IN THE ROYAL COURTS OF JUSTICE CLAIM NO: HQ04X04168

QUEENS BENCH DIVISION

BETWEEN:

A B & OTHERS

Claimants

-and-

THE MINISTRY OF DEFENCE

Defendant

PRELIMINARY EVIDENCE OF JOHN H LARGE

Instructing Solicitors: **ROSENBLATT**

LARGE & ASSOCIATES Ref N^{o} R3169-A2

1ST ISSUE	REVISION NO	APPROVED	CURRENT ISSUE DATE
6 NOVEMBER 2008	R2		**20 NOVEMBER 2008**

A B & OTHERS -and- **THE MINISTRY OF DEFENCE**

1 I am John H Large of the Gatehouse, 1 & 2 Repository Road, Ha Ha Road, Woolwich, London SEI8.

2 I am a Consulting Engineer, Chartered Engineer, Fellow of the Institution of Mechanical Engineers, Graduate Member of the Institution Civil Engineers, Member of the British Nuclear Society and a Fellow of the Royal Society of Arts.[1]

3 **INSTRUCTIONS**

4 I have been instructed by Mr Tony Jeffrey of Rosenblatt, a firm of solicitors acting on behalf of the Claimants in this matter.

5 In March 2008 Mr Jeffrey instructed me to provide opinion on the subject matter, particularly with regard to the nature and detail of the further information referred or alluded to in the *Summary Defence*.

6 In this respect I met with Mr Jeffrey and his colleague Richard Hyde in late April 2008 and, subsequently, in October 2008 I was further instructed to provide this Preliminary Evidence.

7 I am aware that this Evidence is to be considered at the preliminary hearing on *limitation* and that it is not necessary for me to present my findings and opinion in great detail, as would be expected at a hearing of the main case. Accordingly, in this Preliminary Evidence I have confined my examination to the general and key points at issue, concentrating my opinion in terms of the inadequacies of the Defendant's Summary Defence (SD).

8 **QUALIFICATIONS & EXPERIENCE**

9 I have set down my specific experience as it relates to this evidence in **APPENDIX I**.

10 Previously, I have advised on the matter of two British Nuclear Test veterans,[2] preparing evidence for the European Court of Justice in Strasbourg in 1997. Since I shall refer to this evidence I have appended its four parts as **APPENDIX II**.

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1 Briefly, from the mid 1960s I was engaged as a Research Fellow working on defence related systems in the United States, thereafter from the early 1970s through to the late 1980s I was employed as a full-time member of the academic research staff on behalf of the United Kingdom Atomic Energy Authority (UKAEA) and other government agencies undertaking postgraduate research in the nuclear area and, subsequently, I joined the academic teaching staff at Brunel University. In the early 1990s I transferred to the firm of Consulting Engineers Large & Associates, that I had established on a part-time basis earlier and which provides specialist analysis and advice in nuclear related activities, including the development, deployment, transportation and storage of nuclear warheads and weapons systems. During the course of my career I have been involved in aspects of fundamental research, with the development and analysis of a number of technically demanding nuclear projects, including aspects of nuclear fuel reprocessing, nuclear power generation and marine propulsion, and nuclear weapons. A full CV and Bibliography may be accessed at http://www.largeassociates.com.

2 Messrs McGinley and Egan, *Case of McGinley and Egan v United Kingdom* (10/1997/794/995-996)

11 I consider myself adequately qualified to provide evidence on this matter, having considerable knowledge as a university-based academic researcher and a wealth of practicable experience as a professional consulting engineer in the fields of radiation exposure and dose uptake, the dispersion and deposition of radioactive materials and debris, and generally in the design and application of nuclear weaponry.

12 **SUMMARY OF MY PRELIMINARY EVIDENCE**

13 Here follows a summary of my evidence:

14 **Incompleteness of the Response of the SD:** The Claimants are British, New Zealand and Fijian veterans and civilians or their survivors who participated in the British nuclear weapons tests and trials undertaken in the 1950s. The British nuclear tests comprised 21 surface and atmospheric nuclear detonations with, in addition, about 700 or so separate activities (burnings, explosions, dispersal, etc., of nuclear and/or radioactive materials and nuclear weapon components) that are collectively referred to as the *Minor Trials*. The British also provided armed forces personnel (codename *Brigadoon*) in support of the *Dominic* series of 23 or 24 atmospheric nuclear detonations carried out by the United States over and around Christmas Island in 1962.

15 In responding to the claim, the SD fails to respond in any detail about 10 of the 21 British tests; no further information has been provided about the *Minor Trials*; and there is absolutely nothing relating to the *Brigadoon* involvement.

16 In the absence of this withheld information and documentation, which must be reasonably accessible to the Ministry of Defence (MoD), there remains considerable doubt over the SD claim that the levels of radiation to which the Claimants were exposed did not compromise their health.

17 **Radiation Exposure of the Individual Claimants:** In responding on the levels of radiation exposure to individual Claimants the MoD argues that it observed contemporaneous limits and principles to maintain the appropriate levels of radiological management and welfare. It claims to substantiate that these limits and principles were strictly adhered to in practice via the statement of John Lilley (JL).

18 I have to admit to being troubled by certain aspects of JL's statement, particularly that like the SD, i) he gives opinion on only 10 of the 21 test detonations and nothing at all on the *Minor Trials*; then by my doubts on the applicability and reliability of his ii) calculated *'safety distances'* necessary to avert excessive exposure to prompt neutron-gamma ray radiation; and I

entirely disagree with how he has relegated to secondary importance iii) the contribution of the localised fall-out from the test detonations, particularly for the ground and tower bursts with their high burden of irradiated and contaminated ground debris and, indeed, how this might have added significantly to the short, interim and longer term uptake of both *external* and *internal* radiation dose.

19 **Experimental Nature of the Test and Trials:** By their very nature, the trials and tests were experimental in themselves, comprising many unknowns and determinations that could have only been made by, at least to some extent, trial and error. The MoD admits to this in referring to the experimental nature and role of the *Buffalo* indoctrinees force (IF)

20 I give examples a number of activities that were undertaken by individuals and groups of men in the immediate aftermath of the nuclear detonation; such as flying through the mushroom cloud solely to determine the radiation exposure of the flying crew; undertaking physical activity in the contaminated zones; and being exposed to establish the efficacy of a rough-and-ready field decontamination system. I consider that these activities could only have been of an experimental nature and uncertain outcome of radiation dose exposure to those participants (individual Claimants) involved.

21 One of these examples is taken directly from the SD itself, and others I have picked, but not cherry picked, by quickly scanning through just part of my own private collection of Atomic Weapons Research Establishment (AWRE) reports.

22 For all of these experiments involving dose exposure to individuals and groups of men, there is no contemporaneous evidence that a pre-assessment was made of the radiation dose exposure anticipated for the particular activity planned. I have studied the documentation provided with the SD and, together with my past reading of many AWRE reports drawn from my own private collection; I cannot recall ever noting a realistic pre-assessment of exposure having been made.

23 In this respect, I consider that the experiments to have been blind, that is the radiological outcome was unknown, so much so that the participants must have been placed at some risk of overexposure and the dose received could not have been planned to be as low as reasonably practicable (ALARP).

24 I believe that these examples illustrate the radiological role played and the personal detriment that the Claimants sustained, maybe unwittingly, in participating in Britain's acquisition of nuclear weapons.

25 **Overall:** I find that the MoD's present assessment (ie the SD and JL) of the total potential dose exposure – prompt external + fallout external and internal – to be heavily flawed and I very much doubt the reliably of the MoD's claim that none of the Claimants (save the very few exceptions admitted) received a dose greater than the radiological limits accepted at the time.

26 I consider that even if the individual Claimant's dose exposure was within the then prescribed limits,[3] which I very much doubt, the planned involvement of a number of Claimants in experiments in which they were unnecessarily put at risk of additional exposure contravened the underlying ICRO principle of radiological protection, being that *' . . every effort be made to reduce exposure to all types of ionising radiations to the lowest possible level. . .'*. This ALARP principle was adopted by the ICRP in 1950 and has remained the cornerstone of radiological protection since that time.

27 I am of the opinion that the MoD should make such analysis to improve the assessment of the radiation exposures of the Claimants. This should certainly be undertaken on a test-by-test basis, covering all of the British test detonations, possibly covering the potential radiological impact of the US *Dominic* series of air bursts, and including some representative case assessments appropriate to the *Minor Trials*. These assessments should apply, where possible, to a range of representative individual Claimants or, at least, habit defined critical groups of Claimants.

28 Moreover, I consider that it is for the MoD to undertake this improved assessment rather than to rely upon the Claimants proving the same. This is because it is only the MoD that is privy to the documents and records that it holds and, as I have demonstrated in my examination of the SD, the MoD remains unwilling to release to the Claimants all that is required for a meaningful assessment of their radiation exposures received whilst participating in the British Nuclear Weapons Test programme.

29 I now present my Preliminary Evidence in the main:

30 **ISSUES RAISED AND CONTENDED IN THE SUMMARY DEFENCE**

31 I refer to *Section C (ALLEGED BREACHES OF DUTY)* of the SD wherein the Defendant (MoD) asserts (SD *para 18*) that

ii) a careful assessment was made of the risks relating to radiation safety of all participants; and

3 As prescribed by the recommendations of the International Committee on Radiological Protection (ICRP).

iii) that radiation exposure of all participants was consistent with prevalent knowledge and in accord with then international guidance.

32 In support of these assertions the SD provides a series of documents in conjunction with the opinion of John Lilley (JL) in his statement of 29 July 2008.

33 As I understand it, the MoD's proposition is that the SD provides documentary evidence gathered from the period of UK atmospheric testing of nuclear weapons and that, alongside this, JL purports that it was (then) possible to reliably forecast the physical and radiological aftermaths of a nuclear explosion.

34 In terms of the exposure of services personnel stationed at or nearby the nuclear weapons test sites, JL goes on to claim that it was also quite reasonable (then) to accurately predict the quantity and composition of the radioactive material so generated, how this material would airborne disperse and eventually deposit (fall-out). With this knowledge, JL reckons that it is possible to forecast the extent of radiation dose exposure to each of many individuals stationed at various locations who were undertaking various tasks in the instance, immediate, short and interim term aftermaths of the nuclear test detonations.

35 All of this JL claims would have been possible for a diverse range of atomic and thermonuclear nuclear test detonations[4] carried out at shallow ocean surface (essentially a ground burst), for tower mounted (virtual ground burst), balloon tethered, and aircraft delivered free-fall nuclear weapons detonated at different altitudes, of assorted designs and constructions, and producing a range of nuclear yields under different atmospheric conditions and applied over different terrains.

36 The SD *(para 20)* lists and subsequently selectively examples the precautions that the MoD claims to have been in place throughout each of the 21 atmospheric test detonations undertaken until the close of the British atmospheric programme in late 1958.[5]

4 *Atomic* or *A-bomb* involving only fission of the plutonium and/or uranium fissile core – *thermonuclear* or *H-Bomb* comprising second stage fusion of light elements (ie Hydrogen) triggered by the high energy obtained by a first stage fission device.

5 Although two further atmospheric tests were planned for Christmas (Kiritimati) Island these were abandoned in compliance with the *Moratorium of Atmospheric Testing* of October 1958. even so the UK co-operated and had services personnel present at the United States use of Christmas Island and its locality for 23/24 atmospheric nuclear explosions of 1962 under its operation *Dominic*.

37 **DOUBTS AND UNCERTAINTIES OVER THE MOD'S SD CLAIMS**

38 **Scope of the Matters Addressed by the SD**

39 The Master Particulars of Claim (PC – para 2) states quite clearly the contention that each Claimant was exposed to ionising radiations during the *'tests, trials, experiments and clean-up operations'* arising from the nuclear weapons testing programme on behalf of the British government.

40 The tests undertaken comprised 21 nuclear detonations, including tests conducted on the sea surface (within a ship), on the ground, from towers, slung from balloons and free dropped from aircraft at various locations in Australia and on and around a number of pacific islands – these are comprehensively listed in PC Appendix 1. In addition to the British nuclear test detonations, UK and commonwealth services personnel were involved in a series of *Minor Trials* undertaken on the Woomera Range and at and around Maralinga,[6] and in providing service facilities at Kiritimati (Christmas Island) for the United States *Dominic* atmospheric test series.[7]

41 In **TABLE A** I summarise the overseas components of the UK nuclear test and trials programmes that relate to this matter identifying those areas that have been directly addressed by the SD, statements of evidence and accompanying (discovered) documentation:

6 Maralinga, part of the *Woomera Prohibited Area* in South Australia where between 1955 and 1963 about 700 trials or field experiments involving fissile and other radioactive materials in the *Kittens*, *Tims*, *Rats* and *Vixen* series and the subsequent clean-up operations such as Brumby (1967) – these trials involve the low-energy release and dispersion of plutonium, uranium, beryllium, etc to determine, amongst other events, the contamination effects of an aviation accident with a nuclear weapon being subject to conventional high-explosive detonation and burning of the fissile core materials – the *Vixen B* fire trials involved the dispersion of about 22kg of plutonium of which about 2kg was subsequently recovered and accounted for..

7 Even though the UK chose to observe the *Moratorium of Atmospheric Testing* from 1958, the UK co-operated and had services personnel present at the United States use of Christmas Island and its locality for 23/24 atmospheric nuclear explosions of 1962 under its operation *Dominic* which was codenamed *Operation Brigadoon* by the MoD. In October 1963 the nuclear armed states agreed the *Treaty Banning Nuclear Weapons Test in the Atmosphere, in Outer Space and Underwater*.

TABLE A - TOPICS ADDRESSED BY THE SD AND ASSOCIATED STATEMENT & DOCUMENTS

CODENAME Nº ROUNDS	SD	SD APP 1 OVERVIEW	SD APP 2 RAD SAFETY	SD APP 3 RAD DOSE	SD APP 4 PROTECTION	SD APP 5 BRIEFINGS	SD APP 6 MONITORING	SD APP 6 AIRCRAFT	DISCOVERED DOCUMENTATION	JOHN LILLEY STATEMENT
HURRICANE 1	⊙	✓	✓	⊙	✓	✓	✓	✓	¤	✓
TOTEM 2	⊙	×	×⊙ §	⊙	×	×	×	×	¤	×
MOSAIC 2	⊙	✓	✓⊙ §	⊙	✓	✓	✓	✓	¤	✓
BUFFALO 4	⊙	✓	✓	⊙	✓	✓	✓	✓	¤	✓
GRAPPLE 3	⊙	×	×	⊙	×	×	×	×	¤	×
ANTLER 3	⊙	×	×	⊙	×	×	×	×	¤	×
GRAPPLE X 1	⊙	×	×	⊙	×	×	×	×	¤	×
GRAPPLE Y 1	⊙	×	×	⊙	×	×	×	×	¤	×
GRAPPLE Z 4	⊙	✓	✓	⊙	✓	✓	✓	✓	¤	✓
BRIGADOON DOMINIC 24	×	×	×	×	×	×	×	×	¤	×
KITTENS EMU RANGE	×	×	×	×	×	×	×	×	¤	×
TIMS	×	×	×	×	×	×	×	×	¤	×
RATS	×	×	×	×	×	×	×	×	¤	×
VIXEN	×	×	×	×	×	×	×	×	¤	×

Key:
⊙ Addressed in a general context.
✓ Specifically addressed in some aspect or other.
× Not referred to at all.
§ Applies to the Maralinga Range generally.
¤ The range and detail of the topics covered is not required at this stage for the Limitation Hearing.

42 **TABLE A** clearly shows that the MoD has failed to respond with any detail whatsoever to 10 of the 21 nuclear test detonations conducted by the British each of which is considered to involve one or more of the Claimants; there is no information whatsoever presented relating to the potential radiation exposure of UK and Commonwealth armed forces personnel providing services in support of the 24 atmospheric detonations conducted over and around Christmas Island by the United States; and there is nothing on the 700 or so *Minor Trails* codenamed *Kittens*, *Tims*, *Rats* and *Vixen*, many of which involved the deliberate dispersion of fissile materials (plutonium, enriched uranium).

43 In those cases where the MoD has responded (✓) the information provided is often incomplete and sometimes of little relevance to the Claim. In my evidence to the Strasbourg Court (see APPENDIX II - First Statement para 3.7 through to 3.14) I was critical of the limited release of essential information by the MoD.

44 Much the same applies to certain of the documentation provided in support of the SD with, in some instances, the same documentation being released with the unchanged redacted or withdrawn sections as for the Strasbourg case, and where other documentation is really little more than bumph of no direct relevance to the matter under consideration here.

45 Also, I note here that much of the documentation referred to in the *Schedule of Additional Documents*[8] is not included in the documents passed to me so, I assume, the Defence has yet to supply these.

46 More specifically in responding to this claim, whereas the MoD acknowledges that *'. . . the majority of the Claimant group allege participation in the Grapple group of tests at Malden and Christmas Islands . .'* (SD *para 54*), it provides virtually no information for *Grapple X* and *Grapple Y* other than the single, but somewhat subjective opinion of *para 55*.[9]

47 **IN SUMMARY: I am of the opinion that the MoD should provide further information and documentation in its defence of this Claim. In the absence of this withheld information and documentation, which must be reasonably accessible to the Ministry of Defence (MoD), there remains considerable doubt over the SD assertion that the levels of radiation to which the Claimants were exposed did not compromise their health.**

48 **John Lilley's (JL) Statement**

45 I have no major disagreement with the first forty of so introductory paragraphs of JL's statement although, with respect, the topics are covered somewhat text-bookish, not being really germane to the matter in hand.

46 **Prompt Radiation & Safety Distances**

47 As explained by JL, the first and immediate phase of potential radiation exposure derives from near instantaneous generation of neutrons and gamma rays during the nuclear detonation sequence, being termed prompt nuclear radiation.[10]

48 Whereas I accept JL's Table 1 (*para 51*) as a useful and general guide, it should be noted that these are for an air blast (atmospheric detonation) and that there seems to be no account of the

8 Schedule of Additional Documents Referred to in the Summary Defence and Appendices to the Summary Defence, 262854v2, undated.

9 Para 55 refers to the Grapple detonations ' . . . were high airbursts and the debris was mostly carried very high into the upper atmosphere to be slowly dispersed over great distances . . ' – my added emphasis.

10 In the process of a nuclear detonation in air about one-half of the initial energy in the form of X-rays is transformed, within a few milliseconds, into kinetic energy of the air molecules by interaction with the X-rays – the remaining energy escapes as thermal radiation or soft X-rays. The outward movement of the excited air molecules results in the formation of a pressure front and the blast wave, which receives further energy from the escaping nuclei and fission fragments with, all in all, the air blast accounting for about 50% of the yield energy, with 40% or thereabouts depending on the weapon design comprises thermal energy and the remaining 5% or so is stored in excited nuclei (essentially radioactivity)

atmospheric conditions. This is because the prompt radiation emitted during the 100 nanoseconds[11] or so of the nuclear detonation process will be more effective further in clear, crisp conditions than when the air humidity is high, that is with more neutrons and gamma rays (the source of the prompt radiation exposure) are absorbed by water vapour molecules in humid air.[12] Similarly, prompt radiation generated in and travelling from a ground or tower burst will travel less effectively than the pulse from an air burst because of absorption by ground surfaces, etc., and, particularly, the configuration of the burst resulting in a reduction factor of about x2 over an equivalent yield air burst.[13]

49 In referring to Table 1, JL states

> *". . . These distances are well within the typical safety distances applied in tests for both indoctrinees and the majority of veterans."*
>
> *[my added emphasis]*

thereby inferring that some of the veterans were positioned closer to Ground Zero[14] than the *'typical safety distances'* derived from Table 1.

50 This raises the need for further information in two respects:

1) a definition of the *'safety distances'* referred to by JL because there is nothing in the SD and its supporting documentation that establishes the *'safety distances'* from ground zero, rather the radiation controls were specified in terms of exposure units (ie Rems); and

2) those individual Claimants that may have been closer to ground zero than the *'safety distances'* need to be identified.

51 Similar ambiguities arise in JL's statement at *para 95* where he refers to the *'. . distance of most personnel . . .'* being positioned beyond the 10mSv prompt radiation exposure distance for *Buffalo* Rounds 3 and 4.

52 As shown in my **TABLE A**, JL omits to include *Grapple Y* in his summary of test explosions (JL *para 75*) which is odd in itself because this was, at approximately 3Mt yield, the largest of the British nuclear test detonations.

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11 1 nanosecond = one thousandth of a millionth of a second, ie 1nanosec =1.E-9 sec.

12 Immediately local to the nuclear detonation the prompt neutron radiation is very much greater than the gamma ray component, but with increasing distance and greater absorption of neutrons in air, the neutron-gamma ratio decreases with the neutron component becoming negligible.

13 That said, the modification or reduction in prompt neutron irradiation from a ground burst does not make that much of a significant difference and the lethal area remains about the same as that for an air burst which, for a 1Mt yield extends over an area of about 20km^2 or a circular ground footprint of 6km radius

14 There is some ambiguity in JL's distances as to whether these are *slant* or *ground* distances – for the higher altitude air bursts this could be significant.

53 As a rough-and-ready comparison with the *Level 2* distances of JL's Table 1 *(para 51)*, the distance at which an unshielded individual would receive prompt radiation exposure of 1,000mSv[15] is very approximately 3.8km from ground zero for the *Grapple Y* air burst as defined in yield and burst altitude by the MoD (but see para 70 following).

54 I am unable to make a similar comparison to JL tabulated summaries *(para 75 et seq)* because the basis for and the assumptions laid for his method of calculation are not stated. Indeed, he seems to entirely rely upon three references, one of which is a non-technical history text. It is not at all clear to me how JL cobbles together the information from these references to arrive at the 10mSv and 1mSv distances.

55 The calculation of the prompt radiation dose requires considerable knowledge of the weapon design, the prevailing atmospheric conditions, soil conditions and terrain, and of the human receptors themselves,[16] I am very reluctant indeed to accept JL's summarised distances at which the defining dose of 10mSv and 1mSv would have been received. This is particularly so because of the sensitivity of the numerical outcome such analysis when subject to relatively small changes in the contributory parameters (humidity, burst distances, weapon design, receptor shielding, etc).

56 **IN SUMMARY: The prompt radiation exposure of individual claimants could be, particularly for in-flight air crew and others positioned in the forward areas towards ground zero, a significant contribution to the overall dose of individuals being in addition to any subsequent exposure received from fall-out and ground/surface contamination.**

57 **Reliable calculation of this dose could only be completed by the MoD with its resources and detailed knowledge of the weapon designs, atmospheric and terrain conditions, positioning and shielding of the individual Claimants at the times of various test**

15 In terms of the energy being imparted during exposure, 1,000mSv or more properly 1 Gray is the assumed acute and lethal dose taken for comparison.

16 Neutron emission is classified as prompt and delayed. Prompt neutrons are produced while the weapon is still intact and able to sustain the fission process. Delayed neutrons originate from fission products produced during the fission process. The gamma rays stem from several sources including their production during fission, from reactions of the weapon neutrons in the air, ground and in the weapon itself prior to disassembly, and from fission product decay after disassembly. To carry out radiation transport calculations after detonations, it is necessary to have the angle and energy dependent distributions of the prompt neutron and gamma-ray leakage from the weapon. Other parameters needed for these calculations are height of burst and yield, and the compositions of the local environment including the air (density and humidity), ground surface composition including water content and other materials that may have been present at the time of the explosions that would further absorb or scatter the source radiation. Then knowledge of the temporal distribution of prompt and delayed neutrons, and the sources of primary (leaking from the weapon) and secondary (generated by interaction or activation of prompt neutrons with the air, ground, debris, etc., is also required in order to determine prompt and short term radiation exposure of individuals located at various distances from the burst.

detonations. It will be necessary for the MoD to undertake such an analysis if, as it claims, the prompt exposures are so low, both generally and individual specifically, and that all individuals were stationed within the appropriate *Safety Distance*.

58 **Radioactive Fall-Out**

59 So far, I have discussed the uncertainties in the assessment by JL and SD of the first and immediate phase of potential radiation exposure, that is prompt radiation that commences near-instantaneously at detonation and which will persist of an ever lessening magnitude for about one minute.

60 The second phase of potential radiation exposure derives from the presence of unstable (radioactive) substances, that arise from the i) the destabilisation of matter by neutron irradiation (ie from interaction with the neutron component of the prompt radiation) and ii) the natural radioactive decay of the fission product debris generated during the nuclear detonation and within the fireball. These two processes produce a complex inventory of radioactive substances of individual radioactive decay characteristics (radioactive half-lives) that may last from a few milli-seconds to years, tens, thousands and millions of years.

61 Moreover, in the form of gases and, particularly, tiny oxidised particles, these radioactive components of a nuclear detonation will bio-chemically interact with living matter, resulting in concentrations of (radio)activity in specific organs that will continue to generate radiation exposure (ie dose) in the human recipient until the radioactivity has naturally decayed and/or the body has purged itself the contaminant. Some radioactive components are systemic with the body unable to purge itself free of the contaminant – for example, the plutonium 'fuel' of a nuclear weapon, plutonium-239 of which only a small proportion actually fissions during detonation, is a systemic 'bone-seeker' (ie reconcentrating in by absorption into skeletal surfaces and, separately, reconcentration particularly in the liver) which has a radioactive half-life of about 24,400 years.

62 In describing the second-phase of potential radiation exposure, radioactive fall-out, JL confines his reasoning to the dispersion and eventual deposition mechanisms that apply, in the main, to air bursts at high altitude. Noting that with a high altitude air burst the fission product and other radioactive debris contains the minimum amount of contamination introduced by interaction with the ground, also that it is vaporised by the intensely hot fireball of the detonation, resulting in such small particle sizes that it is carried way and dispersed as far reaching global fall-out.

63 There are a number of shortcomings in JL's reasoning and approach to this.

64 First, there is one affect of an air burst than can result in precipitation front during the phase that the fireball is rapidly expanding, when the highly excited air molecules provide a compressed front that liberates its water vapour in the form of a short and sharp downfall of rain – I provide a brief explanation of this phenomena in para 4.71 of my Second Statement in the Strasburg case which is included in my **APPENDIX II**.

65 The formation of the ice fronts that give rise this precipitation can be seen on the video of the Grapple X detonation video.[17] At its formation the water vapour is receptive to attachment by certain of the highly volatised fission product fragments. The forming rain droplets then provide an efficient transport mechanism to bring certain normally self-buoyant radioactive particles generated by the nuclear detonation down to earth. This deposition mechanism can result in fall-out local to the periphery and beyond of the mushroom cloud that characterises a nuclear detonation.

66 Direct contact with this rainfall, or subsequent contact with surfaces contaminated by the rain, would introduce a further dose component to that individual.

67 Second, I find that JL glosses over the potential contribution of local fall-out to the individual's radiation exposure. This is particularly so for both the tests (explosions), of which 10 of the 21 detonations were either sea surface/ground bursts (*Hurricane* and *Buffalo 3*) or tower mounted, and the many trials (*Minor Trials* of *Kittens*, etc) involved releasing radioactive materials into the atmosphere at low altitude (by fire, localised conventional chemical explosion, etc).

68 In a ground or near-ground burst, much ground debris is sucked into the immediate area of the nuclear detonation, irradiated and vaporised to a degree resulting a much richer and more laden inventory of radioactivity being available for both local, regional and distant deposition as fall-out.

69 The uptake of terrain material can also occur in the process of an air burst with the material being drawn up through the stalk of the characteristic mushroom cloud. In these circumstances the sucked in ground debris comprises the top soil layer being rendered radioactive (referred to as *'ground induced'*) by prompt neutron irradiation at the instance of detonation, mixed together with the lower layers soil, etc., which have been shielded from prompt irradiation, but which become contaminated with fission product and other radioactive debris present in the decaying fireball. This mix of soil debris is not subject to the great heat of the initial fireball and, hence, its aerosolisation results in a generally courser distribution of larger-sized particles, these being

17 To view the video, go to www.largeassociates.com, choose *'Client Zones'* tab, enter *'CZ3169'*, click on the *CZ3169* entry in the Document Box and then on the *Grapple X* button – videos are taken from the Atomic Forum web site.

available for fairly rapid deposition much more locally than the fall-out of an air burst that does not have an inclusion ground debris.

70 There has been considerable doubt expressed about the amount of ground material uptake during the free-drop *Grapple Y* 3Mt detonation which may have detonated below its intended burst height – my revised burst height of 1,000 to 1,250m suggests that ground scavenging occurred. I refer to this in detail in para 4.43 et seq in my *Second Statement* in the Strasbourg Case of **APPENDIX II –** the violent disturbance and introduction of ground material into the *Grapple Y* stalk is quite clear from the *Grapple Y* video clip.[18]

71 Of course, fall-out and particularly localised fall-out results in ground and surface contamination. Thus and unlike the prompt radiation exposure phase which will last for less than one minute, unless the ground and surfaces are decontaminated then the potential for continuing *external* exposure from *'shine'* carries on so long as the contaminants remain radioactive (days, months, years, etc).

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18 Only relatively recently has the MoD confirmed the yield of Grapple Y from its design yield of 1.8Mt to actual yield of ~3Mt but there remains some uncertainty about the burst height of this aircraft dropped free-fall bomb. If provided with the time lapse photography of the fireball development in the first 100 milliseconds of its development then it is possible to determine both the yield and altitude of the burst.

For this, the equation derived from the motion of the shock wave given by G Taylor (Proc R Soc A201 159 1950) from the instance of detonation commencement to the breakaway point of the fireball is gives:

$$W = 2.05.E{+}7\ \rho_o\ r^5\ t^{-2}$$

where ρ_o is air density, r the fireball radius, t the time in milliseconds and W the yield in kilotons. This equation assumes a truly spherical fireball but this seldom occurs at low and medium altitudes because of the development of reflected shock waves.

To determine the yield W, time sequenced photography is examined to determine the point at relationship between fireball diameter and time which gives a $t^{2/5}$ characteristic for both fireball radius and height of the fireball centre. The breakaway point is determined visually at the point in time when the compressive air shock front separates and moves away from the fireball. I was provided with US-sourced time sequenced photography of Grapple Y (and some similar US altitude bursts for a contribution that I made to a TV documentary some years back, about the early or mid 1990s) from which a logarithmic relation of the developing *fireball diameter -v- time* is graphed from a time start point of about 5ms to avoid the preceding halation effects to the breakaway time, to which a best fit line is taken to represent $r^5\ t^{-2}$ with is extracted value being then substituted into the above equation to obtain the yield in kilotons.

Predicting the fireball height is similar but determining the resulting mushroom cloud height, width and particularly burst altitude is quite complex for which I referred to the empirical data given by J MacDougall (A general Formula for the Dependence of Medium Range Fallout on the Yield and Height of Burst of an Atomic Weapon, Theoretical Physics Note 45/56).

For *Grapple Y* my calculations show the strong possibility that before the breakaway point the developing fireball swept the ground or was sufficiently strong enough the intensely heat the ground surface because an ascending 'jet' was formed over the hot patch of ground - you can see this jet emerging up into the stalk in the video. This jet will carry with it ground debris (already (radio)activated by the prompt neutron irradiation) which is cooling and will form a subsidiary cloud as it mixes with ambient air trailing below the rising fireball generated main cloud - in fact the stem separates into two components, the lower section is virtually free of contamination, above which is the stem proper - the division of this, give or take some thermal modifications, also gives the approximate location of the burst altitude.

This burst height can also be determined by adaptation the empirical formula developed by O C Sutton (*Note on Entrainment and Maximum Height of an Atomic Cloud*, B Amer Met Soc V 31, 6 June 1950) where

$$r \approx 1.5Cx_b(1-n/2)$$

where x_b denotes the vertical height above the burst height, n is a stability parameter at $n=0.25$ for normal air turbulence conditions, and C is Sutton's generalised coefficient of turbulence.

The result of my analysis are given in para 17 of my *First Statement* for the Strasbourg case of **APPENDIX II**.

72 There is also the risk of biological uptake of the fine particles of contaminants, via food ingestion and, particularly, respiration of particles resuspended by disturbance by human activity, machinery, wind, etc.. This form of uptake, again potentially available over days, months, etc., following the detonation (and where the level and complexity of contaminants may accumulate over a series of tests or trials), could result in a significant *internal* exposure to specific organs, via the natural biological process of reconcentration.

73 **IN SUMMARY: The localised fall-out of radioactive contaminants, from ground and near-ground burst test detonations, quite possibly from the large ~3Mt *Grapple Y* detonation, and most certainly from the deliberate dispersion of radioactive (and other toxic materials) during the *Minor Trials* could have resulted in a significant component of localised fall-out radiation dose in addition to the prompt radiation exposure.**

74 **I am of the opinion that the potential contribution of localised fall-out exposure, both *external* and *internal*, should be subject to more analysis and greater detail of discovery.**

75 **Of particular concern is that if the presence of ground, etc., contamination existed to any extent (which I consider to be more likely than not) then services personnel would have required quite specific training to live and work in a radioactive contaminated environment, not just for a few days following each detonation or trial, but in the interim and longer terms so long as they remained in the potential contamination zones.**

76 **The radiological risks applied not only to land-based services personnel but, particularly in my view, to individuals stationed on naval ships, such as HMS *Diana*, involved in tracking and monitoring the fall-out plumes, and to members of the *Buffalo* (and other) *Indoctrinees Force* that, to my mind, were unnecessarily put at risk of exposure when taken into the Target Areas.**

77 **Experiments Involving Potential Radiation Exposure**

78 Whereas the SD presents an impression that every aspect of the nuclear tests and trials (where these are referred to – see Table A of para 41) was planned in meticulous detail and with certainty of outcome, there were clearly a number of tasks that were experimental and which involved a great deal of uncertainty of outcome.

79 The key point here is that I doubt very much that it would have been possible at the time to have achieved the claims of the SD, that is throughout the tests and trials generally to *'avoid or*

minimise the risk of radiation exposure' and. particularly, to maintain any exposure below *'permissible levels' (para 20)*.

80 This is because in general and by their very nature, the trials and tests were experimental in themselves, comprising many unknowns and determinations that could have only been made by, at least to some extent, trial and error.

81 This is very apparent in the smaller scale field trials and activities, especially those conducted in the immediate and short-term aftermaths of the test detonations.

82 For example, the MoD admits to this when referring to the experimental nature of the *Buffalo* indoctrinees *(para 20d)* with members of this group positioned between 1,700 to 2,700m from ground zero for the Round 2 shot of *Buffalo Marcoo* on the Maralinga Range.[19]

a My point here is that the information and data provided by the SD is insufficient to arrive at a determination of the most likely individual and group dose exposures for members of the Indoctrination Force (IF) that were, as admitted by the MoD, subjects of experimentation during the *Buffalo* series of tests.

b For this access is required to the Dose Registry for *Operation Buffalo* but these records, according to documents[20] referred to by the SD, remain restricted and unavailable.[21]

82 There are other examples of participants being subjects of or where they contributed to experiments:

83 **i) Totem Canberra Sortie**

84 For the first round of *Totem*[22] a Canberra aircraft flew into the developing edge of the cloud at about 6 minutes (but turned away from this run because of very high radiation levels) and again

19 The locations of this group of indoctrinees straddle the JL's rule-of-thumb 2,200m distance for a projected exposure from the nuclear detonation alone of 10mSv (JL – *para 92*) with the maximum actual dose receipt of one or more individuals being 20mSv *(para 96)*.

In fact, JL's maximum dose exposure of 20mSv does not tally with the Table 3 entry for the *Buffalo* series (SD, *Appendix 2*) of 400mSv and 52.7mSv (scientific and non-scientific personnel respectively). From this it appears that either JL is in error, or that the two high doses include an additional and significant element of exposure received when individuals toured the *'Target Response'* area *(para 49)*.[19]

In fact, both SD and JL are somewhat selective or, indeed, ambiguous about:

a) the further involvement of the indoctrinees in *Buffalo Kite* and *Breakaway* detonations (Rounds 3 and 4 respectively);[19]

b) the levels of (radio)activity on the ground, equipment and other surfaces from prompt neutron irradiation and deposition of fission products and (radio)activated particles from the debris of the weapons; and

c) the levels of ground contamination at and dispersed from the ground zero points for *Buffalo One Tree, Marcoo* and *Breakaway* which were all tower shots, that is virtual ground bursts with considerable quantities of ground debris being sucked into the zone of the fireball, irradiated and then dispersed over areas of the test range.

20 *Radiological Safety Assurance at UK Atmospheric Nuclear Trials*, AWE/HPK/C/REP/DHEG/NTV/9902,August 1999

21 The same inaccessibility applies to Operations Hurricane, Totem, Grapple, Antler, Grapple X, Grapple Z and Brigadoon.

22 15 October 1953 – *Totem* 1 Tower Shot, 10kt – see video at www.largeassociates.com

into the centre of the cloud at about 9 minutes following the detonation, with three further entry runs into the cloud thereafter. This experiment, codenamed *Operation Hot Box* was not part of the trial proper, nor part of the air-sampling or radiological survey programmes, but a separate experiment planned by the then Air Ministry to determine if aircrews and aircraft could reasonably operate in the aftermath of a nuclear weapon air burst.[23]

85 Each of the three aircrew was monitored by personal dosimetry, via quartz fibre dosimeter and film badges. The dose rates inside the cockpit when the aircraft flying the through the main region of the cloud at H+9 minutes peaked at about 20,000mSv per hour with the fly through taking 9.2 seconds and, in total four similar runs were made through the cloud. The personal dosimeter recorded dose exposures for the entire sortie was 190, 210 and 180mSv for the group leader, pilot and navigator respectively, although the recorded doses were entered from the film badges at about one-half the dosimeter levels no explanation was given for the large discrepancy and why the lower series of doses were adopted for the record.

86 Of interest here is that there is no reference in the sortie preparation procedure to the preset radiation protocol or dose limitation system in place for *Totem*, and that there was no prior attempt to forecast the likely levels of exposure for the planned incursion of the aircraft into the developing radioactive cloud.

87 **ii) Buffalo Indoctrinees Force Clothing Trial**

88 SD Appendix 1 (*para 32*) refers to the *Clothing Trials* in which 18 IF and 6 members of the War Officer User Trial Team combined to undertake what might be best described as *Monty Pythoness* activities, dressed as they were in a variety of garb, some with hand towels wrapped around their head, and each donning one of two different types of respirator (gas mask).

89 Divided into three groups, these men either were driven to and fro in an open topped lorry dragging sacks behind it; another group marched over the same two mile course with the same lorry passing frequently by them; and the third group marched across country, brushing against trees, deliberately stirring up dust and crawling through the undergrowth for about 100 yards.

90 All of these activities were undertaken in an area of land known to have been contaminated to a dose rate level of 1 to 10mSv per hour from fall-out 3 days earlier of the firing of the *Buffalo* Round 1. Quite obviously, the deliberate raising of dusts (dragging sacks behind the lorry) was

23 Wilson D A, *Canberra Flight Report*, AWRE, April 1954

intended to resuspend contaminant particulate on the ground, and the physical activity of marching two of the groups across contaminated terrain would have increased the respiratory rate to establish the efficiency (and any weaknesses) of the two different types of respiratory mask issued for the experiment.

91 At completion of this activity, each individual's film badge was removed for processing and there seems to have been no attempt whatsoever (SD *Appendix 1 para 35*) to establish if any of the individuals had taken in, by respiration, skin cuts, etc., radioactive contaminants for subsequent bio-transfer to internal organs.[24]

92 I can only describe these activities as breathtakingly brash experimentation in order to compare different clothing and respirators under simulated field conditions in a radiological environment.

93 **iii) Buffalo Indoctrinees Force Decontamination Trial**

94 Also reported,[25] a *Buffalo* field trial to determine the operational effectiveness of managing large numbers of personnel through an in-theatre erected decontamination facility.

95 For this 250 members of the IF were decontaminated following their passing through contaminated areas during one and two days following the firing of *Buffalo* Round 1 – the decontamination and showering facilities were erected with materials and resources that were likely to be available in or nearby a real in-theatre of operations situation (eg modified oil drums for shower tanks, canvas screens, soakaway pits to receive contaminated shower water, and so on).

96 In other words, the 250 IF members were denied the superior decontamination and showering facilities available at the Maralinga base camp. Moreover, their role was confined to that of passing through the crude, in-theatre decontamination facility and they had no part in its design, erection or operation so, in these respects, their involvement in this crude method of decontamination would not have given them *(para 47) '. . . experience firsthand of the effects of atomic weapons . . . in order to educate other members of the armed forces. . .'*.

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24 This subject and these and other trials and experiments at *Hurricane, Totem* and *Buffalo* continued to attract interest when in 1960 the topic was further reviewed –Stewart K *On the Resuspension in the Atmosphere of Radioactive and other Fine Particulate Material Deposited on the Ground,* AWRE Report No T 10/60, which itself refers to contemporaneous reports of Carter P A, *The Dust Hazard During Operation Totem*, AWRE Report No T1/56, and Chamberlain et al, *The Hazard from Inhaled Fission Products in Rescue Operations after and Atomic Bomb Explosion,* AERE Report HP/R737 – all three of these reports have not been made available by the Defence and are taken from my own private collection.

25 Janisch RD B B et al *The Construction and Operation of a Field Radiological Decontamination Centre,* AWRE Report No T1/57 July 1957 – not made available to the Claimants but from my own private collection.

97 I find this use of such a large number of the IF force to be contrary to the SD claim *(para 47-48)* that *'. . . it was not the purpose to . . . in any way "experiment" biologically on the indoctrinees or otherwise to observe or test what happened when an individual was irradiated. . .'.*

98 **iv) Operation Hurricane Human Experiments**

99 There is reference to individuals and groups of individuals were somewhat casually, or perhaps intentionally, placed in radiological environment for experimental purposes during *Operation Hurricane*.

100 In a summary report entitled *Biological Experiments*[26] there is somewhat guarded[27] reference to the contamination of groups of individuals:

> *". . . At various times, men entered the radioactive areas without respirators and it was possible to find traces of radioactivity in their urine within a few days. In an experiment designed to utilize a situation which arose fortuitously, it was possible to secure convincing evidence that such radioactivity in urine had been due to the inhalation of fission products, rather than by other routes of entry. These, and other, results indicated that respirators were effective barriers against the inhalation of fission products from this atomic weapon . . ."*

101 **IN SUMMARY: For all of these experiments involving dose exposure to individuals and groups of men, there is no contemporaneous evidence that a pre-experiment assessment was made of the radiation dose exposure anticipated for the particular activity planned. I have studied the documentation provided with the SD and, together with my past reading of many AWRE reports drawn from my own private collection; I cannot recall ever noting a realistic pre-assessment of exposure having been made.**

102 **In this respect, I consider the experiments to have been blind, that is the radiological outcome was unknown and uncertain, so much so that the participants must have been**

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26 Butterfield W J H, *Summary Report on Biological Experiments*, AWRE Report No T44/54 August 1954 – not made available to the Claimants but from my own private collection.

27 *'guarded'* because the Butterfield report cites not references whatsoever which is quite exceptional for AWRE reports. However, I recall another Butterfield AWRE report referring to two groups, each of 20 or so men, that entered a contaminated zone with the individuals of one group with no respiratory protection and a second group, of the same number, who quite fortuitously were equipped with respiratory protection thus, or so it would seem, providing a comparative or control group. That said, it would take me some time and effort to sift through the reports that I have to locate this specific reference.

placed at some risk of overexposure and the dose received could not have been planned to be as low as reasonably practicable (ALARP).

103 **I believe that these examples illustrate the radiological role and, perhaps, personal detriment that the Claimants played, maybe unwittingly, when participating in Britain's acquisition of nuclear weapons.**

JOHN H LARGE
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20 November 2008

APPENDIX I

EXPERIENCE IN THE ASPECTS DEALT WITH BY THIS PRELIMINARY EVIDENCE

1 Here I set down examples of my past and recent experience with nuclear weaponry and radiation dose exposure, particularly:

a) From 1986 through to the early 1990s I was retained by the National Fire Brigades Union (NFU) to advise on the expected and tolerable levels of radiation exposure to firefighters attending emergency incidents at nuclear facilities, such as nuclear power plants, and in transportation accidents involving nuclear materials including nuclear warheads.[28] On behalf of the FBU I negotiated directly with HM Home Office and secured the National Agreement on Emergency Incident Dose Levels – this nationally agreed dose limitation system applies to all male and female firefighters attending incidents involving radioactivity and/or nuclear materials.

b) In 1992 I joined the Rubin-Novgorod Working Group of the then Soviet Union charged to investigate and make recommendations relating to the physical state and potential dispersion of the fissile material cores (plutonium and uranium) of the two nuclear weapon torpedo rounds lost with the sinking of the *Mike* Class nuclear powered submarine *Komsomolets* (K-278) lost in the Barents Sea in 1989.[29,30]

c) In the mid-1990s I confidentially advised a UK gas supplier on the radiological condition and stability of the underground nuclear test caverns adapted for the storage of gas drawn from the West Kazakhstan gas fields – the utility was then in negotiation to bulk purchase gas supplies from Kazakhstan.

d) In 1995 I was retained by the Rochester City Council to negotiate on behalf of 1,200 or so Chatham Naval Dockyard employees who had been involved in the refit and refuelling programme for the Royal Navy flotilla of nuclear powered submarines – the Royal Dockyard had ceased nuclear operations in the mid-1980s but, and as the years progressed, there was increasing concern in the ageing ex-employee group on the incidence cancers possibly linked to occupational radiation exposure. My role included examination and analysis of the MoD

28 Large J H, Matthews O, *Emergency Response Planning for a Nuclear Weapons Accident, Emergency Planning* '91 International Conference, Lancaster University, 8 to 11 September 1991 proc, Int Conf, 8 Sep 1991, 04]

29 Large J H, *Accident Hazards on Nuclear-Powered Surface Ships - Fire and Sinkings -Radiological Consequences*, Symp Env and Safety Aspects of Maritime operations in the Arctic, on board Soviet Icebreaker Vajgatsj, Norway, 4 September 1990 - RL1945

30 Large J H, *Hazards of Nuclear-Powered Vessels, Fires and Sinkings, Radiological Consequences* - Atomic Energy on Sea Safety and Ecology, International Scientific Seminar of the USSR NS, Murmansk, USSR, 24-28 September 1990

radiation records, the systems under which these had been collected and collated, and the establishment in conjunction with the MoD of a counselling service.[31]

e) Throughout 2001 I was charged with the task of establishing and heading up a team of experts to assess the nuclear related risks and hazards likely to encountered and which had then to be overcome during the salvage of the Russian Federation Northern Fleet nuclear powered and armed submarine *Kursk* (K-141) which was lost with all hands in August 2000. My involvement, which was agreed with and part-funded by the Russian Federation authorities, involved assessment of the reactor and weaponry hazards throughout the salvage operations of 2001 – I was awarded a commemorative medal by the Russian authorities for my contribution to this world-first, successful recovery of a sunken nuclear submarine.[32]

f) In 2003 I was commissioned by Greenpeace International to direct the radiological and investigative aspects of a campaign relating to the deteriorating radiological situation at and around the Tuwaitha Nuclear Centre in Iraq. At that time, in the period following the occupation of Iraq by allied forces, considerable concern was mounting about the contamination of civilians from leakages and looting of the site. My work involved preparing the Greenpeace campaign team in radiological protection measures, establishing working limits of exposure and dose uptake for all individuals involved and, then for the campaign itself, analysis of video footage, collected dusts and other materials, and urine samples from a cross section of the local population.[33]

g) I presented a lecture to the Emirates Centre for Strategic Studies & Research (ECSSR) in Abu Dhabi n November 2006 on the potential for development of nuclear weapons technology in neighbouring Iran.[34] I am returning to present a second lecture on the subject of nuclear weaponry to the ECSSR in November 2008.

2 More generally relating to this current matter, I have published on the risks and hazards of the transportation of nuclear weapons in the UK dealing extensively with the release contamination and potential for dose uptake of the nuclear weapon fissile pit materials;[35] I have visited a number of sites

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31 Large & Associates, *Radiation Dose Receipt of Chatham Royal Dockyard Employees*, Rochester City Council, RL2083-A1, June 1995

32 *The Recovery of the Russian Federation Nuclear Powered Submarine Kursk*, Society of Naval Architects and Marine Engineers, World Maritime Technology Conference, Int Conf, Sans Francisco, October 2003 -http://www.largeassociates.com/kurskpaper.pdf

33 Large J H, Video and Other Material and Data Acquired by Greenpeace International at and Around the Iraq Tuwaitha Nuclear Centre site during 2003, Greenpeace International. December 2006 - http://www.largeassociates.com/3099%20Iraq%20Sampling/r3099-a2.pdf

34 *Potential Development of Nuclear Weapons Technology in Iran*, Illustrated Lecture, Emirates Center of Strategic Studies and Research, Abu Dhabi, 13 December 2006 - http://www.largeassociates.com/3158%20ECSSR/R3158-final.pdf

35 *Transportation of Nuclear Weapons through Urban Areas in the United Kingdom,* C1 *Absract & Summary*, November 1990 - Reissued March 2008 - http://www.largeassociates.com/1875%20Nuclear%20Weapon%20Transportation/RL1875-Ch1%20Abst-Summary.pdf

where atmospheric and underground tests have been undertaken, particularly Semipalatinsk in Kazakhstan and Novaya Zemlya in North Russian; and I completed an extensive study in 2006 of the continuing development of the radioactive contamination systems of the 1986 Chernobyl accident in the Ukraine; [36] and I have undertaken a number of analyses and assessments involving the mathematical modelling of radioactive contaminants ejected to atmosphere in the aftermath of relatively (hypothetical) high energy events at nuclear facilities.[37]

3 I consider myself to be sufficiently experienced and practised in the topics upon which I called to provide expert opinion,

36 Large J H, *Chernobyl - A Nuclear Catastrophe 20 Years On*, April 2006, Int Conf Chernobyl +20, Kiev 22-24 April 2006 - http://www.largeassociates.com/3143%20Chernobyl/R3143-A3%2022%20April%202006.pdf

37 Large J H, *Assessments of the Radiological Consequences of Releases from Existing and Proposed French EPR/PWR Nuclear Power Plants,* February 2007 - http://www.largeassociates.com/3150%20Flamanville/r3150-final-1.pdf

APPENDIX II

EVIDENCE FOR *CASE OF McGINLEY AND EGAN V UNITED KINGDOM* - 10/1997/794/995-996

FIRST STATEMENT OF JOHN HENRY LARGE

1 Qualifications and Experience

2 I am a Chartered Engineer, Fellow of the Institution of Mechanical Engineers, Graduate Member of the Institution Civil Engineers, Member of the British Nuclear Engineering Society, and Fellow of the Royal Society of Arts.

3 From the mid-1960s through to the mid-1980s I was a full-time member of the academic staff of Brunel University (London), throughout which I undertook research on behalf of the United Kingdom Atomic Energy Authority on nuclear reactor systems and other nuclear devices.

4 Since 1986 I have headed the firm of Consulting Engineers, Large & Associates. In this capacity and relating to civil and military nuclear technology, I have given evidence to the House of Commons Environment and Energy Committees, and at several Public Inquiries in the United Kingdom, including a Public Inquiry into the operation of the United Kingdom's nuclear weapon procurement facility at Aldermaston. In much the same military-nuclear topics, I have advised a number of overseas governments, including Japan, Italy, South Africa, Bulgaria and the Russian Federation, and state and county authorities in Australia, New Zealand and the United States.

5 Relating specifically to the testing and detonation of nuclear weapons, I have visited a number of nuclear weapons test ranges, where nuclear weapons have been test detonated, in the territories of the former Soviet Union (Novaya Zemlya, Semipalatinsk, Orenburg and Chapayevo) and I have undertaken analysis and calculations relating to the radiation, thermal and blast effects of atmospheric and underground detonations at these sites, including (for the longer term) radiation dose implications for nearby groups of population. I have also completed a substantial study, for 40 (UK) metropolitan, local and county public authorities, on the transportation of nuclear weapon assemblies between the points of manufacture and refurbishment and the sites of deployment - this study included the analysis and prediction of the consequences of nuclear weapon(s) involved in severely damaging transportation accidents, including for a partial detonation of the device and the release of airborne plutonium and fission products.

6 Presently, and for the last three years, I have been retained by City Corporation of Rochester-upon-Medway (UK) to advise on its involvement in the HMG Ministry of Defence's Counselling and Health Screening programme of former Chatham Dockyard employees who were exposed to radiation during refitting and refuelling operations of nuclear-powered submarines until closure of the dockyard in 1983. For the group comprising 4,000 individuals, it has been necessary to 'reconstruct' the radiation dose of a number of

individuals whose records have been lost or mislaid since the dockyard commenced operations in 1966. Although the source of the radiation dose exposure of the Chatham group is quite different, there are a number of similarities to the British Nuclear Test Veterans group, particularly in the reconstruction of the radiation dose.

7 In account of my long term, full time research into nuclear topics at university and my subsequent career involvement in nuclear topics, I consider myself sufficiently experienced and qualified to give opinion in this matter.

8 Instructions

9 I have been requested to address the question of the risk of radiation exposure to services personnel stationed on Christmas Island during the Grapple Y atmospheric test detonation of 28 April, 1958.

10 For this I need, first, the determine the explosive yield and detonation height of Grapple Y - this requires a combination of physics and thermodynamics - then I have to assess whether these conditions resulted in interactions between the nuclear fireball and the ground - essentially, some basic chemistry and gas dynamics - and then, if ground material was scavenged and consumed by the fireball, when, how and where this now radioactive material would descend to and deposit onto the ground surfaces - by chemistry and deposition theory.

11 Previous Analysis

12 Just over six years ago, I was engaged by another Client to analyse the Grapple Y detonation in terms of the explosive yield and height of the initial detonation. For this, the Client provided a bundle of confidential documents relating to the Grapple Y detonation and post-detonation sequence.

13 At the time I considered all of these to be genuine and contemporary documents relating to the Grapple Series of atmospheric test explosions. Certain documents, particularly about six sequentially exposed and timed photographs of the developing detonation (mushroom) cloud and a sketch note of the bomb drop aircraft's launch trajectory, related specifically to the *Grapple Y* detonation of 28 April 1958. Included within the documents there was a confidential paper relating the barometric and impact fusing devices incorporated in nuclear weapons, although this did not relate specifically to Grapple Y or the Grapple series, it seemed to be a contemporary design of the devices likely to have been incorporated in nuclear weapons of this period.

14 I have a copy of my original analysis but, following the completion of my work, I returned the photographs and documents to the Client.

15 In the main, my previous analysis aimed at determining the *i)* yield of the Grapple Y explosion; *ii)* the height at which the initial nuclear sequencing commenced; and attempted some, what I describe as, *rough-and-ready* determinations of the *iii)* amount of ground debris swept up into and consumed (irradiated) by the nuclear fireball of the detonation cloud.

16 From the series of timed, sequential photographs, I was able to determine what is called the *break-away* diameter. The development, size and delayed visibility of the fireball to the *break-away* point are determined by a number of established relationships,[38] from which the explosive yield is available. Given this, it is possible to scale the successive photographs of the mushroom cloud, in terms of both cloud diameter, plume rise height and stalk diameter and, importantly, so far as detonation height, the development of striated rings in the stalk. I checked these observations and deductions by comparison with a series of photographs of US nuclear atmospheric test detonations for which the yield and detonation height is published.

17 My findings were that the Grapple Y detonation was an air blast of about *i)* 2.8 Megaton (million tonnes equivalent TNT), the initial detonation centre height was about 1,000 to 1,250m above ground datum, and that the *ii)* mushroom cloud expanded over a period of about 10 minutes to a steady state (diametrical) size and height (top of cloud) of 30,000m and 27,000m respectively. Referring back to the break-away diameter of ~1,900m diameter and my observations of the mushroom stalk development, I concluded that *iii)* a substantial mass of ground debris (or if sited over the sea, seawater and sands, coral etc., of the shallow lagoon) would have been scavenged by, swept into and subject to intense irradiation within the nuclear-active stages of the fireball and, hence, the risk of localised and longer-range fall-out of radioactive fission and (radio)activated products would have been high.

18 I also analysed the projected trajectory of the bomb-drop aircraft, examining into three possibilities of *a)* the aircrew misjudging the roughly parabolic approach to the bomb release point; with the correct approach, *b)* within-tolerance variations of the barometric fuse triggering, and *c)* a combination of *a)* and *b)* together. My analysis of *Case c)* resulted in a much lower initial detonation height (by about 1,250m) and the detonation location being closer to the occupied parts of the island by at least 600m.

19 The aircraft-bomb release trajectory calculations of about 1,500m correspond to the detonation height that I determined quite independently from the break-away diameter and sequential photographs.

20 Finally, I calculated the extent of the break-away fireball and its effects on the extent of ground debris collection for *a)* a then (1958) planned yield of 1.8 Megaton and the intended height of 3,700m (both of which have been cited in the past for Grapple Y); *b)* at 1.8 Megaton at my calculated detonation height of 1,500m; and *c)* at 3 Megaton at the now published official detonation height of 2,500m (NRPB). For *a)* the ground debris uptake effect (which gives rise to localised radioactive fallout and radioactive dose) is absolutely minimal; and for both Cases *b)* and *c)* the ground debris effect is marginal.

38 In the initial detonation stage the air surrounding the nuclear sequence is incandescently hot, so much so that it absorbs all visible light. In effect, an observer sees the instant flash of the very first stage of nuclear detonation, but thereafter the developing fireball is invisible only becoming visible again when the air surrounding the developing fireball has cooled sufficiently to allow visible light to escape. The timing and, particularly the size of the fireball at the instance of re-visibility, follows quite precise physical laws so it is possible to calculate the explosive yield from the observed conditions at the break-away point. The fireball growth involves two pulses of energy - first a prompt pulse of about 1% of the total energy, and a second that peaks at about 1 second after the detonation initiation and lasts for about 10 seconds - these two pulses determine the development of the fireball to break-away and, hence, the relationship with fireball size and weapon yield, of which about one-third is dissipated as thermal energy.

21 I then applied my estimated yield of 2.8 Megaton at my calculated detonation height of 1,500m, these circumstances, Case *d)*, shows that the active fireball would have scavenged and carried aloft a substantial mass of ground or sea bed debris

22 Mechanism and Processes of Radioactive Fall-Out from a Nuclear Detonation

23 Essentially, there are three phases of radiation dose exposure to be considered during, in the immediate aftermath and following in the shorter and longer terms, that arise from a nuclear weapon detonation.

24 During the initial nuclear sequence an abundance of prompt neutrons radiate from the fire ball - for Grapple Y the lethal area under the detonation would have overshadowed an area of about 12 square miles (a circular area of about 4 miles diameter) - obviously, no services personnel were stationed in this prompt neutron lethal dose area.[39] Also, the land surfaces in this area become highly radioactive because the emitted high energy neutrons irradiate ground substances producing short life radio-isotopes and, although the radioactive decay is rapid, individuals entering this area (to retrieve equipment, etc.,) even for short times post-detonation would have received a substantial radioactive dose.

25 The second phase of radiation dose exposure is more complex. Of all of the energy created during the nuclear detonation about 10% is stored in unstable or radioactive nuclei - each nuclei sheds gamma and/or beta radiation and, according to its particular nuclei species, its return to a stable, unexcited condition might occupy a few seconds to millions of years.

26 Now if the weapon explodes high enough above the ground these radioactive nuclei are carried aloft by the thermal plume (and the nuclei are self heating, many to the degree that they are self buoyant) into the jet stream to disperse in the higher atmosphere before eventually return to earth distributed as a global fall-out. Thus, in this situation the fall-out is very widely dispersed but the deposition unit area (radio)activity is very low.

27 However, a very different situation arises if the weapon detonates at a sufficiently low enough altitude to the extent that the fissioning and fusioning fireball vaporises ground debris - as in my Case *d*). In this situation, vaporised ground debris is carried aloft, together with the radioactive nuclei. As the fireball cools, the vaporised debris condenses back to solid or liquid forms, dropping back to the surface as small particles of dust, mists and/or precipitation. About 50% to 70% of the excited nuclei attach to these dust and liquid particles and return as radioactive fall-out in large concentrations in less than one day following the detonation.

28 Since atmospheric and meteorological conditions vary considerably (and indeed may be substantially modified by the nuclear explosion itself), the locality, pattern and extent of this distribution will vary considerably with the prevailing conditions.

39 Most services personnel were positioned about 20 miles from the point of detonation, although some forward observers are believed to have been at 17 miles.

29 So, there is a clear distinction between the radiological consequences arising from the post-detonation phase for a nuclear weapon that has detonated at altitude sufficiently high for ground debris **not** to be drawn into the fireball, and a detonation closer to the ground surface where substantial volumes of ground debris will be vaporised and drawn into the fireball.

30 In the first case, ground contamination is very localised (under the point of detonation) and comprises short-lived (radio)activated products. In these circumstances, it is possible to position individuals quite close to the centre of detonation (say, at distances greater than 15 miles) without any significant radiation dose being experienced by those individuals.[40]

31 For the second case, *d)*, where the detonation height is lower, when the fireball has scavenged the earth surface and drawn vaporised debris into the developing mushroom cloud, the localised fall-out will comprise largish particles of ground debris, in themselves (radio)activated, to which are attached radioactive fission products and which are, generally, very long-lived. In these circumstances, it is not realistic to position individuals close to the centre of detonation since, during the aftermath, for one or two days, highly contaminated fall-out would descend at the dictate of wind and weather.

32 The footprint of radioactive deposition from a low-altitude burst could extend very significant distances indeed. For example, the extreme case is where the weapon is detonated on the surface of the ground - a 1 Megaton yield will excavate and vaporise a crater in wet soil of about 500m diameter and 80m deep (say, ~1.5 million tonnes of soil), and the subsequent deposition might be expected to lay down a blanket covering of about two-thirds of total airborne radioactivity over a cigar-shaped area extending up to 200 miles or more from the detonation point. Radiation levels within this footprint can be very high, with immediate dose rates of 10 rads/hour in the first 50 mile zone, decaying to 1 to 3 rads/hour over the period of one week.

33 The point here is that the Grapple series of atmospheric tests, including the Grapple Y detonation, were planned to be atmospheric detonations with resulting, as for my first case, insignificant levels of localised ground contamination from fall-out. If the yield and height of the detonations could be assured then, it might be argued, it was perfectly reasonable, in radiological dose exposure terms, to station services personnel within 20 or so miles of the point of detonation.

34 If, however, as my observations and calculations show, the Grapple Y detonation point was at lower altitude (but, of course, not as extreme as the ground burst example I give above) then significant levels of ground contamination could have arisen in the hours and few days immediately following the detonation. If the wind conditions then prevailing resulted in deposition over the occupied areas of Christmas Island, then services personnel on this small island could not be relocated to uncontaminated areas (generally, they were positioned at the head of the island furthest from the detonation point), nor would it had been practicable to evacuate them off the island.

40 At these distances it is necessary to provide protection against retina burn by individual looking directly at the point of detonation and, depending on the ground terrain, against air blast, thermal radiation and seismic aftershocks.

35 Relating the Grapple Y Detonation Yield, Height and Location to Services Personnel Radiation Dose Exposure

36 In the previous section of this Statement, I have gone to some length to explain the mechanisms and processes, and the variables that strongly influence these, which give rise to radioactive fall-out from a nuclear detonation.

37 Whereas I am able to assess the yield of Grapple Y, height of detonation, and subsequent development of the radioactive mushroom cloud from the documents and photographs available with some degree of reliably, I cannot determine with the same degree of reliability the extent of radiation exposure of the services personnel located nearby. This is because I cannot model the local meteorological conditions (and the very localised conditions caused by the detonation itself),[41] nor is there sufficient data available on the ground and sea bed structures available for Christmas Island - both of these considerations would determine the extent and locality of the radioactive fall-out from the detonation, and hence the radiation dose exposure to services personnel in the area.

38 However, I am of the opinion that if, as I have deduced, the Grapple Y yield was at about 3 Megaton at a detonation height of about 1,500m, there is a reasonable to high probability that the detonation would have been followed by relatively high concentrations of radioactive fall-out. This fall-out deposition would be expected, in all probability, to blanket surface areas with significant levels of radioactivity for distances of 50 to 100 miles (or thereabouts) from the detonation point and, given unfavourable wind and weather conditions, this fall-out or remnants of the fall-out cloud could have deposited on occupied areas of Christmas Island.

39 In other words, I am of the opinion that there was a substantial risk of radiation dose exposure to those services personnel stationed on Christmas Island at the time and for days (and weeks) following the detonation of Grapple Y.

40 **RECONSTRUCTION OF THE RADIATION DOSE EXPOSURE**

41 My understanding is that most, if not all, of the services personnel stationed on Christmas Island were <u>not</u> issued with personal dosimetry (essentially, a film badge capsule). Thus, there are no records of the radiation dose received by these unmonitored individuals.

42 There are two means by which the dose exposure of these individuals could be reconstructed: Either, reference could be made to the individual and collective doses of AWRE (the Atomic Weapons Research Establishment) personnel who were film badge monitored and on the island at the time, and/or the *'on-the-ground'* radiological regime on Christmas Island for the period immediately following the Grapple Y

41 In the past and unconnected to this instruction, I have read and listened to the largely anecdotal recollections of individuals stationed on Christmas Island. These recollections include reference to a sharp downpour of rain at about 10 minutes following the detonation, this would correspond to melting and precipitation of the ice-fronts that form ahead of the violently compressing air wave forward of the fire-ball; and the strength and timing of the air blast and seismic ground waves which, considered together, provide a measure of the distance of the individual from the point of detonation. However, since these must be considered largely anecdotal, I have not taken account of such in my analysis.

detonation could be used as a basis for the dose reconstruction (using much the same techniques as I have applied to the Chatham nuclear-powered submarine work force that I referred to earlier).

43 For this latter option, HMG Ministry of Defence will retain on file technical, scientific analysis reports for the planning, detonation and post-detonation phases of the Grapple series of atmospheric nuclear tests - full details of the Grapple Y detonation will be included in this series of reports and analysis. Collectively, these reports contain sufficient information and data for a technician, such as myself, to assess and provide a reliable measure of the radiation dose exposure of representative services personnel stationed on the Island at the time of Grapple Y.

44 My statement of the preceding paragraph is made with certainty. This is because I have in my possession copies of scientific and technical reports relating the series of ground (tower mounted) and atmospheric nuclear tests conducted by the United Kingdom on and off the mainland of Australia during the mid to late 1950s - it was these tests, Hurricane, Antler, Totem, etc., that preceded the move of the principal test site to Christmas Island for the thermonuclear Grapple series in 1958. I obtained these copies via another Client for analysis and projection of the terrestrial environmental effects of the Australian test series - for this test series alone there about 400 individual reports occupying a shelf space of about 2.5m length.

45 Put simply, if I was asked to analyse and assess the radiation dose of services personnel stationed in proximity to these earlier Australian tests, then I could do so with a high degree of confidence and certainty.

46 Likewise, I could do much the same for those services personnel stationed on Christmas Island during the Grapple series if, that is, I had access to the Grapple series reports.

47 Thus, I consider that HMG Ministry of Defence should make available the relevant records and reports relating to the Grapple series of atmospheric nuclear tests so that an independent assessment of services personnel dose exposure may be undertaken.

48 Finally, I note that the limited publication of the Grapple series scientific and technical reports in the specific topic areas that I have identified would not, for reasons that nuclear weapons technology has advanced so much since the 1950s, infringe the national security of the United Kingdom, nor would it assist any terrorist or sub-national group in the construction of such a device.

JOHN H LARGE
The Gatehouse
Woolwich, London SE18 4BQ
20 November 2008

SECOND STATEMENT OF JOHN HENRY LARGE

1 QUALIFICATIONS AND EXPERIENCE

1.1 I have given my qualifications and experience in my First Statement, dated 21, September 1997.

2 INSTRUCTIONS

2.1 I received further instructions from Mr Ian Anderson, representing the Applicants on 29 October 1997.

2.2 I have been provided with a series of documents which I am informed are true copies of the references cited in the (unofficial) AWE 16/93 report *'Environmental Monitoring at Christmas Island 1957-1958'*, October 1993 and the Sharp and Muirhead report *'McGinley and Egan v UK and LCB v UK Epidemiological Information for UK Submission'* of September 1997. I also have a part copy of the statement by Martin Eaton (Agent for the UK Government) of 2 October 1997.

2.3 My instructions are to analyse and comment on *i)* the AWE October 1993 16/93 report references and how these might relate to *ii)* the Sharp and Muirhead report.

3 SUMMARY

3.1 Since this is a somewhat lengthy Statement it might be convenient to the Court for me to summarise my findings here.

Recording of the Applicants' Radiation Dose Exposure

3.2 First, I examine Mr Eaton's claim (his para 1.86) that because of experience gained in the previous nuclear tests, it was not necessary to issue the Applicants with radiation monitoring film badges for the Grapple Y and Z tests, because their individual radiation dose exposure would have been and was zero.

3.3 I find there to be nothing in the UK Government's submission (the Annexes) that substantiates this claim. Indeed, analysis of the UK Government's own published figures (previously available NRPB-R226) shows that the practice of issuing so few film badges to the test participants was bound to lead to a number of unmonitored individuals receiving unrecorded radiation dose.

Application and Sufficiency of the UK Government Annexes

3.4 The UK Government has submitted a series of Annexes which it purports shows that the Applicants' would not have received any measurable radiation dose from the Grapple Y and Z test series. The Annexes have been supplied in support of the AWE 16/93 report claim that the radiation levels at Christmas Island did not constitute a hazard or danger to the test participants (the Applicants).

3.5 None of the documents submitted apply to the circumstances of Applicant Egan who was on board *HMS Ulysses* at the time of the Grapple Y detonation and who was not in attendance for the following Grapple Z series of tests.

3.6 My review of the UK Government Annexes shows that:

3.7 i) Whereas I understood that all of the pertinence references cited in AWE 16/93 were to be released to the Court, the UK Government has released only the first 5 references. References [10], [11], [12], [13] and [14] have not been released and remain unavailable, yet these references refer directly to the matter under consideration by the Court, namely the issue of film badges [10] and [11], the radiation exposure of test participants [12] and [13], and the radiological condition of Christmas Island prior to and following its final decontamination in 1964 [14].

3.8 ii) Of the Annexes submitted by the UK Government, several of these are incomplete with sections of text (whole pages) missing, graphs and figures omitted, parts of and whole appendices removed. For example, an appendix (F) of Annex 24, giving the radiation dose exposure for an individual over a 1 year period for the Grapple Z series, which directly relates to the matter under consideration by the Court, is missing.

3.9 iii) Even if the UK Government Annexes were complete, such are not of much value for reconstructing the radiation dose of Applicant McGinley, both for external whole body and internal dose receipt. I discuss the reasons for this in the main text of this Statement, so here I shall just highlight the salient difficulties, etc., with the information provided in the UK Government's Annexes:

3.10 1) So far as external radiation dose receipt is concerned, the data is piecemeal and taken from very few sampling points on Christmas (Kiritimati) Island itself. This is because the reports of Annexes 23 and 24 are primarily concerned with monitoring the radiation fall-out over a number of Pacific Islands (from Fiji to Honolulu) spread out over a sea area of approximately 5,000 by 5,000 kilometres.

3.11 2) The radiation data provided in Annexes 23 and 24 is given for the time of measurement and not for the time of deposition. Since the sampling plates (sticky tape) were sent back to the UK for counting, between 7 to 28 days passed between the time of deposition and counting, during which rapid, natural decay of the radioactivity would have occurred. Essentially, this means that the UK Government's results (as transferred to AWE 16/93) would be substantially lower (a factor of 100 or more less) than the actual radiation present on Christmas Island at the time of deposition.

3.12 3) Where there are specific results for Christmas Island (Annexes 26, 27, 28 and 29) the reports are incomplete:- Annex 26 is clearly a preliminary draft, with hand written amendments, eg *"The measurements of residual radiation following the Grapple Y test explosion showed* ~~*appreciable*~~ measurable *levels on Christmas Island itself."* and its tables and figures are not included. Annex 27 comprises just 2 pages of the original 10 text pages and figures (at least 3) are missing. Annex 28 has figure missing and is primarily concerned with aircraft mounted surveys over-sea areas, the levels of contamination of the aircraft involved, and the immediate or prompt radiation effects of the detonation. Annex 29 has at least 4 figures omitted and the radiation levels at the time of deposition are back-calculated and not direct.

3.13 4) Selected data that could only derive from Annexes 26, 27, 28 and 29 has been included in the charts of AWE 16/93, although this report makes no reference to the documents of these Annexes. Other UK Government Annexes included reports related to subjects that have, apparently and to my mind, no connection whatsoever with the Applicants' case:- For example, Annex 14 is concerned with the movements of aborigines prior to the Buffalo nuclear tests at Maralinga in 1956; Annex 15 refers to biological experiments on animals, herbage and dummies of men for the Buffalo series; Annex 16 considers the thermal damage to service uniforms; and Annexes 17 and 18 refer to the effects of blast on dummy men and military equipment for the Buffalo and Antler test series respectively.

3.14 I am disappointed with the UK Government's Annexes. Indeed, I am surprised that the UK Government should submit such a scant and disconnected set of documents, some of which have had text pages, graphs and figures intentionally removed. I personally would be very reluctant to draw upon any results presented in such incomplete documents, nor would I rely upon any findings dependent upon these documents as sources of original information and data - if, as it seems, the AWE 16/93 report depends on these documents as its sources of information and data, then I must express the same reservations on the usefulness, reliability and validity of AWE 16/93.

NRPB Sharp and Muirhead Report

3.15 I make no comment on the medical opinion expressed in this report, although I must note my surprise that neither of the Applicants was subject to medical examination by the first author (Sharp).

3.16 Certain of the medical opinion expressed is accompanied by a caveat relating to an assumed low (or zero) radiation dose exposure of the Applicants, although the report does not quantify the actual level of radiation dose exposure assumed in arriving at the opinion. Since the UK Government's submission has not shown that the Applicants received very low, negligible or zero radiation dose, then caution should be applied to those Sharp and Muirhead opinions which are unsupported in this respect.

Now I give my Statement in main:

4 Analysis and Comment

4.1 First, it might be useful for me to make a number of comments and observations of the UK Government's submission, as presented by Mr M Eaton:

STATEMENT OF MARTIN EATON OF 2 OCTOBER 1997

On the Availability of AWE Files

4.2 Generally, throughout his statement, Mr Eaton implies that records and files, once declassified, are readily available to members of the public via the Public Records Office.

4.3 My own, and the experience of others,[42] is that records and files relating to Britain's nuclear weapons tests and other nuclear related matters are far from readily accessible in the UK.

Para 1.88-89 Omission of Certain Reference Documents Provided by UK Government

4.4 In referring to the references cited in AWE Technical Note 16/93, Mr Eaton states the first five references [1 to 5] to be key contemporaneous radiation level monitoring records and that the other references [6 to 16] are either publications, or have never been classified.

4.5 I agree that references [6], [7], [8] and [9] are published and available in the public domain. However, references [10], [11], [12], [13], [14] (all AWE reports except [10] which is MOD) are not, to the best of my knowledge, available in the public domain. References [15] and [16] may be in the public domain or such may be restricted if subject to commercial confidentiality (ie undertaken on a sub-contracted basis).

4.6 Also, Mr Eaton states that these references *"like Annexes 20 to 24, have never been classified."*, yet pages of Annex 20 (pp3-4) are stamped **'RESTRICTED'**, similarly Annex 22 (p2) is stamped **'RESTRICTED'**, and Annex 23 carries the stamped **'UNCLASSIFIED'** above a blanked out section which probably reads **'RESTRICTED'** or **'CLASSIFIED',** and page 21 of this report carries the footing **'CONFIDENTIAL'**.

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42 So far as AWE records and files, there is a great deal of difficulty in, first, knowing precisely what records exist and, secondly, if these records are declassified (indeed, if such have ever been classified), and if these are available in the Public Records Office. For example, Mr Draper (referred to by Mr Eaton in his paragraph 1.99) formally applied in September 1996 to the UK Ministry of Defence for the classification status and availability of 257 specifically cited AWE files relating to the British nuclear weapons programme. Within 30 days of this request the MOD responded noting that the request was under consideration. A second, similar 'holding' letter was received by Mr Draper early in 1997. In late April 1997, the MOD informed Mr Draper that a number of files were in the process of being released, although during the period June to October 1997 Mr Draper was able to access only about 20 of the original list of his enquiry, and several of these files were incomplete with extracts removed. In other words, following over a year since his initial enquiry, Mr Draper has gained access to about 20 of 257 files, but to this date he does not know when the remaining 237 or so files will be made available and, if indeed, this bundle of 257 files represents all of the information held by the AWE in the subject area.

Since mid-1995, Retained (unavailable) AWE files have been listed by title at the Public Records Office - this is how Mr Draper was able to select specific files - but the list of files Retained does **not** necessarily include **all** of the files held by the AWE in that particular topic area, this being so it is not possible for a member for the public to identify all files (either Retained or Available) that are held by the AWE.

Before mid-1995 Retained AWE files were simply not listed by the Public Records Office, so no information was available on what was not available. Another UK Government agency involved in the nuclear weapons development programme was the United Kingdom Atomic Energy Authority, unlike the MOD and AWE, the Public Records Office listing for UKAEA Retained files does not include any title or other information indicating the subject contents of the files.

I have cited Mr Draper's experience because he was specifically seeking information about the British nuclear weapon test programme, although not with much success. I have also personally experienced great difficulties with HMG Ministry of Defence with regard to obtaining information on defence related matters.

For the past three years I have acted on behalf of Rochester City Council with regard the implementation of a scheme of counselling for ex-employees of the Chatham Dockyard (located within the City of Rochester), seeking from MOD the radiation dose statistics for the group of individuals engaged in the refitting and refuelling of nuclear-powered submarines - although the counselling scheme is now operational, the MOD has steadfastly refused, and continues to do so, to release any data relating to the group dose statistics. In a similar vein, I have been involved in a civil claim by the relatives of an ex-employee of the Chatham Dockyard who died as a result of leukaemia, possibly related to his employment radiation dose exposure - for the last twelve or so months, the MOD has been unable, or unwilling, to provide details of the radiation dose exposure of the deceased and it was only recently (5 November 1997) that a Master of the Court ordered the MOD to release details of all radiation incidents and accidents involving nuclear-powered submarines whilst in the Dockyard to the Solicitors acting for the relatives of the deceased. In another matter, I approached the MOD for a copy of some AWE biological experiment results at Monte Bello for an Australian client some six weeks ago - I, like Draper, received the cursory acknowledgement letter with the specified time period and was informed that AWE Aldermaston would deal with the request - I have heard nothing since then.

4.7 If the references *"have never been classified"* as Mr Eaton claims, then why were such originally marked Restricted or Classified ? The point at issue here is not whether this information has classified, restricted or whatever, but if it has ever been available to members of the public - I would say that this information has never been made available until this time.

Para 1.86 Issue of Film Badges

4.8 In the above section I referred to references [10] and [11] as being amongst those references not included in the submission of the UK Government. These two references refer specifically to the issue of film badges (which are used to for monitoring individual radiation dose uptake).

4.9 Mr Eaton explains that film badges were issued only to a limited number of personnel (about 1000) because *"film badges had been issued generally (ie to all personnel) at earlier nuclear test explosions in Australia, but this had shown that personnel with the duties of the Applicants were not exposed to measurable levels of ionising radiation. For this reason, there was no specific monitoring of the Applicants' individual exposure to radiation, which was zero."*.[43]

4.10 There are three matters of fact relating to Mr Eaton's claim that cause me concern:-

i) Comparison with other British Tests

4.11 First, reference to Table 2.7 of NRPB-R266 *(Mortality and Cancer Incidence 1952-1990 - UK Nuclear Weapons Tests)* shows that only at the first test (Hurricane) were film badges issued to all personnel (96%), and that for subsequent tests the fraction of participants individually monitored reduced (except the Maralinga Experimental Programme at 92%) to the low levels (ranging between 2% to 14%) for the Grapple test series.

4.12 The implication of Mr Eaton's claim is that, in advance of the tests, the MOD were able to identify those individuals (by their duties) who would be expected to receive radiation dose exposure and, thus, issue film badges only to those individuals.

4.13 Now if I re-examine the NRPB Table 2.7 with some additional columns (*italicised*) I would expect to see Mr Eaton's confidence reflected in the tabulated data.

TABLE A - *NRPB R266 - TABLE 2.7 - WITH ADDITIONAL COLUMNS*

TEST	No	HP	%HP	HP = 0	HP >0	*%HP >0*	*%ALL >0*	MAN-mSv	*AVERAGE HP>0*
Hurricane	1397	1339	96%	1133	206	*15%*	*14.75%*	2470	*11.99*
Mosaic	1383	599	43%	404	195	*33%*	*14.10%*	1274	*6.53*
other Monte B	9	0	0%	0	0	-	*0.00%*	0	-
Totem	106	78	74%	19	59	*76%*	*55.66%*	1209	*20.49*
Buffalo	1285	786	61%	404	382	*49%*	*29.73%*	2156	*5.64*
Antler	1548	737	48%	418	319	*43%*	*20.61%*	1874	*5.87*

43 Although Mr Eaton states that about 1000 film badges were issued, here we are considering 5 separate test detonations, so it is not at all clear if the same individuals were issued with film badges for each test - this is suggested not to be the case by my (NRPB) TABLE A.

Maralinga Exp Prog	555	510	92%	314	196	*38%*	*35.32%*	775	*4.95*
other Maralinga	2555	253	10%	228	25	*10%*	*0.98%*	111	*4.44*
Grapple (Malden)	3515	83	2%	4	79	*95%*	*2.25%*	1018	*12.89*
Grapple X	**2338**	**179**	**8%**	**53**	**126**	***70%***	***5.39%***	**1081**	***8.58***
Grapple Y	**3722**	**114**[44]	**3%**	**18**	**96**	***84%***	***2.58%***	**981**	***10.22***
Grapple Z	**4375**	**618**	**14%**	**395**	**223**	***36%***	***5.10%***	**3814**	***17.10***
Brigadoon	729	379	52%	29	350	*92%*	*48.01%*	251	*0.72*
other Christmas	3984	11	0%	3	8	*73%*	*0.20%*	1	*0.13*

Note: **HP** is 'Health Physics', that is the group issued with film badges under Health Physics control; **HP=0** is those individuals issued with film badges but which did not register any radiation dose; **HP>0** is the number of film badges that registered a dose greater (>) than zero; **MAN-mSv** is the collective dose, that is all of the individual doses registered on the film badges added together; and **AVERAGE HP>0** is the total MAN-mSv dose divided by the number of individuals who received a dose (HP>0), to give the average dose.

4.14 In the above tabulated data I am interested in the correspondence between the descending entries in the columns headed **%HP, *%HP >0*** and ***%ALL >0*** - I have block shaded out those rows that do not apply to my comparison (such as 'Other Maralinga' which included ground decontamination campaigns).

4.15 For ***%HP>0*** I have simply calculated the percentage of all of the issued film badges that registered radiation dose above background (Column 6 divided by Column 5), and likewise for ***%ALL >0*** the percentage of all of the individuals (with and without film badges) attending the tests that registered radiation dose (C6/C2). Obviously for *Hurricane*, where it is claimed that virtually everyone (**HP%** = 96%) was issued with film badges, my two additional columns should be about the same.

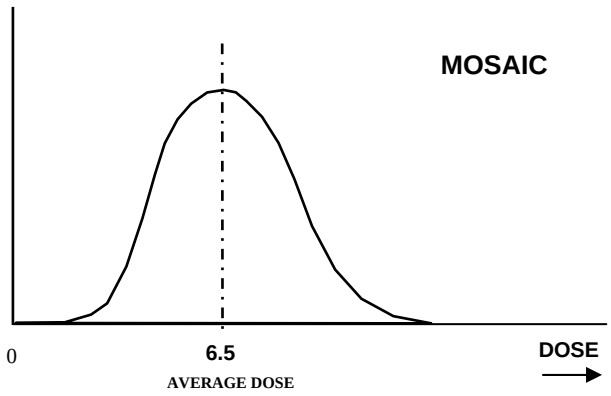
4.16 Now, moving down a row to *Mosaic*, 14.3% of the entire test population was exposed which corresponds with the *Hurricane* exposure fraction, so in for this test series it seems that the UK Ministry of Defence was justified in reducing the film badge issue to 43% leaving a margin of (100-33=) 67% of individuals issued with badges but who did not receive radiation exposure.[45] In the other earlier tests, excluding the *Grapple* series, a similar margin exists.

4.17 My final additional column ***AVERAGE HP>0*** shows the average individual dose of those individuals wearing film badges that registered dose exposure (C9/C6). The average, individual dose exposures (which are, of course, notional) are generally higher than the other tests (excluding *Totem* that is statistically corrupt because of the relatively small number of personnel involved).

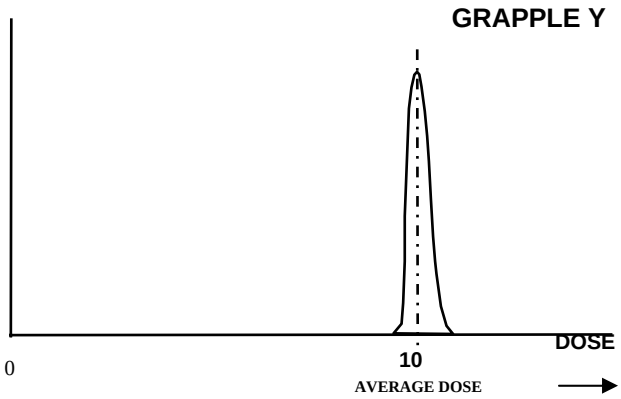
44 Annex 28 gives the number of film badges issued at Grapple Y to be at least 160 to AWRE (including attached Services personnel) with other badges (number unknown) to RAF crews - thus the combined total considerably exceeds the 114 issued badges of NRPB R266.

45 For the two Mosaic test detonations at Monte Bello Islands, all test participants were accommodated on board ships moored away from the test area, whereas at Christmas Island the participants were accommodated on the Island.

4.18 If I had access to the individual film badge records for the Mosaic test detonations, I would expect a plot of the recorded radiation doses -*v*- numbers to result in the bell-shaped distribution to the right.[46] The plot would show that about 14% of all of the test participants (the area under the curve) received a measurable radiation dose - some of these doses would be low (left-hand side) and others high (right-hand side), but generally the dose levels would cluster around the centre of the distribution at about the average dose of about 6.5mSv. The final bell shape of my normal distribution might be somewhat squatter, more elongated, or skewed to one side, depending on such factors as where the men were situated, the fall-out pattern, and so on.



4.19 Now, if I repeat this exercise for Grapple Y, the plot shows that only 2.5% of the test participants received a measurable dose centred on a higher average dose of about 10mSv



4.20 What distinguishes the *Grapple* series of tests is the number of individuals issued with badges reduces significantly (**HP%** = 2, 8, 3, 14%), and the number of these badges that registered a dose increases significantly (***%HP >0*** = 95, 70, 84 and 36%). In other words, for *Grapple* there is very little margin for error and, in reducing the issue of film badges, the MOD had to be very confident that those individuals not issued would not receive dose.

4.21 The problem here is in assessing the UK Government's confidence. If the UK Government is right that, for Grapple, 95% of the film badges issued to just 2% of the test participants recorded dose then that is a quite remarkable achievement. Or, it could be that issuing so few film badges produced, in itself, an aberration of confidence.[47]

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46 A 'normal distribution' is the pattern of distribution expected for a collection of data. For example, if one considers the height of a group of men, the average height would be about 1.75m and this would be represented by the apex of the hump, to each side would be shorter and taller men, each diminishing in number until the shortest and tallest of the men were located at the left- and right-hand extremes of the graph - in the analogy the average height corresponds to the average radiation dose. It follows that this pattern of normal distribution will occur in any group selected, so a similar analysis of, say, basket ball players will produce a similar distribution, with shorter and taller distributions, but the average height of this distribution will be taller, thus moving the hump along the bottom axis to the right, and the distribution of heights will be narrower, because basket ball players are selected for their height, that is compressing the width of the hump, nevertheless there will always be a distribution of heights within the group.

47 Assuming the distribution of radiation dose follows a normal distribution, a very important and fundamental theorem in statistics (the *Central Limit Theorem*) states that the distribution will be close to a normal distribution however selective the group is (providing the group size is > 10) - essentially, this means that for Grapple some extraordinary control must have been applied to achieve 95% of the 2% issued film badges measuring radiation dose if, that is, none of the individuals who were not issued with film badges received any unrecorded radiation dose. This Central Limit Theorem explains the occurrence of normal distributions in nature, for instance, the length of a leaf will depend on the sum of many variables and, as long as these variables are substantially independent and there are a lot of them, the population of leaf lengths will be approximately normal.

4.22 There is nothing in the Annexes submitted by the UK Government showing *a)* that the dose receipt experience gained in the earlier Australian tests had been correlated in the form of sound, statistical evidence and, if it had, *b)* how the distinction was to be made between those individuals to be issued and not issued with film badges.

4.23 Of course my distributions of radiation dose uptake sketched above are not drawn from any database - the data required for this has not been released into the public domain by the UK Government. This is why I consider it very important indeed that Mr Eaton demonstrate his claim that issuing so few film badges was justified by past experience which, as I have explained, is not available from the sparse data contained in Table 2.7 of the NRPB report. This data may be included in References [10], [11], [12] and [13], which I consider should be released by the UK Government.

ii) Doses Cited in the (Annex 31) NRPB Sharp & Muirhead Report

4.24 Included within Appendix B are the *Blue Book* service records of both Applicants.

4.25 The pertinent entries relating to radiation dose exposure are located at the top right-hand corner of each record - both record a gamma/beta dose as *'none recorded'*. Of course, since neither Applicant was issued with a film badge, the *'none recorded'* means just that and not that the individuals did **NOT** receive radiation dose exposure. Mr Eaton makes this clear in his para 1.86 in that *"for this reason, there was no specific monitoring of the applicant's individual exposure to radiation, which was zero."*, and in para 4.12 that *"there was no monitoring of the applicant's individual exposure to radiation."*.

4.26 On the other hand, Sharp and Muirhead are very vague about the actual dose receipts of both Applicants - their report includes the zero dose receipt service records for both Applicants but makes no direct reference to these. Also, it is of interest to note that Sharp and Muirhead do not refer specifically to the AWE 16/93 report, relying almost totally upon the NRPB-R266 report which primarily relates to mortality across the entire group of participants for the whole of the UK nuclear weapon test detonation and experimental programme.[48]

iii) Pre-Planning and Post-Detonation Response for Dose Control

4.27 As I have previously stated, Mr Eaton gives the impression that the decision to issue film badges to a limited number of personnel seems to have been settled well *before* the test detonations were undertaken.

4.28 However, Annex 8 *(Radiological Safety Regulations, Christmas Island, March 1958 - AWRE RSRC/58[1])* indicates that the final radiological controls applied in the immediate aftermath of the detonation were to be determined by the *Health Physics Controller* on the Island at the time. For example, para 2.4.2 of p4, when referring to radioactive fall-out areas states that *"The Health Physics Controller will determine the boundaries of the Controlled Area according to the circumstances."*, further noting that, para 3, p5 *"All parts*

48 NRPB-R266 cites the AWE 16/93 report as a reference [27], although only in respect of the expected mortality rates found in the overall UK weapons test and experimental programme participants - about 20,000 individuals, whereas here we are concerned with just 2 participants involved in a particular test series.

of the Test Area will be classified according to the nature of the work which may be done in that particular part.", that para 4.2.3 *"The classification will be laid down by the Health Physics Adviser who must be informed prior to any proposed change . . . He will review the classification periodically."*, and that para 4 *"All personnel who have duties in a Controlled Area will wear a Personal Monitoring Film* (badge) *at all times."*.

4.29 My point here is that this Annex sets down extremely detailed procedures and controls for the radiological protection and monitoring of individuals, contaminated surfaces, airborne levels, etc., and, as such, would have been expected to require numerous and detailed reports of the levels of radiation, classification of areas, and radiation doses actually received during the test.[49] More to the point, the monitoring and classification of areas undertaken by the Health Physicist at the time would have related specifically to the potential uptake of radiation dose (as compared to the general environmental monitoring relied upon in AWE 16/93).

4.30 It is these Health Physicist records that relate to the potential exposure of the Applicants and not the environmental monitoring results given in AWE 16/93, as Mr Eaton states para 1.88(2), p 41, *"These base records of individual measurements, given their nature and the fact that the information recorded in them was assembled in the two documents at Annexes 20 and 21, have not to the best of the Government's knowledge been retained."*.

4.31 Actually, the documents of Annexes 20 and 21 (and Annex 22) do not include Mr Eaton's *"base records"* since these are procedural instructions written in advance of the Grapple Y (Annex 20) and Grapple Z (Annex 21) tests and, importantly, neither document contains any data, or prediction, that relates to the dose potential of the Applicants. Thus, it is not all clear to me why Mr Eaton places so much reliance upon these references in relation to the Applicants' present action.

4.32 So far as Mr Eaton's statement that "*These base records . . . have not to the best of the Government's knowledge been retained."*, I must express some degree of incredulity that such important records would have been discarded.[50]

4.33 This is particularly so when I give regard to, at that time, the UK Government's awareness of the potential exposure and ill effects on the test participants reflected in the documents of Annex 11. These documents provide an insight into what I might best describe as quite intentional misrepresentation and, indeed, direct meddling with matters of fact by those in charge of the test programme at the time. For example, (Sir Frederick Brundett - 22 December 1953) *"On balance I am recommending that if they ask we give them* (Australia*) a little piece of the filters, but that we wait a few days so that some of the short-lived key isotopes have decayed a good deal."*, (Air Vice-Marshall J Grundy - 15 July 1958) "*Air Commodore Stamm . . .*

49 Annex 8 applies to Grapple Y, although it is reasonable to assume that similar protocols were issued in advance of the other Grapple test. Annexes 9 and 10 are also of relevance, although these relate to operational procedures rather than to specific radiological management as Annex 8.

50 Although not strictly applicable here, because the Applicants were services personnel, the requirement in the UK is that personal radiation dose records for what are termed Classified Radiation Workers (UK Ionising Radiations Regulations) have to be maintained for 50 years after the date of the last radiation exposure. It would be reasonable to assume that the UK Government would apply the same to nuclear weapons test participants, if not just for the personal dose records but also to any monitoring records that relate thereto.

suggested that if a person was examined (by blood count) *and found to be normal before posting to Christmas Island and who later developed leukaemia, it might be difficult to refute the allegation that this was due to radiation received at Christmas Island."*, and in the telex from Lloyd (31 7 56) *"A safer interpretation of the MRC report . . . would be "has not shown an increase" rather than "shows an increase"."*[51]

4.34 I also note that AWE 16/93 para 17 refers to the earlier records *"These* (the results*) are taken from references [4] and [5] and from many other documents at the time of the tests, often handwritten."*,[52] which suggests to me that the authors of AWE 16/93 had access to the original *'base records'* in 1993 but that since that time, according to Mr Eaton, the records have been discarded.

Availability of Information on the Grapple Series

4.35 Returning to the availability of information, it seems to me that Mr Eaton has been very selective in providing the Court with data and reports about the Grapple test series.

4.36 On the basis of how the information so far provided by the UK Government relates to the Applicants' potential radiation dose receipt, I summarise my opinion on the relevance and usefulness of the Annexes (other than the Annexes (20-24, 25 -29, 31) relating to AWE16/93) to be as follows:

51 Although it is not my purpose to present further evidence on these malpractices in this Statement, relating to the Monte Bello Hurricane test there is an interesting note (Butterfield W Medical Research Council, Operation Hurricane Group Reports Part 46, *Summary Report on Biological Experiments* - ES 1 104 Operation HURRICANE: *Biological Investigations On Monte Bello Island* 1951-1953 0076) on the inhalation of fission products by services personnel entering the contaminated areas of Trimouille Island a few days following the detonation. This work reports sampling of men who had not worn respiratory protection in *"an experiment designed to utilize a situation that arose fortuitously"*, and from which it was possible to correlate the levels of contamination measured on the ground to that passed in the urine a few days later. It is not clear whether the subjects involved had been issued with respiratory protection but had not worn it, and/or if they had inadvertently strayed into a heavily contaminated area without respiratory protection, or if they had not been issued with respiratory protection but assigned duties in a contaminated area. It seems odd that under the regime of military discipline applied at that time, particularly where all personnel were monitored for external contamination before reboarding the accommodation ships, that not only could such a *'fortuitous situation'* arise but, moreover, that the malpractice continued for a sufficient time thereafter (*'a few days'*) for the *"experiment"* to be organised, samples to be taken (urine from both protected and unprotected men), and for the rapidly changing ground contamination environment to be surveyed.

The very limited results reported that subjects exposed without respiratory protection passed urine contaminated up to 25.10-3microcuries after 30 hours of the time of exposure. The individual uptakes were found to have *"rough correlation*" with the fission product inventory on the ground and that the *"results were in general agreement with the previous predictions as between the uptake by inhalation, and the surface radiation intensity."*.

52 The headings of Tables 4 and 5 of AWE 16/93 state "Reproduced from contemporary documents' - other than some corrections and amendments, none of UK Government's Annexes contain hand written reports.

TABLE B

ANNEX	TOPIC	PERTINENCE	FURTHER INFORMATION REQUIRED
8	Radiological Safety Regulations	Useful, but preplanning procedures only.	Does not relate directly to Applicants' potential radiation dose, should be supported by Health Physics reports and monitoring taken during the post test period.
9	Personal Safety Plan - Grapple Y	Preplanning procedures only.	Ditto.
10	Burgee Safety Plan - Grapple Z	Ditto.	Ditto.
11	Collection of Documents	Illustrates alteration and misrepresentation.	Only blood test meeting minutes applicable to Grapple.
12	Parliamentary Debate -12 March 1984	Published and known.	Not specifically applicable to Grapple.
13	Advice for Grapple Y	Preplanning procedures only.	Does not relate to Applicant's potential radiation dose.
14	Untitled section - Maralinga	Relates to exposure of Aboriginal safety during Buffalo	Does not relate to Applicant's potential radiation dose.
15	Operation Buffalo	Fauna/Flora survey, equipment damage, blast effects, etc..	Does not relate to Applicant's potential radiation dose.
16	Operation Buffalo	Thermal radiation effects on Service Uniforms.	Does not relate to Applicant's potential radiation dose.
17	Operation Buffalo	Blast effects on dummy men.	Does not relate to Applicant's potential radiation dose.
18	Operation Antler	Blast effects on dummy men and scout cars.	Does not relate to Applicant's potential radiation dose.
30	Collected letters, etc	Queries over Public records Offices files, etc..	Does not relate to Applicant's potential radiation dose.

4.37 As can be seen from my tabulated summary, the usefulness of this first batch of the UK Government submission is very limited indeed and it does not provide a comprehensive database from which to assess the Applicants' potential dose exposure.

4.38 It is quite apparent to me that there exists a wealth of information available to the UK Government that would provide a more meaningful route of assessment of the Applicants' dose exposure. For example, if I scan through the publicly available reports (about previously classified 150 reports) relating to previous UK nuclear weapons tests (the Australian Tests), it is obvious that later, similar reports would have been compiled for the Grapple series. I can tabulate the relevant reports for these tests, indicating the authors who would have been most likely involved in the Grapple tests, concluding that it would not be difficult for the UK Government to locate and retrieve these from its Retained files - I have ***italicised*** particularly pertinent report topic areas in Table **C** my Reference,[53]

53 **TABLE C**

TOPIC	AGENCY	PERSONNEL	REFERENCES	SUBJECT NOTES
Post Detonation Effects	Ministry of Supply	W J Moyce Woolwich SAM		Peak Pressure - Distance Relationship, Blast Damage, ***Gamma Flash - Dose Distance Relationship, Radioactive Fall Out***
Post Detonation Effects	Home Office	E T Paris		***Ditto***
Safety Levels for Fall Out	UKAEA AWRE UKAEA Harwell	G C Dale J H Howes D H Pierson	H7/53 Dale AERE HP/R 551 Chamberlain USN ADC 65 Hunter, Ballou AWRE 0-41/55,0-35/56X,AERE HP/R 2606, HP/R 2606, J Howes AERE EL/R 1507, A C Chamberlain AERE HP/R551, G C Dale AWRE 0-35/56(X), W Abson, AERE EL/R 1997	Maximum permissible levels - ***fission product hazards - fall-out exposure-time relationships - inhalation pre-deposition rates - inhalation post-deposition resuspended dust relationships - Harwell work on measured rates following detonation***
Fall-out	UKAEA AWRE ADMIRALTY RES LAB	E P Hicks, J D MacDougall, A G Matthewman, E M Beale, W T M Gaskell, W N Saxby		***Experimental ground contamination readings and measurements of the rates of deposition, including respired dose rates***
U235 and Pu239 Contamination	UKAEA AWRE	G C Dale, R A Kendall, J C McKendrick	NBS Circular 499 USN AD-268 Baietti, Holden	***Ground deposition in immediate post-detonation phase v fission yield curves for Pu239*** for simultaneous slow neutron fission of U235 relating to effective screening by service clothing, including intense neutron flux, all relating to hours/days following detonation zero time

4.39 The point illustrated by the **TABLE C** is that it is to be expected that a wealth of specific reports exist for the Grapple test series. If the reports relating to the earlier UK tests are considered to be a reasonable index of what should exist for Grapple, then extracting the radiological environment, and indeed the actual radiation doses and in situ dose rates (see later for definition), should be relatively straightforward.

Radiation exposure in contaminated areas	Ministry of Supply	R H Liston, J Corner Ft Halstead C F Barnaby A V Sheldon		***Gamma exposure for fission product ground contamination post neutron activity, organ dose over recorded dose***
Rain Washout	Ministry of Supply - ARE	E R Woodstock Ft Halstead	US AEC MDDC 919, ARE 1/48	Entry prohibitions following heavy/moderate precipitation on contaminated land in the immediate post-detonation phase of a nuclear test
Growth and Development of Fireball and Cloud	Admiralty Res lab	H W Pyne		Analysis and predictions v Observations of fireball development
Height Rise of Cloud	AWRE	I C Cheeseman, D Sams, E P Hicks	Matthewwman A G TPN 42/56, TPN 12/54	Initial post detonation cloud radius and subsequent development relating to explosive yield
Ditto	AWRE	Sutton		Ditto
Debris Content of Cloud	AWRE	MacDougall A G		Predictions and measurements of ***total activity and entrained debris content*** within a post-detonation cloud
Debris fall-Out from upper part of Stem	Admiralty Res Lab	E M Beale		Debris fall out from stem higher region related to cross wind in immediate post detonation phase
Fall-Out from Cloud	AWRE	J D MacDougall, D F Godard, J C Bomyer, P F Beaver	TPN 78/75 See Beale AWRE 0-35/56	***Ground contamination, related to yield and height***
Cloud Rise	AWRE	R A Siddons I C Cheeseman	Freeman AWRE T12/54, Pike HERR 417, Cheeseman AWRE E9/57, Matthewman TPN 42/56, C G Dale AWRE 0-41/55, R A Siddons AWRE E1/54,TPN 40/56,45/56/37/56/183/56	Cloud Rise and containment of atmospheric cold air, measurements and predictions
Dose and Activity Measuring Devices	AWRE	D B Janisch, E R Drake, J A Carr, D H Pierson	AWRE 0-28/56	Trials on reliability, accuracy etc of dosimetric and radiac equipment deployed during and following nuclear tests and ***gamma dose-distance measurements***
Meteorological Conditions	AWRE Met Office Air Ministry	F L Westwater, M H Freeman		Recording camera positions, meteorological conditions
Neutron Measurements	AWRE	E W Titterton		Lethal range measurements
Ground deposition sampling	AWRE	R S Cambray, W C T Munnock, G George, P A Carter, P B Whiting, R L Cater, R A Siddons, E P Hicks	AWRE B12/55 AERE HP/R737 AWRE 0-41/55	***Aerial surveys of ground contamination levels***
Decontamination of Personnel	Admiralty Res Lab	C A Luxford, P Halliday, L Lavender		Decontamination of personnel in and about fall out area
Polar Distribution of Flash Gamma radiation	AWRE	B W Soole	Soole B W ARL/R2/R862.1	Angular and vertical Plane gamma radiation at detonation
Energy of Flash Gamma Radiation	AWRE	B W Soole	Soole B W ARL/R/R463,R424, R642, Williams J H Naval Radiological Measurements - Response of Glass Flash Gamma Dosimeters, Soole ARL 251	Ditto
Neutron Flash	AWRE, Salisbury	D G Vallis		Neutron dose rates v distance
Neutron Dose	AWRE	A D MacDonald R E Ashton		Ditto
Remote Measurement of Gamma Rate from fall Out	AWRE	J K Jones J J Rae		Ground measurements
Attenuation and Scattering	Home Office	A M Western	C F Barnaby AWRE 0-28/56	Dose reception in scattering situations
Air Blast	AWRE	R Potter A C Ourdie, R G Turner, W E Worsfold	Potter R AWRE E1/53 Pierce N AWRE E1/53, W E Worsfold, AWRE 0-42/57, F H Grover AWRE T42/58	Air Blast to Yield relationship with Ground shock, detonation height correlation
Biological Experiments	Medical Research Council	W J H Butterfield		Assessment and measurement of biological effects
Effects of Blast on men in the open	Medical Research Council RAMC	W J H Butterfield E G Hardy ER Drake P L Krohn G Lovell J F Gilbert	P L Krohn AWRE T3/58 G Lovell ARE 1/48	
Gamma Intensity immediate post-burst	AWRE	J F Hogg, J Cave		***Correlation between gamma and dosimetric records***
Thermal Measurements	AWRE	J A Carruthers, R G Dorman, R J Wilson, P C East, E J Ellis	AWRE T10/55, T61/57(X)	Thermal yields v distance, intensity and time
Ground Protection on Personnel	AWRE	L Cave Drake Seager, M Crook	AWRE T75/54 C Dale AWRE T52/54	Protection offered by slit trenches
Resuspension of Fine Particles	AWRE	K Stewart P A Carter	P A Carter AWRE T1/56, T52/57, A C Chamberlain AERE HP/R1261	***Post deposition dose uptake mechanisms***
Radiological Safety Regulations	Ministry of Supply			As issued for each test series
Decontamination in the Field	AWRE	D B Janisch		Field decontamination trials and effectiveness
Airborne Sampling	AWRE, RAF	A W Eyre, D E Barnes, E R Woodcock	AWRE T52/57,0-39/58, T45/58, HP/R896	

4.40 Instead, with its submissions the UK Government chooses to submit a few reports (my **TABLE B**), some of which are totally irrelevant, and others from which is difficult to extract any meaningful information and data.

4.41 Now I turn to the AWE 16/93 report which Mr Eaton claims to be sufficient for and relevant to indicate the level of radiation that each of the Applicants were individually exposed to (Mr Eaton's para 4.12).

AWE REPORT 16/93 - ENVIRONMENTAL MONITORING OF CHRISTMAS ISLAND

4.42 Referring to AWE 16/93 and its supporting references ([1] to [5]) as supplied by the UK Government, I now give my opinion as to whether *a)* 16/93 in itself provides sufficient information to determine the Applicants' radiation dose and b) if the cited references are sufficient to support the summary (p1) claim that *". . . the* (radioactivity) *levels were low, decayed or dispersed rapidly, and did not constitute a hazard or danger to test participants, visitors or inhabitants of the Island."*

Paras 5, 6 and 7 - Fall-Out

4.43 This section claims that before each test detonation, the firing altitude was selected so that the developing fireball did not touch the ground and thus, so it is asserted, there was no ground debris entrained and radioactive fall-out was limited to weapons debris alone.

4.44 The somewhat simplified model given is that *"Such* (weapon) *debris, in the form of very small particles, did not fall to earth locally, but was carried up to high altitudes by the rising cloud. Here it dispersed around the earth, its radioactivity continually decaying. By the time it returned to earth as global fall-out it had decayed and dispersed to negligible levels."*

4.45 In my first and previous Statement to the Court, I gave opinion specifically relating to Grapple Y. My findings were that the Grapple Y detonation was an air blast of about *i)* 2.8 Megaton (million tonnes equivalent TNT), the initial detonation centre height was about 1,000 to 1,250m above ground datum, and that the *ii)* mushroom cloud expanded over a period of about 10 minutes to a steady state (diametrical) size and height (top of cloud) of 30,000m and 27,000m respectively. Referring back to the break-away diameter of ~1,900m diameter and my observations of the mushroom stalk development, I concluded that *iii)* a substantial mass of ground debris (or if sited over the sea, seawater and sands, coral etc., of the shallow lagoon) would have been scavenged by, swept into and subject to intense irradiation within the nuclear-active stages of the fireball and, hence, the risk of localised and longer-range fall-out of radioactive fission and (radio)activated products would have been high.

4.46 Thus, for Grapple Y, I disagree with the claims of AWE 16/94.

4.47 In making the assertion that the Grapple detonations fall-out was global and comprised only weapon debris, AWE 16/93 cites no references specific to the setting of the firing height, nor do any of the references submitted by the UK Government (AWE 16/93 [1] to [5]) refer to this.

4.48 Accordingly, I believe that the UK Government should make available its reports and calculations relating to setting of the firing heights and, particularly, records of its test observations that confirm that each test was fired at the pre-set height and, importantly, that the developing fire-ball did not scavenge the ground surface.

Paras 7 & 8 - Flash Radiation

4.49 Para 7 simply states that since the participants were mustered at sufficient distance from the detonation ground zero, there was no risk of exposure, thereafter giving no further attention to this aspect of exposure. I note that the charts supplied as Annex 25, particularly the right-hand margin annotations, do not seem to be contemporaneous (1957-8) documents.

4.50 In general, I agree with this statement, although I do not agree that distance alone precludes all forms of injury incurred during the observation of an atmospheric nuclear test.[54]

Remaining Sections Relating to Radiation Monitoring

4.51 AWE 16/93 draws on five cited references for its data, these are:

[1] Air Water and Sticky Paper Samplings - February 1958 (Annex 20)

[2] Check for Possible Radioactive Contamination of Fish - May 1957 (Annex 21)

[3] Fish Sampling - 14 February 1958 (Annex 22)

4.52 These three reports are pre-planning protocols, each dated prior to the test detonations, and do not directly relate to the Applicants' potential dose uptake.

[4] Operation Grapple Y - Sampling at Outlying Stations, TR53/58, undated (Annex 23)

4.53 Two monitoring stations are identified, one sampling fall-out deposition and the other fresh fish. The exact location of the deposition sampler on Christmas Island is not given.

5] Operation Grapple Z - Sampling at Outlying Stations, undated (Annex 24)

4.54 Sheet 3 of Appendix E (September 1958 - Rainwater for Grapple Z2, Z3, Z4) and Appendix F (1 year dose receipt for certain individuals) are missing from Annex 24.

4.55 There are a further 4 annexes submitted by the UK Government, although these are not cited in the AWE 16/93 report:

[not referenced) Grapple Y - Residual Radiation Measurements, undated (Annex 26)

54 The only precaution taken against individual participants view the initial and intense flash was the 'EYES CLOSED' order. It may have been that individuals could have been caught unawares (or disobeyed this instruction) and viewed the instance of detonation directly with the naked eye. The cataract formation complained of by some nuclear test participants (not the Applicants) may have resulted from such viewing since the eye is relatively ischemic and unable to dissipate heat energy effectively. The lens of the eye, being avascular and encapsulated, is particularly vulnerable to heat build up and temperature rise from high thermal radiation intensities. Temperature rise in the lens increases rapidly with power absorption, reaching a cataract threshold at about 0.7 Watts absorption, with lens temperatures of about 50oC being sustained.

4.56 This document is incomplete with none of the tables (1 set of results) and figures (at least 3 in number) included.

[not referenced) Grapple Y - Summary of Results, May 1958 (Annex 27)

4.57 This document is incomplete, comprising just pages 5 and 6 of 10 pages in total.

[not referenced) Grapple Y - Interim Report, undated (Annex 28)

4.58 Figure 1 (TP) is not included (this should identify the most likely area of fall-out on Christmas Island)

[not referenced) Grapple Z - Interim Report, October 1958 (Annex 29)

4.59 Incomplete, Figures 1, 2, 3 and 4 missing - Figure 3 should give the neutron flux/distance, and Figure 4 should give the decay curve for the ground contamination

4.60 I summarise my observations on the sufficiency of the above reports to determine the Applicants' potential radiation dose exposure as follows:-

1) Applicant Egan

4.61 None of the results given apply to Applicant Egan who was involved in the Grapple Y test of 28 April 1958 but on board HMS Ulysses some 60 miles north east of Christmas Island.

4.62 For this particular Applicant the radiation dose levels recorded on board HMS Ulysses whilst at sea are required.[55]

2) Radiation Dose Rate

External Whole Body Dose

4.63 The most obvious and straightforward means of determining the presence of ionising radiations is to measure the radiation field directly at the scene - this can be done with a hand held Geiger counter with an in-built integrator to convert the rate of disintegrations (clicks per second) to a dose rate in Rems per hour (or mSv/hour).[56] This type of Geiger counter is called a dosimeter and would have been available at the time of the Grapple series of tests.

55 I do not know of the role of HMS Ulysses in the Grapple Y test. In earlier tests, Royal Navy ships were deployed to monitor the atmospheric fall-out at sea - for Mosaic G1 and G2, HMS Diana sailed into known fall-out areas shortly following the detonation in order to both collect fission product samples and to test the ship's nuclear protection systems. A significant element of exposure to naval personnel during and, particularly, following a nuclear weapons test is from radiation emission from the ship's boiler refractory linings which can encapsulate and fuse high levels of contamination via the very voluminous intake of combustion air when steaming in a fall-out zone.

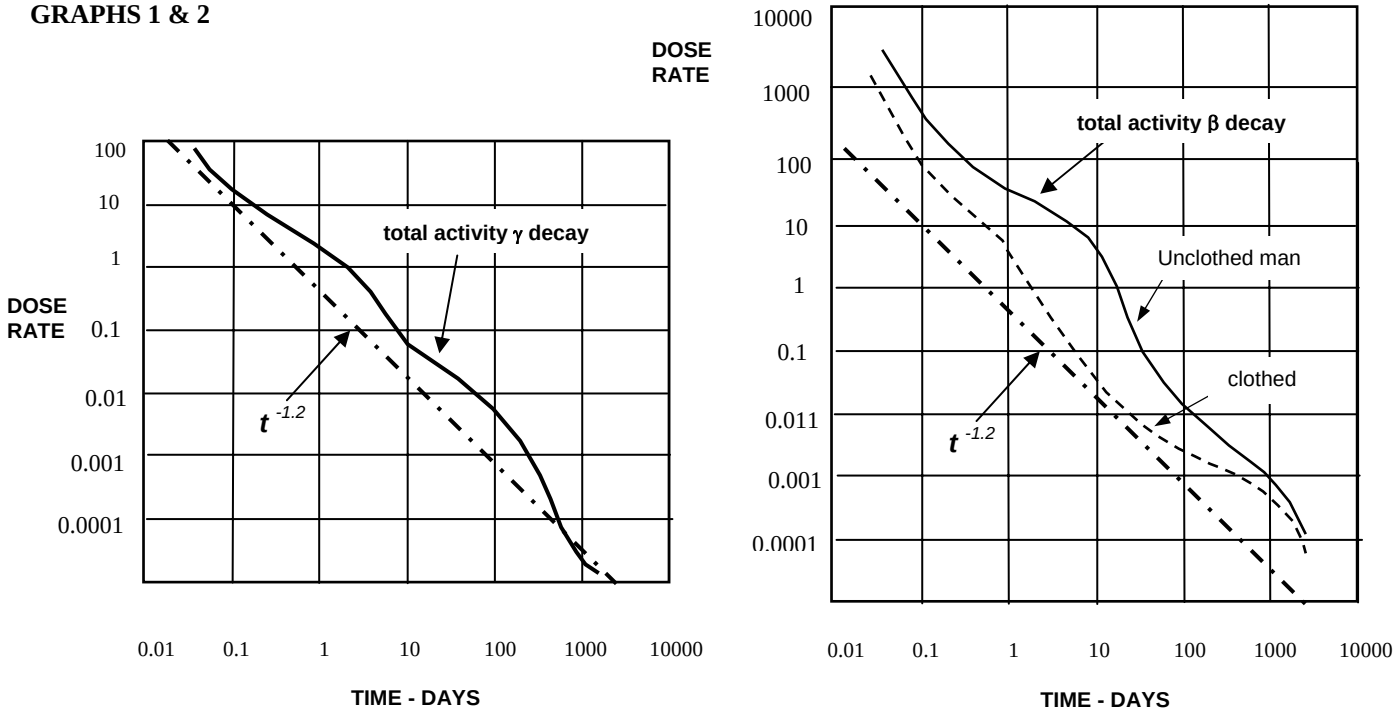
56 The current unit adopted for dose rate is Sievert per hour, more often expressed as milliSv/hr (one-thousandth Sv). At the time of Grapple, the equivalent unit was Rem/hr, although other units of measure, such as Rep/hr and Roentgens, were used at the time.

4.64 If, for example, an individual is present in an area where the dosimeter records a dose rate of, say, 0.5 Rem/hour then that individual will receive that rate of dose. If the individual stays in the area for 1 hour, the exposure will be (1 x 0.5=) 0.5Rem, if the individual stays longer, say for 24 hours, then the total exposure is (24x0.5=) 12Rem, and so on and so forth. The radiation dose received by the individual is referred to as the *Whole Body Dose*, that is from external radiation on the surface of the body and excludes any internal radiation emanating from within the body.

4.65 The whole body dose received over a prolonged time period is a little more complex[57] because the source of radiation comprises a menu of different radioisotope species, each of which has an individual radioactive decay characteristic (half-life). This means that as time passes the radiation dose rate will lessen in a non-uniform way as the shorter-lived radioisotopes decay more rapidly. The fall-out from a nuclear detonation comprises both short- and long-lived radioisotopes, with the short-lived β-γ isotopes dominating the radiation dose rate in the first few hours and days. To account for radioactive decay, either the overall (all nuclides) decay characteristic has to be back calculated from the time of monitoring and/or the monitoring has to be repeated periodically until the decay rate stabilises.

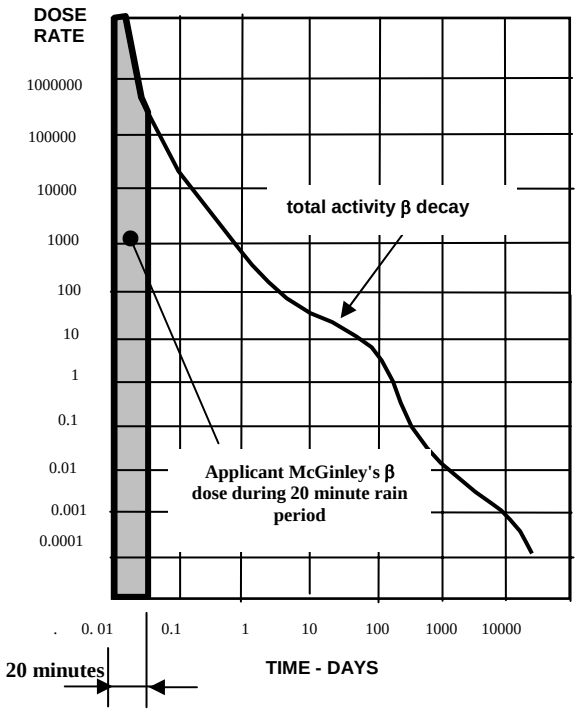
4.66 I have sketched out these rapid decay rates on Graphs 1 and 2:

GRAPHS 1 & 2



57 In the immediate aftermath of a nuclear detonation, the doses from β and γ emitters are very significant, whereas α emissions are not generally a hazard as far as external dose update is concerned. For β the thickness of clothing is an important factor in shielding human tissue, although scantily dressed personnel in tropical climates (as likely at the test sites) could be exposed to reddening of exposed parts of the skin - higher torso, face and neck, legs and, particularly, ankles from close proximity with ground deposited fall-out. The radioactive decay of γ emitters from a nuclear detonation is usually taken to follow the decay rate of $t^{-1.2}$ with time (t), although this is not an accurate prediction for the radiation levels for the first few minutes following the detonation (ie it gives a much lower result, particularly for β emitters). The primary source of fission product activity derives from the fissioning of the plutonium Pu^{239} fissile core of the weapon, but there are other reactions between neutrons and heavy elements which take place, giving U^{237} and U^{239} to Np*239* which give rise to appreciable dose rates at about 4 days.

4.67 Therefore, obviously, the task of the Health Physicist responsible for radiological safety at the test site would have been to monitor the occupied areas for radiation dose rate with a dosimeter, measuring β and γ emissions either separately or combined. These reading, taken over intervals of time, would give a construction similar to the two graphs above. The Whole Body radiation dose exposure for any individual within a radiation area could then be determined on the basis from at which time, and for the duration of time thereafter, the individual was within the radiation zone.



4.68 This simple and straightforward means of assessing the radiation hazard, and hence the radiation dose receipt, was clearly within the protocol set down for the Health Physicist (see Annex 8) so, on this basis, measurements must have been made and records kept.

4.69 However, the UK Government's submission does not include any such direct dosimeter dose rate records. Instead, Mr Eaton provides the records of what was, surprisingly, some very rudimentary sampling from deposition collectors and airborne monitoring from high flying aircraft. Put simply, instead of providing data (the dosimeter readings) which could be applied directly and without further ado, the UK Government provides some rather muddled, indirect data that requires further 'Retained' information to translate into the Applicants' dose exposure.

4.70 Moreover, the means of collecting the deposition samples, that is by squares of Sellotape (sticky tape) left exposed over a 24 hour period[58] was crude and unreliable, contrasting with the technique used at the earlier Mosaic tests of deploying rotary collectors.[59] The problem with the sticky tape deposition sampling is that the results were delayed by at least 7 to 14 or more days (28 days on some occasions) whilst the samples were in transit to the UK for counting. The results published in the Annexes give the (radio)activity at the time of counting and not at the time of deposition so, as shown by Graphs 1 and 2, the radiation levels would have decayed by at least two orders of magnitude over a typical 10 to 14 day delay.

4.71 At this point I detract from my line of enquiry to consider Applicant's McGinley claim of skin burning and blistering following his soaking by rainfall immediately after the Grapple Y detonation on 28 April 1958.

58 Just how effective Sellotape is as a particle collector is unknown to me, although I suspect that when left exposed in a sunny, hot climate much of the adhesive solvent would evaporate depleting the exposed surface of its 'stickiness' and thus lower the retention of fission product particles.

59 A rotary sampler comprises a radial tray of collector material which turns and slots into position under an open aperture for a given time period - this enables the fall-out dispersion to be determined over time units.

Appendix F (p17) of Annex 23 does not indicate any rainwater collection on the 28 April,[60] although Applicant McGinley is adamant that there was a sharp burst of rain within a minute or so following the detonation - as I referred to in Footnote 4 of my first Statement a bout of precipitation is not unusual following an atmospheric test detonation. This rain, formed at the ice-condensation front of the expanding fire ball, could (would most probably) contain fission products that had formed just earlier during the nuclear sequence (and which may be continuing to be formed in the weapons debris). As shown by the extended thumbnail sketch of **GRAPH 2,** the β radiations would be very high and products entrained in the rain could result in a high skin dose to the exposed parts of the body.

4.72 I believe this to be a reasonable explanation for the rashes and itchy blisters complained of by Applicant McGinley (and, incidentally, a number of other Grapple Y test participants).

4.73 Now returning to my line of enquiry: Annex 23, para 4.2 [4 - Grapple Y] states *"Included in the Appendices are the various results obtained at the date of measurement. No attempt has been made to evaluate the activity at deposition."*, thereby confirming that the published (radio)activity results (for Grapple Y at least) are at least 7 to 14 days into the rapid natural decay of **GRAPHS 1** and **2**.

4.74 It is also of interest to note that para 4.1.2 of Annex 23 states that *"Although sufficient equipment is available at Christmas Island it is inconvenient to do the counting there. It was therefore decided to do the work in the UK . . ."*, which could suggest that the background radiation levels at Christmas Island were sufficiently high to interfere with the counting process.

4.75 Effectively, this decay of radiation strength, or dose rate, means that unless the decay curves of **GRAPHS 1** and **2** are available for each particular test detonation, it is not possible to back-calculate the potential dose receipt for Applicant McGinley. Another problem with this method of monitoring is that each sample gives the radiation fall-out only for the immediately previous nuclear detonation, yet the total source of radiation dose on the ground derives from the cumulative fall-out of all previous nuclear tests on the Island.

4.76 So, in these important respects, I cannot rely upon the UK Government's submissions to determine Applicant McGinley's radiation dose receipt and, very certainly, I could not concur with Mr Eaton's statement that Applicant McGinley received no dose whatsoever through the period of April to September 1958, during which he was in continuous occupation of the Island.[61]

4.77 I note with interest that Appendix F of Annex 24 has not be included with the UK Government's submission - this appendix relates specifically to the issue under consideration since it gives the expected cumulative radiation dose receipt deriving from the four Grapple Z nuclear detonations for a number of cases of occupancy on Christmas Island of 1 year.

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60 Annex 23 does not give the precise location of the rainwater collector on Christmas Island, so it could be that the belt of rain passed over, or fell short of the collector.

61 I understand that Applicant McGinley was on Christmas Island from about February through to December 1958.

Cloud Shine Dose, Resuspension, Internal Dose and Other Means of Dose Uptake

4.78 In the previous section I have gone to some length to explain how external, whole body dose is received. The other routes of radiation dose receipt are similarly if not more complex and, particularly, for respired uptake of fine, sub-micron sized airborne particles such may result in significant longer-term health consequences.

4.79 However, for brevity, it is sufficient to state here that the Annexes do not provide sufficient information and data to enable these modes of radiation dose receipt to be assessed, particularly that there is a total absence of radionuclide assaying (ie identifying the menu of fission product species, ie strontium-90, iodine-131, plutonium-239, etc), which is important in respect to the route of dose uptake (ie resuspension and thereafter respiration) and reconcentration in specific organs of the body; measurement of the particle size deposited, again important to assess the possible internal organ uptake route; and the trajectory and height of the weapon debris cloud which could result in significant 'cloud' shine radiation dose.[62]

5 CONCLUSION

5.1 Overall, I find the information and data contained within the UK Government's submitted Annexes not to be of any significant help in assessing the potential dose receipt of the two Applicants.

5.2 As I have stated, there is no useful information relating to the potential exposure of Applicant Egan. For Applicant McGinley, the information provided contains too much variability, uncertainty and doubtfulness to provide a reliable basis for reconstruction of the radiation dose.

5.3 I would go so far as to state my opinion that the UK Government has been disingenuous in making this submission to the Court, in that it must know that the information that it has chosen to place before the Court is of no real use. Furthermore, I am very concerned that the UK Government has, apparently, selectively removed sections of the documents and chosen not to present other documents, all of which are likely to contain information and data which could be of use in reconstructing the Applicants' radiation dose.

62 *'Cloud-Shine'* is parlance for the radiation dose received on the ground from a cloud of radioactive particles passing or stationed overhead - ie the cloud is effectively a radioactive mass which emits radiation. During the first few hours following a nuclear detonation, cloud shine radiation will be high but the cloud or plume trajectory must be known relative to individuals positioned on the ground to determine this dose component - the UK submission gives only two examples of a cloud trajectory (Annex 29 - Grapple Z Pennant and Burgee). Annex 26 (para 3.5) refers to radiation from the overhead cloud interfering with the monitoring in that *". . . during the afternoon following the burst, the background level varied continually and was presumed to be due to large sections of the contaminated cloud overhead."* Interestingly, Annex 26 also identifies another source of radiation dose nearby (para 3.5) in that *"Another source of error probably lies in the fact that the background varied considerably due to the handling nearby of substantial quantities of radioactive materials."*.

5.4 With regard to the Sharp and Muirhead report, certain of the opinion expressed is accompanied by a caveat relating to an assumed low (or zero) radiation dose exposure of the Applicants, although the report does not quantify the actual level of radiation dose exposure assumed in arriving at the opinion. Since the UK Government's submission has not shown that the Applicants received very low, negligible or zero radiation dose, then caution should be applied to those Sharp and Muirhead opinions which are unsupported in this respect.

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20 November 2008

THIRD STATEMENT OF JOHN HENRY LARGE

1 QUALIFICATIONS AND EXPERIENCE

1.1 I have given my qualifications and experience in my First Statement, dated 21, September 1997.

2 INSTRUCTIONS

2.1 I received further instructions from Mr Ian Anderson, representing the Applicants, on 27 January 1999.

2.2 Mr Anderson explained to me that in its Comments to the Court on the Commission's request for a revision of judgement, that in responding to a request under Rule 6 of a Pension Tribunal for another nuclear test veteran (Mike Doyle), the UK Government withheld access to a number of reports (because it considered the reports to contain classified information or that it simply failed to respond).

2.3 I have no other information concerning Mr Doyle other than he, like Applicant McGinley, was a United Kingdom Services Personnel stationed on the Christmas Island at about the same time as Mr McGinley.

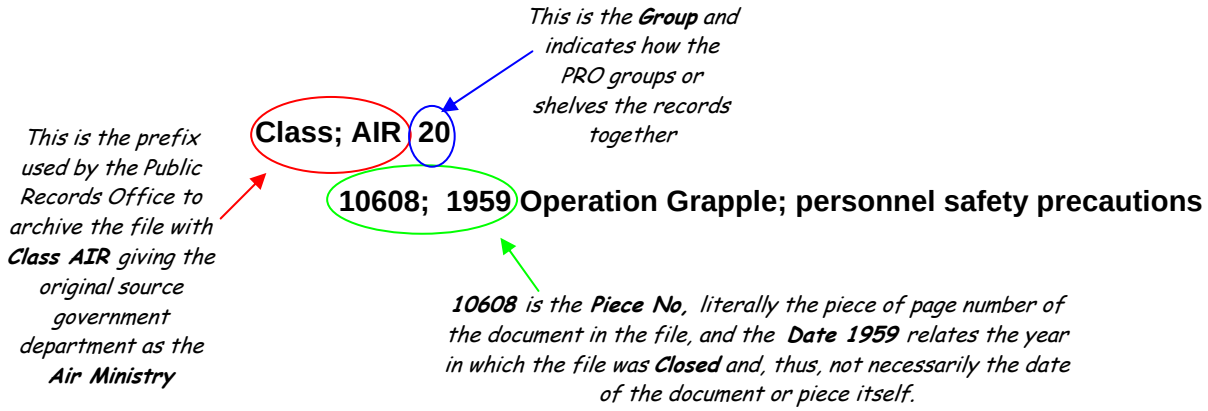
2.4 According to Mr Anderson, the UK Government Ministry of Defence reason for refusing Mr Doyle was that

> *". . . even if access had been obtained to these files (reports), their contents would have been irrelevant to support Mr Doyle's pension appeal.".*

2.5 Mr Anderson asked if I could comment on this allegation.

3 DECIPHERING THE FILES TITLES CITED BY MR DOYLE

3.1 Mr Anderson has presented 8 report titles in a format which requires some brief explanation. For example, the 1st report on Mr Anderson's list is presented as:



3.2 The first point I make is that the Public Records Office identifies, for its own referencing, the information by an annotation which includes the useful information of the originating government department (in this case the Air Ministry) and the year (1959) that the complete file was closed - this file closure date does not necessarily relate exactly to the date of the report under consideration.

3.3 Actually, a little more information is given by the UK Government's listing of the information itself, again for the 1st report on Mr Anderson's list, the information provided listed by the Ministry of Defence for the original report as follows:-

Operation GRAPPLE: Personnel Safety Precautions, GRA/TS8/26/AIR IVA/146/2/166(B), 1958

3.4 From this fuller listing I can glean a little more information about the contents and subject of the report. Here, for example, the subject year is 1958 and the Air Ministry is confirmed to be the most probable source of the report authorship.

4 POSSIBLE RELEVANCE OF THE FILES CITED BY MR DOYLE

4.1 Consider each of the report titles individually - I have added the other information available as in the example of paragraph 3.3 above:

Operation GRAPPLE: Personnel Safety Precautions, GRA/TS8/26/AIR IVA/146/2/166(B), 1958

4.2 Being sourced from the Air Ministry, this report probably relates to the radiation exposure and uptake of air crew and, again possibly, ground crew servicing/cleaning aircraft involved in the Grapple series of tests.

4.3 Unless Mr Doyle was involved with aircraft servicing/cleaning or, perhaps, stationed on the airfield nearby possibly contaminated aircraft, I doubt that this particular report would directly relate to the radiation exposure.

4.4 That said, it is quite astonishing that this report related radiation exposure protection, hardly an issue that would jeopardize state security, should remain classified and unavailable for public scrutiny now more than 40 years following the Grapple series of nuclear detonations.

Monthly Meetings with the Minister on Nuclear Test Matters, 1955-57, XY/112/02

4.5 This seems to be a series of minutes of briefings with the Ministry of Aviation which I would not have expected to have related directly or indirectly to the radiation dose exposure of Mr Doyle.

4.6 The reporting period ends just before (at) M Doyle's arrival on Christmas Island. Unless, the briefing minutes include reference to any residual ground/equipment contamination from previous tests, then it is unlikely that this relates directly to Mr Doyle’s radiation exposure.

Atomic Weapons: General Safety Conditions, XY/204/06, 1955-62

4.7 The title of this Ministry of Aviation series suggests that this relates to the rules and procedures for the handling of nuclear warhead assemblies prior to detonation.

4.8 I have no knowledge of any nuclear weapons 'accidents' at Christmas Island and, if so, this series of reports would not relate to Mr Doyle's radiation exposure.

Operation GRAPPLE: Consideration of Results, XY/204\06, 1951-58

4.9 Again, this seems to be a series of reports from the Ministry of Aviation which I would not have expected to have related directly or indirectly to the radiation dose exposure of Mr Doyle.

4.10 That said, there remains considerable uncertainty about the nuclear yield size and radiological impact of the *Grapple Y* test shot because of the acknowledged difficulties experienced with the aircraft drop trajectory - I review and discuss these issues in my 1st Statement of September 1997). Thus, this series of reports may relate to and assist in the reconstruction of Mr Doyle's radiation dose exposure.

Nuclear Accidents, Medical Arrangements, AF/CT1473/64 Part 1, 1959-64

4.11 As for my paragraph 4.4.

Radiation, Safety Aspects for Personnel, AF/CT2979/65 Part 1, 1959-65

4.12 As for my paragraph 4.2.

Radiation Hazards and Protections, AF/CT3483/64, 1960-68

4.13 This Air Ministry series most probably relates aircrew personnel, both flight and maintenance and, as previously explained, would be unlikely to relate Mr Doyle's exposure.

Document 11/1/79 1954

4.14 This document citation exists on my database as a group of 4 related reports:

AB6 Research on the biological effects of atomic energy, AERE, 11/1/1/79 Part 1, 1948-1954
AB6 Research on the biological aspects of atomic energy, AERE/UKAEA, 11/1/1/79 Part 2, 1954
AB6 Biological Investigation into the Genetic Effects of Radiation, AERE, 11/1/1/79(2), 1954-1959
AB6 Agricultural Res. - radioactive contamination of food & water, AERE/UKAEA, 11/1/1/79(3), 1953-1958

4.15 On the assumption that the above citation is correct, these documents are likely to contain information and indication of knowledge and understanding of the time that would be highly relevant to the radiation exposure of Mr Doyle. Although the source organisation is the Atomic Energy Research Establishment (AERE), the head of which was Cockcroft at the time, there were close and collaborative links between the AERE and the Atomic Weapons Research Establishment (AWRE) at the time.

4.16 The Monto Bello connection is via the work of the AWRE (W J Buttefield) who was able to complete a number of experiments relating to ground contamination to radiation dose exposure of personnel passing over the ground (see Endnotes 10 and 12 of my 2nd Statement)

5 CONCLUSIONS

5.1 Of course, since I cannot see the actual contents of these reports my opinion carries no certainty of reliability whatsoever.

5.2 In the exact sense, I doubt if any of these reports specifically and directly refers to Mr Doyle (by name) nor his radiation dose uptake (expected in anticipation or measured whilst he was on Christmas Island.

5.3 In the direct sense of relating Mr Doyle as a member of a group of services personnel (ie aircrew, aircraft maintenance, cleaning, etc.,), unless Mr Doyle was somehow involved in aircraft operations, then most of these reports would be unlikely to relate to his radiation dose uptake.

5.4 However, that said, all of these reports must provide a further insight into the UK Government's then (c1958) understanding of radiation exposure, its harmful effects and to what extent its duty to safeguard the health and safety of its services personnel was compromised by the manner in which it chose to conduct its nuclear weapons atmospheric test programme.

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19 February 1999

FOURTH STATEMENT OF JOHN HENRY LARGE

1 QUALIFICATIONS AND EXPERIENCE

1.1 I have given my qualifications and experience in my First Statement, dated 21, September 1997.

2 INSTRUCTIONS

2.1 I received further instructions from Mr Ian Anderson, representing the Applicants, on 27 January 1999.

2.2 Mr Anderson explained to me that in its Comments to the Court on the Commission's request for a revision of judgement, that in responding to a request under Rule 6 of a Pension Tribunal for another nuclear test veteran (Mike Doyle), the UK Government withheld access to a number of reports (because it considered the reports to contain classified information or that it simply failed to respond).

2.3 According to Mr Anderson, the UK Government Ministry of Defence reason for refusing Mr Doyle was that

> *". . . even if access had been obtained to these files (reports), their contents would have been irrelevant to support Mr Doyle's pension appeal. . . . "*

2.4 Mr Anderson asked if I could comment on this allegation.

3 THE CLASSIFIED FILES

3.1 I have to admit that from the file titles alone it is not possible for me to give a reliable opinion on whether or not (and by how much) Mr Doyle would have learnt more about his potential radiation dose exposure if he had been granted access to the files.

3.2 That said, those file titles that include reference to 'personnel *safety precautions'*, *'radiation; safety aspects for personnel'* , *'radiation hazards and protections'* and which give reference to the *'medical problems following the Monte Bello and Totem tests',* would provide a greater understanding of the radiological management regimes adopted at the time and, particularly, how these might have catered for the radiation environment during and in the aftermath of the individual tests conducted at Christmas Island.

3.3 What I do find surprising is that, after more than 40 years have past, the UK Government still considers it necessary for this information to remain withheld from public accessibility and scrutiny.

3.4 I am surprised because the type of information held within such files can only relate to very dated technology which would not be of any real use today (ie because it is already common knowledge). Moreover, the files that relate to radiation safety and protection would not relate the nuclear weapons technology in any meaningful detail but, as I emphasised in my 2nd Statement, this information would enable a better understanding of both the radiological environment and most likely levels of radiation dose receipt, all of which would contribute to a possible reconstruction of the radiation dose received by the Applicants.

3.5 With respect, could I suggest that the Court question for what possible reason the Doyle documents were not released at the time requested and, of greater relevance to Applicants McGinley and Egan, why the UK Government continues to withhold documents asked of it in this matter (those I have listed in my 2nd Statement), the absence of which hinders a proper and factual resolution of this matter.

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