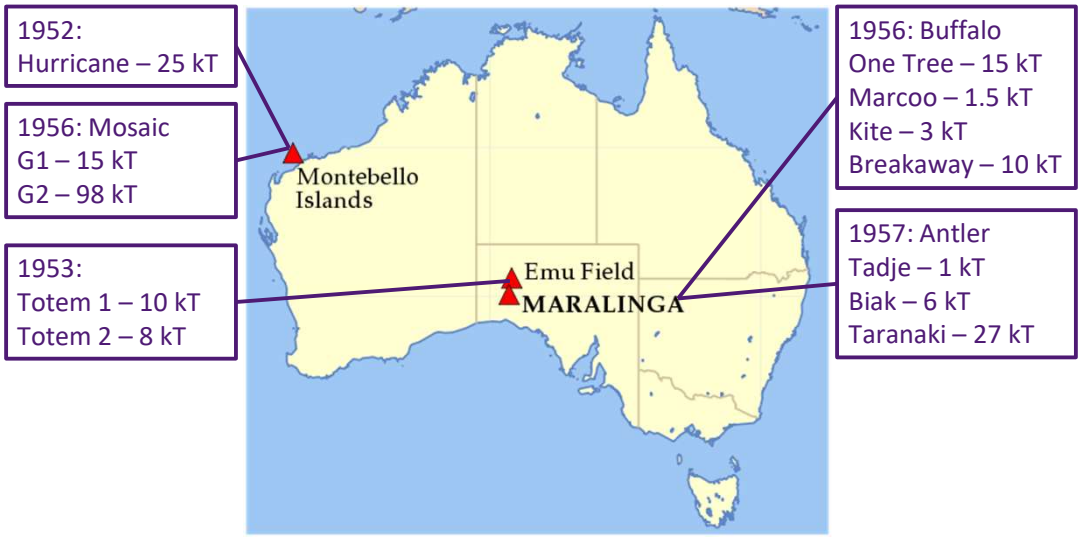
Stakeholder Driven Remediation

The Maralinga Rehabilitation Project Case Study

Stephen Long

ICRP

British Nuclear Weapons Testing in Australia



ICRP

Hurricane was the 'proof of concept' test and was a hurried affair.

The Totem tests used improved fuel and had better instrumentation

Mosaic tested fusion fuels for MT weapons (The actual yield of the G2 test was concealed until 1984 as it was greater than the agreed limit)

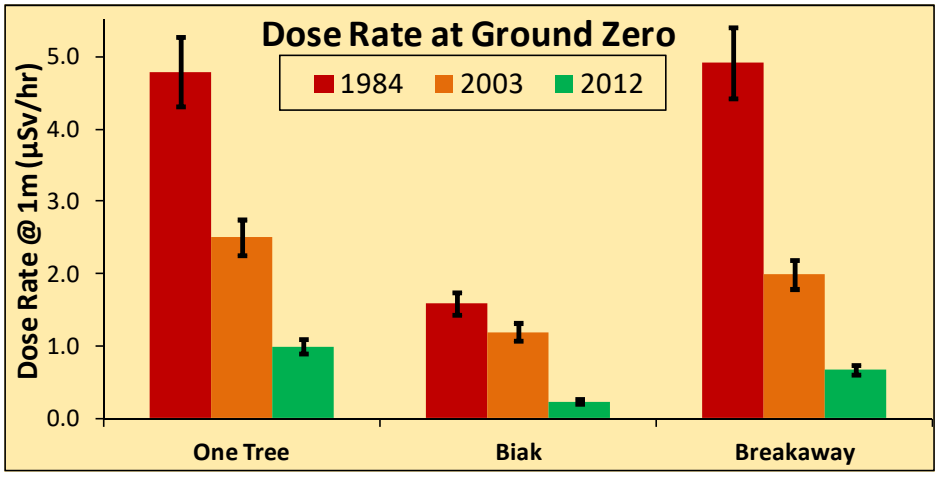
Testing moved to Maralinga for logistics reasons.

H-Bomb tests conducted on Christmas Islands in 1957 and 1958

Joint testing with USA after 1958.

Residual Contamination from Weapons Tests

Fission and
Neutron Activation Products



ICRP

3

Most radioactive material transported to upper atmosphere and deposited across the globe

Some local fallout around ground zero

The Real Contamination: The Minor Trials

- Five types of Minor Trials
  - large-scale scientific and engineering experiments
- Many series conducted between 1955 and 1963
  - Kittens: weapon initiator experiments
    - Alpha-emitters forced into beryllium by compression from chemical explosion
  - TMs: tamper compression experiments
    - Study of explosive compression of uranium
  - RATS: Similar to TMs
    - Intense gamma-source buried in material prior to explosion – high-speed radiography
  - Vixen A: Studies of dispersion of weapon material due to fire or explosion in storage
  - Vixen B: Studies of dispersion of weapon material due to accidental detonation
- All effectively Radiation Dispersion Devices

ICRP

4

Kittens, TMs and RATS were large-scale experiments to develop weapon components.

The Vixen experiments were to determine the extent of contamination caused by accidents in weapons storage areas.

Toxic Materials Used in Minor Trials

Series	Location	Toxic Material						
		Pu-239 (kg)	**Uranium (kg)**	Po-210 (TBq)	Sc-46 (TBq)	Pb-212 (TBq)	Ac-227 (TBq)	Be (kg)
Kittens	Naya	-	120	210	-	-	-	0.75
TIMS	TMs	1.2	172	-	-	-	-	-
	Kuli	-	7700	-	-	-	-	>28
	TM50	-	90	-	-	-	-	10
RATS	Dobo	-	28	-	3.7	4.4	-	-
	Naya	-	170	15	75	-	-	-
Vixen A	Wewak	0.98	57	-	-	-	5	8
Vixen B	Taranaki	22	22	-	-	-	-	18

Pu used in these Trials also contained Pu-241
Pu-241 decays to Am-241 (Half-life = 14 years)
Am-241 used as proxy for Pu-239 via measured ratio

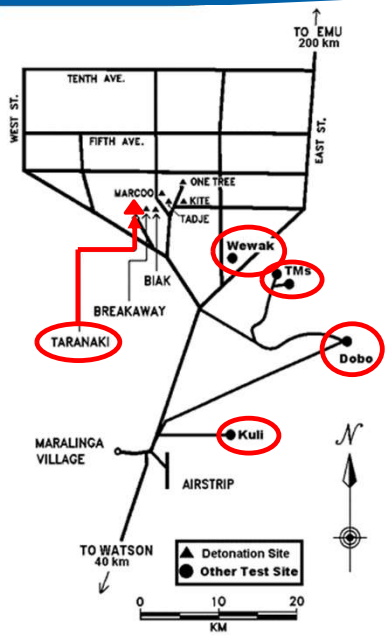
ICRP

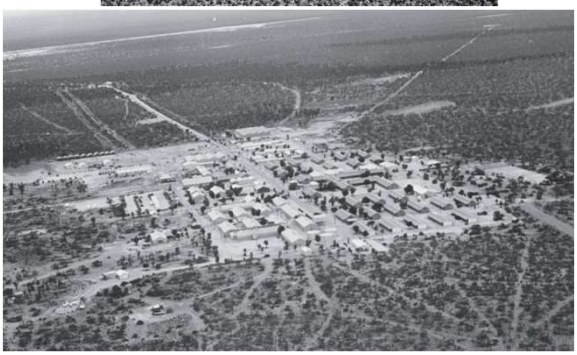
5

The plutonium used was essentially only chemically separated and had the isotopic ratios created in the reactor.

The uranium was primarily depleted uranium or natural uranium. No evidence of enriched uranium has been found.

The Maralinga Test Site





6

Naya is south of TMs

The airstrip was certified as a secondary landing area for the space shuttle

By 1959, the Maralinga village would have accommodation for 750 people, with catering facilities that could cope with up to 1,600.

There were laboratories and workshops, shops, a hospital, church, power station, post office, bank, library, cinema and swimming pool. There were also playing areas for tennis, Australian football, cricket and golf.

Watson is on the rail line between Adelaide and Perth.

Emu is the site of the 1953 weapons tests.

A Brief History of Maralinga: The UK Years

1953: Reconnaissance for permanent Test Site

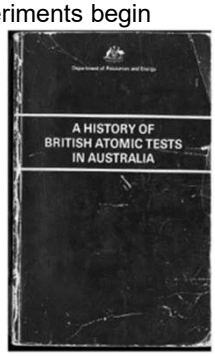
1955: Large-scale scientific and engineering experiments begin

1956: **Memorandum of Arrangements signed**

Nuclear weapons tests begin

1958: **Moratorium on Nuclear Testing**

Participation in US Program



Author: J. L Symonds
ISBN-13: 9780644041188
ISBN-10: 0644041188
Australian Government Publishing Service

1963: **Partial Nuclear Test Ban Treaty**

1964: Operation Hercules: 'clean-up' program

1966: Operation Radsur: site survey

1967: Operation Brumby: site remediation

UK relinquishes site to Australia

1968: Pearce Report on residual contamination

ICRP

The Pearce Report calculated that 20 of the 22 kg of Plutonium used was buried in pits during Operation Brumby.

This was subsequently shown to be a gross overestimate (by more than an order of magnitude!) – more than 20kg was still spread over tens of square kilometres.

A Brief History of Maralinga: Post-Brumby

1971: **Cessation of maintenance by Australian military**

1973: Atomic Weapons Tests Safety Committee advice on contamination

Government supervision ceases

1979: Australian Ionising Radiation Advisory Council recommendations

Government supervision reinstated

1983: **Australian Government determines to return land to traditional owners**

1984: **ARPANSA (ARL) discover serious Pu contamination**

Kerr Committee recommends public enquiry

Royal Commission established

1985: **Royal Commission recommends further remediation**

1986: **Maralinga Consultative Group formed**

Technical Assessment Group formed

1990: TAG report published

1993: **UK agrees to contribute AU$45M to rehabilitation**

Maralinga Rehabilitation Technical Advisory Committee formed

1994: Traditional Owners compensated

1995–2000: **Maralinga Rehabilitation Project**

2009: Traditional Owners take control of Maralinga

2002–Present: **Maralinga Land and Environment Management Plan**

ICRP

8

AWSTC accepted the Pearce report and recommended removal of all fences and notices identifying contaminated areas.

AIRAC accepted the Pearce Report but recommended that areas with high dose rates should be marked, those areas where radioactive waste was buried should be fenced and that the public should not be able to access these areas.

In 1983, the Australian government had determined to return the site to the traditional aboriginal owners.

A team of scientists from ARPANSA (then ARL) went to check the radioactivity at Maralinga prior to hand-over of the site. The group was stunned to find levels that were higher and spread more widely than Pearce had described. They also found the first of many fragments of contaminated equipment spread on the surface. One piece of steel was contaminated with 3 grams of plutonium!

Report of the Royal Commission available as PDF from Australian Parliament:

Volume 1:
https://parlinfo.aph.gov.au/parlInfo/download/publications/tabledpapers/HPP032016010928/upload_pdf/HPP032016010928.pdf;fileType=application%2Fpdf#search=%22publications/tabledpapers/HPP032016010928%22

Volume 2:
https://parlinfo.aph.gov.au/parlInfo/download/publications/tabledpapers/HPP032016010929/upload_pdf/HPP032016010929.pdf;fileType=application%2Fpdf#search=%22publications/tabledpapers/HPP032016010929%22

Volume 3:
https://parlinfo.aph.gov.au/parlInfo/download/publications/tabledpapers/HPP032016010930/upload_pdf/HPP032016010930.pdf;fileType=application%2Fpdf#search=%22British%20Nuclear%20Tests%20in%20Australia%20-%20Royal%20Commission%22

Maralinga Consultative Group

Formed to facilitate stakeholder participation

- Involvement of local community and traditional landowners to develop the remediation reference level and the extent of remediation undertaken
- Open and frank communication using non-technical but clearly understood language
- Lifestyle (anthropological) studies to inform the modelling of exposure scenarios
- Understanding of the expectations of the local community for the future rehabilitation actions
- Ongoing feedback from interested parties on the details of the remediation and rehabilitation
- Ongoing consultation prior to, during and following the remedial actions

ICRP

9

Comprised of representatives of:

- Australian Government
- British Government
- South Australian Government
- Western Australian Government
- Maralinga Tjarutja (traditional owners of the Maralinga and Emu lands)

Technical Assessment Group

Expert Scientists: 2x Australian, 2x British, 1x American

- Determine the nature of the hazard - external dose, inhalation, particles.
- Characterise the contamination through field & laboratory studies – particle size distribution, dust loadings, radionuclides present, solubilities and chemical properties.
- Effects on the environment - uptake by plants & animals.
- Spatial extent of the contamination - aerial and ground-based surveys.



ICRP

TAG instigated a series of laboratory and field studies that allowed it to develop:

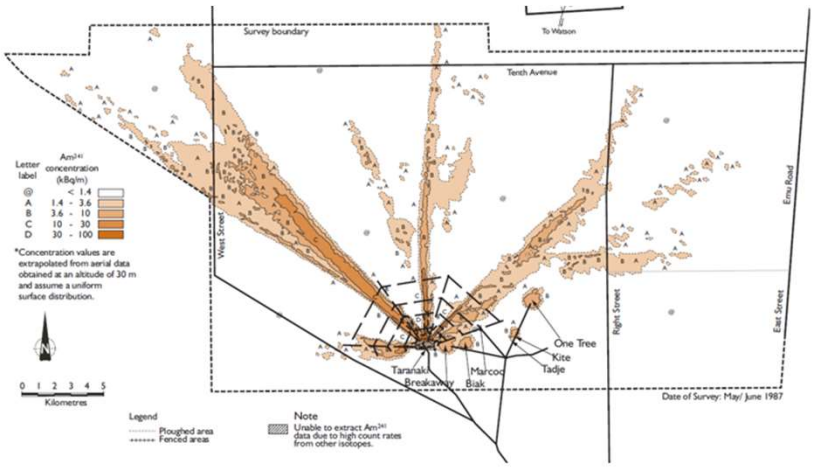
- Clearance criteria for the sites.
- Engineering options and costs for rehabilitation works.

Utilised expertise in ARPANSA and ANSTO and international collaborators (e.g. EG&G Ortec)

Technical Assessment Group (TAG) Tasks

Understand the issue and propose clean-up options and costs for Maralinga.

- Source term definition
- Determine bioavailability
- Identify exposure pathways
- Dose Assessment
- Evaluate uncertainties



Am-241 contamination at Taranaki
(Proxy for Pu-239 contamination)

ICRP

11

Note that each plume is approximately 20 km in length!

MCG Considerations for Remediation

- Maralinga Range is not acceptable without remediation
- Enable traditional owners access with minimal restriction
- Most significant hazard on site is the plutonium contamination
  - Primarily an inhalation hazard
  - Critical group is infants living semi-traditional lifestyle
- Minimise removal of vegetation and soil due to environmental damage
- Only the highest levels of contamination to be treated by soil removal
- Accept that some areas may be unsuitable for permanent occupation

ICRP

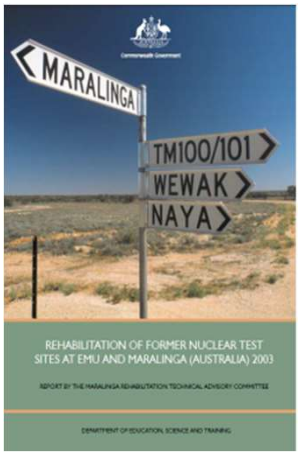
Traditional owners have a significant cultural relationship with the land.

Significant land clearing is incompatible with this relationship.

Maralinga Remediation Criteria

The risk of fatal cancer following uptake of contamination should not exceed 1 in 10 000 by the fiftieth year, i.e. 5 mSv/y

- Soil removed if:
  - Am-241 activity concentration > 40 kBq/m^2; or
  - Contains contaminated particles > 100 kBq Am-241; or
  - Density of particles >20 kBq Am-241 > 10/m^2
- Land use restricted if:
  - Am-241 activity concentration > 3 kBq/m^2



Maralinga Rehabilitation Technical Advisory Committee formed to define engineering tasks and studies required to assure remediation criteria are met

ICRP

13

Note that 5 mSv/y is approximately the same dose as received by long-haul air crew.

Criteria stated in terms of Am-241 as proxy for Pu-239.

Pu-239 to Am-241 activity ratio is approximately 8.

The main restriction is prohibition of permanent occupation.

MARTAC report available at https://www.industry.gov.au/sites/default/files/July%202018/document/pdf/rehabilitation-of-former-nuclear-test-sites-at-emu-and-maralinga.pdf

Maralinga Rehabilitation Project

Timeframe: 1994 – 2000

Cost: AU$104 Million

Industrial-scale land clearing of contaminated soil – 2.5 km^2

In Situ Vitrification of historic disposal pits

Burial of contaminated material on site - 5 trenches ~ 400,000 m^3

Sign-posting restricted land use area – 400 km^2

ICRP

14

In Situ Vitrification encountered safety issues and was abandoned as a methodology during the project.

Largest burial trench contains 250,000 m^3 of soil and 3 kg of Pu

All contaminated soil is at least 5 m below surface.

Protection of Workers

All workers treated as occupationally exposed

- Operate in sealed vehicles or PPE
- Change clothes and shower after leaving contaminated areas
  - Clothing laundered on site
- Air particulate monitoring
- Lung monitoring




ICRP

15

The plant used for this operation were specially modified standard machines.

Modifications included:

- strengthening and sealing of cabins;
- fitting of ‘submarine’ doors;
- high strength glazing;
- high efficiency particulate air (HEPA) filtering cabin and engine inlets; and
- stripping plant of unnecessary fittings.

The cabins operated at a continuous over-pressure and had warning alarms that activated if the cabin over-pressure dropped. The modified plant allowed most fieldwork to be conducted in a clean environment free of any requirement for personal protective equipment. This had two advantages:

- personal protection that was superior to and more consistent than that provided by respirators; and
- minimal hindrance to operations.

Ongoing Management

Maralinga Handback Deed 2009

- Land managed by traditional owners – Maralinga-Tjarutja
  - On-site caretaker
- Maralinga Land and Environment Management Committee (MLEMC)
  - oversees Maralinga Land and Environment Management Plan
    - Maintenance of hazard reduction measures
  - membership includes:
    - Commonwealth Government
    - South Australian Government
    - Maralinga Tjarutja representatives

Licenced as a radiation facility by South Australian Government

Commercial tourism managed by Maralinga-Tjarutja

- Site access limited

ICRP

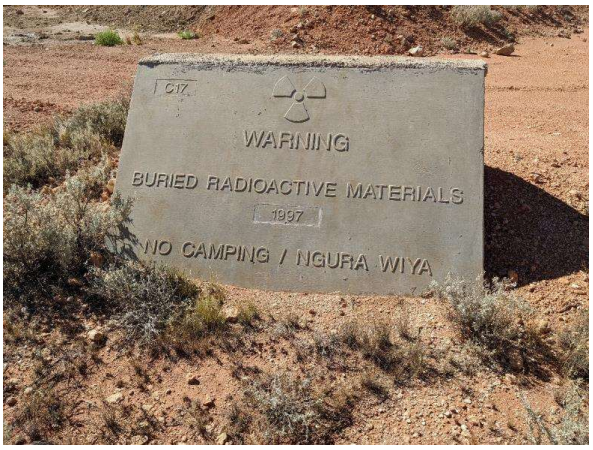
16

Maralinga has been open for commercial tourism since 2015.

Maralinga Land and Environment Management Plan

MLEMP Provides for:

- Institutional management.
- Records management related to the site.
- Maintenance of hazard reduction measures.
- Radiological safety assessment
- Conservation management
- Revegetation of soil removal areas
- Auditing to ensure compliance with the Plan
- Contingency planning to monitor and manage unanticipated events



ICRP

MLEMP is an ongoing plan reviewed every 5 years.


www.icrp.org
18