317

DEFENCE COMMITTEE

Twelfth Report

RADIOLOGICAL PROTECTION OF SERVICE AND CIVILIAN PERSONNEL

Report,
together with the
Proceedings of the Committee
relating to the Report,
Minutes of Evidence and
Memoranda

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The Defence Committee is appointed under SO No 130 to examine the expenditure, administration and policy of the Ministry of Defence and associated public bodies, and similar matters within the responsibilities of the Secretary of State for Northern Ireland

The Committee consists of a maximum of eleven Members, of whom the quorum is three. Unless the House otherwise orders, all Members nominated to the Committee continue to be members of it for the remainder of the Parliament.

The Committee has power:

(a) to send for persons, papers and records, to sit notwithstanding any adjournment of the House, to adjourn from place to place, and to report from time to time;

(b) to appoint persons with technical knowledge either to supply information which is not readily available or to elucidate matters of complexity within the Committee's order of reference;

(c) to communicate to any other Committee appointed under Standing Order No 130 its evidence and any other documents relating to matters of common interest; and

(d) to meet concurrently with any other such Committee for the purpose of deliberating, taking evidence, or considering draft reports.

WEDNESDAY 2 DECEMBER 1987

The following were nominated Members of the Committee

Mr John Cartwright	Mr John McWilliam
Mr Churchill	Mr Michael Mates
Mr Dick Douglas	Mr Jonathan Sayeed
Mr John Evans	Mr Neil Thorne
Mr Bruce George	Mr John Wilkinson
Sir Barney Hayhoe	

Mr Michael Mates was elected Chairman on 9 December 1987.

On 28 April 1988 Mr John Evans was discharged and Mr John McFall added to the Committee.

On 16 May 1990 Mr Dick Douglas was discharged and Mr John Home Robertson added to the Committee.

On 26 October 1990 Mr John Wilkinson was discharged and Mr John Lee added to the Committee.

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TABLE OF CONTENTS

TWELFTH REPORT

The Defence Committee has agreed to the following Report:—

RADIOLOGICAL PROTECTION OF SERVICE AND CIVILIAN PERSONNEL

I: INTRODUCTION

1. Since the United Kingdom's defence nuclear industry was founded in the late 1940s, Service and civilian personnel have been exposed to ionising radiation. During the last forty years, as knowledge about the effects of radiation exposure has grown, concern to ensure adequate protection against exposure has also increased. As part of our continuing scrutiny of the Ministry of Defence (MoD), we have undertaken a short inquiry to examine MoD's current and future policy and practice on radiological protection. We received written evidence from MoD, the trade unions representing civilian personnel in defence establishments, the management companies of the Royal Dockyards at Rosyth and Devonport, the National Radiological Protection Board (NRPB) and the Committee on Medical Aspects of Radiation in the Environment (COMARE). We took oral evidence from MoD officials on 13 June 1990. To enhance our understanding of radiological protection measures and of some of the work which involves exposure to radiation, we visited Rosyth Royal Dockyard in July 1990. We are most grateful to all those who submitted evidence, and to those who made our visit to Rosyth so worthwhile.

2. The principal work involving exposure of Service and civilian personnel to significant levels of radiation falls into two discrete areas: the nuclear weapons programme and the nuclear propulsion programme. The nuclear weapons programme involves research, the production of nuclear warheads and their deployment with HM Forces. The main sites affected are the Atomic Weapons Establishments (AWE) at Aldermaston and Burghfield, and the Royal Naval Armaments Depot (RNAD) at Coulport. The nuclear propulsion programme involves research, production, operation, refitting and decommissioning of pressurised water reactors as a source of propulsion power in Royal Navy submarines. The main sites affected are the Royal Dockyards at Devonport and Rosyth, the Clyde Submarine Base (HMS NEPTUNE), the Devonport Fleet Maintenance Base (HMS DEFIANCE) and the Naval Reactor Test Establishment (NRTE) VULCAN at Dounreay.[1] These two nuclear programmes are not the only sources of ionising radiation within MoD's responsibility: it also arises from research, non-destructive testing and medical applications, most notably conventional radiography.[2] In this Report we have concentrated upon ionising radiation arising from the two defence nuclear programmes.

II: THE CONTEXT OF MoD POLICY

(a) International and National Requirements

3 MoD policy on radiological protection is not formulated in a vacuum. Its parameters are determined by international and national legislation and guidance. The principal international body concerned with radiological protection is

[1] Evidence, pp 23-25
[2] Evidence, p 23, Q42.

the International Commission on Radiological Protection (ICRP), which issued its main recommendations in 1977. The ICRP has recommended limits on the doses of exposure to which individuals are exposed—50 milliSieverts (mSv) per year is the current limit—and expounded the principle that all doses should be As Low As Reasonably Achievable (ALARA), economic and social factors being taken into account.[3] The Council of the European Communities issued Directives in 1980 and 1984 in line with ICRP recommendations.[4]

4. These international requirements have been given legislative force within the United Kingdom in the Ionising Radiations Regulations 1985 (IRR85), made under the Health and Safety at Work Act 1974. These set a limit on individual annual exposure levels of 50 mSv and also implement the ALARP requirement. Those responsible for radiological protection must strive to reduce doses to the lowest level practicable; it is not adequate merely to demonstrate compliance with dose limits.[5] The National Radiological Protection Board (NRPB) carries out research on protection from radiation hazards and provides advice to those, including Government departments, with responsibilities in relation to protection from radiation hazards.[6]

(b) Possible Changes

5. As a result of increased knowledge about the effects of radiation exposure, dose limits are likely to be tightened throughout the nuclear industry in the near future. It has been known for some years that radiation exposure involves a risk of cancer, and leukaemia in particular. Further data in respect of the Hiroshima and Nagasaki bomb survivors have caused risk estimates to be reviewed. These revisions suggest an increased risk of cancer arising from exposure to ionising radiation which might be two or three times greater than previously thought.[7] As a result, both the ICRP and the Health and Safety Commission are considering possible new recommendations. The draft ICRP report currently in circulation proposes a limit on individual exposure doses of 100 mSv within 5 years, with no more than 50 mSv in any one year. The ICRP has not yet finalised its advice; it hopes to publish its recommendations early in 1991.[8] The European Commission is awaiting the publication of these recommendations before proposing amendments to the EC directive from which IRR85 is derived.[9] Similarly, within the United Kingdom, the NRPB has already suggested that, as long as the dose limit remains at 50 mSv per year, the average dose to the most exposed workers should be controlled so as not to exceed an effective dose equivalent of 15 mSv per year. The Health and Safety Commission has issued a draft code of practice which recommends an investigation when an individual employee's cumulative dose reaches 150 mSv within ten years. It is expected that a final version of this code of practice will be issued early next year.[10]

6. These developments are independent of, and antedate, the publication of the so-called Gardner report in February 1990.[11] The study by Professor Martin Gardner and other members of the Environmental Epidemiology Unit at the University of Southampton suggested a statistical association between occupational exposure to radiation among fathers prior to conception and raised incidence of leukaemia and non-Hodgkin's lymphoma among their children. The association was marked among fathers subject to a cumulative life-time exposure of 100 mSv prior to conception or 10 mSv in the six months prior to conception. The findings of this study have not been validated. There are good

[3] Evidence, p 46 ALARA is an acronym usually used internationally but within the United Kingdom ALARP (As Low as Reasonably Practicable) has been used historically They are regarded as synonymous.
[4] Evidence p 46
[5] SI 1985/1333, Evidence, pp 21, 47
[6] Evidence, p 46.
[7] Evidence, p 47; Qq 59-60, 62, Health and Safety Commission, Draft Approved Code of Practice, Part 4· Dose Limitation - restriction of exposure, 1990, p 2
[8] Evidence, pp 22, 46, 49, HC Deb, 19 July 1990, col 1282
[9] Draft Approved Code of Practice, 1990, p 3.
[10] Evidence, pp 47, 49, 22, Draft Approved Code of Practice, 1990, p 4, Q48
[11] Martin J Gardner, Michael P Snee, Andrew J Hall, Caroline A Powell, Susan Downes, John D Terrell, "Results of case control study of leukaemia and lymphoma among young people near Sellafield nuclear plant in West Cumbria", British Medical Journal, Vol 300, 17 February 1990, pp 423-429

reasons to view the results with caution. First, the findings are not foreshadowed in previous research. In particular, data available on the 7,400 children of Japanese men who survived the atomic bomb explosions show no hint of an increased risk of leukaemia in the offspring, even though the average exposure to external ionising radiation of the Japanese men was four times higher than that of the Sellafield workers.[12] Secondly, they are based on a small sample; the association observed depends on just four cases. Thirdly, the study only suggests a *statistical* association between occupational exposure to radiation and leukaemia among offspring; it does not provide a *causal* explanation. Some commentators doubt that this causal link can be established. Other factors may explain the correlation; an increase in the relative risk of leukaemia was also apparent in the Gardner study among fathers employed in farming and the iron and steel industry.[13]

7. In a Parliamentary written answer, the Government noted with concern the results of the study, and recognised the anxieties that it must cause to those who might be at risk. It asked COMARE to consider the report urgently and give advice.[14] In its advice, COMARE agreed with the broad thrust of the study's main conclusions. It called for the early completion of similar case control studies around Dounreay and Aldermaston and Burghfield and for further co-ordinated studies. Given the uncertainty about Gardner's findings, it made no specific recommendations on reduction of exposures but it strongly supported steps taken to continue to reduce occupational exposures, particularly for those likely to have children, and to counsel workers on the possible risks.[15]

8. The Gardner report has led to concern throughout the nuclear industry. In the course of our inquiry into the Trident Programme a trade union representative described it as "a hammer blow to the entire industry".[16] It may also have added to general public concern about nuclear safety. **MoD is obliged to ensure that its policy and practice on radiological protection conforms to current legislative requirements. It must also be able to respond to anticipated future demands for higher levels of radiological protection arising from the deliberations of the ICRP and the relevant British authorities or the possible verification of Gardner's findings.**

III: CURRENT MoD POLICY AND PRACTICE

(a) MoD Policy

9. Current MoD policy on radiological protection, in line with statutory requirements and expert advice, is based on three principles:

- All radiation exposure doses should be justified.
- Radiological protection should be optimised: exposure should be as low as reasonably practicable (ALARP).
- Dose limits must be applied to all workers whether or not they are classified as radiation workers.

The need to justify all doses and, where possible, reduce them has been a basic feature of MoD policy since the late 1940s.[17] In that time the statutory annual dose limits have fallen, from 150 mSv in 1950 to 50 mSv now.[18] Since January 1989 MoD has imposed its own limit of 30 mSv per year in response to the

[12] Evidence, p 23; Valerie Beral, "Leukaemia and nuclear installations", British Medical Journal, Vol 300, 17 February 1990, pp 411-412

[13] H John Evans, "Leukaemia and radiation", *Nature* Vol 345, 3 May 1990, pp 1617, Q177, Gardner et al, p 425; see also Nature, Vol 347, 11 October 1990, p 521

[14] HC Deb, 15 February 1990, col 397w

[15] HC Deb, 2 April 1990, cols 430-434w

[16] Ninth Report from the Defence Committee, *The Progress of the Trident Programme*, HC 237 of Session 1989-90, Minutes of Evidence, Q49 and paragraph 69

[17] Evidence, p 21

[18] For details of past limits see footnote to Q58

NRPB's advice and following closely the action taken by the rest of the United Kingdom nuclear industry[19] This lower limit is welcome MoD policy on dose limits is however still essentially reactive. While MoD cannot be expected to second-guess the advice of the NRPB and other bodies, we believe that it has sufficient expertise to satisfy itself that the levels it has imposed are unquestionably safe, as well as in accordance with the best available advice. **MoD's confidence in the safety of the limits to which it works should be conveyed to its employees.**

(b) Regulation and Advice

10. MoD is subject to many of the provisions of IRR85, but is granted exemptions from others. MoD and its contractors, in certain circumstances, are not obliged to notify the Health and Safety Executive (HSE) of work involving ionising radiations, to avoid the revelation of the precise location of security sensitive facilities. HM Forces are exempt from the requirement to notify HSE of certain exposure levels and from provisions permitting an employee who is aggrieved by a decision recorded in his health record to apply to HSE to have the decision reviewed by the Health and Safety Commission. MoD is exempt from the requirement to notify HSE of a suspected over-exposure beyond annual limits and the results of a consequent investigation and assessment in relation to HM Forces. MoD is partially exempt from the obligation to notify HSE of accidental releases. Additionally, the Secretary of State for Defence has power to exempt some workers from all or any of the requirements or prohibitions imposed in the Regulations in the interests of security, a power which has not been invoked.[20]

11. The licensing provisions of the Nuclear Installations Act 1965 do not apply to MoD. Its sites are therefore not inspected by the Nuclear Installations Inspectorate (NII), part of HSE which has a statutory responsibility to ensure a safe operating regime for civil nuclear installations. However, section 9 of the Act requires Government departments to notify HSE/NII of nuclear occurrences in respect of facilities which are nuclear installations as defined in the Act. It has never been necessary to invoke these provisions. MoD is subject to inspection and enforcement by HSE. By agreement, HSE does not choose to inspect what are defined as operational activities, but reserves the right to intervene if valid cause is shown. At AWE this inspection is carried out by a member of the Technical Division of the NII, but not in his capacity as a member of the NII. The contractorised dockyards at Devonport and Rosyth are licensed and inspected by the NII.[21] An NII inspector also acts as "lead inspector" at VULCAN NRTE under health and safety regulations.[22]

12. The trade unions questioned the effectiveness of this regulatory framework. They suggested that inspectors from the NII should have a right of unannounced entry to defence sites—pointing out that in each HSE area office at least one factory inspector is security cleared—and that safety representatives or trade union representatives should have direct access to HSE inspectors.[23] MoD said in response that their sites were not subject to licensing and inspection in that form. They pointed out that there were special provisions to control access to sensitive areas, and said they would not want a spot inspection regime in those areas.[24] While we accept the need to maintain security, we consider that the accountability of the inspection procedures should be enhanced, and **we recommend that reports by HSE inspectors on MoD sites, and those by NII inspectors at *contractor-managed sites, should* be submitted to Ministers.**

13 The central co-ordinating responsibility within MoD for health and safety at work matters lies with the Second Permanent Under Secretary of State. Within the Service Departments and the Procurement Executive lead responsibility rests with the appropriate Board member. MoD has recently strengthened

[19] Evidence, pp 21-22, Q48
[20] Evidence, p 38, Qq 2-7, 9
[21] Evidence, p 41, Qq 2-9
[22] Evidence, p 41
[23] Evidence, pp 53, 55
[24] Q47

its central machinery by establishing a high level committee structure for co-ordinating and monitoring Health and Safety at Work matters, including radiological protection.[25] The defence trade unions referred to difficulty "in finding out who had MoD-wide authority to speak on radiation exposure" and called for the creation of "a clear central authority at departmental level on these matters".[26] MoD witnesses denied that there was a gap at the centre. They said the Radiological Protection Technical Advisory Committee (RAPTAC), which was established in 1976, bridges the two nuclear programmes and provides the central focus for policy and administration. RAPTAC meets about twice a year.[27] MoD staff maintain regular contact with the NRPB, although the latter has no formal links or responsibilities for radiation protection on a day-to-day basis for any MoD site.[28] **We recommend that MoD should establish a formal liaison procedure between RAPTAC and the trade unions representing civilian personnel in defence establishments.**

14. Responsibility for implementation and control of radiological protection on site lies with the Commanding Officer of a Unit or the Head of an Establishment operating with ionising radiations.[29] Day-to-day practice is overseen by Radiation Protection Advisers (RPAs), who are statutorily appointed by the HSE as being qualified and experienced. RPAs are responsible for providing advice to the Commanding Officer or Head of an Establishment and assessing all radiological practices and for reviewing doses and procedures for compliance with the ALARP principles of dose restriction. It is recommended that large nuclear operators should have in-house RPAs.[30]

15. The Safety Division of AWE acts as RPA there, monitoring the effectiveness of the radiological protection measures taken in the design of plant and the operating procedures.[31] The trade unions drew attention to past staffing shortfalls among health physicists at AWE arising from inadequate pay levels. They claimed this had led to enormous burdens on those remaining, although they acknowledged that recent pay improvements had eased difficulties.[32] There are 6 vacancies out of 105 posts in the Radiological Protection advisory group and 7 vacancies out of 28 posts for operational health physicists. Mr Saxby of AWE admitted that "the recruitment of operational health physicists at the time they are needed is particularly difficult".[33] The Division was able to meet its current obligations, but the shortages had led to "more overtime, more contracting-out of certain of the tasks to be done by others to advise us and help". The cost of contracting out some of the radiological protection and safety professional advisory work amounted to about £250,000 in the financial year 1989–90.[34] He foresaw a continuing difficulty in recruiting staff due to a national shortage of health physicists and said "it is going to be very difficult for a long time".[35] However, MoD told us subsequently that it was expected that five new graduates would be appointed as operational health physicists this autumn, partly as a result of a graduate entry training scheme.[36] We welcome this improvement. **It is essential that the current commitment of staff and resources to radiological protection at AWE is maintained following contractorisation.[37] We therefore recommend that a duty to keep health physics staffing up to strength should be included in the relevant contract.**

16. The Defence Radiological Protection Service (DRPS) is appointed as the corporate RPA for HM Forces, except for those areas and functions which have their own appointed RPAs.[38] It has a wider responsibility to provide advice on

[25] Evidence, p 21
[26] Evidence, p 53
[27] Qq 1, 45, Evidence, p 40
[28] Evidence, p 47, Q45.
[29] Evidence, p 21
[30] Evidence, p 22, Q41.
[31] Evidence, p 22
[32] Evidence, p 54.
[33] Qq 10-14, 25
[34] Qq 15-20, Evidence, p 38
[35] Qq 27-28
[36] Footnotes to Qq 28 and 34, Evidence, p 38
[37] See Ninth Report from the Defence Committee of Session 1989-90, *The Progress of the Trident Programme*, HC 237 of Session 1989-90, Paras 69-71
[38] Evidence, p 41

radiological matters across the whole of MoD's activities except AWE. It also provides an approved dosimetry service. DRPS currently has a complement of 54; 22 of the staff are health physicists. There are currently three vacancies, of which one is for a health physicist. Surgeon Captain Harrison, the Head of DRPS, acknowledged that there had been difficulties with recruitment and retention of health physicists. He attributed the current success in staffing among health physicists to the introduction in the last four to five years of a graduate entry training scheme at Greenwich, which was "bringing really good first-class graduates into the service".[39]

17. Within the nuclear propulsion programme, each naval base has an environmental support department including professional health physics staff. The senior person in each of these departments acts as the RPA to the commanding officer or head of establishment. Since contractorisation, the companies in the Royal Dockyards of Devonport and Rosyth have their own RPA and radiological protection service.[40] During our visit to Rosyth we met the dockyard RPA and members of the Health Physics Branch and were briefed on some of the advantages of radiation protection advisers who work closely with management. Where relevant, specific MoD instructions are complied with by the contractor in accordance with the terms of the contract.[41] The Naval Nuclear Technical Safety Panel and DRPS conduct regular audits of the nuclear propulsion programme, including an examination of radiation practices. This is to confirm that "standards maintained, not only by MoD establishments but by the two Royal Dockyards, are satisfactory and in accordance with national practice".[42]

(c) Measuring Exposure

18. A prerequisite for effective protection against ionising radiation is the accurate measurement and recording of exposure doses. A standard dosemeter is employed to measure external whole body radiation exposure. This is a 2-inch long badge, normally worn on the lapel. Formerly, MoD employed a film badge, but this has now been superseded by a thermoluminescent dosemeter (TLD), containing lithium borate.[43] TLDs are regularly calibrated and checked in accordance with IRR85.[44] Additional TLDs can be worn on other parts of the body, such as the fingers, to compare doses to the extremities against the whole body dose.[45] The NRPB is discussing with MoD the development of a personal integrating electronic dosemeter. This is not intended to replace the TLD, but it would enable high doses to be seen quickly and to be acted upon.[46] In addition to the TLD, at Rosyth Royal Dockyard a gammacom electronic dosemeter has been introduced. This provides a continuous display of both the dose and the dose rate. It is programmed to sound an alarm at preset dose and dose rate levels.

19. TLDs measure external, mainly gamma, radiation. At AWE, separate dosemeters are worn where the neutron dose may exceed 2.5 mSv per year. In the nuclear propulsion programme, they are worn "where it is appropriate".[47] The trade unions expressed concern about a failure of dosemeters accurately to measure neutron radiation which had recently come to light at RNAD Coulport.[48] Surgeon Captain Harrison explained that the dosemeter employed there was sensitive to neutrons, but under-read them slightly. The impact of the under-reading on the overall dose measured was very slight, a fact which has been emphasised to staff at RNAD Coulport. This problem was felt to be unique to RNAD Coulport and a solution has been adopted for that establishment. A main dosemeter is used which is not sensitive to neutrons and a separate neutron

[39] Evidence, p 22, Qq 33-34
[40] Evidence, p 25, Qq 32, 38
[41] HC Deb, 18 April 1990, col 943w
[42] Q44
[43] Evidence, pp 24, 25; Q93
[44] HC Deb, *18 April 1990, col 940w*
[45] Evidence, p 24, Qq 93, 102
[46] Evidence, p 24, Q103
[47] Evidence, pp 24, 25
[48] Evidence, pp 54-55

dosemeter is also worn.[49] **MoD must seek to ensure that employees at RNAD Coulport fully understand the reasons for the problem and are completely satisfied that it will not recur.**

20 At AWE, the monitoring and measurement of internal radiation has been enhanced since the recommendations made in the 1978 Pochin report. Installed air samplers in ventilation systems and working areas are operated continuously to demonstrate that radioactive material does not escape and thus that the air breathed is clean. Personal air samplers are issued to workers on a routine basis. These consist of a small battery-operated pump drawing air from near the worker's face and passing it through a filter. Routine urine analysis is conducted to support the assessment of internal dose for all plutonium, uranium and tritium workers Faecal sampling is also used, although not routinely, mainly in the short term following a suspected intake incident.[50] Within the nuclear propulsion programme, the facility to carry out biological monitoring exists Surgeon Captain Harrison said that it was mainly to provide reassurance It does not extend to blood tests, which he did not consider necessary [51]

(d) Records

21. There is a statutory requirement to maintain records of the radiation exposure doses of each worker Records for workers at AWE are held by AWE itself All other MoD records are held by DRPS There are two additional sources of records: the Central Index of Dose Information (CIDI) operated by NRPB on behalf of HSE who require the records under IRR85 and the National Registry of Radiation Workers (NRRW), also operated by NRPB, which is held for epidemiological analyses.[52]

22. For AWE, records of external exposure for all records since 1949 are held on computer and can be used for statistical purposes; they were provided in evidence by MoD. There are also data for civilian personnel who participated in the overseas Atmospheric Nuclear Test and Experimental Programme from 1952 to 1967.[53] These records dating back to the late 1940s are only of external exposure; internal exposure has only been measured since 1986. In 1992 AWE will acquire a new computer which will enable internal exposure data to be added to the computer-held records of external exposure [54]

23 DRPS holds centrally records for 35,000 people, including all past and present naval nuclear propulsion personnel, all Army and Royal Air Force personnel and other Royal Navy personnel who may be exposed to radiation and a number of civilian personnel in small MoD establishments.[55] Unlike those of AWE, we were told that the pre-1979 DRPS records were not in a form that readily permits statistical analysis.[56] These records are held on paper and not on computer. For each radiation worker there is a booklet which records all medical examinations and quarterly and annual dose record summaries Pre-1979 records cannot readily be broken down into dose bands Nevertheless, none of the records have been lost and they are available upon request to current or former workers MoD stressed that

> "there is no health risk to the individual arising from our inability to collate and statistically present the statistics pre-1979 As far as the health of the individual is concerned, his records are complete and there is access to them" [57]

DRPS expects to upgrade its computer system in the next few years to take into account the likely need to maintain moving average exposure figures rather than

[49] Evidence, p 24, Qq 93-98
[50] Evidence, pp 23, 24
[51] Qq 99-101
[52] Evidence, p 48
[53] Qq 72-73, 75, 91, Evidence, pp 41, 44
[54] Evidence, p 24, Q86
[55] Evidence, pp 25, 26, Q75
[56] Evidence, p 25
[57] Q87

annual figures. MoD did not consider it worthwhile to transfer the pre-1979 records to the new computer since over 1 million separate items of dose information would have to be input with no health dividend. DRPS has not analysed a statistical sample of pre-1979 records.[58] **We look to MoD to develop increasingly sophisticated statistics on exposure levels.**

(e) Current Protection and Levels of Radiation

(i) AWE

24. MoD outlined a number of radiological protection measures which are currently in place at AWE. The main sources of radiation exposure in the nuclear weapons programme are the two radioactive fissile materials, plutonium and highly enriched uranium, and the non-fissile depleted uranium. Because steps are taken to prevent or minimise direct contact, external irradiation by penetrating gamma rays and, to a lesser extent by neutrons, produces most of the dose experienced. The prime means used to restrict these exposures is to shield the sources of radiation as close to them as possible. Containment is designed to prevent the intake of radioactive material. Personal protective equipment, in the form of clothing and respiratory protection, is also provided.[59]

25. As a result of these measures, steady reductions have been achieved in both the average annual doses and the cumulative doses to the workforce. The average annual exposure has fallen from around 1.5 mSv in the 1960s to below 1 mSv in the 1980s and to only 0.23 mSv in 1989. During the 1970s several employees received annual exposures in excess of 20 mSv each year. Since 1983 no employee has done so. Despite increases in the number of personnel monitored the collective dose has remained roughly constant, and indeed has fallen substantially in the last two years from 2.81 man-Sv in 1987 to 0.88 man-Sv in 1989. Very few workers have cumulative exposures in excess of 100 mSv—the figure above which Gardner's study suggested a statistically significant association with leukaemia among offspring.[60] To set these figures in context, it should be borne in mind that members of the public receive radiation of about 2 mSv per year from the natural environment.[61]

(ii) Nuclear Propulsion Programme

26. The United Kingdom's fleet of 21 nuclear-propelled submarines is powered by pressurised water-cooled reactors. The main source of radiation exposure is external irradiation by penetrating radiations emanating from the fission process or from fission or activation products such as radioactive Cobalt 60 formed within the steel of the reactor structure during its operating life. This leads to exposure to submariners and those working in submarines at bases and dockyards.

27. Although some submariners are subject to radiation exposure, it is generally at a lower level than for land based personnel because the reactor is heavily shielded when operating. Nevertheless, the major decontamination processes which we discuss below cannot be used in submarines while operational.[62] There has been a steady decline in the annual average dose of monitored submariners in the past decade, from 3.26 mSv in 1979 to 1.30 mSv in 1989. Only 2 per cent of submariners monitored have received cumulative lifetime doses over 50 mSv and only seven submariners have received doses above 150 mSv.[63] MoD points out that submariners at sea are shielded from natural cosmic and terrestrial radiation received by members of the public.[64]

28 Most exposure to personnel comes during inspection, maintenance (including refitting and refuelling operations) and repair inside the reactor compartment or on components which form the primary cooling circuit, which

[58] Qq 75-80, 82-92.
[59] Evidence, p 23
[60] Evidence, pp 23-24, 29, 30, 48, 50, 44
[61] HC 237 of Session 1989-90, p 68
[62] Evidence, pp 24, 26.
[63] Evidence, p 29; HC Deb 15 March 1990, col 332 w
[64] HC Deb, 20 March 1989, col 478w

contains radioactive activation products. As with the nuclear weapons programme, shielding provides one means of protection. However, the tight confines of a submarine reactor compartment make it difficult to introduce shielding, a point we readily appreciate from our tour of the reactor compartment of HMS CHURCHILL.[65] Greater use is now made of temporary shielding and, where shielding is not possible, signs are used to draw attention to radiation "hotspots" so that they can be avoided whenever possible.[66] Protective equipment is available.[67] Modifications have been made to the reactor plant to reduce radioactivity, and working methods have been changed so as to reduce exposure. Mock-ups with non-active components are used in training to minimise the time in reactor compartments. Some work has been automated, with similar effect. Equipment has been improved: for example, the use of preformed lagging has led to substantial reductions in the dose accrued in removing and replacing it.[68]

29. The most important breakthrough has been the introduction of a primary plant decontamination process. The Multi-Stage Oxidative Decontamination with Ion Exchange clean up (MODIX) process was first introduced at VULCAN NRTE to decontaminate the first reactor prototype. Following its successful trial at Dounreay it has been introduced at Rosyth and Devonport dockyards at considerable expense and with similar success. This decontamination takes place before submarine refits begin and adds about three months to the length of the refit. Its benefits in terms of radiological protection are significant. It reduces the level of background radiation by between 3 and 8 times.[69]

30. An unavoidable consequence of the decontamination process is the production of intermediate level radioactive waste. Each submarine decontamination generates 4 or 5 tanks of resin. There is no nationally available method of off-site storage of such waste and there is unlikely to be so this century. The waste therefore has to be stored on site at the two dockyards.[70] The demand for storage space for this waste will increase over the next few years and a new store has already been designed at Rosyth.[71]

31. An additional issue which arose during our visit to Rosyth was that of the decommissioning of nuclear submarines. So far one submarine has been decommissioned — HMS DREADNOUGHT — which is currently lying at Rosyth. We have discussed the difficulties of decommissioning and the options for disposal of the reactor compartment in an earlier Report.[72] Since then it has become evident that several further nuclear submarines will shortly be decommissioned, including at least one which was undergoing refit — HMS CHURCHILL.[73] These vessels cannot remain tied up at the dockyards indefinitely, so this issue must be addressed and resolved. We will pursue this issue in our forthcoming inquiry into naval aspects of the Options for Change proposals.

32 The measures which have been taken have led to a steady reduction in the total collective and average individual dose at the dockyards and naval installations since 1979, with a similar reduction in numbers of personnel receiving doses in excess of 15 mSv per year. This has been achieved during a period which has also seen a steady increase in the size of the Royal Navy nuclear powered submarine force.[74] These reductions would appear even more marked if compared with pre-1979 levels of exposure which were significantly higher than the post 1979 levels.[75] Only 2 per cent of workers monitored by DRPS exceeded 10 mSv in 1988 and only 0.1 per cent (10 workers) exceeded 20 mSv in that year.[76]

[65] Evidence, pp 24, 25, 26
[66] Evidence, pp 43-44
[67] Q140
[68] Evidence, pp 25, 43-44, Q136
[69] Evidence, pp 26, 43, 56, 60-61, Q142
[70] Q146
[71] HC Deb, 11 June 1990, col 32w
[72] Seventh Report from the Defence Committee, Session 1988-89 *Decommissioning of Nuclear Submarines*, HC 316
[73] HC Deb, 29 October 1990, col 414w
[74] Evidence, pp 26, 31
[75] Qq 179-180
[76] Evidence, p 48

33. The major advances which have taken place in radiological protection at nuclear defence sites in recent years and the consequent downward trend in exposure levels indicate the strong collective will to tackle this issue, which long preceded the publication of the Gardner report. Devonport Management Limited (DML) state that "strict dose management has been the practice long before Gardner".[77] From our visit to Rosyth we know that this is also true of the other Royal Dockyard. **MoD has played a commendable role in the advances made. Much has been achieved by way of improving radiological protection, and we urge MoD to maintain this momentum so that further challenges can be overcome.**

(f) Variations

34. The general trend of radiation exposure doses in the nuclear propulsion programme in the 1980s has been downwards. Nevertheless, there are a number of variations in the figures the reasons for which we sought to explore. MoD accept that "no major reduction in exposure is demonstrated" at the two operational bases, HMS DEFIANCE at Devonport and HMS NEPTUNE at Faslane. The average dose at NEPTUNE is approximately double that at DEFIANCE, a divergence attributed to the fact that the Scottish base is larger and older vessels tend to be concentrated there. Fluctuations in exposure levels are apparent: there was, for example, a rise in the number of staff exposed to annual doses over 20 mSv at NEPTUNE in 1985 and 1986. MoD described these fluctuations as the results of the "unpredictability of day to day operational support": more work was carried out because more submarines were berthed at that time.[78] Nevertheless, the average cumulative lifetime exposures at these operational bases are significantly lower than those at the dockyards. This is because the bases are manned by naval personnel subject to a relatively short service drafting system whereas the dockyards have a more stable workforce.[79]

35. Levels of exposure at the dockyards have also reflected changes in the workload. The collective dose, the average dose and the number of workers in the dose ranges from 15 mSv to 50 mSv all increased sharply at Devonport in 1984.[80] MoD told us that these increases arose from: first, the build-up of the submarine refitting capability there; secondly, the effect of the closure of Chatham Dockyard and the transfer of the majority of the refit work programme to Devonport; and, thirdly, the onset of three-stream refitting, in which three submarines could be refitted at one time, one of which was an older and more radioactive submarine.[81] Similarly, the downward trend in collective and average dose was halted and reversed at Rosyth in both 1983 and 1989.[82] MoD was not certain of the reason for the first peak. Nothing unusual occurred in that year and they thought it was explained simply by the refit cycle in that year. The peak in 1989 was due to the commencement of two-stream refitting at the dockyard.[83]

36. The cumulative lifetime radiation dose equivalents at Rosyth are noticeably higher than those at Devonport: 46.7 per cent of the registered radiation workers employed at Rosyth at the end of 1989 had received lifetime exposures over 50 mSv compared with only 25 per cent of those at Devonport.[84] One reason for this is that the Scottish dockyard has been engaged in submarine refit operations for longer—they began at Rosyth in 1968 and at Devonport in 1980.[85] The second reason is that Rosyth tends to refit older submarines.[86] These tend to be more radioactive and require more maintenance, leading to higher exposures.[87] **These factors point to a need to ensure that particular efforts are made to reduce exposure levels at Rosyth dockyard.**

[77] Evidence, p 61.
[78] Evidence, pp 26, 34; Qq 108-109.
[79] Evidence, pp 26, 34, 35; Q107.
[80] Evidence, p 31.
[81] Evidence, p 26, Qq 104, 110-114.
[82] Evidence, p 32
[83] Q104.
[84] Evidence, pp 31, 32.
[85] Evidence, p 26.
[86] Q105
[87] Evidence, p 26

37. There are also variations affecting individual workers which are not immediately apparent from aggregate figures. Some workers have accumulated substantial doses over a period of years. The highest dose recorded for any worker at the royal dockyards is 775.95 mSv. This was accrued over the period June 1953 to March 1982.[88] All work practices which might result in exposures above 15 mSv a year have to be formally investigated and continuing exposure beyond this level formally justified.[89] Captain Thomas, Chairman of the Naval Nuclear Technical Safety Panel, told us that several investigations of this kind had been carried out, principally in relation to naval personnel at the fleet operating bases working on operational submarines which could not be decontaminated. Skilled workers, such as fitters and welders, working on the reactor plant also accrue doses over 15 mSv. These investigations had on occasions led to changes in work practices.[90]

(g) Comparisons

38. One means of assessing the effectiveness and efficiency of the current radiological protection practices of MoD is to compare levels of exposure with those in foreign nuclear propulsion programmes and the United Kingdom's civil nuclear industry. During our inquiry into the Statement on the Defence Estimates we explored reasons why levels of radiation exposure at United Kingdom dockyards are apparently higher than those at United States naval dockyards.[91] In evidence for this inquiry, MoD witnesses stressed that the US figures for recent years were broadly very similar to those of the United Kingdom.[92] This statement can be tested against the figures set out in the following table:

Average Annual Exposure Dose at US and UK Dockyards 1979–1989*

Year	US Shipyard Personnel (mSv)	All Royal Dockyards (mSv)	Devonport (mSv)	Rosyth (mSv)
1979	1.33	4.91	0.81	6.45
1980	1.53	3.60	1.04	4.59
1981	1.30	3.15	0.99	4.73
1982	1.69	2.34	0.91	4.34
1983	1.66	2.84	1.83	5.70
1984	1.50	3.82	3.30	5.09
1985	1.31	2.47	2.50	2.45
1986	1.58	1.82	1.99	1.55
1987	1.44	1.46	1.70	1.14
1988	1.26	1.26	1.03	1.64
1989	1.20	1.69	1.16	2 43

**Sources.* *Occupational Radiation Exposure from US Naval Nuclear Plants and Their Support Facilities*, Naval Nuclear Propulsion Programme, February 1990, p 22; HC Deb, 18 April 1990, cols 944-945*w*; Evidence, pp 31, 32

From this table it is evident that, while the differential between the US and UK dockyards is now small, it has been substantial in the recent past. This impression is reinforced by figures on cumulative lifetime exposures. Fewer than 12 per cent of US shipyard personnel monitored in 1989 had cumulative exposures above

[88] HC Deb, 18 April 1990, cols 945-946w
[89] Evidence, p 22
[90] Qq 55-57, Evidence, p 38
[91] HC 388 of Session 1989-90, Qq 110-118
[92] Q122

50 mSv, while nearly 25 per cent of registered employees at Devonport and nearly 47 per cent at Rosyth at the end of 1989 had exposures over 50 mSv.[93] Moreover, MoD admitted that no one involved in the United States programme had received an annual dose greater than 20 mSv in recent years whereas a number of staff in the United Kingdom had received doses above 20 mSv.[94] MoD attributed the apparently lower levels in the USA to the following reasons:

> "The US has a much larger fleet and they began operations in 1955 — eight years before the UK. They have already decommissioned many of their older ships. The US nuclear-powered ships require refuelling less frequently than UK nuclear-powered ships and the larger scale of the US programme, with six naval shipyards and two private shipyards performing work on nuclear-powered ships, means that there is a larger pool of experience to apply to shipboard work".[95]

When judged in terms of radiation per ship, MoD argued, the difference in the levels of exposure was closer than a factor of two.[96] We also asked about comparative information on the French nuclear propulsion programme. The information available to MoD was inconclusive [97] **Examination of data from the US and French nuclear propulsion programmes has led MoD to conclude that their own *"performance overall is comparable with the best"*.[98] This conclusion is scarcely justified by historical comparison with the US or by the evidence produced by MoD on the French nuclear propulsion programme. We recommend that MoD take whatever steps are necessary to ensure that their radiological protection practices are at least as good as those prevailing in other countries.**

39. Evidence from NRPB suggests that exposure doses in MoD compare well with those in the United Kingdom's civil nuclear programme. Mean annual doses for MoD staff were just less than 1.3 mSv in 1987 and 1.0 mSv in 1988 compared with mean doses to the civil nuclear industry of 2 mSv and 1.7 mSv in each year respectively. About 5 per cent of MoD workers exceeded 5 mSv in each year, compared with about 10 per cent of the civil nuclear workforce.[99] For the years since 1979, the average dose levels at AWE are markedly lower than those in the civil nuclear industry. Exposure levels in the naval nuclear propulsion programme are also slightly lower than those in the civil nuclear industry, although both have shown a similar downward trend.[100] This may well arise from differences in the work performed.

IV: FUTURE MoD POLICY AND PRACTICE

(a) Responding to Change

40. MoD's current policy and practices on radiological protection influences their capacity to respond to changes which may be required. MoD has no influence on the work of ICRP which may lead to a reduction in dose limits. MoD witnesses also told us that it lacks the expertise to come to an independent judgement on the medical issues determining these limits.[101] It has some input into the formulation of national policy. For example, MoD has expressed support for the recommendation of NRPB that doses should be averaged over moving periods rather than only over a calendar year.[102] MoD has not made any policy changes in advance of the outcome of the deliberations of the ICRP. It has "chosen not to set specific new dose targets, but to reinforce ALARP practices throughout MoD until firm legislative advice is promulgated".[103]

[93] *Occupational Exposure from US Naval Nuclear Plants*, p 25, Evidence, pp 31, 32
[94] Q124, Evidence, p 31
[95] Q124
[96] *ibid*
[97] Qq 125-126, Evidence, p 39
[98] Evidence, p 39
[99] Evidence, pp 48, 50
[100] Evidence, pp 37, 29, 31
[101] Qq 61, 66-71
[102] Q69
[103] Evidence, p 22

41. MoD has adopted a similarly cautious approach to the Gardner report. It has stressed that the findings "cannot yet be regarded as fully understood and may yet be shown to be due simply to chance".[104] MoD sets great store by COMARE's advice that policy changes should not be made until further studies have been undertaken and completed. Dr Ridley, MoD's Assistant Chief Scientific Adviser (Nuclear), told us that "MoD will watch the results of these further studies very carefully indeed and react accordingly".[105]

42. A number of studies have been completed or are underway relating to the effects of exposure to ionising radiation on MoD staff. These include a study of the incidence of childhood leukaemia in West Berkshire and North Hampshire, in which the AWE facilities at Aldermaston and Burghfield are located, a mortality study of workers at Aldermaston and an examination of the health of submariners. A case control study of Aldermaston and Burghfield similar in scope to Gardner's study of Sellafield is due to be completed at the end of 1990.[106] Following COMARE's recent advice, MoD place greater stress, however, on a wider study being undertaken by NRPB and HSE based on the records of all radiation workers which should eventually be established in the NRRW.[107] MoD is co-operating with Dr Kinlen, Director of the Cancer Epidemiology Unit at Edinburgh University, who is seeking endorsement from COMARE for a study which would test the Gardner hypothesis by comparing data on childhood leukaemia in Scotland with data provided by the nuclear industry in Scotland on occupational radiation exposure. The principal sites covered would be Rosyth Royal Dockyard, RNAD Coulport and NRTE VULCAN at Dounreay.

43. MoD was unable to foresee how quickly it might be able to respond to the implications of this research. Dr Ridley said that "it would depend on the results of those studies".[108] The defence trade unions were critical of MoD's response to the Gardner report. They argued that the present annual dose limit of 30 mSv was too high and that MoD was "wrong not to take immediate action to set lower limits". While acknowledging the need for further studies, they argued that MoD "must proceed on the basis that the findings of the Gardner report will be substantiated by further studies".[109] We appreciate some of the concerns leading to this view. The timescale envisaged for some of the studies needed to validate Gardner's findings is long: the main study based on the NRRW "is likely to take more than three years".[110] While there may be good reasons for this, the period before conclusions are reached on the Gardner hypothesis will be an anxious one for many Service and civilian personnel and their families. The results of the case control studies on Dounreay and Aldermaston and Burghfield which may go some way to validate or contradict Gardner's findings should both be known by early in 1991. A new Code of Practice from the Health and Safety Commission and the final report of the ICRP, based not on the Gardner findings but on the revised risk estimates of cancer among exposed persons themselves, are expected around the same time. **While MoD cannot be expected to predict the outcome of these developments, it must be in a position to respond to a range of possible outcomes.** We examine three areas: radiological protection, the related issues of counselling and personnel management, and compensation.

(b) Future Radiological Protection

44. MoD told us of several measures to improve the level of protection offered and thus to reduce exposure doses. Designs for future classes of submarine include targets for further significant reductions in levels of exposure for both submariners and dockyard workers. Alternative materials will be used in

[104] Evidence, pp 22-23
[105] Qq 170, 177, see paragraphs 6 to 7 above
[106] Evidence, p 27, Q164
[107] Evidence, p 27, Qq 166, 178, 181
[108] Q168.
[109] Evidence, p 54
[110] Evidence, p 27

the pressurised water reactor plant which give out lower levels of radiation. They are unlikely to affect existing target costs for the submarines.[111] While these targets are welcome, the benefits would not be apparent until a projected new class of nuclear submarines were to enter service some time after 2000. It is in any event by no means certain, in the light of recent events and the Options for Change exercise, whether or when the procurement of this new class of submarines will go ahead.[112]

45. It appears that, following the introduction of the MODIX decontamination facility, the levels of background radiation in submarine compartments are unlikely to be reduced. However, a development programme is continuing aimed at producing improved methods of decontaminating components removed from the plant for inspection and repair.[113] Furthermore, the proposed reduction in the nuclear submarine fleet to about 12, excluding SSBNs, recently announced by the Secretary of State for Defence[114] suggests that the overall number of submarine refits required in the 1990s will decline substantially, a suggestion reinforced by the fact that the refit of HMS CHURCHILL has been abandoned. **In these circumstances, we believe that, rather than reductions in overall staff levels, the opportunity should be taken to reduce the average level of individual exposure by dose sharing or reductions in overtime.**

46. Further reductions in dose levels at the dockyards are likely to be achieved by reducing the time spent by workers in the reactor compartment during each refit. At Rosyth, we learnt of various projects designed to minimise the requirement to enter the reactor compartment and to reduce the time spent performing work within it. For example, the use of automatic welding could be extended and closed-circuit televisions could be employed. Similar developments are taking place at Devonport.[115] Not all of these changes will necessarily increase the efficiency of the work. Some may be costly. Nevertheless, given that both MoD and the contractors are firmly committed to the ALARP principle, we expect MoD to take into account the cost of any necessary changes in negotiating contracts for future refits. Cost effectiveness clearly represents one constraint upon what is "reasonably practicable", as NRPB has acknowledged.[116] **We expect MoD to explore and, where appropriate, encourage and fund methods of reducing the time spent in reactor compartments during refits, not only where such methods are cost-effective, but also those which may increase the cost of refits.**

47. At AWE, management is continuing to seek improvements in shielding, better containment and more effective personal protection.[117] Nevertheless, Mr Saxby felt that they were "getting close . . . to the current limits of physics" and went on to say that

> "There comes a limit when shielding becomes so large it begins to affect the time people spend working there and so eventually you go past a dip in the effectiveness curve and the doses start to rise again because of the length of time that people have to spend working there. We are pretty close to the optimum position at the bottom of that dip in relation to the new designs of building and much depends on the level of the future programme campaigns as to whether in any particular year one climbs up that side of the dip".

AWE are however looking at research to improve automation of work where it is possible.[118] They are also seeking to make protective clothing more comfortable and to improve respiratory protection.[119]

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[111] Evidence, p 26, Qq 130-135
[112] Tenth Report from the Defence Committee, Defence Implications of Recent Events, HC 320 of Session 1989-90, paragraph 40.
[113] Evidence, p 43.
[114] HC Deb, 25 July 1990, col 471
[115] Evidence, p 61
[116] See "Cost benefit analysis in the optimisation of radiological protection", NRPB, 1986
[117] Evidence, pp 23-24.
[118] Qq 128-130
[119] Qq 137-138

48. The acid test of these measures will be in future levels of exposure. Dr Ridley appeared reasonably confident that MoD could respond to limits which might be imposed by international and national law. These involve a limit of either 100 mSv within five years or 150 mSv within ten years. The defence trade unions went further. They suggested a target of "no more than 10 mSv in any calendar year or 5 mSv on a six months rolling average".[120] MoD responded very cautiously to this suggestion. They said "it would cause problems to achieve that. . . . There would be certain tasks that would be difficult to do at that level. We nonetheless hope that in time, if we keep to the ALARP principle, we may approach that in future".[121]

49. At Rosyth, a local agreement was reached between management and unions for the first half of 1990 that a 10 mSv exposure limit would not be exceeded by an individual in that six-month period without his agreement; that agreement has now been repeated for the second half of 1990. It was thought possible that a few workers might be asked to exceed this level. If this limit—effectively 20 mSv per year—may have to be breached in individual cases, a 10 mSv annual limit would not at present be realistic. At Devonport, management has implemented a dose target of 15 mSv per year for classified workers.[122] **We believe that the agreement at Rosyth represents a welcome example of effective co-operation between unions and management to set rigorous targets for reduction in exposure levels. In particular, MoD should consider the adoption at MoD controlled sites of the practice at Rosyth whereby specified limits are not exceeded by individuals without their consent. MoD should also actively encourage local arrangements for dose reduction committees similar to those in the civil nuclear sector, and provide a national mechanism to assist in the implementation of this committee structure.**

(c) Counselling and Personnel Management

50. Following the publication of the Gardner report, counselling has been offered to workers throughout the MoD nuclear programmes, for employees, their families and for ex-employees. This has been welcomed by the defence trade unions.[123] Information has been given by MoD to medical officers for them to pass on to employees. Within the dockyards, the exact nature of the briefing is a matter for the contractors. DML has given a full briefing to their employees.[124] MoD told us that there had been relatively few requests for counselling: three at Faslane, fewer than 20 at Rosyth and 39 at Devonport.[125]

51. One AWE employee requested to be moved from radiation work, but, after counselling, withdrew his request.[126] This case raises the general issue of personnel management in relation to radiological protection. The trade unions argued that if, after counselling, a radiation worker wanted to move out of an active area he or she should be able to do so. They noted that this assurance had been given by British Nuclear Fuels and the United Kingdom Atomic Energy Authority.[127] In response, MoD was only able to say "we would look at [a request] very sympathetically". They were unable to give a guarantee in all circumstances to move someone They felt that operational imperatives applied in a way they did not in the civil nuclear industry. Service personnel could not be allowed the same latitude as civilians.[128] While we accept the validity of these points, this is clearly an important issue which MoD and contractors must address with sensitivity. It is not MoD's current policy to remove workers receiving occupational external exposure doses in excess of 15 mSv per year over a period of years from the work that led to that exposure.[129] Nevertheless, consideration of relocation of staff or restrictions on overtime are almost bound

[120] Evidence, p 54
[121] Q64
[122] Evidence, p 59
[123] Evidence, pp 23, 54, Q170
[124] Q175, Evidence, pp 59-60
[125] Q170
[126] Q163
[127] Evidence, p 54
[128] Qq 155-161
[129] HC Deb, 18 April 1990, col 947w

to follow from stricter dose limits in future years. **In the case of the dockyards, we believe that the contractors should agree that classified radiation workers should be given the option of transfer to non-classified work.**

(d) Compensation

52. Finally, we turn to the vexed issue of compensation. In the past, permitted levels of exposure were considerably higher—150 mSv per year from 1950 to 1958 and 30 mSv per calendar quarter from 1958 to 1985—because medical knowledge on the effects of radiation was more limited.[130] We make no judgement on these past policies, but we are concerned with their consequences for future policy. Knowledge about the possible effects of past exposure has led to a number of claims for compensation. MoD had received, as of 18 July 1990, 126 such claims from Service and civilian employees for illnesses which may be radiation-related dating back over a number of years. Only six of the cases were still unresolved. All claims are considered on the basis of legal liability; to date no money has been paid out in compensation by MoD.[131]

53. In 1988 the defence trade unions proposed that MoD should introduce a "no-fault" compensation scheme comparable to that in the civil nuclear industry. Under the latter scheme compensation is paid, not on the basis of legal liability, but according to a graduated scale which takes into account the degree of probability, in the judgement of a panel of experts, that an employee's injuries might have been caused by exposure to radiation. MoD has not yet responded to this proposal, a fact which the unions criticised.[132] MoD witnesses assured us that the proposal was being actively and seriously considered at the moment and that they expected to come to a decision in the next few months. Nevertheless, they said the civil scheme itself was being reviewed and MoD would await the results of this review before coming to a decision. The important question of whether the scheme would cover Service and civilian personnel has not yet been determined. It has established that, in the case of the dockyards, MoD would be responsible for meeting the cost of any compensation paid in respect of injuries or illnesses attributable to any period prior to Vesting Day.[133] If Gardner's findings were validated, more claims could be expected from employees or ex-employees whose children have had leukaemia. As we remarked in our recent report on the Trident Programme, the possible financial implications of future liability for compensation is one further factor which potential contractors at AWE will have to bear in mind.[134] **We believe that, in coming to a decision on the establishment of a no-fault compensation scheme, MoD should bear in mind the success of other no-fault compensation schemes and the anxiety, distress and unnecessary expense which could arise from extended actions in the court to gain compensation. While we have not examined the arguments for and against no-fault compensation in any detail, those in its favour are, at first sight, persuasive. We believe that MoD should treat its consideration of the establishment of a no-fault compensation scheme as a matter of urgency and make an announcement before the end of 1990, or, if there are insuperable difficulties in meeting this timescale, and MoD are prepared to specify them, by 31 March 1991.**

V: CONCLUSION

54. During our inquiry we have been impressed by the firm commitment of MoD and its contractors to achieving the highest standards of radiological protection for Service and civilian personnel. This commitment pre-dates the publication of the Gardner report. Regardless of the Gardner report, however,

[130] Qs 58
[131] Qq 182-191, Evidence, pp 39-40
[132] Evidence, p 54.
[133] Qq 194-203; Evidence P 40
[134] Ninth Report from the Defence Committee of Session 1989-90, *The Progress of the Trident Programme*, HC 237 para 71

exposure limits are likely to be further reduced as a result of international and national regulation. Were the Gardner hypothesis to be substantiated, even lower limits might be required. ***We consider that the levels of exposure to ionising*** **radiation in the nuclear weapons programme and the nuclear propulsion programme can be further reduced. Such reductions would add to the reassurance of both the employees affected, their families and the general public about the safety of the United Kingdom's defence nuclear programmes.**

LIST OF ABBREVIATIONS AND TERMS

ALARA	As Low As Reasonably Achievable
ALARP	As Low As Reasonably Practicable
AWE	Atomic Weapons Establishment
CIDI	Central Index of Dose Information
COMARE	Committee on the Medical Aspects of Radiation
DML	Devonport Management Limited
DRPS	Defence Radiological Protection Service
HSE	Health and Safety Executive
ICRP	International Commission on Radiological Protection
IRR85	Ionising Radiations Regulations 1985
man-Sv	man-Sievert (unit measuring collective radiation dose, ie the dose received by a population or a defined group of people—reached by adding all the radiation doses received by individuals or by multiplying the average dose by the number of people) (see Sv)
MoD	Ministry of Defence
MODIX	Multi-Stage Oxidative Decontamination with Ion Exchange clean up
mSv	milliSievert (see Sv) One Sv = 1,000 mSv
NII	Nuclear Installations Inspectorate
NRPB	National Radiological Protection Board
NRRW	National Registry of Radiation Workers
NRTE	Naval Reactor Test Establishment
RAPTAC	Radiological Protection Technical Advisory Committee
RNAD	Royal Naval Armaments Depot
RPA	Radiation Protection Adviser
SSBN	A nuclear powered submarine armed with ballistic nuclear missiles
SSN	A nuclear powered hunter killer submarine
Sv	Sievert (unit measuring the biologically effective absorbed radiation dose)
TLD	Thermoluminescent Dosemeter
UK	United Kingdom
US	United States
μSv	microSievert (see Sv) One Sv = 1,000,000 μSv

PROCEEDINGS OF THE COMMITTEE RELATING TO THE REPORT

WEDNESDAY 31 OCTOBER

Members present:
Mr Michael Mates, in the Chair

Mr John Cartwright
Mr Churchill
Mr Bruce George
Sir Barney Hayhoe
Mr John Home Robertson
Mr John Lee
Mr John McFall
Mr John McWilliam
Mr Jonathan Sayeed
Mr Neil Thorne

The Committee deliberated.

Draft Report (Radiological Protection of Service and Civilian Personnel), proposed by the Chairman brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 54 read and agreed to.

Resolved, That the Report be the Twelfth Report of the Committee to the House.

Ordered, That the provisions of Standing Order No 116 (Select Committees (reports)) be applied to the Report.

Ordered, That the Chairman do make the Report to the House.

[Adjourned till Wednesday 14 November at half past Ten o'clock.

LIST OF WITNESSES

LIST OF WRITTEN EVIDENCE

MINUTES OF EVIDENCE

TAKEN BEFORE THE DEFENCE COMMITTEE

WEDNESDAY 13 JUNE 1990

Members present:
Mr Michael Mates, in the Chair
Mr Churchill
Mr John Home Robertson
Mr John McFall
Mr Jonathan Sayeed

Examination of Witnesses

MR JOHN HOWE, Assistant Under Secretary of State (Personnel and Logistics), DR BOB RIDLEY, Assistant Chief Scientific Adviser (Nuclear), MR BILL SAXBY, OBE, Atomic Weapons Establishment, CAPT PAUL THOMAS, Chairman, Naval Nuclear Technical Safety Panel, SURGEON CAPT JOHN HARRISON, Head of Defence Radiological Protection Service, MR NIGEL PAREN, Assistant Under Secretary of State (Fleet Support), and SURGEON CDR CHRIS KALMAN, Deputy Chairman, Naval Nuclear Technical Safety Panel, Ministry of Defence, examined.

Chairman

1. *Mr Howe, gentlemen, good morning. Thank you for coming to attend in front of us in the context of our look at the radiation protection of service and civilian personnel. Let us start, please, by looking at your policy and the regulatory system. You set out the policy of the MoD on radiological protection in your memorandum, which we have. Can you begin by responding to the suggestion of the defence trade unions that there is no clear central authority at departmental level responsible for this policy, and does the new "high-level committee" referred to in paragraph 2 indicate a sense that there was a lack of such authority?*

(Mr Howe) We have recently introduced new machinery at the Ministry of Defence to bring together all our health and safety interests and there is a committee in the centre which does that. In the specific area of radiological protection we do not think that there is a gap in the centre. There are two main organisations involved, represented along the table—AWE, on the one hand, and the Defence Radiological Protection Service, on the other. There is a committee which bridges those two organisations, the Radiological Protection Technical Advisory Committee, which is chaired by Dr Ridley's staff, and that provides the central focus for policy and administration.

2. *The principal statutory basis for MoD policy on radiation protection is the Ionising Radiations Regulations 1985. Is the MoD subject to all the provisions of these Regulations?*

(Mr Howe) We are indeed We are subject to the Health and Safety at Work Act in general and the IRR in particular. We are also subject to inspection by the Health and Safety Executive but there are special provisions which apply to the Ministry of Defence. I have a note here, the essence of which is that the Secretary of State for Defence does have power to exempt classes of our people from the operation of the Act in times of emergency.

3. *From the Act and the Ionising Radiation Regulations?*

(Mr Howe) Indeed.

4. *In time of what?*

(Mr Howe) In time of emergency, and we also have special arrangements in relation to the inspection of our activities in sensitive areas.

5. *What sort of emergency, Mr Howe?*

(Mr Howe) This would be a defence emergency. I do not mean an emergency in terms of a nuclear accident.

6. *You do not mean a nuclear emergency?*

(Mr Howe) No.

7. *You mean an emergency of heightened tension?*

(Mr Howe) If there were a grave defence emergency, such as has not actually occurred since the provision was introduced.

8. *But subject to that there are no exemptions?*

(Mr Howe) There are a number of detailed provisions rather of a procedural character which apply to the Ministry of Defence. I could supplement that information in a note, if you like, but in general we are subject to the obligations of the Act. The exemptions are more of a procedural nature and have to do, for example, with the right of entry of HSE inspectors in sensitive areas, where we have to receive notice and that sort of thing.

Mr Sayeed

9. *Mr Howe, I missed something you said. When was the last time you consider there was a grave emergency?*

(Mr Howe) That clause has never been invoked since the Act was introduced.

Chairman: Not since 1985, I would hope!

Mr Sayeed: I did not know. The answer was lost in your question.

Chairman

10. Radiological protection for the nuclear weapons programme is a matter for the Safety Division of the AWE. How many specialist radiological protection staff are in post in the Safety Division of the AWE and is this the same as the complement should be?

(Mr Saxby) There are 133 senior professional posts of a specialist radiological protection kind. About 105 of those do the equivalent radiological protection duties to the DRPS and the remainder are the radiological protection specialists you would expect to find in places like a big factory organisation. There are 13 vacancies in those professional posts, of which six are vacancies in the general Radiological Protection Advisory Group.

11. So you have seven vacancies out of the 28 that you mentioned?

(Mr Saxby) No, we have six vacancies out of the 105 Radiological Protection Advisory Group and seven vacancies out of the 28.

12. So you have seven out of 28 not in post?

(Mr Saxby) Not in post.

13. Nearly a quarter?

(Mr Saxby) Nearly a quarter.

14. Is that because you cannot recruit them?

(Mr Saxby) That is because of difficulties of recruitment and, indeed, the shortage of such people overall in the country.

15. What is the consequence of your being 25 per cent under strength in that particular group?

(Mr Saxby) More overtime, more contracting-out of certain of the tasks to be done by others to advise us and help. In the end we meet our current obligations.

16. So you are meeting all of the obligations under the Regulations?

(Mr Saxby) At the present time, yes.

17. Without exception?

(Mr Saxby) Without exception.

18. You are 25 per cent short on staff, so how much of the work is contracted out?

(Mr Saxby) I cannot answer that question in detail, sir. We would expect to be able to meet a shortfall for training recruitment leave, purposes of about 15 per cent, so that about 5 to 10 per cent of our commitments go to others.

19. At what cost, do you know?

(Mr Saxby) No, sir.

20. Would you be able to let us know?

(Mr Saxby) We could find the costs of contracting-out work, yes.

21. And then of what you call the professional staff of 105, you are seven short?

(Mr Saxby) Of the radiological protection advisory staff we are currently six short.

22. One is six and one is seven. I think you have told me——

(Mr Saxby) Seven of the 28 and six of the 105.

23. So you are six short of the 105?

(Mr Saxby) Correct.

24. That presumably has a less harmful effect because that is only——

(Mr Saxby) That is the kind of variation you expect to be able to meet in normal managerial practice.

25. Why is the difference so marked between the two? Is it because of professional qualifications or is it because you would rather hire them into the 105 than into the 28?

(Mr Saxby) The recruitment to the smaller group, operational health physicists, at the time they are needed is particularly difficult but at the same time they are not quite so important at the moment because we are building up new buildings and until those new buildings are operational there is not so much effort needed from the operational side.

26. So do you transfer them across?

(Mr Saxby) We can transfer staff across and do so as necessary to meet the requirements of the day, as we see them.

Mr Sayeed

27. Mr Saxby, you sounded rather pessimistic when you were answering the Chairman about the 25 per cent shortfall. You said something along the lines that "at the moment we can cope". Does that mean you are expecting not to be able to cope in the future? Are you going to lose more staff or are you going to have more duties imposed upon you, or did I misunderstand you?

(Mr Saxby) What I see is a continuing difficulty in recruiting staff because there is a national shortage and that means, yes, that I have to be at the moment pessimistic. But these recruiting difficulties have occurred in the past and have been overcome, so that it is not all black. One would hope that by a combination of contracting, reducing some effort and by keeping a balance within the overall work going on, we should be able to continue to cope.

28. So is it going to get better or get worse, this shortfall?

(Mr Saxby) I cannot really forecast what the national position is going to be. I suspect it is not going to change very much. It is going to be very difficult for a long time.*

**Footnote by witness.* Since the Committee met there has been sign of a welcome improvement. We now expect five new graduates to enter the operational group, and two to enter the Radiological Protection Group in the early Autumn.

Mr Home Robertson

29. If I can follow up some of the figures you referred to there, you said you were 25 per cent under establishment in these key staff and you are contracting out 5 per cent of your workload. Something does not add up there.

(Mr Saxby) Under normal management processes you expect to be able to cope with changes of about 15 per cent any way, so that you are just having to work harder all the time as you have got people away on leave or on courses and other things. The difficulties are to get the people into post by the time the new buildings are operational. Until they are operational it is not causing a great deal of trouble.

30. To whom are you contracting out the work?

(Mr Saxby) We contract some work out to engineering inspectors from industry who have people who can do work for us.

31. How can they attract staff when you cannot attract them?

(Mr Saxby) They can pay large sums of money to their staff.

Chairman

32. For most areas of the nuclear propulsion programme the Defence Radiological Protection Service acts as a corporate radiation protection adviser. The contractors in the nuclear propulsion programme promulgate their own internal rules, appoint their own RPAs; both Devonport and Rosyth have appointed DRPS under contract. Are there other radiation protection advisers for the nuclear propulsion programme?

(Capt Thomas) Yes, sir, there are indeed. For each of the naval bases there is an environmental support department and they have professional health physics staff in those departments and the senior person in each of those departments is the radiation protection adviser to the commanding officer or head of establishment.

33. How many staff are employed by the Defence Radiological Protection Service?

(Surgeon Capt Harrison) Sir, my current complement is 54 persons, one serviceman—that is, myself—and 53 civilians. I currently have three vacancies overall. I have 22 health physicists, of which I have one vacancy; I have one vacancy in a grade known as P & GSC, a health physics monitor, and one further health physics monitor vacancy as well.

34. Have there been difficulties in recruiting and retaining specialist staff as the unions suggested?

(Surgeon Capt Harrison) I think there always have been, but the Ministry has responded to this by starting up a graduate entry training scheme for health physicists which has been running now for some four to five years, and this is bringing really good first-class graduates into the service. They receive their training by going to Greenwich and receiving higher qualifications and then, once they have finished that training, they come in. I think we are beginning to see the benefits of that programme.

35. How many staff of the DRPS work at Rosyth and Devonport respectively?

(Surgeon Capt Harrison) None, sir. We do not look after the radiation protection side at Devonport or Rosyth. That is done by the nuclear propulsion area.

36. Did they do it before contractorisation?

(Surgeon Capt Harrison) That is correct, yes.

37. That is one of the changes?

(Surgeon Capt Harrison) There is no change. We do not have responsibility for that area.

38. You did not have before contractorisation?

(Surgeon Capt Harrison) Not at all. We do supply, of course, an approved dosimetry service right across the board but we do not actually provide specific radiation protection advice. We give a service. We do environmental monitoring and a whole series of other things. We provide a service but we do not actually have the statutory radiation protection advisory role.

(Capt Thomas) Could I just clarify something there please, sir. With the naval nuclear propulsion programme as a whole, because of the specialist nature of the work, the Defence Radiological Protection Service do not provide a corporate RPA service. It is important that each of the establishments has its own radiation protection adviser and its own radiological protection service. In the past before contractorisation of the two Royal Dockyards that service was provided by the Ministry of Defence personnel. Now they are contractorised the two dockyard companies are obliged to have, and do have, their own professional organisation.

Mr Sayeed

39. What about dockyards overseas like Malabar or Gibraltar?

(Capt Thomas) In the case of Gibraltar, sir, there is a radiation protection service there but the corporate activities are provided from Portsmouth Dockyard, so they have a radiation protection adviser who is a senior professional officer who is provided from Portsmouth Dockyard when that service is required. There is very little in the nature of nuclear work carried out at Gibraltar Dockyard.

40. Would that be the same for other dockyards round the world? There are not too many, I accept.

(Capt Thomas) No, sir, there are not. Nuclear work is not done at other facilities. We do not carry out nuclear work at other facilities.

Chairman

41. The radiation protection advisers used by the MoD are both part of the MoD Is it satisfactory to use internal advisers?

[**Chairman** *Contd*]

(Surgeon Capt Harrison) Yes, sir. The Act specifically suggests that. The approved code of practice in the Ionising Radiations Regulations states that large nuclear operators would be expected to have their radiation protection advisers in-house. The important point, of course, is that they will have to reach a standard which is acceptable to the Health and Safety Executive and all their names and qualifications are forwarded to them for approval.

42. Would it not be easier if the DRPS covered naval bases and dockyards as well rather than having a separate radiation protection adviser for each place?

(Mr Howe) I will let my colleagues answer in more detail, but I think the arrangements we have are in conformity with the requirements of the Act and we feel they do meet the case.

(Surgeon Capt Harrison) The DRPS has a wider role throughout the entire Ministry in looking at all the Naval, Army and Air Force establishments. In the key areas of the nuclear propulsion area they have their own radiation protection advisers because they can look after the specific problems that might arise there. My organisation is concerned with a thousand odd establishments world-wide. We are looking at wider issues which include service hospitals, x-ray machines, veterinary services, non-destructive testing, all these wide uses of radiation go right across the patch, and so we tend to distance ourselves from the specific propulsion and weapon areas; however we do provide services to them.

Mr Sayeed

43. But you do not feel that you run the risk of there being suspicion that you are acting as both poacher and gamekeeper?

(Mr Howe) No, sir.

Mr Sayeed: You are quite satisfied.

Chairman

44. Can DRPS tell one of the dockyard contractors that they are not doing something right?

(Surgeon Capt Harrison) We do not have a right of access but we do go on audits with Captain Thomas who carries out audits.

(Mr Howe) I think Captain Thomas is the person to respond.

(Capt Thomas) Contractually we have a right to inquire into the radiation protection practices of the two contractorised dockyards; that is in the contract and is part and parcel of the overall impartial auditing of the naval nuclear propulsion programme. I carry out with my panel regular audits of all the elements of the naval nuclear propulsion programme. One of the most important facets of these audits is the examination of the radiation protection practices. It is in that way that we confirm that standards maintained, not only by the MoD establishments but by the two Royal Dockyards, are satisfactory and in accordance with national practice.

45. How close is the liaison between your internal advisers and the civil nuclear industry, the National Radiological Protection Board and the Health and Safety Executive?

(Dr Ridley) There are contacts with NRPB at the individual radiation protection adviser level throughout MoD and we ensure that the centre also has an access to discussions with NRPB. You heard mention earlier of RAPTAC, the Radiological Protection Technical Advisory Committee, which is in the centre. It brings in representatives of the people represented here and right across the MoD, the Army and the Air Force as well as the Royal Navy. We mix and evaluate experience throughout MoD and approach NRPB for advice collectively. This is done on a regular basis and is a very useful means of getting an understanding of what is in the mind of NRPB and ourselves. The NRPB does understand some of our problems. They produce advice notes, for instance, for discussion and we ensure that MoD is able to gather centrally and collectively a co-ordinated MoD view and have discussions with NRPB on their suggestions for the future.

46. Has consideration been given to defence installations being subject to spot inspection by the Health and Safety Executive and the Nuclear Installations Inspectorate, as suggested by the defence unions?

(Mr Howe) No, sir, in general——

47. You have not even considered it?

(Mr Howe) Our installations are not in any case subject to licensing in that sense. In the IRR context we are in general within the purview of the HSE. There are special provisions, as it were, to control access to sensitive areas. We would not want a spot inspection regime in those areas.

48. Let us turn to the current radiation protection, first of all the limits. The presently circulated draft of the International Commission on Radiological Protection's new report proposes a limit of 100 mSv within any five-year period. Is this catered for in current MoD practices?

(Dr Ridley) As we have set out in the memorandum, current MoD practice is to have a limit of 30 mSv a year. This was in response to the NRPB's advice in 1987[(1)] and followed closely the similar action taken by the rest of the nuclear industry in the UK. We have commented on the HSE draft approved code of practice which is out for discussion, which suggests an investigation at 150 mSv over a ten-year period. We would expect that there will be discussion within the HSE, with the Working Group on Ionising Radiation, which includes all interested parties in the UK. They will take into account comments and we would expect the code of practice to be issued early next year. Clearly MoD will respond to it when it is issued, but the actual

[(1)]NRPB, Interim Guidance on the Implications of Recent Revisions of Risk Estimates and the IRCP 1987 Como Statement. NRPB—GS9 (1987)

[**Chairman** *Contd*]

numbers in it might change by then. The ICRP report itself, a very complicated document indeed, because it reviews all of the relevant publications since 1977. Its conclusions are based on a very considerable amount of scientific work, and it will be longer before that body completes its recommendations. They are due to meet in September this year and I would expect a new ICRP report to be out some time next year.

49. And you will take account of any new figures issued in the code of practice by then?

(Dr Ridley) We will take account of the code of practice. Whether the approved code of practice will come out before the ICRP have finished their deliberations is not quite clear. It is likely to be ahead but it could be revised later.

50. All work practices which might result in exposures reaching 15 mSv have to be formally investigated and continuing exposure beyond this level formally justified, you tell us. How many work practices at the MoD have been investigated in the last three years and how many of these have not been deemed justified?

(Dr Ridley) I think we would have to give you a note on the detail of that. Every time we hit 15 mSv we have to do an investigation, though we are allowed to do this for a group. The individual number of investigations is therefore not large. I think we would have to give you a note to answer your question in detail.

51. Can you give us some examples?

(Mr Saxby) There have been no occasions in the AWE in the last three or four years when we have exceeded the 15 mSv limit The last occasion when that level was exceeded was before the new regulations requiring these investigations came in.

52. When was that?

(Mr Saxby) 1985

53. And what was the occasion?

(Mr Saxby) I would have to give you details in a note.

54. Because you cannot remember?

(Mr Saxby) I do not remember.

55. Have there been any other examples anywhere else?

(Capt Thomas) Yes, in the Faslane fleet operating base for the operational submarines, because of the work on the boats, which could not, of course, be decontaminated as they are operational submarines. At Faslane there are small numbers of people, particularly highly-skilled technical workers such as fitters and welders working on the reactor plant, who do accrue a dose of 15 mSv. As Mr Howe said, at the point when the 15 mSv has been accrued, a formal investigation is carried out. That may be on an individual basis or for a group of people. Not only is the radiation dose justified at that stage—of course any radiation exposure has to be justified and we consider that to be very important—but there have been over the years several instances where such investigations have been carried out.

56. And as a result have you changed work practices?

(Capt Thomas) Indeed. It is not only because of the investigations that we change work practices. We have a full panoply of review procedures which are currently in place at the bases to ensure that the dose is as low as reasonably practicable and we certainly do not consider 15 mSv as something we should work to. We endeavour to keep this dose as low as we possibly practically can.

57. And those highly-skilled specialists who receive this 15 mSv dose, are they civilians or service personnel?

(Capt Thomas) In the majority of cases at the Naval bases they will be service people.

Mr Churchill

58. In your memorandum to this Committee dated 5 June at paragraph 8 you state that: "Additional guidance on restriction of exposure intended to be incorporated in a future Code of Practice associated with IRR85 has been drafted for consultation with interested parties. It proposes an investigation focusing on the individual when the employee accumulates a dose of 150 mSv within 10 years. . .". Am I right in thinking that between 1950 and 1985—a 35-year period—the dose that was permitted at that time was 150 mSv per annum?

(Dr Ridley) That is correct, yes.[1]

59. What has been the specific reason for your proposing to reduce this exposure by a factor of 10 for the future?

(Dr Ridley) I think the answer to that is that the bodies concerned—the ICRP, an international body whose deliberations are reflected into national legislation—have reviewed the data available and are continuing to do so. The main body of evidence comes from the populations exposed in Japan to the two detonations there. The effects from radiation take very many years to show and we still have uncertainty as to the effects of low-level doses. This reflects some of the problem in trying to get the regulatory limits right. In the latest round of the ICRP deliberations they have reviewed all the data afresh and come up with suggestions for change which you mention.

[1] Historical dose limits are as follows:

1950–1958	150 mSv per annum
1958–1985	30 mSv/calendar quarter subject to not exceeding a cumulative life dose of 50 mSv/year from age 18
1985—Present	50 mSv per annum

[**Mr Churchill** *Contd*]

60. So you are saying that 45 years on from Hiroshima and Nagasaki we are still learning a very significant amount about the effects of ionising radiation which was not known, say, 20 or 30 years ago?

(Dr Ridley) A very considerable proportion of the population that was exposed are still alive. For the regulatory process we are trying to estimate the risk of death.

61. Would I be right in thinking that it is now the view of the Ministry of Defence that what was regarded as safe practice in 1950 or, indeed, as recently as 1985 is no longer regarded as safe practice in terms of the dosage to which individuals may be exposed?

(Dr Ridley) We follow the regulatory process MoD itself has no expertise to do the review that I was talking about. The ICRP has all the experts and they are concluding in their latest draft (which, of course, could change when it comes round again in the final form) that the risks have increased.

62. But the implication is, surely, that in the light of knowledge that stands today it would be reckless and irresponsible to expose workers and other individuals to doses which a few years ago were regarded as acceptable and safe?

(Dr Ridley) The simple answer to that is yes.[1] However I ought to point out the move towards looking at an average over a period, which is in the current ICRP draft recommendations. We are talking about an average dose over a period of 10 years or 5 years, depending on which of the documents we are talking about. Both of the underlying support arguments for this averaging suggest that there is no detriment to health if that total is achieved by perhaps larger doses in any one year. It is the average over a period which is considered important, or the total after a period of time has elapsed, and that represents a change It is related to the fact that it takes a long time for any health effect to show. I have to emphasise that we do not have real information on health detriment at such very low doses. It is all done by complex assessment based on the much higher doses experienced by this population in Japan. The view is that one is being very conservative in setting these levels.

Mr Home Robertson

63. I think, and hope, you have just confirmed that it is the policy of the Department to ensure that doses are kept as low as reasonably practicable and I trust that will be confirmed and verified in the coming months and years, but the trade unions have put it to us that a target of no more than 10 mSv in any calendar year or 5 mSv in six months average should be set. Does that present you with any difficulties?

(Dr Ridley) That is very much lower than either the HSE code of practice or the ICRP draft is suggesting.

Footnote by witness

[1]The answer refers to the pre-1958 limit of 150 mSv/annum

64. It would be, would it not?

(Mr Howe) Yes, it would. It would cause problems to achieve that. We would be trying to go, as you said, as low as reasonably practicable but there would be certain tasks that would be difficult to do at that level. We nonetheless would hope that in time, if we keep to the ALARP principle, we may approach that in future.

65 So a significant number of your service staff and civilian staff are subject to doses that are significantly higher than the targets they referred to?

(Mr Howe) As I think the memorandum suggests, yes.

Mr McFall

66. Dr Ridley, you mention the view of the Department. What answer will you give the trade unions for not coming down to the 10 mSv level? What is the case you have to present?

(Dr Ridley) I think the case we would have to present is that others—not the Ministry of Defence—are responsible for assessing risk and we defer to the experts in ICRP and the deliberations which then take place. Others set the regulatory limits.

67. But the ICRP contains quite a number of bodies, quite a number of countries, am I correct?

(Dr Ridley) Yes, indeed.

68. What is the view of the MoD on the level? In other words, what is the input of MoD to ICRP deliberations?

(Dr Ridley) I think the answer to that is none. The experts in ICRP are experts in their field. They are experts in the field of radio-biology and eminent professors from academic institutions world-wide. The MoD does not have a place. I think in fact the individuals in ICRP are individuals, they are picked for their intellectual merit and MoD does not have a role in ICRP deliberations.

69. In a body like the ICRP, a delegate body, different countries are putting their point of view. You are telling us here the MoD, the largest department in government with £21 billion spending, does not have experts of its own, does not have any information to provide and, therefore, has no view of its own and takes what other people say is safe?

(Dr Ridley) You asked a specific question on ICRP. I tried to answer it. If we turn to what do we do in terms of commenting on the draft ICRP document, we make MoD views known to NRPB who act for the United Kingdom as a channel to the ICRP. Of course, we make our views as an operator known based on doses currently being received. We have certainly made very clear to NRPB that we are in favour of the arguments to average dose over a period. We point out that this gives advantages to us. It avoids the sillinesses with doses occurring at the end of a calendar year—the dose in December is no different from the dose in January. We find, as

[**Mr McFall** *Contd*]

others do, that measuring internal dose is a protracted business and it is very useful to be able to get the number right before we freeze it. We also note that MoD's workload is variable as is demonstrated in some of the data that is presented in our Memorandum. The application of ALARP is certainly something we would continue and, if it is at all possible without health detriment then MoD is greatly in favour of averaging doses over a period of time.

70. If the choice were between 15 mSv and 10 mSv and the MoD were to give their point of view, there is no view you can put forward in terms of what is the best?

(Dr Ridley) Certainly we have not got the means of directly judging health detriment. We have to rely on others to do that.

71. Do you not think it would be wise if MoD did have the means of judging?

(Dr Ridley) I think the expertise which ICRP brings together is unique.

72. Can I go on to records now? What figures are available for the exposure levels from the 1960s and 1970s?

(Mr Saxby) From AWE we have records of external exposures from the time when the former Master General of Ordnance Radiological Protection Service was taken into AWRE, then called HER, in 1949, and those data are available to us and held on our computer in exactly the same way as the data presented before the Committee.

73. You have data on your computer from 1949?

(Mr Saxby) Yes, including people who were working as far back as 1946.

74. None of the annual radiation exposure records that the MoD provides predates 1979 because, you say, data for earlier years is not in a form that readily permits statistical analysis. I put down a Parliamentary Question and received an answer from the MoD, but I am hearing from AWE that you have records going back to 1949, yet those records are not available in other parts of the MoD.

(Mr Howe) If I may pick up the question and then turn to Captain Harrison, I think there is a difference between records available in relation to the history of individuals which go right back and are available for health purposes and the records which can be used, which lend themselves to being used, for statistical treatment. There is a difference there. Can I ask Captain Harrison to comment on the DRPS?

75. Could I just ask, could the records you have on computer at AWE be used for statistical comparisons?

(Mr Saxby) Yes, sir, they could. As to that, they were in fact used in the epidemiological study of the AWRE employees which was carried out some years ago.

(Surgeon Capt Harrison) In my approved dosimetry system we currently have 35,000 people who have been registered since the inception of that system and it is only since 1979 that the individual data has been put on to a computer. Prior to that the data exists in files. If someone was actually working in the MoD in 1979 then his cumulative dose at that point goes into the computer, so that some of my records will include doses which have accrued prior to 1979, but if people have left the service or left the Ministry of Defence prior to 1979 then their records are essentially dead within the record-keeping system.

76. But if I understand it correctly, if AWE have records in the computer going back to 1949, that permits statistical analysis readily but that is not available elsewhere in MoD?

(Surgeon Capt Harrison) I can do it collectively.

77. But am I correct in that assertion?

(Surgeon Capt Harrison) Not completely, no.

78. Why?

(Surgeon Capt Harrison) The difference is that we can give you some data, overall figures for people who have been on the DRPS computer and in the DRPS record-keeping system. What we cannot do is give you an individual breakdown by dose bands because those data have never been put into the system.

79. When, in my Parliamentary Question, I just asked for information pre-1979, I was informed that the computer was put in in 1979 and, therefore, information was not readily available.

(Surgeon Capt Harrison) It is only available on individuals.

80. So I still could not get that information?

(Surgeon Capt Harrison) No.

81. Although I might get it from AWE or——

(Surgeon Capt Harrison) Yes.

(Mr Saxby) If the question had been directed at the AWE the answer would have been at that stage to say we could give you the last set of data because we have already been asked for such recent data and when we had to go back to the computer it was not readily available at that time because of computer management problems and that was the background for that answer. Given the time to overcome those particular problems, with the down time on the computer, yes, we can go back and get the data and have done so.

82. The records are not available before 1979. Is that because they do not tell a good story?

(Surgeon Capt Harrison) No, I do not think so at all. I have an example of my own personal record, which is the only one I would be prepared to let people look at, and it does give an example of what is held. This is for me, when I joined the service as a radiation worker in 1968. It is a record of all my

[Mr McFall *Contd*]

doses from that time up to the present. It is a record of all the medical examinations that have been carried out and they are all held there and will be held there for 50 years. That is what is required by statute. That is what we are complying with. What I cannot do at the moment, because it is not required by statute, is to go back into pre-1979 data in detail and produce it in a statistical table.

83. Is it the case that some records have been lost?

(Surgeon Capt Harrison) No, not to the best of my knowledge.

84. How many records are there?

(Surgeon Capt Harrison) As I mentioned earlier, there are about 35,000 records *in toto*.

Chairman

85. I think, because we do not have a TV screen, you might just describe for us very briefly the form that the records are in.

(Surgeon Capt Harrison) The form is in the form of a booklet. It is what is known as an FMed form, which is a good old-fashioned military name for a form.

86. It is familiar!

(Surgeon Capt Harrison) It is a series of clinical records of medical examinations which were carried out on me, and this would be the same for every other classified radiation worker. Then there are a series of dose record summaries which take the form of quarterly doses and annual dose summaries on a cumulative basis, so that it is possible for me to pick up the record and tell you how much radiation I have received whilst working in the Ministry since 1968.

(Mr Saxby) Could I just add one thing regarding the system of records. We have talked about external records only not records of uptake of radio active materials. Only in the last few years since 1986 has it been necessary to put those into a form for immediate access for the regulatory bodies. In two years' time we will take delivery of a big new computer and at that stage the individual records of internal data will be transferred on to the computer-held records for the internal dosimetry as well as for the external dosimetry.

Mr McFall

87. Given that the big computer will give the rest of the MoD the records which are not there already, will those records be transferred on to the computer, so that at some stage when I ask a Parliamentary Question I may get information pre-1979?

(Surgeon Capt Harrison) What I can say is that we have in the Long-Term Costings, a bid in to upgrade our system and that is due in about two years' time That particular time was selected because that would reflect changes in the ICRP. The fact is that the record-keeping systems will have to change them anyway to take account of the possible changes in the legislation, in other words, the averaging rather than the annual dose system. That will require computer software which will require a slightly different method of keeping the doses. As to whether it would be justifiable to spend money on putting those records pre-1979 on to the computer, I would have difficulty at the moment in justifying that as it is not required by statute and it would have very little benefit, in my personal view, to current work practices.

(Mr Howe) Could I emphasise the last point, deferring to the experts. I think the point is that in our view there is no health risk to the individual arising from our inability to collate and statistically present the statistics pre-1979. As far as the health of the individual is concerned, his records are complete and there is access to them.

(Surgeon Capt Harrison) Absolutely.

(Mr Howe) So we do not consider that there is a health dividend in this retrospective computerisation, and given the fact that it is extremely expensive, or would be extremely expensive, we do have to balance and will have to balance investment cost against the benefit.

88. Has the idea of analysing a sample of pre-1979 records been considered?

(Surgeon Capt Harrison) We have not done it yet.

89. That would not cost a lot of money?

(Surgeon Capt Harrison) It certainly would not cost as much as the equipment. The problem is that it is very difficult to describe something which you do not actually have here, but if you were to see the enormous number of files that we are required by statute to keep, all 35,000 records, you would be able to see that for each person I can pull out a record and give him his dose within an hour and be certain that it has been checked, however, I cannot pull it out of the computer because the data has not been put into the computer. We are talking in terms of about, I would suggest, a million separate items of dose information that would need to be put into a suitable computer and that would have to be validated before such information would be available.

90. What rights have former workers now to receive copies of their exposure levels?

(Surgeon Capt Harrison) They do have a right. It is a statutory right that they can have those.

91. So someone who worked in the MoD and left in 1980 can ask for the record and it will be publicly available and sent to him or her?

(Surgeon Capt Harrison) In the event that someone left the employment of the MoD there is a statutory requirement to give them their termination record, both them and also to forward it to the HSE, and they can take it to their next employer should they be going to work somewhere else.

Mr Churchill

92. Can you tell us how long that has been the case?

[**Mr Churchill** *Contd*]

(Surgeon Capt Harrison) Since 1985. The previous Regulations required a transfer record, a slightly different name, but it was provided in exactly the same context.

Mr McFall

93. On the issue of measurements, the unions have expressed concern about past inaccuracies of dosemeters and, indeed, in my own constituency I had a letter from the MoD, I think in May, telling me that radiation exposure for workers was under-recorded. How reliable were these dosemeters and how reliable are they now?

(Surgeon Capt Harrison) We act as the RPA to the Royal Armament Depot at Coulport, which we are referring to. What we had been doing prior to 1989 was to issue people with the standard dosemeter. *This*[1] is an example of the dosemeter here and inside this dosemeter it contains two small quantities of lithium borate. This substance absorbs radiation. The container has a small window and a thickened window and *this*[2] thickened window is to give the effective dose in the body, whilst *this*[2] clear one the dose to the skin. This was the system which was in operation. As part of our job as the RPA we conducted a base-wide environmental review plan, which I know you are aware of, sir. What this plan demonstrated was that most of the practices were satisfactory but in one or two key areas, where additional monitoring was conducted new procedures were advisable particularly in the areas where people were maintaining the nuclear weapons. Now that we had the new technology to measure some of the radiation, particularly the neutron radiation, and also looking at the ICRP recommendations for the future, we looked at the records and decided that the dosimetry needed to change. If I could now just go into a little more detail on this, this particular dosemeter is sensitive to neutrons, but in fact it under-reads slightly. What we decided as a result of all our studies was that we should change uniquely for that establishment the type of lithium borate which is used and use a very pure type of lithium borate, not sensitive to the neutrons, and to wear a separate neutron dosemeter. The effect of this is that the neutron dose component, which is still a very small part of the overall dose, was under-read by—it sounds a lot—78 per cent. In fact, for that component there is probably no legal requirement to measure; if one looks at the regulations in the approved codes of practice, because that component is less than 10 per cent of the dose limit, there is not actually any necessity to measure it. What we are saying as RPAs in giving our advice—and the depot supports this—is that looking ahead into the future, into the 21st century, with the changes of ICRP recommendations, and with probable quality factor changes occurring for neutrons, it is prudent to change our practices. The result of that, of course, is we may need to amend some of those records. Whether they actually have to be amended is not up to us, it is up to the HSE. They are, however, very small.

Footnote by witness.

[1]The dosemeter demonstrated was a Thermoluminescent Dosemeter.

[2]The clear window will record skin dose to all radiations except alpha The thickened window will record the depth or penetrating dose

Chairman

94. Why did you change it uniquely at Coulport and nowhere else?

(Surgeon Capt Harrison) That is the only place where I can actually say publicly we store nuclear weapons, or may store nuclear weapons.

95. Would it not have application in AWE?

(Mr Saxby) No, sir, because at AWE the work programme is such that this particular problem does not arise at any significant level and we in any case have measured the neutron exposures of our staff across the board for many years, thirty years.

Mr McFall

96. You were always aware of neutron emission presumably from the warhead but it was just that you did not have a facility to measure that neutron emission correctly?

(Surgeon Capt Harrison) No, sir. Maybe I have not made myself clear. We carried out a survey to establish precisely what the neutron dose was. We were not able to do that till we had actually procured state of the art technology to enable us to do it. That has now been done. Looking ahead, we feel we have gone the right way by changing the dosimetry system uniquely for that establishment.

97. So there is neutron emission but you were not able to record it because you did not have the technology?

(Surgeon Capt Harrison) It was being recorded using the old lithium borate substance but it was being under-recorded. The fact that it is less than 10 per cent of the dose limit means it does not have to be measured by statute.

98. But for the more personal concern of individuals they like to know?

(Surgeon Capt Harrison) Exactly, and this is precisely what we have done. In fact, I have visited Coulport and spent a full day up there talking about this to all the workforce involved and did my very best to try and allay their fears and concerns and I tried to put this very small amendment to doses into the right perspective.

99. Are blood tests or biological tests employed to check on the accuracy of dosemeters?

(Surgeon Capt Harrison) Not in my area, sir.

100. Do you not think it would be a good idea?

(Surgeon Capt Harrison) It certainly is not necessary in the areas in which I carry out work.

101. Information we have had from advisers indicates that that could be a prudent step. Would that be one you would consider looking at?

[**Mr McFall** *Contd*]

(Surgeon Capt Harrison) We have the facility to do biological monitoring. For example, we still do reassurance monitoring of the dockyard workers for cobalt 60 to ensure that they have not taken up any cobalt 60—in fact, my staff carried out studies into that area—but it is not done routinely as a requirement of the legislation, it is reassurance monitoring carried out in full consultation and in agreement with the trades unions.

102. Lastly you refer to special dose limits on individual organs, skin and the eye. How are these measured?

(Surgeon Capt Harrison) By using extremity dosemeters. These are slightly different dosemeters which can be taped on to the fingers, on the body, anywhere really, then by taking a detailed study of how people work in that environment one can measure what the doses to the extremities are as against the whole body dose measured by *this* type of dosemeter and so we are able to double check.

Chairman

103. The NRPB is discussing with you the development of a personal integrating electronic dosemeter. What advantages will the new equipment have and when is it likely to be ready for use?

(Mr Saxby) Essentially, sir, it would enable highish doses to be seen quickly and to be acted upon. It will not replace, nor is it intended to replace, the kind of dosemeter the Surgeon Captain has been describing. There are, in fact, in existence already less sensitive and slightly less reliable types of integrated dosemeters of this kind. The NRPB are trying to drive their design and construction towards reasonably ultimate limits of reliability and sensitivity.

104. Let us go to some variations. The general trend in radiation exposures during the 1980s has been downwards, but this trend was interrupted at both Devonport in 1984 and 1985 and Rosyth in 1984, 1985 and 1989. Are these blips exclusively attributable to the fact that more submarines were refitted in the course of a year?

(Capt Thomas) The straight answer to your question is, yes, sir. May I please give a little more detail? For Devonport the rise in collective dose which peaked in 1984 was due basically to three factors: first, the build-up of the refitting capability in Devonport Dockyard bringing on stream refitting in the submarine refit complex; secondly, the effect of the closure of Chatham Dockyard and the transfer of the majority of the refit work programme across to Devonport; thirdly, the onset at about that time of what we call three-stream refitting, three submarines being refitted at one time. There were two new submarines and the third submarine was, in fact, an older and therefore slightly more radio-active submarine. So that accounts for the increase in 1984 in Devonport. In Rosyth, as you noted, sir, there is a smaller peak around 1983-84. It is difficult to come to a complete conclusion on that. It is probably due to the fact that, because dosimetry is carried out for a calendar year and it just so happened that the refit cycle entailed the completion of one refitting submarine in close proximity to the start of the other, the accumulation of those two things actually meant there were high doses in that year. There is nothing in our records which shows there was anything particularly unusual. You also noted, sir, in 1989 the increase that is wholly due to the commencement of two-stream refitting at Rosyth Dockyard.

105. Are the average doses at Rosyth noticeably higher than those at Devonport only because Rosyth is an older refit plant and refits older vessels?

(Capt Thomas) That is correct, sir.

106. Figures from the NRPB show that the DRPS figures on exposures are markedly higher for contractors. Is this simply because they perform different work or because they have lower standards of protection?

(Capt Thomas) You refer to the cumulative doses at dockyards, do you, sir?

107. Yes.

(Capt Thomas) The cumulative doses at dockyards look higher—are higher—because the dockyard workforce is a relatively stable workforce. The workers who operate refitting nuclear submarines are on the whole specialists who remain in that area for obvious reasons, whereas most of the submarine workers at operational bases will be naval personnel and, of course, their working patterns move them on so they do not accumulate the same sort of dose. That is the reason, sir.

108. How do you account for the unusually high levels of radiation at HMS NEPTUNE, the Clyde Submarine Base, in 1985 and 1986?

(Capt Thomas) It is not a particularly high one, sir. It is a blip and it actually reflects two things: firstly, that there was a period where increased numbers of inspections were carried out but more so that the build-up of submarines operating from NEPTUNE occasioned this fluctuation.

109. In a word, it was just a build-up?

(Capt Thomas) It was a build-up and also there will inevitably be with operating submarines fluctuations because of various elements of the programme which require more work on the large number of submarines berthed at that place.

Mr McFall

110. Can I take Capt Thomas back to one answer on Devonport. You mentioned the difference between 1983 and 1984, one of the reasons being the closure of Chatham. Can you tell me if you have figures for the number of individuals working in Devonport in 1983 who were not working in 1984?

(Capt Thomas) The actual numbers of personnel, the personnel who were working on the submarines?

[Mr McFall *Contd*)

111. Yes?

(Capt Thomas) If you refer to the table, sir, the figures are basically given in there. Can I just refer you to table 8 in the memorandum. For 1983 and 1984 we can work on the number of people who were monitored as being radiation workers, and you will see there was an increase from something around 2,500 up to something over 3,000 in 1983, and that peaked in 1984 to 3,074 persons who were monitored. That gives a direct reflection of the increase of the workforce to accommodate the increase in the submarine refitting scheduled there.

112. If one goes to the information supplied in the press—I think it was a report in *The Guardian* on Monday, 4 June, about the figures for high radiation at the base—they mentioned the figure has risen from over 2,000 mSv in 1983 to 9.230 mSv in 1984, so can I take it that that difference of over 7,000 was due to the increase in the number of personnel, 500 or so from Chatham mainly? Am I correct in that assumption?

(Capt Thomas) No, sir, it is not directly that. It is, in fact, a very large increase in nuclear work which accrued at Devonport at that period, as I referred to. I am referring you to the table and that is the reason.

113. Therefore, generally the workers have had a higher dose of radiation?

(Capt Thomas) Indeed, yes, sir, there is an increase. Again the table will show that over that period the average dose to workers did increase significantly and, of course, subsequent to that the dose reduction measures have come into force.

(Mr Howe) Could I add to that—and Capt Thomas will correct me if I am wrong—I do not actually have the article but as I recall, they actually attributed to one year an increase which was spread over a rather longer period. The graph showed one thing and the words said another. Actually the blip was not quite so sharp.

Chairman

114. So the *Guardian* article was wrong?

(Mr Howe) The words slightly misread the graph, yes.

115. It has happened before! I see the author sitting at the back, so I thought I would mention that! Let us turn now to the civil comparison. Figures for 1987 and 1988 from the NRPB show that levels of exposure for MoD workers are significantly lower than those of workers in the civil nuclear industry. Has this always been the case and is it because of the nature of the work?

(Dr Ridley) I was going to look at the same table and say we performed well compared to the civil industry. I do not have the figures available, I am afraid, to compare with the past, so I think I ought not just to guess.

116. I am sorry. I did not catch that.

(Dr Ridley) I also was going to use the NRPB memorandum if you had asked me to compare MoD's performance with the civil industry's. It is the only set of data I have to do that and I have no information about the past to answer your question as you put it.

117. So you do not know why the levels of exposure for MoD workers are significantly lower than those of the civil nuclear industry?

(Dr Ridley) I have no information on the civil nuclear industry from the past to hand.

118. How would we be able to make that comparison and discover that?

(Dr Ridley) I think we could ask the NRPB if they had information from the past for the civil industry. Our information over the last ten years is presented in the memorandum.

119. I am slightly surprised that they are the only people who should have it.

(Dr Ridley) I was trying to be helpful.

120. I am sure you are trying to be helpful, yes. Does not anybody else know?

(Surgeon Capt Harrison) I think I can answer that. There is a National Register of Radiation Workers that has been set up at the NRPB since approximately 1978, or thereabouts, and the civil industry and the Ministry of Defence have provided dosimetric data for its workforce to the NRPB. It should therefore be possible for the NRPB to break down the data year by year for all the nuclear operators, of which, of course, MoD would be just one.

121. Let us make a comparison with overseas. Is it true to say the levels of exposure at the royal dockyards are significantly higher than those at equivalent US dockyards?

(Dr Ridley) Sir, I have managed to locate two reports and, if you wish, I could send copies to the Clerk.

122. First of all, could you answer the question. Is it true?

(Dr Ridley) It is a complicated question. To compare like with like, it is helpful to look at data for recent years in the US and UK shipyards. For instance in 1988 the average dose for Devonport and Rosyth is exactly the same as the US shipyard average dose for 1988. It is slightly higher in the UK in 1989 but essentially it is broadly very similar to the corresponding figure for the US. In comparing the US and the UK there are a number of different aspects to look at and an average dose is just one.

Mr Churchill

123. What about the maximum doses? How do they compare?

(Dr Ridley) I would have to look at the tables to answer the question. We could write in and give you an answer. It is here.

124. Are they favourable to the UK or unfavourable?

[**Mr Churchill** *Contd*]

(Dr Ridley) For the naval propulsion programme the data for the last ten years in the US show that no-one has achieved a dose greater than 20 mSv. Their performance on just that measure looks considerably better than ours, because if you look at our results as presented in the memorandum, you will see that we had quite a number of people receiving doses greater than 20 mSv. I would submit that our own practice is steadily improving. In that category in 1979, for instance, we had 308 individuals. More recently, we have 41, 10 and 50 in that category in 1987, 1988 and 1989. There are reasons which would explain the difference. First, in the document which I will arrange to be sent to the Clerk you will read that the US Navy set an annual dose limit of 50 mSv, exactly the same as we do in the UK. In the dockyards they operate controls ranging from 5 mSv to 20 mSv for the year, depending on the amount of radioactive work scheduled. This explains their results. We have to look at differences between the US and UK programmes. The US has a much larger fleet and they began operations in 1955—eight years before the UK. The have already decommissioned many of their older ships. The US nuclear-powered ships require refuelling less frequently than UK nuclear-powered ships and the larger scale of the US programme, with six naval shipyards and two private shipyards performing work on nuclear-powered ships, means that there is a larger pool of experience to apply to shipboard work. Having said that and given you the answer to the question in terms of maximum individual dose, I was interested—and I thought you might be—in the issue of what was some measure of the cumulative dose that was experienced by the workforce. It is a complicated comparison between their big programme and our comparatively smaller programme, but if you take the data they give in their report, which covers all years up to 1989, their recent levels of man Sievert per ship, which is the total integrated dose in a year, and then divided by the total number of ships that they have—and they have something like 145 ships estimated for the data they present here—the result from that compared to doing the same sum with our programme is very similar. We are closer than a factor of two. So I believe that we can understand the difference between the two programmes and how the data which prompted your question comes about.

Chairman

125. Are you aware of the levels of exposure of the French nuclear submarine dockyards and bases?

(Dr Ridley) We could obtain no information on that. The French do not publish anything in this area.

126. Does that make you wish to transfer to the French Ministry of Defence so that you do not have to come in front of us and explain yourself?

(Dr Ridley) I did persist with seeing if I could get some information from France. Incidentally one of these documents covers doses experienced by personnel in the Department of Energy in the United States which could perhaps be compared with Aldermaston. The average dose in 1987 was similar. But the French CEA which covers the nuclear weapons research and production programmes tell me that they follow the EEC Directives, as we do, and operate to a dose limit of 50 mSv. The French Academy of Science recommends that lifetime doses should not exceed 1 Sievert. I have been told that the French have submitted a summary of information to the EEC. We have not succeeded in obtaining a copy, but when we do we will make it available to the Clerk.

127. That is very kind. To summarise all this, you look pretty good now, but do you think that is because of the measures that you took in 1985-86 to reduce radiation levels? Would you agree until then you were behind the United States and the civilian sector in radiation protection?

(Dr Ridley) I think where we are at the moment is a result of the continuous effort to apply ALARP throughout the MoD from very early days. It takes a long time for some of the improvements, particularly in the design area, to work through to results. But I believe that what we were seeing in the US data is that they apply exactly the same ideas as we do and they have just been at it a little longer.

(Mr Howe) I was going to add that point, that they were in the game before we were and they have been moving up the learning curve therefore ahead of us. I think that is a large part of the reason.

128. Let us turn to future radiation protection. You say the prime means of restricting occupational exposures in the AWE controlled areas for processing radio-active materials is to shield the sources of radiation as close to the source as possible. Can current shielding methods be improved?

(Mr Saxby) We are getting close, I think to the current limits of physics, but one looks always for new materials, for new mixes of materials, to try to improve the amount of shielding. There comes a limit to when shielding becomes so large it begins to affect the time people spend working there and so eventually you go past a dip in the effectiveness curve and the doses start to rise again because of the length of time that people have to spend working there. We are pretty close to the optimum position at the bottom of that dip in relation to the new designs of building and much depends upon the level of the future programme campaigns as to whether in any particular year one climbs up that side of the dip. So far as other means of protection are concerned, we have looked at and improved the containment of materials, so-called gloveboxes, over the years. Again we think that our current methods, which we have discussed much with other countries and other operators, are at about the optimum for present design processes. That does not mean we are in any way resting on our—backsides, we are looking to the future.

129. "Laurels" is the word you were looking for.

(Mr Saxby) Thank you, sir, I stand corrected. We

[**Chairman** *Contd*]

are not by any means trying to be complacent, we are looking to the future. The programme is necessarily, as I said, a campaign type work programme and one wants to be in the position to take those upward variations when they come and keep levels down. The other element is automation and we are looking to research in this area.

130. One way to increase protection is to increase the distance between radio-active material and workers. Is new technology being developed by MoD to enable you to do this better?

(Mr Saxby) Yes, sir, a lot of the requirement with nuclear weapons necessarily involves close contact work, but wherever we can see opportunities for increasing the distance between the operator and the work we are doing so, and we currently have some quite extensive research and development projects to look at that aspect in the weapon-handling area.

(Mr Howe) Might I give the opportunity to Capt Thomas, if he wants to, to add something about the naval programme?

(Capt Thomas) If I may. There are many, many areas in which we are working to continue the downward trend, but particularly for the new classes of submarine you have mentioned, the new class of fleet submarines. Perhaps it would be helpful to give an indication of the areas we are working on specifically later.

131. We have some specific questions for you on that. I am delighted to hear you say there are targets for the further significant reductions. What design changes are involved?

(Capt Thomas) Specific design changes both in the field of materials—there are specific materials used in the pressurised water reactor plant which, if activated, are plated out through the circuit and give out relatively high levels associated with the specific type of plant. We along with industry are looking at alternative materials to obviate this problem. It is one which is not unique to us, it is one where we are working very much in concert with both national and international agencies who have the same problems as we do. Inevitably the problem is that the materials used currently are good materials, they are materials that are fit for the purpose, and one has to be immensely careful not to make changes which could have an influence on the plant safety. In this particular area I speak of we do see the light at the end of the tunnel and anticipate that in the new classes of submarines we will be able to incorporate alternative materials that will make a very significant change.

132. Will they benefit submariners or refit workers?

(Capt Thomas) A benefit across the board, sir.

133. Have you yet got any indication of whether the targets will be met for reductions?

(Capt Thomas) We believe the more stringent targets we have set are achievable.

134. How much will the additional design features cost?

(Capt Thomas) I could not give you that at present, sir, because we do not have the full details of the materials. We anticipate being able to include or incorporate those within the existing target costs for the submarines.

135. Is the cost likely to be significant?

(Capt Thomas) I do not believe so, sir.

Mr Churchill

136. In addition to the change in materials, what consideration has been or is being given to enabling specific jobs to be done significantly quicker than was possible in the past so as by that means to reduce the exposure which clearly is a factor of time as well as one of distance from the source of radiation?

(Capt Thomas) We have given considerable consideration to that, sir, not only for the new submarines but for existing classes of submarines, a lot of work, and the great success has been that in the fields of training, the use of mock-ups, the use of non-active components, so that the time actually down in the reactor compartments has been minimised. We have achieved much in the field of automation and semi-automation, the use of automatic pipe-welding machines, the provision of motored components, so that the operative can set the thing up and come out of the compartment and enter another area. Where considerable improvements have been made is in the use of preformed lagging, so that when we have to go in and carry out in-service inspections, which is required by the safety programme, then the dose accrued in taking the lagging off and putting it back on again has been reduced by orders of magnitude. So those are the areas where we have had great success. They have not been cheap. In answer to the Chairman about the cost of changes to materials, there are other material and plant changes we are making which will incur significant costs.

Chairman

137. Your evidence says that at AWE Aldermaston, appropriate personal protective equipment (clothing and respiratory protection) is provided. Do you foresee any improvements in this equipment?

(Mr Saxby) So far as protective clothing is concerned, I do not think there is a great deal of scope for improvements there, in the current protective clothing being used at Aldermaston.

138. So we have gone as far as we can go?

(Mr Saxby) As far as one can go but it can be made a little more comfortable because the more comfortable the clothing is the better the effect on the workforce, so that people will react better. Respiratory protection is always an area where improvements are being looked at and we collaborate closely with our colleagues elsewhere and in the Ministry of Defence in endeavouring to improve respiratory protection.

[**Chairman** *Contd*]

139. Do you all use the same or similar equipment at the dockyards as well?

(Mr Saxby) The work patterns are so very different that I think there are different commitments as between AWE, on the one hand, in its handling of the radioactive materials, and the dockyards with their particular problems, on the other.

140. But you have available all the protective equipment you need?

(Capt Thomas) Indeed we do, yes.

141. The MoD has a duty to optimise protection and ensure levels of exposure are "as low as reasonably practicable" (in your words). How costly would changes to increase protection and further reduce the levels of exposure be? Have you undertaken a cost-benefit analysis of possible changes?

(Dr Ridley) I do not have a full answer to that question. We look at reducing doses, as the examples which have just been mentioned. We do not collect a central total that would answer your question, unless my colleagues can add to that.

(Mr Howe) Can any of my colleagues give an example?

142. Is cost-effectiveness the main constraint on what is reasonably practicable? They are your words

(Mr Howe) I would say it is one among several.

(Capt Thomas) Could I cite the example of the whole-plant decontamination process for the naval nuclear propulsion programme. That has been an immensely costly development which has been taken right the way through from the prototype where we tried out this process and it is now being operated by both the royal dockyards. But seen against the radiation figure given by the NRPB and updated in their evidence to the Sizewell Inquiry, we would have spent certainly a factor of 10 more per man-sievert on reducing dose against that sort of arbitrary figure of so many thousand pounds per man-sievert. So that is a good example of where cost certainly has not been brought in as an overall balancing factor and we certainly do carry out for the major elements of our programme cost-benefit analyses on the cost of doing the job, the decontamination versus the benefit, as far as dose improvements are concerned.

143. Can you give us an example of a protection measure which has been rejected because it is not cost-effective?

(Capt Thomas) I certainly could not in our programme, sir.

Mr Home Robertson

144. You indicated just now that cost was one of the factors which you took into account in determining whether something was practical in terms of "as low as reasonably practicable". Can you give us a list of the factors which are taken into account in ranking order?

(Mr Howe) I am not sure I could do quite that. I would comment that what was going through my mind was simply that there must be circumstances when it actually, impedes one operationally to do it a different way, and that difficulty cannot be measured only in terms of cost-effectiveness. It is actually detrimental to one's operations to design the submarine or whatever it is in a different way

145. Yes, but the term "practicable" is obviously crucial to the determination of whether the objective is being achieved, and what I would like to understand is who forms that judgment and what factors go into it?

(Dr Ridley) I think the difficulty we have is that dose reduction is done with all the factors brought in and we have not got readily available a nice tidy list of them. They are all looked at together. I am not sure they are taken in any priority order. For instance, if you decide that you wish to increase the shielding in a submarine so that the radiation levels hypothetically went very low and the shielding got very thick, so that you could not take the submarine to sea, that would be impractical. That is a somewhat extreme example.

146. It is rather, yes.

(Dr Ridley) But certainly in other areas you are getting close to that, and Mr Saxby earlier did mention that you could impede the access to a particular area.

(Mr Howe) Could I amplify one point. You said, who makes the judgment. This is a point that perhaps I did not make very clear at the very beginning. The actual responsibility for, as it were, delivering radiological safety is with the management of the establishment or the commanding officer of the ship or whatever it is, so that the judgment on a day-to-day basis to implement the ALARP policy rests very much with the management or the commander or with those responsible for the design of the equipment. It depends what the particular problem is.

(Capt Thomas) Can I make two very quick points. First, picking up from Mr Howe, within the Naval nuclear propulsion programme there are two particular high-level committees who are responsible for reviewing and coordinating dose reduction measures, and from those there are off-shoots which would look at specific points, so there are people who are properly qualified to do that. The other point is on this whole-plant decontamination process. One of the factors in its cost, of course, is the management of the waste which arises from this programme, and if you have a submarine which is a new submarine, it has accrued only a small amount of specific activity and one would have to bear thought in the cost-benefit analysis as to not only, of course, what was reasonably sensible but also the problem of storing the radioactive material—and it is quite large in bulk—which arises from doing that decontamination process. Currently there is no nationally approved mechanism whereby we can dispose of that material and, therefore, one has to

[**Mr Home Robertson** *Contd*]

bear in mind the fact that it has to be stored on site That is one example which might be helpful.

Chairman

147. When you find ways of improving protection in dockyards, who bears the cost?

(Capt Thomas) At the end of the day—and I am not very well positioned to answer this—basically the cost will be borne by the Ministry of Defence. It must be.

148. Not by the contractors?

(Capt Thomas) I must be careful how I answer this because I am not a contractual expert, but generally speaking, it would be borne by the Ministry.

149. Have you had any experience of any of the contractors saying, "This is going to cost us money"?

(Capt Thomas) Yes, sir

150. What is the answer when that happens?

(Capt Thomas) The answer is it has to be debated with us and at the end of the day the Ministry of Defence must give the answer, "The responsibility basically rests with us as the people who own the submarines."

Chairman: So at the end of the day the MoD pays?

Mr Home Robertson

151. Or does not, as the case may be?

(Capt Thomas) I think if you will allow me, I am getting into deep water here and I will be——

Chairman

152. Do you know the answer, Mr Howe?

(Mr Howe) I do not, I am afraid.

(Mr Paren) I think it is undoubtedly true, Mr Chairman, that the Ministry of Defence would pay and this is because, of course. when you are using nuclear facilities to do nuclear work on behalf of the Department there is no other customer than the Ministry of Defence. We own the assets, the dockyards, and this is, of course, reflected in the costs that we charge for those assets That inturn is reflected in the overheads which we pay for all the work done on behalf of the Ministry of Defence. Most of the work which is done by the two dockyards is done on our behalf; a relatively small proportion at the moment is done on behalf of other customers. In the nuclear field all the work is done on our behalf Therefore, it is inevitable that the costs associated with that work will come back to the Ministry of Defence

Mr Home Robertson

153. Can the Ministry insist on the adoption of any particular working practice in the dockyards in order to achieve the lowest practical dose?

(Capt Thomas) Generally speaking, sir, yes, we can.

154. And you would accept the responsibility to pay for it if necessary?

(Capt Thomas) I believe that is exactly as Mr Paren has said.

Chairman

155. Would you or the contractors consider removing workers from work involving high levels of exposure after a period of years?

(Dr Ridley) Certainly if an individual worker expressed a wish to be removed from radiation work we would look at it very sympathetically.

156. Has that happened?

(Dr Ridley) I think there has been——

157. That was my next question. I am very happy to take it because the next question I was going to ask was, how would you respond to the union suggestion that if a worker wanted to move out of an active area he or she should be able to do so, which is an assurance given in the civil nuclear industry. Has this occurred?

(Dr Ridley) I am not sure I understood the question, sir.

(Mr Howe) I think the answer is right as far as our position is concerned.

158. If a worker asked to be moved out of an area where he was receiving radiation doses, you would accede to his request?

(Mr Howe) No, Dr Ridley did not say that, he said "give it sympathetic consideration".

159. Yes, you made that clear. What does that mean?

(Mr Howe) It means, I think, we cannot give a guarantee in all circumstances to move someone who asks but we will do our best.

160. But assurance is given in the civil nuclear industry.

(Mr Howe) But I think the circumstances are different. We might be dealing with defence requirements, operational requirements, operational imperatives I think we would fall short of that guarantee

161. Let us break the thing down between servicemen and civilians. Are they treated the same? What happens if a serviceman says "I have received X amount of radiation dose over these years, you may be happy with it—I am not. I would like to stop getting any more"?

(Mr Howe) In general I think we would not allow servicemen quite the same latitude in terms of military discipline in determining their own employment within the service that we would to civilians, quite frankly, because I think there is a difference there.

162 Has this happened? Have you had people asking to be relieved of working on further radiation?

[**Chairman** *Contd*]

(Capt Thomas) To our knowledge we have not as yet had that.

163. Has it happened on the civilian side?

(Mr Saxby) We have had one case recently of a man who requested to be moved but he asked if he could come and talk first to the staff who were responsible for the counselling post-Gardner and after that discussion he went back to his work and has not followed up the request to be moved.

Chairman: That leads us neatly into Gardner and various studies. Mr Churchill?

Mr Churchill

164. The Ministry of Defence notes that Gardner's findings "cannot yet be regarded as fully understood and may yet be shown to be due simply to chance", Annex B, paragraph 9. A case control study similar to the Gardner report is being undertaken for Aldermaston and Burghfield and is due at the end of 1990. How far is that study progressing and will its results be publicly available as soon as it is completed?

(Dr Ridley) The study, of course, is funded by the Department of Health and, as you say, is similar to the Gardner study at Sellafield. MoD has no information on the likely results. Where appropriate, MoD are supplying information to the researchers. When the report is complete it will be published in a learned journal.

165. Do you understand it is on schedule?

(Dr Ridley) I have no information on that.

166. You refer in paragraph 41 of your paper to a possible major study by NRPB. How far is that progressing?

(Dr Ridley) That study involves merging a large computer base which NRPB have—we referred earlier to NRRW—and another computer base compiled by the Oxford Childhood Cancer Research Group. The Department of Health are well advanced in discussing how such a study might be carried forward in terms of finance.

167. If the Gardner findings were to be validated, what would be the implications of that for MoD policy, and how soon could changes be implemented?

(Dr Ridley) If the other studies being done were reported and produced results anything like the Gardner study, we would have to consider them very carefully

168 How quickly would you be able to move to decisive action in that field?

(Dr Ridley) It would depend on the results of those studies.

Chairman

169. If they validated Gardner, what would the implications be in that light? It goes without saying that you would consider them

(Dr Ridley) The problem is that Gardner correlated various things. He referred to men whose cumulative dose was greater than a hundred mSv, but did not say how much greater. He also referred to paternal doses "greater than 10 mSv in six months before conception" and again did not say by how much greater than 10 mSv. One would wish to see more data to answer your question as to what the proper reaction might be. We look forward to the results of these studies with considerable interest.

Mr Churchill

170. What steps has the MoD taken to inform workers who are occupationally exposed to radiation at defence establishments of the Gardner findings and their implications? .

(Mr Saxby) The AWE first of all discussed this with its unions in the Health and Safety at Work Committee which is the statutory body, and then issued a notice which was given to every single employee with the exhortation to employees to discuss this with their families. In the ultimate paragraph of that notice employees were invited to come for counselling with the medical officer and with specialists and also, if they so wished, bring their families as well—and ex-employees. We have had a small take-up on that, somewhere between five and ten people came back to us. As I said earlier on, one was sufficiently concerned to be thinking whether or not he ought to stay in radiation work.

(Surgeon Capt Harrison) Yes, the response to Gardner was first of all to look at the report itself very carefully, but being a government department we needed to wait to see what the specialist advice was from COMARE. COMARE, in fact, suggested no changes specifically and suggested the further studies. What we did within the Ministry of Defence was that the Surgeon General's department issued guidance to all medical officers within the Ministry of Defence worldwide, both to service people and civilians, and this involved the Civil Service Occupational Health Service as well. That guidance took the main points of the COMARE advice and tried to put the Gardner hypothesis into perspective against many other hazards that exist within industry and the natural incidence of leukaemia and various other things, and it was made available to medical officers within the service who counsel both individuals who are employed in radiation work and their families. To date in Rosyth fewer than 20 people have sought guidance, in Faslane, 3, in DML, 39, and I went out personally to check all the workforce at Coulport, because it coincided with the publication of the programme.

171. Guidance has been given to medical officers?

(Surgeon Capt Harrison) Yes.

172. Have you taken steps to issue those individuals who do have contact with ionising radiation with a leaflet?

(Surgeon Capt Harrison) Not specifically, sir, no, we have not. We have allowed the individual

[**Mr Churchill** *Contd*]

medical officer to decide how he will pass that information down the line. It is a little complex.

173. Are you satisfied that it has been passed down the line?

(Surgeon Capt Harrison) I am.

174. That it has not been retained by the medical officers?

(Surgeon Capt Harrison) I think in all establishments the opportunity has been given for staff to come for counselling. Quite how that counselling is carried out on an individual basis I do not think we are privy to at all. Certainly we are quite happy that the medical officers are properly briefed, and as to whether the medical officers themselves pass our advice down to individuals I am afraid I cannot say. We certainly have not produced a special leaflet at this stage.

Mr Churchill: But as I understand it, AWE have. Has that been made available to our Committee or could it be?

Chairman

175. Capt Thomas, would you like to add to that?

(Capt Thomas) In answer to Mr Churchill's question, in the Naval nuclear propulsion programme, of course we do not have any ability to instruct the two royal dockyards but we are aware that Devonport Management Ltd have given a very full briefing to their people and we have participated. My deputy, as a radiation biologist, has been to HMS NEPTUNE, where there are a large number of radiation workers, and has reasonably recently visited the training establishments, where clearly there are people coming to see him who hear about Gardner and hear about these concerns. So we are trying to issue guidance to them at this stage before they come into the programme, so we are taking these things effectively forward.

(Surgeon Capt Harrison) Can I add, because I think it might help, the Surgeon General is contracted at the moment to provide an occupational health service to the two privatised dockyards. I thought it would be useful for you to be aware that it is a Ministry of Defence responsibility to provide medical counselling in those two areas.

Mr Churchill

176. In line with the seriousness with which the Ministry of Defence are treating Gardner pending further verification of the studies, have any specific studies been undertaken to reduce the exposure specifically of the younger workers who may be contemplating starting families and to use instead in certain situations the older workers and employees who have already produced their families?

(Surgeon Capt Harrison) I think the difficulty here, sir, is that the age of the worker does not relate to the age of his wife.

Mr McFall

177. Following Mr Churchill's questions, may I state I have had a communication from the trade unions, like other Members of the Committee, and they state that the MoD is proving to be the most difficult of all employers in the nuclear industry. Indeed, their initial position in response to Gardner was to do nothing until further studies are carried out. May I say that that assertion has a certain legitimacy in my eyes because, like all parliamentarians, I received parliamentary briefing from BNFL dated 26 February 1990 stating that in the light of Gardner BNFL has announced a series of new initiatives and if further work in Gardner is substantiated these initiatives would include discussions of ways of mitigating the effects of the disease, ways in which its cause can be identified and eliminated and a compensation formula agreed. Is it not the case that the MoD has just taken a "say nothing, do nothing" stance and it has not been in the interests of the workers in the Ministry of Defence?

(Dr Ridley) I think MoD is confident that the policy of dose control within MoD, wherein all doses are maintained at low as reasonably practical, will keep dose levels low without the need to set further targets, which was some of the reaction of some of the other industries that you mention. As we have stated in the memorandum, we have set a voluntary annual dose limit of 30 mSv which will be strictly adhered to and we also mentioned, of course, that we will certainly look carefully at the result of further studies. But it is very clear that the Gardner study itself did not say a causal connection had been proven. Since the Gardner Report has come out, there have been communications in the technical literature which have questioned whether there could be that causal connection. In fact, words as strong as "does not stand up to scrutiny" are used by other eminent people in the technical press. The results do not match or compare with the data available on 7,400 men survivors of the atomic bomb in Japan, men who had an average exposure of 500 mSv, their children suffered no increased incidence of leukaemia. MoD will watch the results of these further studies very carefully indeed and react accordingly.

178. But, as Captain Harrison has said, I think 45,000 records were mentioned earlier on of people who had been involved. Why do you not then, given the high number of individuals involved, undertake your own studies to allay the fears of individuals? Why do you not set limits with the trades unions to demonstrate that you are concerned about the situation in Gardner instead of sitting on your hands and putting the responsibility on other bodies like the ICRP where delicate political negotiations are going on from different countries? They are putting their point of view, yet the MoD is doing nothing.

(Surgeon Capt Harrison)) I think I can help here, sir. I think we need to look at the normal incidence of leukaemia in the general population. It is of the order of 2 per thousand children born, that is

[**Mr McFall** *Contd*]

dealing with childhood leukaemias.[1] That is the sort of general figure. If you take all our workers, therefore, and you assume they have all procreated whilst they were actually receiving their doses and all had one child, we are dealing with a very small number of children and, therefore, we would be dealing with a very small number of potential cases of leukaemia. It is not certain that we definitely will have those cases; so if you look at our total numbers, no matter which view you look at them—either historically or today—the total number of cases of leukaemias would not stand up to any statistical scrutiny in the epidemiological sense. We need to be involved in a much wider study to look at the causation of this very rare disease. It is an extremely rare disease. That is the only answer I can give you because to do a smaller study will not have the statistical power.

179. Is it reasonable to assume then that the average annual radiation exposure at defence sites prior to 1979 was significantly higher than post-1979 levels? Is that a reasonable assumption?

(Surgeon Capt Harrison) I think it is a reasonable assumption in the areas where the nuclear programme was under way certainly.

180. So we have come down with our radiation levels?

(Surgeon Capt Harrison) That is right.

181. But as yet you are not fully accepting Gardner and you are waiting for other people to proclaim on Gardner and you are doing nothing on your own yet, there is no MoD initiative?

(Surgeon Capt Harrison) The point about it is that the MoD has been part of the National Registry of Radiation Workers since its inception. We formed part of this large package of workers and their dose records which the NRPB have provided you with, this wider package of people, this is the group that must be studied right across the board. To look at our workers, rather than looking nationally, I do not think would help us at all. We may be able to do some sort of small study—we could possibly—but it is not likely to come up with a worthwhile answer. We must do, as I said, as COMARE has advised.

(Mr Howe) I want to give Dr Ridley the chance to take up that same point because the clear advice we get is that, of course, studies need to be done but they need to be high-powered, much bigger studies than we could mount, as it were, on our own population and with our own resources, so that our contribution is essentially to contribute to the studies of other people and not to run similar studies of our own, but Dr Ridley will amplify that.

(Dr Ridley) Following what the Surgeon Captain said, we rely on COMARE's advice. COMARE suggested the need for the case studies such, as the one I mentioned earlier, at Aldermaston. Since then, COMARE has modified its advice and, has come out very strongly indeed against further small studies which individually have very low statistical power. Their recommendation goes strongly for this much larger study on, 100,000 workers. It has a much greater chance of having statistical validity. Around Sellafield there were very few cases, so the uncertainty of the Gardner study, although very carefully conducted, yielded only four cases. Hence the possibility that it might be by chance, but no-one can tell that until one has more statistics to bring to bear.

(Mr Howe) Could I say I do not want you to derive from that the impression that we do not take Gardner seriously, that we do not take our responsibility seriously. We jolly well do and we take the ALARP principle extremely seriously and make strenuous efforts to implement that policy, so I do not think I can accept the criticism that we just do nothing.

Chairman: Let us turn finally to compensation.

Mr Churchill

182. The Ministry of Defence has received, so we are told, a number of claims for compensation from service and civilian employees for radiation-related illness, and a Minister stated as recently as 18 April in the House that every claim is dealt with on the basis of legal liability. Can you tell us how many claims have been received and of those, how many have been settled?

(Mr Howe) I believe we have had 126 claims in all and we have paid compensation in none up to now.

183. How far back do these claims go? When was the first of the 126 lodged?

(Mr Howe) I cannot answer that question from the information in front of me, I am afraid.

184. Are we talking of claims which have been lodged in the last two or three years or are we talking of claims which have been lodged over the last couple of decades?

(Mr Howe) We are talking about a long-term trend, but exactly how long I cannot tell you, how far back the statistic goes.

185. How do you explain the fact that no settlement has been reached in any of these cases?

(Mr Howe) As you have just said, we address claims on the basis of legal liability and the essential point there is that the claimant has to show that there is a causal relationship between his illness and radiation to which he has been exposed, and the claimants up to now have not established that

Footnote:

[1]In 1984, 871 registrations for ICD No 201–208 (leukaemias; including lymphomas, Hodgkins disease and myelomas) for ages 0–24 were made to OPCS; there were 637,000 live births

Sources:

a. Table 4 Cancer Statistics registrations 1984. OPCS Series M81 No 16. Published HMSO 1988 ISBN 011 6912189.

b Table 2.16 Annual Abstract of Statistics 1990 Edition. Central Statistical Office No 126. Published HMSO 1990 ISBN 011 6203951

[**Mr Churchill** *Contd*]

186. Is that not because the dice are so loaded against him that it is effectively quite impossible to provide that in his lifetime?

(Mr Howe) I do not think so. I think if there were a demonstrable link it could be demonstrated. I think it rather reflects that we are more successful than we are given credit for in implementing a safe regime.

187. You are certainly very successful—whether it is a matter for credit is a matter for debate—in resisting all these claims for compensation. What confidence can present employees of the Ministry of Defence have in this field, given MoD's record in the case of these 126 applications for compensation and the fact that it is virtually impossible, as the rules stand, to prove that a particular leukaemia or myeloma or cancer has been caused through an individual's service in the nuclear field rather than from any other conceivable cause?

(Mr Howe) I think all I could say about that is the 126 cover quite a wide variety of cases.

Chairman

188. Are any submariners or dockyard workers?

(Mr Howe) I have not got that breakdown. They may well be, yes.

189. Do either of you know if any submariners have made claims?

(Capt Thomas) I do not know.

(Surgeon Capt Harrison) I would not know

(Mr Howe) I do not have that in front of me. We can do our best to amplify the figure. The point I am making is that many of those cases are supported by very little evidence except simply an assertion. Others are more supported than that. There are some six cases which are still what you might call active, current.

Mr Churchill

190. Of the 126 claims how many are in respect of specific forms of radiation-induced diseases that are liable to have been caused almost certainly by ionising radiation and not from natural causes?

(Mr Howe) I think if they were almost certainly caused by ionising radiation to which they had been exposed, then the claim would have been validated.

Chairman

191. You say six are still current. You mean the claims are still being investigated?

(Mr Howe) They are still active on our books, they have not been disposed of. I think the breakdown is that quite a small minority of those 126 are leukaemia and cancer—some 25—and the rest are other illnesses for which I do not have the breakdown, I am afraid. We are talking about a smallish minority of cancers among the total claims. I cannot break that down between cancers which are more or less likely to have been related to radiation, I am afraid.

Mr Churchill

192. There have been certain cases where in recent months the DSS has made payments relating to individuals who were involved in our nuclear test programme over the years. Have any of these 126 claimants been granted any compensation or pension by the Department of Health or the DSS even though they have not been given compensation by the Ministry of Defence?

(Mr Howe) I do not have that information. I think it very possible, yes. I am talking here just about claims under common law against us for compensation in respect of injuries received.

193. Could you let us have a note about that?

(Mr Howe) We will try and amplify the figures as much as possible.

194. Could you say when and how the Ministry of Defence will be responding to the proposal from the trade unions that the civil nuclear industry "no fault" compensation scheme should be extended to cover MoD employees?

(Mr Howe) I cannot give a precise date for that. As you will know, we are looking very seriously at it. It is quite a complicated issue and the BNFL scheme itself is being reviewed at the moment. I think we want to see whether any adjustments to the scheme come out of that review before we finally take a decision. I think it will be some time in the next few months, but I would not like to put a clear number of weeks on it.

195. How long has this proposal so far been before you?

(Mr Howe) I think it was first raised in 1988. I acknowledge that is some time ago, but it is very actively being looked at at the moment.

196. When you say in the next few months, you presumably mean before the end of the year?

(Mr Howe) I hope so, yes. I was thinking partly when I said that of the fact that, as I understand it, the examination of the BNFL scheme is due to be completed some time in the late summer or early autumn. I doubt whether we would take a firm decision until we see how that comes out.

197. What would be the situation in the case of a dockyard worker in the event that liability was to be proved? Who would pay for the consequences of cumulative exposure of an employee who was first employed by the Ministry of Defence, then subsequently by a contractor?

(Mr Howe) If I were to answer it would be a pure guess. I could not really comment on that. I see the point of the question. This is obviously one of the points that is part of our review of how we treat people who were formerly employed by the Ministry of Defence and are now employed by other departments. This is one of the complications that we are having to look at.

[**Mr Churchill** *Contd*]

198. But earlier in your evidence this morning you agreed that it would be reckless and irresponsible in the future to expose individuals to doses of radiation which had been regarded as acceptable as recently as five years ago. In those circumstances, it is really defensible for the Ministry of Defence absolutely to stonewall these claims for compensation from 126 of your former employees?

(Mr Howe) I do not think we are really stonewalling. Some are still active. We are—and please accept it—genuinely looking at the scheme you mentioned also, and I am not going to predict either way how our examination will come out. As for reckless and irresponsible, I do not think we quite said that. I think what we said is that the policies to which we work and the limits to which we work have been considerably tightened over the years. I do not think we would accept that everything that happened prior to 1985 is reckless and irresponsible.

199. You are saying that, so far as the information which is available to you today which you say was not available to you 10, 15 or 20 years ago is concerned, prudent management and concern for the health of your workforce requires that these doses be significantly reduced. The clear implication of that is that had you known this information 15 or 20 years ago you would have acted upon it so that people would not have been exposed to the same level of doses. How can you square this approach with the approach that you are taking in resolutely denying that any part of their melanoma or their cancer or leukaemia has been caused through employment with the Ministry of Defence?

(Mr Howe) I think that in our own policies of control and the ALARP limits we set ourselves, we as it were aim off in the direction of safety. Those limits cannot be described as the threshold above which we acknowledge legal liability and it is legal liability which at the moment governs our response to claims, but that is not, as you said yourself, to say that people are not compensated in other ways through other compensation schemes. But in terms of common law claims against us they have to establish that the injury is attributable and there is, frankly, a gap between what is required to demonstrate that and what we consider to be a safe margin that is reflected in our own policy.

200. What consideration has been given to introducing similar rules as were brought in under the Reagan Administration in the United States, where, if workers were exposed or military personnel were exposed to particular doses in particular locations at particular times, the burden of proof should no longer be on them to prove that their particular illness could only have derived from their military service?

(Mr Howe) As I understand it, that is rather the logic of the BNFL scheme which you are asking about and it is part of the logic that we are now looking at in the context where you have, as it were, levels of radiation and levels of payment in a banded system but you do not need to prove causation.

201. Is it not very unfair if the present employees who are having to undertake this work in the interests of the nation as a whole should not be seen to be able to have available to them a proper scheme of compensation in the event that their work leads them to an increased risk of developing these diseases?

(Mr Howe) Well, as I say, I cannot do better than say we are looking at the BNFL type of scheme, the logic of which is as you describe. But it is a complicated issue as I think has come out. We are looking at how we would handle those who are no longer in our employment but were in the past, how the benefits under any such scheme might relate to what might already be available from other sources, industrial injuries compensation arrangements, war pension schemes and so on. We need to decide whether such a scheme would cover servicemen and civilians or one or the other. It is a complicated issue. Believe me, we are taking it seriously and we will come out with a view fairly shortly.

Mr Churchill: Thank you.

Mr McFall

202. At Rosyth and Devonport where contractors are undertaking work with MoD (at Rosyth, Babcock Thorne, and at Devonport, Devonport Dockyards), if it is found that there is a link between radiation and cancers, who would be responsible in that case? Would it be the contractors or would it be the Government?

(Mr Howe) I think my simple answer would be it depends, just turning the thing round, on whose responsibility it is, to whose action that exposure can be attributed. I do not know if we have any clear answer on that. May we look at that ex-Committee and see if we can illuminate it.

203. Sure. Are there any legal contracts between contractors and government to that effect? If you cannot answer just now——

(Mr Howe) We shall have to look at that. I am sorry I do not know the answer to that.

Mr Home Robertson

204. One very quick supplementary: can you give an indication of how many of your 126 complainants have died?

(Mr Howe) No, I am afraid I cannot do that either.

205. A significant number must have.

(Mr Howe) I do not know. As I said before, about a quarter or a fifth of those are cancer cases.

Chairman

206. You can give a breakdown of the 126?

(Mr Howe) I will do my best.

Mr Churchill

207. The years when the claims were lodged?

(Mr Howe) Yes, how old they were. I have that.

Chairman: Mr Howe, gentlemen, thank you very much indeed for a useful and helpful session.

WRITTEN EVIDENCE

Asterisks in the Evidence denote that a passage has not been reported, at the request of the Ministry of Defence and with the agreement of the Committee.

1. Memorandum submitted by the Ministry of Defence (5 June 1990)

RADIOLOGICAL PROTECTION IN THE MINISTRY OF DEFENCE POLICY AND PRACTICE

Introduction

1. This memorandum provides to the House of Commons Defence Committee an account of Radiological Protection policy and practice as operated by the Ministry of Defence (MoD). It outlines legislative requirements, particularly in respect of radiation dose limits, and sets them in their historical context. A MoD assessment of and response to the Gardner Report is given. The remainder of the paper describes the radiation sources present and the radiological protection strategy adopted within the nuclear weapons and nuclear propulsion programmes, to measure and minimise radiation exposures[1]. Its efficacy is demonstrated by statistical information on the doses recorded for various groups of personnel and MoD as a whole. Finally, it briefly outlines a number of studies relevant to the health of the occupationally exposed MoD workforce.

Administrative Responsibilities for Radiological Protection

2. On behalf of the Secretary of State for Defence, central co-ordinating responsibility for Health and Safety at Work matters generally in MoD lies with the Second Permanent Under Secretary of State (2nd PUS): within the Service Departments and the Procurement Executive lead responsibility rests with the appropriate Board member. Responsibility for implementation and control of radiological protection in particular lies with the Commanding Officer of a Unit or the Head of an Establishment operating with ionising radiations. National legislation on radiological protection applies throughout MoD and specific MoD requirements in this area are defined in Defence Council Instructions or equivalent Service instructions (published as Joint Service Publications). MoD has recently strengthened its central machinery by establishing a high level committee structure for co-ordinating and monitoring Health and Safety at Work matters, including radiological protection. In no way does this remove the executive responsibility from Commanding Officers and Heads of Establishments. These arrangements provide the basis for co-ordination and control of work involving access to ionising radiation throughout MoD.

Statutory Background

3. Under UK legislation, occupational exposure of all persons, including MoD personnel (Service and Civilian), to ionising radiation has to be justified, must be as low as reasonably practicable (ALARP) and must be fully in accord with the legislative limits. These are given in Schedule I of the Ionising Radiations Regulations 1985 (IRR85, Reference 1) made under the terms of the Health and Safety at Work Act 1974. The same requirements, promulgated in Joint Services Publication No 392 (JSP392, Reference 2), apply to all HM Ships, Units and Establishments. The policy underlying this legislation reflects the recommendations published in 1977 by the International Commission for Radiological Protection (ICRP) (Reference 3) when the ALARP principle was formally promulgated. The need to justify all doses and, where possible, reduce them has long been a feature of ICRP recommendations and has been a basic feature of MoD policy since the late 1940s when the UK defence nuclear industry was founded.

4. Dose limits were first incorporated into legislation by the Radioactive Sealed and Unsealed Sources Regulations between 1961 and 1969 During the period from 1950 until 1985, when the current legislative limits were specified, the main annual limits (in current units of millisieverts (mSv) per annum) have decreased from 150mSv to the figure of 50mSv which applies today. The occupational limit recommended by ICRP in 1950 was 500 milliRontgens per week (equivalent to 150mSv per annum). This was replaced in 1958 by a quarterly limit of 30mSv, ie up to 120mSv in a year, but with a formula giving an overriding age related limit which amounted to 50mSv per annum over a working lifetime from age 18. The legislation also includes a 15mSv level at which work practices have to be investigated and beyond which any exposure has to be formally and fully justified. In addition to the present whole body exposure limit of 50mSv per annum, including doses due to intakes of radioactivity, other special limits apply for individual organs, skin and the lens of the eye and for certain classes of personnel such as trainees under 18 and pregnant women.

5. For regulating work with ionising radiations, a system of designated 'controlled' and 'supervised' areas is required by statute. Work above specified levels of radiation must be carried out in 'controlled' areas where special protective measures are applicable Where the radiation doses are lower, the area may be designated 'supervised'. It is a requirement that people working with radiation and radioactivity in 'controlled' areas be designated as classified persons. Notwithstanding, other personnel may also work in controlled areas without necessarily being designated as classified persons, provided that their work would not result in individual exposures greater than 15mSv per annum and their work is carried out under conditions laid down in a formal "Written System of Work". Personal dosemeters must be issued to and

[1]The NRPB booklet, "Living with Radiation" 4th Edition 1989, gives an excellent background to sources of radiation exposure, including occupational exposure

worn by all classified persons, whenever their work requires them to be exposed to ionising radiations. In MoD, personal dosemeters are normally also issued to others, ie those subject to Written Systems of Work, though it is not a requirement to do so if it can be shown by other means that the 15mSv annual dose will not be exceeded. For classified persons, formal personal dose records must be held for at least 50 years. When they leave, a formal summary must be given to them and another passed to the Health and Safety Executive (HSE) so that the data can be carried into any new employer's records. An initial medical examination by an approved doctor is required for each classified person. All persons working with or associated with work with ionising radiations must be informed, instructed and trained, so that they have a basic understanding of the types of radiation and other hazards involved, the precautions to be taken and the dosimetric and other personal safety measures required to provide assurance of safe working. All such workers must be provided with appropriate supervision. The principles of justification, optimisation (ALARP) and dose limits apply to all workers whether or not they are classified persons.

6. Radiation Protection Advisers (RPAs), who are statutorily appointed by the HSE as being qualified and experienced, are responsible for providing advice and assessing all radiological practices and for reviewing doses and procedures for compliance with the ALARP principles of dose restriction. All MoD establishments and contractors have the assigned services of one or more RPAs, either in-house or with ready access. For some areas the Defence Radiological Protection Service (DRPS) acts as a corporate RPA, and has a wider responsibility to provide advice on radiological matters across the whole of MoDs activities, excepting the Atomic Weapons Establishment (AWE) which has its own Safety Division including specialist radiological protection staff. Dosimetry, which, for classified persons has to be by a dosimetry service approved by HSE, provides data to enable the local management to maintain a close awareness of the extent of radiation exposure of the workforce, to take action promptly to curtail doses if higher than expected doses occur and to monitor the effectiveness of the measures taken in the design of plant and the operating procedures. The dosimetric data is also available to internal safety organisations and for scrutiny during safety audits.

7. Since 1977 the ICRP has continued to assess and re-examine all the evidence for the effects of ionising radiation on man, taking account both of revised modelling of the doses associated with the Hiroshima and Nagasaki atomic explosions on which the assessed risk factors largely rely, and an extensive re-evaluation of the modelling of cancer incidence in populations. Though ICRP have yet to make any definitive recommendations in light of these new data, it was clear by 1987 that the risk factors promulgated in 1977 may be too low. The National Radiological Protection Board (NRPB), who are advisers to HMG on radiation matters, therefore issued interim advice in GS9 (Reference 4). They recommended that as long as legal limits remained at their present levels, it would be prudent to adopt some restriction on individual exposure. The suggestion was an "average" of 15mSv per annum over several years but the precise method of averaging was not defined. No legislative changes were made. The response of the UK nuclear industry, pending authoritative ICRP guidance, was to adopt lower annual limits in the range 25 to 30mSv voluntarily. For its part, MoD issued a Defence Council Instruction in January 1989 (DCI/GEN 70/89 Reference 5) imposing a MoD wide limit of 30mSv per annum. The investigation level remains at 15mSv and requires that the work practices which might result in exposures reaching this level, have to be formally investigated and continuing exposure beyond this level formally justified.

8. Additional guidance on restriction of exposure intended to be incorporated in a future Code of Practice associated with IRR85 has been drafted for consultation with interested parties. It proposes an investigation focusing on the individual when the employee accumulates a dose of 150mSv within 10 years, so that an informed decision can be taken whether he may continue to work with radiation or to restrict or prohibit further exposure. The presently circulated draft of the ICRP report, a final version of which is not expected to be published until late this year, at the earliest, proposes a limit of 100mSv within 5 years, with no more than 50mSv in any one year rather than a fixed annual limit. These values, or the whole scheme of dose limits, may well change in the final version as a result of further review of the contributory data, its *analysis and validation, and consideration of comment received from a worldwide comprehensive consultative* process. Accordingly, MoD has chosen not to set specific new dose targets, but to reinforce ALARP practices throughout MoD until firm legislative advice is promulgated.

Gardner Report

9. In a study on childhood leukaemia in Cumbria (Reference 6), published in the British Medical Journal by Professor Gardner et al, public attention has been drawn recently to a statistical association with fathers who have experienced occupational exposure to ionising radiations. In viewing these observations, it is important to distinguish between a *statistical* association and a causal association, a distinction clearly recognised by Professor Gardner but not always understood by those reporting his work. The difficulty is well illustrated in the report itself. Gardner found four cases of childhood leukaemia whose fathers worked in the Sellafield BNFL plant and had experienced either a total lifetime dose of 100mSv external whole body radiation, or a dose of 10mSv in the six months prior to conception of the child. Viewing the Sellafield plant as a whole, however, the incidence of fathers of children affected by leukaemia was similar to three of the four other East Cumbrian employments examined. These were the chemical industry, agriculture and iron and steel. This raises the question of whether the Sellafield occurrence was specifically related to

employment there, or possibly to other factors in common with these other industries in the area. Similarly within Sellafield, the question must be asked whether the leukaemia cases have any other factors in common besides high parental dose rates—were they employed on the same kind of work in the complex where, for example, they might have been exposed to other hazards, eg dangerous solvents? The BMJ Abstract contains the sentence, "This result suggests an effect of ionising radiation on fathers that may be leukaemogenic in their offspring, though other, less likely explanations are possible." These comments are offered in no way to belittle the importance of the findings, but to illustrate that they cannot yet be regarded as fully understood and may yet be shown to be due simply to chance.

10. In 1985, the Government established under the sponsorship of Department of Health, a Committee on the Medical Aspects of Radiation in the Environment (COMARE) following the Black Study (Reference 7) of the elevated incidence of childhood leukaemia in Cumbria. The Committee has been asked to advise on the Gardner Study. Their formal advice (Reference 8) was that because the conclusions were based on small numbers, and because the observations were novel and not recorded previously, they had to be treated with caution and more research was necessary. They were unable to recommend any specific measures to reduce the possible risks, but supported the actions undertaken to continue to reduce occupational exposures, particularly to those likely to have children. Further studies are under way or are being considered to clarify the significance of Professor Gardner's work. Meanwhile, MoD is continuing to implement the ALARP principle within the voluntary limit of 30mSv per annum and, as required by legislation, carries out investigations at the 15mSv level. This is an effective mechanism for limiting all doses. Counselling, which was also advised by COMARE, is being offered throughout the MoD nuclear programmes.

MoD Programmes Involving Use of or Access to Ionising Radiation

11. MoD makes wide use of ionising radiations but particularly in the nuclear programmes The Nuclear Weapons Programme covers research, production and service deployment with HM Forces. The Nuclear Propulsion Programme involves the research, production, operation, refitting and decommissioning of pressurised water reactors as a source of propulsion power in Royal Navy submarines. Ionising radiations are also used extensively in research, non-destructive testing and medical applications. Much of the work using x-rays is straightforward conventional radiography, using standard techniques deployed throughout industry and in medical applications. The MoD implementation of radiological protection legislation, with its emphasis on dose justification, dose reduction and ALARP, applies throughout all the above programmes. In the sections which follow, particular emphasis is given to the nuclear programmes in which significant exposures to ionising radiations occur.

NUCLEAR WEAPONS PROGRAMME

12. The main sources of radiation exposure in the Nuclear Weapon Programme are the two radioactive fissile materials, plutonium and highly enriched uranium and the non-fissile depleted uranium. Because steps are taken to prevent or minimise direct contact, external irradiation by penetrating gamma rays and, to a lesser extent by neutrons, produces most of the dose experienced. Nevertheless, inhalation and ingestion of small quantities of radioactive material also have potential to contribute to the doses experienced by individuals concerned with processing and fabrication of these materials before they are enclosed within nuclear weapons. The dose from intakes of these radionuclides arises primarily from the alpha-particles which they emit. Doses from beta radiation are generally so small that they do not need to be recorded. The only exception is tritium which, for a few individuals, contributes a small internal dose.

NUCLEAR WARHEAD PROGRAMME—AWE

13. The prime means of restricting occupational exposures in the AWE controlled areas for processing radioactive materials is to shield the sources of radiation as close to the source as possible. Containment, to prevent the intake of radioactive material, also provides a degree of shielding

14. In addition to the physical containment, appropriate personal protective equipment (clothing and respiratory protection) is provided. Extensive routine surveys of the external radiation, airborne and surface radioactivity are conducted in all areas where radioactive materials are processed and, as a precaution against undetected leakage, in many areas where they are not handled. Installed air samplers in ventilation systems and in areas where personnel work, are operated continuously to demonstrate that radioactive material does not escape and thus the air breathed is clean. Personal air samplers (PAS) which consist of a small battery operated pump drawing air from near the wearer's face and passing it through a filter, are used as a further check. They are issued to individual workers on a routine basis, to show either that no radioactive intake has occurred, or, if some activity is present on the filter paper, to estimate the intake. Some 700 PAS samples are measured each working day.

15. The practice in areas other than those used for processing radioactive materials varies according to the sources of radiation. The AWE programme continues to emphasise dose reduction by seeking

improved shielding, better containment, more effective personnel protection and monitoring, in conformity with the ALARP principle. By these means, steady reductions have been made in both the average annual doses and the cumulative doses to the workforce, and to reduce further the already small impact of the programme on the public and the environment.

Dosimetry

16. AWE operates an approved dosimetry service registered with the Health and Safety Executive in accordance with IRR85. Currently AWE use a thermoluminescent dosemeter (TLD) to detect external (mainly gamma) radiation. The main TLD badge is worn on the trunk but additional ones may be used elsewhere on fingertips, head or other parts of the body depending on the type of handling involved. The TLD records beta, x-ray and gamma but not neutrons. Neutron dosemeters are worn where the neutron dose may exceed 2.5mSv in one year (some of these are supplied by NRPB). The PAS filter measurements are used to calculate the committed effective dose to add to the external radiation dose obtained from the TLD (and neutron dosemeter if worn). Routine urine analysis is also conducted as part of a bioassay programme to support the assessment of internal dose for all plutonium, uranium and tritium workers. Faecal sampling is also used, though not routinely, mainly in the short term following a suspected intake incident. Whole body monitoring is used routinely to check on uptake of radioactive material for those at risk.

17. Dosimetry for external radiation, though it is subject to continuous improvement, has not changed markedly over the years, except in respect of the shift from old style film badges to modern TLDs. A number of additional features, particularly for internal dosimetry and air monitoring, were implemented to meet the recommendations made in the Pochin investigation (Reference 9) which reported in 1978. The use of PAS for example was greatly extended, more and improved static monitors were installed and additional staffing of change rooms was implemented. Developments of bioassay techniques have also improved their sensitivity and reliability. The widespread introduction and development of increasingly sophisticated whole body monitors has contributed to the assessment of internal dosimetry.

Exposure Statistics

18. The tabulations provide a statistical summary of external exposures monitored by the AWE organisation from 1979[2]. Internal doses from intakes are given from 1986. Tables 1, 2 and 3 provide data on annual external exposures and the annual individual doses from intakes of tritium and actinides (plutonium and uranium) for those AWE employees monitored. Although the internal dose which arises from these intakes continues throughout the remaining life of the person, this "committed" dose is allocated to the year of intake. Internal doses are therefore "pessimistic" in that the annual dose includes doses not received until later years. Table 4 gives an indication of the external exposures accumulated by those employees presently monitored, showing the percentage in the various dose ranges. The data show that very few have exceeded 15mSv per annum. Table 1 shows that, despite increases in the numbers of personnel monitored, the collective dose remains nearly constant and the small average doses continue to decrease steadily. The proportion shown in Table 4 with cumulative exposures in excess of 100mSv is also very small indeed.

NUCLEAR WEAPONS PROGRAMME—COULPORT

19. At the Royal Naval Armaments Depot (RNAD) Coulport, DRPS acts as the RPA and provides the approved dosimetry service. Apart from the work which involves handling nuclear weapons, some of the occupationally exposed persons do other work involving ionising radiations.

20. Tables 5 and 6 respectively list the annual individual external and the corresponding cumulative exposures attributable to the programme. When the recent introduction of neutron dosemeters was announced, following a Base Environmental Review Plan, reference was made to the need to make a correction to earlier doses to allow for the under-recorded neutron component. The highest exposure after correction would not exceed 15mSv.

NUCLEAR PROPULSION PROGRAMME

21. The main source of radiation exposure in the Nuclear Propulsion Programme is external irradiation by penetrating radiations emanating from the fission process or from fission or activation products such as radioactive $Cobalt^{60}$ formed within the steel of the reactor structure during its operating life. Because the reactor is heavily shielded when operating, most exposure to personnel comes during inspection, maintenance (including refitting and refuelling operations) and repair inside the reactor compartment or on components which form the primary cooling circuit, which contains radioactive activation products. $Cobalt^{60}$, which has a 5.24 year half-life is the most important source. Others, such as nitrogen, have a short half life and some are removed by the water purification systems. (Reference 10 to HCDC presented data on the activity of the plant 1 year after defuelling.)

[2]Data is available for earlier years but not in a form that readily permits statistical analysis.

22. The personnel of the Nuclear Propulsion Programme who are liable to experience exposure to ionising radiation include MoD (Service and civilian) and various contractors. Rolls Royce and Associates (RRA) are the Navy's delegated design authority. Vickers Shipbuilding and Engineering Limited (VSEL) deal mainly with the building and installation in new ships. They and the two Royal Dockyard Contractors, Devonport Management Limited (DML) and Rosyth Royal Dockyard (Babcock Thorn Limited (BTL)), are concerned with maintenance, repair and refit (the period during which the used reactor fuel is removed and replaced with new fuel). Naval personnel also undertake maintenance and repair, mainly at the Clyde Submarine Base HMS NEPTUNE and at the Devonport Fleet Maintenance Base HMS DEFIANCE. The Naval Reactor Test Establishment (NRTE) VULCAN at Dounreay is operated by RRA personnel under Naval supervision. Small numbers of service and civilian personnel are involved in training at Royal Naval College, Greenwich, which has a small reactor and a few civilians work in the radioactive waste store at Chatham.

23. As stated in paragraph 3, all staff are subject to the legal requirements of IRR85, promulgated for the Armed Services in JSP392, including justification of exposure, ALARP and dose limits. The contractors in the nuclear propulsion programme promulgate their own internal rules, appoint their own RPAs. Mandatory levels of qualification and training are set and regular audits are conducted.

24. From the inception of the UK Naval Nuclear Propulsion Programme in the early 1960s, there has been continuing development of procedures, design changes to equipment and facilities and optimisation studies to reduce the exposures experienced by the personnel involved in every stage of the programme. These include the operating crews during deployment cycles, the Naval and Civilian personnel concerned with repair and routine maintenance and the dockyard staffs (including the contractors' personnel) concerned with repairs, refits and refuelling the reactors. The steps taken to reduce doses involve detailed continuous assessment of dose rates, use of mock-ups for training, use of additional shielding and thorough decontamination of items of plant which may contain removable radioactive debris before commencing work on them. As regards dispersed radioactivity, the measures adopted are firstly to control or prevent it to the maximum extent, secondly to provide protection against ingestion or inhalation if it is present, despite the efforts to minimise it, and finally, to confirm by monitoring surfaces, air etc that the risk of intakes is low. Confirmation that these measures are effective is obtained from biological sampling or whole body monitoring.

Dosimetry

25. DRPS provides an approved dosimetry service for the MoD areas within the Nuclear Propulsion Programme and, under the terms of their contracts, for both the Dockyard companies. Dosemeters used to measure the exposure to x-and gamma-rays are normally worn on the trunk but additional dosemeters may be employed. The results are available for local management purposes as well as providing the statutory individual record which is kept centrally. Where it is appropriate, neutron dosemeters (supplied by NRPB) are deployed and within the Dockyards and Naval Bases, written systems of work are operated in which the direct reading of personal dosemeters is controlled by on-site radiation protection staff.

26 In the early days, all submariners were provided with film badges. During the 1970s and again in the early 1980s, having established that ship's company doses during operational sorties were sufficiently low, the number of badges issued to personnel was reduced Dosimetry is now restricted to those few personnel who have been shown to require it during their duties at sea and to those designated as classified persons on the basis of their repair/maintenance duties ashore. At sea, because the shielding effect of the hull and the ocean reduces cosmic radiation and because of the absence of geological radiation, submariners experience less "natural" background radiation than their shore based counterparts Confirmation of the low exposures is provided by on board comprehensive monitoring surveys for radiation and for airborne and surface radioactivity.

Exposure Statistics

27. In the tabulations which follow, the doses are derived from measurements using a dosemeter on the trunk. The main tabulations cover annual doses since 1979[1] for all Naval Nuclear Propulsion personnel monitored by DRPS under approved dosimetry service arrangements. Personnel under the written system of work systems operated at both Royal Dockyards are also included—in terms of annual dose the latter all appear in the under 15mSv category.

28. Table 7 presents the overall picture in terms of annual individual radiation dose equivalents for the Nuclear Propulsion Programme. In addition to those covered separately in Tables 8 to 19 inclusive for each of the major sites, it includes submariners some of whom, as explained in paragraph 24, also carry out repair/maintenance work ashore, involving radiation exposure. The corresponding data for the Royal

[1]Data is available for earlier years but not in a form that readily permits statistical analysis

Dockyard Devonport, which, since 1986, includes data for DML[4], is given in Table 8. Cumulative doses for workers with records on the DRPS system are in Table 9. Tables 10-19 inclusive provide 5 pairs of tables corresponding to Tables 8 and 9 for the Royal Rosyth Dockyard[4] which, since 1986 includes data for BTL (Tables 10 and 11), the Royal Dockyard at Chatham (Tables 12 and 13), the Naval Reactor Test Establishment, VULCAN[4] (Tables 14 and 15), the Fleet Maintenance base at Devonport, HMS DEFIANCE (Tables 16 and 17) and the Clyde Submarine Base, HMS NEPTUNE (Tables 18 and 19).

29. The pattern shown overall in Table 7 shows a general trend of steadily reducing total collective and average individual dose, with a similar reduction in numbers of personnel receiving doses in excess of 30 and 20mSv per annum. These reductions in dose should be seen against a steady increase in the size of the Royal Navy nuclear powered submarine force during this period. In relation to exposure in the dockyards, differences in cumulative doses clearly reflect the length of time since nuclear submarine refit operations commenced in each area with Rosyth starting in 1968, Chatham in 1969 and Devonport 11 years later. Site specific fluctuations in exposure are demonstrated for the onset of 2 and 3 stream refits at Devonport as well as work resulting from the closure of Chatham. A similar increase is now identifiable at Rosyth reflecting the recent onset of 2 stream refits. Overall refit doses are continuing to reduce on the basis of improvements in design, operational control and decontamination processes. Designs for future classes of submarine include targets for further significant reductions. Exposure resulting from dockyard work has been closely related to the age of the boat undergoing refit, older boats requiring more maintenance. Significant reductions in dose are associated with the newer plants. Current decontamination techniques have helped to reduce doses.

30. Within the operational bases, no major reduction in exposure is demonstrated, though very significant reductions have been achieved in the dose resulting from specific tasks. Both operational bases have seen a steady increase in nuclear related work and the Tables show fluctuations resulting from the unpredictability of day to day operational support, as opposed to the steady dockyard refit cycle. Differences between the 2 bases not only reflect the scale of work at the 2 locations, but also the relative concentration of older vessels at the Scottish base. The tight confines of a submarine reactor compartment make it difficult to introduce shielding. Additionally, the major decontamination processes cannot be used in operational submarines. Cumulative lifetime exposure at both bases show the effects of the relatively short service drafting system in comparison to dockyard employment.

31. The VULCAN statistics also show a generally downward trend consistent with the pattern of dose reduction, though operations involving decommissioning of major items of plant have caused less marked fluctuations than in the repair and refit operations at the Dockyards. The data for Chatham, where the present small workforce is operating on a care and maintenance basis, reflects a reducing involvement with radiation exposure.

32. Table 20 is included to show the cumulative exposures overall for the current workforce within the Nuclear Propulsion Programme and in addition to the workforces at Devonport, Rosyth, Chatham, VULCAN, HMS DEFIANCE and HMS NEPTUNE, includes submarine operating personnel.

DRPS RADIATION DOSE STATISTICS

33. MoD operates two approved dosimetry services, AWE and DRPS. The data provided by AWE is referred to in paragraph 18. This paragraph deals with the remainder of MoD exposed persons, all those for whom DRPS is currently responsible for maintaining records of their dosimetry. Table 21 summarises the annual doses[5]. In addition to the personnel in the Nuclear Propulsion Programme, this total includes all Army and Royal Air Force personnel and all other Royal Navy personnel (Service and civilian) and a number of civilian personnel in other small MoD establishments (excluding AWE). As indicated in paragraph 11 above, MoD has a wide range of other work involving radiation exposure including conventional x-ray and gamma radiography, industrial, medical and veterinary, all transport, storage and handling of nuclear weapons in-Service and work with depleted uranium munitions. Comparison with Table 7 shows a very small number of additional entries in the 15mSv columns, mainly in the earlier years, and a steady general decrease in both the collective dose and the average dose, though the fluctuating nature of the Nuclear Propulsion Programme is still apparent.

34. Table 22 shows the distribution of cumulative doses experienced by personnel currently within the three Services and by civilians currently employed by MoD. The Army and Royal Air Force data which covers mainly x-radiography is generally satisfactory. The data for the Royal Air Force also includes personnel in that Service concerned with nuclear weapon transport, storage and handling whose activity requires that they wear dosemeters. In addition to personnel covered in the earlier Tables, Table 22 includes Royal Navy servicemen with duties comparable to the RAF servicemen who deal with nuclear weapons and personnel engaged in radiography (other than in the Nuclear Propulsion Programme).

[4]Data from RRA, DML and BTL held by DRPS has been included with their permission.

[5]In the years prior to 1984, because of transferees to the DRPS records, some of the entries in the ranges above 15mSv are lifetime rather than the dose for the year of entry. From 1984 onwards all such entries have been corrected.

EPIDEMIOLOGICAL & OTHER STUDIES OF HEALTH

35. In order to monitor the health of persons exposed occupationally to ionising radiation, studies specifically directed at parts of the MoD workforce have been undertaken.

36. Following further findings (Reference 11) relating to higher rates of childhood leukaemia in Seascale, Cumbria, where the BNF plc Sellafield plant is located, studies have also been conducted of the incidence of specific diseases in the population in areas which include MoD facilities. These include various epidemiological studies of childhood leukaemia referred to in the 3rd COMARE report (Reference 12) which found a slightly raised level in West Berkshire and North Hampshire, in which are the AWE facilities at Aldermaston and Burghfield and on the borders of which is the UKAEA Harwell-Culham site.

Studies of the MoD Workforce

37. The mortality study (Reference 13) on employees of the Atomic Weapons Establishment at Aldermaston was carried out by the MRC and included a total of 22,552 workers employed between 1951 - 1982. The findings show a "healthy worker" effect, reflecting a degree of health selection for employment, but do reveal some scattered instances of increased incidence, though the overall incidence of disease, including cancers and the mortality rates, does not exceed that for the whole population. The results have been largely consistent with similar studies of BNF plc and Atomic Energy Authority (AEA) personnel and with studies conducted elsewhere, such as in the US. Mortality was found to be 23 per cent lower than the national average for all causes of death and 18 per cent lower for cancer. There were only 4 deaths from leukaemia amongst workers monitored for exposure to radiation compared with the expected number from national rates of 9.16. Mortality for malignant neoplasms as a whole was not increased among those monitored for internal contamination, though incidence of prostatic, renal and lung cancers were apparently elevated and require further study.

38. Currently, the MRC is in the process of updating and combining the three studies covering AWE, AEA and BNF personnel to provide an industry-wide analysis of some 80,000 persons, using the data collated for the individual studies and additional information on later years supplied by each of the organisations involved. The additional numbers will materially increase the statistical power of the combined study and should give better estimates of the risk factors appropriate to occupationally exposed persons in the UK.

39. MoD has commissioned a study under the direction of the MRC into the health of submariners which includes 15,000 serving Royal Navy personnel who completed submarine training after 1960. The aim of the study, which will include personnel from both nuclear powered and conventional submarines, is to study the effects on people of working for long periods in an artificially controlled environment. Comparison will be made with a matched control population. It is due to report within the next two years.

COMARE Reports on areas near Aldermaston and Dounreay

40. COMARE has published reports on leukaemia clusters in the areas where Aldermaston and Dounreay are located (References 12 and 14). They found the radioactive discharges to be far too low to account for the observed increased incidence of childhood leukaemia in these areas. Following on from the COMARE report on Aldermaston and Burghfield, the Department of Health funded a case control study (report due end of 1990 and similar in scope to Gardner's) and a sample survey of the levels of radioactivity in household dust. A case control study around Dounreay is expected to report in the first half of 1990. A birth and school cohort study in Thurso and Dounreay and a study on exposure levels to chemicals in the Dounreay area are also under way.

Proposed Future Studies Involving MoD Data

41. A new study to test the Gardner hypothesis has been proposed and will be conducted by NRPB. Its procedure would be to use data from the National Childhood Tumour Registry in conjunction with the National Register of Radiation Workers (NRRW) to check whether the fathers of children affected are occupationally exposed persons. Statistical analysis would then show whether their incidence of leukaemia differed from the national rates. The NRRW data base already contains summarised dosimetric records on 100,000 radiation workers covering the whole of the UK nuclear industry and other exposed persons. Dosimetric data from MoD, including the Royal Dockyards are already in the NRRW. Early data in the form of paper records held by DRPS, has yet to be transferred to NRRW. The study is likely to take more than 3 years. MoD has undertaken to give full support to any study which the Department of Health/Scottish Home and Health Department, with the advice of COMARE, decided was appropriate.

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TABLE 1: ANNUAL INDIVIDUAL EXTERNAL EXPOSURES† IN A GIVEN YEAR FOR AWE MONITORED EMPLOYEES

Year	Number of Personnel in Dose Ranges 0–15mSv	15–20mSv	20–30mSv	30–40mSv	>40mSv	Total No. Monitored Employees	Collective Exposures (Man Sv)	Average Exposure (mSv)
1979	2,953	0	0	0	0*	2,953	2.69	0.91
1980	3,180	0	0	0	0	3,180	3.34	1.05
1981	3,340	0	0	0	0*	3,340	3.34	1.00
1982	3,525	2	1	0	0	3,528	3.60	1.02
1983	3,623	0	0	0	0	3,623	3.44	0.95
1984	3,756	0	0	0	0	3,756	3.00	0.80
1985	4,007	0	0	0	0*	4,007	2.93	0.72
1986	3,967	0	0	0	0	3,967	2.94	0.74
1987	4,191	0	0	0	0	4,191	2.81	0.67
1988	4,094	0	0	0	0	4,094	2.13	0.52
1989	3,843	0	0	0	0	3,843	0.88	0.23

*Two films from dosemeter issues in 1979 indicated apparent exposures of 269 and 1,604 mSv. These films are known to have been exposed while not being worn by any individuals. Similarly, one dosemeter in 1981 indicated a pseudo exposure of 32.9 mSv and 2 dosemeters in 1985 indicated pseudo exposures of 28.3 mSV and 14.7 mSv. These films recorded exposures that did not arise from occupational activities. These results have not been included in the tables.

†The effective (whole-body) doses equivalent are typically less than 50 per cent of the indicated levels both at AWE and for warhead handling.

TABLE 2: ANNUAL INDIVIDUAL COMMITTED EFFECTIVE DOSE EQUIVALENT FROM THE INTAKES OF TRITIUM FOR AWE MONITORED EMPLOYEES

Year	0–5 (mSv)	>5 (mSv)	Total No. monitored	Average dose (mSv)	Maximum dose (mSv)
1986	489	0	489	0.17	0.91
1987	548	0	548	0.12	0.81
1988	621	0	621	0.12	0.80
1989	546	0	546	0.10	3.34

TABLE 3: ANNUAL INDIVIDUAL DOSES (CEDE)* FROM INTAKES OF ACTINIDES (PLUTONIUM (Pu) AND URANIUM (U)) FOR AWE MONITORED EMPLOYEES

Pre-1985, dose assignment for actinide exposure was not required by legislation. It is assessed that less than 10 current employees had significant intakes prior to 1985 (ie dose>25 mSv). These included an accidental intake in 1984 leading to an assessed committed effective dose equivalent of 100 mSv.

Since 1986 doses have been assessed from Personnel-Borne Air-Sampler (PAS) measurements on a routine basis with the following results:

Year		No monitored (whole year)	Average dose (mSv)	Maximum dose (mSv)	Single-intake investigations >1 mSv	
1986	Pu	1,293	0.14	8.6	5	(all<10 mSv)
	U	1,000	0.18	5.2	0	
1987	Pu	1,279	0.06	2.3	1	(<2 mSv)
	U	1,062	0.16	6.6	0	
1988	Pu	1,316	0.06	2.5	0	
	U	1,095	0.12	6.6	0	
1989	Pu	1,298	0.04	2.4	1	(<2 mSv)
	U	1,060	0.07	3.6	1	(<2 mSv)

*CEDE = Committed (50 year) Effective Dose Equivalent.

TABLE 4: CUMULATIVE INDIVIDUAL EXTERNAL EXPOSURES AWE MONITORED EMPLOYEES

Based on number registered as employees at end 1989

Exposure range (mSv)	Percentage of monitored workforce
0– 50	96 31
50–100	2 44
100–200	0 91
200–300	0 26
300–400	0 05
400–500	0 03
Greater than 500	0 00
Total	100 00

TABLE 5: ANNUAL INDIVIDUAL EXTERNAL EXPOSURES FOR ALL PERSONNEL AT RNAD COULPORT

	NUMBERS OF PERSONNEL IN DOSE RANGES								
Year	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv	No of Monitored Employees	Collective Exposure (Man Sv)	Average Exposure (mSv)
1979	183	0	0	0	0	0	183	0 259	1 42
1980	213	0	0	0	0	0	213	0 388	1 82
1981	195	0	0	0	0	0	195	0 317	1 63
1982	223	0	0	0	0	0	223	0 188	0 84
1983	261	0	0	0	0	0	261	0 094	0 36
1984	244	0	0	0	0	0	244	0 082	0 34
1985	198	0	0	0	0	0	198	0 101	0 51
1986	183	0	0	0	0	0	183	0 084	0 46
1987	169	0	0	0	0	0	169	0 260	1 54
1988	187	0	0	0	0	0	187	0 087	0 47
1989	187	0	0	0	0	0*	188	0 101	0 54

* One Dosemeter Result >50mSv is being assessed

TABLE 6: CUMULATIVE INDIVIDUAL EXTERNAL EXPOSURES—RNAD COULPORT

Based on number registered as employed at end 1989

Exposure range (mSv)	Percentage of monitored workforce
0– 50	99 1
50–100	0 3
100–200	0 6
200–300	0 0
300–400	0 0
400–500	0 0
Greater than 500	0 0
Total	100 00

TABLE 7: ANNUAL INDIVIDUAL RADIATION DOSE EQUIVALENTS NAVAL PROPULSION PROGRAMME ALL PERSONNEL

Year	NUMBERS OF PERSONNEL IN DOSE RANGES								
	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv	No of Monitored Employees	Collective Dose (Man Sv)	Average Dose mSv
1979	5,913	141	152	86	68	2	6 362	26 3	4 13
1980	7,476	128	173	92	48	2	7 919	26 4	3 34
1981	6,065	128	148	48	11	0	6 400	20 3	3 18
1982	6,120	108	86	15	6	0	6,335	15 2	2 40
1983	5,719	109	105	39	29	0	6,001	17 7	2 95
1984	5,160	145	153	58	8	1	5 525	20 8	3 77
1985	5,730	109	86	27	3	0	5,955	16 0	2 68
1986	5,996	79	57	21	1	0	6,154	12 8	2 09
1987	6,327	58	30	11	0	0	6,426	10 1	1 58
1988	6,123	21*	10	0	0	0	6,154	8 18	1 33
1989	6,462	44	44	5	1	0	6,556	11 1	1 70

Notes (a) The 0–15mSv dose band includes those employed on written systems of work
(b) A few nuclear submarine personnel with doses below 15mSv/a are not included

*This differs from the answer obtained by combining data given in answers to PQs in 1989 and 1990 Official Report 20 March 1989 Columns 477 and 478 gave 4 submariners in 15–20mSv category Official Report 2 May 1990 Columns 595 and 596 have 18 from Rosyth Dockyard for the same category ie a total of 22 The above figure of 21 reflects the fact that a notional dose in 1989 has been replaced by a measured dose which shifts the man concerned to the 0–15mSv category

TABLE 8: ANNUAL INDIVIDUAL RADIATION DOSE EQUIVALENTS FOR DEVONPORT DOCKYARD CIVILIAN WORKERS

Year	NUMBERS OF PERSONNEL IN DOSE RANGES								
	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv	No of Monitored Employees	Collective Dose (Man Sv)	Average Dose mSv
1979	1,258	6	1	0	0	0	1,265	1 02	0 81
1980	1,643	0	0	0	0	0	1 643	1 71	1 04
1981	2,159	0	0	0	0	0	2,159	2 13	0 99
1982	2,543	4	0	0	0	0	2,547	2 32	0 91
1983	2,968	26	17	5	0	0	3 016	5 53	1 83
1984	2,879	77	82	31	5	0	3 074	10 14	3 30
1985	2,831	48	44	13	0	0	2,936	7 33	2 50
1986	2,945	47	38	5	0	0	3,035	6 03	1 99
1987*	2,616	34	13	6	0	0	2,669	4 54	1 70
1988	2,676	0	1	0	0	0	2 677	2 76	1 03
1989	2,382	9	3	0	0	0	2 394	2 77	1 16

Notes (a) The 0–15mSv dose band includes those employed on written systems of work
(b) Since 1986 radiation dose records are maintained by DRPS on behalf of Devonport Management Ltd

*This data includes MoD dose data for 1987 prior to contractorisation on 4 April 1987 and DML data from 4 April to end of year The dose data provided for the *Official Report* 18 April 1990 Columns 941–942 was for the Dockyard Contractors only

TABLE 9: CUMULATIVE LIFETIME RADIATION DOSE EQUIVALENTS DEVONPORT DOCKYARD

Based on number registered as employed at end 1989

Dose Range (mSv)	Percentage of monitored workforce
0– 50	75 1
50–100	14 6
100–200	7 4
200–300	2 4
300–400	0 6
400–500	0 0
Greater than 500	0 0
Total	100 1

Note Cumulative doses do not include employees working under a written system of work

TABLE 10: ANNUAL INDIVIDUAL RADIATION DOSE EQUIVALENT FOR ROSYTH DOCKYARD CIVILIAN WORKERS

(Part previously published in answer to a question *Official Report* 2 May 1990 Column 595)

NUMBERS OF PERSONNEL IN DOSE RANGES

Year	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv	No of Monitored Employees	Collective Dose (Man Sv)	Average Dose (mSv)
1979	1,087	39	50	38	48	1	1,263	8.14	6 45
1980	1,315	49	77	35	4	0	1,480	6 79	4.59
1981	1,119	37	49	21	4	0	1,230	5.82	4 73
1982	1,119	44	39	10	6	0	1,218	5.29	4 34
1983	1,194	49	68	31	29	0	1,371	7.81	5.70
1984	1,158	34	56	21	3	1	1,273	6.48	5.09
1985	1,662	28	18	4	0	0	1,712	4.20	2.45
1986	1,713	6	1	0	0	0	1,720	2 67	1.55
1987*	2,008	6	2	1	0	0	2,017	2 29	1 14
1988	1,645	18	9	0	0	0	1,672	2.74	1.64
1989	1,678	20	28	5	1	0	1,732	4.20	2.43

Notes: a. The 0–15mSv dose band includes those employed on written systems of work.
b Since 1986 radiation dose records are maintained by DRPS on behalf of Rosyth Royal Dockyard

*This data includes MoD dose data for 1987 prior to contractorisation on 4 April 1987 and BTL data from 4 April to end of year
The dose data provided for the *Official Report* 18 April 1990 Columns 941–942 was for the Dockyard Contractors only

TABLE 11: CUMULATIVE LIFETIME RADIATION DOSE EQUIVALENTS ROSYTH DOCKYARD

Based on number registered as employed at end 1989

Dose range (mSv)	Percentage of monitored workforce
0– 50	53.3
50–100	18 5
100–200	17.0
200–300	7.7
300–400	2 2
400–500	1.1
Greater than 500	0.2
Total	100.00

Note Cumulative doses do not include employees working under a written system of work

TABLE 12: ANNUAL INDIVIDUAL RADIATION DOSE EQUIVALENTS FOR CHATHAM CIVILIAN WORKERS

NUMBERS OF PERSONNEL IN DOSE RANGES

Year	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv	No of Monitored Employees	Collective Dose (Man Sv)	Average Exposure (mSv)
1979	821	57	74	37	18	1	1,008	8 21	8.15
1980	1,703	36	77	54	44	1	1,915	9 65	5 04
1981	1,285	56	84	24	7	0	1,456	7.33	5.03
1982	1,175	37	30	4	0	0	1,246	4 11	3.30
1983	446	0	1	0	0	0	447	0.390	0.87
1984	22	0	0	0	0	0	22	0.062	2.82
1985	19	0	0	0	0	0	19	0 009	0 47
1986	17	0	0	0	0	0	17	0.006	0.35
1987	12	0	0	0	0	0	12	0.001	0.08
1988	10	0	0	0	0	0	10	0.002	0 20
1989	9	0	0	0	0	0	9	0.009	1.00

Notes· (a) The 0–15mSv dose band includes those employed on written systems of work
(b) Chatham Dockyard was closed in 1981–82 A small number of personnel remain at Chatham and are responsible for the care and maintenance of the radioactive waste store and burial site

TABLE 13: CUMULATIVE LIFETIME RADIATION DOSE EQUIVALENTS CHATHAM DOCKYARD

Based on number registered as employed at end 1989

Dose range (mSv)	Percentage of monitored workforce
0– 50	62.5
50–100	12.5
100–200	12.5
200–300	12.5
300–400	0 0
400–500	0 0
Greater than 500	0 0
Total	100 0

Note Cumulative doses do not include employees under a written system of work

TABLE 14: ANNUAL INDIVIDUAL RADIATION DOSE EQUIVALENTS FOR ALL PERSONNEL AT VULCAN NRTE

	NUMBERS OF PERSONNEL IN DOSE RANGES								
Year	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv	No of Monitored Employees	Collective Dose (Man Sv)	Average Dose (mSv)
1979	385	6	4	1	1	0	397	1 02	2 57
1980	342	12	11	1	0	0	366	1 65	4.51
1981	276	22	10	1	0	0	309	1 93	6.26
1982	289	12	9	0	0	0	310	1.40	4.52
1983	297	7	4	0	0	0	308	1.07	3.48
1984	324	10	2	0	0	0	336	1.31	3.89
1985	313	15	8	0	0	0	336	1.53	4 55
1986	376	7	0	0	0	0	383	1 07	2 80
1987	386	0	0	0	0	0	386	0 734	1 90
1988	393	0	0	0	0	0	393	0 577	1 47
1989	377	0	0	0	0	0	377	0 696	1 85

TABLE 15: CUMULATIVE LIFETIME RADIATION DOSE EQUIVALENTS VULCAN NRTE

Based on number registered as employed at end 1989

Dose range (mSv)	Percentage of monitored workforce
0– 50	67.8
50–100	18 1
100–200	9 1
200–300	3 2
300–400	1 4
400–500	0 5
Greater than 500	0 0
Total	100 1

TABLE 16: ANNUAL INDIVIDUAL RADIATION DOSE EQUIVALENTS FOR ALL PERSONNEL AT HMS DEFIANCE

NUMBERS OF PERSONNEL IN DOSE RANGES

Year	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv	No of Monitored Employees	Collective Dose (Man Sv)	Average Exposure (mSv)
1979	231	0	0	0	0	0	231	0 486	2 10
1980	252	0	0	0	0	0	252	0 247	0 98
1981	179	0	1	0	0	0	180	0 368	2.04
1982	77	0	0	0	0	0	77	0 108	1.40
1983	81	1	0	0	0	0	82	0 240	2.93
1984	107	0	0	0	0	0	107	0.158	1 48
1985	160	0	0	0	0	0	160	0.145	0 91
1986	242	0	0	0	0	0	242	0.260	1 07
1987	242	0	0	0	0	0	242	0 206	0 85
1988	244	0	0	0	0	0	244	0 220	0.90
1989	244	0	0	0	0	0	244	0 414	1.70

Note The HMS DEFIANCE is the Fleet Maintenance Base at Devonport

TABLE 17: CUMULATIVE LIFETIME RADIATION DOSE EQUIVALENTS HMS DEFIANCE

Based on number registered as employed at end 1989

Dose range (mSv)	Percentage of monitored workforce
0– 50	95 3
50–100	4 7
100–200	0 0
200–300	0 0
300–400	0 0
400–500	0 0
Greater than 500	0.0
Total	100 0

Note Cumulative doses do not include employees working under a written system of work

TABLE 18: ANNUAL INDIVIDUAL RADIATION DOSE EQUIVALENTS FOR ALL PERSONNEL AT HMS NEPTUNE (CLYDE SUBMARINE BASE)

NUMBERS OF PERSONNEL IN DOSE RANGES

Year	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv	No of Monitored Employees	Collective Dose (Man Sv)	Average Dose (mSv)
1979	367	7	9	5	1	0	389	1 47	3 79
1980	332	4	4	0	0	0	340	1 07	3.15
1981	221	7	1	1	0	0	230	0 835	3 63
1982	218	7	6	0	0	0	231	0 739	3 20
1983	213	17	11	1	0	0	242	1.15	4 73
1984	218	18	7	4	0	0	247	1 15	4 67
1985	231	11	14	9	3	0	268	1 58	5 88
1986	213	11	13	13	1	0	251	1 50	5 96
1987	209	13	5	3	0	0	230	0 916	3.98
1988	251	0	0	0	0	0	251	0.515	2.05
1989	291	14	11	0	0	0	316	1 12	3.54

TABLE 19: CUMULATIVE LIFETIME RADIATION DOSE EQUIVALENTS CLYDE SUBMARINE BASE

Based on number registered as employed at end 1989

Dose range (mSv)	Percentage of monitored workforce
0– 50	91 4
50–100	5 9
100–200	2 5
200–300	0 2
300–400	0 0
400–500	0 0
Greater than 500	0 0
Total	100 0

Note Cumulative doses do not include employees working under a written system of work

TABLE 20: CUMULATIVE LIFETIME DOSE EQUIVALENTS FOR THE NAVAL NUCLEAR PROPULSION PROGRAMME INCLUDING SUBMARINES

Based on number registered as employed at end 1989

Dose range (mSv)	Percentage of monitored workforce
0– 50	87 4
50–100	7 0
100–200	3 7
200–300	1 3
300–400	0 40
400–500	0 13
500–600	0 02
Total	99 95

Note This table includes the personnel from Devonport Rosyth, Chatham Vulcan Defiance Clyde Submarine Base and also operational submarine personnel

TABLE 21: ANNUAL INDIVIDUAL RADIATION DOSE EQUIVALENTS FOR ALL PERSONNEL MONITORED ON THE DRPS SYSTEM

Year	NUMBERS OF PERSONNEL IN DOSE RANGES						No of Monitored Employees	Collective Dose (Man Sv)	Average Dose (mSv)
	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv			
1979	8,477	143	176	86	69	12	8,963	33 1	3 69
1980	9,004	134	194	105	49	8	9,494	33 7	3 55
1981	9,218	134	148	50	11	0	9,561	27 2	2 84
1982	9,162	112	87	16	6	0	9,383	16 9	1 80
1983	9,046	113	110	40	30	0	9,339	18 2	1 95
1984	8,297	150	159	58	8	1	8,673	19 1	2 21
1985	8,461	110	87	28	3	0	8,689	16 4	1 89
1986	7,965	81	59	21	1	0	8,127	13 5	1 66
1987	7,847	58	30	12	0	0	7,947	10 7	1 35
1988	7,699	21	10	0	0	0	7,730	9 0	1 16
1989	8,289	48	46	5	1	0*	8,390	11 5	1 37

*One dosemeter result >50mSv is being assessed

TABLE 22: CUMULATIVE LIFETIME RADIATION DOSE EQUIVALENTS FOR MOD PERSONNEL (EXCLUDING AWE)

Based on number registered as employed at end 1989

Lifetime Dose Range (mSv)	Percentage of personnel receiving doses in the ranges shown				
	Navy	Army	RAF	Civilian	Total
0–50	95 50	96 30	99 70	75 80	86 70
50–100	3 86	2 23	0 13	12 00	7 05
100–200	0 63	0 38	0 13	7 74	3 97
200–300	0	0 37	0	2 91	1 45
300–400	0	0 37	0	0 98	0 52
400–500	0	0 37	0	0 45	0 26
Greater than 500	0	0	0	0 08	0 04
TOTAL	99 99	100 02	99 96	99 96	99 99

2. Part of a letter from the Assistant Liaison Officer at the Ministry of Defence to the Clerk of the Committee (20 July 1990)

During the oral session on the radiation protection of Service and Civilian personnel, the Committee asked, at Question 115, about the past data from the civil nuclear industry This was not available at the time but the NRPB have since kindly supplied data from published reports, this is summarised at Annex A.

ANNEX A

DOSES RECEIVED IN THE CIVIL NUCLEAR INDUSTRY

Year	Total Number	Number >15 mSv	Number >50 mSv	Collective Dose (ManSv)	Average Dose (mSv)
1972	17,000	2,300	170	120	6 8
1973	18,000	2,100	120	110	6 0
1974	19,000	1,900	120	110	5 6
1975	21,000	2,100	38	110	5.3
1976	23,000	2,400	8	120	5 4
1977	26,000	2,000	4	120	4 6
1978	27,000	2,000	4	120	4.2
1979	28,000	1,600	5	110	3.8
1980	30,000	1,700	4	110	3.6
1981	36,000	1,600	0	100	2 9
1982	37,000	1,400	0	100	2 7
1983	39,000	1,100	0	90	2.3
1984	39,000	1,100	0	90	2.3
1985	44,000	1,100	3	90	2 0
1986	48,000	1,300	2	100	2.1
1987	46,000	1,100	5	90	2.0
1988	48,000	670	0	80	1.6

Data extracted from:

Taylor, F E and Webb, G A M, Radiation exposure of the UK population Chilton, NRPB–R77 (1978) (London, HMSO)

Hughes, J S, and Roberts, G C, The radiation exposure of the UK population—1984 review Chilton, NRPB–R173 (1984) (London, HMSO)

Hughes, J S, Shaw, K B and O'Riordan, M C, Radiation exposure of the UK population—1988 review Chilton, NRPB–R277 (1989) (London, HMSO)

Hughes, J S, Occupational exposure in the UK during 1988, with estimates of the contribution from high LET radiation. (Paper prepared for the Committee on the Medical Aspects of Radiation in the Environment, 1990).

BNFL, Annual report on occupational safety, 1988 British Nuclear Fuels plc 1989.

Notes

1 The numbers in the central four columns of the table above have been rounded where appropriate

2 Apart from a review of doses in the UKAEA in 1957, comprehensive data before 1972 are not readily available

3 Up to, and including 1985, data for some groups of contractors are not available However, the inclusion of these data would not significantly affect the overall pattern of the dose distributions

4 Since 1986 the data includes doses from internal exposure and this largely accounts for the increase in the collective dose from 1985 to 1986

5 Since the Bulletin article was published, extra data have been included for a group of about 200 contractors (referred to in the article) for the year 1985. Also, some data for 1972 has been revised, resulting in a very slight change in the average dose, from 6 9 mSv to 6 8 mSv

JSH 29/6/90

3. Further memorandum submitted by the Ministry of Defence (18 July 1990)

The following information is provided in response to the written questions asked by the Defence Committee.

1. What exemptions does the MoD have from the Ionising radiation Regulations 1985, when were they granted and under what authority?

1. The MoD exemptions from the Ionising Radiation Regulations 1985 (IRR 85) are given in the Regulations themselves, and were made when the Regulations were laid before Parliament on 23 August 1985 by the Joint Parliamentary Under Secretary of State for Employment. Regulation 40 has the effect of exempting MoD from a number of provisions. These exemptions apply either to MoD as a whole, or partially, to visiting forces, and to Head Quarters organisations. Regulation 40(2) permits the Secretary of State for Defence to exempt in the interests of security HM Forces, visiting forces and any person engaged in work with ionising radiations for the Secretary of State for Defence, from all or any of the requirements or prohibitions imposed in the Regulations. This provision has not been invoked to date.

Regulations 40(3) and (4) enable MoD and its contractors, in certain circumstances, to exercise exemption from the obligation to notify the Health and Safety Executive (HSE) of work involving ionising radiations; this is on the understanding that MoD has a satisfactory internal system for ensuring that the regulations are applied, and enables MoD not to reveal the precise location of security-sensitive facilities.

Regulation 13(3)f requires that, for any employee who has received a dose in any calendar quarter of three fifths of the annual dose limit for adult employees, the details must be sent to the HSE. HM Forces (but not civilians) are exempt from this provision (Regulation 40(5) and (6)).

Regulation 16(10) permits an employee who is aggrieved by a decision recorded in his health record to apply to the HSE to have the decision reviewed by the Health and Safety Commission. HM Forces (but not civilians) are excluded from this requirement (Regulation 40(7)).

Regulations 40(8), (9) and (11) refer to the requirement, stated in Regulations 26 and 27, to send to the HSE copies of Special Hazard Assessments, Hazard Assessments and Accident Contingency Plans. The information is provided to HSE under arrangements which take account of the interests of national security.

The MoD is exempt from the requirement to notify the Executive of a suspected overexposure beyond annual limits and the results of a consequent investigation and assessment in relation to HM Forces (Regulation 40(11)). The MoD is partially exempt from the obligations in Regulation 31(1) to notify the HSE of accidental releases (Regulation 40(12)) Assurances that releases during operations are extremely small have been given in answers to Parliamentary Questions.

2. What has been the cost of contracting out some of the radiological protection work of the Safety Division of AWE?

2. The cost of contracting out some of the radiological protection and safety professional advisory work in AWE in FY 1989/90 amounted to about £250K.

Since the Committee took evidence from officials on 13 June, some progress has been made in relation to filling vacancies. 7 newly qualified professionals are expected to become available in the late summer, of whom 5 will go to the small operational grouping and 2 to the larger advisory grouping.

3. Can MoD provide specific examples of instances since 1979 when investigations of work practices resulting in radiation exposure over 15mSv have resulted in such practices being deemed not to be justified (Qq 50-57)?

3. The basic justifications for all exposures in the RN programme, including those which have exceeded 15mSv, is operation, maintenance, repair and refit of the nuclear powered submarine fleet to meet Defence needs. No alternative submarine power source is capable of meeting the requirement. No examples have been identified of exposures deemed not to be justified for this purpose. Nevertheless, over the years numerous recommendations for improved means of dose control have been made and implemented. The dose reductions which have been achieved as a result are apparent in the Tables in the Memorandum.

4. The MoD offered to provide the Committee with documents relating to the United States and French defence nuclear programmes. Any further information on statistical differences and the reasons for them would be welcome (Qq 123-126).

4. 1. *Occupational Radiation Exposure from US Naval Nuclear Plants and their Support Facilities* Report NT-90-2 February 1990.

A copy of a report with the above title is provided herewith for the Committee. It describes the extent of exposure to radiation of Service and civilian support personnel directly involved in the US Naval Propulsion Program.

2. *Radiation Exposures for DOE and DOE Contract Employees - 1987* Report DOE/EH-0128 October 1989.

A copy of a report with the above title is provided herewith for the Committee It refers to previous reports giving similar information dating back to 1974, when the facilities were mostly included in the Energy Research and Development Administration (ERDA). Only 1.9% received a dose equivalent exceeding 1rem (10mSv) and none exceeded 4rem (40mSv) with an average for all who received a measurable exposure of 159mrem (1.59mSv).

3. *French Data on Exposures of Personnel in the Nuclear Industry*

A copy of a document supplied to the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR) by the French Ministries of Employment and Health is attached. It does not specifically cover the French Defence Nuclear industry and refers to medical and therapeutic exposures as well as "occupational" and research. Overall, it quotes an average annual dose for 1989 of 0.58 milligrays (equivalent to 0.58mSv). However, the figures given in Table IV for "Industrie" can be interpreted to give annual averages of 7.1mSv if only those experiencing doses greater than zero are counted. On the other hand, if the convention of counting all monitored personnel is adopted, the average is about 2.9mSv.

The data contained in these various reviews show average annual exposures ranging from less than 1mSv to over 7mSv. The proportion of monitored personnel in the higher dose categories also varies considerably. No single measure of the efficacy of exposure control exists, but examination of other data indicates that MoD performance overall is comparable with the best. This is not taken to imply that MoD can relax its efforts to reduce doses in accordance with the ALARP principles.

5. Can the 126 claims for compensation be broken down by the type of work involved, the year of the claim, the nature of the claim, and the number of claimants still alive (Qq 188-189, 204-207)? Have any of the claimants received any compensation other than as a result of a common law claim (Q192)?

5. The following table gives a breakdown of the 126 claims received by the Department since 1978 which relate to alleged radiation exposure. Claims from participants in the UK Atmospheric Test Programme (the Nuclear Test Veterans) are not included. The breakdown shows the year of the claim and nature of illness to which it relates, where specified.

BREAKDOWN OF 126 CLAIMS BY YEAR AND NATURE

Illness	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Total
Leukaemia				1	2	1		1		2	2	2	11
Cancer:													
Unspecified							1	1		1	2		
Specified:													
Colon			1										
Lung			1	1					1				
Brain											1		
Stomach								1					
Bladder									1				
Bone Marrow												1	
Liver												1	14
Others specified:													
Aplastic Anaemia					1								
Hypothyroid			1										
Melanoma												1	
Impotency											1		
Berylliosis											1		
Lung Condition								1					
Tumor of Testicle								1					
Wrist Ulcer		1											
TB/Chronic Diarrhoea										1			
Cateracts			1										
Burn to Eye			1										
Plutonium Poisoning	1												12
Unspecified:													
Skin Condition		4	4	1	1								
Radiation Exposure	43	23	1		1	6	1		1	1	2		89
Sub Totals	44	28	10	3	5	7	2	5	3	5	9	5	126

It is not possible to state the type of work on which each claimant has been employed. Available records show only the establishment at which the claimant worked but not his occupation. To provide this information would be a considerable administrative task in checking individual files, and, if need be, consulting the establishment concerned or the claimant himself. It would not be possible to give the numbers of claimants still alive without a similarly extensive check.

The 1975 Social Security Act provides that Industrial Injuries Benefits are payable to those who suffer an accident or the onset of a prescribed disease whilst they are in employment Occupational exposure to ionising radiation is covered by both the accident and disease provisions of the Industrial Injuries Scheme. No MoD civilian radiation worker has demonstrated to the Medical Board that the diseases from which they were suffering were directly attributable to their occupation and therefore none has received the benefit under the scheme.

Members of HM Forces are excluded from the Industrial Injuries Scheme. But where disablement is attributable to or aggravated by service, compensation is available under the War Pensions Scheme. DSS do not record these awards by category and MoD does not have sufficient information on claimants to enable DSS to make a check without excessive manual effort.

There is a range of other benefits available through the DSS (e.g. invalidity benefit) to which claimants may have been entitled, but it is not possible to say whether any have been awarded.

6. *When was the Radiological Protection Technical Advisory Committee (RAPTAC) established? How frequently does it meet?*

6. The Radiological Protection Technical Advisory Committee (RAPTAC) was formed in 1976. The frequency of meetings is not laid down but in practice it meets about twice a year.

7. *What progress has been made in determining the responsibility for any compensation payments as between the MoD and contractors at the dockyards (Q202)?*

7. The Ministry of Defence under the provisions of the Term Contracts with DML and BTL is responsible for meeting the cost of any compensation paid in respect of injuries or illnesses attributable to any period prior to Vesting Day. Thereafter the contractors are responsible. If the illness is attributable to work undertaken both pre and post Vesting Day the liabilities would be shared

4. Further memorandum submitted by the Ministry of Defence (2 October, 1990)

Following earlier written and oral evidence from the Ministry and the visit of the Committee to Rosyth Dockyard, the Committee sought answers to further questions. These are set out below.

Q 1. At what sites within the nuclear propulsion programme does the Defence Radiological Service act as the Radiation Protection Adviser?

The DRPS is appointed as the corporate RPA for HM Forces, except for those areas and functions which have their own appointed RPAs. All sites within the nuclear propulsion programme have qualified individuals appointed as RPAs, although DRPS occasionally acts in a temporary capacity over periods of leave etc for the RPA at Portsmouth, Gibraltar, Portland and the Clyde Submarine Base. In addition to its formal RPA role, which is defined in the Ionising Radiations Regulations (1985), DRPS provides advice generally in the field of radiological protection matters.

A 2. *What role does the Nuclear Installations Inspectorate of the Health and Safety Inspectorate currently play within (a) the nuclear weapons programme and (b) the nuclear propulsion programmes; and at what sites?*

a. The licensing provisions of the Nuclear Installations Act 1965 do not apply to the Ministry of Defence. However section 9 requires Government departments to notify HSE/NII of nuclear occurrences in respect of facilities that are nuclear installations as defined in the Act. It has never been necessary to invoke these provisions.

Under the terms of the Health and Safety at Work Act 1974 (HSWA) the Ministry of Defence is subject to inspection and enforcement by HSE. By agreement, HSE does not choose to inspect what are defined as operational activities, but reserves the right to intervene if valid cause is demonstrated.

At the Atomic Weapons Establishment, HSE has chosen to undertake this inspection by the Principal Specialist Inspector HSE, a member of the Technical Division of the Nuclear Inspectorate but operating under the remit of the HSWA, not in his capacity as a member of the Nuclear Installation Inspectorate.

RNAD Coulport advises HSE of relevant activities and the local Inspector visits at his discretion. This arrangement covers all site areas.

Security requirements are fully met and, with the exception of the activities agreed to be "operational", no part of the nuclear weapons programme is excluded.

b. The contractorised HM Dockyard facilities at Devonport and Rosyth are licensed by the Nuclear Installations Inspectorate (NII) for the handling and storage of unirradiated and irradiated fuel and bulk quantities of other radioactive materials. Within the licensed sites, the NII provides the lead inspector by agreement with HM Factory Inspectorate for inspections under the HSWA and the Ionising Radiations Regulations.

A similar licence is issued by the NII to Vickers Shipbuilding and Engineering Limited at its Barrow Shipbuilding Works, Barrow-in-Furness.

Vulcan NRTE is not a licensed site, but again by agreement with the HM Factory Inspectorate the NII Inspector acts as lead inspector for inspections under the HSWA and the Ionising Radiations Regulations.

Q 3. Pursuant to questions 72–73, 75 and 81, can the aggregate figures on annual exposure doses at AWE prior to 1979 on computer be made available to the Committee?

A 3 The information required is set out in the attached Table 1. During the period covered by these data AWE (then designated AWRE) became part of the UKAEA in 1955, reverting to MoD in 1973. The figures also include data for civilian personnel who participated in the overseas Atmospheric Nuclear Test and Experimental Programme 1952–1967, managed by the Ministry of Supply and its successors.

Table 1 includes figures for 1979–89 given in the Ministry's original Memorandum; this is to help the Committee in assessing the full run of data and to allow the correction of three small compilation errors in the original table. (To clarify the presentation, column entries are blank following a preceding zero where there are no entries in any of the higher dose ranges).

Q 4. *What is the risk of the intake of radioactive materials within the nuclear propulsion programme? What records are held on the intake of radioactive materials within the nucler propulsion programme?*

A 4. The reactor plant used in nuclear submarines is designed to be leak tight. The risk of the intake of radioactive materials during submarine operations is therefore very small. Nevertheless the submarine atmosphere is continuously monitored for airborne radioactivity. Operating procedures are laid down to be used in the very unlikely event of a leak, and where appropriate these include the use of protective clothing and respiratory protection which is always readily available within the submarine. Even if a leak of coolant were to occur, the levels of activity in the atmosphere would be low.

During maintenance and refit it is sometimes necessary to remove components from the reactor plant and during major refit to open the reactor coolant circuit to remove old fuel and replace it with new fuel elements. The components involved may themselves be radioactive such that work on them, particularly any machining operation, has the potential to produce some airborne radioactivity. Additionally, within the coolant circuit there can be an accumulation of loose radioactive debris. Special precautions are taken in these situations to prevent the intake of radioactive material by workers including decontamination processes where necessary, the enclosure and specialist ventilation of potentially contaminated areas, and personnel protection measures of clothing and respiratory protection. In all cases air sampling will take place during such work. All removal, replacement and refitting work is carried out under formal and rigorous health physics control, including the use of authorised written procedures to specify, inter alia, the required working practice.

The International Commission on Radiological Protection has recommended the use of the concept of a recording level. The recording level is a formally defined value of committed dose equivalent or intake above which a result from a monitoring programme requires recording and interpreting. Recording levels are calculated separately for each radionuclide, and are set at one-tenth of that fraction of the annual dose limit corresponding to the monitoring period to which the measurement refers.

Assessments of the intakes of radiocative material have been carried out on a sampling basis since 1980. During 1980, when assessments of internal activity were made on 45 civilian workers from Rosyth, 45 from Chatham and 38 from Devonport, using the DRPS whole body monitoring system, radiologically insignificant quantities of Cobalt 60 (the radionuclide of principal concern in operations involving nuclear reactor plant) were detectable in 50 workers monitored. In none of these cases was the level of radioactivity greater than the recording level. Checks continued for several years at DRPS and have subsequently been undertaken at local hospitals. (Derriford for Devonport and Edinburgh for Rosyth). Monitoring continues to demonstrate that no significant radiation dose accrues to personnel within the Naval Nuclear Propulsion Programme (NNPP) as a result of internal radioactivity. Dose records since 1979 for NNPP workers show no instances where an entry based on assesssment of internal radioactivity has been required.

Prior to the introduction of the computerised DRPS record keeping system in December 1984, the results of assessments of intakes of radioactive materials were held on index cards within an individual's radiation dose record folder. Since then DRPS has had the ability to include the results of such radiation dose assessments within the computerised record keeping system should this be needed.

Q 5. *(a) Can figures be provided on the annual individual dose equivalents for those submariners classified as radiation workers since 1979 and the cumulative lifetime radiation dose equivalents at the end of 1989?*

(b) What radiological protection measures are adopted within operational submarines?

(a) The annual and cumulative lifetime individual radiation dose equivalents for personnel monitored for external radiation exposure while serving onboard HM submarines are shown at Tables 2 and 3 respectively. These doses are derived from measurements using a dosemeter worn on the trunk.

(b) The radiological protection measure taken in operational submarines are similar to the stringent procedures taken anywhere else within the Ministry of Defence where radiation hazards exist. Instructions for Radiological Protection (JSP 392) are put into effect Service-wide, and local rules are prepared to suit particular circumstances that may exist in any ship or establishment. The specialised nature of nuclear submarine operations requires the promulgation of additional detailed radiation protection procedures. These take the form of classified volumes, the most important of which are:

i. BR 3030(2) Radiological Controls for Nuclear Submarines, which constitutes the framework or a written system of work. This volume was re-written at the time IRR85 came into force and further amendments have been made in the light of experience since.

ii. BR 3018 Technical Organisation and Administration of Nuclear Submarines, which includes the definition of safety responsibilities, requirements for training, instructions for the control of work and the organisation of audit.

Radiation Protection Advisers are available to assist with any problem, but day-to-day procedures in submarines are monitored by the Environmental Control Officer who, normally, would also be the Radiation Protection Supervisor. He would issue direct-reading dosemeters, as required, for operational control purposes.

Q 6. *Pursuant to supplementary answer 3, could MoD list recommendations for improved means of dose control which have been made and implemented within the nuclear propulsion programme in the last five years?*

A 6 A significant number of practical steps have been taken within the last five years to reduce the radiation dose accrued by personnel in the NNPP. The following list is not exhaustive but comprehends the most important individual items and the generic measures.

(a) *Decontamination*

(i) Whole plant decontamination—the MODIX (Multi-Stage Oxidative Decontamination with Ion Exchange clean up) process was introduced at VULCAN NRTE to decontaminate the first reactor protoype. Following its successful trial at Dounreay it has been applied to submarines at both Rosyth and Devonport with similar success. The Ministry development has attracted significant reductions in refit dose. It is anticipated that maintenance doses will also benefit.

(ii) Component decontamination—a development programme is continuing aimed at producing improved methods of decontaminating components removed from the plant for inspection and repair.

(b) *Plant Improvements*

(i) Reactor Plant Thermal Insulation—changes to lagging have been introduced which decrease significantly the time required to relag the primary circuit during refit. This attracts a considerable dose saving for the workers carrying out this task.

(ii) Primary Water Chemistry—improvements to the already strict control of primary coolant chemistry have been introduced to reduce the amount of radioactivity deposited on primary circuit components and hence the background radiation levels in the reactor compartment.

(iii) Cobalt Replacement—some of the materials used in reactor plant valves have a high cobalt content. During plant operation normal wear results in small quantities of this material being circulated by the primary coolant through the reactor core where the cobalt become radioactive. This radioactive cobalt makes a significant contribution to radiation levels overall. Work continues to identify suitable alternative materials. The first of the modified components are being introduced at registry of the latest submarines.

(c) *Equipment Improvements*

Many improvements have been introduced in this period aimed at reducing the time that personnel are exposed during maintenance or refit. Some have been developed locally at the Naval Bases/Dockyards whilst others have stemmed from work managed centrally and normally carried out by Rolls-Royce and Associates. Examples include·

(i) Mechanisation of cable gland packing

(ii) Automatic welding of pipes and valve canopies.

(iii) Automatic cutting and welding of large toroidal seals.

(iv) Remotely controlled and monitored In-Service Inspection (ISI) techniques.

(d) *Dose Management*

(i) Dose Reduction—modern and sophisticated dose prediction computer programmes have been introduced to facilitate effective dose management including identification of the need for shielding.

(ii) Dose Maintenance—individual direct reading electronic dosemeters (eg. Gammacom) have been introduced to assist with day-to-day dose control.

(iii) Dose Analysis—computer programmes have been introduced which provide an analysis of dose by individual task. This is a vital tool in the management of dose.

(iv) Training—more sophisticated and realistic models and mock-ups have been introduced to reduce further the time spent in radiation areas.

(v) Temporary shielding—even greater use is now made of temporary shielding, particularly in the vicinity of hot spots. The Dose Prediction programmes and radiation surveys assist in optimising the use of such shielding.

Q7. *Have any improved means of dose control been recommended within the nuclear propulsion programme which are awaiting implementation?*

A7. No significant dose reduction measures have been identified which have subsequently not been implemented, or are not in the course of evaluation or implementation.

TABLE 1: ANNUAL INDIVIDUAL EXTERNAL EXPOSURES* IN A GIVEN YEAR FOR AWE MONITORED EMPLOYEES

NUMBERS OF PERSONNEL IN DOSE RANGES

Year	0–15 mSv	15–20 mSv	20–30 mSv	30–40 mSv	40–50 mSv	50–100 mSv	100–150 mSv	150–200 mSv	200–250 mSv	>250 mSv	No of Monitored Employees	Collective Exposures (Man Sv)	Average Exposure (mSv)
1946	1	0									1	0.005	–
1947	2	1	0								3	0.033	11
1948	4	1	1	1	0						7	0 087	12
1949	13	1	2	0							16	0.15	9.4
1950	40	3	3	0	0	1	0				47	0.39	8.3
1951	60	4	3	1	1	0					69	0.56	8.1
1952	374	15	4	5	4	1	0				403	1.6	4.0
1953	570	8	8	7	3	0					596	2.0	3.4
1954	698	5	10	1	0						714	1.8	2.5
1955	870	2	13	0	0	1	0				886	2.0	2.2
1956	1,156	14	13	5	2	3	1	0	1	0	1,195	3.5	2.9
1957	1,457	10	15	7	2	5	0				1,496	4.0	2.7
1958	1,873	5	10	4	0	1	0				1,893	3.9	2.1
1959	2,004	13	10	2	0	2	1	0			2,032	5.3	2.6
1960	2,557	7	10	1	1	0					2,576	6.1	2.4
1961	2,765	20	24	6	1	1	0				2,817	7.8	2.8
1962	3,314	8	8	0	0	1	0				3,331	5.1	1.5
1963	3,413	5	8	1	0						3,427	4.9	1.4
1964	3,323	7	0	1	0	1	0				3,332	4.6	1.4
1965	3,285	6	1	1	0	1	0				3,294	4.5	1.4
1966	3,145	7	5	3	0						3,160	4.3	1.3
1967	3,118	10	4	0							3,132	4.2	1.4
1968	3,019	18	10	1	1	0					3,049	4.9	1.6
1969	2,829	13	10	2	1	0					2,855	4 6	1.6
1970	2,679	9	11	13	3	0					2,715	4 1	1.5
1971	2,563	13	19	14	12	0					2,621	5.0	1 9
1972	2,524	23	18	6	0						2,571	4.2	1.7
1973	2,556	13	17	4	2	1	0				2,593	4.0	1.5
1974	2,491	10	24	7	1	0					2,533	3.8	1.5
1975	2,557	11	18	12	4	2	0				2,604	4.0	1.5
1976	2,627	17	18	11	0	0	1	0			2,674	3.9	1.5
1977	2,638	14	13	1	2	0					2,668	3.3	1.2
1978	2,735	9	2	0							2,746	3 4	1.2
1979	2,953	0									2,953	2.7	0.91
1980	3,180	0									3,180	3.3	1.1
1981	3,340	0									3,340	3.3	1.0
1982	3,525	2	1	0							3,528	3.6	1.0
1983	3,623	0									3,623	3.4	0.95
1984	3,756	0									3,756	3.0	0.80
1985	4,007	0									4,007	2.9	0.72
1986	3,967	0									3,967	2.9	0 74
1987	4,191	0									4,191	2.8	0.67
1988	4,094	0									4,094	2.1	0.52
1989	3,843	0									3,843	0 88	0.23

*The effective (whole body) doses equivalent are typically less than 50 per cent of the indicated levels both at AWE and for warhead handling.

TABLE 2: ANNUAL RADIATION DOSE EQUIVALENTS FOR PERSONNEL SERVING ONBOARD NUCLEAR POWERED WARSHIPS

Year	NUMBERS OF PERSONNEL IN DOSE RANGES								
	0–15mSv	15–20mSv	20–30mSv	30–40mSv	40–50mSv	>50mSv	No of Monitored Employees	Collective Dose (Man Sv)	Average Dose (mSv)
1979	1,764	26	14	5	0		1,809	5,894	3 26
1980	1,889	27	4	2	0	1	1,923	5,286	2 75
1981	826	6	3	1	0		836	1,927	2 31
1982	699	4	2	1	0		706	1,260	1 78
1983	520	9	4	2	0		535	1,492	2.79
1984	452	6	6	2	0		466	1,522	3 27
1985	514	7	2	1	0		524	1,185	2 26
1986	490	8	5	3	0		506	1,306	2 58
1987	856	6	7	1	0		870	1,429	1 64
1988	904	3	0				907	1,363	1 50
1989	1,481	1	2	0			1,484	1,929	1 30

TABLE 3: CUMULATIVE LIFETIME RADIATION DOSE EQUIVALENTS FOR PERSONNEL SERVING ONBOARD NUCLEAR POWERED WARSHIPS

Dose range (mSv)	Percentage of workforce monitored
0– 50	98 0
50–100	1 8
100–200	0 2
200–300	0 0
300–400	0 0
400–500	0 0
Greater than 500	0 0
Total	100 00

5. Memorandum submitted by the National Radiological Protection Board (May 1990)

Summary

1. This Memorandum was produced at the request of the House of Commons Defence Committee. It covers the role and responsibilities of the National Radiological Protection Board within the United Kingdom and specifically identifies the interactions with the Ministry of Defence on radiological protection issues. Information is provided on contracts undertaken for the Ministry of Defence, both for assessments and dosimetry services, and on the principal ways in which advice is given. An analysis is given of occupational exposure data held by NRPB, relating the Ministry of Defence.

The National Radiological Protection Board (NRPB)

2. NRPB was established by the Radiological Protection Act, 1970. The functions of the Board are to carry out research on protection from radiation hazards and to provide advice to those, including government departments with responsibilities in the United Kingdom in relation to protection from radiation hazards, either to the community as a whole or of particular sections of the community. The Act also gives NRPB the power to provide technical services, for which charges may be made.

3. The Board has a staff of about 315, of whom some 235 are scientific or technical. The remaining staff carry out administrative, financial and personnel services. In the financial year 1989/90, the Board's income was £9,856,000, made up of 54 per cent Government grants from the Department of Health and Scottish Home and Health Department, while 46 per cent was from income-earning activities. The programme of work is determined by the Board itself, the Chairman and members of which are appointed by the Health Ministers or any one of them acting on behalf of all. The current Chairman is Sir Richard Southwood, FRS, Vice-Chancellor of Oxford University.

4. In addition to its statutory functions, NRPB can be given Directions by Health Ministers. In 1977, NRPB received a Direction to advise appropriate government departments and statutory bodies on the acceptability to and applicability in the UK of recommendations made by certain specified international agencies. At the same time, NRPB was directed to be responsible for specifying Emergency Reference Levels of dose (ERLs).

5. The current version of the Radiological Protection Act and Directions given to the Board have been published recently in Documents of the NRPB[1]. The Board publishes its corporate plan annually, which details the programme of work, financial implications, and, incidentally, provides a list of Board Members[2].

International Recommendations

6. The foremost body making recommendations in radiation protection is the International Commission on Radiological Protection (ICRP), which was established in 1928 under the name of the International X-ray and Radium Protection Committee. It assumed its present name and organisational form in 1950 in order to cover more effectively the field of radiation protection As one of the commissions established by the International Society of Radiology, ICRP continues its close relationship with the medical profession, while enacting its responsibility to provide guidance within the field of radiation protection as a whole.

7. ICRP issued its current main recommendations in 1977[3] and issued in February 1990 a draft version, for comment, of its new recommendations, which may be expected to be finalised by end of 1990 and published in the first half of 1991.

8. The Council of the European Communities has the power to adopt Directives that are binding on the Governments of the Member States by reference to the result to be achieved. The most recent Directive issued in 1980[4] and amended in 1984[5] is largely implemented in the UK by means of the Ionising Radiations Regulations, 1985[6], which are made under the Health and Safety at Work etc. Act 1974.

NRPB Interim Advice on Standards for Normal Operation

9. The system of dose limitation recommended by the International Commission on Radiological Protection[3] applies to the control of radiation exposure from normal operations including the exposures of radiation workers and the exposures of the public from routine discharges of gaseous and liquid radioactive effluents. The two requirements of the system which have most practical influence are that doses to individuals should not exceed the limits recommended by ICRP, and that all doses should be As Low As Reasonably Achievable (ALARA), economic and social factors being taken into account. ALARA is an acronym usually used internationally but within the UK ALARP (As Low As Reasonably Practicable) has been used historically. The Board regards the two as synonymous.

10. The dose limits define the lower boundary of a region in which exposures are unacceptable, while the ALARA requirement gives a mechanism for decisions on how far below these limits it should be reasonable to strive to reduce doses. This latter requirement, also known as the principle of 'optimisation of protection', means that it is not adequate just to demonstrate compliance with dose limits.

11. The current dose limits for both occupationally exposed persons and the general public are specified for the UK in the Ionising Radiations Regulations, 1985[6].

12. As noted in paragraph 7, ICRP is currently reviewing its basic standards of protection and revised recommendations are expected to be completed by 1990. Given the evidence that was emerging regarding changes in the estimates of the risks of fatal cancer, NRPB in 1987 produced interim guidance[7] for those with regulatory responsibility for setting dose limits for workers and the public, and for those involved in the management for those exposures. The guidance was based on an anticipated increase in the risk for fatal cancers by a factor of two or three. We recommended that as long as the dose limit remained at 50 mSv per year, the average dose to the most exposed workers should be so controlled as not to exceed an effective dose equivalent of 15 mSv per year. For the public, we recommended that, as the principal dose limit was already at 1 mSv per year, the doses to the most exposed groups from effluent discharges from nuclear installations should be so controlled as not to exceed an effective dose equivalent of 0.5 mSv per year for a single site.

13. In response to our advice, the Health and Safety Commission asked its Working Group on Ionising Radiations to recommend the actions that the Commission should take. The result of the deliberations of that Group has been the publication, for comment, of a Draft Code of Practice which would effectively enact the Board's advice[8]. This draft code was published prior to the Gardner report and could be changed before final publication.

NRPB Interactions with MoD

14. The Board has no formal links or responsibilities for radiation protection on a day-to-day basis for any MoD site. However, contacts are made at informal levels for advice on assessments or personal monitoring. In addition, the Board undertakes contract work for MoD; an example is the mortality of UK veterans of UK atomic weapons tests. The Board also provides some personal dosemeters to MoD as customers of NRPB's commercial sales. Finally, the Board would provide direct advice to MoD in the event of their having a nuclear emergency. These topics are dealt with in turn below.

Regular contacts

15. Regular discussions are held between appropriate Board staff and MoD staff on a variety of topics. Contacts with Aldermaston would cover consequences of routine discharges, accident consequence modelling, Derived Limits for radionuclides in the environment, and Derived Emergency Reference Levels, ie activity concentration in air, water, food, etc., which correspond to the Board's ERLs. There have also been discussions with MoD on berthing criteria for submarines and disposal of decommissioned submarines. The Board's Personal Monitoring Service is approached from time to time on questions of interpretation of personal dosimetry. High level information exchange meetings are held between MoD and Board staff every 18 months or so

Contract work

16. Contracts have been given to the Board to undertake specific studies for MoD. Jointly with the Imperial Cancer Research Fund, the Board published the results of its study into mortality and cancer incidence in UK participants in UK atmospheric nuclear weapons tests and experimental programmes in 1988 (NRPB-R214). A commitment has been given to update this work for a longer follow-up period of the cohorts studied.

17. The assessment of the radiological impact of disposal of decommissioned submarines was published (NRPB-M168) and reproduced in full in the 7th Report of the House of Commons Defence Committee in 1989. There has been a review of a report on the proposed Devonport waste store (NRPB-M195) and contracts are nearing completion on assessments of doses from discharges from MoD sites at Aldermaston, Burghfield, Foulness and Cardiff

Commercial services

18. The Board provides neutron monitoring services on a commercial basis to both Aldermaston (AWE) and the Defence Radiological Protection Service (DRPS). The contract from AWE is for 250 Track etch detectors per month, while DRPS is provided with 150 Track etch detectors on a monthly basis,

a further 150 on a quarterly basis, and, in addition, 190 monthly neutron film emulsion detectors. There is regular informal contact as a result of these services and, in addition, the Board is discussing with MoD the development of the Board's personal integrating electronic dosemeter.

Emergency response

19. In the event of an accident involving either a submarine reactor or a nuclear weapon, there is a formal agreement that the Board provides radiological advice to MoD. The Board would be represented in the Nuclear Accident Information and Advisory Group (NAIAG) and would send a senior member of staff to the site of the incident. The Board therefore participates in MoD emergency exercises. NRPB would not expect to provide environmental monitoring in the event of an MoD nuclear accident.

Information from the Central Index of Dose Information (CIDI)

20. NRPB operates CIDI on behalf of the Health and Safety Executive (HSE) who require the data under the Ionising Radiations Regulations. Data extracted from CIDI can only be used with HSE approval, which has been given for the analysis here.

21. The Board also produces periodic reviews of exposure of the UK population from all sources. The last review was published in 1989 as NRPB report R227. Data are collected routinely in preparation for these reviews. The data collected consist of annual doses rather than lifetime totals. Table 1 compares data for 1987 and 1988 for MoD, including contractors at naval dockyards, and the nuclear industry. Mean annual doses for MoD were just less than 1.3 mSv in 1987 and 1.0 mSv in 1988 compared with mean doses to the civil nuclear industry of 2 mSv and 1.7 mSv in each year respectively. About 5 per cent of MoD workers exceeded 5 mSv in each year, compared with about 10 per cent of the civil workforce.

22. Table 2 breaks down the 1988 statistics into the components arising from DRPS and AWE. Mean annual doses were lower for workers monitored at AWE (0.57 mSv) than those monitored by DRPS (1.2 mSv). About 2 per cent of workers monitored by DRPS and no monitored workers at AWE exceeded 10 mSv in 1988. Only 10 workers monitored by DRPS (0.1 per cent) and no-one at AWE exceeded 20 mSv in the year—a figure of interest since the Gardner report showed a statistical association between childhood leukaemia and paternal exposure greater than 10 mSv in the 6 months prior to conception. The doses in Tables 1 and 2 are the sum of external radiation and committed doses from intakes of radionuclides in the year.

23. Data held on CIDI are for classified radiation workers, rather than all workers, although the doses recorded again include estimates not only for external radiation exposures, but also for doses from intakes of radionuclides in the year. Provision of lifetime external exposure data to CIDI was optional since there was no obligation on employers to maintain lifetime doses under the regulations prior to the IRRs 1985. It can be seen that the highest lifetime doses were accumulated by MoD contractors with a mean lifetime dose of 58 mSv, almost exactly twice that incurred by MoD employees as a whole. Data supplied by MoD seem substantially complete and are presented in Table 3.

24. The Gardner report showed an association between childhood leukaemia and a total paternal dose in excess of 100 mSv prior to conception. Data from Table 3 show that 7.7 per cent of MoD employees have exceeded a lifetime dose of 100 mSv from external radiation, compared with 9.5 per cent for all classified workers. It is not possible to derive from CIDI doses received by individual workers before they produced any children, because annual returns have only been sent to CIDI since 1986.

Data from the National Registry of Radiation Workers (NRRW)

25. Data from NRRW are held for epidemiological analyses and cannot strictly be used for other purposes because of the Data Protection Act. At present publication of the first analysis of the Registry is anticipated later in the year. Data cannot therefore be provided on average doses to specific groups in the Registry. However, MoD have agreed to the release of their data from AWE and DRPS.

26. The data held by the National Registry for Radiation Workers cover all MoD employees, not just classified workers. A few individuals have refused to participate in NRRW but this is unlikely to have much effect since the number of refusals is low overall (1–2 per cent) and particularly low for MoD. The dose data currently held for the Registry covers years up to 1986 only and is presently being validated. It is thus not as up-to-date as the information on CIDI and is likely to undergo small revisions, but these are only likely to have a very small effect. More seriously, doses incurred by the same individual in different employments may not yet be correlated properly. It is estimated that this might affect the records of up to 10,000 individuals overall on the Registry, ie up to 10 per cent of all participants. However, the data held by NRRW have the large advantage of containing doses broken down into annual components over many years. This allows an investigation into the component of lifetime dose incurred up to age 30. This is chosen, fairly arbitrarily, to give an estimate of the average dose likely to have been received by a worker prior to fathering a child.

27. Information on lifetime doses stored on NRRW are given in Table 4, which has the same format as Table 3, based on data from CIDI. NRRW does not have information on contractors but DRPS and AWE components are given separately. Since NRRW includes both classified and non-classified workers and also covers a long time period, it has data on many more MoD employees than does CIDI (about 43,000 vs 9,000). The mean lifetime recorded on NRRW for all MoD employees are lower by a factor of about two than those on CIDI (14.1 mSv cf. 29 mSv).

28. Table 4 also gives information on doses incurred up to age 30. The calculation is not exact since it has to be based on annual doses, but it should generally be representative. For all MoD employees taken together the mean dose to age 30 (4.9 mSv) is about one-third of the lifetime dose (14.1 mSv). The number of individuals exceeding 100 mSv by age 30 is about 300 (0.7 per cent of all workers). In contrast, about 1,200 MoD employees (2.8 per cent of the total) exceeded 100 mSv lifetime dose. The relationship between dose to age 30 and lifetime dose for MoD personnel appears not to be dissimilar to that for NRRW participants as a whole.

29. Two other items of information are of particular interest. Firstly, in HSC's Approved Code of Practice, Part 4[8], an investigation would be held if an employee's accumulated dose exceeds 150 mSv in 10 years (ie exceeds an average 15 mSv/year). Secondly, as mentioned in paragraph 7, ICRP is currently consulting on its new proposed recommendations: these contain a suggested dose limit of 100 mSv over any 5-year period with no more than 50 mSv in a single year. Information can be obtained from NRRW on the number of individuals exceeding 150 mSv in 10 years or 100 mSv in 5 years For AWE, 50 individuals had exceeded the former criterion and 40 had exceeded the latter. For DRPS the numbers were 173 and 319. However, it must be emphasised that most of these are historical exposures. Data from CIDI show that only 4 individuals employed at AWE had exceeded 45 mSv in the 3 years 1986 to 1988 and only 3 had exceeded 60 mSv. For DRPS, 66 had exceeded 45 mSv in the years 1986 to 1988, and 14 had exceeded 60 mSv in those years. For all classified workers within CIDI for the UK nuclear industry, the corresponding numbers would be 1,861 and 872

References

(1) Documents of the NRPB, Vol 1, No 1, pp 1–13 (1990)

(2) NRPB, Corporate Plan 1990/91 to 1994/95 (1990)

(3) ICRP, Recommendations of the ICRP, Annals of the ICRP, Vol 1, No 3 (1977)

(4) CEC, Council Directive of 15 July 1980 (80/836/Euratom) amending the Directives laying down the basic safety standards for the health protection of the general public and workers against the dangers of ionising radiation Official Journal of the European Communities, Vol 23, No L246 (1980)

(5) CEC, Council Directive of 3 September 1984 (84/467/Euratom) amending the Directive 80/836/Euratom as regards the basic safety standards for the health protection of the general public and workers against the dangers of ionising radiation Official Journal of the European Communities, Vol 27, No L265 (1984)

(6) The Ionising Radiations Regulations London, HMSO, Statutory Instrument No 1333 (1985)

(7) NRPB, Interim guidance on the implications of recent revisions of risk estimates and the ICRP 1987 Como Statement Chilton, NRPB–GS9 (1987)

(8) HSC, Draft Approved Code of Practice, Part 4 Dose limitation—restriction of exposure Additional guidance on Regulation 6 of the Ionising Radiations Regulations 1985 (1990)

TABLE 1: RECENT OCCUPATIONAL EXPOSURES IN THE MINISTRY OF DEFENCE AND CIVIL NUCLEAR INDUSTRY

WORKERS IN DOSE RANGE (mSv)

Sites	Year	0–5	5–15	15–50	>50	Total Number	Collective Dose (Man Sv)	Average Dose (mSv)
Sellafield	1987	6,799	1,974	633	2	9,408	39.26	4.17
	1988	6,565	2,049	418	0	9,032	34.83	3.86
Capenhurst and	1987	3,853	468	71	0	4,392	9.92	2.26
Springfields	1988	3,649	367	10	0	4,026	7.39	1.84
CEGB, SSEB and	1987	22,208	701	62	0	22,971	18.19	0.79
Chapelcross	1988	24,884	674	29	0	25,587	16.87	0.66
UKAEA and	1987	8,060	801	331	3	9,195	24.63	2.68
Berkeley Labs	1988	7,991	822	211	0	9,024	19.57	2.17
All civil nuclear	1987	40,920	3,944	1,097	5	45,966	92	2.00
industry	1988	43,089	3,912	668	0	47,669	78.66	1.65
MoD	1987	11,522	528	100	0	12,150	15.3	1.26
	1988	11,335	458	31	0	11,824	11.31	0.96

TABLE 2: DOSE DISTRIBUTION WITHIN MOD AND FOR ALL CIVIL NUCLEAR INDUSTRY FOR 1988

Dose Range (mSv)	Number of Workers in Dose Ranges shown DRPS	AWE	ALL MOD	Civil Nuclear industry
0– 5	7,267	4,068	11,335	43,089
5–10	303	26	329	2,800
10–15	129	0	129	1,112
15–20	21	0	21	413
20–30	10	0	10	251
30–40	0	0	0	4
40–50	0	0	0	0
>50	0	0	0	0
Total Number	7,730	4,094	11,824	47,669
Collective dose (man Sv)	8.96	2.35	11.31	78.66
Average dose (mSv)	1.16	0.57	0.96	1.65

TABLE 3: LIFETIME DOSES FROM CIDI

Breakdown of measured lifetime doses (mSv)

Lifetime dose up to	1 0	5 0	10 0	20 0	50 0	100 0	200 0	300 0	400 0	600 0	Larger	Total	Mean
DRPS	716	517	324	326	367	157	63	13	4	3	0	2,490	18 3
DRPS contractors	207	273	230	252	433	356	255	98	37	16	0	2,157	58 1
ALDERMASTON	780	974	496	616	626	224	151	33	11	1	1	3,913	21 8
ALDERMASTON contractors	84	110	75	72	38	9	0	0	0	0	0	388	9 4
All MOD	1,787	1,874	1,125	1,266	1.464	746	469	144	52	20	1	8,948	29 0
Cumulative %	20 0%	40 9%	53 5%	67 6%	84 0%	92 3%	97 6%	99 2%	99 8%				
All Classified	19,855	12,061	6,151	7,074	8,820	5,192	3,448	1,239	601	595	320	65,356	36 3
Cumulative %	30 4%	48 8%	58 2%	69 1%	82 6%	90.5%	95 8%	97 7%	98 9%	99 5%			

TABLE 4: LIFETIME DOSES FROM NRRW

Breakdown of measured lifetime doses and dose to age 30 (msv)

Lifetime dose up to	1 0	5 0	10 0	20 0	50 0	100 0	200 0	300 0	400 0	600 0	Larger	Total	Mean
DRPS	12,270	8,279	3,755	3,216	2,731	1,221	700	217	86	38	10	32,523	14 5
AWE	1,917	3,396	1,718	1,529	1,226	326	127	28	8	2	1	10,278	13 0
All MOD	14,187	11,675	5,473	4,745	3,957	1,547	827	245	94	40	11	42,810	14 1
Cumulative per cent	33 1	60 4	73 2	84 3	93 5	97 1	99 1	99 6	99 8	99 9	100		

Dose up to age thirty	1 0	5 0	10 0	20 0	50 0	100 0	200 0	300 0	400 0	600 0	Larger	Total	Mean
DRPS	19,842	6,468	2,448	1,787	1.241	466	210	47	6	3	5	32,523	5 3
AWE	6,353	2,195	859	544	251	51	18	5	0	1	1	10,278	3 5
All MOD	26,195	8,663	3,307	2,331	1,492	517	228	52	6	4	6	42,810	4 9
Cumulative per cent	61 2	81 4	89 2	94 6	98 1	99 3	99 8	99 9	99 9	99 9	100		

6. Memorandum submitted by the Committee on Medical Aspects of Radiation in the Environment (COMARE) (6 June 1990)

Thank you for your letter of 10 May seeking a note setting out COMARE's response to the Gardner Report, and the background to its advice to Government Departments. You also commented that your Committee would be assisted by any general observations COMARE may wish to make on the Ministry of Defence's radiation protection policy and practices.

2. By way of background information, COMARE was established in 1985 to advise Government on the health effects of natural and man-made radiation in the environment and to assess the adequacy of the available data and the need for further research. Further information about the Committee's past and future work programme was given in response to a Parliamentary Question from Mr Tim Yeo MP on 10 January (Hansard, Volume 164 columns 662–3 – copy enclosed for ease of reference).

3. With regard to the Government's request for advice on the Gardner Report, Mr Roger Freeman (the then Parliamentary Under-Secretary of State for Health) announced on 15 February that the Report had been referred to COMARE for urgent consideration and preliminary advice (Hansard, Volume 167 columns 397–398). On 2 April, Mr Freeman announced that the Government had received COMARE's preliminary advice and had accepted all the Committee's recommendations (Hansard, Volume 167 columns 430–434).

4. Your Committee's attention is drawn in particular to paragraphs 15–18 of COMARE's Statement in which specific recommendations are made about further research, and to the interim action suggested at paragraphs 19–20.

5. In view of COMARE's Terms of Reference, it would not be appropriate for the Committee to make any observations in relation to the radiation protection policy and practices of the Ministry of Defence. We would suggest that such questions ought more properly to be addressed to the National Radiological Protection Board and the Health and Safety Executive, both of whom bear statutory responsibilities in these areas.

7. Memorandum submitted by Trade Unions representing civilian personnel in Defence Establishments (June 1990)

1. Introduction

1.1 The Trade Unions representing civilian personnel in defence establishments are grateful for the invitation by the House of Commons Defence Committee to submit a memorandum setting out our views on radiation exposure. Details of the individual trade unions with members at both the Ministry of Defence establishments concerned and also the contractorised Royal Dockyards at Devonport and Rosyth are shown at **Annex A.**

1.2 This note sets out preliminary views. Although it has not been possible to consult as widely as we would wish in the time available, we have taken the opportunity to express our major concerns arising from the publication of the Gardner Report, meetings with MoD and discussions with members and representatives.

2. Radiological Protection in MoD

2.1 Although the Civil Service has accepted in principle its responsibilities under the Health and Safety at Work (etc) Act 1974 and regulations made under the Act, it is still the case that the Crown is exempt from prosecution. In addition it is our understanding that there are several exemptions for MoD in specified situations and in certain regulations. We appreciate that there are circumstances in which operational commitment will take priority and also that there are security considerations to be taken into account, however these factors should not preclude proper protection for civilian (or indeed service) personnel.

2.2 The precise position as to the application of the Ionising Radiation Regulations 1985 to MoD and MoD Contractors is not clear. It is our understanding that procedural variations have been agreed between the Health and Safety Executive and the Ministry of Defence and that more general exemptions from HSE regulations have been given for MoD Nuclear activities under Clause 40 of the Ionising Radiation Regulations.

2.3 We believe that the inability to prosecute MoD has led to a less than satisfactory implementation of Health and Safety legislation by MoD. We do not accept that there is any reason why, when it comes to enforcement, the MoD should be allowed to maintain standards that are lower than any other employer. This should involve:

a. the right of safety representatives or trade unions representatives to direct access to Health and Safety Inspectors;

b. the right of Inspectors to unannounced entry;

c. the ability of HSE to prosecute for failure to comply with the law.

2.4 We are also concerned that the structure of HSE does not appear to facilitate an organised or strategic approach to enforcement across MoD. In each HSE area office at least one factory inspector is security cleared. That inspector is then responsible for dealing with security sites in that area. Overall responsibility for Health and Safety at work in the "Crown, Fire and Police" National Interest Group rests with the Deputy Superintending (Factory) Inspector in the South Area. However, matters relating to the Ionising Radiation Regulations and safety of nuclear sites are mainly the responsibility of the Nuclear Installation Inspectorate. This split responsibility between the Operations Group (which includes the Factory Inspectorate and the Technology Division) and the Nuclear Installations Inspectorate means that the only person with responsibility for MoD as a whole is the Director General of HSE and this can not be the best way to produce a consistent and thought out policy towards enforcement in MoD.

2.5 Within MoD responsibilty for radiological protection matters seems to be split between different areas. Following the publication of the Gardner Report the Trade Unions had some difficulty in finding out who had MoD wide authority to speak on radiation exposure. There should be a clear central authority at departmental level on these matters.

2.6 We would welcome clarification as to the precise position of MoD under all the provisions of the Ionising Radiation Regulations 1985 and subsequent agreements between HSE and MoD. We presume that any exemptions would exclude Defence contractors at, for example, the Royal Dockyards at Devonport and Rosyth which are presently managed by contractors.

2.7 There has been a further problem in MoD concerning recruitment of Health Physics staff to both the Defence Radiological Protection Service and also the Atomic Weapons Establishment. Inadequate pay levels have produced recruitment and retention problems which have caused shortfalls in staffing. This has produced enormous burdens on the remaining Health Physicists and although the individuals in post have worked hard to produce the best possible service, the shortfall in staff is bound to create problems. It is our understanding that recent pay improvements have brought some improvement to the situation but more needs to be done, especially in view of the heightened awareness of the danger of radiation exposure to ensure that all Health Physics posts are filled.

3. Joint Meeting with MoD

3.1 Representatives from both industrial and non-industrial trade unions met MoD officials on 10 May to discuss the implications of the report by Professor Martin Gardner on a case control study on leukaemia and lymphoma in young persons near the Sellafield nuclear plant. The study was of particular concern to the Trade Unions and radiation workers because it suggested a raised incidence of leukaemia in children fathered by men who had accumulated radiation doses at levels previously thought safe. Leukaemia clusters have also been found close to other nuclear sites, including the Atomic Weapons Establishments at Aldermaston and Burghfield.

3.2 Immediately following the publication of the Gardner report we wrote to MoD calling for action on a number of points and a departmental level meeting to discuss the steps needed to be taken to protect civilian employees at MoD sites. A copy of the non-industrial union letter is at **Annex B**. A similar letter was sent on behalf of the industrial unions. Unfortunately the meeting did not take place until 10 May because of difficulties in assembling MoD experts. The minutes of the meeting are not yet available but the position on the issued raised is as follows:

Dose limits: The Trade Unions said that the present MoD practice of limit dosage to 30 mSv in a calendar year was unsatisfactory. Dose levels for all radiation workers should be brought as low as possible, as soon as possible and we suggested a target of no more than 10 mSv in any calendar year or 5 mSv in a six months rolling average MoD declined to take any immediate specific action in the wake of the Gardner Report but did agree to provide data on levels of radiation exposure for civilian workers at Defence establishments in order that problem areas could be identified. The Trade Unions have since specified the form in which the information should be supplied and a copy of this letter is at **Annex C**. We believe that an annual dose limit of 30 mSv is too high and that the MoD are wrong not to take immediate action to set lower limits. Although we agree that further work needs to be carried out to either prove or disprove the suggested relationship between paternal exposure to radiation and childhood leukaemia, it is our view that we must proceed on the basis that the findings of the Gardner Report will be substantiated by further studies. Nevertheless, we welcome the commitment to provide information and to hold further meetings at departmental level with trade unions. In the light of information received on dosages we will be pressing for a departmental strategy for achieving reduced exposure and specific investigation and action in problem areas. We hope this will now move quickly in view of the possible implications for defence workers and their families.

Rights of individuals: We pressed MoD to agree that if, after counselling, an individual wanted to move out of an active area he or she should be able to do so. This assurance has been given in British Nuclear Fuels and the Atomic Energy Authority. This is still under consideration by MoD but it is our view that they should now give this reassurance to radiation workers.

Counselling: MoD have agreed that radiation workers (or former radiation workers) and their families can receive expert counselling and we welcome this.

Compensation: Almost two years ago the Trade Unions put forward the proposal that the BNFL/AEA compensation scheme should be extended to cover MoD employees. This is a "no fault" scheme which decides compensation on the basis of expert advice and avoid the problems of sometimes lengthy litigation. We still have no substantive response from MoD and understand that a view will not be forthcoming until the Autumn at the earliest. We have criticised the length of time taken to consider this matter.

RNAD Coulport: We were informed in March that a survey at RNAD Coulport had discovered the under-recording of radiation exposure of a number of employees in areas containing nuclear warheads. The dosimeters used did not accurately measure the level of neutron radiation. As a result of local negotiations at Coulport the following agreement has been reached

a) Recalculated dosage levels be made available These were disclosed and are 0–4 mSv 65 workers, 4–9 mSv 6 workers, over 9 mSv nil workers.

b) All workers employed on warhead work to be classified radiation workers.

c) Neutron sensitive dosimeters to be checked monthly

d) Hourly rate reading dosimeters to be used on a 3 months trial basis and then need for them to be reviewed

e) Individuals level of dosage to be reported to them as matter of course rather than, as present, on request

f) Medicals to be available on request to non classified workers in special areas

g) Defence Radiological Protection Service to explain to members the implications of any Radiation Hazards

h) Radiation levels revealed by survey to be made available to trade unions

We welcome the local agreement at Coulport but remain deeply concerned about why the under-recording took place and the possible implications elsewhere in MoD Recalculation of past exposure records have taken place We will be pressing MoD for details of the way in which this was done. We have been promised a written transcript of the explanation given at the departmental level meeting which will be examined in detail as it is clearly most unsatisfactory that this situation should arise

4. Conclusions

1 The position of MoD and defence contractors under the Ionised Radiation Regulations 1985 should be made precisely clear

2. Trade Union representatives should have the right of direct access to Health and Safety Inspectors on radiological protection issues

3 HSE/NII Inspectors should have the right of unannounced entry to defence establishments

4. HSE should be able to prosecute MoD for any failure to comply with the law

5 Policy and enforcement responsibilities in HSE should be brought together to produce a strategic approach to radiation protection in MoD

6 There should be a clear central authority within MoD on radiological protection

7 Pay levels for Health Physics staff should be maintained at such a level as to prevent recruitment and retention problems

8. The present MoD dose limit of 30mSv in any calendar year is too high Comprehensive data on dose limits throughout MoD and Defence contractors should be produced and urgent action taken in problem areas MoD should set a target of no more than 10 mSvs in any one year and no more than 5 mSvs in a six month rolling average

9 Individuals who after counselling wish to move out of active areas should be able to do so

10 MoD should respond quickly and constructively to the proposal from the Trade Unions that the BNFL/AEA compensation scheme should be extended to cover MoD employees

ANNEX A

Ministry of Defence Council of Civil Service Trade Unions

Institution of Professionals, Managers and Specialists
Civil and Public Services Association
National Union of Civil and Public Servants

Trade Union Side of MoD Joint Industrial Whitley Council

Transport and General Workers Union
Amalgamated Engineering Union
Union of Construction, Allied Trades and Technicians
General, Municipal, Boilermakers
Manufacturing, Science and Finance
Electrical, Electronic, Telecommunication and Plumbing Union
Furniture Trade and Allied Trade Unions

8. Memorandum submitted by Rosyth Royal Dockyard Management (16 July 1990)

Rosyth Royal Dockyard: Submarine Refitting Facilities

1. The Site

1.1 Activities are carried out within the Nuclear Licensed Site areas. Nuclear submarines are refitted in Nos. 2 and 3 Docks. Support facilities for handling removed radioactive items and waste situated on the 'spine' between the two docks, and at the separate Solid Waste Disposal Complex.

1.2 Access to all radiological Controlled areas, including the Submarine Reactor Compartments, is gained through the Health Physics Control Issue Point and change room situated on the ground floor of the Health Physics Building.

1.3 Other active facilities include the Refuelling Equipment Shop (which includes a new nuclear fuel store and training rig); Effluent Treatment Plant; Core Pond, active stores and work areas; and solid radioactive waste handling and accumulation facilities.

2. Reactor Compartment Doserates and Control

2.1 Doserates vary throughout the Reactor Compartment. An indication of the general environmental levels is given by average values over predetermined scan areas for both the upper and lower levels of the compartment. These can be also used for comparison between different submarine refits. Typical mid-refit values are shown below:

Submarine Refit	A	B	C
Average Low Level Scan (μSv/hr)	*	*	*
Average Upper Level Scan (μSv/hr)	*	*	*

2.2 The main methods used for reducing doserates are plant/component decontamination, lead shielding, removal of active components. The MODIX primary plant decontamination process produces major benefits, as shown below:

Submarine Refit		A	B	C
Low Level Scan (μSv/hr)	Before	*	*	*
	After	*	*	*
Upper Level Scan (μSv/hr)	Before	*	*	*
	After	*	*	*

Lead shielding is used over high spots throughout the compartment and may be re-positioned according to the work in hand. * * *.

2.3 Internal exposure to radioactive material is avoided through the use of containment and respiratory protective equipment. A continuous air sampling programme is undertaken.

3. Key Trade Centres

3.1 The typical distribution of refit dose between trades is shown below:

Mechanical fitters	15%
Boilermakers/nuclear welders	12%
Nuclear non-craft	9%
Refuellers	9%
Nuclear Standards	7%
Pipeshop/plumbers/coppersmiths	6%
Health Physics	5%
Electrical fitters	5%

3.2 The number of persons in each centre varies considerably. Those centres containing individuals with the highest doses are: the mechanical fitters, boilermakers/nuclear welders, nuclear standards and metallurgists.

4. Trends

The overall annual dose commitment to the dockyard workforce is dependent on the submarine refit sequence. The general trend is downwards, but year to year variations occur due to different refit loadings and the different doserate characteristics of each submarine.

5. Local Dose Management

The dockyard company, in consultation with the trade unions through the Radiation Safety Committee, has introduced local dose limits which are considerably lower than those prescribed in the statutory regulations (IRR '85).

Concerns on working in radiation areas—progress statement

1. A previously agreed short term dose limitation of 10 mSv, subject to certain caveats, is being operated by the Company to cover the first six months of 1990. The arrangements apply to exposure of staff and industrial employees.

It has been further agreed to extend the voluntary dose limitation concept. The Company will operate a 10 mSv ceiling for exposure incurred in the 6 month period commencing 1 July until end of 1990. This will be subject to the caveats previously agreed, namely:

(a) Should a special situation arise involving a requirement for an individual radiation worker to exceed 10 mSv in this period agreement will be sought on a case by case basis. Should agreement not be reached no employee will be directed to exceed 10 mSv in this period.

(b) Individual exposure will be reduced by dose sharing whenever it is practical to do so.

2. Management and Trade Unions are currently examining yard resources and programme of work for future years on the basis of MoD information currently available. Further discussions to consider these issues and associated implications for individual exposure of radiation workers will continue through the Dockyard Radiation Safety Committee in pursuance of a realistic and flexible voluntary dose limitation policy. The Committee will establish a joint working group to review the way ahead.

3. The Managing Director has written to the MoD expressing his desire for the Company to be involved in any investigations concerned with radiation workers that may be under consideration in the immediate future. The Managing Director further offered the willing co-operation of the Company in any such investigations.

4. Further arrangements to underpin confidence of radiation workers have been agreed and are as follows:

(a) *Personal Dose Notification*

Arrangements will be made to inform individual radiation workers quarterly when their exposure exceeds 80 per cent of any Company voluntary limitations.

(b) *Personal Dose Information*

Dose management information for all radiation workers is held in the HP Department RADMAP computer. In addition to statutory requirements the Company has agreed to retain indefinitely any dose information relating to Written Systems Persons obtained since 1987.

Employees can request their current personal dose on application to HP Department Control Issue Point. More detailed information may be obtained through HP Department RADMAP Section (Ext. 52904).

(c) *Medical Surveillance of Radiation Workers*

Medical surveillance for radiation workers will be enhanced on the following basis. These new arrangements are on a voluntary basis and will be jointly reviewed by the Dockyard Radiation Safety Committee annually.

(i) *Written Systems Persons* – An annual health review of records will be undertaken.

(ii) *Ex Classified Workers* – An annual health review of records plus medical examination, inclusive of blood sample, at three year intervals to be agreed between doctor and employee.

(iii) *Classified Workers* – Annual medical will continue as normal

Initial applications for medical surveillance appointments in category (ii) above will be processed through first line management

5. A.L.A.R.P.

The Company commitment to the A L A R P principle through further improvement of engineering controls, design features, improved ventilation, systems of work, supervision and new technology is reiterated A dedicated Industrial Engineering Department Working Party has been established to review these matters

However, it is the wish of the Trade Unions and the Company to involve all employees in dose reduction initiatives By utilising relevant divisional area working parties and gang meetings this objective can be achieved

All relevant area working parties and gang meetings are required to include dose reduction on their regular agendas for discussion

Charge Managers are required to send details of dose reduction suggestions and achievements to the Secretary, Dockyard Radiation Safety Committee for information

9. Memorandum submitted by Devonport Management Ltd, addressing Questions raised by the Committee (27 September 1990)

Q 1. *Has Devonport Management Limited introduced any local dose limit beyond those prescribed in IRR85?*

a. Devonport Management Limited (DML) has implemented one local dose limits and one dose reduction target beyond those prescribed in IRR 1985. The former is an annual dose limit of 5 mSv for DML Approved System Persons, the latter is an annual dose target of only 15 mSv for DML Classified Persons.

b. Annexes A and B show the Annual Exposure Control and Shift Exposure Control for DML radiation workers.

c. Dose reduction practices are under continuous review by management and the Trade Unions through the Radiation Safety Committee.

Q 2. *What consultation with the workforce and/or changes have taken place at the dockyard following the publication of the Gardner Report?*

a. Following publication of the Gardner report, a total of eight special meetings of the Radiation Safety Sub Committee (a sub committee of the Dockyard Safety Committee), were convened with the aim of studying the implications of the report for workers at DML. Through this joint Management and Trade Union committee, the following actions and intentions were agreed:

i. To brief supervisors of radiation workers on the Company's actions in response to the Gardner report. Two briefing sessions, given by the Technical Directors, were held on the 16 and 19 February, 1990. These sessions were arranged outside of the Radiation Safety Sub Committee and provided material for onward briefing to the workforce.

ii. To create a dose data base for all DML radiation workers ie those employees who have received a radiation dose since April 1987.

iii. To make available to all DML radiation workers their personal radiation dose history (as known by DML as of that date). This would include the following information: lifetime dose to date, annual dose history, list of any periods when dose exceeded 10 mSv in any six month period and date when 100 mSv was passed.

iv. To reaffirm the Company's Dose Reduction Policy and DML's commitment to the ALARP principle, and specifically the aim to keep annual whole body doses below 15 mSv.

v. To liaise with NRPB, NII, and through the Appointed Doctor, the Plymouth District Medical Officer and Plymouth Consultant Haematologist, in order to obtain advice and information. Liaison also took place with BNFL PLC.

vi. To provide employee counselling on a group and individual basis. Group counsellings were given by the Appointed Doctor (or staff) with a Health Physicist present. Representatives from the Trade Unions also attended group counselling sessions. Individual counselling was with the Appointed Doctor (or staff).

vii. To advise that counselling for partners and families must be through their General Practitioners (GPs). The District Medical Officer of the Area Health Authority forwarded information and advice on the Gardner report to all GPs in the area, with the contact number of the Appointed Doctor of DML included, in case further information was required. The Appointed Doctor undertook to communicate with GPs as appropriate after individual counselling.

viii. To keep employees informed of facts relevant to the situation via "Devonport Focus" and Team Briefs.

ix. To form a DML Public Health Liaison Committee with representatives from the Local Authority, DML Nuclear Department and Public Affairs Group, the Appointed Doctor and the Trade Unions. Membership of this committee enabled useful statistics with regard to incidence of leukaemia etc to be available for onward transmission to the RSSC and the workforce

x. To maintain a dose reduction target of 5 mSv for DML persons working under a Written System of Work ie. Approved System Persons.

xi. To declassify DML Classified Persons at the end of the calendar year if the personal dose received was less than 1 mSv and line management had not justified the person staying on the Classified Persons Register.

xii. To encourage the formation of Local Dose Control Committees (in addition to the Company Radiation Dose Reduction Committee) to implement the Company Dose Reduction Policy at gang level in a rigorous manner.

xiii. To present dose statistics to radiation workers and their families.

xiv. That the Company contribute to any local or national studies which are undertaken as a result of the COMARE recommendations.

xv. To answer Parliamentary Enquiries as necessary.

xvi. To give press briefings as necessary.

b. Through the involvement of Health Physics at the counselling sessions, the Health Physics Department has undertaken the following actions in response to questions and comments raised:

i. produced a fact sheet on the locally used dosemeter, the RAD 80.

ii. introduced additional relevant information into training lectures for radiation workers.

c. The result of specific actions described in paras 2a (i)-(xvi)—are as follows:

i. 3812 personal dose histories and explanatory letters were produced. 1507 were not issued as the persons were no longer DML employees. 298 were issued and subsequently returned.

ii. DML received a videotape of a presentation by experts and a question and answer session with Sellafield employees. This videotape was shown to the RSSC.

iii. Approximately 300 personnel received group counselling and 71 personnel received *individual counselling.*

iv. Six issues of "Devenport focus" (from 19 February to 4 June 1990) included an update of the Company's position with regard to Gardner. Further information has also been included in two Team Briefs and a DML Temporary memorandum.

v. A number of Local Dose Control Committees were formulated eg. Reactor Plant Manager and Dockside Test Organisation.

vi. A presentation to radiation workers and their relatives was held on 29 May 1990. A Nuclear Medicine Consultant addressed the meeting and took in a question and answer session.

Q 3. (a) What are the typical average mid refit dose rate values for the low level and upper level scans for the last three submarines to undergo refit at Devonport?

(b) What are the low level and upper level scans for the same submarines before and after the MODIX primary plant decontamination process?

A 3. a. The typical average mid refit dose rates for the upper and lower level scans (U/L and L/L) for the last three submarines to undergo refit at Devonport are as follows:

Submarine	*A*	*B*	*C*
U/L Dose Rate	* uSvh-1	* uSvh-1	* uSvh-1
L/L Dose Rate	* uSvh-1	* uSvh-1	* uSvh-1

b. The dose rates for the upper and lower level scans for Submarines B and C immediately before and after the MODIX primary Plant Decontamination Process are as follows:

Submarine B

	U/L Dose Rate	L/L Dose Rate
Pre-MODIX	* uSvh-1	* uSvh-1
Post-MODIX	* uSvh-1	* uSvh-1

Submarine C

	U/L Dose Rate	L/L Dose Rate
Pre-MODIX	* uSvh-1	* uSvh-1
Post-MODIX	* uSvh-1	* uSvh-1

It should be noted that the immediate post MODIX dose rates for Submarines B and C are higher than the typical average refit dose rates shown at 3(a). This is because lead shielding was applied to certain specific areas of the primary circuit, after MODIX, in order to further reduce dose rates before refit work started.

MODIX was not undertaken in Submarine A because the process was not available at the time, however additional lead shielding was applied as in Submarines B and C.

Q 4. What measures have been introduced or are being developed to reduce the time spent by workers in the reactor compartment of submarines undergoing refit?

A. (a) The DML Dose Reduction Policy is at Annex C. The specific areas of this policy that in practice relate to the reduction of time spent by workers in the reactor compartment are as follows:

(i) Thorough planning and scheduling of work.

(ii) Development and training in the use of new tools, skills or techniques to improve the quality of the work (ie. "to get it right first time"), and to reduce the time spent in radiologically controlled areas by completing the work in less time.

(iii) Training in radiological protection, including the use of the Permit to Work System.

The training aspects are a specific responsibility of the Radiation Protection Supervisor in the Reactor Managers Organisation.

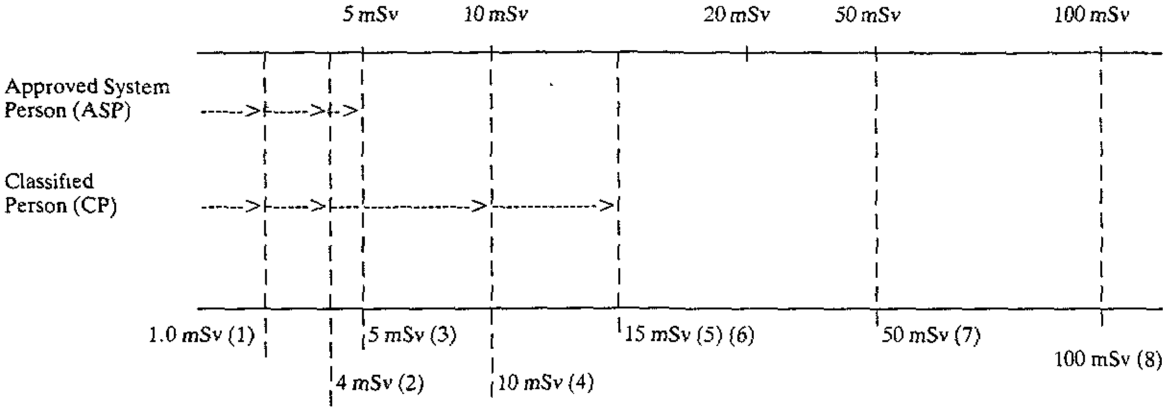
(b) A programme of refresher training in radiological protection has started. There will be separate training for Supervisors who have the responsibility to ensure that time spent in the Reactor Compartment is only that required for the task in hand.

(c) The Radiation Dose Reduction Committee (Management and Trade Union) meets every six weeks to review dose reduction methods required for the ongoing programme of work. (Annex C para 4.0). The formation of Local Dose Control Committees as described in para 2xii will enable further ideas from the workforce regarding dose reduction to be examined, and implemented where possible.

5. Finally, it should be made clear that strict dose management has been the practice long before Gardner. *All* work in reactor compartments, including refitting, refuelling and testing, is undertaken in accordance with written detailed, step by step, procedures. Every draft procedure is scrutinised and authorised by a Procedure Authorisation Group (PAG) comprised of professional and nuclear qualified persons, including a Health Physics representative. They ensure in detail that the method of working is not only safe from the plant operation point of view and that the results achieved comply with design specification, but also that it is as dose efficient as practicable, which may include refitting certain items ashore where possible. The PAG authorise each procedure and nominate a qualified Co-ordinator who has the responsibility for ensuring that the procedure is undertaken in strict accordance with the authorised working regime. No departure from this is permitted without signed authorisation from the PAG.

ANNEX A

DOSE CONTROL CRITERIA: ANNUAL EXPOSURE CONTROL



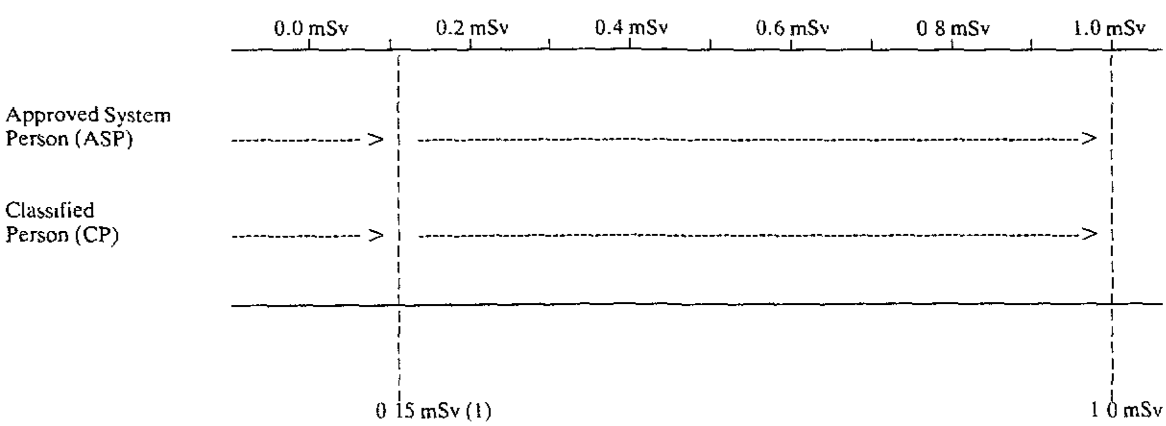
1. All CPs not exceeding 1.0 mSv at the end of the year (mid December) will be deleted from the RADMAP system unless the Centre Manager requests retention. Health Physics Branch (HPB) will inform Centre Managers by letter of all personnel fitting into this category.
2. Health Physics Branch will inform Centre Manager by letter that an individual's dose is approaching 5 mSv. Centre Manager is to request Classification if individual is required for further work in Controlled Areas which may result in 5 mSv being exceeded.
3. ASP must be Classified prior to exceeding 5 mSv. (ASP maximum dose). Female Classified Persons shall not exceed 5 mSv in a calender quarter.
4. If 10 mSv is exceeded in any 6 month period, the Centre Manager will be informed by HPB and personal counselling offered.
5. DML Classified Person annual dose reduction target is 15 mSv.
6. Statutory investigation level. (IRR 85).
7. Statutory annual dose maximum. (IRR 85).
8. Whenever an individuals life-time accrued dose approaches 100 mSv HPB will inform the Centre Manager and offer personal counselling.

NOTE:

1. Centre Managers should ensure that Centre dose is shared to minimise individual accrued doses. Centre personnel should be trained to undertake as many tasks as practicable to maximise dose sharing capability.
2. Nuclear Procedure Coordinators should take all practicable steps to ensure that personnel exposure is kept to ALARP.
3. A female radiation worker who has declared a pregnancy will be allocated work in low dose rate areas where possible. A dose of 10 mSv shall not be exceeded during the declared term of pregnancy.

ANNEX B

DOSE CONTROL CRITERIA: SHIFT EXPOSURE CONTROL



1. Health Physics Branch (HPB) Local investigation Level. Senior Health Physicist (SHP) will investigate circumstances of exposure whenever a person's dose exceeds 0 15 mSv in an individual shift Health Physicist (Assessments) Dosimetry (HP(A)D) will routinely check 0 15 mSv investigation log to identify any trends and undertake any actions as seen necessary
2. Alarm setting on RAD 80 electronic dosimeters set at 1 0 mSv On hearing the alarm the wearer is to leave the Controlled Area as soon as practicably possible and inform the Duty Health Physics Foreman or Radiation Protection Supervisor as appropriate. Re-entry may be allowed depending on the circumstances.

ANNEX C

DML Dose Reduction Policy

1.0 Work carried out by DML on nuclear submarines is subject to the Ionising Radiations Regulations 1985. There is a clear requirement for DML to carry out work in Radiologically Controlled areas. It is the responsibility of all persons involved with work within a controlled area to ensure that the total dose commitment to persons, both collectively and individually, is as low as reasonably practicable (ALARP).

2.0 The Company Policy for Radiation Dose Reduction is:

a. No individual is to exceed the Legal Dose limits.

b. Collective and Individual doses to personnel are to be minimised as far as is reasonably practicable.

c. Where practicable work is to be planned to keep individual whole body doses for classified persons below 15 mSv per calendar year.

3.0 The following principles therefore apply:

a. Dose sharing is to be employed as a means of reducing individual doses.

b. Dose targets are to be set both for individuals and for discrete tasks.

c. Planning and preparation at all levels is to recognise the importance of dose reduction and should aim to minimise accrued dose wherever practicable.

d. *Radiation Survey data and historical dose records are to be readily available.*

e. Maximum use is to be made of new or improved techniques and equipments to minimise both time and presence on the job.

f. Sufficient numbers of people in each trade group are to be authorised and trained to work in controlled areas, to enable dose targets to be met.

g. The planning of all operations must include consideration of the application of special processes to reduce activity inventories and radiation doses.

h. *Training appropriate to every task is to be given.*

i. Local protection and dose reduction measures, such as shielding, the use of remote viewing equipment, training mock-ups, and minimisation of personnel in areas where dose rates are above 2.5 mSv per hour, are to be operated wherever practicable.

j. Personnel are to be briefed on the radiological aspects of each task an on an and all precautionary measures to be adopted

4.0 The Radiation Dose Reduction Committee (RDRC) meets regularly to consider all aspects of dose reduction and will advise as necessary on dose reduction measures. The composition of the RDRC is defined in the Nuclear Submarine Repair Manual Volume 2 Chapter VIIA which covers Radiation Dose Reduction Management. Managers at all levels with an involvement in the nuclear submarine repair tasks should be conversant with the content of this Chapter.

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14. Decisions on individual measures must have regard to the resource implications. Nevertheless the Ministry of Defence has adopted as a design aim for new boats a target of keeping all effective doses below 10mSv per annum and will continue to evaluate all means of reducing exposure in other areas.

15. The attitude of the Ministry of Defence to requests from individuals to be moved from work involving further exposure to radiation at any particular level of dose remains as stated by the Committee, namely that the Ministry will give them sympathetic consideration, but it cannot guarantee that Establishments will be able to accede to all such requests.

Dockyards

16. The Government notes the Committee's view that particular efforts should be made to reduce exposure levels at Rosyth Dockyard, and that generally contractors should agree that classified radiation workers should be given the option of transfer to non-classified work. While it is the Ministry's policy to secure as common an approach as possible, these are matters for the companies concerned. Nevertheless the Ministry will, in accordance with ALARP principles, continue to encourage local management to adopt their own targets for a particular operation. The new Joint Radiation sub-Committee is intended to assist the implementation of this policy, but cannot be a substitute for local knowledge or provide the necessary input at working level.

Compensation

17. Finally the Government notes the Committee's interest in the establishment of a no-fault compensation scheme for Ministry of Defence employees and its wish that the Minisry should consider this urgently. The Committee will appreciate that the proposal to operate such a scheme within a Government Department raises complex and time consuming legal questions. Nevertheless consideration of such a scheme is well advanced and the Ministry of Defence expects to be able to make an early announcement, although this may not unfortunately be possible by the end of March.

Communication with Trade Unions

10. The Government notes the Committee's interest in effective communication between the Ministry of Defence and the Trade Unions and workforce. It considers that the promulgation of new limits in advance of any statutory requirement re-emphasises the continuing concern of the Ministry of Defence for the safety of its employees. The Ministry places considerable importance on communication with its staff on radiation safety. This is currently dealt with in the more general Ministry of Defence Joint Health and Safety Committee. The Ministry welcomes the suggestion of the Committee that central liaison should be enhanced, and it proposes to form a joint radiation sub-committee; the Ministry membership will comprise many of the members of RAPTAC. RAPTAC itself is primarily a technical committee and is unsuited for the liaison procedure suggested by the Committee.

Personnel Management

11. *The Committee was concerned that the staff at* RNAD Coulport should fully understand the doubts which had arisen about dosemeter readings. Extensive briefings of the Coulport staff have already taken place since the changes in dosemeter practice were implemented. Similar explanations will continue to be undertaken at all Establishments in corresponding situations where changes are made in measuring and/or recording arrangements for radiation exposures.

12. The Government notes the Committee's wish that the opportunity should be taken to reduce the average level of individual exposure. The Ministry of Defence is fully committed to pursuing this goal, although the Committee will understand *that some potential measures*, such as the introduction of improved shielding may be counter-productive, if it results in the worker spending longer in a (lower) radiation environment, with no net reduction in dose.

13. Planned changes to the submarine fleet and the consequent reduction in the number of refits will in any event be reflected in reductions in the numbers of personnel exposed to ionising radiations. The recommended aim is nevertheless accepted within the wider objective of reducing the total dose accumulated by all personnel on a given task. Dose sharing and equalisation must not be regarded as a substitute for measures aimed at bringing about an overall reduction. These matters are amongst those addressed in joint working level committees at which the workforce is represented.

/14. ..

Ministry of Defence Policy and Practice

5. The Ministry of Defence has in the past maintained a strong commitment to radiological protection measures for its workforce and has every intention of maintaining the momentum to overcome further challenges. Although the Ministry's current policy and practice on radiological protection conforms to legislation the primary guide, Departmental dose limits, is tighter than the statutory dose limits. Equally importantly the Ministry imposes the ALARP principle, through which exposures generally are held to levels well below even the Departmental limits.

6. The Government considers that the evidence presented to the Committee confirms the statement that the Ministry's current exposure levels compare favourably with those of the American nuclear propulsion programme and those of the French which are derived from a wider spectrum of nuclear activities. However the American nuclear propulsion programme achieved present levels some 10 years earlier than in the United Kingdom. The Ministry of Defence is well seized of the need to match the efforts of other countries as well as those within the civil nuclear industry in the UK.

7. In tune with its policy of seeking improvement when possible the Ministry of Defence is about to implement a further tightening of its Departmental limits and to operate an individual investigation level, in accordance with a new Code of Practice about to be promulgated nationally. The intention is to retain the existing annual limit of 30mSv in any single year, but now subject to an overall limitation of 100mSv in any consecutive period of five calendar years starting from the beginning of 1991. The investigation level will be similarly cumulative over five years at a total of 75mSv. These initiatives enable the Department to exercise close scrutiny and control over the early build up of cumulative exposures and as the Committee required place it in a position to respond to a wide range of possible developments, including the outcome of the ICRP's deliberations.

8. The Government notes the concern of the Committee about the commitment to radiological protection at AWE following contractorisation; the Ministry of Defence is ensuring that the existing commitment be maintained by requiring the contractor to keep health physics staffing up to strength.

9. The Committee was told about the upgrading of computer systems for statistical analysis. In the context of the new Departmental dose limits referred to in paragraph 1, this will enable account to be taken of each individual's exposure record over a period of five years.

/Communication ...

DEFENCE COMMITTEE

RADIOLOGICAL PROTECTION OF SERVICE AND CIVILIAN PERSONNEL

MEMORANDUM

INTRODUCTION

1. This Memorandum addresses the Defence Committee's 12th Report (Session 1989/90) on Radiological Protection of Service and Civilian Personnel.

2. In its report the Committee considers the current policy and practice of the Ministry of Defence in providing radiological protection to its staff exposed to ionising radiation, and it acknowledges the strong commitment by the Ministry to achieving high standards of protection and safety throughout its nuclear programme. The Committee sought assurances that these high standards would be maintained and that where possible levels of exposure to ionising radiation would be reduced; the Committee also made a number of detailed recommendations aimed at giving greater visibility of radiation protection matters to trade union and staff representatives, as well as the workforce concerned.

THE GOVERNMENT'S RESPONSE

3. The Government welcomes this report as a full and constructive consideration of the factors involved in drawing up the principles and practice for the protection of Service and civilian personnel from ionising radiation. The Government accepts the need to continue to give such protection a high priority, and to ensure that the extent and purpose of the measures adopted by the Ministry of Defence are fully understood by trade unions and the workforce. The Ministry of Defence is taking measures to develop its arrangements with the trade unions as described in this Memorandum.

4. Further information and comment about some of the points made in the Committee's report are set out below.

/Ministry ...