UK atmospheric nuclear weapons tests

Factsheet 5: UK programme

UK atmospheric nuclear tests

From information available, the Ministry of Defence estimated that only about 10% of all participants were likely to have been exposed to measurable levels of ionising radiation. The relevant groups of personnel, in order of the likelihood of exposure, were:

- RAF aircrews involved in sampling from airburst clouds (205 men); Mosaic, Totem, Buffalo, Antler, Grapple.

- RAF decontamination flight crews who sluiced the aircraft (129 men).

- RN personnel on HMS Diana when she sailed through the fallout at Operation Mosaic (282 men).

- The officers of the Buffalo Indoctrinee Force (IF) and Target response group. They assembled to observe at first hand the effects of the detonation (249 men). At the first Buffalo round, the IF were positioned at North Base, 8.5 km from ground zero. At the second round, most members of the IF had departed, but 24 officers were positioned at 1.7 km, and 70 officers were at 2.7 km. There were no indoctrinees present at rounds 3 and 4 of Buffalo.

- Others – with recorded exposures greater than zero (1123 men).

The total of the five groups equals almost 2,000 men.

A nuclear explosion can produce effects on health via visible light, heat, air blast and ionising radiation.

The visible light from a nuclear detonation can cause flash-blindness at considerable distances and permanent eye injury at short ranges. (There is no absolutely safe range for this effect). Protection at UK trials was assured by mustering all persons and ordering them to face away from the detonation with eyes covered.

The heat from a nuclear detonation can cause first-degree burns to bare human skin at ranges up to three kilometres from a ten-kiloton detonation or twenty-one kilometres from a one-megaton detonation. Protection is by maintaining a sufficient distance.

Air blast is unlikely to cause injury to a person more than three kilometres from a ten-kiloton burst or six kilometres from a one-megaton burst. Protection is again by maintaining a sufficient distance.

The ionising radiation exposure associated with nuclear detonations is of two types. First, a large pulse of radiation is emitted by the device as it explodes. This is absorbed by the air over distances of a few kilometres. To be close enough to receive a significant dose of ionising radiation an individual would also be within the lethal range of the air-blast and heat. Second, ionising radiation, under certain circumstances, is also emitted by the radioactive particulate fallout. The fallout particulates are carried downwind after the detonation. Wherever possible, UK trial detonations were carried out as high air-bursts to minimise fallout. All UK atmospheric nuclear trials devices produced yields at, or very close to, the design figure.

Specialist instrumentation was used at the trials to measure ionising radiation. Personal dosemeters, designed to estimate the dose to an individual from photons and beta particles, were carried for typically a month. The film badge consists of a piece of photographic film, sealed in a light-tight package bearing a unique number, and contained in a cassette adapted for securing to the clothing. Exposure to ionising radiation causes blackening of the film. After conventional photographic development, the film is compared with a standard and an estimate of dose obtained. It is sensitive to photons (gamma rays and X-rays), beta particles and low-energy neutrons, and can distinguish between them.

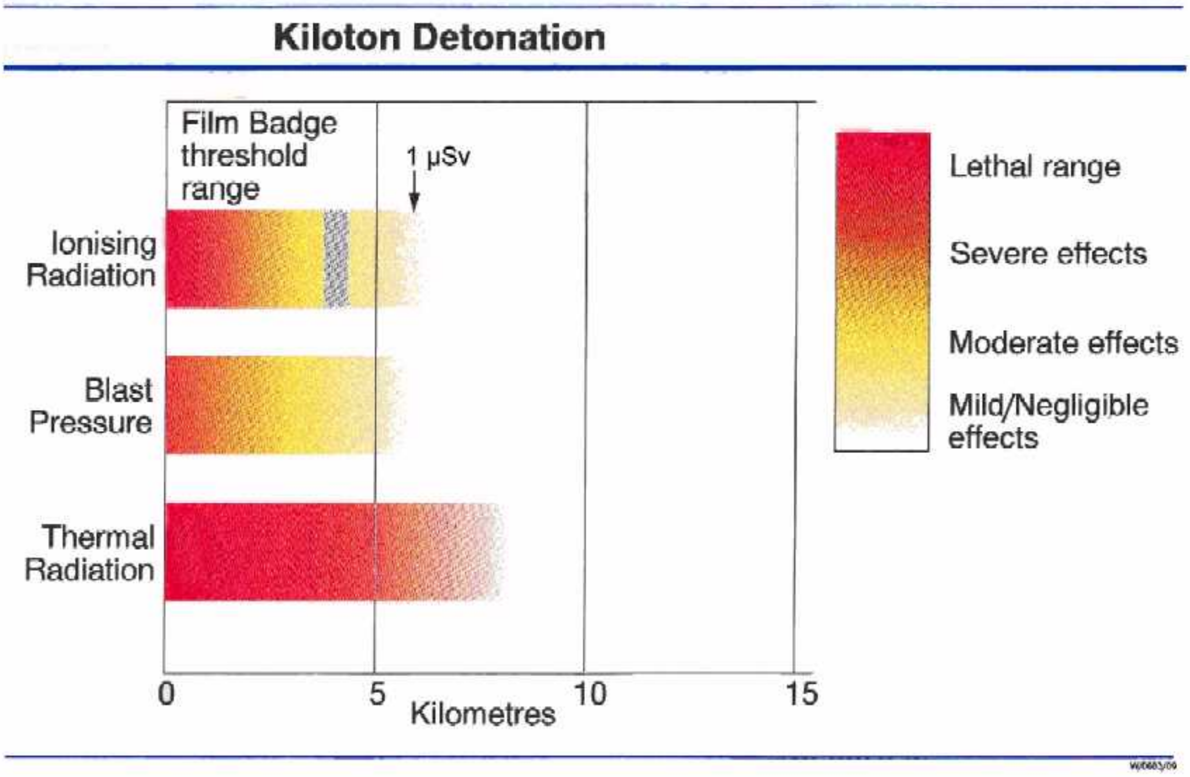
The Atomic Weapons Establishment, Aldermaston holds the film badge records of the test participants. Badges were not issued to all personnel: the Ministry of Defence estimates that 21% of total participants had badges. In general more badges were issued for the earlier tests (96% of those present at Operation Hurricane had a badge while only 20% of those at Operation Grapple). The reducing percentage of people monitored was informed by the actual exposure levels and characteristics of preceding operations. In general only those men most likely by the nature and location of their duties to be exposed to measurable doses were monitored. Not all of those monitored showed a recordable dose. Fewer than 500 individuals received 5 mSv or more and about 80 of these received 50 mSv. Doses recorded refer to the entire test programme for the individual, and in some cases this will be several years. Of the 80, the majority were RAF crew who took part in cloud sampling.

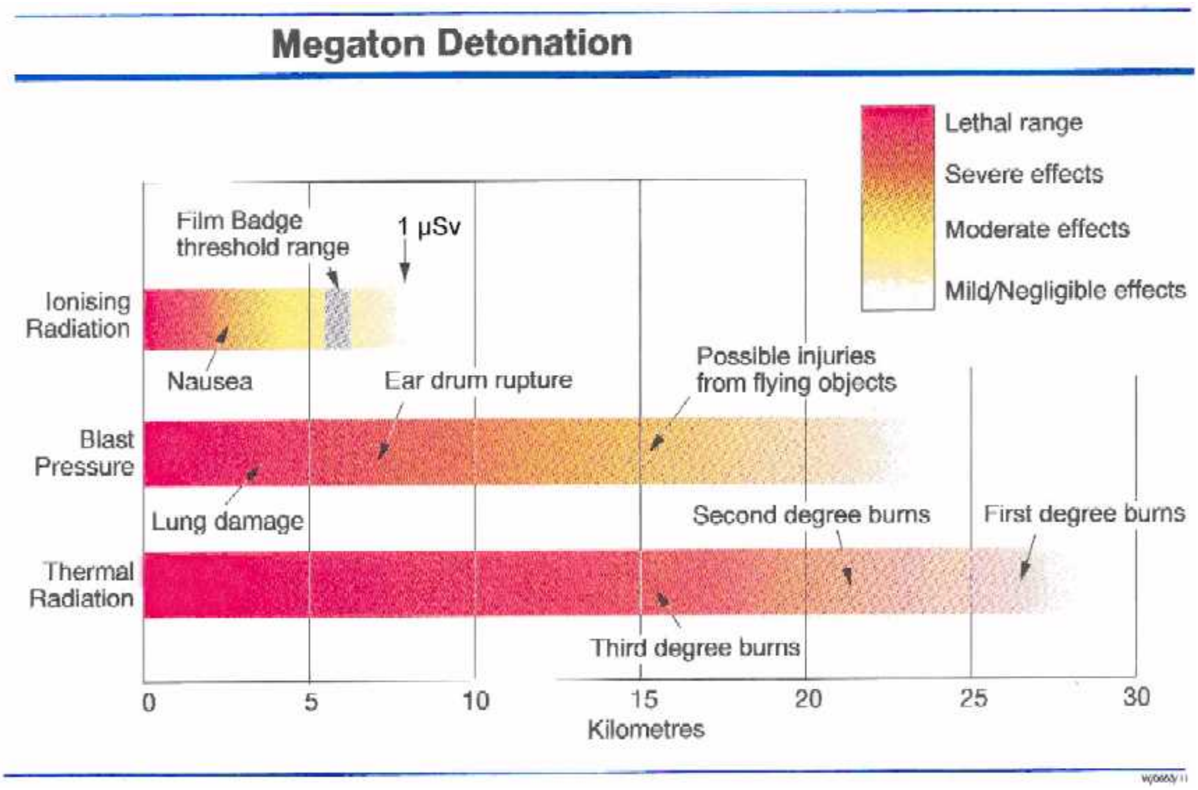
Doses of ionising radiation can also arise by internal contamination, through breathing or swallowing contaminated dust. Although alpha-emitting materials would be the most hazardous in this respect, they are a very small component of fallout compared with beta and photon-emitting materials. The risk of internal dose was minimised at the trials by ensuring that only essential and fully-protected personnel were ever in areas where internal contamination was possible. In addition, while a film badge did not measure internal dose directly, to receive a significant internal dose an individual would have to enter an area where there were high levels of resuspendable fallout emitting photon and beta radiation. It is highly unlikely that this could happen without at the same time there being a measurable external dose received as indicated by his film badge.

The Ministry of Defence records identified those men present at the minor Maralinga trials who were at highest risk of radionuclide ingestion or inhalation. There were 847 in total. In the NRPB study, this group was considered separately. It did not show any increased risk of multiple myeloma, leukaemia or other malignancies relative to the rest of the participant group.

In conclusion, almost all the British servicemen involved in the UK nuclear tests received little or no additional radiation as a result of participation. If personnel who served at Christmas Island at that time had been stationed in the UK in an average location, their dose of naturally-occurring ionising radiation would have been three times *greater* than it was at Christmas Island.

Safe distances are indicated on page 3.


Kiloton Detonation
Film Badge threshold range
1 µSv
Ionising Radiation
Blast Pressure
Thermal Radiation
0
5
10
15
Kilometres
Lethal range
Severe effects
Moderate effects
Mild/Negligible effects


Megaton Detonation
Lethal range
Severe effects
Moderate effects
Mild/Negligible effects
Film Badge threshold range
1 µSv
Ionising Radiation
Nausea
Ear drum rupture
Possible injuries from flying objects
Blast Pressure
Lung damage
Second degree burns
First degree burns
Thermal Radiation
Third degree burns
0
5
10
15
20
25
30
Kilometres

UK atmospheric nuclear weapons tests

Factsheet 5: UK programme

KEY EVENTS IN THE UK ATMOSPHERIC NUCLEAR TEST PROGRAMME

BACKGROUND EVENTS:

1947 Jan Ministerial decision on UK weapon production

1948 May Decision disclosed to UK Parliament

1953 Nov First UK nuclear weapon in service (RAF)

1955 Feb Government announces decision to develop H bomb

TESTS IN AUSTRALIA:

1951 Mar Australian Government approval sought to use Monte Bello Island for tests

1952 Oct First UK test on 3 October – code named "Hurricane"

1953 Sep Minor trials at Emu Field on Australian mainland

1953 Oct Next two UK tests, known as "Totem 1 and 2" on 14 and 26 October, at Emu Field

1955 May Permanent test site at Maralinga announced

1955 Jun Minor trials start at Maralinga

1956 May UK conducts tests "Mosaic 1 and 2" on 16 May and 19 June at Monte Bello

1956 Sep "Buffalo" tests at Maralinga (four shots on 27 Sept, and 4, 11 and 21 October; Buffalo 3 was the first UK airdrop test

1957 Sep "Antler" tests at Maralinga, 3 shots (14 and 25 September and 9 October)

Minor trials continued in short annual campaigns until May 1963.

RELATED ISSUES IN AUSTRALIA:

1967 Aug The final UK clean-up operation at Maralinga completed (Operation Brumby in May to Aug 67)

1984 Jul Australian Royal Commission (ARC) established

1985 Nov ARC Report published

1986 Feb Post-ARC Technical Assessment Group (TAG) established with UK membership; study of options and costs of decontamination and rehabilitation of Emu and Maralinga

1989 Mar TAG reports to Australian ministers

UK atmospheric nuclear weapons tests

Factsheet 5: UK programme

1993 Dec UK Government agrees to pay £20M on an *ex-gratia* basis toward the cost of site rehabilitation

2003 Mar Report into the clean up of Maralinga published in Australia. The Australian Science Minister reports to Federal Parliament that the land at Maralinga can be handed back to its traditional owner, the Maralinga Tjarutja

CHRISTMAS ISLAND RADIOLOGICAL SURVEYS:

1964 Jun Surveyed by Atomic Weapons Research Establishment (AWRE)

1975 Sep Surveyed by Washington State University for Gilbert Island Government

1981 Mar Surveyed by New Zealand Department of Health for the Kiribati Government (Christmas Island is now known as the Kiribati Republic)

Ongoing MOD has agreed to carry out the collection and removal of materials associated with the nuclear test programme's construction and accommodation works. Defence Estates is managing the clean-up project using commercial specialists (Safety and Ecology Corporation (SEC) Ltd). Completion of clean-up of the site is expected in 2007

HEALTH STUDIES:

1983 MOD commissioned NRPB Study of UK test veterans

1983 Nov Australian Government study published (no detriment to health reported)

1988 Jan NRPB Study (R214) published; reported no detriment to health except a possible risk of leukaemia and multiple myeloma

1990 Mar New Zealand study published; reported no detriment to health except some risk of leukaemias and possible other hematologic cancers

1993 Nov NRPB second study reported (R266); reported no detriment except possible small risk of leukaemia in the first 25 years following exposure

2003 Feb NRPB third study reported (W27); concluded that overall levels of mortality and cancer incidence in UK nuclear weapons test participants have continued to be similar to those in a matched control group and for overall mortality to be lower than expected from national rates.

UK atmospheric nuclear weapons tests

Factsheet 5: UK programme

UK NUCLEAR TESTS

AUSTRALIA:

Test Codename	Date			Yield	
HURRICANE	3	Oct	1952	25	kilotons (kt)
TOTEM	14	Oct	1953	10	kt
	26	Oct	1953	8	kt
MOSAIC	16	May	1956	15	kt
	19	Jun	1956	60	kt
BUFFALO	27	Sep	1956	15	kt
	4	Oct	1956	1.5	kt
	11	Oct	1956	3	kt
	21	Oct	1956	10	kt
ANTLER	14	Sep	1957	1	kt
	25	Sep	1957	6	kt
	9	Oct	1957	25	kt

PACIFIC OCEAN:

GRAPPLE	15	May	1957	0.3	Megatons (Mt)
	31	May	1957	0.72	Mt
	19	Jun	1957	0.2	Mt
GRAPPLE X	8	Nov	1957	1.8	Mt
GRAPPLE Y	28	Apr	1958	3	Mt
GRAPPLE Z	22	Aug	1958	24	kt
	2	Sep	1958	1	Mt
	11	Sep	1958	0.8	kt
	23	Sep	1958	25	kt

UK atmospheric nuclear weapons tests

Factsheet 5: UK programme

Glossary

Absorbed dose See **dose.**

Acute radiation syndrome (ARS) The onset, within hours of high **dose** whole body **irradiation,** of nausea and vomiting followed by destruction and diminished (or absent) replacement of essential blood cells resulting in vulnerability to serious infection and bleeding; recovery is possible but with increasing **doses** these effects are more severe and death is more likely.

Alpha particle A particle consisting of two protons plus two neutrons; emitted by a radionuclide.

Background radiation **Ionising radiation** from naturally occurring **radionuclides** both in the environment (from soil, rock and building materials and from space – cosmic radiation) and in the body.

Beta particle An electron emitted by the nucleus of a radionuclide. The electric charge may be positive, in which case the beta particle is called a positron.

Contamination The suspension in air or deposition of **radionuclides** upon, or in, the ground, water and other surfaces, and personnel and equipment

- **External contamination** Of a person or equipment - deposition, general or localised, of **radionuclides** upon all or any of clothing, hair, skin and/or equipment
- **Internal contamination** Of a person - deposition within the body, usually by inspiration, by ingestion or sometimes through penetration of (usually broken) skin by **radionuclides** which will then **irradiate** the cells of surrounding body tissues.

Cosmic rays High-energy ionising radiation from outer space.

Decay The process of spontaneous transformation of a radionuclide; the decrease in the activity of a radioactive substance.

Dose The amount of **ionising radiation** received, as deduced from the energy absorbed from an external radiation source

- **Absorbed dose** Quantity of energy imparted by ionising radiation to unit mass of matter such as tissue. Unit is the gray, symbol Gy. 1Gy = 1 joule per kilogram
- **Equivalent dose** The quantity obtained by multiplying the absorbed dose by a factor to allow for the different effectiveness of the various ionising radiations in causing harm to tissue. Unit is the sievert, symbol Sv
- **Effective dose** The quantity obtained by multiplying the equivalent dose to various tissues and organs by a weighting factor appropriate to each and summing the products. Unit is the sievert, symbol Sv.

Dosemeter A small device worn on the person to measure absorbed energy and from which a record of **Absorbed Dose** may be obtained.

Dosimetry The estimating, recording and maintaining of records of **dose.**

Emitter A **radionuclide** decays by emission of certain radioactive particles and/or electromagnetic radiation. A particular **radionuclide** may be described as an **alpha** or **beta** or **beta/gamma** emitter.

UK atmospheric nuclear weapons tests

Factsheet 5: UK programme

Fallout The transfer of radionuclides produced by nuclear weapons from the atmosphere to earth; the material transferred.

Fission products The two, invariably radioactive, fragments remaining after an atom has been split (undergone fission).

Gamma ray A discrete quantity of electromagnetic energy without mass or charge, emitted by a radionuclide; similar to an X-ray but with higher energy.

Ionising radiation Radiation that produces ionisation in matter; examples include alpha particles, gamma rays, X-rays and neutrons. When these radiations pass through the tissues of the body, they have sufficient energy to damage the DNA.

Ionisation The process by which a neutral atom or molecule acquires or loses an electric charge; the production of ions.

Monitoring The process of searching for the presence of radiation and then measuring, reporting and recording radiation **dose rates** found within a given area or on a person.

Neutron A nuclear particle (similar to a proton but without electrical change); emitted during fission and fusion by only a few **radionuclides;** long range (kilometres) in air and highly penetrating; an external **hazard** only at detonation; densely **ionising.**

Non-ionising radiation Radiation that does not produce ionisation in matter; examples include ultraviolet radiation, light, infrared radiation and radiofrequency radiation. When these radiations pass through the tissues of the body they do not have sufficient energy to damage the DNA directly.

Radiation weighting factor (RWF) A factor intended to take account of the relative biological effectiveness of different types of radiation according to both their energies and how densely ionising they are.

Radionuclide An unstable nuclide (atomic nucleus) that emits ionising radiation.

X-ray A discrete quantity of electromagnetic energy without mass or charge, emitted by an X-ray machine; similar to a gamma ray but with lower energy.