two weeks) and searching annual inspection covering all those who have any contact with nuclear weapons (WE177) or direct responsibility for them. The inspection is carried out by a specialist Weapons Standardisation Team that reports to the Chief Inspector of Explosives, RAF in MoD.

[redacted]

2 *Overview of UK Nuclear Weapon Systems and Current Requirement and Procurement Procedures (continued)*

2.5.4 In the case of the Navy, the formal inspection responsibility rests with the Controller of the Navy. For surface ships and submarines he in practice delegates it to Commander-in-Chief Fleet. For surface ships, a two phase Nuclear Weapon Capability Inspection is carried out before nuclear weapons are embarked. Phase I is shore based (one day) and Phase II lasts several days at sea. There are similar arrangements for submarines and also "no notice" inspections of crew competence. These inspections are both rigorous and formal, and recently a major warship did not reach the required standard and therefore did not embark her weapons on the originally planned timetable.

2.5.5 The responsibility for maintaining safety standards at the Naval shore facilities is delegated by the Chief of Fleet Support to DGST(N). For strategic weapons, the control of weapon processing in RN shore facilities is ensured by thorough generation and implementation of procedures, and certification of personnel. An exacting US/UK audit, involving the PE, the CINO organisation and the US authorities, occurs periodically in Missile Technical Proficiency Inspections.

2.5.6 Comparison with US practice leads us to believe that UK design authorities may be insufficiently acquainted with Service practices. *We recommend that consideration be given to the involvement of UK nuclear weapons design authorities in Weapon Standardisation Team Inspections, Nuclear Weapon Capability Inspections and Missile Technical Proficiency Inspections.*

2.6 **Security**

2.6.1 Policy advice for the security of nuclear weapons is the responsibility of ACDS(Pol&Nuc). There are several broad but interrelated aspects to weapon security. [redacted] There are also the practical arrangements and guarding procedures associated with the storage and transport of the weapons. Finally there are nuclear release procedures that have to be implemented before a weapon can be used operationally.

2.6.2 On the question of [redacted] ACDS(Pol&Nuc) would be expected to take advice widely within the department and particularly from AWE. Vehicles for weapon transport, like all other defence land vehicles, are procured by the Land Systems part of the PE, but have to meet security standards proposed by ACDS(Pol&Nuc). Similarly, although the RAF has the responsibility for the delivery and transportation of nuclear weapons, this is done to standards and to meet threats of a kind specified by ACDS(Pol&Nuc). The procedures for the release of weapons for use are the business of a special Cabinet Office committee.

3 The Management of Nuclear Weapon Safety

3.1 Introduction

3.1.1 In this section we comment on arrangements described in Section 2 and on the committees that give advice on, and to a degree regulate, nuclear weapon safety. In detail, the arrangements appear to show the knock-on effects of repeated wider restructurings to meet operational or other organisational needs. These needs have not had the simplicity of the safety management chain as a principal concern. It is perhaps inevitable that, in an area that is properly governed by high security and the dissemination of information on a need-to-know basis, the existing inconsistencies should not have been widely apparent.

3.1.2 We were most encouraged by the high degree of dedication and experience that we encountered amongst the individuals with nuclear weapon safety responsibilities, and it is a tribute to their flexibility and common sense that the complex system works as well as it does. On the other hand, the fact that there has been no serious accident does not allow grounds for complacency. We found no such complacency amongst those with day-to-day responsibilities, although we found no individual with effective responsibility for scrutinising the entirety of the safety procedures and organisation.

3.1.3 Our principal concern about the present structure is that, although individual areas of activity may be very well managed, as we believe they are, the interfaces between them may not always be adequately overseen. In the case of large projects, the safety case for individual elements of the project may be handled thoroughly, but arrangements examining the safety of the interactions between the elements are, we believe, less effective.

3.1.4 We also felt that MoD has no clear champion for nuclear weapon safety, with the responsibility for continually pressing the questions of whether MoD's nuclear weapon safety organisation and standards are adequate, and whether MoD can be confident that these standards are being achieved. A comparison with the large number of individuals concerned that proper standards are maintained in the use of financial resources is striking. On warhead design, the principal drive for safety has in the past come from AWE, largely through advice to other bodies. The Services, on the other hand, deal with the warhead only as part of a system, and their principal concern is to ensure compliance with procedures. These procedures are generated by the procurement and design authorities, who are not in every case well placed to take account of the context in which the nuclear weapon system is deployed (see Paragraph 2.5.6).

3.1.5 Nevertheless, it is important to record that we found no indication that every practicable step to optimise weapon safety at the design stage had not been taken, and, once in service, to make weapon handling and storage as safe as practicably possible.

3.2 The New Management Strategy

3.2.1 The New Management Strategy (NMS) within MoD seeks to decentralise administration and to devolve decision-making to the level where the best-informed decisions can be made. This involves the clear statement of objectives, the proper attribution of costs and, as far as possible, the measurement of output. Among other things, it is intended to provide an instrument for implementing the annual targets for increased efficiency sought of departments by the Government.

3.2.2 There are both potential gains and losses for safety under such a system. The potential gain is that safety delegations could and should accompany financial delegations, and should be equally clearly documented. This should clarify the chain of responsibility and reduce some of the complexity mentioned earlier. The potential loss is that if safety is not identified as an objective for a particular post, the post-holder may find it difficult to justify an appropriate level of resource allocation, and may even consider that safety is the responsibility of others. We were fortunate to be able to see a draft copy of a system of delegations being proposed for the safety of naval vessels (DRAFT SHIP SAFETY POLICY DOCUMENT, November 91). We endorse the approach used in this document and believe that it affords a model that could be followed more generally for safety delegations under NMS. *We recommend that all those with nuclear responsibilities should review their delegations under the New Management Strategy to make sure that responsibilities for both promoting and ensuring safety are explicitly stated and acknowledged.*

3.2.3 In one respect, however, some senior managers may not find such an arrangement completely satisfactory. It happens in some cases that those who have a genuine and thorough technical understanding of safety problems are at best no higher than half way up the safety management chain. At the same time, those higher in the chain have neither the time nor the competence to add additional value to the assurances they have received from below before passing them on upwards. The problem is accentuated if there is a rapid turnover of staff occupying posts within the chain.

3.2.4 For this reason *we recommend that senior MoD managers ensure that professional views from those with the highest level of technical overview are properly represented, together with the wider view of management in the area concerned. The senior MoD managers should also maintain sufficient direct links with the technical level to satisfy themselves that the procedures are sound.* These delegations must recognise that safety must be a fundamental attribute of nuclear weapon systems, and that it is a line management responsibility to ensure that such systems can be safely operated in the UK. The approvals of design standards, operating procedures, transport and maintenance arrangements are examples of areas which should always, and generally do, receive specific management attention, but which should be explicitly covered by management plans and delegations.

3.2.5 The Drell panel was concerned that many of those who deal with administrative aspects of technical issues related to nuclear weapons were ignorant of some of the important aspects of weapon safety. In the UK such problems are accentuated by the

short tours of duty individuals may have in particular posts. Drell proposed that training courses of approximately a month's length should be established which such officials should be obliged to attend. We see an advantage in exploring such an idea and considering which UK administrative posts could most benefit from training of this kind (eg in the Policy & Nuclear area); this might also be a possible area of UK/US co-operation. In a few cases, we also had concerns about the backgrounds and experience of those filling other posts with responsibilities for nuclear weapon safety. We noted that this was in marked contrast to the Services, who devoted much effort to ensuring that those with nuclear weapon responsibilities were properly trained and kept up to date. *We recommend that arrangements be instituted to define the levels of experience and training that should be associated with all posts in MoD having responsibilities for nuclear weapon safety, and to ensure that these requirements can be and are satisfied.*

3.3 A Champion for Nuclear Weapon Safety

3.3.1 Regardless of what changes may come about as a result of the actions we propose above, there will remain several concerns.

3.3.2 First, there is a need to designate an individual who has both the competence and the clearly identified responsibility to keep the procedures and the organisation for nuclear safety under continuous review.

3.3.3 A second important need is that highest MoD management should receive for nuclear weapons systems, as they do already for naval nuclear propulsion plants, independent advice on the adequacy of the safety case provided by line management. This process is known as the provision of an independent safety assessment. At present parts of nuclear weapon systems benefit from this approach (eg through the Ordnance Board), but not the whole system. We see a need for a clearly identified and technically well informed authority for the completeness and quality of safety assessments in nuclear weapon *systems*. Such a body should be independent and not part of the management chain for weapon design and procurement. Its approval should be sought at the earliest stages of setting a Staff Target for weapons procurement, and at a number of subsequent stages in the procurement process. Although it would not attempt to prescribe design standards, it would, for any project, indicate the criteria against which it would conduct an assessment of the safety case for the system as a whole. The existence of such a body must neither diminish the responsibility of the Procurement Executive and operating authorities for whole system safety, nor duplicate the work of existing bodies.

3.3.4 A third need arises from the way in which the advent of nuclear weapons has been handled by MoD. Not unreasonably, the existing procedures and institutions dealing with the safety of munitions were extended to include nuclear munitions. In some respects this is very valuable, because some experience with conventional weapons is directly relevant to nuclear weapons; on the other hand, in some respects (eg the extent of the potential hazard to the civil community) nuclear weapons are unique and have

to be treated in special ways. At present there is no central repository of experience of this latter kind within MoD and, although experience exists, it is fragmented among different bodies.

3.3.5 *We therefore recommend that MoD should identify a champion for nuclear weapon safety. This individual would need to have the competence, resources and seniority to discharge the following responsibilities:*

- *to be the independent champion for safety in nuclear procurements who would be involved in nuclear procurements from the earliest stages and who could, if necessary, raise to Ministerial level any conflict between safety and cost, performance or timescale;*
- *to provide an independent assessment of the completeness and quality of the safety case prepared for any nuclear weapon system, and to promote best practice in this area;*
- *to keep continuously under review the organisation and management of nuclear weapon safety in all procedures and activities related to present or future nuclear weapon systems, to be satisfied that they are functioning effectively, and to bring to the attention of the responsible authorities any deficiencies or unnecessary duplications;*
- *to set criteria for the reporting of incidents actually or potentially hazardous to nuclear weapon systems or their critical components, and to receive, maintain, analyse and appropriately disseminate records of such incidents;*
- *to serve as a centre of experience and best practice in safety matters relating to the ownership of nuclear weapons;*
- *to interact with appropriate technical organisations in the formulation of nuclear safety R&D objectives;*
- *to provide to the EPC(N) and EPC or their successor bodies, assessments of the treatment of system safety in submissions relating to nuclear weapons, and similarly to the other approving bodies or individuals for items too small to be considered by the senior committees.*

3.3.6 In order to discharge these responsibilities the identified champion would need to hold a relatively senior post and have a suitably sized staff of high quality that would need augmentation at times during major procurements. For convenience in writing we refer to the champion and his group as the NWSG - Nuclear Weapon Safety Group. The group should operate independently of, but interact with, the procurement and operational requirements organisations.

3.3.7 The MoD reporting line for the NWSG would be a matter for the Department, but our firm view is that it should be outside the Procurement Executive and the Defence staff, and it should be known that the NWSG had right of access to Ministers. It should also be represented on the NWSC.

3.3.8 An early task would be to consider the compilation of a Nuclear Weapons Safety Manual along the lines of the Manual of Naval Nuclear Propulsion Safety. A further important function for the NWSG would be that of both maintaining its own safety databases and keeping a record of other relevant databases maintained within MoD and elsewhere. These databases would be an essential resource for those engaged in establishing quantitative safety cases for nuclear weapon systems.

3.3.9 We have indicated that the NWSG should receive reports of all reportable incidents involving nuclear weapon systems; clear and consistent reporting criteria should be defined. Such reporting does take place at present within different areas of activity, but the information is not collated centrally and reporting is against different criteria. Each incident should be assessed and a report returned to the initiator through the responsible administrative authorities. The overall list of reportable incidents should be reviewed annually and the status of any recommended actions should be audited.

3.3.10 It is worth commenting that although there is some interaction between the RN and RAF on matters relating to nuclear procedures and their safety, it is not extensive and the proposed NWSG should act to promote active interaction between the services with a view to establishing best safety practice.

3.3.11 The standards of safety that have been achieved to date have resulted from the depth of technical expertise and the corporate memory that has existed in all branches concerned. The adverse consequences of a reduction in overall numbers of staff competent in areas related to nuclear weapon safety could, to some extent, be offset by building a central repository of expertise in the NWSG.

3.3.12 The role of the NWSG would be complementary to that of the NWSC in the same way that the Safety and Reliability Directorate of the Atomic Energy Authority is complementary to that of the Nuclear Powered Warships Safety Committee in matters concerned with nuclear propulsion (Annex C).

3.3.13 As far as we are aware, there is no existing body that could discharge all or most of these functions proposed for the NWSG. Although the Ordnance Board comes closest, it could not do so in its present form within its present remit (Annex B). Indeed the OB would continue to provide guidelines for the design assessment of nuclear weapons, and to provide a valuable link with experience in the use of explosives and electronic systems in conventional military applications.

3.4 Committee Responsibilities

3.4.1 Committees may have a variety of useful roles - coordinating, advisory or executive. We recognize that in safety matters above all, advisory committees will seek to act by consensus and, where that is not possible, it will be the chairman's responsibility to convey the committee's advice along with any divergence of opinion. We do not, however, believe that it is normally satisfactory for a committee to be part of a safety responsibility chain. It is most important that each committee be clear about its own

role, the terms on which it makes decisions or offers advice (consensus, unanimity or majority) and the powers and responsibilities carried by its chairman (ie whether he carries executive authority and the committee is advisory to him, or whether he is bound by committee decisions). *We recommend that MoD committees with nuclear weapon safety responsibilities should review their roles, and that the way in which they reach and communicate decisions, and the responsibilities of the chairman, should be agreed by the members and those to whom advice or direction is normally offered.*

3.5 Weapon Transport

3.5.1 The transport of nuclear weapons is the responsibility of the RAF on land and by air and of the RN by sea. During transport, weapons are vulnerable both to security threats and to accidents associated with the transporting vehicle.

3.5.2 We were able to examine parts of the transport and weapon handling system and with one exception found that the approach to safety and security were sensible and practical. We comment in more detail in Annex G.

3.5.3 The exception relates to the age and mechanical unreliability of the special vehicles used for the road transport of nuclear weapons. Although the vehicle bodies incorporate a variety of special features that give a high degree of confidence in both the safety and security of the load even in the case of a severe accident, even occasional breakdowns and the conspicuous inconvenience that these cause to other road users must inevitably undermine public confidence in what is in other respects a well run operation.

3.5.4 The unreliability of the vehicles must to a small degree increase the hazard associated with transport. We were told that the vehicles are due to be replaced in 1992.

3.6 Weapon Related Incidents and Accident Response

3.6.1 We wished to know how frequently weapon incidents had occurred and by what criteria an incident was identified for reporting. There is record of some twenty incidents since 1960. As far as we can tell, in no case was a weapon damaged, but in a few cases the casing was scratched. We do not, however, have any way of knowing whether this information is complete. It was not easy to assemble and, as explained in Paragraph 3.3.9, there is no single central record maintained. These matters are discussed further in Annex F.

3.6.2 We have already recommended that clear criteria be set for the reporting of incidents affecting any part of a nuclear weapon system, and that the reported incidents be reviewed annually by the proposed NWSG with a view to recognising any lessons that may be learned, and bringing them to the attention of the appropriate authorities.

3.6.3 There are well developed procedures for dealing with accidents involving nuclear weapons. These are the responsibility of the Directorate of Nuclear Policy and Security. Time precluded any detailed examination of these arrangements, which are described in Annex D, and we offer no comment on their sufficiency or quality. We do, however, attach great importance to them as the ultimate means of limiting the consequences of an accident should it happen.

3.6.4 However unlikely an accident may be, *we recommend that as long as the country retains nuclear weapons, high priority continue to be given to the retention of properly trained, equipped and regularly exercised nuclear accident response teams.*

3.7 Security

3.7.1 The Group's terms of reference addressed nuclear weapon safety and the interest in nuclear weapon security was therefore limited to any possible interaction between safety and security. The security of nuclear weapons relates to their physical custody during storage, transport, in-service maintenance and use; to the custody of information and material associated with their design, manufacture and deep maintenance; and to the proper authorisation of their deployment and, ultimately, use. As with safety, it is difficult to specify absolute standards, and the arrangements for achieving security tend to be prescriptive measures such as the rule that, whenever nuclear weapons are accessible, at least two people must be present. More generally, such measures impose highly procedural controls on the handling of nuclear weapons and associated material and information. The Group was satisfied that such measures tended to promote the achievement of nuclear safety and that there was therefore no general conflict between the security and safety of UK nuclear weapons.

3.7.2 The Group did, however, note that the basis of weapon system safety was project specific in that it was embedded in the arrangements for MoD procurement of weapon systems. Security measures were prescribed on a more general basis, with proper dependence on the MoD's wider arrangements for the security of both personnel and information. However, the focus for the specification of physical protection and technical security measures associated with nuclear weapons is provided by the Directorate of Nuclear Policy and Security (D Nuc (Pol/Sy)) within the Defence Staff. *We recommend that the potential linkage of security to nuclear weapon safety be recognised by requiring the Director of Nuclear Policy and Security to report any proposed change in the physical or technical security measures to be applied to an operational nuclear weapon system, whether or not it was yet in operational service, to the relevant procurement authority. The procurement authority, whether for the warhead or the overall system, should conduct a formal assessment of the nuclear safety implications of the proposed change.* If the assessment concluded that there was any possible degradation of nuclear safety, then the overall safety approval should be revisited by the procurement authority. Any necessary reconciliation of safety and security would need to recognise that the one was not a substitute for the other, and that adequate standards had to be achieved in each area.

[redacted]

3.8 The Atomic Weapons Establishment

3.8.1 AWE plays a central role in nuclear weapon safety, both as the design authority for the warhead and in an advisory capacity for many aspects of the programme. We found the approach of the establishment to be thorough, professional and responsible. We noted that an important aim of the AWE research programme is the investigation of new safety technologies, and it is this that has allowed AWE to promote safety standards for adoption by the procurement authorities and bodies such as the OB. We endorse this aim and *recommend that a vigorous research programme be pursued at AWE towards continuing improvements in the safety of warhead designs*. The aims of such a programme must be:

- to develop new designs that are safer;
- to accumulate the databases necessary to perform credible risk assessments on all in-service weapons;
- to maintain and foster the technical expertise that is essential for the responsible manufacture, custody and management of nuclear weapons.

3.8.2 In their new contractual role, as previously, AWE will remain a sole source supplier of warhead design expertise to MoD. Overall we judge the quality of the service to have been very high. It was not for our Group to judge whether this represents value for money, but any progressive squeezing of resources until there is evidence that the organisation is no longer able to deliver, with the intention of then easing back, is not an acceptable option. The consequences of such a process would at least have profound implications for UK defence policy, and at the extreme are unthinkable. This means that MoD will have to be more than usually sophisticated in ensuring that AWE is appropriately tasked and adequately resourced.

3.8.3 [redacted]

3.8.4 AWE is in practice consulted by many different bodies on a very wide range of issues relating to the safety of nuclear weapons. Table 1 (Page 15) shows how widely AWE is represented in the committee structure. We nevertheless came across apparently simple and innocuous procedures, or procedural changes, where, as the warhead design authority, AWE should have been consulted but had not. We are sure that this is inadvertent, but there are situations where the special properties of nuclear warheads mean that they should be treated in ways that might run counter to conventional weapons experience. *We therefore recommend that steps be taken to ensure*

that AWE be consulted over the planning or modification of all procedures relating to the handling, storage, or movement of nuclear weapons.

3.8.5 It would give us grave cause for concern if the contractorisation of AWE were to inhibit the deployment of AWE-trained staff in senior positions in MoD, particularly in the nuclear controllerate of the Procurement Executive and in the central scientific staff. AWE will remain the sole UK source of expertise and experience for warhead design, development and production. If safety considerations in design are to be properly addressed by MoD, it is important that there be experienced staff available. It may be uncomfortable to depend on a sole source contractor in this way and there is an undeniable risk of conflict of interest. The alternative, however, is to run a serious risk (because there are insufficient technical resources available outside AWE) of being unable to ensure adequate safety appraisal of nuclear weapon systems, wasting resources through being an unintelligent customer, and providing ill-informed and unauthoritative advice to Ministers. We were concerned by this possibility and *recommend that the contractorisation of AWE not be allowed to reduce the availability of nuclear expertise to MoD.*

4 Safety of UK Nuclear Weapons

4.1 Introduction

4.1.1 There are two main safety hazards potentially associated with a nuclear weapon. The first is that the weapon might be accidentally triggered and generate a nuclear yield (ie operate as a nuclear bomb). It could be triggered either by receiving a false firing signal through its electrical system, or by a violent shock which detonated the high explosive in the warhead directly. A range of electrical breaks and switches can be built in to prevent the former, and it is a key design aim to prevent the latter by building a device that is one-point safe (*ie* a detonation initiated at any one point in the explosive shell surrounding the primary stage of the weapon would be incapable of generating a nuclear yield).

4.1.2 The second type of hazard is the longer term health risk associated with the dispersal of plutonium over an area of some square miles, as could happen if high explosive in the warhead exploded (eg through shock) without producing a nuclear yield. The possibility of accidents of this type would be much reduced in most circumstances by the incorporation of insensitive high explosive (IHE) which detonates only with great difficulty. A similar hazard, but over about one hundredth of the area, would occur if the high explosive burned without exploding (eg in a fuel fire). The probability of this happening can be reduced by incorporating fire resistant pits. There may also be some dispersal of uranium in such accidents, but plutonium provides the main concern.

4.1.3 Once the decision has been made to own nuclear weapons, every effort must be made to ensure that they meet the best practical design standards for safety, and that the warhead is fully compatible with the design of the missile. Although the widespread use of advanced assessment techniques has not yet been practicable, *we recommend that comprehensive assessment methodologies such as those based on the use of probabilistic design criteria continue to be actively pursued for application to the design of nuclear weapon systems.*

4.1.4 In the sections which follow we discuss each of the weapons systems within the UK's national armoury.

4.2 The WE177 Bomb

4.2.1 The WE177 free-fall bomb is entirely of British design and manufacture. Some details of its design features and variants are given in Annex E. The nuclear design has been reinvestigated by AWE with current analytical techniques. These confirm that the original designers adopted a very conservative safety approach in which there can be considerable confidence. It is one-point safe.

4.2.2 Over the years, as with all similar systems, there have been various small changes to the weapon that were implemented when weapons returned for servicing. It is desirable to review periodically the full cumulative effect of these small modifications along with any actual or proposed changes in weapon environment or handling. *We therefore recommend that approximately every seven years during service there should be a*

design review of a nuclear weapon system that should take into account any advances in methods of assessing safety, the sum of all design or engineering modifications introduced or planned, the full range of handling, transportation and storage environments to which the weapon has been exposed, and any reportable incidents affecting the weapon. We chose a period of seven years, taking into account the two to three year frequency of turnover of staff in post (with the consequential loss of corporate memory) and the typical life in service of operational systems of ten to twenty years. The review should be initiated by the Project Manager and the results should be reported to the relevant procurement Controller(s) and the NWSG. *We therefore recommend that a design review of the WE177 weapon should be undertaken forthwith, not because we have identified any specific cause for concern, but as a prudent precaution.* The review should also re-evaluate the continuing technical competence of sub-system design authorities. We note that the Royal Aerospace Establishment (RAE) was the R&D authority for the WE177 bomb carcase, while AWE and RAE supported by a contractor, were the joint design authority for the electronics. It should be confirmed that these organisations retain both the intention and the capability to continue their roles and any consequential action should be initiated.

4.2.3 Subject to the outcome of such a review, and to the continued satisfactory outcome of the periodic weapon disassembly procedures and component tests described above, there appear at present to be no safety grounds to prevent the WE177 continuing in service until its planned replacement early next century.

4.2.4 The principal in-service hazard associated with the WE177 is that of an air crash during transport operations. Such an event could well lead to a plutonium dispersal accident although not a nuclear explosion. Weapons held abroad are returned in specially prepared transport aircraft for periodic servicing at AWE. We have the highest regard for the way in which the RAF carries out the presently prescribed arrangements. *We recommend, however, that weapons continue to be transported by air as infrequently as possible and that practices relating to the number of weapons transported at one time by air, and how they are contained, should be re-examined with modern risk assessment techniques.*

4.2.5 *We recommend that if it is the intention that surface ships should remain nuclear capable after the withdrawal of the WE177 from deployment at sea, then there be a safety requirement to ensure that the capabilities of ships and shore facilities are maintained by exercising with training rounds.* This would be in line with RAF practice.

4.3 Polaris-Chevaline

4.3.1 Details of the Polaris-Chevaline system are given in Annex E. In so far as our investigations have brought to light no unsuspected difficulties either in design or in handling procedures, and, given that the system is relatively new by comparison with WE177 and will relatively soon be withdrawn from service, we make no special comment. We accept the AWE assessment that the warhead is one-point safe. The system (like WE177 and indeed Trident) uses the best safety technology available at

the time. There is no reason not to allow the system to continue in service until it is replaced as planned.

4.4 Trident

4.4.1 The Trident system was a particular concern for the Drell panel and we have considered it at some length. The UK system comprises a UK designed and tested warhead that was engineered to match the Trident re-entry body shell provided by the US.

4.4.2 AWE are at present reviewing the nuclear safety design of the warhead with new computational methods. Studies of this kind have become feasible only in recent years and involve complex and time-consuming three-dimensional calculations on supercomputers. Validation of the results of such analyses is possible, however, only by comparing the results with those of a different expert team that has independently analysed the same problem, and by comparison with the results of low yield underground tests. We have no such alternative team in the UK and for this reason the Group can offer no definitive view on Trident one-point safety. Nevertheless the approach adopted by AWE gives us confidence in their preliminary judgement that the original design aim to make the device one-point safe has been achieved. We note that this is an area of active interchange between AWE and the weapons design teams in the US and that the groups are to a significant extent able to confirm each others methods. This is the only feasible validation of AWE work in this area.

4.4.3 [redacted]

4.4.4 We have several observations:

- Our analysis suggests that in some accident scenarios the Trident system is safer than Chevaline, and in others it appears to be comparable (Annex E).

- We are buying the Trident missile off the shelf from the US and unless the US decide to modify their system our only choices are to use it as it is, or not to let it enter service.

[redacted]

- The Drell panel recognised that the most delicate operation was missile embarkation and disembarkation and expressed concern at the intended US practice of mounting the missile warheads on the missile on shore and then transporting the complete missile/warhead assembly to the submarine for lowering into the firing tube. They preferred that warheads should be mounted onto missiles already in the submarine. This latter procedure is in fact intended to be standard UK practice during the initial outfitting and final offloading before refit of Trident submarines. When whole system considerations are taken into account, however, we feel that one practice may not be significantly preferable to the other. *We recommend that studies continue in order to further understanding of the potential hazard of Trident missile loading and unloading, and to ensure that it is minimised in every situation.*

4.4.5 The arrangements for the procurement of Strategic Weapons Systems (SWSs) are unique and covered by a US/UK agreement known as the Polaris Sales Agreement (PSA). The PSA requires the US to underwrite the quality and safety of the material provided to the UK and that it should be of a standard equivalent to that provided to the US Navy. Nonetheless the US agreed to provide the UK with a safety case based on the information provided to the US Nuclear Weapon System Safety Group, and this information was received in November 1990. The US have now accepted the Trident SWS for service use but, particularly because some elements of the UK system are different, the UK authorities do not take the view that it can therefore be assumed to be safe for UK use. The Staff Requirement requires the UK procurement authorities to assess the safety of the system independently using US provided safety data where necessary. As indicated above, this is not because of any doubts about the reliability or thoroughness of the US development, but because the UK must also assess safety thoroughly where there are differences from the US practices, eg different cranes, different jetties, different hulls, differently trained civilian and military personnel, etc. The US has agreed to provide additional information at the UK's request on a case by case basis. We note the importance of the safety assessors and the procurement authorities quickly resolving the outstanding requirement for information to complete the UK safety case.

4.4.6 On the question of the overall safety and acceptability of the Trident system to enter service we have already noted that the system incorporates state-of-the-art safety technology for the time it was designed. The continuing development of technology means that it is always possible to think of a new design that is safer than the one designed a decade earlier, but such a design would take a further decade to bring into service. Given the limited remaining life of the Polaris system, if the UK wishes to retain a strategic nuclear capability the Trident system offers a way of doing so with safety levels that are comparable to and in some ways higher than those associated with the Polaris system. Therefore, provided that the full UK safety case and its assessment are completed, we see no reason to suggest that it should not be accepted into service.

4.5 Future Nuclear Weapons

4.5.1 We earlier described the procedures that lead to the procurement of a new nuclear weapon and in the preceding section we have made various suggestions about management responsibilities. Our main concern is that safety issues should be aired fully when the Staff Requirement is written, and that costs and benefits of different design features are weighed in a fully informed way and at a sufficiently high level. We are not satisfied that present procurement procedures provide for a clear champion for safety at the time that alternative weapon designs are under consideration, or for a systematic and consistent assessment of the intended safety standards. The responsibility for procuring a safe weapon system must lie with the relevant Controller within the Procurement Executive and we believe that the proposed NWSG should inform the Controller that they are content that safety is properly treated at every procurement approval stage.

4.5.2 We have earlier noted that the reference document from which safety standards for design are derived, Ordnance Board Proc N392, was issued in 1984. *We recommend that the Ordnance Board revisit its guidelines for nuclear weapon design assessment on a regular basis, recognising that it is essential that this be done before any new weapon procurement is embarked upon.* Furthermore, the Board should revisit the way in which it expresses safety aims in nuclear warhead design, recognising that both deterministic and probabilistic methods may have applications in the nuclear weapon safety field.

4.5.3 [redacted]

4.5.4 We have already expressed our concern that whole system safety issues should be properly addressed, and have noted that off-shore purchases of parts of the weapon can constrain safety assessment. *We recommend that a strategy for the safety justification of any future nuclear weapon system be defined.* There will be early requirements in judging delivery vehicle procurement options and AWE development options, that account is taken of the most appropriate safety technologies and that contract conditions can be made to ensure provision of design and development information for a full system safety case.

[redacted]

5 Specific Comments on the Drell Recommendations

5.1 Introduction

5.1.1 In the earlier sections of the report we have commented on various aspects of UK nuclear weapon safety. We comment here on the main recommendations of the US panel on nuclear safety and their bearing on the present situation in the UK. Naturally, some issues are specific to the US organisation of nuclear weapon activities and have no direct bearing on the UK, and some others we have already addressed in the main report. The Drell recommendations are summarised in Annex A and are addressed in order.

5.2 Red Teams

5.2.1 [redacted]

5.3 Proposal for a "Joint Advisory Committee for Nuclear Weapons Surety"

5.3.1 [redacted]

5.4 Changes to the internal arrangements within the Departments of Energy and Defence to define and delineate better responsibilities for safety and to ensure that safety is properly balanced against military utility

5.4.1 Although we are satisfied that all three existing weapons systems considered in this report were designed to include the most advanced safety features that our technology of the time would allow, we are not satisfied that present procurement procedures recognise a clear and well-informed champion for safety at the time that alternative weapon designs are under consideration. Although the responsibility for procuring a safe weapon system must lie with the relevant Controller within the Procurement Executive, we believe that it should be possible for a body such as our NWSG to have full oversight of these matters and to inform all appropriate authorities if they believe that safety is receiving insufficient attention.

5.5 Training programmes in nuclear safety for mid-level and senior officials.

5.5.1 We have addressed this matter in Paragraph 3.2.5. Drell was also concerned that in some cases senior officials with prime nuclear responsibilities had for convenience over the years been assigned additional unrelated duties that distracted them from their main responsibilities. We share these concerns and noted the wide range of duties encompassed by the post of Assistant Chief of Defence Staff (Policy and Nuclear).

5.6 Legislation to allow for the ready movement of experts between the public and private sectors

5.6.1 The Drell panel commented on the need in the US for arrangements by which "highly qualified technical leaders" from outside government would be permitted to "accept temporary government positions of authority and still be permitted to return to their original positions after their tours of duty". We were concerned about this point, particularly in view of the impending AWE contractorisation, and have discussed it in Section 3.

5.7 Safety concerns about the existing stockpile

5.7.1 The Drell panel expressed considerable concern about the safety of some components of the US nuclear stockpile. The UK stockpile consists solely of air-delivered WE177 bombs and the submarine-launched Polaris-Chevaline system. Both systems are of elderly but robust design. We have learned nothing to suggest that there are previously unsuspected hazards associated with either. Chevaline will be withdrawn from service over the next five years and it is proposed to replace the WE177 by FTNW in about ten years time. Subject to the conditions indicated earlier we see no reason why both should not remain in service until replaced as planned.

5.8 Joint policy directive emphasising the importance of the safety and security dimensions of nuclear weapons

5.8.1 Within the UK, responsibility for nuclear weapon safety lies solely with the Secretary of State for Defence. Ministers have made clear statements to Parliament on the UK commitment to nuclear weapon safety.

5.9 System safety studies

5.9.1 Drell had various concerns about the way in which safety standards for the design of nuclear weapons were established and assessed. We have proposed the establishment of a Nuclear Weapons Safety Group and see it as having *inter alia* a central role in ensuring that proper weight is given to system safety issues both at the stages of concept and design. We have earlier proposed that the reference document from which safety standards for design are currently derived, Ordnance Board Proc N392, should be revisited by the Board on a regular basis and believe that it is essential that this should be done before any new weapon procurement is embarked upon (Annex B).

5.10 Changes to the stockpile

5.10.1 For the reasons set out in Section 4 we do not believe that it is necessary to consider modification of the UK stockpile.

5.11 Trident

5.11.1 The Trident system was a particular concern for the Drell panel. We recognise the problems identified by the panel and have discussed them at some length in Section 4.

5.12 Safety optimised designs

5.12.1 The Drell panel also commented on the need for "a vigorous R&D program at the weapons laboratories" in the search for advanced technologies and new design concepts with the aim of achieving "higher confidence in advanced weapons safety". We regard such a programme as essential for the UK as long as it is policy to retain nuclear weapons.

[redacted]

6 Concluding Comments

6.1 We conclude as we began by emphasising that there is inevitably some degree of hazard associated with nuclear weapons. That said, the UK record of safety in building, handling and deploying such weapons is good.

6.2 Nevertheless, for a variety of reasons, but in particular because of the complexity of modern weapon systems, we believe that it is time to look again at nuclear weapon safety responsibilities within MoD and that a professionally competent Nuclear Weapons Safety Group should be established. The organisational changes needed to do this will allow the safety responsibilities to be clarified, including those of the many coordinating and advisory committees.

6.3 AWE will continue to be the linchpin of the UK nuclear weapons programme. The establishment has made major contributions to weapon safety, but we are concerned at the safety implications of the loss of capability in the important area of weapon electronics design. We believe that it is essential that the new contractual arrangements proposed for AWE should not inhibit the establishment from exercising its traditional proactive role in advancing safety in nuclear weapon designs and procedures.

6.4 [redacted]

6.5 To some extent, the UK nuclear weapons programme has been technically so successful that this success could become its own worst enemy. The physics and engineering programmes remain enormously challenging, but they have been conducted so long without major untoward incident, that there is a danger that they may come to be regarded as straightforward and routine. Nothing could be further from the truth: the fatal Challenger accident in the US space programme is a chilling reminder of what can happen if a potentially dangerous technology is taken for granted.

[redacted]

Annexes A to D of a Report on the Safety of UK Nuclear Weapons

CSA 42/5/1/1 (46/92)

Copy 11 of 60

Prepared by the Safety Review Group
Chaired by the Chief Scientific Adviser of MoD

13 February 1992

Cover + 36 pages

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List of Contents

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Annex A: Review Group Brief and Activities

A.1 Terms of Reference and Interpretation

A.1.1 Following the United States review of nuclear weapons safety (the "Drell Panel" report), the Secretary of State for Defence commissioned a review group, chaired by the Chief Scientific Adviser, with the following terms of reference:

"To review, in the light of any relevant aspects of the report of the Drell Panel in the United States, the safety of the present and prospective United Kingdom nuclear armoury."

A.1.2 The following interpretations of these terms of reference have been made:

s.21

- that any foreign nuclear weapons within the United Kingdom would not lie within this review;
- that although safety and security are separate attributes of a nuclear weapon system, security arrangements could affect safety.

A.2 Group Membership

A.2.1 Membership of the group was as follows:

Prof E R Oxburgh FRS, Chief Scientific Adviser of MoD (Chairman);

[redacted]

R Adm R Walmsley, serving naval officer.

A.3 Record of Activities

A.3.1 The group first met on 24 July 1991 and undertook a series of visits and discussions leading to the production of a departmental draft of this report in December 1991, which was then circulated for confirmation of factual content. As well as those detailed below, the group held many less formal briefings and discussions with Services and MoD personnel with responsibilities for nuclear weapons safety and security. The Chairman held discussions with Dr Drell on two occasions.

[redacted]

A.3.2 The visit programme comprised the following:

1 & 2 October 1991	Clyde Submarine Base, Royal Naval Armament Depot (Coulport) and Trident Development Area
14 October 1991	RAF Honington
15 & 16 October 1991	Atomic Weapons Establishment, Aldermaston and Burghfield
22 & 23 November 1991	Portsmouth Naval Base and HMS Ark Royal

Discussions were held in group meetings with:

Cdre J A Aston	Vice President (Naval) of the Ordnance Board
[redacted]	[redacted]
Cdre R G Bryan RN	Director General Strategic Weapon Systems
AVM J M P Calnan	President of the Ordnance Board
[redacted]	[redacted]
V Adm Sir Kenneth Eaton	Controller of the Navy
V Adm Sir Robert Hill	Chairman of Magazine Safety Committee
[redacted]	[redacted]
R Adm I H Pirnie	Chief Strategic Systems Executive
[redacted]	[redacted]
R Adm J J R Tod	Assistant Chief of Defence Staff (Policy & Nuclear)
[redacted]	[redacted]

A.4 Bibliography

1 *"Report of The Panel on Nuclear Weapons Safety of The House Armed Services Committee"*, Sidney D Drell, John S Foster Jr and Charles H Townes, December 1990, UNCLASSIFIED (Main Report), SECRET ATOMIC (Annex).

2 *"Statement of Richard A Claytor, Assistant Secretary for Defense Programs US Department of Energy Before the House Armed Services Committee DOE Defense Nuclear Facilities Panel"*, February 1991.

3 *"Statement by the Honourable Robert B Barker, Assistant to the Secretary of Defense (Atomic Energy) Before the US House of Representatives Committee on Armed Services Department of Energy Defense Nuclear Facilities Panel"*, February 1991.

4 *"Statement of the Honourable Charles M Herzfield, Chairman Nuclear Weapons Council Before the House Armed Services Committee Department of Energy Defense Nuclear Facilities Panel"*, February 1991.

5 *"Preliminary Evidence to the UK Nuclear Weapons Safety Review Working Group"*, D/DC(Nuc) LON/17/11/1, D/CSSE/8/1/2 (316/91), joint DC(Nuc)/CSSE statement, September 1991, SECRET.

6 *"Nuclear Safety Issues Relevant to WE177 and Trident Warheads"*, AWE Report No 0 13/89, February 1990, UK SECRET ATOMIC PRINCIPAL.

7 *"Significance of the Drell Report for the UK"*, D R&D/40/91, X113243, K Johnston, February 1991, SECRET ATOMIC PRINCIPAL.

8 *"Nuclear Weapons Safety in a Contractorised Atomic Weapons Establishment'"* D/ACSA(N)3/3/1/2, M H McTaggart, August 1991, RESTRICTED.

9 *"Aims and Principles for Assessing Safety of Nuclear Warheads and Associated Systems"*, OB Proc N392, April 1984, UK CONFIDENTIAL.

10 *"Classification, Storage a[redacted]sport of Nuclear Ammunition, Explosive Types 16 and 17"*, ESTC Prescription N[redacted]ne 1985, UK CONFIDENTIAL.

11 *"The Roles and Safety Responsibilities of Safety Committees and Others in Nuclear Weapon Safety"*, D/DSc3/10/3/1, M H McTaggart, August 1984, CONFIDENTIAL.

12 *"TRIDENT Missile and Re-Entry Body Assembly (RBA) Safety within the Royal Naval Armament Depot (Coulport) and during transfer to and from Vanguard Class Submarines"*, D/SSC/DGSWS 28/2/2, September 1991, UK CONFIDENTIAL.

[redacted]

Annex A: Review Group Brief and Activities (continued)

13 *"Brief for UK Nuclear Weapons Safety Review Panel - RN Tactical Nuclear Weapon"*, D/Sec(NS) 57/1/40, September 1991, SECRET UK EYES B.

14 *"Nuclear Weapons Incidents Involving the UK"*, D/ACSA(N)2/2/25, October 1991, SECRET UK EYES A.

15 *"Central Government and MoD Headquarters Arrangements in Event of a Nuclear Emergency Involving Defence Nuclear Reactors, Nuclear Weapons or Defence Nuclear Material"*, D/ACDS(Pol&Nuc)211/4/1/1, October 1991, RESTRICTED.

16 *"Brief on Nuclear Weapon Inspection Policy for the Trident and Polaris Strategic Weapon Systems"*, D/SSC/DGSWS/21/8/8, October 1991, RESTRICTED.

17 *"SSN & SSBN Collisions and Near Misses 1986-1990"*, Sec(NS), November 1991, RESTRICTED.

18 *"Draft Ship Safety Policy Document"*, D/SSC/SSMSPO/850/4, November 1991.

19 *"Magazine Safety Committee Composition and Terms of Reference"*, OM(GEN) 93/84, August 1984, RESTRICTED.

20 *"Report to Congress: Assessment of the Safety of US Nuclear Weapons and Related Nuclear Test Requirements"*, UCRL-LR-107454, R E Kidder, July 1991.

A.5 Synopsis of the Report of the Drell Panel and Official Response

A.5.1 In May 1990, the United States House of Representatives Committee on Armed Services empanelled three eminent physicists, Dr Sidney Drell of Stanford University, Dr John S Foster of TRW Corporation and Dr Charles H Townes of University of California at Berkeley, to conduct a wide ranging independent review of nuclear weapons safety. This review considered the organisation of nuclear weapons management as well as the safety of the current designs and handling procedures.

A.5.2 With regard to organisation, the panel had concerns about the importance attached to nuclear weapons safety, and recommended several changes to the current structures. These may be summarised as:

1) creation of "Red Teams" from sister laboratories to scrutinise weapons designs and operational procedures;

2) creation of an independent Joint Advisory Committee for Nuclear Weapons Security, reporting directly to the Secretaries of Defense and Energy, based on the model of the UK Nuclear Weapons Safety Committee;

3) modification of the internal management structure of the Departments of Defense and Energy to define and delineate safety responsibilities better, to allow a more direct reporting line to Secretaries on nuclear weapons safety issues and to assure a better balance of interest in safety versus military requirements;

4) development of a training programme for mid-level and senior officials to increase awareness of the importance of nuclear weapons safety;

5) legislation to protect the careers of individuals moving back and forth across the Government/contractor divide to take account of the unusual nature of nuclear weapons development where expertise is, of necessity, heavily concentrated;

6) formulation of a strategy to address safety concerns about the existing stockpile, including a priority effort towards designs which are as safe as practically possible;

7) issuing, by the Secretaries of Defense and Energy, of a joint policy directive emphasising the importance of the safety and security dimensions of nuclear weapons.

A.5.3 The panel had four major recommendations towards enhancing the safety of designs and procedures:

8) carrying out system safety studies (in particular fault tree analyses) to calculate overall risk and safety levels and developing the databases to provide the necessary factual input;

9) [redacted]

10) [redacted]

11) direction and funding of R&D to pursue new technologies that could create possibilities for significant advances in safety-optimised designs.

A.5.4 [redacted]

A.5.5 The responses of the Departments of Defense and Energy and the Nuclear Weapons Council may be summarised as:

1) Red Teams: accepted by DoD and DoE;
2) New Joint Advisory Committee: accepted by DoD and DoE;
3) Management Reorganisation: not fully accepted, but will be reviewed by both DoD and DoE;
4) Training: accepted by DoD and DoE;
5) Career protection: supported, but would require legislation;
6) Stockpile review: agreed by DoD and DoE;
7) Policy directive: agreed;
8) Safety studies: agreed as part of 6 above;
9) Safety technology:

[redacted]

10) Missile review: agreed for submarine and land-based systems;
11) R&D: agreed, following from the safety studies.

[redacted]

Annex B: Safety Responsibilities and Advisory Bodies

B.1 Introduction

B.1.1 The following account summarises the Group's best understanding of the managerial and operational responsibilities for nuclear weapons safety. These may be described over three phases of a system's lifecycle:

- requirement;
- procurement and approval (design, manufacture and acceptance);
- operation (transport, storage, maintenance and deployment).

B.1.2 In practice there is considerable overlap and interaction between these phases, but, for convenience and clarity, they are discussed separately below.

B.1.3 Since decommissioning of warheads is carried out at the manufacturing and maintenance location (AWE Burghfield), it is included within operations.

B.2 Requirement

B.2.1 The requirement definition is formally the responsibility of the OR branches, but in practice involves the participation of a number of organisations. The safety aspects will involve:

- the Atomic Weapons Establishment (AWE) in advising what safety technologies will be available and feasible to incorporate;
- the Ordnance Board through the inclusion of their guidelines (OB Proc N392);
- Assistant Chief of Defence Staff (Policy&Nuclear) (ACDS(Pol&Nuc)) who formulates safety and security policy.

B.2.2 The outcome of this process is a Staff Requirement or a series of Staff Requirements, against which the system will be designed, manufactured and operated.

B.3 Procurement and Approval

B.3.1 Owing to their complexity, the design of nuclear weapons systems is not usually carried out by a single Design Authority (DA). The procurement therefore involves the management of the safety interfaces between different components of the system as well as ensuring that the design of each component satisfies its safety requirements.

B.3.2 Generally, the procurement of a safe delivery system is the responsibility of the relevant Service controllerate, Controller Aircraft (CA) for the current tactical system

or Controller of the Navy (CofN) for the strategic system. Responsibility for the procurement of the warhead lies with Controller Nuclear (CNuc). Overall responsibility for the procurement of the whole system passes up through the relevant Service controller to the Chief of Defence Procurement (CDP) and thence to Ministers.

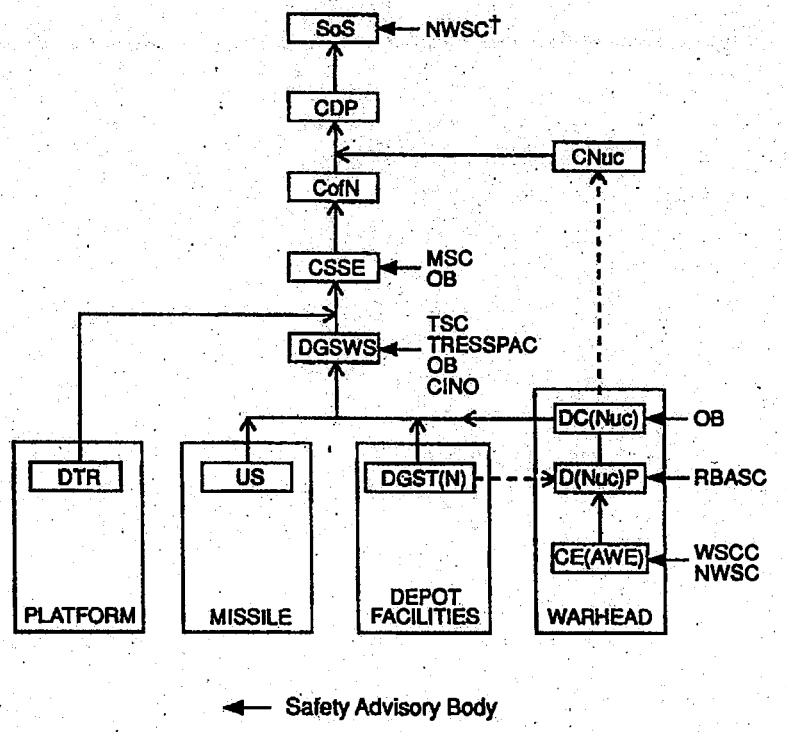
B.3.3 Taking the current procurement of Trident as an example, the key responsibilities lie with:

- Secretary of State (SoS), ultimately responsible;
- Chief of Defence Procurement (CDP), responsible to SoS;
- Controller of the Navy (CofN), responsible to CDP for approving release of the submarine and weapon system to the RN;
- Controller Nuclear (CNuc), responsible to CDP for procurement of the warhead;
- Chief Strategic Systems Executive (CSSE), responsible to CofN for managing the procurement of the submarine and weapon system;
- Director General Strategic Weapon System (DGSWS), responsible to CSSE for procuring the strategic weapon system (including the purchase of the US missile);
- Director Trident (DTR), responsible to CSSE for verifying the ability of the submarine to support the strategic weapon system;
- Director General Supplies and Transport (Navy) (DGST(N)), responsible to the Chief of Fleet Support (CFS) for operating the support facilities at the Naval depots;
- Deputy Controller (Nuclear) (DC(Nuc)), responsible to CNuc for procuring the warhead, and the project manager, Director (Nuclear) Projects (D(Nuc)P);
- Atomic Weapons Establishment (AWE), the Design Authority (DA) for the warhead; the Chief Executive reports through CNuc to CDP;
- Director General Fleet Support (P&S) responsible to Chief of Fleet Support for supporting Naval works programmes.

B.3.4 The chain of responsibilities for the procurement of a strategic system is given in Figure B.1. It also shows an upward flow of submissions for approval of operational suitability and safety, and shows where safety advice is provided. This is the structure for approving both the weapon system and the associated procedures for handling operations. This includes any modifications to procedures during the in-service life of the weapon system. In describing the responsibilities for approval, we

[redacted]

Figure B.1 Responsibility chain for procurement of Trident



† Although constituted to provide independent advice to the SoS, the NWSC can provide advice at any point in the structure.

CDP	Chief of Defence Procurement
CE(AWE)	Chief Executive, Atomic Weapons Establishment
CINO	Chief Inspector Naval Ordnance
CNuc	Controller Nuclear
CofN	Controller of the Navy
CSSE	Chief Strategic Systems Executive
DC(Nuc)	Deputy Controller (Nuclear)
DGST(N)	Director General Supplies and Transport (Naval)
DGSWS	Director General Strategic Weapon Systems
D(Nuc)P	Director (Nuclear) Projects
DTR	Director Trident
MSC	Magazine Safety Committee
NWSC	Nuclear Weapons Safety Committee
OB	Ordnance Board
RBASC	Re-entry Body Assembly Safety Committee
SoS	Secretary of State
TRESSPAC	Trident Re-entry System Service Publications Approval Committee
TSC	Trident Safety Committee
US	United States
WSCC	Warhead Safety Co-ordinating Committee

[redacted]

follow the Naval weapon arrangements because they are currently relevant. A new tactical weapon will require analogous arrangements on the Air side.

B.3.5 Nuclear weapons are specified by the Defence Staff and procured by MoD(PE). Warhead approval is separately conducted by Controller Nuclear, and this is a prerequisite to the approval of the overall nuclear weapon system by the appropriate system controller: Controller of the Navy for submarine based weapons and Controller Aircraft for weapons in service with the Fleet Air Arm. The appropriate Controller is also responsible for specifying the procedures to be followed during a weapon's operational service, and their approval forms part of the introduction into service. In both cases the Controller of the Navy is responsible for approving the arrangements for carriage of naval nuclear weapons in ships, through the Magazine Safety Committee under the Chairmanship of Deputy Controller of the Navy.

B.3.6 For submarine based nuclear weapons, the overall system approval is focussed in the departments reporting to the Chief Strategic Systems Executive (CSSE). Missile work undertaken ashore in UK is the responsibility of the Chief of Fleet Support at the Royal Naval Armament Depot at Coulport. Whereas such work is routine in the case of Polaris, Trident missiles will be disembarked in the UK only if the circumstances of the missile or the submarine demand it or, in a limited way, to support particular crew training exercises. Warheads will be mated to the Trident missiles by a specialist naval team operating on board the submarine while it is berthed at the Explosive Handling Jetty in Coulport.

B.3.7 Although arrangements are currently under review, Fleet Air Arm nuclear weapons can be embarked in ships equipped to carry relevant aircraft; they can also be carried in certain Royal Fleet Auxiliaries. Approval of the aircraft/weapon combination rests with Controller Aircraft. All work ashore is undertaken by the same authorities as for the Royal Air Force; the Royal Naval Armament Depots handle only the naval training weapons, which have no nuclear components. Nuclear weapons themselves are not carried on or in naval aircraft in peacetime.

B.3.8 Naval weapons are generally transported ashore by the Royal Air Force, but can be moved by sea under arrangements which are the operational responsibility of Commander-in-Chief Fleet.

B.3.9 In approving all these arrangements the relevant Controller will receive independent advice from Ordnance Board as to the safety of the Weapon System; and from the Chief Inspector of Naval Ordnance as to the safety of the arrangements for embarking the weapon in ships and for any processing or handling in naval facilities ashore. Advice from the Nuclear Weapons Safety Committee, although formally due to the Secretary of State, is in practice supplied to, or sought by, any appropriate level within the Controller's safety approval chain.

B.3.10 Compliance with the procedures specified for handling and processing weapons in service and in the custody of the Royal Navy is the responsibility of either

Commander-in-Chief Fleet or the Chief of Fleet Support. The Group heard that Controller of the Navy has delegated inspections of compliance to Commander-in-Chief Fleet, albeit that representatives of Controller of the Navy and the Chief of Fleet Support are included in the inspection team.

B.3.11 The Group heard that the leading role played by the Controller of the Navy in nuclear weapon system approvals was paralleled by his role in relation to naval nuclear propulsion plants. A significant difference is, however, that the Safety and Reliability Directorate (SRD) of the Atomic Energy Authority is contracted by Director General Submarines to provide a comprehensive independent safety assessment. This is a formal and long standing arrangement under which a new or refuelled nuclear propulsion plant would not normally be taken critical until the Director of Nuclear Policy and Security in MoD has received a letter from SRD stating that there is no safety objection to plant operation.

B.4 Operations

B.4.1 Operations involve a number of activities including transport, storage, maintenance, deployment and disposal of both the strategic weapon (currently Chevaline) and the tactical weapon (currently WE177).

B.4.2 The responsible bodies for these are:

- AWE Burghfield for maintenance, storage and disposal of WE177 bombs and missile payloads;
- RN for deployment of both weapons;
- RAF for land transport of warheads and for air transport, storage and deployment of tactical weapons;
- DGST(N) for storage and maintenance of strategic weapons, and for sea transport of both weapons.

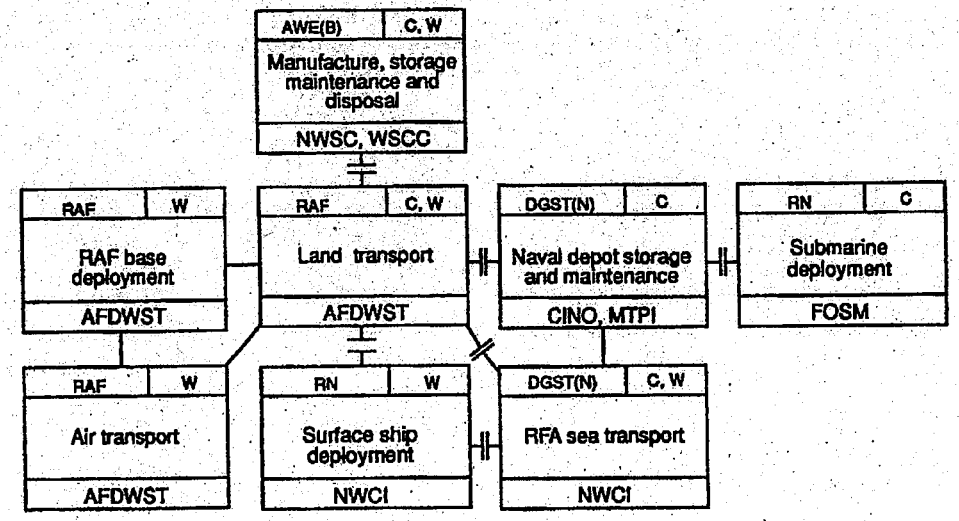
B.4.3 The interfaces where transfer of responsibilities occur are shown in Figure B.2. Also shown are the inspecting bodies who aim to ensure safety through compliance with procedures. Their roles are described below.

B.5 Key Safety Organisations

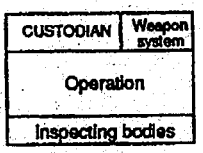
B.5.1 The principal bodies giving advice on nuclear safety during the procurement process, including Trident, are:

- Nuclear Weapons Safety Committee (NWSC);

Figure B.2 Current operational responsibilities and inspecting bodies



———	Change of operation by the same custodian
—‖—	Interface where responsibility transfer occurs
W	WE177, tactical weapon
C	Chevaline, strategic weapon
AFDWST	Air Force Department Weapon Standardisation Team
CINO	Chief Inspector of Naval Ordnance
DGST(N)	Director General Supplies and Transport (Naval)
FOSM	Flag Office Submarines
MTPI	Missile Technical Proficiency Inspection
NWCI	Nuclear Weapons Capability Inspection
NWSC	Nuclear Weapons Safety Committee (overview of all aspects)
RFA	Royal Fleet Auxiliary
WSCC	Warhead Safety Coordinating Committee



- Ordnance Board (OB);
- Explosive Storage and Transport Committee (ESTC);
- Warhead Safety Coordinating Committee (WSCC);
- Magazine Safety Committee (MSC);
- Chief Inspector of Naval Ordnance (CINO);
- Trident Safety Committee (TSC);
- Trident Re-entry System Service Publications Approval Committee (TRESSPAC);
- Re-entry Body Assembly Safety Committee (RBASC).

B.5.2 These bodies allow both a degree of independent checking on the safety of the system and cross-fertilisation between the authorities responsible for safety. A matrix indicating the representation of these authorities on each of the safety committees is given in Figure B.3.

B.5.3 The key safety organisations are overviewed in the sections below, with their roles and memberships described. These overviews are factual, with the exception of the NWSC and OB, where comments are made.

B.5.4 The safety committees are advisory with the exception of the Magazine Safety Committee. The terms of reference are, where appropriate, stated in full, but in the case where a body has activities unrelated to nuclear weapons safety the relevant parts are paraphrased.

B.6 Nuclear Weapons Safety Committee (NWSC)

B.6.1 Nuclear weapon safety is of such importance, and has such potential for widespread severe consequences to people and the environment in the event of a serious accident, that SoS has appointed the NWSC to provide a source of independent advice on any safety issue. The external full committee members have no direct current line responsibility for nuclear safety in MoD but have high level expertise and wide experience in nuclear safety or radiation protection in other applications (or formerly in MoD).

B.6.2 The committee's terms of reference are:

"To advise the Secretary of State for Defence, the Services and other interested Departments on safety matters pertaining to the transport, storage, handling and operational training in the use of nuclear weapons."

Annex B: Safety Responsibilities and Advisory Bodies (continued)

Figure B.3. Representation of MoD safety authorities on committees with nuclear safety interests

	CSSE /DGSWS	DC(Nuc)	AWE	DGST(N)	OB	CINO
NWSC (SoS)	√	√	√	√		√
TSC (DGSWS)	√	√	√	√	√	√
MSC (DCofN)	√			√	√	√
WSCC (AWE)	√	√	√	√	√	√
RBASC (DC(Nuc))	√	√	√	√	√	√
ESTC		√	√	√	√	√

Committees		Authorities	
NWSC	Nuclear Weapons Safety Committee (advises Secretary of State)	CSSE/ DGSWS	Chief Strategic Systems Executive/Director General Strategic Weapon Systems
TSC	Trident Safety Committee (advises Director General Strategic Weapon Systems)	DC(Nuc)	Deputy Controller (Nuclear)
MSC	Magazine Safety Committee (advises Deputy Controller of the Navy)	AWE	Atomic Weapons Establishment
WSCC	Warhead Safety Coordinating Committee (advises Chief Executive, AWE)	DGST(N)	Director General Supplies and Transport (Navy)
RBASC	Re-entry Body Assembly Safety Committee (advises Deputy Controller (Nuclear))	OB	Ordnance Board
ESTC	Explosive Storage and Transport Committee	CINO	Chief Inspector of Naval Ordnance

Comment

B.6.3 The committee's influence depends on their professional expertise and their direct access to SoS. Their standing is (and must be) such that their advice cannot be set aside. If the Procurement Executive or the Services were proposing to act against NWSC advice then it can be expected that this would need to be formally justified at the highest level.

B.6.4 The committee is most effective in advising on technical policy issues which involve safety related judgements. The committee works on the information put forward by the responsible authorities. They neither undertake nor commission parallel work elsewhere, but often require additional work to be undertaken by the responsible authorities. Furthermore, in some highly specialist areas subgroups act for the whole committee (eg inherent nuclear warhead safety).

B.6.5 The committee promotes interaction between the 13 independent members and the responsible authorities through representation of the latter at most meetings. However, decisions derive from the views of the independent external members. This interaction encourages early identification of critical issues; topics for NWSC attention occur either by authorities offering them or the committee requesting them. It did not seem to the Group that this procedure would necessarily continue to ensure that all important issues would be identified for consideration with the correct priorities. Its effectiveness owes much to the personalities involved, both in the UK and the US, and to the fact that long-serving members of the present committee have had many years of association with nuclear R&D.

B.7 Ordnance Board (OB)

B.7.1 The Ordnance Board supplied us with their terms of reference as follows:

Status

1 The Ordnance Board is an inter-Service, professionally independent advisory body accountable to CDP and under the line management of DUS(DP).

Constitution

2 The Board consists of a President and 2 Vice-Presidents (The Senior Members for the Royal Navy, Army and Royal Air Force), Members and Associate Members. The Members are suitably trained and experienced Service and Civilian Officers nominated by the MoD. The Presidency is taken in rotation by each Service. Ex-officio Associate Members are Officers holding certain designated appointments. Associate Members (Emeritus) are eminent persons, invited by the Board because of their special knowledge and experience.

Annex B: Safety Responsibilities and Advisory Bodies (continued)

Purposes

3 The primary purposes of the Ordnance Board are:

a To provide impartial appraisal of the safety, and advice on the suitability for service, of those parts of weapon systems and stores within the Board's scope (see Paragraph 5 below) in which explosives are used. In this context:

1) The term 'explosive' encompasses initiatory compositions, high explosives, propellants and pyrotechnics.

2) The term 'suitable for service' means that the explosive and associated elements of a weapon system or store are capable of functioning technically as designed, and that neither this functioning, nor safety, will be unacceptably degraded by the service environment throughout the agreed service life. It does not embrace operational effectiveness or lethality.

b To provide impartial appraisal of the safety, and advice on the suitability for service of support equipment, road and air transportation for nuclear warheads and weapons.

c To give advice on safety matters affecting the use of weapons and other hazardous stores during military training.

d To provide the MoD focus for international standardisation in testing, assessment and acceptance criteria relating to the above matters.

4 In addition, when so requested by an Approving Authority, and subject to the availability of staff resources and approval by the President, the Board may:

- Provide advice on certain aspects of weapon systems beyond their safety and suitability for service, where Members have unique knowledge or experience.

- Provide advice as in sub-paras 3.a and 3.c in respect of weapon systems and stores offered for sale overseas which are not in service with the United Kingdom armed forces. The request for such advice, normally provided on a repayment basis, must be endorsed by the Defence Export Services Organisation.

Scope

5 The Board undertakes work in the following fields:

a Gun systems, small arms, mortars, associated ammunition and grenades.

b Torpedoes, anti-submarine weapons and Naval mines.

c Anti-armour and anti-personnel mines and demolition stores.

d Unguided rocket systems and aircraft bombs.

e Guided weapon systems.

f Pyrotechnic stores.

Annex B: Safety Responsibilities and Advisory Bodies (continued)

g Power cartridges and miscellaneous explosive devices including aircraft emergency escape systems.

h Explosives, pyrotechnics and incendiary compositions in general.

i Electrical hazards to weapon systems including those from electromagnetic and electrostatic influences.

j Safety critical computing systems.

k Ship magazine safety.

l Nuclear hardening of weapon systems.

m Laser safety.

n Fragmentation and ricochet studies.

o Range safety for conventional and guided weapons.

p The safety of nuclear warheads and weapons and their associated servicing, support and test equipment, during development and in service. Where nuclear warheads are fitted, the safety of aircraft weapon control and release mechanisms and missile delivery systems. The assessment of safety and suitability for service of road vehicles and transport aircraft for the carriage of nuclear warheads and weapons. (The responsibilities of the Board in this field are subject to special arrangements approved by the appropriate authorities from time to time.)

Tasking

6 The Board is normally tasked by, and its advice addressed to, the appropriate Approving Authorities in the Procurement Executive and additionally, on certain nuclear matters, to DC(Nuc). The Board may be tasked by the In-Service Managers (ISM) of all three services to advise on in-service munitions, in particular the reassessment of their lives. For Private Venture work the Board is tasked by Defence Export Services Organisation.

Duties

7 The main duties of the Board are:

a To establish design safety principles for weapon systems and stores containing explosives.

b To appraise those parts of weapon systems and stores containing explosives for safety and to advise the Approving Authority on their suitability for service as requested. Such work generally includes appraisal and testing of related packaging and may include appraisal and testing of related test and handling equipment. In the case of nuclear warheads and weapons, to advise on the safety and suitability for service of the associated servicing and support equipment, road and air transportation.

c To advise the Service Staffs, Establishments, Defence Export Services Organisation, Technical and Logistic Directors and Industry on all such

matters referred to the Board, through the appropriate Approving Authority, where applicable. Also to draw their attention, if necessary, to matters which come to the Board's notice, particularly where inter-Service co-ordination appears to be required.

d To provide life assessment advice on munitions and other advice in the weapons field, within the capacity of the staff available.

e To report and publish in Proceedings:

1) The programmes and results of tests and trials.

2) The corporate opinions and recommendations of the Members, together with the views and recommendations of the appropriate Directorates and Establishments and of individuals associated in the investigation in question.

3) Statements of Board policy and other decisions as appropriate.

4) Reports on investigations containing the advice and recommendations of Committees operating under the auspices of the Board.

f To provide advice on the procedures necessary to demonstrate that a weapon system under development is safe for manned firings by service personnel, (Live Crew Clearance).

g To provide, at the request of the authorities responsible for training Ranges, advice on safety at those Ranges.

h To work for international standardisation within its fields of operation.

Authority

8 In pursuance of the above duties the Board is authorised:

a To obtain the assistance of trials, research, design and other Establishments in connection with its work. Similarly, all Establishments concerned with trials and development may consult the Board direct.

b To consult any other official bodies, firms or persons associated with scientific or technical development.

c To consult representatives of the Naval, General and Air Staffs and to advise them directly on matters of their particular concern. Where the subsequent decisions or actions arising are the concern of an Approving Authority, the advice will be directed through that Authority.

d To establish a close liaison with the Service Staffs, to enable the Board to appraise shortcomings of weapons and weapon systems safety arising in service.

e To consult and to collaborate with NATO, Commonwealth and foreign countries as appropriate.

f To order and to account for materials required for trials when such materials are not supplied through the Project Office of the Approving Authority or from service sources.

Annex B: Safety Responsibilities and Advisory Bodies (continued)

Administration

9 The Board is administered by DOS(DP).

Finance

10 Board work in support of specific tasks is financed by the Approving Authority concerned out of project funds. Vote management responsibilities for general supporting activities and non-project specific technical support are vested in the Ordnance Board.

Accountability

11 The President of the Board is accountable to CDP for ensuring the efficient and effective operation of the Board and that its professional standard is upheld, and to DUS(DP) for the administration of the Board. The President is authorised to report his concern to 2nd PUS and/or VCDS if he believes that decisions taken by the Procurement Executive represent an unacceptable risk to safety.

Comment

B.7.2 In the present safety structure for nuclear weapons the Ordnance Board is widely seen as playing a pivotal role. Virtually all other bodies take OB pronouncements as their starting point. It issues safety guidelines to be followed in the safety assessment of nuclear weapons which are interpreted as design standards. It is represented on the majority of advisory committees in the safety chain and its standing is such that no weapon would normally be accepted into service against its advice. The OB emphasised to us that, in line with their terms of reference, they were not required to consider the "suitability for service" of nuclear weapons.

B.7.3 The OB's resources are limited, and it discharges a wide range of responsibilities among which nuclear matters are only one. At present there are 6 staff fully committed to nuclear work from their total complement of about 100. After discussion with the President and other senior members of the OB, the Group was concerned that a gap may exist between the OB's properly conservative view of its nuclear capability and the perceptions of various external groups, among whom we commonly found that an OB endorsement was considered to be definitive and absolving them from any obligation to consider safety further.

B.7.4 The most recent design guidance for nuclear weapons safety is provided by OB Proc N392, issued in 1984. This was not reviewed prior to the formulation of the Staff Requirement for the Future Theatre Nuclear Weapon (FTNW). The Group believes that it is essential that the Board should revisit OB Proc N392 urgently and that they should be staffed appropriately, on a temporary basis, to achieve this. Not only have there been technological developments since 1984 that need to be taken into account for FTNW, but the extent of any adoption of a probabilistic approach to safety to supplement the current deterministic approach should be considered again.

B.7.5 We noted that there is no requirement that incidents/accidents involving systems or weapons that they have approved should be reported to the OB. Although in practice they would expect to hear of such events eventually, we believe that such information would be valuable to them and that the OB should receive notification of reportable incidents involving nuclear weapons as a matter of course. This could be achieved by the compilation of an annual report classifying and analysing the causes of incidents and accidents. The OB would be on the circulation list of such a report.

B.7.6 Although it is not within our remit to comment on the overall structure of the OB, the Group has two other concerns which affect nuclear matters but are of much wider significance:

- it is not clear that the OB, as a body whose principal role is to provide independent advice, is appropriately sited within the Procurement Executive. There are possible conflicts of interest. We are concerned that the PE may not be the body to champion the needs of safety and to ensure that the work on which it depends is properly resourced. Safety features may well increase procurement costs and timescales;

- we also question whether strict rotation of the Presidency between the three services is the best way of ensuring that the most appropriate person with the necessary knowledge and experience is always appointed to this very responsible post. Consideration might be given to opening this position to technical civilian as well as service personnel.

B.8 Explosive Storage and Transport Committee (ESTC)

B.8.1 ESTC is an interdepartmental committee, sponsored by MoD, responsible for classifying military explosives and for prescribing the standards of safety for use throughout MoD during the storage of military explosives and regulating their conveyance. These standards are incorporated within MoD Service and Procurement Executive explosives regulations.

B.8.2 The Deputy Under Secretary (Personnel and Logistics) is the Responsible Authority. The Chairman is Director of Defence Health and Safety, and the committee is accountable to 2nd PUS, in his role as Chairman of the MoD Health and Safety Steering Committee, through the General Health and Safety Policy Committee. The committee also has direct responsibility on explosives to the Vice Chief of Defence Staff for Service Board matters.

B.8.3 Its terms of reference are currently being reviewed and, at present, are:

1) To classify for storage and transport all military explosives in accordance with Statutory Instrument 1983/1140 and ESTC Leaflet No 2.

2) To prescribe the safety conditions to be observed in the storage of military explosives, chemical and other such defence preparations as may be decided from time to time by the Responsible Authority.

3) To prescribe and advise on the safety conditions to be observed in the storage and transport of nuclear weapons, depleted uranium ammunition and other munitions containing radio-active materials.

4) To advise when requested by the appropriate HQ, on all questions connected with the siting, design and layout, construction and maintenance of ammunition depots, magazines, laboratories, process buildings and explosives storehouses.

5) To negotiate conditions to be observed to ensure the safe conveyance of military explosives and chemicals or other like defence preparations by rail, road or sea, and to advise on their conveyance under the appropriate statutory authority.

6) To negotiate conditions of conveyance of military types of dangerous goods for which commercial provision has not been made.

7) To place the criteria for quantity-distances on a scientific basis by arranging field trials, or by association with foreign field trials.

8) To register as suitable for storage and transport explosives packagings of net mass of greater than 400kg and unpackaged articles, and to maintain a record of such registrations and UN certificates for packagings of net mass of less than 400kg.

B.8.4 The Chairman appoints sub-committees as may be necessary to deal with particular subjects, nominating a member of the main committee to act as chairman. One such sub-committee considers nuclear weapons, and includes representatives from AWE, DC(Nuc), DGST(N) and CINO.

B.8.5 ESTC lays down Prescriptions which specify conditions to be observed for the storage and transport of potentially hazardous military items. Prescription No 2 deals with Storage and Transport of Nuclear Ammunition Explosives Types 16 and 17, and is based on proposals and container designs which were received by the NWSC.

B.9 Warhead Safety Coordinating Committee (WSCC)

B.9.1 WSCC endorses the safety of the warhead design to the design authority (Chief Executive AWE) and advises him on safety problems associated with weapons in service.

B.9.2 Its terms of reference are:

1) to provide assurance that the design and characteristics of nuclear warheads developed for HM Forces use, and their assembly, together with handling equipment, test sets, packaging and procedures achieve a satisfactory standard of safety;

2) to arrange that adequate evidence of the safety of the items developed by AWE for HM Forces use is obtainable from the programme of trials and assessments;

3) to examine the adequacy of the render safe procedures for dealing with warheads in the Forces;

4) to advise on safety matters associated with nuclear weapons in service with HM Forces;

5) to keep under review and comment upon the safety of HM Forces' stockpile;

6) to provide assurance that the design and characteristics of other components of weapon systems for which AWE is the Design Authority achieve a satisfactory standard of safety;

7) to review, when necessary, any part of a weapon system which interfaces with the warhead to ensure that the safety of the warhead is not impaired;

8) to examine the safety aspects on new concepts in warhead designs;

9) to provide assurance that all experimental nuclear assemblies, other than reactors, for which AWE is responsible, achieve a satisfactory standard of safety;

10) to examine the safety aspects of any item as directed by Chief Executive AWE;

11) to report to Chief Executive AWE at least annually.

B.9.3 It is chaired by the Director of Safety at AWE and, as well as AWE personnel from both the design and safety areas, its membership includes representatives of DC(Nuc), OB, CINO, Defence Research Agency (DRA), and the senior RN and RAF liaison officers at AWE.

B.9.4 It has three panels reporting to it:

- Warhead Nuclear Safety Panel (WNSP) to advise the WSCC on all nuclear and radiological safety aspects of warhead design;
- Warhead Explosives and Compatibility Safety Panel (WECSP) to advise the WSCC on the safety aspects of materials, including explosives, for their use in specific warhead designs;
- Warhead Systems Safety Panel (WSSP) to advise the WSCC on electrical, mechanical and structural safety aspects of all warhead systems and component designs.

B.10 Magazine Safety Committee (MSC)

B.10.1 MSC approves Magazine Safety Certificates giving authority for explosive stores to be embarked on specific classes of surface ships or submarines. This certificate

identifies the permitted environment for handling the store, including any associated conditions or restrictions.

B.10.2 The committee has three subcommittees concerned with HM surface ships, HM submarines and Royal Fleet Auxiliaries (RFAs) and support vessels. Each subcommittee reconciles the weapon safety statement provided by CINO with the in-service environment, and presents the certificate to the main committee for approval.

B.10.3 The membership of the main committee includes:

- Deputy Controller of the Navy (DCofN), (Chairman);
- chairmen of the three subcommittees;
- representatives of OB, CINO, Naval Staff, Commander in Chief Fleet.

B.10.4 The subcommittees have the same basic representation, but at a more specialist level.

B.10.5 The committee's terms of reference are:

1 **Magazine safety in ship design**

To keep under review and to advise regarding measures considered necessary to minimise the risks involved in the embarkation, stowage, handling, on board testing and discharge of weapons, explosive stores and pyrotechnics in existing and future designs of surface warships, submarines, RFAs and support vessels, through all stages of design, service life and modernization with particular reference to:

1) weapon stowage areas, magazine and/or cargo hold protection and environment;

2) the types of weapons and explosives involved;

3) the proposed embarkation, stowage, handling, on board testing and discharge arrangements.

2 **Weapon/ship compatibility**

To consider whether proposed new weapons (as concerns their explosive content) can be provided with an acceptable environment and suitable stowage and handling arrangements in existing and new design surface warships, submarines, RFAs and support vessels (including STUFT ships under Navy Department control) and to establish any special safety requirements for their stowage and handling both at sea and in harbour. In the event of the committee not being satisfied that appropriate safety arrangements can be provided in warships or submarines for a particular weapon design, the problems are to be raised with the Ministry's weapon project organization in order to explore possible modifications to the weapon.

3 Explosive safety regulations

1) To advise whether amendment or addition to NMERs (BR 862) is necessary and to approve policy changes of the regulations for the safe stowage and general safety of explosives.

2) To consider any proposals for departing from or invoking the concessions in NMERs, and to approve and record all decisions reached as appropriate.

3) To maintain liaison with other Service and government departments regarding all regulations, statutory or otherwise, which may affect the carriage of explosives in ships and vessels under Naval control.

B.11 Trident Safety Committee (TSC)

B.11.1 TSC is responsible to DGSWS for the assessment of safety in his area of responsibility.

B.11.2 Its terms of reference are:

1) to recommend safety approval of the strategic weapon system in support of the DGSWS Approval process;

2) to assess the adequacy of US and UK data to meet the requirements of UK safety authorities;

3) to provide a forum for identifying evidence to support safety approval and for any additional UK trials and assessments;

4) to review DGSWS inputs to CSSE presentations to the NWSC;

5) to coordinate the activities of the independent safety advisers to CSSE to ensure the timely preparation of their statements and certificates, supporting that part of the weapon system approval and acceptance into service, for which DGSWS has responsibility;

6) to plan the resources to meet the safety approval programme.

B.11.3 Its responsibilities include managing interfaces between the missile and Re-entry Body Assembly (RBA) which have an impact on safety. It also monitors TRESSPAC activities. Its membership includes representatives from DGSWS (ADQS) (Chairman), OB, Principal Director Supplies and Transport (Armament Supplies) (PDST(AS)), Chief Inspector Naval Ordnance (CINO), Secretary WSCC, Defence Research Agency (DRA), Magazine Safety Committee (MSC), Commander Strategic Weapon System Acceptance (CSWSA), Chairman of RBASC, Chairman of Coulport Trident Facility Safety Committee (CTFSC) and Secretary DGSM SSBN safety review committee.

B.12 Trident Re-entry System Service Publications Approval Committee (TRESSPAC)

B.12.1 TRESSPAC is responsible for approving all relevant publications for use on or in association with the TRES prior to slow run through, and for recommending full approval be granted by the approval authorities (CSSE and DC(Nuc)). It is chaired by SWS132, who is directly responsible to DGSWS, and its members are representatives of AWE(A), CINO, D(Nuc)P, DGST(N), OB and the Defence Radiological Protection Service.

B.13 Re-entry Body Assembly Safety Committee (RBASC)

B.13.1 RBASC is chaired by a nominee of D(Nuc)P who is responsible to DC(Nuc) for ensuring that all aspects of RBA safety relevant to approval are properly staffed in a timely and coordinated manner. To that end, its terms of reference are:

1) to advise the TSC on all aspects of safety relating to the RBA;

2) to assure the TSC that all safety aspects during the stockpile to target sequence which relate to the RBA have been properly examined and correctly embraced by the relevant Approval;

3) to review the RBA/Missile and/or submarine (SSBN) interfaces in order to ensure that there are no operations/processes that could affect the safety of RBAs.

B.13.2 The scope of RBASC covers all safety matters relating to the RBA with the exception of single point safety.

B.13.3 The committee has met only once.

B.13.4 Its membership comprises representatives from D(Nuc)P (Chairman), OB, CSSE, DGST(N), DGSWS, Design Authority/AWE(A), WSCC and DC(Nuc) (independently of D(Nuc)P).

B.14 Air Force Department Weapon Standardisation Team (AFDWST)

B.14.1 The AFDWST inspects RAF activities associated with nuclear weapons including:

- land transport (convoys);
- air transport;
- base storage;
- operational deployment of training rounds.

B.14.2 The inspection considers both safety and security as well as the operational reliability, and is fully independent of the RAF operational command structure, reporting to the Chief Inspector of Explosives, RAF in MoD.

B.14.3 The inspections take place annually and are thorough, with the team spending one to two weeks at a base.

B.15 Chief Inspector of Naval Ordnance (CINO)

B.15.1 CINO has two key roles pertinent to nuclear weapon safety:

- assuring that the procured weapon will be safe in its specified environments;
- inspecting operations to assure that the weapons are handled safely and within their specified environments.

B.15.2 He is formally responsible to DGST(N), but has access to Chief of Fleet Support (CFS) and CofN should he require it (for example over the inspection of facilities for which DGST(N) is responsible). His work in support of new system assessments is formally discharged to CofN.

B.15.3 For the first of the roles identified in Paragraph B.15.1, he operates through safety committees in the procurement cycle both to gather information from, and to input his likely requirements to the project. When he is satisfied with the safety of the weapon, he issues a safety statement. This is passed to the MSC who will certify it as safe to be carried in specific ships. [redacted]

B.15.4 For the second role identified in Paragraph B.15.1, CINO places Naval Ordnance Inspection Officers (NOIOs) to observe relevant operations at Royal Naval Armament Depots (the responsibility of DGST(N)).

B.16 Flag Officer Submarines (FOSM)

B.16.1 FOSM is responsible for operating the strategic missile carrying submarines. This activity is not independently inspected, but is audited by FOSM personnel with assistance and advice from DGSWS representatives.

B.17 Missile Technical Proficiency Inspection (MTPI)

B.17.1 MTPIs are joint UK/US external audits of the Naval Depot's facilities for processing missiles and warheads associated with SSBNs. These inspections take place every two years and last two or three weeks, examining all aspects of the depot's activities.

B.18 Nuclear Weapon Capability Inspection (NWCI)

B.18.1 NWCIs review the capability of HM surface ships to carry nuclear weapons. These are carried out in two phases:

- an administration inspection in harbour, lasting one day;
- an operations inspection at sea, lasting two or three days.

B.18.2 These inspections cover all aspects of safety, security and operational deployment (using training rounds) of nuclear weapons.

B.18.3 The inspections take place approximately every 18 months and are carried out by Commander-in-Chief Fleet on behalf of CofN.

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Annex C: SRD Role in Naval Reactor Safety

C.1 Naval nuclear steam raising plants are procured by MoD(PE), specifically by Director General Submarines (DGSM), from Rolls Royce and Associates (RRA) who are designated as the Delegated Design Authority. RRA is responsible for preparing a safety justification of the plant and providing this to DGSM. Separately, DGSM places a contract with the Safety and Reliability Directorate (SRD) of the UKAEA to provide an independent assessment of the safety justification. This assessment is a continuous process operating throughout the design, construction and operational phases of naval nuclear plant but which culminates in the issue of a safety clearance letter from the UKAEA to MoD. This letter states that, subject to any specified terms or conditions, the UKAEA considers that the operation of the specified nuclear plant does not constitute an unreasonable risk. UKAEA will base this letter on both SRD's safety assessment of the plant in question and on a separate SRD running review of the facilities at the berth(s) designated for operation of nuclear powered warships. Without such a letter, the necessary MoD approval to operate a naval nuclear propulsion plant would not normally be provided.

C.2 The size of DGSM's contract with SRD is dependent on the amount of work in progress on new design plants or facilities, with Trident being a pre-eminent example. However there is a more or less steady level of activity, currently valued at some £4M per annum, associated with the through life assessment of existing plants, including nuclear powered warship berths and facilities.

C.3 SRD contributes to the work of the Nuclear Powered Warship Safety Committee which is a committee with nuclear safety responsibilities related to nuclear powered warships that are analogous to those of the Nuclear Weapons Safety Committee for nuclear weapons.

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Annex D: Accident Response

D.1 Introduction

D.1.1 The Nuclear Accident Response Organisation (NARO) is activated following any accident or significant incident involving:

- a RN nuclear reactor;
- a UK nuclear weapon in UK territory or abroad;
- foreign nuclear powered warships in the UK or in UK waters, or in UK dependent territories and waters;
- foreign nuclear weapons in the UK, dependent territories and waters;
- MoD UK nuclear material;
- a nuclear accident overseas likely to have consequences for Service operations or the safety of MoD personnel.

D.1.2 For nuclear weapons (the primary area of interest to the group), an *accident* is defined as any unplanned occurrence involving loss (other than by theft) or destruction of, or damage or suspected damage to, nuclear weapons, nuclear components or nuclear materials which has either resulted in actual or potential hazard to life or property, or which may have impaired nuclear safety. A *major incident* is defined as any unplanned occurrence involving nuclear weapons, nuclear components or nuclear materials which does not comprise a nuclear weapon accident, but which needs to be reported in the interests of safety or because it is likely to come to the attention of the public or the media.

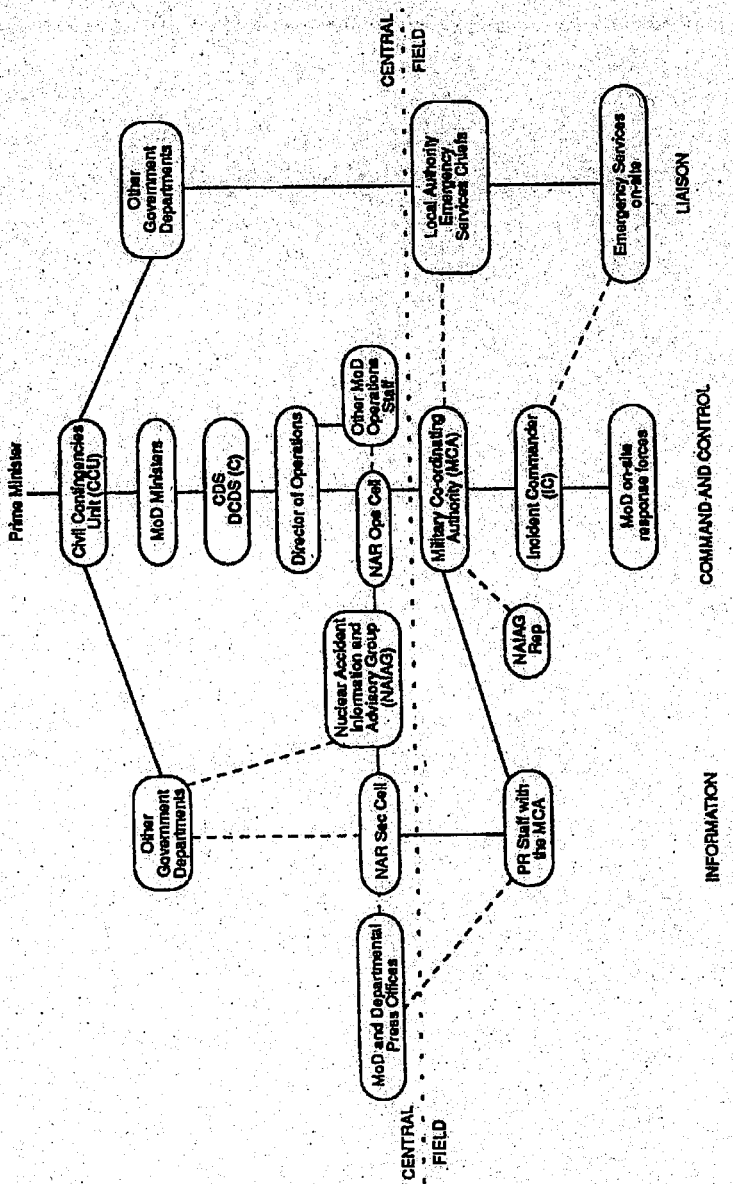
D.1.3 The purpose of the response is to minimise the danger to the public and to control the situation as safely as possible. Due to the rarity of nuclear accidents, exercises are regularly held to rehearse procedures and harmonise interfaces between the many elements of the response.

D.2 Organisation

D.2.1 Accident response is formally controlled by central Government, with the responsible Services (RN and RAF) reporting to NARO HQ. These reporting lines are shown in Figure D.1.

Annex D: Accident Response (continued)

Figure D.1 Nuclear Accident Response Organisation



D.2.2 The central bodies are concerned with co-ordinating the Governmental response to the accidents, including:

- public affairs issues;
- inter-Departmental liaison;
- if appropriate, liaison with other countries and international organisations.

D.2.3 The Nuclear Accident Information and Advisory Group (NAIAG) brings together staff from the MoD, other Government Departments and other external agencies with a key role in the response. It acts as a focus for information and provides advice on public affairs issues. The interface with the field organisation is handled by NARO HQ which is manned constantly whilst field operations are in progress.

D.2.4 The field organisation will reflect the site and scale of the accident, and the availability of local resources. For an accident on a military base, MoD will control activities on-base and the Police/Local Authority off-base. For an accident off-base, activities will be under Police control and the MoD can provide, in support, a comprehensive mobile military complex from resources on call. The description below gives an overview, covering the generic functions at all accidents. The field operation is controlled by the Military Co-ordinating Authority (MCA). He is the main link with MoD HQ and is responsible for:

- the organisation of military support as required by the Police/Incident Commander;
- liaison with officials of Local Authorities, the Police and other emergency services;
- providing authoritative advice to the local authority and civil emergency services on protecting the public (where appropriate);
- handling media enquiries in accordance with advice received from MoD HQ.

D.2.5 The Incident Commander (IC) is the officer initially in command at the site of the accident. He is responsible to the MCA and handles the initial response to a defence nuclear accident. These activities include:

- establishing a secure cordon around the accident;
- liaising with civil emergency services.

Annex D: Accident Response (continued)

D.2.6 Technical support can be called in from a number of organisations including:

- AWE (weapons specialists);
- CINO (who would advise on, for example, rendering a magazine safe before allowing weapon specialist access);
- Health Physics staff;
- Health Control and Monitoring Force.

D.2.7 These organisations have staff on call, and can provide teams at accident sites within a few hours.

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Annexes E to G of a Report on the Safety of UK Nuclear Weapons

CSA 42/5/1/1 (46/92)

Copy 11 of 60

Prepared by the Safety Review Group
Chaired by the Chief Scientific Adviser of MoD

12 February 1992

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Annex E: UK Nuclear Weapon Systems

Note: this annex is written in amplification of Section 4 of the main report. Matters adequately covered at that level of classification are not repeated except where this is necessary for continuity and coherence.

E.1 Contributions to Weapon Safety

E.1.1 Direct contributions to weapon safety are made by those who design and test safety technology, those who specify the weapon requirement taking account of such technology, those who carry out hazard analysis to define accident environments, and those who provide facilities and procedures for supply and service handling. Good quality work in all these areas is essential.

E.1.2 Indirect contributions to safety are made by those who make safety assessments, those who provide guidelines, and those who approve the weapons by comparing development and requirement. Good quality work in these areas, however important to the assurance of deployed weapon safety, cannot be the main vehicle of improvement. It follows that the most effective use of resources in the achievement of safety is obtained by direct interaction of those responsible for the requirement and the design authorities, including sub-system designers, to achieve an overall balance. As development work starts, the assessment roles must be integrated to achieve a balanced assessment of where achievement is strong or weak.

E.1.3 During the work of the Group it became quite clear that the existing arrangements in MoD place much more emphasis on ensuring that the design assessment of safety is achieved, rather than upon its improvement; safety management tends to be neutral, rather than positive. It was evident that during formulation of Staff Targets and Staff Requirements, and in assessments of options from research programmes or feasibility studies, pressure would originate for better performance, tighter timescales, and lower costs. The need for a champion for nuclear weapon safety has been addressed in the main report and is the subject of our recommendations.

E.2 Competence in Weapon Safety

E.2.1 Adequate provision and assessment of safety require competent and current design and development experience and the parallel involvement of independent assessors. This was achieved for the WE177 warhead and the Chevaline front end through the presence of both the design and safety authorities on the Warhead Safety Co-ordinating Committee at AWE. No doubt has been expressed that the Director of Air Armament also achieved this in the safety management of the WE177 bomb case and arming and fusing systems.

E.2.2 [redacted]

[redacted]

E.2.3 [redacted]

E.2.4 [redacted]

E.2.5 By conventional definition, a warhead is regarded as having inherent (or one-point) nuclear safety if accidental detonation of the high explosive at any single point provides less than one chance in a million of a nuclear yield in excess of the equivalent of four pounds of TNT. Determination of inherent safety is done by highly specialised calculation techniques which must be validated by low yield nuclear safety tests. One dimensional (1-D) computer codes sufficed to predict the design mode performance of the WE177 warhead but much more complicated 2-D codes are needed to evaluate its inherent safety. Such codes were devised, and have been validated by nuclear tests, to predict the performance of the Chevaline warhead, and have been used to re-confirm the inherent safety of WE177. Immensely complex 3-D codes are needed for estimates of the inherent safety of modern warheads such as Chevaline, Trident, or FTNW. Only fairly recently has AWE acquired the necessary computer power to enable it to pursue code development and plan test validation. This competence can be expected in due course if AWE's work is adequately supported.
some US work on 3-D codes was not confirming [redacted]

E.3 Technologies in Warhead Safety

E.3.1 The potential hazards which require more stringent safety measures to be imposed in nuclear weapons than in conventional weapons are inadvertent nuclear yield and, even when that is prevented, inadvertent dispersion of plutonium.

E.3.2 [redacted]

E.3.3 The AFD is designed to fire the warhead at full nuclear yield, so the safety technology within it must provide the highest possible assurance that it cannot function inadvertently. This is usually achieved by triplication of independent safety breaks which are tested and proved to survive the abnormal accident environments identified and quantified by hazard analysis. If vital functional components (necessary for the correct operation of the warhead) are designed to fail in abnormal environments before the safety breaks malfunction, then an additional margin of safety may be achieved by collocating the two. This provides added assurance against unforeseen abnormal environments. [redacted]

E.3.4 [redacted]

E.3.5 One-point safety is particularly important in arrays of warheads, as in a multiple warhead missile or in magazines, where minor yield from a single one-point safe weapon could, if precautions were not taken to avoid it, escalate severely, with sympathetic detonations of other warheads in the array. [redacted]

E.3.6 [redacted]

E.3.7 The plutonium component of a nuclear warhead is at the centre of the implosion system, and this plutonium is colloquially known as the "pit" of the warhead.

[redacted]

E.3.8 The technologies described above apply to the warhead in isolation. It is, however, important to recognise that the balance of safety, and the balance with performance and cost, is subject to great change when the warhead is integrated with its delivery vehicle, and when the weapon is then integrated with the launch platform. For instance, the advantage of using IHE in the warhead to reduce the likelihood of plutonium dispersal would be lost if the warhead were integrated with a missile fuelled with a powerful but sensitive and detonable propellant.

E.3.9 Taking these descriptions of the severity of hazards and the effectiveness of safety technologies, Table E.1 can be devised to illustrate how safety issues have been addressed in a series of UK nuclear weapons and trends in safety improvement. As was mentioned above the earliest UK free-fall nuclear bombs were extremely safe because the explosive and the plutonium were not brought together until the weapon was armed for use. However, subsequent application of this approach within the tighter size and reliability constraints of more modern weapons required technology that was not available. [redacted]

E.3.10 AWE's research on advanced warhead design shows potential for the re-introduction of a separable plutonium component. Propellant, HE and FRPs would then have much less significance to nuclear safety. This illustrates the advantages which could in theory be gained by the Drell Panel's recommendation to pursue aggressively new safety technologies in warhead design. This Group cannot judge whether such technology should have been pursued more vigorously for future designs, but we are concerned that no balanced appraisal can be found of what safety technology could or should be included or excluded in study options of future warhead and missile systems.

E.4 Stockpile Appraisal

E.4.1 The WE177 weapon is a bomb of which there are three variations in service. WE177A (the "A" weapon) is a kiloton class bomb, whereas the addition of thermonuclear components in a lengthened bomb case provides the megaton "B" and "C" class weapons, having different yields. The bombs can be delivered in the free fall mode, by parachute retardation or by laydown, whilst the "A" weapon can be used as a depth bomb at sea. As far as this review could judge there are no cases where WE177, Chevaline or Trident have not made use of the best safety technology available at the time. The WE177 variants are part of a system of wholly British design; the exceptionally robust bomb case (a consequence of its planned deployment arrangements) protects the warhead and contains no materials hazardous to the

[redacted]

Annex E: UK Nuclear Weapon Systems (continued)

Table E.1 The safety characteristics of some UK nuclear weapons

	Hazard	Technology	Weapon			
			[redacted]			
WARHEAD	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
MISSILE	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Note: [redacted]

[redacted]

warhead. Since the bomb is never fitted to aircraft in peacetime, accidents from interaction between weapon and platform do not arise. The warhead and AFD were based on contemporary and active technology programmes; the WSCC had been instituted as part of a strong safety drive and was active throughout the development.

E.4.2 Chevaline is a development of the Polaris A3T system in which the three ballistic re-entry vehicles are replaced by a more complex payload and additional propulsion to enhance its ability to penetrate anti-ballistic missile systems. Chevaline inherited the SSBN and missile safety systems from Polaris but the incorporation of liquid propellants stimulated within the Chevaline project a much stronger coordination of safety. Throughout project definition and the first several years of development, AWE's role led to WSCC overseeing safety assessment of the whole of the payload penetrative system and also to very close interaction between design authorities, WSCC and Chief Strategic Systems Executive safety organisations. The performance requirements stimulated a new warhead technology coupled with advances in HE and one-point safety.

E.4.3 The 1980 decision to acquire Trident initially presumed acquisition of the Trident C4 missile and its associated re-entry vehicle which the US had designed for its W76 warhead; missile processing was planned to occur at RNAD Coulport. The AWE warhead was based on contemporary active technology programmes using HE with improved safety characteristics; [redacted] The subsequent change to the Trident D5 missile, and the change to using a common US missile stockpile, and MoD changes to management of the nuclear programme made no difference to the warhead but distanced AWE from system safety involvement.

E.4.4 A programme as complex as, for example, that for Trident, has necessarily to be divided into several separate areas of development and safety responsibilities. As these are worked through and begin to be seen as a whole, then sub-system interaction may cause safety concerns or show that different sub-system options might have been better. At the staff target, feasibility and project definition stages of a project, when development has not yet filled out the technological data, broad judgements have nevertheless to be made on the technical options; there is no reason why broad system safety assessments should not also be made at those times, so that safety takes a proper place in the balance and critical areas are earmarked for priority attention.

E.4.5 A sufficient and structured emphasis on system safety right from the start is not evident in the UK nuclear weapon system procurement arrangements, eg see Paragraph 4.5.1 of the main report. The presence of sensitive and energetic fuels in any future nuclear missile would make a great difference to the safety appraisal by comparison with WE177, and overall system safety would in turn have a profound effect on service handling procedures and facilities.

E.4.6 [redacted]

[redacted]

E.5 Production

E.5.1 [redacted]

E.5.2 For WE177 and Chevaline refurbishments and for Trident Re-entry Body Assemblies (RBAs), confidence that safety will be maintained in production and through life depends on the arrangements between AWE(Aldermaston) and AWE(Burghfield).

E.5.3 The Group found a strongly established safety culture at AWE(B) and noted the arrangements to ensure that all production processes were subject to design authority approval and were required to meet design authority specifications.

E.6 Technical Implications of Drell Report

E.6.1 [redacted] In accepting this, the US Government noted that it should be complete by the year 2000. This is not inconsistent with UK replacements of Chevaline and WE177, and so in neither case is retro-fit appropriate, [redacted]

E.6.2 Drell recommended that all aircraft-carried US weapons should be fitted or retro-fitted with warheads having IHE and FRPs. The US Government accepted IHE but not FRPs by about the year 2000, a timescale which is comparable with that for the replacement of WE177 in the UK.

E.6.3 Drell also recommended a review of all missiles without non-detonable composite propellants and whose warheads are not fitted with IHE or FRPs. Since Chevaline will be replaced, the UK is only concerned in this respect with Trident D5 fitted with the British warhead. Drell advised particular attention to D5 fitted with the large W88 warhead whilst loading to or unloading from the SSBN. This Group has noted that D5 explosives and propellants are directly comparable with those of Polaris and Chevaline and are unlikely to prove any greater hazard. The inclusion of IHE in the warhead or composite propellant in the third stage undoubtedly increases safety when they are handled individually. When, however, the warhead and third stage are handled together or in close proximity (eg during loading and unloading), the total system must be considered. The complete missile has detonable propellant in the first and second stages as well as the third and, should accidental explosion occur in the

[redacted]

SSBN or its vicinity, any radiological risks arising from the reactor must also be taken into account. The method of loading missiles (with or without warheads) must be decided by overall system hazard analysis of both cases and cannot be pre-judged by this Group.

E.6.4 Drell recommended that there should be an overall system safety assessment before the start of project development, and the acquisition of reliability or failure data bases to support quantitative analysis at all stages of hazard and safety assessment. There are indications that the UK may not assess system safety early enough for balanced selection of the way forward. Different safety organisations, eg Chief Inspector of Naval Ordnance and WSCC, were compiling data for particular problems such as frequencies of road accidents or crane failures. Most data came from civil sources and some was of dubious relevance to specialised military equipment. There would be benefit in a central pool of data, preferably linked with the report and review of nuclear weapon incidents.

E.6.5 In Paragraph E.3.10 we have drawn attention to Drell's recommendation to pursue an aggressive R&D programme in search of new technologies for safety; this was linked with a relaxation of prescriptive criteria, such as inherent nuclear safety, to encourage design initiatives and judge their safety on achievement rather than method. Forward looking physics design research at AWE lends strength to this recommendation. In the UK there are only two systems to consider and thus research can be focussed on immediate problems.

E.6.6 Drell drew attention to the results of calculations using 3-D codes (that are admittedly not yet fully proven), [redacted] As discussed earlier such codes are not necessary to establish the one-point safety of WE177 which is of a relatively simple design. The calculation of Trident warhead safety for single point accidental initiation on the axis of the warhead can be done adequately with 2-D codes and, for this case, the Trident warhead has been shown to be inherently safe.

[redacted]

[redacted]

Annex F: Incidents

F.1 Introduction

F.1.1 The Group wished to know the frequency of incidents involving nuclear weapon systems and the criteria for their reporting. It became apparent that there was no central repository of such information and the details below represent information collated during the period of the review from different sources. Since information proved difficult to obtain, the list may be incomplete.

F.1.2 Two categories of incident were collated:

- those directly involving the weapons;
- those involving the carrying platforms (submarines).

F.1.3 These latter are given only for the last five years, but include all submarines with nuclear propulsion (both SSBN "missile carriers" and SSN "hunter-killers") in order to increase the sample size.

F.2 Nuclear Weapon Incidents Involving UK Nuclear Weapons

F.2.1 The criteria for the inclusion of an incident in the list that follows is that it involved UK nuclear weapons or warheads, or their carriage or transportation or storage arrangements, whether in the UK or overseas, in which any of the following conditions were met:

1) The event caused physical damage to the warhead, weapon, or container, or exposed, or created significant risk of exposing, any of these directly to fire, shock or immersion.

2) The event killed or injured personnel (military or civilian).

3) The event caused a detected increase in radiation above background levels.

4) Any nuclear accident response force was called out.

5) Any public countermeasure (including setting up a cordon) was instigated.

1960 In Lincolnshire an RAF load carrier (low loader) had a brake failure on an incline and overturned. A warhead was being transported but the extent of any damage is not recorded.

1963 At Coningsby, during an exercise outload in the early hours of the morning from a special storage area (SSA) outside the station boundary, the rear trolley (one of a number under tow) unhitched and rolled into a ditch 50 yards from the SSA. This was not observed at the time and the weapon was not discovered until day-break. The extent of damage is not known.

[redacted]

Annex F: Incidents (continued)

1963 *En route* from Coningsby to Finningly, a load carrier's brakes locked and caught fire. Traffic on the A1 was held up by a temporary cordon. No damage to the warhead is known of. The extent of any publicity is not known, but the incident was clearly observed by the public.

1973 In the vicinity of RNAD Coulport, a Landrover reversed into a truck carrying a nuclear weapon. There was no damage to the weapon.

1974 In HMS Tiger a torpedo dropped on to a nuclear weapon, causing "slight scratching". There was no other damage to the nuclear weapon.

1974 In HMS Revenge the diaphragm in a missile tube compressed on to a weapon. There was no damage to the weapon.

1974 At RAF Laarbruch as part of normal procedures for a routine logistic flight, a weapon in its container was moved by a crane between trolleys. The crane gear failed and the container hit the ground. The extent of any damage is not known, but it is believed that an AWE team was in attendance.

1974 At Akrotiri (Cyprus) a tritium leak was suspected. UK based personnel were deployed in response. No one was reported contaminated or injured.

1977 A hoist broke while a weapon was being winched aboard HMS Renown. There was no damage to the weapon.

1982 South Atlantic Incidents. There were a number of individual events in which seven containers were damaged, ranging from minor damage to one container having its door housing severely distorted. Weapon casings received only minor superficial damage. The warheads were "safe and serviceable".

1983 At RAF Bruggen a weapon was being moved in its container when it slipped from its trolley as a result of bad driving. An internal tool box - which has since been removed from all containers in the stockpile - caused superficial damage to the weapon case.

1985 At Helensburgh two weapon transporters in an RAF convoy collided with each other at low speed in the town centre. No other vehicles were involved. The damage to the transporters was minor. There was no damage to weapons and no hazard to the public. The incident was widely reported, but the "neither confirm nor deny" (NCND) policy was maintained.

1987 At West Dean, Wiltshire, one weapon carrier in an RAF convoy left the road and overturned. Another skidded and came to rest partly off the road. The nuclear weapons in their containers were undamaged. The incident was widely reported, but the NCND policy was maintained.

1987 At RNAD Coulport a fault developed on a crane while a missile was being loaded on board HMS Repulse. The missile dropped slightly but was not damaged.

1988 In Hong Kong Harbour the USS Omaha (SSN) and USNS Sioux (ocean going tug) dragged anchor for some 1km and collided with RFA Fort Grange, despite the latter's attempts to warn the US vessels. The RFA was carrying nuclear weapons as part of an RN task force on round-the-world deployment. This fact was subsequently hinted at, but not confirmed to the US authorities. There was superficial damage to all three vessels but no radiological hazard. There was local press coverage only.

1988 On the Ilminster bypass an RAF convoy was travelling empty to RNAD Bull Point, Plymouth. On a single carriageway part of the bypass, a civilian coach was hit by a sports car, which then collided with one of the convoy Mammoth Major transporters, under which it became wedged. The civilian driver of the car was dead on arrival at hospital. The incident was widely reported, but the NCND policy was maintained.

1991 On the M25 the rear suspension of a transporter in an RAF convoy collapsed. The motorway was closed for over one hour while the load was transferred to another transporter. The incident was widely reported, but the NCND policy was maintained.

F.2.2 Of the seventeen incidents reported above, eight involved road transporters. Of the eight, four were related to mechanical failure and four to road accidents. Five incidents occurred through lifting-gear failure. Weapons may not be protected by containers when they have to be lifted, and for this reason lifting accidents are potentially serious. This had clearly been taken fully into account by those planning procedures for handling Trident. There is no pattern to the other four reports. We make no comment on the South Atlantic incidents which are not fully documented.

F.3 SSBN and SSN Collisions and Near Misses: 1986-1990

F.3.1 Queen's Regulations for the Royal Navy specify that HM ships must report all near-misses, collisions, groundings or other navigational accidents to the Commander-in-Chief Fleet. The report should be by signal in the first instance with a written report forwarded as soon as possible afterwards.

F.3.2 It is for the administrative authority to decide whether further action is necessary. In most cases involving SSNs and SSBNs, the administrative authority will be the Flag Officer Submarines although for SSBNs on patrol, it will be the Commander-in-Chief Fleet. Further action may be in the form of a ship's investigation or, in the case of serious incidents, a full Board of Inquiry. The former is conducted by the ship's own personnel whereas a Board of Inquiry consists of personnel detached from elsewhere

specifically for the investigation. The purpose of both is to examine the causes of the incident and to recommend measures to prevent a recurrence. Reports are forwarded to the administrative authority up the chain of command.

F.3.3 [redacted]

F.3.4 [redacted]

[redacted]

Annex G: Transport Security

G.1 This annex briefly discusses two aspects of the security of nuclear weapons transportation, the vulnerability to communications intercept and the terrorist threat. But for their sensitivity, they would have been included in the main report.

G.2 We noted that there was a need for the transport convoy vehicles to communicate with each other, with local police forces and with their base. Currently all these communications are conducted in plain language, albeit using appropriate low level codes, and are liable to interception. We welcomed the intention to seek the introduction of secure communications equipment but noted that this would not be able to cover communications with the police. As a result of separate advice we were broadly satisfied that these arrangements did not significantly increase the risk to the convoy, but noted that there would be important benefits for the protection of sensitive information, such as that associated with incidents, from the introduction of secure communications equipment. *We therefore recommend that the introduction of secure communications equipment be considered.*

G.3 The Services base their security measures on the NATO standard threat detailed in a document controlled by the Assistant Chief of Defence Staff (Policy and Nuclear). It was not clear to the Group that this encompassed all threats to nuclear weapons transported by road in the UK. Although convoys may use any one of a number of alternative routes the end-points are fixed and are known. It would not seem difficult for a terrorist organisation such as the IRA to place explosive in a culvert close to an end-point and then to await a target of opportunity. Preparations against such a threat are not made at present. Even if there were no nuclear hazard associated with such an event, the publicity alone could cause enormous difficulty for the nuclear programme. *We recommend that the present policy in relation to threat definition be reviewed.*

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