

AWE: Nuclear Test Veterans Records Exercise Phase 1 Report – Policy – v2

Introduction

AWE plc (AWE), along with the three service historical branches, was asked by the OVA to answer three questions in relation to UK nuclear test veterans:

History: “what testing was conducted on UK veterans by whom and when”;

Record Keeping: “what was the policy/instruction at the time for the retention of this medical information. To what extent was the information transferred to individual medical files and/or retained elsewhere”; and

What happened to these records? “What was the instruction for the retention of this material; some records are held on medical files, however, are there other test results, including anonymised data, held elsewhere? This will include any consideration of policy/decisions for destruction of blood and urine test results and the rationale for that direction”.¹

AWE’s answers were given in October 2025.² At OVA’s request, this updated and expanded version of AWE’s input incorporates the extensive comments, clarifications, responses to supplementary questions and additional background material provided in correspondence between OVA and AWE since October. It is presented in three main sections, corresponding to the Minister’s original questions, and four appendices containing the most substantial additional background material. The opportunity has also been taken where possible, in re-checking each of the footnotes, to replace references to documents in the Merlin database with references to copies now released to the National Archives in the ES 38 series. Personal names have been included where the latest MoD guidance on data protection and privacy allows.

Executive Summary

Extensive blood and some urine testing was carried out in connection with the British nuclear testing programme but film-badge dosimetry, not any medical testing or surveillance, was the fundamental basis of radiological protection and assessment of radiation exposure of personnel, civilian and military, at the nuclear tests.

Radiological protection was discussed between the services and the Atomic Weapons Research Establishment (AWRE) and policy applying to all personnel, civilian and military, was issued on the basis of these discussions by the service Task Force Commanders for each operation.

Because of the risk of radiation exposure, blood counts were consistently required as part of “special medical examinations” for all personnel, civilian and military, to assess fitness to deploy on nuclear test operations. In practice, almost all personnel at tests in Australia were covered by this requirement but, for the several Grapple test series in the Pacific in 1957-58, the assessment of who was at risk was relaxed in line with experience: film-badge dosimetry had consistently shown that only a minority of test participants ever received a measurable

¹ Ministerial submission of 16 Sep 2024, ‘Nuclear test veterans - advice on options’, pp. 7-8.

² ‘AWE: Nuclear Test Veterans Records Exercise Phase 1 Report - Policy’, by email to OVA, 16 Oct 2025.

dose. A second, less common reason for blood testing, given in documents especially after 1957, was to provide a “medico-legal” baseline against which to assess later claims for health damage (see also Appendix 1). AWE has found only a small handful of references to *post-deployment* or *post-exposure* blood testing.

Radiological protection measures were broadly consistent with evolving practice and later statutory regulation for industrial radiation workers in the UK and internationally. In particular, radiation exposure limits were set with reference to internationally agreed threshold doses, with the important difference that some higher doses over shorter periods were permitted at nuclear tests (see also Appendix 2). Policy on pre-deployment blood counts was similar to internationally agreed guidance on pre-employment testing for industrial radiation workers (see also Appendix 3).

Blood test results were originally to be filed and kept with personal medical records by the appropriate parent service; AWRE received and kept records only for its own personnel. Policy on retention of such records for industrial radiation workers in the UK was established only in 1961 and even then it did not apply specifically to nuclear test participants although it may have been applied to AWRE civilians by analogy, there being no other relevant regulation. Dosimetry records for all test participants, civilian and military, were received and kept by AWRE.

AWE has found no evidence of urine testing as a matter of policy. In isolated cases urine testing was used, seemingly on an *ad hoc* basis.

Scope

In line with the Minister's original questions this report focuses on policy for blood and urine testing, including records-management policy, and the background to and reasons for that policy. Extensive searches for blood and urine test *results* have not produced sufficient evidence to draw firm conclusions on the extent to which policy was complied with. This may be at least partly because records-management policy applicable to medical records of AWRE civilians specifies only 30 years' retention after an individual's retirement (see below, section 3).

The period 1952-67 was taken, by agreement with OVA and the service historical branches, as the period covered by the Minister's questions, starting with the first British nuclear test in the Montebello Islands off Western Australia and ending with the closure and handover of the Maralinga range in South Australia.³

It was not AWE plc but its predecessor organisations which were involved in the atmospheric nuclear testing programme. The government first set up a small team to work on the design of an atomic bomb in 1947 under the name 'High Explosives Research' (HER). From 1950, the HER team moved from Fort Halstead in Kent to Aldermaston in Berkshire where the Atomic Weapons Research Establishment (AWRE) was created in 1953. Responsibility for AWRE was transferred from the Ministry of Supply to the new United Kingdom Atomic Energy Authority (UKAEA) in 1954. The Ministry of Supply remained responsible for most defence procurement and for aspects of nuclear testing including the UK's part in the

³ This is the date range used by the UK Health Security Agency and its predecessors for the four population-wide medical statistical studies of the nuclear test veterans since the 1980s, and also (originally) by the government to determine eligibility for the nuclear test veterans' medal introduced in 2022: SC Darby et al., Mortality and cancer incidence in UK participants in UK atmospheric nuclear weapon tests and experimental programmes, NRPB-R214 (National Radiological Protection Board, Jan 1988), p. 23; <https://www.gov.uk/government/publications/nuclear-test-medal-eligibility-criteria> [accessed 29 Mar 2025].

management of the Maralinga test range in Australia. AWRE's main role was research, design and development of nuclear weapons and the manufacture of certain nuclear weapons components. As regards the nuclear testing programme, AWRE provided technical direction, including on safety and radiological protection, and health physics services including film-badge processing for all test participants, civilian and military. The only evidence found of any AWRE involvement in medical examinations for service personnel is in cases where test participants arrived at a range without, presumably for some administrative or logistical reason, having had the necessary pre-deployment medical, in which case there is evidence, for example at Operation Grapple Z in 1958 (see below), that AWRE medical staff at the range helped to carry out these medical tests.

A complete picture will only be found by combining this report with the responses to the Minister's questions from the Naval, Army and Air Historical Branches.

Methodology

The report is based on documentary evidence only: first and foremost, contemporary papers, reports and correspondence, which in many cases were published or have been available in the public domain since their declassification starting in the 1980s; and second, papers, correspondence and compiled reports relating to later controversy and litigation, where these clearly include information from retrospective study of contemporary records. References have also been supplied to relevant passages in official histories and the report of the Australian Royal Commission of 1984-85 on British nuclear tests, accounts we have found to be reliable and consistent with contemporary records.

The following research methods have been used:

- The Merlin database⁴ was searched using a range of key words to find everything relevant to blood and urine testing; mostly contemporary documents but also some compiled from contemporary records in response to later controversy and litigation.
- Background research on radiological protection, blood testing and regulation in the period using internet search, library resources and published official histories.
- Specific targeted research, guided by catalogue search, in The National Archives at Kew, especially in relation to records management, in the National Archives of Australia's online records, and in AWE's paper archive.

⁴ The Merlin database was created by AWE at MoD's request between 2006 and 2008, to enable MoD and the Treasury Solicitors quickly to identify documentary evidence relevant to litigation then underway: see <https://www.nationalarchives.gov.uk/help-with-your-research/research-guides/records-of-veterans-of-nuclear-testing-the-contents-of-the-merlin-database/> [accessed 19 May 2026].

1. What testing was conducted on UK veterans by whom and when?

Introduction

It is important to distinguish between dosimetry and medical testing, both of which are relevant when considering nuclear test veterans.

Dosimetry. The measurement of radiation doses, mainly using personal film badges, was the fundamental basis of radiological protection. It was directed and supported by health physics teams. Urine testing is a recognised method of dosimetry, to estimate possible exposure to inhaled or ingested radioactive material, but it was evidently used at the nuclear tests only on an *ad hoc* basis. Blood testing is not used for dosimetry: differences in the blood can be observed in cases of very high radiation exposure leading to acute radiation sickness, but there is no useful correlation between blood counts and low levels of radiation exposure. This was well understood at the time of the nuclear tests (see also Appendix 3).

Medical testing. This included blood counts and chest x-rays used to establish general health and fitness to deploy on nuclear test operations. It was conducted by what would now be called occupational health teams providing employee care in the workplace. The terms “blood tests” and “blood examinations”, as well as the more specific “blood counts”, appear in contemporary documents from the nuclear test operations, usually without expansion or explanation. But whenever there was an expansion or explanation, blood counts were meant.

Dosimetry records were created and have been kept by AWRE and now AWE, and physically separate from other medical records held by the appropriate parent organisation.

AWE did carry out a search for blood and urine test results in all of the 129 surviving staff medical records of AWRE test veterans (out of 815 AWRE civilian nuclear test veterans overall). 96 of the 129 records found were for “classified workers” (industrial radiation workers) and showed they had been given blood counts, urine tests, and x-rays as part of their routine health surveillance as classified workers. 30 more were not classified workers but had been given similar tests on first joining AWRE. The final three records contained no evidence of blood or urine testing. Extensive searches of AWE’s holdings of medical records have not found any complete medical records of Royal Navy, Army or RAF test participants. Later correspondence folders on individual cases such as war pensions claims, which involved AWE when searches of AWE dosimetry records were required, have in some cases been found to contain copied extracts - not originals - from such service medical records. These extracts appear to have been passed to AWE to help identify the individuals concerned and to make it easier to search for dosimetry records and give the most substantive possible responses.

Operation Hurricane (1952)

In preparation for the first British nuclear test, Operation Hurricane, Dr William Penney, the leader of the HER project tasked with designing and building an atomic bomb, discussed radiological protection policy with Dr Neville Langdon Lloyd, the Chief Medical Officer at the Ministry of Supply, the government department then responsible for the entire UK nuclear programme both civil and military.

In October 1951, Penney suggested three threshold limits for radiation exposure: the normal International Commission on Radiological Protection (ICRP) working limit of 0.1 roentgen (r)/day at the surface of the body; and “integrated” or cumulative dose limits for the period of the test operation of 3 r (in a “limited number of cases”) and 10 r (in case of “extreme urgency”) for personnel whose duties might include, for example, retrieving important data from instruments in the contaminated area after the test (see also Appendix 2). Dose measurement would be by film badges. In addition, “all personnel who are to be subject to any of these levels will undergo a pre-exposure medical examination and no person will be allowed to accept the radiation exposure until the Medical Officer has approved him as fit for such work”.⁵

Lloyd approved this proposal, emphasising that “monitoring films must be worn by all personnel entering the radiation area, so that individual exposures will be known in every case” and that “in the pre-operational medical examination there should, if possible, be three blood counts done on those whose work is likely to involve higher dose rates”.⁶

A Royal Navy-led task force carried out Operation Hurricane in the uninhabited Montebello Islands off the coast of Western Australia over several months, culminating in a successful atomic test in October 1952.

Trial Orders issued by the Task Force Commander Rear Adm David Torlesse in the summer of 1952 and applicable to all personnel, civilian and military, stated that:

No person is to be exposed knowingly to ionising radiations unless such exposure is necessary in the execution of the operation. In cases where exposure is necessary, no person is to be exposed who has not passed the appropriate medical tests. The actual dosage received is to be kept to a minimum and is not to exceed the maximum authorised.⁷

The Trial Orders specified “blood counts” before and during the operation:

Everyone who may be exposed to radiation in excess of the normal working rate is to have a total and differential white count done between the beginning of September 1952 and the time of possible exposure. Anyone whose records show that he has been exposed to radiation to the extent of more than 10 roentgens in all, or more than 5 roentgens in any one week, is to have the counts repeated.⁸

This is one of only a very small number of references AWE has found to the idea that blood counts might need to be repeated post-exposure.

The Trial Orders also provided that “No person is to enter a contaminated area unless he has been passed as medically fit to do so. The S.M.O. [Senior Medical Officer, RAF Wing Cdr Geoffrey Dhenin] is responsible for making the necessary medical examinations”.⁹

⁵ Penney, ‘Operation Hurricane radiation dosage’, 22 Oct 1951, TNA ES 38/ZT3HG and draft in ES 1/325.

⁶ Lloyd, 14 Nov 1951, TNA ES 38/ZT767 and ES 1/325. At this early planning stage, because of the natural variability of blood tests results, it was presumably considered more important to take several counts, and thereby establish a more certain baseline, for personnel likely to be at higher risk. No later reference has been found to suggest more counts were taken in practice for personnel likely to be at higher risk.

⁷ Hurricane Trial Orders No.160, ‘Exposure to radiation’, 26 Jul 1952, Merlin database 22876 and TNA ES 1/325. Trial Orders were “orders” in the naval or military sense of the word, and covered all aspects of the trial from organisation and logistics to safety. They were issued by the naval or military Task Force Commander.

⁸ Hurricane Trial Orders No.1101, ‘Medical arrangements for dealing with radiological hazards’, 14 Sep 1952, TNA ES 38/ZSR73.

⁹ Hurricane Trial Orders No.276, ‘Protection of personnel’, 25 Sep 1952, TNA ES 38/ZSPRP and ES 1/325. The terms “active area” and later “controlled area” would be used in the radiological safety regulations for later

The Trial Orders made no reference to blood tests being taken after the completion of Operation Hurricane, nor any reference to urine testing. A 'Summary of biological observations at Operation Hurricane', dated 27 October 1952 and produced by Dr John Butterfield, does show that urine testing took place, although the policy basis on which it was performed, and how widespread it was, are unclear:

On several occasions persons moved about contaminated areas of Trimouille Island without respirators, and it was possible to conduct certain crude observations by examining for radioactive urine they passed subsequent to those exposures to a dust hazard. It was shown that the radioactivity detected in such urine samples probably resulted from inhalation.¹⁰

The Australian Royal Commission in the 1980s reported that the radioactivity detected "though measurable, was well below the maximum permissible levels of the time".¹¹

In relation to dosimetry, the Trial Orders provided:¹²

4. Film badges are to be worn by all personnel at all times whether or not they are in a contaminated area. They will be issued prior to the commencement of Phase III and are to be withdrawn and interpreted at the end of the operation. In the case of personnel working in the contaminated area they are to be renewed after each day's work.
5. Arrangements are to be made to issue more than one badge to each of a number of selected personnel entering the contaminated area in order that an assessment can be made of the relative dosage received by different parts of the body.
6. In addition, pocket electrosopes are to be worn by all persons whilst in a contaminated area to enable the approximate dose received to be read at a glance.

Operation Totem and minor trials at Emu Field (1953)

Operation Totem at Emu Field in South Australia included two nuclear tests in October 1953 and also, starting in September, the first in the long series in Australia of "minor trials" - experiments with no nuclear yield but which, in many cases, involved the use of radioactive materials.

On 14 August 1953, Charles Adams of AWRE, the Scientific Superintendent for Operation Totem, issued "Radiological Safety Orders" which had been prepared by the AWRE Radiological Hazards Group and approved by the AWRE Health Physics Branch. The orders used the same threshold values for permissible exposure as applied in Operation Hurricane but now expressed these in units of rep, or roentgen equivalent physical.¹³ They again provided for pre-exposure testing: "In cases where the exposure is necessary:- The individual must have passed the appropriate medical tests".¹⁴ Conditions of service for

test operations where "contaminated area" was used here. Dhenin's official Medical Officer's journal in relation to Hurricane survives (there is a gap in the record between 23 July and the end of September). On 1 October, it noted "All blood counts are now finished": Wing Cdr Dhenin's journal for 1 Oct 1952, Merlin database 13993.

¹⁰ WJH Butterfield, 'Summary of biological observations at Operation Hurricane: preliminary report to the Technical Director', 27 Oct 1952, TNA ES 38/ZFH2C, ES 1/105 and ES 20/16.

¹¹ *Report of the Royal Commission into British nuclear tests in Australia* (3 vols, AGPS 1985), vol. 1, p. 126.

¹² Hurricane Trial Orders No.276, 'Protection of personnel', 25 Sep 1952, TNA ES 38/ZSPRP and TNA ES 1/325.

¹³ The rep, now obsolete, was a unit of absorbed dose broadly equivalent to the rad.

¹⁴ CA Adams, 'Op Totem: Radiological safety orders', 14 Aug 1953, TNA ES 38/ZSFF8; AWE dosimetry and health effects group, 'Radiological safety assurance at UK atmospheric nuclear weapon trials', 1 Aug 1999, Merlin database 25327.

civilian staff at Totem specified that “all staff will be required to undergo a periodical medical examination which will include a blood count”. A chest X-ray and inoculations were also specified.¹⁵

An AWRE report on “Totem Administration”, prepared after the test to summarise arrangements made for the operation, stated that:

Inoculations, X-rays, blood counts, and examinations presented no difficulty at Harwell and Aldermaston where the necessary facilities were available and such requirements are day to day routine. At Woolwich however, no facilities existed for X-rays or blood counts and the S[enior] M[edical] O[fficer] arranged to have these carried out at the Brook Hospital ... Medical examinations for staff seconded from other Ministries were carried out mainly at Woolwich, but where long distances were involved medicals were arranged locally.¹⁶

The report also made clear that, for services personnel on Totem - the only full-scale UK nuclear test operation with no appointed armed forces Task Force Commander - “the medical requirements were the same as for civilian staff”.¹⁷

The summary plan for Totem, prepared by AWRE, listed “medical measurements, urine and blood samples” among the responsibilities of the radiation hazards team.¹⁸ A letter from Vice Adm Pat Brooking, the Deputy Director of AWRE, to Air Marshal Sir Thomas Elmhirst, the Chairman of the Totem Executive at the Ministry of Supply, stated that “white cell blood counts and urine examinations” would be available to medical staff in the field.¹⁹

At the first Totem test, an RAF Canberra aircraft was flown through the mushroom cloud to collect radiochemical samples in an operation codenamed Hot Box. The AWRE report of the Hot Box flight, prepared by Group Capt Denis Wilson (RAF Medical Services), included a reference to pre-and post-flight blood and urine testing, which showed no “alteration in the blood counts” and no evidence of “ingested fission products”.²⁰ No other reference has been found to blood or urine testing post-exposure in Operation Totem. Radiochemical sampling flights similar to Hot Box were also mounted at subsequent test operations.

Operation Mosaic (1956)

Operation Mosaic, comprising two nuclear tests, was carried out in June 1956 in the Montebello Islands. AWRE prepared Section E of the Joint Operational Plan for Mosaic (“Radiological Safety Regulations”), which was distributed to the Ministry of Defence and the services. These regulations had the object of ensuring “complete protection both of staff and of the general public, whilst imposing the minimum interference with work” and were applicable to “all who are concerned with the Operation, whether stationed in the Monte Bello Area, or at Onslow, Pearce Field or elsewhere”.²¹ The regulations provided that:

¹⁵ ‘Conditions of service for civilian staff participating in Op Totem’, 11 May 1953, Merlin database 25317.

¹⁶ Op Totem admin report, T54/54, 1954, TNA ES 38/ZSFCG and ES 5/56. The exact meaning of “seconded” - whether just for the test operation or on a more permanent basis - is not clear from the document. The two apparently contradictory references to Woolwich presumably both mean the Brook Hospital in nearby Greenwich.

¹⁷ *ibid.*

¹⁸ Totem summary plan pt. 1, 1953, p. 8.2, TNA ES38/ZSF28 and ES 1/823.

¹⁹ Brooking to Elmhirst, 31 Jul 1953, Merlin database 07078.

²⁰ ‘Canberra flight report Oct 1953 (Operation Hot Box)’, AWRE report T3/54, TNA ES 38/ZSG28.

²¹ Mosaic Joint Operational Plan Section E: Radiological Safety Regulations, 17 Jan 1956, e.g. TNA ES 38/ZSRFH.

Gamma ray dosage will be measured by means of film badges which will be worn by all persons at all times ...

No person will be allowed to work in an ACTIVE area, or with radioactive materials, who has not previously been cleared for such work by a special medical examination either immediately prior to the operation concerned, or immediately prior to his first exposure during the operation.²²

“Active” areas, defined in advance, were those “in which there may be some radiation risk and where precautions appropriate to the degree of risk must be taken”.²³

It seems clear that the term “special medical examination”, which appeared here for the first time and was repeated in every subsequent edition of the radiological safety regulations for later operations, included blood counts. The term was never expanded in the radiological safety regulations themselves, but every time there *was* an expansion or list, that list *did* include blood counts - for example in the Hurricane and Totem trial orders,²⁴ a 1957 War Office paper on personnel for Maralinga,²⁵ a Bomber Command Op Order for Grapple Y,²⁶ Confidential Admiralty Fleet Orders,²⁷ ICRP guidance,²⁸ and the UK statutory regulations for industrial radiation workers introduced in 1961.²⁹ In July 1958, in correspondence between the task force commander AVM John Grandy and the Senior Superintendent of AWRE's Trials Division Roy Pilgrim, the link was explicit: “medically examined (blood counts)” and “medical examination (blood count)”.³⁰ AWE has found no evidence of any definition of “special medical examination” for the nuclear test programme *not* including blood counts. AWE has also found no evidence that the nature of the “special medical examinations” changed over time.

The Radiological Safety Regulations for Mosaic used the same threshold values for permissible exposure as applied in Operation Totem, but now including a further “special higher integrated dose” equivalent to 25 r of exposure to gamma radiation, “applicable only in cases of extreme necessity and only to personnel who are not normally exposed to radiation, and then only with the express personal permission of the Scientific Superintendent after consultation with the Health Controller and the Medical Officer”.³¹ The new special higher integrated dose was introduced because “at previous trials valuable information had been lost because the upper dose limit had been set too low”. It was to be allowed only at “the express permission of the commander of the operation who would have expert medical and radiological advice at hand”, and only for personnel not normally

²² *ibid.*

²³ *ibid.*

²⁴ Hurricane Trial Orders No.1101, ‘Medical arrangements for dealing with radiological hazards’, 14 Sep 1952, TNA ES 38/ZSR73; ‘Conditions of service for civilian staff participating in Op Totem’, 11 May 1953, Merlin database 25317; Op Totem admin report, T54/54, 1954, TNA ES 38/ZSFCG and ES 5/56.

²⁵ War Office, ‘UK personnel for duty at Maralinga’, 19 Nov 1957, TNA ES 38/ZT4DF.

²⁶ Bomber Command Op Order 2/58 ‘Operation Grapple Y’, 1958, Annexe H, TNA ES 38/ZDRSK and ES 1/585.

²⁷ CAFO 121/57, ‘Nuclear weapons trials parties - blood examinations’, 20 Dec 1957, TNA ES 38/ZT4H4; CAFO 81/58 ‘Nuclear weapons trial parties - blood examinations’, 1 Aug 1958, TNA ES 38/ZSSDL and ES 1/648.

²⁸ See Appendix 3.

²⁹ *Factories (Ionising Radiations) Special Regulations: preliminary draft of regulations* (HMSO/Ministry of Labour and National Service 1957), SI 1961 No.1470, sections 26-27.

³⁰ Grandy to Pilgrim, 2 Jul 1958, TNA ES 38/ZT7V6 and ES 1/648.

³¹ Mosaic Joint Operational Plan Section E: Radiological Safety Regulations, 17 Jan 1956, e.g. TNA ES 38/ZSRFH.

exposed to radiation. If reached, it would be followed by a three-year break from any radiation exposure.³²

Operations Buffalo and Antler and minor trials at Maralinga (1955-1967)

Various tests were held at the purpose-built range at Maralinga in South Australia: (i) minor trials between 1955 and 1963; (ii) Operation Buffalo from September to October 1956; and (iii) Operation Antler, the final series of nuclear tests in Australia, from September to October 1957. Some of the minor trials - Tims experiments in 1960, and Vixen safety experiments between 1960 and 1963 - involved the use of plutonium. Following a clean-up operation, the Maralinga site was handed back to the Australian government under an agreement signed on 23 September 1967.

From January 1955 onwards, AWRE issued Radiological Safety Regulations for Maralinga on behalf of the UK Minister of Supply, with the purpose of ensuring “complete protection both of workers on the Range and of the general public, whilst imposing the minimum interference with work” and applying initially “throughout the Range”. The regulations imposed the same requirements for pre-exposure testing as for Mosaic:

No person will be allowed to be exposed to nuclear radiations who has not previously been cleared for such work by a special medical examination either immediately prior to the Trial concerned, or immediately prior to his first exposure during that Trial.³³

Issue 4 of the regulations included slightly modified wordings, aiming for: “complete protection both of staff and of the general public” and applying to “all who are concerned with trials, whether stationed at Maralinga, Edinburgh Field or elsewhere in Australia”. This issue of the regulations for Maralinga also introduced the new “special higher integrated dose” and the same wording on pre-exposure testing as for Mosaic:

No person will be allowed to work in an ACTIVE area, or with radioactive materials, who has not previously been cleared for such work by a special medical examination either immediately prior to the operation concerned, or immediately prior to his first exposure during the operation.³⁴

A further issue of the regulations in March 1956 extended applicability to “all who are concerned with Maralinga trials, whether stationed at Maralinga, or its outstations at Salisbury, RAAF, Edinburgh and Emu or elsewhere in Australia”.³⁵

Every issue of the Radiological Safety Regulations for Maralinga specified film badges for all: “all personnel will wear a Personal Monitoring Film at all times”.³⁶

It seems clear that the term “special medical examination”, although not further explained in the text of these regulations, included blood counts - in line with previous operations, then-current ICRP guidance, and the specific evidence detailed below relating to the indoctrinee force and from the Maralinga Board of Management and War Office.

³² AWE dosimetry and health effects group, ‘Radiological safety assurance at UK atmospheric nuclear weapon trials’, 1 Aug 1999, Merlin database 25327, p. 26, referring to agreement at the first meeting of a UKAEA health panel of senior medical consultants in London on 5 May 1955. See Lorna Arnold and Mark Smith, *Britain, Australia and the bomb: the nuclear tests and their aftermath* (2nd edn., Palgrave 2006), ch. 7-8; *Report of the Royal Commission into British nuclear tests in Australia*, vol. 1, ch. 7-8.

³³ ‘Radiological Safety Regulations Maralinga’, issue 1, 1 Jan 1955 (TNA ES 38/ZFHBN and ES 1/393).

³⁴ ‘Radiological Safety Regulations Maralinga’, issue 4, Nov 1955 (TNA ES 38/ZT39G).

³⁵ ‘Radiological Safety Regulations Maralinga’, issue 5, 29 Mar 1956 (TNA ES 38/ZFHK5 and ES 1/393).

³⁶ *ibid.* and previous issues.

An “indoctrinee force” of British, Australian and New Zealand officers was taken to the first and second Buffalo nuclear tests “to experience the effects of a nuclear explosion [and] to examine the effects of such explosion on the ground and on weapons and equipment”.³⁷ Alongside the general Maralinga Radiological Safety Regulations referenced above, Indoctrinee Force Instruction No.1, issued by the Army’s Director-General of Military Training, Maj Gen Nigel Tapp, provided that:

In the officers’ own interest they will be subjected to a blood count as for workers with radioactive substances plus a chest X-ray. Both to be completed prior to leaving permanent duty stations.³⁸

In August 1957, the Australian Atomic Weapons Test Safety Committee (a senior Australian advisory body) and Australian National Radiation Advisory Committee expressed doubts about the value of blood testing.³⁹ Charles Adams of AWRE argued that blood testing should continue, at least for personnel going to Maralinga for a week or more, at a meeting of the Australian Maralinga Board of Management in October 1957:

The purpose was two-fold:-

- (a) To disqualify from visiting the range any person whose blood counts showed abnormalities.
- (b) In the event of a claim alleging illness or other damage due to radiation effects being lodged by a person who may have visited or worked at Maralinga ... a record would be available upon which the Australian or UK government may base a case.⁴⁰

At the start of 1958, in line with Adams’s proposal, it was decided that blood counts would continue to be required before arrival at Maralinga for all services, scientific staff and other civilians needing to work in radioactive areas of the range, although not for other civilian visitors.⁴¹ Film badges would continue to be issued to everyone.

During Operation Antler, the Maralinga Radiological Safety Regulations (see above) continued to apply as they had at Buffalo.⁴²

On 19 November 1957 - after the end of Operation Antler - a set of War Office rules was issued for the British Army specifying that:

- 2. Before leaving the United Kingdom [all personnel selected for duty at Maralinga] will be examined for fitness to work with radioactive substances and to serve in a tropical climate.
- 3. The initial medical examination will include a red cell count, packed cell volume, haemoglobin estimation, total white cell count and differential count ...

³⁷ Buffalo Indoctrinee Force Instruction No.1, 16 July 1956, TNA ES 38/ZRPBF.

³⁸ *ibid.* Various inoculations were also specified.

³⁹ JC Bower (AWTSC Secretary) to Secretary, Maralinga Board of Management, ‘Blood counts, chest X-ray and medical examination of officials and observers going to Maralinga’, 2 Aug 1957, TNA ES 38/ZRV7V and NAA A6456 R094/008; Minutes of Maralinga Board of Management meeting in Melbourne, 5 Aug 1957, TNA ES 38/ZRTWS and NAA A6456 R149/004.

⁴⁰ Minutes of Maralinga Board of Management meeting in Melbourne, 18 Oct 1957, TNA ES 38/ZRWNB and NAA A6456 R065/058.

⁴¹ Secretary, [Australian] Dept of Supply, note of 4 Feb 1958 recording Maralinga Board of Management’s agreement on 21 Jan, NAA A705 132/13/50.

⁴² Arnold and Smith, *Britain, Australia and the bomb*, p. 191.

5. On return to the United Kingdom the examinations mentioned in para 2 will be carried out except where the average weekly dose is known to have been less than 0.03 Rads per week, and provided there has been no internal radiation hazard.⁴³

This is another of the very few documents found by AWE to refer to post-deployment or post-exposure blood counts.

AWE has identified some evidence that, some time after Operation Antler, urine testing for personnel at Maralinga was at least considered. In February 1958 Air Cdre JS Wilson, the Air Ministry's Director of Hygiene and Research (H&R), asked the Australian Director General of Medical Services, AVM Ted Daley, "if arrangements can be made for examining urine of personnel exposed to the risk of ingesting or inhaling radioactive material". Explaining this request, he commented:

Some of those stationed at Maralinga and Edinburgh Field have to incur this hazard from time to time. Here, in the [UK] Atomic Energy Establishments, urine tests are carried out on those at risk, but these are much too elaborate and specialised for routine use in the service. Air Cdre Denis Wilson is certain that the facilities exist both in Adelaide and in other centres, and could be used if required in an emergency or when considered necessary.⁴⁴

AVM Daley shared this letter with the Australian Commonwealth X-Ray and Radium Laboratory, requesting their comments and whether they knew of facilities which might be available in Adelaide or elsewhere "which would meet the requirements of Air Ministry".⁴⁵ The Laboratory responded that "Enquiries are being made to determine whether adequate facilities for this work exist".⁴⁶ AWE has not been able to determine the outcome of these enquiries.

The Radiological Safety Regulations for Maralinga continued in force throughout the minor trials programme to 1963, and up to and including the Operation Brumby clean-up and the handover of the range to the Australian government in 1967, after which British personnel ceased to be based there.⁴⁷ Reports from Brumby referenced that "film badges were worn all the time, and when likely to be influenced by some specific radiation, such as when collecting cobalt, individual dosimeters were worn".⁴⁸

Operation Grapple (1957-1958)

As part of developing and testing staged thermonuclear weapons (hydrogen or "H-bombs"), single tests or test series were conducted off Malden Island in May-June 1957 (Operation Grapple) and then Christmas Island in November 1957, April and August-September 1958 (Grapple X, Y and Z).

⁴³ War Office, 'UK personnel for duty at Maralinga', 19 Nov 1957, TNA ES 38/ZT4DF.

⁴⁴ Air Cdre J S Wilson to Daley, 5 Feb; TNA ES 38/ZRWSC and NAA A6456 R087/034. There were two Air Cdre Wilsons, both senior RAF medical officers.

⁴⁵ Daley to CXRL, 25 Feb 1958, TNA ES 38/ZRWHC and NAA A6456 R087/034.

⁴⁶ CXRL reply, 7 Mar 1958, TNA ES 38/ZRWSL and NAA A6456 R161/002.

⁴⁷ 'Amendment No.1 to RSRM/56(5) Radiological Safety Regulations, Maralinga', 20 Jun 1960, Merlin database 28220; Roy Pilgrim, 'Maralinga Experimental Programme 1963: Safety Instructions', Jan 1963, TNA ES 38/ZT9L8.

⁴⁸ 'Operation Brumby [sic] final report', Sep 1967, TNA ES 38/ZSFB3; see also Brumby report for May 1967, Merlin database 22812.

AWRE drew up provisional radiological safety regulations for the Operation Grapple test series in November 1956,⁴⁹ and these were issued on 1 March 1957 as “Radiological Safety Precautions” as part of the Operation Grapple Joint Operational Plan by the Task Force Commander AVM Wilfrid Oulton:

The object of these regulations [*sic*] is to ensure complete protection both of staff and of the general public, whilst imposing the minimum interference with work. To this end, the regulations will, at all times, apply to all who are concerned with the Trial ...

No person will be allowed to work in an ACTIVE area, or with radioactive materials, who has not previously been cleared for such work by a special medical examination either immediately prior to the Trial, or immediately prior to his first exposure during the Trial.⁵⁰

The document was clearly based on the Radiological Safety Regulations for Maralinga, although it differed in one important respect, removing the requirement for film badges to be issued to all personnel (see below, p. 16).

AWE has found no suggestion that these policies were changed in any way for Operation Grapple X in November 1957, for which AVM Oulton remained as Task Force Commander, or indeed until updated Radiological Safety Regulations for Christmas Island were issued by AWRE in March 1958. These contained the same wording as the Radiological Safety Precautions of the previous year, except for the replacement of “all who are concerned with the Trial” with “all who are concerned with the Christmas Island Trials, both Servicemen and Civilians wherever stationed”; and of “ACTIVE area” with “Controlled Area”. “Controlled areas” were defined, a little more tightly than “active areas”, as “those where the levels laid down in section 2 are exceeded and where precautions appropriate to the degree of risk must be taken”. The maximum permissible levels of contamination given in section 2 of the regulations, and the threshold permissible doses for personnel at Christmas Island, were equivalent to those in the previous Maralinga regulations.⁵¹

It seems clear that the term “special medical examination”, although not further explained in the text of these regulations, continued to include blood counts, in line with previous operations, then-current ICRP guidance, and the specific evidence detailed below including Admiralty and RAF Bomber Command orders and extensive policy correspondence between AWRE, the Task Force Commander, Admiralty and Air Ministry in summer 1958.

For example, Admiralty orders dated 20 December 1957 contained the following:

[Naval personnel] likely to be exposed to radiation, are to have a blood examination made before leaving the United Kingdom.

The reason for this is to provide a base line against which to assess the results of possible future blood examinations in the event of accidental exposure of personnel to radiation levels in excess of the maximal permissible dosages ...

⁴⁹ “Radiological Safety Regulations for Op Grapple” RSRG 57(1), provisional issue, Nov 1956, TNA ES 38/ZSR7W and ES 12/358

⁵⁰ ‘Op Grapple: the operational phase: Joint Operational Plan Pt 7: Radiological Safety Precautions’, 1 Mar 1957, reissued formally 22 Apr 1957, TNA ES 38/ZSFPD and AIR 20/10402.

⁵¹ ‘Radiological Safety Regulations Christmas Island’, RSRC/58(1), Mar 1958, TNA ES 38/ZT7TD and ES 12/359.

Each blood examination is to include a full erythrocyte [red cell] count, haemoglobin estimation, leukocyte [white cell] count and differential leukocyte count. A platelet count is not required.⁵²

The reason given for blood testing in these Admiralty orders - and the later issue of 1 August 1958, see below - is at variance with all other explanations in documents found during this exercise by AWE, and with contemporary medical opinion as discussed in Appendix 3. No baseline blood count would have been useful in the event of an “accidental exposure” because the correlation between blood counts and low levels of radiation exposure, such as at the nuclear test operations, was known to be weak. As discussed below, a baseline might nevertheless have been useful for “medico-legal” reasons.

Bomber Command orders for Operation Grapple Y dated 18 February 1958 also provided:

All [Bomber Command] personnel who go to Christmas Island should have the following blood examinations made and the results recorded in the F.Med.4 [personal medical records of a service person]: (a) Total and differential white counts (2). These examinations should be done only when the individual has been clear of any symptoms of infection for at least two weeks. There should be the maximum possible interval between the examinations; (b) Haemoglobin percentage.⁵³

It seems unlikely to be a coincidence that the specific blood counts now listed in these Admiralty and Bomber Command orders were similar to those specified in the draft statutory regulations for UK industrial radiation workers circulated in 1957 (see Appendix 3).

Extensive correspondence in summer 1958 between the Grapple Z Task Force Commander AVM John Grandy, AWRE, the Admiralty and Air Ministry sheds much light on policy on blood counts and the thinking behind it. Significant care was evidently taken to coordinate and agree policy, and keep it under review (see also Appendix 1).

The requirement for film badges and blood counts had been reduced when testing moved from Australia to the Pacific. This was because the understanding of who was practically at risk of radiation exposure had changed in the light of experience: the vast majority of film badges were showing no measurable exposure (see also Appendix 4). But the fact that two of the Grapple Z tests were going to be mounted on tethered balloons on Christmas Island itself, not as high air bursts several miles off the coast, suggested a re-think.

Grandy and Roy Pilgrim, Senior Superintendent of AWRE's Trials Division, decided against extending the issue of film badges but correspondence continued on pre-deployment medicals including blood counts. AWRE's advice, based on the “political” or “legal” need for a baseline against which to assess future health claims, was to increase the number of blood counts. The Admiralty tended to agree but the Air Ministry was sceptical, essentially because blood counts would tell nothing medically about dose or exposure to radiation. Some additional blood counts evidently took place, including for personnel arriving on Christmas Island for potential work in the “controlled area” at the south-eastern corner of the island who had not been tested pre-deployment. The more general policy question, however, had still not been resolved when UK atmospheric nuclear testing came to an end in September 1958.

⁵² Confidential Admiralty Fleet Order CAFO 121/57, ‘Nuclear weapons trials parties - blood examinations’, 20 Dec 1957, TNA ES 38/ZT4H4.

⁵³ Bomber Command Op Order 2/58 ‘Operation Grapple Y’, 1958, Annexe H, TNA ES 38/ZDRSK and ES 1/585. The reference to being clear for two weeks presumably means clear of any infection or other general medical problem that might affect blood count results.

A letter dated 2 July 1958 from Grandy to Pilgrim recorded a discussion between the two men on policy for both film badges and blood counts:

At the moment the vast majority of service personnel at Christmas Island are not medically examined (blood counts) either prior to or after serving on the Island. However, contamination levels have been calculated on the assumption that all serving at the Island could be regarded as occupational workers and this category of personnel at Aldermaston have medical tests (blood count). Those at the Island, other than AWRE, however, do not.

We discussed this matter at length and were of the opinion that measures should be put into effect at the earliest opportunity to ensure that all service personnel going to Christmas Island from now on were subject to medical examination (blood count). We also thought that medical test facilities should be set up at the Island immediately so that all personnel could be examined prior to the first Grapple Z firing. I have today put these two points verbally to ... the H[ygiene] & R[esearch] Medical Branch, Air Ministry. They are not in favour of instituting a universal medical examination (blood count) and consider that our present system of controlled areas is adequate. They do believe, however, that it would be a wise precaution to institute a medical examination (blood count) for those Army and other personnel who are required to take part in rehabilitation work after balloon firings at the southeast end.⁵⁴

Some debate followed and on 15 July Grandy chaired a meeting at AWRE attended by representatives from AWRE, Task Force Grapple, the Admiralty, War Office and Air Ministry. At the meeting, it was resolved that:

(a) All personnel likely to be employed during Grapple "Z" in the forward area where they might be subject to radiation hazards should be given blood counts before the commencement of the tests.

(b) The question of whether all Service replacement personnel posted to Christmas Island should be given blood counts, regardless of their duties or place of work, was to be referred to the Air Ministry for decision in consultation with the other two Services.⁵⁵

In line with this decision, and not yet knowing that there would be no further UK tests on Christmas Island, on 23 September Air Cdre JS Wilson instructed that "all personnel posted to Christmas Island should be examined [i.e. have a blood test] in UK ... provided that they are required to work in the controlled area there".⁵⁶ This echoed Grandy's instructions to the Base Commander on Christmas Island, issued on 23 July, that "before rehabilitation of forward area after each balloon round blood counts will be made on personnel", specifically to be carried out by AWRE at the island hospital at the rate of twelve people a day starting at 0830 on 4 August.⁵⁷

Meanwhile, on 2 July 1958, the senior naval officer for Grapple, Capt Guy Western RN, had already instructed that "very early action may be taken to arrange for all Naval personnel and Royal Marines appointed or drafted to HM Ships *Resolution*, *Narvik*, or *Messina*, to have a blood examination before leaving the United Kingdom ... Separate action is being taken in respect of personnel who have already joined their units. Similar action is being taken by Air

⁵⁴ Grandy to Pilgrim, 2 Jul 1958, TNA ES 38/ZT7V6 and ES 1/648.

⁵⁵ Minutes of a meeting at AWRE, 15 Jul 1958, TNA ES 38/ZFGVF and ES 1/648.

⁵⁶ Wilson to all Principal Medical Officers, 'Radiological safety precautions at Christmas Island - medical examination of personnel posted to Christmas Island from the UK', 23 Sep 1958, TNA ES 38/ZTG6H and ES 1/648.

⁵⁷ By signal from London to Base Cdr Xmas I, 23 Jul 1958, TNA ES 38/ZT4LF.

Ministry and the War Office".⁵⁸ On 1 August 1958, naval orders were issued applying to Christmas Island, Maralinga and ships of the Grapple task force, to the effect that "All Naval personnel appointed or drafted to parties carrying out tests of nuclear weapons and likely to be exposed to radiation, are to have a blood examination BEFORE leaving the United Kingdom ... each blood examination is to include a full erythrocyte count, haemoglobin estimation, leucocyte count and differential leucocyte count. A platelet count is not required".⁵⁹

These naval instructions, referring to *all* personnel appointed to Christmas Island and ships of the Grapple task force, appear to have been more cautious than those advocated by the RAF and discussed between Grandy and Pilgrim, limited specifically to personnel working in controlled areas. Positions were not, however, very far apart. On 7 August 1958, Surgeon Cdr Frank Ellis, assistant to the Admiralty's Medical Director-General, sent a letter to the Air Ministry, agreeing with the decision that those entering the controlled area would have "preliminary blood count examinations carried out by AWRE technicians", and accepting the practical difficulty and limited value of applying this policy to all personnel. For replacement personnel he noted that "Action has already been taken to arrange for blood examinations for naval replacement personnel leaving for Christmas Island in the near future ... in accordance with the practice already adopted for naval personnel appointed to the Maralinga range" but that "This instruction will be cancelled if the Air Ministry, the War Office and AWRE agree that routine blood examinations for replacements are unnecessary".⁶⁰

On 11 August, Ellis sent a letter to Western, referencing "blood counts for the boys" and noting the following:

We have not done anything to cancel own instructions on this so I assume your replacement personnel will be examined; but we have informed the Air Ministry and War Office that we will stop doing blood counts as a routine on replacements (if in fact we are doing them, and I suppose we are!) if Grapple H.Q. consider it unnecessary. Our view is that we are the minority force for much of the time, not fully in the trials future by a very long chalk, what in the analysis really determines the probable health hazard, and that we will do our damndest to do whatever Grapple H.Q. works [*sic*] us to. We do not entirely support the RAF view that the blood count is entirely useless - if there is a real element of risk!!⁶¹

In reply, Western explained that his orders to give blood counts to *all* naval personnel had been issued with AWRE's views uppermost in mind, but that a subsequent meeting between AWRE, the Admiralty and Air Ministry had decided "not to carry out blood tests in UK on any more Grapple personnel". He also expressed the view that a decision should be taken on "political" and not "medical" grounds.⁶² On 16 August 1958, he ordered that "No retrospective action is required in respect of personnel already serving in the [Grapple] Squadron".⁶³

On 13 October 1958, some time after the final UK test at Christmas Island, the Air Ministry wrote to RAF Principal Medical Officers stating that blood counts for personnel required to work in the "controlled area" at Christmas Island would occur at "personnel holding units" or

⁵⁸ Western, 'Blood examinations - personnel proceeding to Christmas Island', 2 Jul 1958, TNA ES 38/ZSR7S.

⁵⁹ CAFO 81/58 'Nuclear weapons trial parties - blood examinations', 1 Aug 1958, TNA ES 38/ZSSDL and ES 1/648.

⁶⁰ Ellis to Air Ministry, 7 Aug 1958, TNA ES 38/ZTG2P.

⁶¹ Ellis to Western, also to Air Min, 11 Aug 1958, TNA ES 38/ZT38V (emphasis in original).

⁶² Western to Ellis, 19 Aug 1958, TNA ES 38/ZT3KC.

⁶³ Western to COs HMS *Resolution*, *Scarborough* and *Narvik* and HMNZS *Pukaki*, 16 Aug 1958, TNA ES 38/ZT49F.

service medical establishments, for whom "Form Med 42 [was] to be raised in respect of all service personnel examined".⁶⁴

In relation to urine testing, an AWRE health physics division note dated 17 October 1958 stated:

Four urine samples despatched from Christmas Island by Maj McDougall following an incident on 22nd September were received on the evening of October 14th and analysed for tritium on the following day. All results obtained were below the normal level of detection of the method at which it is considered the results are at all significant.⁶⁵

So far as dosimetry through the use of film badges is concerned, in January 1957, Charles Adams, by now Chief of Research at Aldermaston, decided to limit the issue of badges to those who might be conceivably exposed to radiation in active areas, originally on the advice of the health physics controller on Malden Island for the first series of Grapple tests.⁶⁶ This was reflected in the Radiological Safety Precautions for Operation Grapple:

All personnel who have duties in an Active Area will wear a Personal Monitoring Film at all times. Others will wear a Film on occasions when they are exposed to radiation.⁶⁷

The letter from AVM Grandy of 2 July 1958 confirmed that:

It has not been thought necessary to issue film badges to date. Since radioactivity and contamination at the Island may occur only in certain areas the policy has been to define these areas and control entry and exit thereto, admitting only personnel both service and civilian (AWRE) whose duty necessitates their working in these areas. These personnel have been given appropriate medical examinations (blood count) and are provided with film badges.

The remainder of the Island is not subject to contamination or radioactivity. However, as a wise insurance policy, counts are taken in all areas to ensure that backgrounds remain within limits. In lay language the count could be regarded as a communal film badge ...

We discussed all this at some length at our meeting yesterday and our conclusion was that it would not be necessary for a general issue of film badges for Grapple Z, and that the present system of controlled areas would be safe and should continue ... all personnel who may have to enter these controlled areas are to be examined and issued with a personal film badge.⁶⁸

Following the decision taken on 2 July 1958, a general order was issued by the Health Physics Controller for Christmas Island that "badges will be issued to all members of AWRE and to those service personnel working in active areas. On firing day aircrew employed in sampling and survey duties will also be supplied with badges".⁶⁹

⁶⁴ Air Ministry H&R Medical Branch, 13 Oct 1958, TNA ES 38/ZTGPG.

⁶⁵ Note of 17 Oct 1958, TNA ES 38/ZTF8B. The final UK atmospheric test on 23 Sep 1958, the day after the incident in question, was the first ever to use any tritium gas.

⁶⁶ Letter of 19 Oct 1956, TNA ES 38/ZSSH; letter to Adams and reply, 18 Jan 1957, AWE archive.

⁶⁷ 'Op Grapple: the operational phase: Joint Operational Plan Pt 7: Radiological Safety Precautions', 1 Mar 1957, reissued formally 22 Apr 1957, TNA ES 38/ZSFPH and AIR 20/10402.

⁶⁸ Grandy to Pilgrim, 2 Jul 1958, TNA ES 38/ZT7V6 and ES 1/648.

⁶⁹ Maj WG McDougall (Health Physics Controller Xmas I), 'Film badges', 1 Aug 1958 (a note covering the issue of the badges themselves), TNA ES 38/ZTFWD and ES 1/648.

2. What was the policy/instruction at the time for the retention of this medical information? To what extent was the information transferred to individual medical files and/or retained elsewhere?

Blood and urine test results

As a matter of course during the nuclear testing, AWRE did not receive the results of blood or urine testing of service personnel. AWRE also did not hold F Med 4 files for service personnel, even for those seconded in some way to AWRE during the nuclear test operations. These would have been held by the relevant branch of the services. AWE has not identified any specific directions to AWRE from the services in relation to the retention or handling of such records.

The War Office Rules issued on 19 November 1957 for testing at Maralinga (see above), applicable to the Army, specified that blood test results should be recorded on F Med 12 (request for special exam), F Med 7 (outpatient record), F Med 4 and F Med 29, and that “each ADP will keep a special register in which will be recorded each successive blood examination”.⁷⁰

AWE has found occasional records relating to blood or urine testing and/or health more generally, including some *ad hoc* records for service personnel where these are included as part of reports on the nuclear tests. For example, the ‘Summary of biological observations at Operation Hurricane’ (see above) contained an anonymised urine test result:

Another study was made of a man who was exposed to 3.0 r without wearing a respirator. The first 13 consecutive urine samples passed after exposure were examined for radioactivity, using a liquid counter. (Subject lived on Base Ship). Counts made within 1 hour of samples being passed ranged up to 81 c[ounts] p[er] m[inute] per 8 ml urine. In 30 hours he had eliminated at least ¼ microcuries.⁷¹

The AWRE report of the Hot Box flight at Totem (see above) records that “Examination of blood samples and specimens of urine failed to show the presence of any ingested fission products”, without providing any further details or numbers, although the names of the airmen involved in the flight were identified in another part of the report.⁷²

In relation to Operation Buffalo, a medical report prepared by AWRE stated that an (unidentified) individual was not permitted to be exposed to the higher integrated dose limit of 10 r “in view of his blood count”.⁷³

In relation to Operation Grapple, an AWRE health physics division note dated 17 October 1958 gave urine test results of four specific individuals. The testing was undertaken by AWRE in Aldermaston in relation to tritium levels, the urine having been sent from Christmas Island.⁷⁴

⁷⁰ War Office, ‘UK personnel for duty at Maralinga’, 19 Nov 1957, TNA ES 38/ZT4DF. ADP appears to have stood for Assistant Director (Personnel), the officer at unit or HQ level responsible for personnel matters.

⁷¹ WJH Butterfield, ‘Summary of biological observations at Operation Hurricane: preliminary report to the Technical Director’, 27 Oct 1952, TNA ES 38/ZFH2C, ES 1/105 and ES 20/16.

⁷² ‘Canberra flight report Oct 1953 (Operation Hot Box)’, AWRE report T3/54, TNA ES 38/ZSG28.

⁷³ AWRE ‘Medical report [on Op Buffalo]’, Jan 1957, Merlin database 24995.

⁷⁴ Note of 17 Oct 1958, TNA ES 38/ZTF8B. The final UK atmospheric test on 23 Sep 1958, the day after the incident in question, was the first ever to use any tritium gas.

Dosimetry

As part of AWRE's responsibility for radiological protection and health physics at the tests, film from the film badges was developed and analysed by AWRE staff, locally or at Aldermaston. Original film badges were not retained once the dose information had been recorded, originally in the form of handwritten paper records. Health physics information (mainly dosimetry records) was included in the 1980s in the "Blue Books" listing nuclear test participants. These give total cumulative doses where known from paper records.

For Operation Hurricane, the Trial Orders provided that, in relation to exposure records obtained through dosimetry testing:

3. These are to be worked out by Health Control and copies of the figures obtained are to be sent daily to the Naval Commander, Technical Director, Safety Adviser and Staff Medical Officer.
4. At the end of the Operation the total exposure is to be recorded in each person's medical history document, and for Naval and Army personnel, in his pay book as well.
5. In the case of Naval and Army personnel the Naval Commander will forward exposure records to Commanding Officers as appropriate. Commanding Officers are responsible for the action in paragraph 4 and for ensuring that individuals have access to their exposure record should they wish to see it.⁷⁵

The trial orders also specified that the Senior Medical Officer, RAF Wing Cdr Geoffrey Dhenin, was required to arrange: "For naval personnel, the entry of radiation exposure into Paybooks and Medical History Sheets and, for other personnel, the transmission of exposure records to the appropriate medical authority".⁷⁶

An Air Ministry doctor wrote to AWRE on 25 June 1957 in relation to the collection of dosimetry information for RAF personnel involved in trials:

I am directed to refer to the participation of serving personnel from the RAF in Atomic Trials either as members of an RAF Task Force or as units in AWRE Scientific Groups and to state that it has been decided that as a medico legal safeguard a record of the total dose of radiation received by personnel on such trials shall be recorded in F.Med.4 Medical History envelope. Current regulations lay down that a record of radiation dose received whilst on service at RAF Stations be so recorded ...

instructions are being issued to ensure that the RAF Health Physics representative on future trials prepares a list of all RAF personnel who receive a radiation dose and a record of that dose which will be forwarded to this directorate in order that the appropriate recording may be arranged. No such record is available for previous trials.

I am to request that the Health Physics Group AWRE be approached with a view to the preparation from their records of a list of RAF personnel who have received a radiation dose on previous trials and of the total dose received in order that the necessary entry be made in RAF Records.⁷⁷

⁷⁵ Hurricane Trial Orders No.160, 'Exposure to radiation', 26 Jul 1952, Merlin database 22876 and TNA ES 1/325.

⁷⁶ Hurricane Trial Orders No.276, 'Protection of personnel', 25 Sep 1952, TNA ES 38/ZSPRP and ES 1/325.

⁷⁷ Air Ministry H&R Medical Branch to Senior RAF Officer AWRE and Air Ministry Liaison Officer AWRE, 25 Jun 1957, TNA ES 38/ZT8N6.

3. What was the instruction for the retention of this material; some records are held on medical files, however, are there other test results, including anonymised data, held elsewhere? This will include any consideration of policy/decisions for destruction of blood and urine test results and the rationale for that direction.

AWE's findings on records-management policy apply principally to civilian nuclear test veterans.

There was no specific regulation, at the time or later, on the retention of medical or dosimetry records for civilian or service personnel at the UK nuclear tests, but statutory regulations on the retention of medical and dosimetry records for industrial radiation workers in the UK (or "classified workers") were circulated in draft in 1957 and introduced in 1961.

AWRE's parent organisation the UKAEA was closely involved in the process of drafting these regulations and its contributions to the debate, then and later, show that it favoured a cautious policy, retaining rather than destroying records, including for legal reasons.

Specific UKAEA policy on the retention of health and safety including both medical and dosimetry records was drawn up and adopted in 1963, in line with the regulations for classified workers, and specified retention for 30 years after the last entry in a person's record. After some changes in the intervening time this 30-year period is once again in place in the current (2017) regulations for classified workers.

Proposed regulations on record-keeping for dosimetry and other medical records of industrial radiation workers in the UK were first issued for consultation in 1957.⁷⁸ These proposals built on a code of practice for radiation workers in the NHS. Following this consultation the Ionising Radiations (Sealed Sources) Regulations were issued in 1961. These statutory regulations included, for the first time, specific provisions on medical record-keeping:

Every register, certificate or record kept in pursuance of these regulations and every transfer record and copy transfer record ... shall be preserved in the factory ... and kept available for inspection ... for at least the following periods after the last entry therein, that is to say, thirty years in the case of the health register, the radiation dose records, the transfer records and the copy transfer records ...⁷⁹

The draft issued for consultation in 1957 had specified only ten years' retention, but the UKAEA (at least) had been unhappy:

In view of the fact that the latent period of certain types of disease which can be induced by radiation is sometimes extremely long it was felt that the records of health and of radiation exposure might well be kept for as long as 25 years. It is the intention in the Authority to retain these records indefinitely and to this end we shall be going over to a system of microfilming.⁸⁰

⁷⁸ *Factories (Ionising Radiations) Special Regulations: preliminary draft of regulations* (HMSO/Ministry of Labour and National Service 1957).

⁷⁹ SI 1961 No.1470, section 5.

⁸⁰ *Factories (Ionising Radiations) Special Regulations: preliminary draft*, section 5; [unclassified] letter of 4 Oct 1957 following a meeting of UKAEA medical officers, AWE archive.

The specific figure of 30 years in the final regulation was suggested by the UKAEA (and perhaps others): “the Authority in fact suggests that all personnel records should be kept for 30 years after the date of the last entry”.⁸¹

Atmospheric nuclear testing was now at an end, although minor trials continued at Maralinga until 1963, and the new regulations did not apply to nuclear test participants directly, only to industrial radiation workers, now formally described as “classified workers”. But in practice the regulations may have been applied by analogy, at least to AWRE civilians, there being no other relevant regulation.

Dosimetry records of nuclear test participants were created and have been kept by AWRE and now AWE, physically separate from other medical records held by the appropriate parent organisation.

In 1958 the Public Records Act was passed which, amongst other things, led the UKAEA for the first time to consider formal retention periods for the records it was creating. Retention periods for records defined as public records by the new Act were considered first, including scientific and technical records. An Advisory Group on Scientific and Technical Records chaired by Harwell’s Martin Fishenden produced a long set of recommendations in February 1961. Health, safety and medical records of individuals did not meet the definition of public records in the Act and so Fishenden’s recommendations did not cover the retention or destruction of these records. Instead two members of the UKAEA’s Health and Safety Branch at Harwell reported separately on health, safety and medical records a year later.⁸² They proposed that medical records of individual classified workers, including specifically blood and urine test results, should be retained *either* for 30 years after leaving employment *or* 100 years after birth, evidently on the practical basis that some UKAEA sites stored these records by leaving date and some by date of birth.⁸³

These recommendations were finally endorsed by the UKAEA’s senior leadership a further year later in February 1963, by which time the retention period for personal medical records had been changed to “30 years after the last entry” - a simple formula, in line with legislation and regulation for industrial workers, and which certainly still applied in 1973 when control of AWRE passed from the UKAEA to the Ministry of Defence.⁸⁴

Surviving correspondence from the 1960s and 70s suggests that the UKAEA erred, for “medico-legal” reasons, on the side of caution, i.e., that it preferred in practice to retain rather than destroying records. Already in April 1963, for example, a legal adviser suggested that “all documents of radioactive interest should be kept indefinitely”, and in 1975 the Authority’s personnel officer Reg Simeone offered the view that “in current circumstances” - a reference to increasing public interest in the health outcomes of classified workers - “we would be unwise to destroy any medical records without giving the matter most careful consideration. I have discussed this with [Arnold] Allen [the UKAEA’s Group Secretary, responsible for administration] who has asked that steps should be taken to

⁸¹ [Unclassified] draft UKAEA letter circulated 30 Mar 1960, AWE archive.

⁸² UKAEA Advisory Group on Science and Technology Records, report circulated 6 Feb 1961, TNA AB 6/2423. Appendix 2 on health and safety records listed 21 types of records including personal “complete medical dossier ... records of exposure to external radiation [and] biological monitoring results”, but left retention periods for the Authority Health and Safety Branch to fill in later.

⁸³ Full draft of report, circulated Feb 1962, TNA AB 65/2; covering letter UKAEA London Office to Allen, 13 Feb; and, on the 30/100 formula specifically, UKAEA London Office to UKAEA Dounreay, 30 Mar 1962, AB 8/1052.

⁸⁴ Second draft of report, circulated Feb 1963, TNA AB 65/2; [unclassified] ‘Document destruction schedule section C: health and safety records’, Mar 1973, AWE archive; copy of Section C1 (Medical) of the UKAEA’s ‘Records Destruction Schedule’, under cover of Lorna Arnold’s letter of 22 May 1975, TNA AB 61/44.

ensure that no records are, in fact, destroyed without his approval being sought".⁸⁵ Agreement was reached to destroy many of the UKAEA's very numerous and bulky chest X-rays only after very protracted correspondence between 1963 and 1976.⁸⁶

Between 1985 and 2017, new statutory Ionising Radiation Regulations increased the retention period for radiation workers' medical records to at least 50 years:

the arrangements that the employer makes with the approved dosimetry service shall include requirements ... to keep those dose records or a copy thereof for at least 50 years from when they were made ... The employer shall ensure that a health record, containing particulars approved by the [Health and Safety] Executive, in respect of each of his employees to whom this regulation relates is made and maintained and that that record or a copy thereof is kept for at least 50 years from the date of the last entry made in it.⁸⁷

the arrangements that the employer makes with the approved dosimetry service shall include requirements ... to keep the records made and maintained pursuant to the arrangements or a copy thereof until the person to whom the record relates has or would have attained the age of 75 years but in any event for at least 50 years from when they were made ... The employer shall ensure that a health record, containing the particulars referred to in Schedule 7, in respect of each of his employees to whom this regulation relates is made and maintained and that that record or a copy thereof is kept until the person to whom the record relates has or would have attained the age of 75 years but in any event for at least 50 years from the date of the last entry made in it.⁸⁸

In 2017, in updated statutory regulations which remain in force, the retention period reverted to 30 years.⁸⁹ It should be emphasised again that all of these statutory instruments applied to classified workers - or since 1985 "classified persons" - an occupationally defined group within the wider nuclear industry whose work brings them into regular contact with radiation hazards. Not all workers in the nuclear industry are classified persons:

the employer must designate as classified persons those of its employees who are likely to receive an effective dose greater than 6 mSv per year or an equivalent dose greater than 15 mSv per year for the lens of the eye or greater than 150 mSv per year for the skin or the extremities.⁹⁰

This 2017 definition of a classified worker is hard to translate into 1950s units but, for example in terms of penetrating (gamma) radiation, 6 mSv is equivalent to 0.6 r which is the kind of dose some personnel did receive at the nuclear tests and, on this basis, one might say that those considered at risk of radiation exposure at the nuclear tests were the kind of people who later qualified as classified workers in the UK, and the rules for retention of medical information of classified workers might reasonably be expected to apply to them.

⁸⁵ UKAEA London office to UKAEA Risley, 26 Apr 1963, TNA AB 65/2; RN Simeone (UKAEA Harwell) letter, 14 Apr 1975, AB 61/44.

⁸⁶ Papers in TNA AB 6/2562.

⁸⁷ Ionising Radiation Regulations 1985 (SI 1985 No.1333).

⁸⁸ Ionising Radiation Regulations 1999 (SI 1999 No.3232).

⁸⁹ Ionising Radiation Regulations 2017 (SI 2017 No.1075).

⁹⁰ *ibid.*

Debate on film-badge and blood-testing policy for Grapple Z

Additional information sent to OVA 16 March 2026 to provide more detail about this correspondence.

As the final Grapple Z series approached, policy on dosimetry and blood counts was reviewed. On 2 July 1958, AVM John Grandy, the Grapple Z task force commander, wrote to Roy Pilgrim, Senior Superintendent of AWRE's Trials Division, to put on record a conversation about reintroducing film badges for all. First, Grandy described current policy and procedures. It had "not been thought necessary" to issue film badges universally on Christmas Island:

the policy has been to define [active] areas and control entry and exit thereto, admitting only personnel both service and civilian (AWRE) whose duty necessitates their working in these areas. These personnel have been given appropriate medical examinations (blood count) and are provided with film badges.

Elsewhere on the island there had been a "communal film badge" system of fixed instruments for background radiation monitoring. Now, however, two of the devices to be tested in the Grapple Z operation were to be suspended under a system of balloons tethered to the ground, rather than dropped by a bomber to burst high in the air well away from the island. Health physics had come under "fresh examination" but Grandy still felt that a universal issue of film badges, including to the native Gilbertese population of seasonal agricultural workers, would be unnecessary and indeed:

may provoke anxiety. What right have we to subject native populations and civilians to the possibility of contamination which, however remote, the issue of a badge to individuals would suggest is a likely possibility? ... First consideration of a film badge issue was provoked by the lego-medical aspect of disability claims. A case is now about to start and there may be some difficulty in disproving such claims. We discussed all this ... and our conclusion was that it would not be necessary for a general issue of film badges for Grapple Z.

Although, therefore, film-badge dosimetry was not expanded, Grandy and Pilgrim had come to a different conclusion on blood tests:

At the moment the vast majority of service personnel at Christmas Island are not medically examined (blood counts) either prior to or after serving on the island ... We discussed this matter at length and were of the opinion that measures should be put into effect at the earliest opportunity to ensure that all service personnel going to Christmas Island from now on were subject to medical examination (blood count).⁹¹

Capt Guy Western RN, the senior naval officer for the Grapple Z operation, confirmed that all Royal Navy or Royal Marines personnel for Christmas Island should have a blood examination: this was "a new requirement by Task Force Grapple arising from the considerable publicity which is being given to the death of an Army other rank who is alleged to have suffered from leukaemia after a tour of duty at Christmas Island". Action, Western believed, was also being taken by the War Office and Air Ministry.⁹² The case mentioned by Grandy and Western was that of a sapper at Grapple X who was not given a film badge, because he was considered at no risk of radiation exposure, and who died of leukaemia in

⁹¹ Grandy to Pilgrim, 2 Jul 1958, TNA ES 38/ZT7V6 and ES 1/648.

⁹² Western, 'Blood examinations - personnel proceeding to Christmas Island', 2 Jul 1958, TNA ES 38/ZSR7S.

summer 1958. A war pensions tribunal concluded in 1961 that he had not been “exposed either to prompt gamma rays or neutrons, or to radiation fallout” at the test.⁹³

Others, in particular senior RAF medical personnel, clearly disagreed with the new line on more blood testing. An officer in the Air Ministry’s Hygiene and Research Directorate wrote a briefing for Grandy around this time noting that several blood counts were necessary to derive a “normal” level for any individual, a single low blood count meant little, and “wholesale blood counts on say 4000 people” would be cumbersome to carry out and “would inevitably raise alarm among many, and others would interpret them as a lack of confidence in the safety arrangements ... I have no hesitation in concluding that the RAF should not accept any such commitment”.⁹⁴ Air Cdre William Stamm, a consultant at the RAF Institute of Pathology and Tropical Medicine at Halton in Buckinghamshire, was also sceptical:

significant changes in blood counts from exposure to radiation are not signs of impending danger but of gross overdosage already received. The routine use of blood counts is therefore not only futile but is actually dangerous in that it tends to produce a feeling of false security ... It is sometimes argued that pre-employment counts should be performed to exclude from employment anyone whose blood picture already shows pathological abnormalities. The validity of this argument is both its professional and administrative or medico-legal aspects is open to question.⁹⁵

AWRE, on the other hand, strongly supported blood testing for all. Pilgrim replied to Grandy, confirming their conversation:

With regard to blood counts, I have sought the best medical and health physics advice available to me and I must advise the implementation as far as possible of a universal blood count for all members of the Task Force. We did agree that it was not possible to cover everyone for the next trial but that all replacements at Christmas Island and all those whose work is in the ‘forward’ area should be ‘blood counted’ and I strongly recommend that you adhere to this. It is recognised that from a purely medical and perhaps also from a logical aspect, Air Cdre [JS] Wilson ... [is] right. However, apart from safety, which I believe is adequately covered in any case, our main concern is to avoid subsequent claims and legal battles and even more important the consequential unwelcome publicity. If a man has a tendency towards leukaemia, anaemia or any similar condition associated with a low blood count (the incidence of these diseases in a normal population is sufficiently high to make it likely that one or more will appear from time to time in a sample of 4500) it matters little to the newspapers if, at Christmas Island, he worked at the port or in the measurements area. The only real safeguard is to make as sure as possible that such men are not included in the Task Force.⁹⁶

Dr J B Lynch, AWRE’s Chief Medical Officer, wrote to Pilgrim in strong support a few days later, having seen Stamm’s sceptical comments:

It is undoubtedly true and has been recognised for many years that routine blood counts are of no value in detecting small over-dosage of radiation in any individual. It is the practice in all [UKAEA] establishments to do blood counts as part of the basic medical examination and at varying routine intervals, the aim being to exclude for medical reasons, persons showing abnormal blood findings which might weight the

⁹³ Correspondence folder, Merlin database 04177.

⁹⁴ ‘Blood counts: notes for T[ask] F[orce] C[ommander], undated, Merlin database 20943 and TNA ES 1/648.

⁹⁵ ACdre Stamm to Air Ministry London, 4 Jul 1958, Merlin database 20943 and TNA ES 1/648.

⁹⁶ Pilgrim to Grandy, 7 Jul 1958, Merlin database 20943 and TNA ES 1/648.

effects of subsequent accidental over-exposure or be the bases for litigation. It is not entirely true that routine blood counts have no value since there is one well known case on record at Harwell in which an over-exposure to a neutron beam showed significant blood changes without any excessive exposure being detected by the monitoring devices.

On the question of pre-employment blood counts. Dr Stamm's arguments are not entirely sound. It seems to most people in this field of medicine that it is reasonable both professionally and medico-legally, to exclude persons whose blood findings lie outside a wide range of normality or who are showing evidence of disease changes. This view about pre-employment blood examinations will become a statutory requirement under the Factories Act and I have no doubt that service personnel who are going to be exposed to radiation should be similarly protected. While it is true that the normal pre-employment blood count will do nothing to help a subsequent claim, it is also true that failure to carry out such counts would be considered in court (especially in the light of the new statutory requirement) to be a failure to take the precautions necessary before exposure. The chances of picking up a leukaemia by this method are obviously very much greater than 1/1,000,000 and 1/40,000 might be a truer figure. I agree however with the economics of it and I have already pointed out the cost of undertaking pre-employment blood counts would probably be ten times the cost of compensation for a possible case of leukaemia ...

Finally, my personal view is that the blood count examination is just as much part of the pre-employment examination as urine analysis, chest X-ray and clinical examination and I have no doubt that sooner or later the services will get round to this view.⁹⁷

Grandy chaired a meeting at AWRE on 15 July to decide future policy on blood counts. The first Grapple Z test was now just over a month away. It would be balloon-borne and require re-entry to the south-east corner of Christmas Island afterwards to "rehabilitate" the area in preparation for a second balloon test. Lynch again explained his reasoning in support of blood counts, starting with "the medico-legal angle" and forthcoming regulation under the Factories Act: "AWRE were concerned about the political repercussions which might ensue if charges of negligence, however unfounded, could be proved". Time being short, it was considered unrealistic to arrange blood tests for all 4500 personnel already at Christmas Island, but the meeting decided that blood tests must go ahead for anyone working in the forward area during Grapple Z, and for *all* future replacement personnel (at this stage nobody knew for certain that the Grapple Z series would be Britain's last atmospheric tests).⁹⁸ Grandy reported this decision to the three service ministries, AWRE and the MoS, noting once again that "all medical opinion present agreed single blood counts to be of negligible scientific value" but also that AWRE favoured blood counts for all "as a medico-legal safeguard, both to satisfy public opinion and as a 'moral' obligation".⁹⁹

⁹⁷ Lynch to Pilgrim, 11 Jul 1958, TNA ES 38/ZFGVF and ES 1/648. From context, the words "chances of picking up a leukaemia" clearly refer, not to a person's *getting* leukaemia, but to the pre-employment blood count's *finding evidence of* leukaemia even if a person had it, the probability of which Stamm had estimated at 1/1m. "Statutory requirement" was a reference to the draft Factories (Ionising Radiations) Special Regulations, issued for consultation the previous year, which led eventually to the Ionising Radiations (Sealed Sources) Regulations of 1961: *Factories (Ionising Radiations) Special Regulations: preliminary draft of regulations* (HMSO/Ministry of Labour and National Service 1957); SI 1961 No.1470.

⁹⁸ Minutes of a meeting at AWRE, 15 Jul 1958, TNA ES 38/ZFGVF and ES 1/648.

⁹⁹ Grandy to Air Min, Admty, AWRE, MoS, WO, 17 Jul 1958, TNA ES 38/ZFGVF and TNA ES 1/648.

Orders were confirmed by signal from the Task Force Commander in London and in writing on the island: "before rehabilitation of forward area after each balloon round blood counts will be made on personnel", specifically to be carried out at the rate of 12 people/day starting at 0830 on 4 August; "badges will be issued to all members of AWRE and to those service personnel working in active areas. On firing day aircrew employed in sampling and survey duties will also be supplied with badges"; "each blood examination is to include a full erythrocyte count, haemoglobin estimate, leukocyte count and differential leukocyte count. A platelet count is not required".¹⁰⁰ On the very day of the final British atmospheric nuclear test, 23 September 1958, Air Cdre J S Wilson, the Air Ministry's Director of Hygiene and Research, confirmed to RAF medical officers that:

In future, all personnel posted to Christmas Island should be examined in UK, as in the [draft statutory] regulations ... provided that they are required to work in the controlled area there ... A blood examination which shall include a total red blood measurement and a white cell count, with a differential white cell count; estimation of haemoglobin in grammes per hundred cubic centimetres of whole blood; and a search for and record of abnormal cells seen".¹⁰¹

Pre-deployment blood counts for personnel going to Christmas Island were evidently made at various locations: naval hospitals or equivalent civilian facilities for Royal Navy personnel, for example; the Cambridge Military Hospital at Aldershot for MoS civilian staff; or at "personnel holding units" or service medical establishments for RAF personnel, for whom "Form Med 42 [was] to be raised in respect of all service personnel examined".¹⁰²

Surgeon Cdr Frank Ellis, assistant to the Admiralty's Medical Director-General, reflected on these discussions and disagreements in a letter to Guy Western on Christmas Island: "You may hear ... of the mild difference of opinion which arose over the question of blood counts for the boys". The Admiralty had by now conceded to the other service ministries that, if all agreed, they would happily stop routine blood counts, but Ellis did "not entirely support the RAF view that the blood count is entirely useless - if there is a real element of risk".¹⁰³ In reply, Western expressed the view that a "political" not a "medical" decision was appropriate.¹⁰⁴

¹⁰⁰ By signal to Base Cdr Xmas I, 23 Jul 1958, TNA ES 38/ZT4LF; Maj WG McDougall (Health Physics Controller Xmas I), 'Film badges', 1 Aug 1958 (a note covering the issue of the badges themselves), TNA ES 38/ZTFWD and ES 1/648; CAFO 81/58 'Nuclear weapons trial parties - blood examinations', 1 Aug 1958, TNA ES 38/ZSSDL and ES 1/648.

¹⁰¹ Wilson to all Principal Medical Officers, 'Radiological safety precautions at Christmas Island - medical examination of personnel posted to Christmas Island from the UK', 23 Sep 1958, TNA ES 38/ZTG6H and ES 1/648. "Regulations" was a reference to the draft Factories (Ionising Radiations) Special Regulations, issued for consultation the previous year, which led eventually to the Ionising Radiations (Sealed Sources) Regulations of 1961, SI 1961 No.1470

¹⁰² CAFO 81/58 applied to all RN personnel for Maralinga, Christmas Island or Task Force Grapple but not other ships in the Pacific such as HMS *Scarborough* or HMNZS *Pukaki*, as clarifying order made clear on 16 Aug: Western to COs HMS *Resolution*, *Scarborough* and *Narvik* and HMNZS *Pukaki*, 16 Aug 1958, TNA ES 38/ZT49F; Capt FB Lloyd RN (Director Atomic Weapons Trials MoS) to Pilgrim, 13 Aug, TNA ES 38/ZTFVJ; Air Ministry H&R Medical Branch, 13 Oct 1958, TNA ES 38/ZTGPG.

¹⁰³ Ellis to Western, also to Air Min, 11 Aug 1958, TNA ES 38/ZT38V.

¹⁰⁴ Western to Ellis, 19 Aug 1958, TNA ES 38/ZT3KC.

Radiological protection and international “threshold” or “permissible” doses

Additional background provided to OVA on 24 March 2026 to supplement or replace fragmentary information on the subject in the narrative report.

In 1950 the International X-ray and Radium Protection Commission (IXRPC), an informal group of physicians which had first met at the third International Congress of Radiology in Paris in 1931, became the International Commission on Radiological Protection (ICRP), an independent scientific group funded by NGOs, private donations, and later by the UN and IAEA.¹⁰⁵ Making clear its strong recommendation that “every effort be made to reduce exposures of all types of ionising radiation to the lowest possible level”, the ICRP nevertheless agreed and published a widely accepted international standard for “permissible” radiation exposure. In the belief that the human body could overcome the effects of small doses of radiation - encouraged by observations of recovery even from acute radiation sickness - the ICRP set permissible or “threshold” doses, well below those known to cause any actual harm.

The ICRP’s threshold dose limit in 1950 for penetrating (X or γ -ray) radiation for workers was 0.3 roentgen (0.3 r) a week. The roentgen was a unit of radiation exposure measured in the air, and 0.3 r/week measured in free air was understood to be equivalent to, and was sometimes expressed as, 0.5 r/week or 0.1 r per working day measured at the surface of the body, for example as detected by a film badge. An equivalent threshold dose was also set for weakly penetrating (β) radiation, potentially affecting exposed areas of the skin such as the hands and face; and threshold amounts of various radionuclides ingested/inhaled in the body were discussed. In line with the IXRPC’s previous position the Commission also recommended that:

radiation workers should be systematically submitted, both on entry and subsequently, to expert blood examinations every three months, and to medical and general examinations once a year ... These examinations will determine the acceptance, refusal, limitation or termination of occupation involving radiation exposure.¹⁰⁶

In later years the concept of a threshold dose was challenged, first where genetic damage from radiation was concerned and later in connection with any injury or illness linked to radiation. In the 1950s, however, the ICRP’s standards were exactly in line with thinking in Britain - not coincidentally, as British scientists were very active in its deliberations - and its threshold doses were used as the fundamental basis for radiological protection during the British nuclear testing programme. Importantly, however, a nuclear test would involve the risk of radiation exposure over a short period of time only. Test personnel would not be exposed week in, week out over a working lifetime; instead they might receive a relatively high dose in a short time, followed by a long break for recovery. A higher accumulated or “integrated” dose for the period of the operation might be permissible, if then followed by such a break.

¹⁰⁵ RH Clarke and J Valentin, ‘The history of ICRP and the evolution of its policies’, *Annals of the ICRP* 39/1 (Feb 2009), pp. 75-110, esp. p. 80; *Report of the Royal Commission into British nuclear tests in Australia*, vol. 1, ch. 4.

¹⁰⁶ ‘International recommendations on radiological protection’, agreed at the 6th International Congress of Radiology in London, 1950 and published in *British Journal of Radiology* 24 (Jan 1951), pp. 46-53.

In October 1951, therefore, planning a year ahead for the first British nuclear test, the head of the British atomic bomb programme William Penney felt able to suggest three threshold limits for radiation exposure: the normal ICRP working limit of 0.1 r/day at the surface of the body; and integrated dose limits for the period of the test operation of 3 r (in a “limited number of cases”) and 10 r (in case of “extreme urgency”) for personnel whose duties might include, for example, retrieving important data from instruments in the contaminated area after the test.

The ICRP, noting disagreement among haematologists over the value of blood counts, updated its advice in 1954, elaborating but also relaxing the requirement for blood counts:

All new personnel in radiological work shall have a pre-employment blood examination in addition to any other pre-employment examination. The results of such an examination shall determine the acceptance or refusal of the potential employee in radiological work ... Blood counts should include a red-cell count, haemoglobin and total and differential white-cell count. A note should be made of any abnormal cells ... the physiological variations in white-cell counts and the possible large day to day variations (about 15 per cent) in normal unexposed persons should be borne in mind ... Provided that radiation monitoring (both site monitoring and personnel monitoring) is carried out ... routine blood counts are unnecessary in the case of workers who receive doses not exceeding one-third of the permissible doses.

Blood counts should be considered “optional”, said the ICRP, for doses between one third and two thirds of the threshold dose, and “desirable” above that.¹⁰⁷ At AWRE, the annual health and safety report in 1955 recorded that regular blood counts had been dropped for almost all radiation workers from six-monthly to annually.¹⁰⁸

The ICRP made no fundamental change to its maximum permissible threshold doses in 1954, but it now discussed the limits using units not only of measurable *exposure* (roentgens) but also *absorbed dose* or energy absorbed in tissue (rads or reps) and *dose equivalent* or absorbed dose adjusted for the biological effectiveness of the specific radiation (rems, or roentgen equivalent man, equal to 0.01 of the modern SI unit the sievert (Sv)). These units, especially the rem, were intended to widen the applicability of the limits to include radiation types other than X or γ-rays. One roentgen of X or γ-ray exposure measured in free air would give approximately one rem of dose equivalent to a human, but for other radiations conversion factors had to be applied to measured doses in order to derive the dose equivalent.

In 1959 the ICRP published comprehensive new recommendations agreed in September 1958. The ICRP now based its thinking on accumulated effective dose over a working life, rather than daily or weekly limits. A formula was introduced based on 0.1 rem/week - or one third of the previous threshold dose - but averaged over longer periods to allow for occasional higher doses, and also reducing proportionately for workers of reproductive age:

For a person who is occupationally exposed at a constant rate from age 18 years, the formula implies a maximum weekly dose of 0.1 rem ...

To the extent the formula permits, an occupationally exposed person may accumulate the maximum permissible dose at a rate not in excess of 3 rems during any period of 13 consecutive weeks (i.e. in no 13 consecutive weeks shall the dose exceed 3 rems).

¹⁰⁷ ‘Recommendations of the International Commission on Radiological Protection’, 1 Dec 1954, published in *British Journal of Radiology*, Supplement No.6, 1955.

¹⁰⁸ UKAEA Weapons Group, ‘First annual report on health and safety’, Oct 1955, TNA ES 38/ZSPJ5 and ES 1/1283.

If necessary, the 3 rems may be received as a single dose, but as the scientific knowledge of the biological effects of differing dose-rates is scant, single doses of the order of 3 rems should be avoided as far as possible.¹⁰⁹

In discussing its formula the ICRP also allowed for “an accidental high exposure that occurs only once in a lifetime and contributes no more than 25 rems”,¹¹⁰ and discussed for the first time in detail limits for individuals, and wider populations, not normally occupationally exposed to radiation. It is interesting that the 3 rem and 25 rem limits were similar to those used as cumulative or integrated special limits for exposure at British nuclear tests, and the 13-week period also broadly matched the planning expectation for deployment at a nuclear test operation.

Blood counts still featured in the new ICRP recommendations, although not prominently. A pre-employment medical, said the ICRP, should include:

a complete blood count, with determination of erythrocyte and leukocyte levels and a differential white cell count ... Medical examinations should be performed at a frequency depending upon the conditions of the occupational exposure. Blood counts, although they are part of a medical examination, are not to be considered as a method of radiation monitoring.¹¹¹

¹⁰⁹ ICRP, ‘Report on decisions at the 1959 meeting of the International Commission on Radiological Protection’, *Acta Radiologica* 53 (1960), p. 27.

¹¹⁰ *ibid.*, p. 29.

¹¹¹ *ibid.*, pp. 34-5.

International radiological protection and blood counts, 1920s-1950s

Additional information sent to OVA 11 May 2026 to provide detail of the evidence to support the comment that ‘Radiological protection measures were broadly consistent with evolving practice and later statutory regulation for industrial radiation workers in the UK and internationally’; Appendix 2 is also relevant to this request.

The hazards of radiation exposure, for example to medical radiographers and those working with luminous paints containing radium, were well known in the early twentieth century. Blood tests were already used in the 1920s as part of general medical assessments of fitness to work, initially and on a continuing basis, with radiation. A British ‘X-ray and Radium Protection Committee’ of eminent physicians recommended as early as 1921 that:

The danger of over-exposure to x rays and radium can be avoided by the provision of efficient protection and suitable working conditions ...
in view of the varying susceptibilities of workers to radiation, the Committee recommend that wherever possible, periodic tests - for example, every three months - be made upon the blood of the personnel, so that any changes which occur may be recognised at an early stage. In the present state of our knowledge it is difficult to decide when small variations from the normal blood count become significant.¹¹²

An International X-ray and Radium Protection Commission (IXRPC), meeting during the third International Congress of Radiology in Paris in 1931, made a similar recommendation:

X-ray and particularly radium workers should be systematically submitted, both on entry and subsequently at least twice a year, to expert medical, general and blood examinations. These examinations will determine the acceptance, limitation or termination of such occupation.¹¹³

Large-scale industrial uses of atomic energy began with the wartime Manhattan Project in the US, for which additional radiation protection measures and the new discipline of ‘health physics’ were developed.¹¹⁴ In particular, personal dosimeters to measure radiation exposure at individual level came into common use: the use of photographic film to detect radiation exposure was known as early as 1905 but reliable and consistent filtered film badges were an innovation of the Manhattan Project.¹¹⁵ In the UK, the National Physical Laboratory, which had already been using films to assess radiation exposure of its own staff, introduced a “dosage-film service” in 1942 for workers in medical radiology at the request of the Ministry of Health.¹¹⁶

The British civil and military atomic programme, set up after the second world war under the Ministry of Supply (MoS), already therefore had available to it a significant body of knowledge on radiological protection. Around 150 British scientists had been involved in the Manhattan Project at Chalk River in Canada and Berkeley and Los Alamos in the US.

¹¹² X-ray and Radium Protection Committee, ‘Preliminary report of committee’, *British Medical Journal* 1/3156 (25 June 1921), pp. 936-7.

¹¹³ International Congress of Radiology, ‘The work of the International X-ray Unit Committee and the International X-ray and Radium Protection Commission during the III International Congress of Radiology in Paris 1931’, *Acta Radiologica* 12 (1931), pp. 586-94.

¹¹⁴ See e.g. RH Wilson, *Historical review of personnel dosimetry development and its use in radiation protection programs at Hanford, 1944 to the 1980s* (US DOE PNL-6125 UC-41, Feb 1987).

¹¹⁵ www.orau.org/health-physics-museum/collection/dosimeters/film/ernest-wollan.html [accessed 9 Feb 2025].

¹¹⁶ W Binks, ‘Protective methods in radiology’, *British Medical Bulletin* 4 (1946), pp. 58-64.

Although the US Atomic Energy Act of 1946 (the 'McMahon Act') ended most atomic collaboration between the US, Britain, and Canada, exchanges on health physics were still permitted, for example at tripartite conferences in 1949 and 1950.¹¹⁷

In a paper written in 1948, the Principal Medical Officer of the UK atomic programme's industrial organisation at Risley in Lancashire reflected a strong sense that health and safety in the new atomic industry needed to be exemplary, calling for "more assiduous health and safety care than any other past or present industrial employment". His account of protective measures covered, in turn: hazard evaluation and design and planning of operations; training and supervision; detection and monitoring of radiation; and medical surveillance, including urine testing as a way to detect and assess the ingestion or inhalation of radioactive materials, and blood testing to assess general fitness:

Medical staffs can help by making sure that those individuals who show evidence or give suspicion of abnormal health are not exposed to radiation hazards ... which could conceivably be made worse by sub-normal radiation exposure ... the doctor must use the most delicate and specific tests available in the present state of our knowledge; blood examinations in which variations are looked for in the numerical distribution of the many types of white cells of the blood, among other things ... and they must maintain records which will enable the next generation of their medical colleagues to decide if our standards of protection really did protect - a rather important point for posterity.¹¹⁸

The Principal Medical Officer at the atomic programme's research headquarters, the Atomic Energy Research Establishment at Harwell, reported in July 1948 that "the initial medical examination of employees is nearly completed ... with regard to blood counts, the film list is taken as an index of exposure to radiations, and all the staff on this list have received a blood examination". Many obstacles had been overcome: it had been difficult, for example, to ensure that scientists, recruited at national level and often interviewed in London, were examined as consistently as locally engaged industrial workers.¹¹⁹ Medical examinations continued to be carried out locally, site by site - where necessary using the resources of larger nearby sites or hospitals - after the creation of the United Kingdom Atomic Energy Authority (UKAEA) in 1954, which took over leadership of the civil and military nuclear programme from the MoS.¹²⁰

William Penney, a Manhattan Project veteran, led the team known euphemistically as 'High Explosives Research' (HER) which was tasked with designing and building an atomic bomb. By 1949, when Penney made a first formal progress report to the MoS, blood counts and film badges were also routine for his staff mainly at Fort Halstead in Kent:

The existing system of taking regular blood counts is being extended to all staff, both radiological and metallurgical, engaged in HER work ... The departmental film monitoring service is also being extended as required.¹²¹

¹¹⁷ Margaret Gowing, *Independence and deterrence: Britain and atomic energy 1946-52* (Macmillan 1974), vol. 2, pp. 94-5.

¹¹⁸ EF Edson, 'Radiation hazards and their control', 4 Oct 1948, paper for the Society of Engineering Industry, Merlin database 01578.

¹¹⁹ Harwell to Lloyd (Chief Medical Officer MoS), 12 Jul 1948, UK National Archives [TNA] AB 6/34, and other correspondence in the same file, AB 6/418 and 1350. The "film list" was evidently the list of people issued with film badges; film badges and blood counts were linked as elements of the protection of the same individuals.

¹²⁰ See e.g. UKAEA-wide summary of arrangements in March 1960, TNA AB 6/1948.

¹²¹ [Unclassified extract from] HER Progress Report No.1, 1949, AWE archive.

By 1950, however, a note of caution on the value of blood testing was evident, for example in a journal paper published by the Principal Medical Officer at Risley. Although blood counts were a useful general indication of fitness to work with radiation, and changes could clearly be seen in the blood after heavy exposures to radiation, it was very hard to establish any relationship between blood counts and low exposures:

In spite of the very large number of blood counts carried out in the past on radiation workers, there is as yet no precise evaluation of the relationship between the blood picture and radiation exposure ... The recorded blood count is influenced by a variable element of technical inconsistency and by a wide range of physiological variation between different individuals, or between the counts obtained at different times from the same individual.¹²²

Published papers of the early 1950s show that the value (or not) of blood counts to radiological protection was now a matter of considerable debate among experts. In the US in 1952, for example, Robert Stone, a veteran of the Manhattan Project, expressed a forthright view:

In 1942 ... my medical colleagues and I decided to make such counts mandatory and, as a result, thousands of records of blood counts are now available; but the chances of finding anything of significance from them seems so remote that no one wants to spend much time analysing them ... Throughout the war years, hundreds of thousands of blood counts were done on 'potentially exposed' personnel and many of these wore monitoring instruments as well. No real correlation was found between blood counts and exposures. Thousands of blood counts are still being done daily on personnel who are also monitored. This is a terrific waste of money, time, manpower, and effort ... mass counting should be discontinued.¹²³

In the UK Robin Mole, a member of a Medical Research Council unit set up at Harwell, similarly saw little value in blood counts, which had seemed important before the war but which showed much natural variation and defied easy correlation either with dose received or damage to the body:

Regular blood counts are of no value to those occupationally exposed to radiation provided there is regular physical measurement of the doses received. The evidence that blood counts are of value has not withstood careful examination. Changes in the peripheral blood by themselves and without further evidence should not be assumed to mirror damage to the bone marrow.¹²⁴

Another Harwell report of 1954, comparing dosimetry with blood counts, concluded simply that there was no correlation: "comparison of blood counts of workers exposed to varying levels of radiation between the periods 1947-50 and 1951-54 gives no evidence of radiation effects on the mean counts of the groups".¹²⁵ Harwell's Principal Medical Officer was more measured, reviewing an already substantial literature on white blood cell counts in particular but concluding only that more research was needed:

The need is felt for reliable data linking blood counts of selected groups with accurate measurements of radiation exposure, and for data on a number of specific controls.

¹²² EF Edson, 'Occupational radiation hazards', *British Medical Bulletin* 7/1-2, pp. 57-63.

¹²³ Robert S Stone, 'The concept of a maximum permissible exposure', *Radiology* 58/5 (May 1952), pp. 639-61.

¹²⁴ RH Mole, 'Risks from chronic irradiation and their haematological control', *Journal of Clinical Pathology* 7 (1954), pp. 267-74.

¹²⁵ 'Blood count levels at AERE in relation to radiation dosage', TNA AB 15/3890. The original is marked "cleared for publication" although no published copy, e.g. as a journal article, has been found.

Consideration should therefore be given to selective processes whereby greater effort is expended when the risk is higher or when positive results may be obtained, with concomitant relaxation on 'potentially exposed' personnel who are also monitored.¹²⁶

In another paper, however, she echoed doubts on the value of the current blood-testing regime:

it is considered that the variation in the white cell count from radiation damage is so small in the case of workers who receive a surface dose of less than 0.1 r per week that the significance of the blood count is very doubtful at this exposure rate.¹²⁷

Bo Lindell, a Swedish expert involved for many years in the work of the ICRP, remarked in his authoritative history of radiological protection on the importance of these views, expressed at a meeting in Stockholm in 1952: "from that day on, people all over the world began to realise the limited benefit of [blood] examinations".¹²⁸ The ICRP, noting disagreement among haematologists over the value of blood counts, updated its advice in 1954, elaborating but also relaxing the requirement for blood counts:

All new personnel in radiological work shall have a pre-employment blood examination in addition to any other pre-employment examination. The results of such an examination shall determine the acceptance or refusal of the potential employee in radiological work ... Blood counts should include a red-cell count, haemoglobin and total and differential white-cell count. A note should be made of any abnormal cells ... the physiological variations in white-cell counts and the possible large day to day variations (about 15 per cent) in normal unexposed persons should be borne in mind ... Provided that radiation monitoring (both site monitoring and personnel monitoring) is carried out ... routine blood counts are unnecessary in the case of workers who receive doses not exceeding one-third of the permissible doses.

Blood counts should be considered "optional", said the ICRP, for doses between one third and two thirds of the threshold dose, and "desirable" above that.¹²⁹ At AWRE, the annual health and safety report in 1955 recorded that regular blood counts had been dropped for almost all radiation workers from six-monthly to annually.¹³⁰

The draft Factories (Ionising Radiations) Special Regulations issued for consultation in 1957, building on a code of practice for radiation workers in the NHS, and intended to apply to all industrial radiation workers in the UK, were produced by a committee chaired by eminent physicist Sir Charles Darwin.¹³¹ The draft led eventually to the Ionising Radiations (Sealed Sources) Regulations of 1961.¹³²

The journal *Nature* noted, amongst other things, that in the 1957 draft "less emphasis than formerly is placed upon the necessity for blood counts", and a submission from the UKAEA protested that "tests by red cell counts are unnecessary and not widely supported by current

¹²⁶ EK Williams, 'The white cell count in relation to occupational radiation dosage', *Acta Radiologica* 41/1 (1954), pp. 21-29.

¹²⁷ 'Radiological protection and the blood count', 16 Nov 1954, TNA ES 38/ZSTNS.

¹²⁸ Bo Lindell, *The labours of Hercules: the history of radiation, radioactivity, and radiological protection, Vol.3 1950-66* (Nordic Society for Radiation Protection 2020), p. 92.

¹²⁹ 'Recommendations of the International Commission on Radiological Protection', 1 Dec 1954, published in *British Journal of Radiology*, Supplement No.6, 1955.

¹³⁰ UKAEA Weapons Group, 'First annual report on health and safety', Oct 1955, Merlin database ES 38/ZSPJ5 and TNA ES 1/1283.

¹³¹ *Factories (Ionising Radiations) Special Regulations: preliminary draft of regulations* (HMSO/Ministry of Labour and National Service 1957).

¹³² SI 1961 No.1470.

radio-biological opinion".¹³³ Nevertheless the final regulations defined employers' responsibilities for medical surveillance of radiation workers in detail, including pre-employment checks and further checks in the event of dose limits being breached, both including blood counts:

Any blood examination ... shall ... either consist of or include (a) in the case of red blood cells a measurement of the packed cell volume or an estimate of the number present per cubic millimetre of whole blood; (b) in the case of white blood cells an estimate of the number present per cubic millimetre of whole blood; (c) a differential white cell count; (d) a search for abnormal cells and a description of any seen; and (e) an estimation of the haemoglobin in grammes per one hundred millilitres of whole blood.¹³⁴

¹³³ FW Spiers, 'A code for protection against radiation', *Nature* 4586 (21 Sep 1957), pp. 578-9; [unclassified] draft comments from UKAEA head office in London, circulated 4 Oct 1957, AWE archive.

¹³⁴ SI 1961 No.1470, sections 26-27. Successive [unclassified] drafts preserved in the AWE archive show that this final wording, slightly more elaborate than that of 1957, was introduced at the end of 1959.

Participants at nuclear test operations

Table provided to OVA on 18 March 2026 as evidence of the reduction over time in the numbers of personnel regarded as at risk of radiation exposure and therefore given film badges. From the third population-wide medical statistical study: CR Muirhead *et al.*, NRPB-W27 ‘Mortality and cancer incidence 1952-98 in UK participants in UK atmospheric nuclear weapon tests and experimental programmes’, Feb 2003.

TABLE 2.6 Numbers of men mentioned in Health Physics (HP) records, with and without recorded doses as a percentage of all participants at each operation

Location and operation	Number of men				Collective dose (man mSv)
	Number of test participants	Number mentioned in HP	Mentioned in HP with zero dose	Mentioned in HP with non-zero dose	
Hurricane	1,398	1,340 (96%)	1,134	206	2,470
Mosaic	1,383	599 (43%)	404	195	1,274
Monte Bello	9	0 (0%)	0	0	0
Totem	106	78 (74%)	19	59	1,209
Buffalo	1,285	786 (61%)	404	382	2,156
Antler	1,548	737 (48%)	418	319	1,874
MEP	555	510 (92%)	314	196	775
Other attendances at Maralinga	2,555	253 (10%)	228	25	111
Grapple	3,515	83 (2%)	4	79	1,018
Grapple X	2,340	179 (8%)	53	126	1,081
Grapple Y	3,723	114 (3%)	18	96	981
Grapple Z	4,374	618 (14%)	395	223	3,814
Brigadoon	729	379 (52%)	29	350	231
Other attendances at Christmas Island	3,985	11 (0%)	3	8	1
Total	27,505	5,687 (21%)	3,423	2,264	16,995

The table's total of 27,505 is a count of “attendances” at nuclear test operations; many of the 22,000+ civilian and military test veterans took part in more than one operation.

The fourth and most recent population-wide medical statistical study is on open access and includes references and links to the previous studies: M Gillies and RJE Haylock, ‘Mortality and cancer incidence 1952–2017 in United Kingdom participants in the United Kingdom’s atmospheric nuclear weapon tests and experimental programmes’, *Journal of Radiological Protection* 42/012507 (2022).