Occupational Safety Procedures - Monte Bello Islands

EP LIBRARY Vol. 132

Page 3

BB & SF FYI

↓

FILE.

Final Draft Copy. Received 30-3-93

SAFE WORKING PROCEDURES

1 Introduction.

2 Exposure Limits.

3 Possible Exposure Routes.

- 3.1 External Gamma Exposure.
- 3.2 Internal Alpha Exposure by Inhalation.
- 3.3 Internal Alpha Exposure by Ingestion or Wounds.

4 Safe Working Practices.

- 4.1 Gamma Exposure.

5 Safe Working Practices - Alpha Exposure - Inhalation.

- 5.1 Source Areas for Alpha Exposure and Maximum Occupancy times.
- 5.2 Control of Alpha Exposure
  - . Minimising Dust Raising Activities.
  - . Use of Water to control Dust.
  - . Use of Dust Masks.
- 5.3 Dust Raising Activities.
- 5.4 Personal Dust Samplers.

6 Safe Working Practices - Surface Contamination

7 Use and Care of Radiation Monitors during routine CALM Operations.

8 Reporting and Recording.

Final Draft Copy.

RADIATION EXPOSURE

RECOMMENDED SAFE WORKING PROCEDURES

1. Introduction

Exposure to Ionising Radiation is possible on Alpha and Trimouille Islands in the Monte Bello Group. The main areas of concern are the G1 Ground Zero and the fall-out path from the HMS Plym explosion on Trimouille and the G2 Ground Zero on Alpha Island. To ensure that CALM personnel exposure is as low as reasonably achievable, this booklet on safe working procedures has been prepared.

2. Exposure Limits

Ionising Radiation exposure limits for members of the public are set by the Radiation Health Section of the W.A. Department of Health based on the Recommendation of the International Commission for Radiological Protection. The current recommended limit is 1 milliSievert per annum (mSv/a) from all sources for lifetime exposure, with a once-off maximum of 5mSv in any one year.

3. Possible Exposure Routes

There are three possible exposure routes for personnel working in the Monte Bello group of islands. These are:

3.1 External Gamma exposure

3.2 Internal Alpha exposure by inhalation

3.3 Internal Alpha exposure by ingestion or wounds.

4. Safe Working Practices

The most effective method of minimising exposure to radiation is avoidance. Therefore it is recommended that no activityinvolving soil movements (e.g. digging pit-fall traps) should be permitted within a 200 metre radius of the locations of G1 and G2 Ground Zeros, or within 500m of the area bounded by MB1 and MB4 on Trimouille Island.

4.1 Gamma Exposure

Control of Gamma exposure is achieved by maximising the distance from the source and/or minimising the time of exposure. The source areas are G2 on Alpha Island, G1 on Trimouille and the Hurricane fall-out plume NW of Main Beach on Trimouille. Stay times, as determined by the Australian Radiation Laboratory[2], to reach exposure limits are:

G1 Ground Zero - 59 days

G2 Ground Zero - 8 days

Hurricane plume - 32 days

* When working or visiting these areas, personnel must wear their personal Gamma dosimeters (TLD) at all times, and leave the area immediately on completion of their task(s). One member of the team should carry a hand-held Gamma survey meter to check the working area for anomalous Gamma sources. If an anomalous Gamma source (an artefact) is discovered in the area, it may be moved away from the working area to minimise exposure. Note: Always wear gloves when handling artefacts.

5. Alpha Exposure - Inhalation

5.1 The source areas for Alpha exposure and maximum occupancy times are:

MB2 Site		3 days
MB4 Site		10 days
G1 & G2	>	1 year

The above times assume that no dust raising activities are taking place.

5.2 Control of Alpha exposure by the inhalation route is by:

- Minimising dust raising activities
- Use of water to control dust
- Use of disposable nose/mouth dust masks(3M Brand Model 8500 or equivalent) to prevent or reduce inhalation. (Note: this type of dust mask is not recommended for use with beards).

5.3 Activities that can result in dust arising such as digging, cement mixing with local sand and vegetation clearance require some attention to minimise dust inhalation:

5.3.1. Where possible, pre-wet area of soil or sand where digging is to take place.

5.3.2. If pre-wetting is not possible, wear a dust mask.

5.3.3. If using on-site sand for concrete, pre-wet sand before mixing.

5.3.4. When preparing pitfall traps and drift fences, wear a dust mask, unless the soil is wet or has been pre-wetted.

5.3.5 During bait dropping excercises from helicopters, avoid inhaling dust, if any, resulting from rotor downwash. Wear dust masks if necessary.

5.4 Personal dust samplers are to be used by one individual of any group carrying out dust raising tasks on Trimouille and Alpha islands within the area mentioned in Paragraph 4. The sampling pump will be carried on a belt and the sampling head attached to the shirt collar front with the inlet oriented downwards.

6. Safe Working Practices - Surface Contamination

Surface Contamination is only of minor importance except when handling artefacts which may or may not be contaminated with Alpha emitting nuclides. If artefacts are found during digging or vegetation clearance, check for surface contamination using the Alpha detector probe. Should the probe not be available, assume that the artefact is contaminated and remove it from the working area using gloves or some other material. If skin contact is

unavoidable, wash as soon as possible and avoid eating, drinking or smoking until after washing.

7. Monitoring Instrument Operations.

7.1 Eberline ESP-1 Gamma Monitor.

The instrument and probe will be provided ready calibrated and should not require any adjustments in the field. It is simple and easy to operate. the Gamma Radiation Monitoring Probe should be connected and ready for use.

a) Switch the instrument to on; The LCK readout should show a bar-graph on the top line with a numerical display of count rate on the second line. If the first character of the display is blinking, it indicates a low battery voltage. Replace batteries before further use.

b) Press RESET: The instrument will display a bar-graph and count-rate, which should be varying slowly.

c) Press MODE: The instrument will display ALM AT on top line and COUNTRATE on the bottom line. This level will be preset and will not require adjustment.

d) Press MODE to return to Ratemeter display.

e) Press MODE to switch to SCALER display.

f) Press "+": This should produce scaler display in uSv/hr.

g) The ALARM has been set for 1 uSv/hr. To stop the ALARM press the SPKR button. The ALARM will then be disabled until the Gamma Radiation has fallen below the set ALARM level.

h) Record all measurements taken and times spent in the area.

7.2 Nuclear Enterprises PCM-5 Contamination Monitor

The instrument and probe will be calibrated prior to use and should not require any field adjustments. It is fitted with a dual Phosphor Alpha and Beta/Gamma probe.

a) Set the function switch to "Alpha" and check the battery using the battery test push button.

b) The probe is now ready to check for Alpha particles. Switch the speaker on - Alpha detection ; This produces a short duration, high pitched whine.

c) Set the function switch to Alpha + Beta. Speaker emits a "click" for Beta particles/Gamma radiation and a high pitched whine for Alphas.

d) To check artefacts for contamination remove cover from probe and hold probe face about, 2cm from surface of object:

Alpha: Use Alpha only position of function switch.

Beta: Use Beta position of function switch.

Beta/Gamma: Use Alpha + Beta position of function switch.

e) record all readings above background.

8. Recording and Reporting

All anomalous measurements of Radiation parameters must be reported on the forms provided. Include name(s) of those involved, location, date and time, type of anomaly, action taken. Full recording and reporting requirements are detailed in Paragraph 5 of the Monitoring Programme.

References:

1. 1990 Recommendations of the International Commission on Radiological Protection.

2. Radiological Hazard Assessment at the Monte Bello Islands. (Austrlian Radiation Laboratory, 1990).

Page 2 129
Page 8
Page 9
Page 12

INDUCTION

1 Introduction

2 Ionising Radiation

3 Sources of Ionising Radiation

4 Effects of Ionising Radiation

5 Radiation Protection - Philosophy and Standards

6 Safe Working Pracices

7 Emergency Procedures.

HAZARD ASSESSMENT

1 Introduction

2 Gamma Exposure

3 Alpha Exposure/Surface Contamination

4 Ingestion Pathway.

5 Conclusions and Recommendations.

Final Draft Copy.

Personnel Induction Programme

1. Introduction

This material has been prepared for presentation to all personnel under CALM supervision who will be carrying out scientific or other tasks in the Monte Bello Group of islands. Nuclear weapons were tested in the island group in 1952 and 1956 and some residual radioactive contamination from the tests is still evident on the islands.

In Operation HURRICANE in 1952, a 25 kiloton nuclear device was exploded on HMS Plym, off the coast of Trimouille Island. This resulted in activation of the soils by neutrons and a fall-out plume of activated particles and larger debris being deposited on the island downwind of the explosion.

During Operation MOSAIC in 1956 two other devices were exploded on land from 31 metre towers. The first, of 15 kilotons, was exploded at G1 on Trimouille Island and the second test, of 60 kilotons, at G2 on Alpha Island. These resulted in further contamination around and down-wind of the sites.

The radiological status of the islands has been assessed by the Australian and Western Australian governments on several occasions and the results published. Results of these surveys (Refs. 1,2,3,4,5) were evaluated, by AIRAC (Ref.6) in 1979 and ARL (Ref.7) in 1990, to determine health hazards for visitors to the Islands. The 1990 assessment by ARL has been the most detailed to date and concentrated on the radiation activity around the G1 and G2 sites and the HMS Plym fall-out zone on Trimouille Island. They found that there would be no undue risk for casual visitors to the Islands with a nominal stay time of 1 week.

The islands remained under the control of the Commonwealth Government under Defence legislation until 1992 when they were handed over to State control under the management of the Conservation and Land Management (CALM) Department of the Western Australian Government. ~~It is proposed that the area be gazetted as a Marine Park~~ for the purposes of recreation and conservation but with the nuclear test sites continuing to be limited access areas.

The islands will be managed as a conservation park

As manager of the area, CALM is required to supervise all aspects of access to the islands, including any works carried out by CALM staff, visiting scientists and volunteers. CALM is further required to ensure that casual visitors to the islands are forewarned of possible ionising radiation exposure.

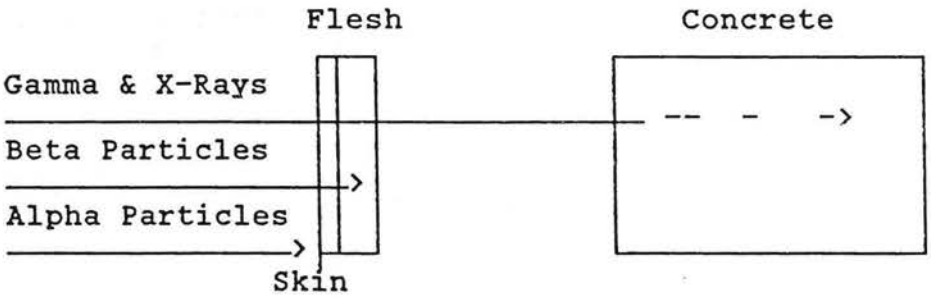
2. Ionising Radiation

Ionising radiation is part of our natural environment and everybody has been exposed to it all their lives. Radiation exposure varies from place to place, depending on such factors as:

Height above sea-level	- Cosmic Radiation
Uranium, Thorium Potassium in soils and rocks	- Gamma and Beta Radiation
Radon Gas in air	- Alpha Radiation

Additional exposure to radiation occurs during medical treatment, such as X-Rays and Gamma Radiation treatment for cancer patients and, to a much smaller degree, radiation from nuclear power stations and fall-out from nuclear weapons testing.

There are two basic types of radioactivity, rays and particles. Gamma and X-Rays are rays; Alpha and Beta Radiation are charged particles. Different types of radiation also have different powers of penetration.



From the diagram it can be seen that Gamma and X-Rays will easily penetrate flesh but can be stopped by massive materials such as lead, steel or concrete. Beta particles, which are high energy electrons can penetrate solids to a depth of only a few millimetres. Alpha particles, which are atomic nuclei, can be stopped by a thin sheet of paper and cannot penetrate the surface of the skin.

3. Sources of Ionising Radiation

3.1 Natural Sources

Natural souces of radiation are:

The Sun - Cosmic Radiation

The Earth - Gamma, Alpha and Beta Radiation from the decay of natural radioactive material such as Uranium, Thorium and Potassium.

3.2 Man-made Sources

Nuclear Weapons Fallout	- Gamma, Beta and Alpha
Nuclear Power Stations	- Gamma, Beta and Alpha
Medicine	- Gamma
Industrial	- Gamma, Beta and Alpha.

4 Effects of Ionising Radiation

Knowledge of the effects of Ionising radiation has increased dramatically during the last 50 years. The major study of the effects on humans has been the, still continuing, study of the survivors of the Hiroshima and Nagasaki explosions and of their children. Other on-going studies are being carried out on Uranium miners and on the workers and general population in and around nuclear power stations. Considerable imformation has also been gathered on patients and operators of X-Ray machines and nuclear medicine facilities.

It is known that radiation affects living cells by the release of energy which can either damage or destroy the cell. Normal repair mechanisms of the body are continually repairing or replacing damaged cells whether the damage results from radiation or other means such as chemicals, bacteria or viruses.

An extremely high exposure to radiation over a short time period can cause so much cellular damage that death results. At lower doses, radiation exposure results in some risk of developing cancer and leukemia and this risk depends on the dose. Exposure to natural radiation may produce a small fraction of the number of recorded cancer cases. This fraction can only be estimated by statistics, since the property of inducing cancer is shared by radiation with a large number of chemicals and other materials, both natural and man-made. Some examples of these are tobacco smoke, asbestos, vinyl chloride and benzene.

Extremely large doses of radiation delivered over a long period of time have produced genetic changes in simple life forms such as plants and fruit-flies. The only large scale study on human data for mutation effects is from the follow-up on the children of Hiroshima and Nagasaki survivors. More than 75000 chidren conceived and born after exposure of the parents show no evidence of any increase in mutation rate compared with the children of unexposed parents. The average exposure of the parents was in the region of 1000 milliSieverts.

Scaling down from the known effects of high level radiation has given epidemiologists a risk factor that can be applied to very low levels of exposure. To minimise this small risk, unnecessary exposure to radiation should be avoided. The level of 1mSv for members of the public exposure has been selected by the ICRP to reflect a very small proportion of the normal everyday risks to which the whole population is exposed.

5. Radiation Protection - Philosophy and Standards

The International Commission for Radiological Protection (ICRP) recommends limits of exposure to ionising radiation for radiation workers and members of the pulic based on research and epidemiology data. In Australia these recommendations are considered by the Australian Ionising Radiation Advisory Council (AIRAC) and the National Health and Medical Research Council (NH&MRC) who recommend exposure limits for Australia. These recommeded limits are normally passed into legislation by State Governments. In Western Australia the Radiation Safety Act (1975) is the applicable legislation, administered by the Radiological Council and the Radiation Health Section of the WA Department of Health.

The ICRP has recommended a limit of exposure for members of the public, from all sources, of 1 milliSievert per annum (mSv/a) above background, with a once only limit of 5mSv in any one year during lifetime exposure. These limits have also to be considered with a further recommendation that all exposures should be As Low As Reasonably Achievable; economic and social factors being taken into account (The ALARA Principle). Since the total is 50mSv over a working life of 50 years, the limit can also be considered as 5mSv/a for 10 years.

Where exposure cannot be avoided, all reasonable means must be taken to minimise the total exposure on a personal and population basis. For cases where more than one type of radiation is present the whole body exposure is considered to be the total of all exposures by all possible exposure routes. The ICRP has recommended conversion factors for exposure via inhalation, ingestion and wound contamination to relate localised exposure to whole body dose.

6. Safe Working Practices

Radiation Safety in the work situation is very reliant on the individual's awareness of the risks of exposure and willingness to follow recommended safe working practices. Ionising radiation is a risk that is not detectable except with special instruments, therefore some common sense rules need to be applied. In the Monte Bello Islands, there are two important sources of radiation exposure to the individual ; Gamma and Alpha radiation.

The areas of the islands where Gamma exposure exceeds background have been mapped. No person should visit these areas unnecessarily and when working in the areas, they should minimise their stay. The areas where no work involving soil movement should take place, unless absolutely unavoidable, are within a 200 metre radius of G1 and G2 Ground Zeros or within 500m of the area bounded by MB1 and MB4 to the North West of Main Beach on Trimouille Island. When working in or near the designated areas, a Gamma survey meter will be used to check for excessive Gamma radiation and, if possible, remove the source to a safer distance or increase the working distance from the source.

Exposure to Alpha emitting radionuclides is the most likely route to increased dose in the Monte Bello islands, therefore it is highly advisable to reduce an individual's exposure as much as possible. The Alpha emitting nuclides are present in the sands and soils in the designated risk areas and have a tendency to concentrate in the finer fraction. Some rehabilitation work carried out by the Defence forces in 1979 decreased the levels of radionuclides in surface soils at the two Ground Zero locations. Sand movement and mixing by high winds have also contributed to decrease the surface concentration of radionuclides on Trimouille Island where material was deposited from the plume of the HMS Plym off-shore explosion.

7. Emergency Procedures

There are no foreseeable occasions during the proposed work programmes on the Monte Bello Islands that could lead to a Radiation Emergency. However, there may be some instances where the on-site personnel may need to seek advice on procedures. Advice can be obtained from either the Radiation Health Section or Western Radiation Services. Telephone numbers are:

Radiation Health Section	09 389 2260
After Hours	09 389 3333
Western Radiation Services	09 330 3444
After Hours	09 277 6652

Final Draft Copy.

RADIOLOGICAL HAZARD ASSESSMENT for CALM Personnel at the Monte Bello Islands.

1. Introduction

1.1 The Western Australian Department of Conservation and Land Management (CALM) is responsible for the management of the Monte Bello Islands as ~~part of~~ a conservation ~~Marine~~ park. This responsibility includes control of access to the Islands and the locations of nuclear tests carried out during the 1950's. As part of their clearance ~~rehabilitation~~ programme, CALM will be supervising flora and fauna studies, baiting programmes for eradication of feral animals and signposting of radioactivity contaminated areas.

1.2 Previous monitoring and hazard assessments carried out by the Australian Radiation Laboratories (ARL) and the Radiation Health Section of the W.A. Health Department considered only the possible exposure of casual visitors to the islands and did not address the possibility of the above-mentioned working situations (Cooper et al 1990).

1.3 This document will assess the radiological hazard to personnel working on the islands for four two-week periods in any one year. This assessment will use the measured and assumed parameters for radiation exposure detailed by ARL in their assessment document but will focus mainly on the major route of possible exposure - the inhalation pathway.

2. External Exposure - Gamma Radiation

2.1 The only sources of Gamma radiation on the islands are the two Ground Zeros; G1 on Trimouille Island, G2 on Alpha Island and the fall-out path of the HMS Plym test on Trimouille Island. There may be some scattered minor sources (activated steel fragments) around these locations or on the sea bed, but their contribution to external Gamma exposure of personnel would be so slight as to be negligible.

no-ground disturbance

2.2 The recommended safe working procedures for personnel on the islands suggests that the areas of G1 and G2 should be considered as "~~no-go~~" areas for the tasks proposed. The "~~no-go~~" area has been proposed as a 200metre radius from each of the Ground Zeros. For the area of the fall-out plume on Trimouille Island a "~~no-go~~" distance of 500 metres from the area bounded by MB1 and MB4 to the North West of Main Beach has been recommended.

2.3 Table 1 shows the measured Gamma levels at 100 metres from G1 and G2 in 1990 (Cooper et al 1990), and an estimate of Gamma levels at 200 metres distance. The 500 metre distance from the fall-out plume should ensure that Gamma levels for workers in the area will not normally exceed 0.05 microGrays per hour (uGy/hr) although there may be some small localised sources resulting from scattered debris and sand movement.

2.4 ARL estimated the time needed for continuous exposure to Gamma Radiation at the three locations of concern to reach the limit of exposure for members of the public (Cooper et al 1990) to be as shown in Table 2. These times are for Gamma exposure only, with no account being taken of internal exposure via the inhalation route. Table 2A shows an estimate of residence time at each area for Gamma exposure only, assuming a normal eight-hour working day.

2.5 Assuming that one day would be spent by workers in the vicinity of G.1 and G.2 with a further 2 days on Trimouille during each of four visits to the island, then the possible Gamma exposure to individuals would be as shown in Table 3.

2.6 The total exposure from Gamma Radiation is therefore not expected to exceed 52 microSieverts per annum or 5.2 per cent of the annual exposure limit for members of the public.

3. Internal Exposure - Alpha Radiation

3.1 The potential hazard to health from Alpha Radiation is via the inhalation pathway. The specific nuclides of concern are Plutonium and Americium resulting from the fall-out of the three nuclear tests. Dose estimates for members of the public visiting the area as tourists or fishermen have been calculated by ARL (Cooper et al 1990) and show that for such casual visits of short duration it is unlikely that any person's exposure to Alpha Radiation would exceed the recommended limits.

3.2 For CALM personnel and visiting scientists who would be working on the islands undertaking maintenance and monitoring tasks, it is necessary to assess the inhalation pathway of exposure using criteria related to movement of soil and dust during such tasks. Measurements by ARL, of Alpha emitting nuclides in the soils at G1, G2 and the HMS Plym fall-out plume area, have shown that the quantities of radionuclides in soil at the three locations are as shown in Table 4. The major portion of the inhalation dose will come from Plutonium and Americium nuclides, with the locations MB2 and MB4 on Trimouille Island being the most contaminated.

3.3 The dose assessments proposed by ARL for members of the public used the data for the most contaminated site sampled at each of G1, G2, MB2 and MB4 locations. The activity concentrations were assumed to be the same as those in the less than 45um fractions. It was also assumed, in the absence of actual site data, that the resuspended dust in air would average 0.1 mgm per cubic metre. These assumptions are considered to be conservative and in the event of personnel passing through the area (e.g. to check on dropped baits for feral animals) their exposures would not be greater than those shown in Table 5.

3.4 In the event that work involving soil movement is required in the contaminated areas, the dose assessments have been linearly scaled to an assumed resuspension of 1mg per cubic metre of air resulting from digging or vegetation clearance. Table 6 shows the estimated exposure and the actual working hours permitted at each location to reach the limit of exposure of 1mSv per year. The assumed breathing rate for workers is $1.2m^3/hr$.

3.5 From the table, it appears that there is little risk of inhalation exposure at locations G1 and G2, compared to MB2 and MB4, but these areas were subjected to rehabilitation works in 1979 with "clean" sand of up to 300mm depth being spread on the surface. Digging in these areas may expose soils with higher contamination levels of Alpha-emitting Radionuclides thereby leading to increased exposure.

Table 1

Measured and Estimated Absorbed Dose Rate in Air (uGy/hr) for G1 and G2

Source	N	NW	W	SW	S	SE	E	NE
G1- 100m	0.12	0.10	0.18	0.04	0.16	0.23	0.20	0.22
est.200m	0.06	0.05	0.09	0.20	0.08	0.12	0.10	0.11
G2- 100m	1.4	2.5	2.8	3.5	2.9	2.5	5.0	1.8
est.200m	0.7	1.3	1.4	1.8	1.5	1.3	2.5	0.9

Table 2

Stay times to Reach Limit of 1mSv
(24hr/dy occupancy)

Location	Stay Time (day)	Average Exposure (uGy/day)
G1	59	17
G2	8	125
Trimouille Plume	32	31

Table 2A

Stay Times to Reach Limit of 1mSv
(8 hours/day Occupancy)

Location	Stay time(days)	Average Exposure (uGy/day)
G.1 - 200m	1237	0.81
G.2 - 200m	88	11.4
Trimouille - 500m	2083	0.48

Table 3

Estimated Gamma Exposure

Area	Exposure/day uGy	Total Exposure uGy
G.1	0.81	3.24
G.2	11.4	45.6
Trim.	0.48	3.84
		52.68

Table 4

Radionuclides in Soil.

	Radionuclides (Bq/g in top 10mm)				
Location	Am-241	Pu-238	Pu239	Pu-240	Pu-241
G-1 25mN	1.28	0.371	25.6	2.94	8.96
G-2 100m SW	1.93	0.414	29.0	2.90	13.90
MB2	107.0	60.90	4260.0	426.0	596.0
MB4	26.6	15.20	1060.0	106.0	149.0

Table 5

Normal Exposure Dose Assessment. uSv/day

Location	Exposure uSv (8 hr dy)	Dys to Limit
G.1	0.81	1235
G.2	0.9	1111
MB.2	127.0	8
MB.4	31.9	32

Table 6

Estimated Exposure During Soil Movements.

Location	CEDE uSv/hr	Time to Limit
G.1	1.21	826.0
G.2	1.35	740.0
MB.2	190.5	5.25
MB.4	47.8	21.0

Table 7

Maximum Working Times in Contaminated Areas (During soil movement ~~ground disturbance~~)

Location	Gamma Exp. uSv/hr	CEDE uSv/hr	Hrs to Limit
G.1	0.1	1.21	758.0
G.2	1.43	1.35	360.0
MB.2	0.06	190.5	5.0
MB.4	0.06	47.8	20.1

3.6 Total Effective Dose for workers will include external Gamma exposure plus the Committed Effective Dose Equivalent (CEDE) for dust inhalation. The small and still reducing Gamma component in all areas leads to an overall reduction in the time permitted in each location for personnel to reach the 1 mSv limit of exposure. These reduced times are shown in Table 7.

3.7 Inhalation of wind carried resuspended material is possible during non-working hours at the chosen living area on Hermite Island. Considerable movement of the sands has been observed during times of high winds that may result in redistribution of Alpha-emitting nuclides (pers. comm. H. Butler). This source is not considered to be a likely major contributer to the total exposure of personnel. However, since strong winds from the N/E quandrant occur mainly during May to August (fig 1A & 1B), the proposed residence times for personnel on the islands, this possible pathway should be included in a future assessment.

3.8 Surface contamination is only likely to occur on artefacts (steel and other fragments from the explosions) and may be masked by rust or dirt. This exposure route will be insignificant if safe working procedures are followed.

4. Ingestion Pathway

From the ARL study, it can be seen the ingestion and wound contamination pathways can be dismissed as being inconsequential. However, the possibility of redeposited material being collected with rainwater should be included in a future assessment when redeposition data are available.

5. Conclusions

The Radiological Hazard Assessment carried out by ARL (Cooper et al 1990) applied only to casual visitors to the Monte Bello island group. Their assessment related in time to November 1990 for nuclear decay. The same time basis has been used for this assessment, since the change in Radionuclide ratios for Alpha emitters over the 2 years will be mimimal.

The assumptions used by ARL of 0.1mg per cubic metre of dust and breathing rate of $0.95m^3$ per hour have been changed to 1mg per cubic metre of dust and $1.2m^3$ per hour breathing rate for workers.

It is recommended that no works involving digging and/or excessive dust movement be carried out in the contaminated areas. A worker could reach the limit of 1mSv exposure from Gamma and inhaled dust on Trimouille Island after 5 hours exposure at the estimated maximum levels. Although the Ground Zero locations G1 and G2 have lower surface contamination levels, these areas have had some soil/sand cover put in place and material at depths greater than 50mm may have greater concentrations of Alpha emitting radionuclides.

The Gamma radiation will continue to decrease significantly in the short term (tens of years) but the inhalation hazard from Alpha emitting radionuclides will not change appreciably over several hundreds of years except for dilution by resuspension and possible weathering effects.

Action should be taken to warn casual visitors to the islands of the possible hazards in the contaminated areas and of the possible hazard of removing souvenirs from those areas.

Information on deposition of resuspended material on other islands from the contaminated areas is not available. Such deposition is only likely to occur during periods of very strong Northerly winds without accompanying rainfall, and would most likely be immeasurable at distances greater than 1 km from the contaminated areas.

Data on resuspension and deposition is not currently available, but an attempt to obtain this information is recommended in order to confirm the assumption of negligible exposure via this route.

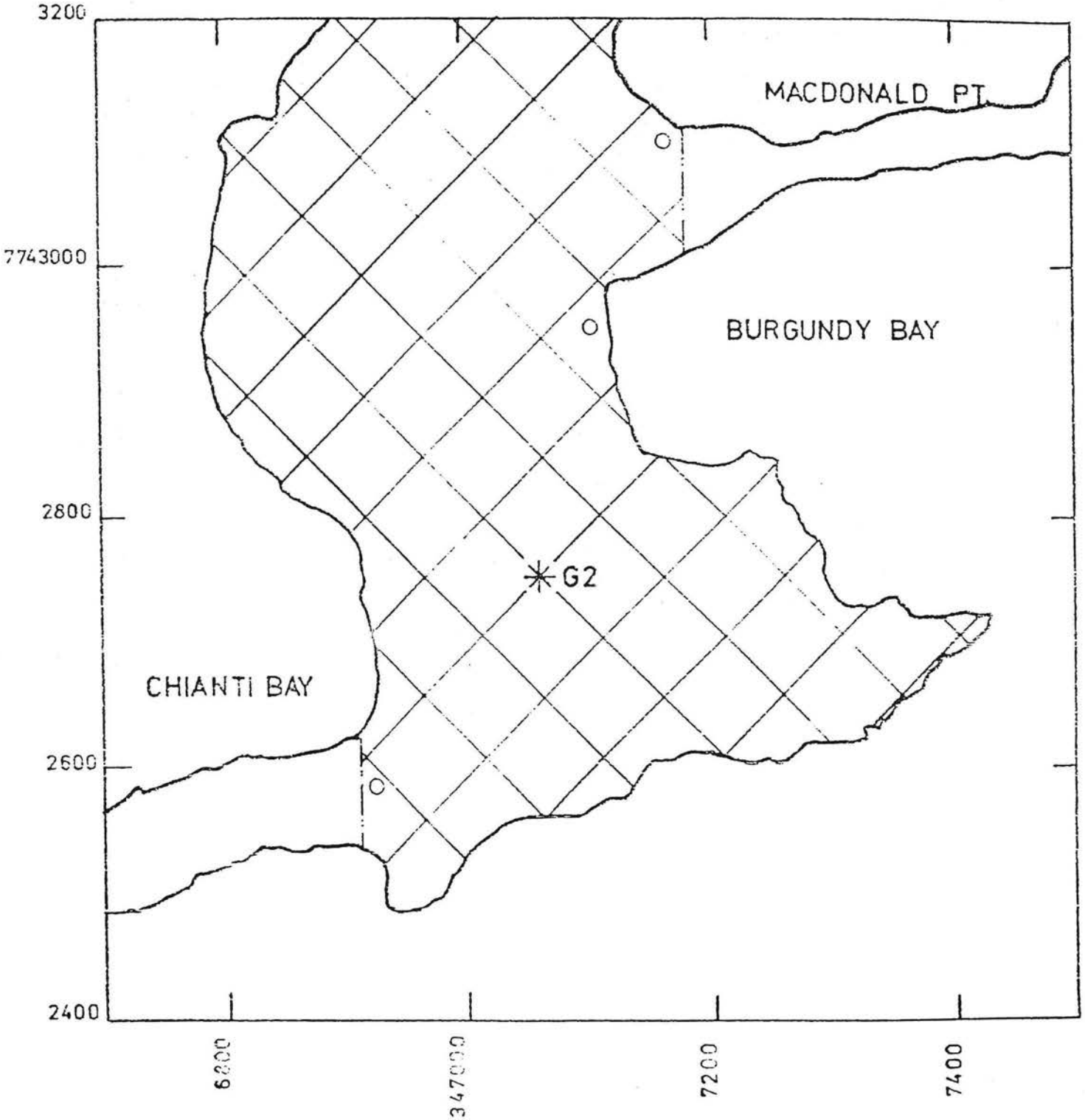


FIG 2 ALPHA ISLAND RESTRICTED ZONE.

LEGEND: Restricted Zone. No camping, digging or wood collection.

O R.Z. sign location.

✳ Nuclear weapon test site.

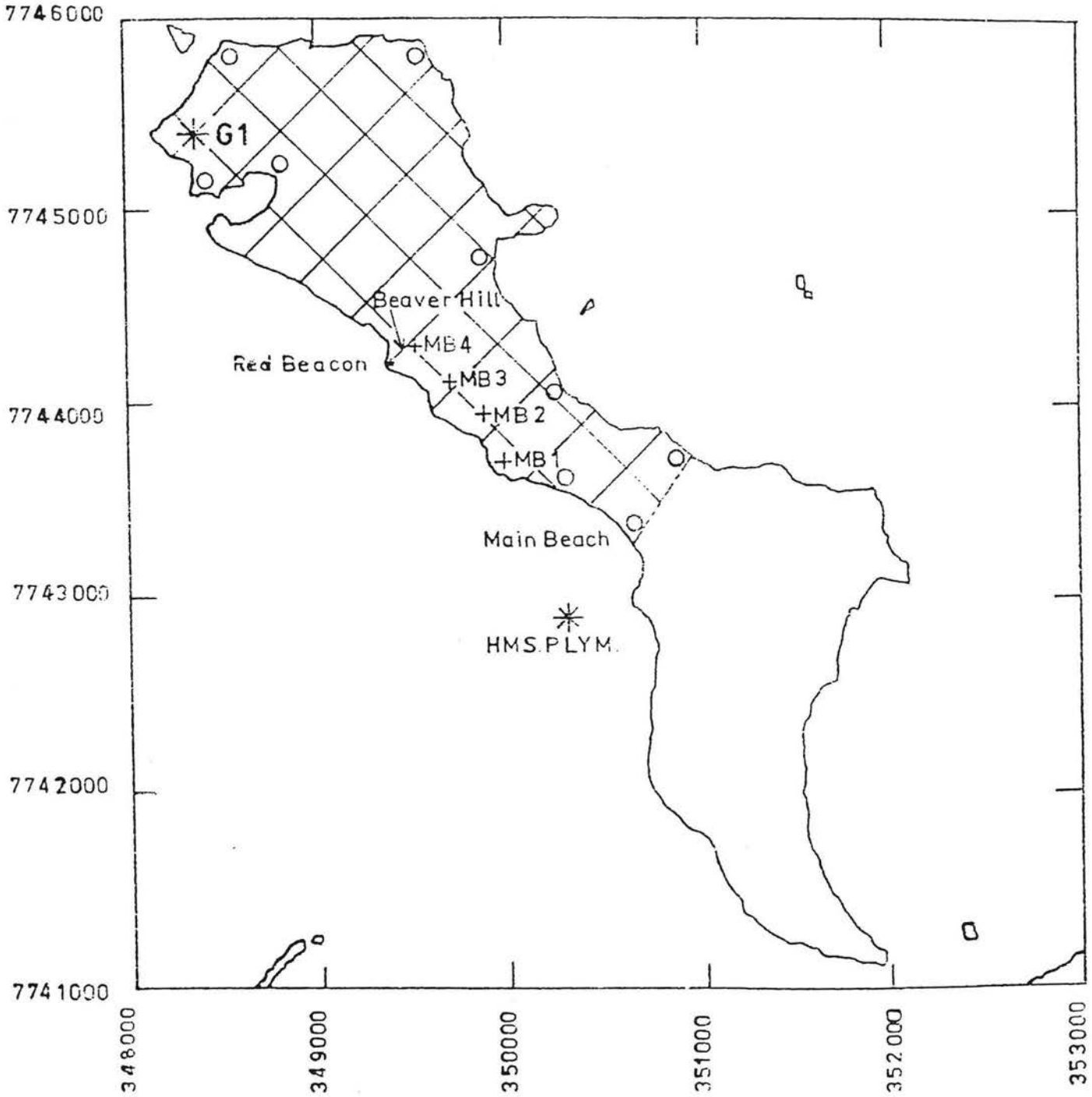
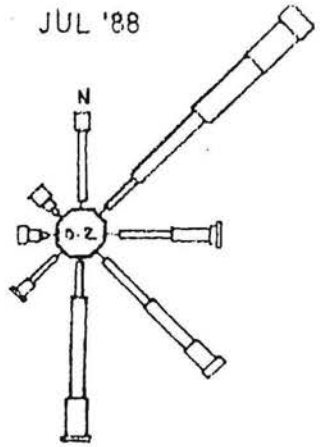


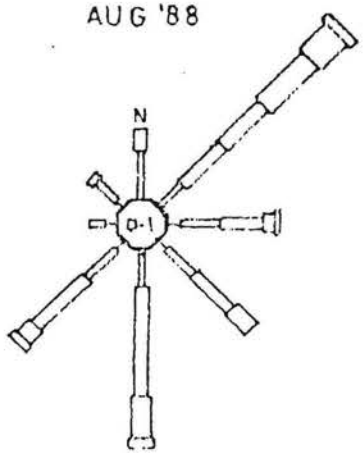
FIG 3. TRIMOUILLE ISLAND RESTRICTED ZONE.

LEGEND: Restricted Zone. No camping, digging or wood collection.

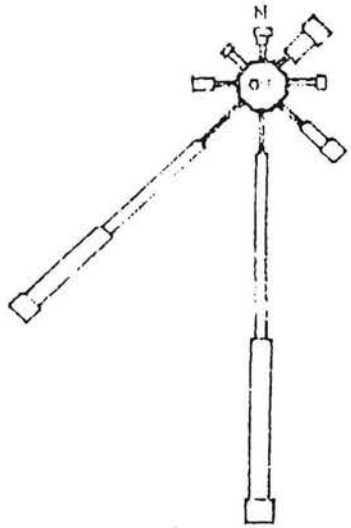
JUL '88



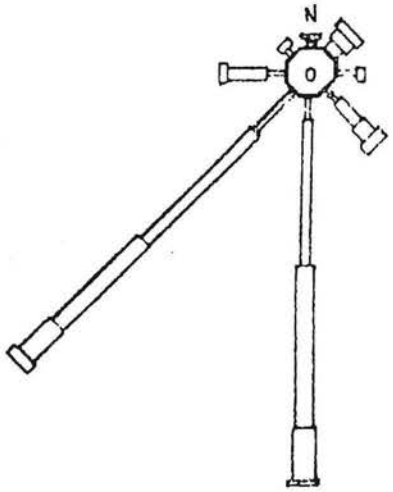
AUG '88



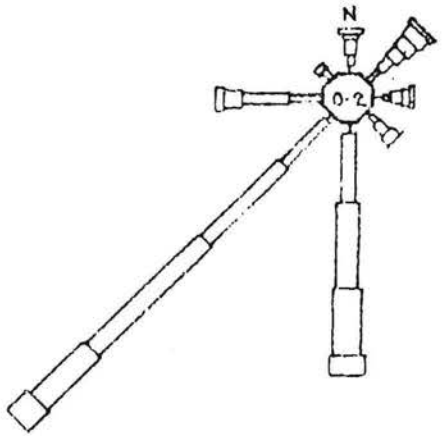
SEP '88



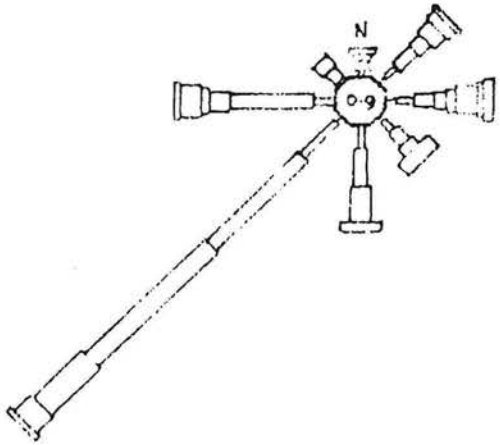
OCT '88

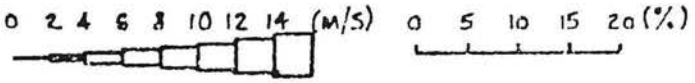


NOV '88



DEC '88



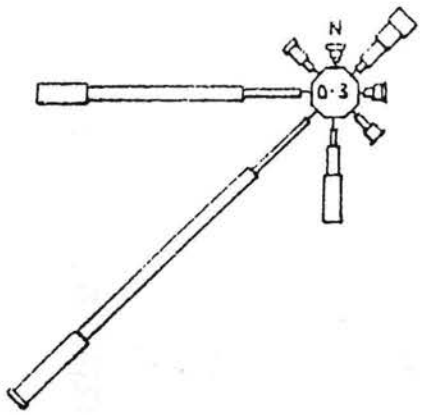


(0.3) % CALM

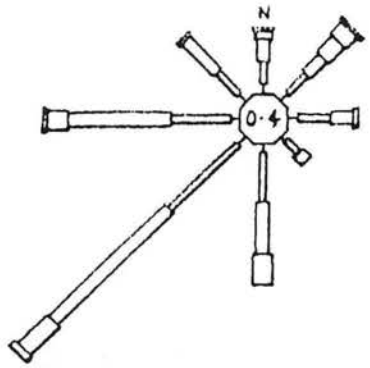
MONTHLY WIND ROSES
JULY - DECEMBER 1988

Fig 1B

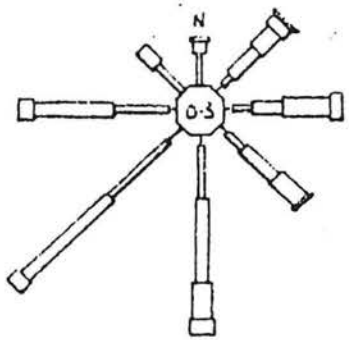
JAN '88



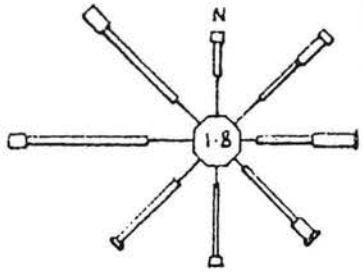
FEB '88



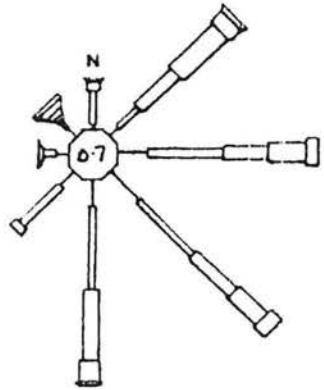
MAR '88



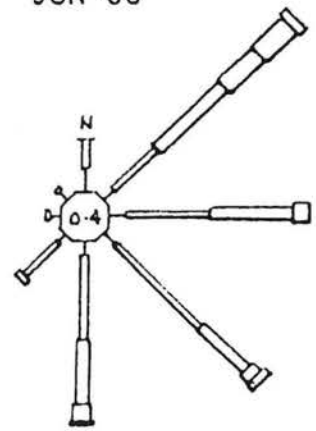
APR '88

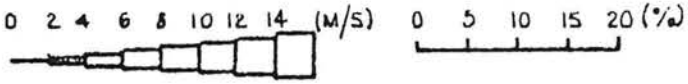


MAY '88



JUN '88





(0·3) % CALM

MONTHLY WIND ROSES
JANUARY – JUNE 1988

Fig 1A

good

MONITORING PROGRAMME

1 Introduction.

2 External Monitoring.

- 2.1 Personal Monitoring.
- 2.2 Area Monitoring.

3 Internal Monitoring.

- 3.1 Personal Monitoring.
- 3.2 Area Monitoring.

4 Surface Contamination.

5 Recording and Reporting.

- 5.1 Field Data.
- 5.2 Exposure Record Log.
- 5.3 TLD Records.
- 5.4 Dust Monitor Recording.
- 5.5 Passive Dust Monitors.
- 5.6 Personnel Records.
- 5.7 Reporting.

Final Draft Copy.

MONITORING PROGRAMME

1. Introduction

This monitoring programme has been designed to meet the perceived requirement for measuring Ionising Radiation exposure of CALM personnel engaged in various activities in the Monte Bello island group. It is anticipated that personnel will be resident at the islands for four two-week periods of continuous occupation between the months of April and October.

Dose assessment calculations by personnel of the Australian Radiation Laboratory (ARL) were based on casual visits to the island group by fishermen and tourists and did not allow for exposure of personnel carrying out work assignments.

This programme will address the additional monitoring needed to ensure that CALM personnel exposures do not exceed the recommended limits.

After the initial monitoring and dose assessment has been completed the programme should be reviewed and expanded or contracted as deemed necessary. If continued monitoring is required for future years, the programme should be reviewed annually.

2. External Monitoring

2.1 Personal Monitoring

- All CALM personnel and visiting scientists working on the islands will be supplied with personal thermoluminescent dosimeters (TLD) to measure their exposure to Gamma radiation. A control TLD will be located in the living quarters on Hermite island and returned with the personal monitors to ARL for reading and dose assessment. TLD monitors will be worn by all personnel when away from the home base for any reason. The monitors should be attached to the wearers shirt between waist and shoulder. When not in use, the personal TLD monitors will be stored with the control in an environment of normal background radiation (e.g. in a box in the living quarters).

2.2 Area Monitoring

A Gamma survey meter will be used by CALM working groups when work is in progress on Alpha and Trimouille Islands to ensure that personnel are not exposed to high radiation levels from possible "hot spots". Such "hot spots" can occur where some artefacts have been deposited that are strong Gamma sources. Data obtained using the survey meter is to be recorded as detailed in Paragraph 5 below.

3. Internal Monitoring

3.1 Personal Monitoring

A personal dust sampler with cyclone head to select dust particles less than 10 um will be used by CALM personnel during any work periods, involving soil movement or vegetation clearance within the designated zones on Alpha and Trimouille Islands. One person in each group will wear the sampler for the duration of each work shift or eight hours whichever is the shorter period. Cyclones and filter heads will be returned to the Radiation Safety Officer (RSO) for analysis and dose assessments.
Data recorded in accordance with Paragraph 5 below will accompany the filters to aid in dose assessment.

3.2 Area Monitoring

* Radioactive material could possibly be resuspended by strong winds and redeposited down-wind. Four passive dust deposition gauges will be located at the residential site. The deposit gauges will comply with Australian Standard AS2724-1 - 1984. Gauge exposure will be for three months approximately to allow for collection of sufficient dust for further analysis.

4. Surface Contamination

The surface contamination monitor (Alpha probe) will be used to check all artefacts for contamination prior to manual handling. Data will be recorded in accordance with Paragraph 5 below.

5. Recording and Reporting

5.1 Field Data

Survey meter readings and surface contamination levels taken in the field using the hand-held instruments shall be recorded in a field data log. The data to be recorded will be:

Date/Time:
Location:
Time at Location: hours
Gamma: uSv/hr
Surface Alphas: counts/sec
Comments:

5.2. Exposure Record Log

A log book containing all field exposures will be kept by CALM personnel and all information from the field books will be written up daily. Personal Gamma exposures will be estimated from the working hours and Gamma survey data and recorded for future comparison with TLD records. A cumulative summary of total estimated dose will be updated on a daily basis.

5.3 TLD Records

A record will be kept of each TLD badge issued to personnel. This record will include:

Wearers Full Name
Date Issued
Date Returned

5.4. Dust Monitor Recording

A record will be kept of each personal dust sampler and filter used during field operations. Data to be recorded will be:

Sampler Serial Number
Filter Number
Wearer
Location
Activity
Date
Start Time
Stop Time
Flow Rate

5.5. Passive Dust Moniters

Information for each passive dust sampler will be recorded as follows:

Location
Date set up
Date stopped
Sample Number
Comments

5.6. Personnel Records

A detailed record will be kept of all CALM personnel, volunteers and visiting scientists working on the islands. This data will include:

Full Name
Address
Date of Birth
Sex
Employer
Position
Previous Occupational Radiation Exposure

5.7. Reporting

All of the above data will be held and forwarded on completion of the annual island work period to the Radiation Safety Officer (RSO) for use in dose assessment. All Personnel data and assessed doses will be reported annually to the Radiation Health Section of the W.A. Department of Health.

correction.

117

RECOMMENDATIONS FOR VISITORS

to the

MONTE BELLO ISLANDS NUCLEAR TEST SITES

1. The Monte Bello Islands group was the location of three nuclear device tests during the 1950's. There is still some remnant radioactive material deposited around the immediate localities of the three test sites which requires that visitors to the islands obey some simple rules for their own future health protection. These rules are:

A. Study the maps of the Islands, which show the areas where radioactive material is still present. If you do not have access to the maps, take notice of the signs erected on Alpha and Trimouille Islands.

B. No camping, digging, wood collection or other activities that may involve soil movement within the areas designated by hatched lines on the maps of Trimouille and Alpha Islands. Hermite Island is the preferred camping location.

C. Do not collect any souvenirs from the Islands or the sea bed near Trimouille, they may be radioactive,

D. Do not stay in the designated areas any longer than necessary to take photographs or view the test locations.

E. Fish and shellfish on and around the islands are safe to eat.

F. If you are unsure whether or not you should be in any area, stay away.

G. The Regional ~~Director~~ manager of the Department of CALM in Karratha will be pleased to answer any queries you may have about the status of the Islands.

colonies. Similarly important turtle nesting beaches on the north and western coasts of North West Island and the western coast of Trimouille Island will be limited to day access only.

QUARANTINE:

Quarantine is an important component of island environmental management. The degree to which quarantine regulations are applied depends very much on the scale of operations. Equipment used in radio positioning facilities (and for manned camps) will generally only require visual inspections for soil, seeds and fauna; and, as required, cleanup with high pressure water or compressed air prior to transportation.

Quarantine issues relating to larger scale operations will require close liaison with this Department.

RADIATION HAZARD ASSESSMENT:

The Department has contracted Western Radiation Services to prepare a report on the risks associated with the remaining radioactivity at the Monte Bellos. The report includes sections on hazard assessment, safe working practices, personnel induction, training, monitoring and visitor safety.

I have included the section titled 'Radiological Hazard Assessment' for your information. There are direct implications for any scientific or operational activities you may wish to undertake on the islands.

Please contact me (prior to 7 April) if you require clarification or further information.

Yours sincerely

Greg Oliver

Greg Oliver
Reserves Management Officer
for STEPHAN FRITZ
A/REGIONAL MANAGER
PILBARA

1 April 1993

c.c. F Batini, Como

B:accessmb.jp.d4

FILED
-8 APR 1993
By.....

032804F4301 Records PL File

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Please address all enquiries to:

PO Box 835
KARRATHA WA 6714

Phone: (091) 868 288

Your Ref:
Our Ref: IA2.20 GO:PW
Enquiries: G Oliver

SENT DIRECT

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
-5 APR 1993
COMO, W.A.

Gary Jeffrey
Operations Manager
Hadson Energy Ltd

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
- 6 APR 1993
COMO, W.A.

Dear Gary

ACCESS TO THE MONTE BELLO CONSERVATION PARK

I have tried to pre-empt the information you require. Hope this will assist.

GAZETTED AREAS:

Please see attachment.

RELEVANT LEGISLATION:

Conservation Park regulations have yet to be drafted by the Department. As a guide, however Part V of the National Parks Authority Regulations - Protection of Flora, Fauna and the Environment (attached), should be adhered to. An area management plan will be prepared by the Department as time and resources become available. In the interim a provisional zonal system will be enacted through necessary operations provisions within the CALM Act.

Scientific/monitoring activities within the conservation park will require permitting by CALM's Wildlife Management Branch at Como. The Pilbara Regional Office should be advised prior to any scientific work being conducted at the Monte Bellos.

ACCESS FOR RADIO POSITIONING PURPOSES:

Attachment 2 are guidelines for the use of island reserves for radio positioning purposes. Additional conditions concerning lighting and waste disposal would be applied if manned camps are required.

ENVIRONMENTALLY SENSITIVE AREAS:

Access to many of the smaller islands of the Monte Bellos will be restricted to protect seabird breeding

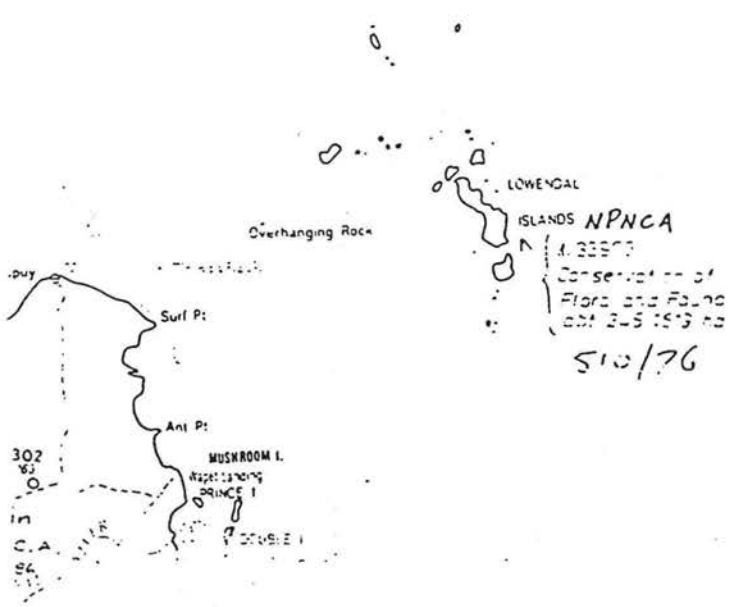
JB 6/4

Advice should be provided in writing 14 days prior to access being required — info. re safety

AA 42196
172
Conservation Park
abt. 1466 ha
Vested in NPNCA
Includes all islands and rocks.
Excludes A's 40828 & 41080 (loc's 49 & 135)

A 42197
171
Conservation Park
Vested in NPNCA
Extends between high & low water marks.
AREA INDETERMINABLE

MONTE BELLO ISLANDS



510/76

SCHEDULE—*continued.*

(2) A person shall not bring a boat of any description into any area set apart pursuant to the provisions of subregulation (1).

Penalty: $200.

Swimming pools.

24. Every person shall, before entering the enclosed area surrounding a swimming pool, pay to an authorised person the fee (if any) determined by the Authority for the use of that swimming pool.

Penalty: $100.

PART V.—PROTECTION OF FLORA, FAUNA AND THE ENVIRONMENT.

Protection of flora.

25. A person shall not without authority injure, cut, break, deface, pull up, fell, pick, burn, remove or destroy any flora, living or dead, on a reserve nor remove any stake supporting any such flora or any label on or near any such flora.

Bulldozing of tracks, etc.

26. A person shall not without authority—

(a) use or drive a bulldozer, grader or other machine or vehicle; or

(b) do any other act,

in such a manner as to make, clear or form a road, track, break, trace or path through a reserve or to widen, shape, reform or realign any existing road, track, break, trace or path through a reserve.

Penalty: $1 000.

Protection of fauna.

27. (1) A person shall not without authority—

(a) disturb, interfere with, catch or destroy any fauna on a reserve;

(b) disturb, interfere with or destroy any nest, spawning ground or habitat of fauna on a reserve; or

(c) use an animal or bird for a purpose mentioned in paragraph (a) or (b) of this subregulation.

(2) Nothing in subregulation (1) prohibits—

(a) the taking of fish by a person for the immediate personal consumption of the person and his family so long as the fish are taken by hand-held rod, line or net, or by drop-net and are taken in accordance with the requirements of the Fisheries Act, 1905, and the regulations thereunder; or

(b) the removal or destruction of feral or stray animals or birds.

Weapons, etc.

28. (1) A person shall not without permission—

(a) carry or discharge any firearm or speargun or any other offensive weapon, device or means for the taking of fauna;

(b) throw or release any missile or dangerous object or material of any kind;

(c) carry, make or set any trap or snare for any fauna,

on a reserve.

(2) A person shall not without authority bring onto or have on a reserve any explosive device.

(3) A person carrying any firearm, speargun, weapon, device, missile, object, material, trap or snare mentioned in subregulation (1) or (2) without permission shall surrender it to a ranger when requested to do so.

Penalty: $1 000.

Lighting of fires.

29. (1) A person shall not without permission kindle, light, make or use a fire in any part of a reserve other than in a cooking stove in a picnic area or camp site or in a fireplace provided for that purpose.

Penalty: $300.

SCHEDULE—*continued.*

(2) Nothing in subregulation (1) authorises a person to light a fire in an open fireplace in contravention of the Bush Fires Act, 1954.

Control of declared plants and animals.

30. Nothing in this Part prohibits the doing of any act in the course of controlling declared plants or declared animals under and in accordance with the Agriculture and Related Resources Protection Act, 1976.

Protection of rocks, soil, etc.

31. A person shall not without authority remove, cut up, damage displace, disfigure, write on or otherwise mark, or interfere with the soil, rocks or turf, on any part of a reserve.

Quarrying.

32. A person shall not, without permission, quarry or remove any stone, gravel or earth from any part of a reserve.

Penality $1 000.

Rubbish.

33. A person shall not—

(a) deposit, throw or leave any rubbish, refuse, paper, glass (broken or otherwise), food or drink container or wrapper, or litter of any kind whatsoever on a reserve except in a receptacle provided for that purpose; or

(b) break any bottle or other glass, china or similar object on a reserve.

Penalty: $100.

Pollution of water.

34. A person shall not pollute or interfere with any waters or water supply on a reserve.

Penalty: $1 000.

PART VI.—CAMPING.

Definitions.

35. In this Part unless the contrary intention appears—

"camp" means to stay or lodge (whether in a camping unit or otherwise) during any period of the night between 9.00 p.m. and 6.00 a.m.;

"camping area" means a camping area set apart by the Authority pursuant to subregulation (1) of regulation 36;

"camping unit" means a caravan or a tent, bivouac or temporary shelter of any kind;

"the ranger" in relation to a camping area means the ranger in charge of the reserve on which the camping area is situated.

Camping areas.

36. (1) Notwithstanding any other provisions of these regulations, the Authority may set apart areas on a reserve for the purposes of camping and may define any such area from time to time by posting a notice or notices indicating the purpose for which the area is so set apart.

(2) A person shall not without authority camp on a reserve except in a camping area.

Penalty: $200.

(3) A person shall not camp on a site in a camping area unless he has obtained a licence in writing from the ranger and has paid to the ranger the fee determined by the Authority for camping in that camping area.

Penalty: $200.

Unauthorised persons not to enter camp site.

37. Where a licence has been issued under subregulation (3) of regulation 36 in respect of a site in a camping area a person shall not enter or remain on that site without the consent of the holder of the licence.

Penalty: $200.

CONDITIONS OF USE: ISLAND SURVEY SITES (Inc Positioning Facilities)

1. Prior to the establishment of new sites on CALM lands, joint site inspection would be required. These should take into account:

   (a) rare, endangered or geographically restricted flora and an assessment of Aboriginal sites, if any, in the immediate vicinity of the proposed facility;

   (b) the need for the proposed site to be suitable to meet the technical and safety requirements of the proponent;

   (c) seabird nesting sites.

2. (a) A minimum of two (2) weeks notice to be given to CALM, whenever possible, prior to the activation of an existing (ie: previously approved) site.

   (b) Notice should include whether the site will be manned, an indication of how long the site will be in use and of the frequency of helicopter visits.

   (c) Subsequent visits to an activated site during that period of activation would not require notification.

   (d) If the CALM Regional Manager believes the existing (previously approved) sites are located in areas known or thought likely to be adjacent to active seabird rookeries and nest sites, CALM will review (including possible site inspection) to decide upon the most appropriate action and to ensure any disturbances are minimised. This may include moving the positioning facilities if technically possible.

   If given notice well in excess of two weeks, CALM could include some pre-activation inspections in normal island inspections.

3. (a) No pets shall be taken to the island.

   (b) Visual checks will be made on all equipment prior to transportation to ensure that it is free of exotic plant propagules and animals.

   (c) Disturbance to flora shall be kept to a minimum.

   (d) Particular care shall be taken to avoid walking over Wedge-tailed Shearwater burrows and in other areas where seabirds are nesting.

   (e) All reasonable precautions shall be taken to minimise disturbance to any animals, its habitat, nesting or spawning ground.

   (f) No firearms shall be taken to the island.

   (g) No rubbish shall be left on the island.

   (h) Compliance with flying and safety requirements applicable at the time, helicopter approaches shall be from the sector which will minimise disturbance to seabird rookeries and nest sites.

Final Draft Copy.

RADIOLOGICAL HAZARD ASSESSMENT for CALM Personnel at the Monte Bello Islands.

1. Introduction

1.1 The Western Australian Department of Conservation and Land Management (CALM) is responsible for the management of the Monte Bello Islands as part of a Conservation ~~Marine~~ park. This responsibility includes control of access to the Islands and the locations of nuclear tests carried out during the 1950's. As part of their rehabilitation programme, CALM will be supervising flora and fauna studies, baiting programmes for eradication of feral animals and signposting of radioactivity contaminated areas.

1.2 Previous monitoring and hazard assessments carried out by the Australian Radiation Laboratories (ARL) and the Radiation Health Section of the W.A. Health Department considered only the possible exposure of casual visitors to the islands and did not address the possibility of the above-mentioned working situations (Cooper et al 1990).

1.3 This document will assess the radiological hazard to personnel working on the islands for four two-week periods in any one year. This assessment will use the measured and assumed parameters for radiation exposure detailed by ARL in their assessment document but will focus mainly on the major route of possible exposure - the inhalation pathway.

2. External Exposure - Gamma Radiation

2.1 The only sources of Gamma radiation on the islands are the two Ground Zeros; G1 on Trimouille Island, G2 on Alpha Island and the fall-out path of the HMS Plym test on Trimouille Island. There may be some scattered minor sources (activated steel fragments) around these locations or on the sea bed, but their contribution to external Gamma exposure of personnel would be so slight as to be negligible.

2.2 The recommended safe working procedures for personnel on the islands suggests that the areas of G1 and G2 should be considered as "~~no-go~~" areas for the tasks proposed. The "no-go" area has been proposed as a 200metre radius from each of the Ground Zeros. For the area of the fall-out plume on Trimouille Island a "~~no-go~~" distance of 500 metres from the area bounded by MB1 and MB4 to the North West of Main Beach has been recommended.

2.3 Table 1 shows the measured Gamma levels at 100 metres from G1 and G2 in 1990 (Cooper et al 1990), and an estimate of Gamma levels at 200 metres distance. The 500 metre distance from the fall-out plume should ensure that Gamma levels for workers in the area will not normally exceed 0.05 microGrays per hour (uGy/hr) although there may be some small localised sources resulting from scattered debris and sand movement.

2.4 ARL estimated the time needed for continuous exposure to Gamma Radiation at the three locations of concern to reach the limit of exposure for members of the public (Cooper et al 1990) to be as shown in Table 2. These times are for Gamma exposure only, with no account being taken of internal exposure via the inhalation route. Table 2A shows an estimate of residence time at each area for Gamma exposure only, assuming a normal eight-hour working day.

2.5 Assuming that one day would be spent by workers in the vicinity of G.1 and G.2 with a further 2 days on Trimouille during each of four visits to the island, then the possible Gamma exposure to individuals would be as shown in Table 3.

2.6 The total exposure from Gamma Radiation is therefore not expected to exceed 52 microSieverts per annum or 5.2 per cent of the annual exposure limit for members of the public.

3. Internal Exposure - Alpha Radiation

3.1 The potential hazard to health from Alpha Radiation is via the inhalation pathway. The specific nuclides of concern are Plutonium and Americium resulting from the fall-out of the three nuclear tests. Dose estimates for members of the public visiting the area as tourists or fishermen have been calculated by ARL (Cooper et al 1990) and show that for such casual visits of short duration it is unlikely that any person's exposure to Alpha Radiation would exceed the recommended limits.

3.2 For CALM personnel and visiting scientists who would be working on the islands undertaking maintenance and monitoring tasks, it is necessary to assess the inhalation pathway of exposure using criteria related to movement of soil and dust during such tasks. Measurements by ARL, of Alpha emitting nuclides in the soils at G1, G2 and the HMS Plym fall-out plume area, have shown that the quantities of radionuclides in soil at the three locations are as shown in Table 4. The major portion of the inhalation dose will come from Plutonium and Americium nuclides, with the locations MB2 and MB4 on Trimouille Island being the most contaminated.

3.3 The dose assessments proposed by ARL for members of the public used the data for the most contaminated site sampled at each of G1, G2, MB2 and MB4 locations. The activity concentrations were assumed to be the same as those in the less than 45um fractions. It was also assumed, in the absence of actual site data, that the resuspended dust in air would average 0.1 mgm per cubic metre. These assumptions are considered to be conservative and in the event of personnel passing through the area (e.g. to check on dropped baits for feral animals) their exposures would not be greater than those shown in Table 5.

3.4 In the event that work involving soil movement is required in the contaminated areas, the dose assessments have been linearly scaled to an assumed resuspension of 1mg per cubic metre of air resulting from digging or vegetation clearance. Table 6 shows the estimated exposure and the actual working hours permitted at each location to reach the limit of exposure of 1mSv per year. The assumed breathing rate for workers is $1.2m^3/hr$.

3.5 From the table, it appears that there is little risk of inhalation exposure at locations G1 and G2, compared to MB2 and MB4, but these areas were subjected to rehabilitation works in 1979 with "clean" sand of up to 300mm depth being spread on the surface. Digging in these areas may expose soils with higher contamination levels of Alpha-emitting Radionuclides thereby leading to increased exposure.

Table 1

Measured and Estimated Absorbed Dose Rate in Air (uGy/hr) for G1 and G2

Source	N	NW	W	SW	S	SE	E	NE
G1- 100m	0.12	0.10	0.18	0.04	0.16	0.23	0.20	0.22
est.200m	0.06	0.05	0.09	0.20	0.08	0.12	0.10	0.11
G2- 100m	1.4	2.5	2.8	3.5	2.9	2.5	5.0	1.8
est.200m	0.7	1.3	1.4	1.8	1.5	1.3	2.5	0.9

Table 2

Stay times to Reach Limit of 1mSv (24hr/dy occupancy)

Location	Stay Time (day)	Average Exposure (uGy/day)
G1	59	17
G2	8	125
Trimouille Plume	32	31

Table 2A

Stay Times to Reach Limit of 1mSv (8 hours/day Occupancy)

Location	Stay time(days)	Average Exposure (uGy/day)
G.1 - 200m	1237	0.81
G.2 - 200m	88	11.4
Trimouille - 500m	2083	0.48

Table 3

Estimated Gamma Exposure

Area	Exposure/day uGy	Total Exposure uGy
G.1	0.81	3.24
G.2	11.4	45.6
Trim.	0.48	3.84
		52.68

Table 4

Radionuclides in Soil.

	Radionuclides (Bq/g in top 10mm)				
Location	Am-241	Pu-238	Pu239	Pu-240	Pu-241
G-1 25mN	1.28	0.371	25.6	2.94	8.96
G-2 100m SW	1.93	0.414	29.0	2.90	13.90
MB2	107.0	60.90	4260.0	426.0	596.0
MB4	26.6	15.20	1060.0	106.0	149.0

Table 5

Normal Exposure Dose Assessment. uSv/day

Location	Exposure uSv (8 hr dy)	Dys to Limit
G.1	0.81	1235
G.2	0.9	1111
MB.2	127.0	8
MB.4	31.9	32

Table 6

Estimated Exposure During Soil Movements.

Location	CEDE uSv/hr	Time to Limit
G.1	1.21	826.0
G.2	1.35	740.0
MB.2	190.5	5.25
MB.4	47.8	21.0

Table 7

Maximum Working Times in Contaminated Areas.

Location	Gamma Exp. uSv/hr	CEDE uSv/hr	Hrs to Limit
G.1	0.1	1.21	758.0
G.2	1.43	1.35	360.0
MB.2	0.06	190.5	5.0
MB.4	0.06	47.8	20.1

3.6 Total Effective Dose for workers will include external Gamma exposure plus the Committed Effective Dose Equivalent (CEDE) for dust inhalation. The small and still reducing Gamma component in all areas leads to an overall reduction in the time permitted in each location for personnel to reach the 1 mSv limit of exposure. These reduced times are shown in Table 7.

3.7 Inhalation of wind carried resuspended material is possible during non-working hours at the chosen living area on Hermite Island. Considerable movement of the sands has been observed during times of high winds that may result in redistribution of Alpha-emitting nuclides (pers. comm. H. Butler). This source is not considered to be a likely major contributer to the total exposure of personnel. However, since strong winds from the N/E quandrant occur mainly during May to August (fig 1A & 1B), the proposed residence times for personnel on the islands, this possible pathway should be included in a future assessment.

3.8 Surface contamination is only likely to occur on artefacts (steel and other fragments from the explosions) and may be masked by rust or dirt. This exposure route will be insignificant if safe working procedures are followed.

4. Ingestion Pathway

From the ARL study, it can be seen the ingestion and wound contamination pathways can be dismissed as being inconsequential. However, the possibility of redeposited material being collected with rainwater should be included in a future assessment when redeposition data are available.

5. Conclusions

The Radiological Hazard Assessment carried out by ARL (Cooper et al 1990) applied only to casual visitors to the Monte Bello island group. Their assessment related in time to November 1990 for nuclear decay. The same time basis has been used for this assessment, since the change in Radionuclide ratios for Alpha emitters over the 2 years will be mimimal.

The assumptions used by ARL of 0.1mg per cubic metre of dust and breathing rate of $0.95m^3$ per hour have been changed to 1mg per cubic metre of dust and $1.2m^3$ per hour breathing rate for workers.

It is recommended that no works involving digging and/or excessive dust movement be carried out in the contaminated areas. A worker could reach the limit of 1mSv exposure from Gamma and inhaled dust on Trimouille Island after 5 hours exposure at the estimated maximum levels. Although the Ground Zero locations G1 and G2 have lower surface contamination levels, these areas have had some soil/sand cover put in place and material at depths greater than 50mm may have greater concentrations of Alpha emitting radionuclides.

The Gamma radiation will continue to decrease significantly in the short term (tens of years) but the [illegible] from Alpha emitting radionuclides will not change appreciably over several hundreds of years except for dilution by resuspension and possible weathering effects.

Action should be taken to warn casual visitors to the islands of the possible hazards in the contaminated areas and of the possible hazard of removing souvenirs from those areas.

Information on deposition of resuspended material on other islands from the contaminated areas is not available. Such deposition is only likely to occur during periods of very strong Northerly winds without accompanying rainfall, and would most likely be immeasurable at distances greater than 1 km from the contaminated areas.

Data on resuspension and deposition is not currently available, but an attempt to obtain this information is recommended in order to confirm the assumption of negligible exposure via this route.

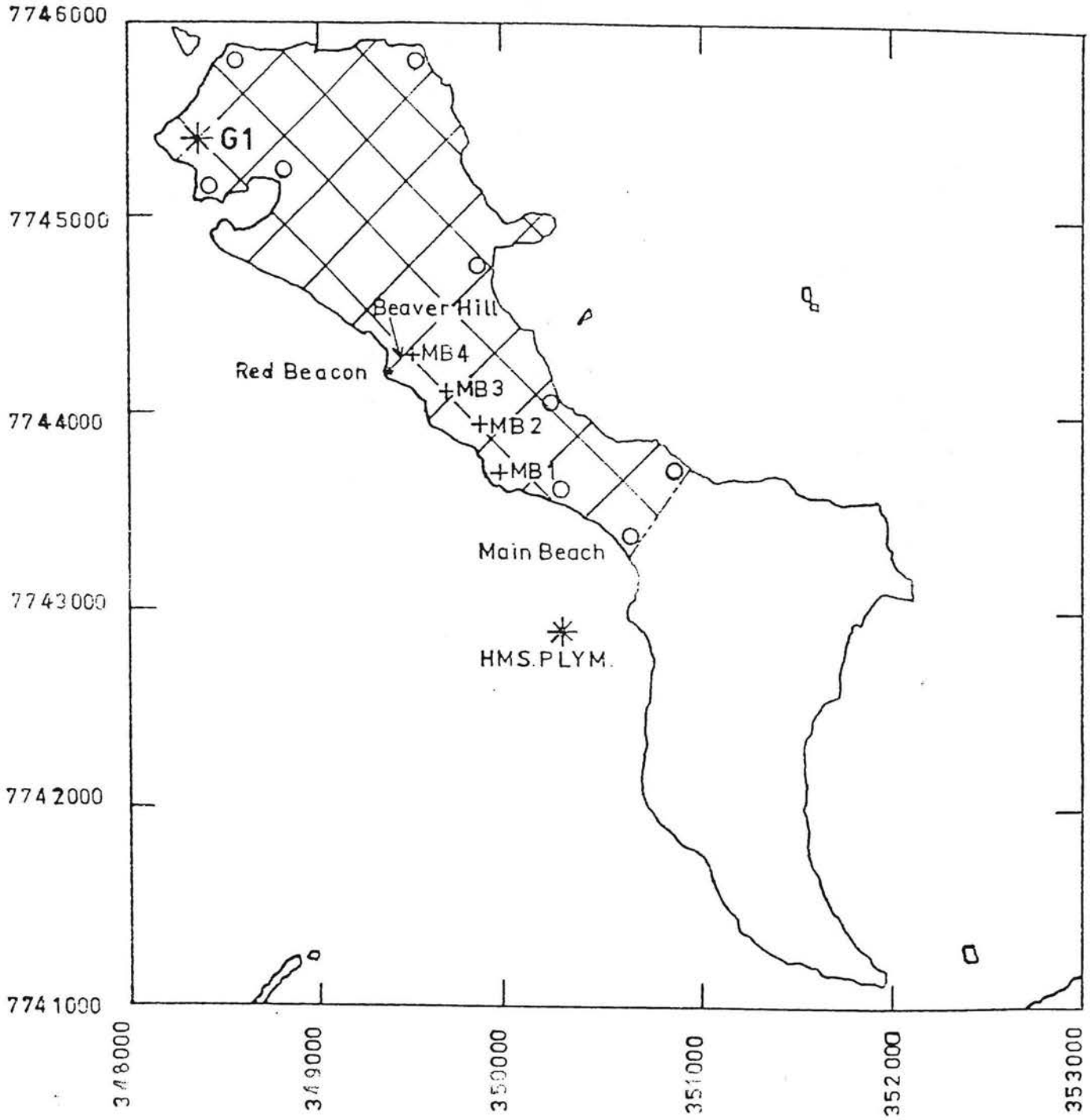


FIG 3. TRIMOUILLE ISLAND RESTRICTED ZONE.

LEGEND: Restricted Zone. No camping, digging or wood collection.

O R.Z. sign location. Nuclear weapon test

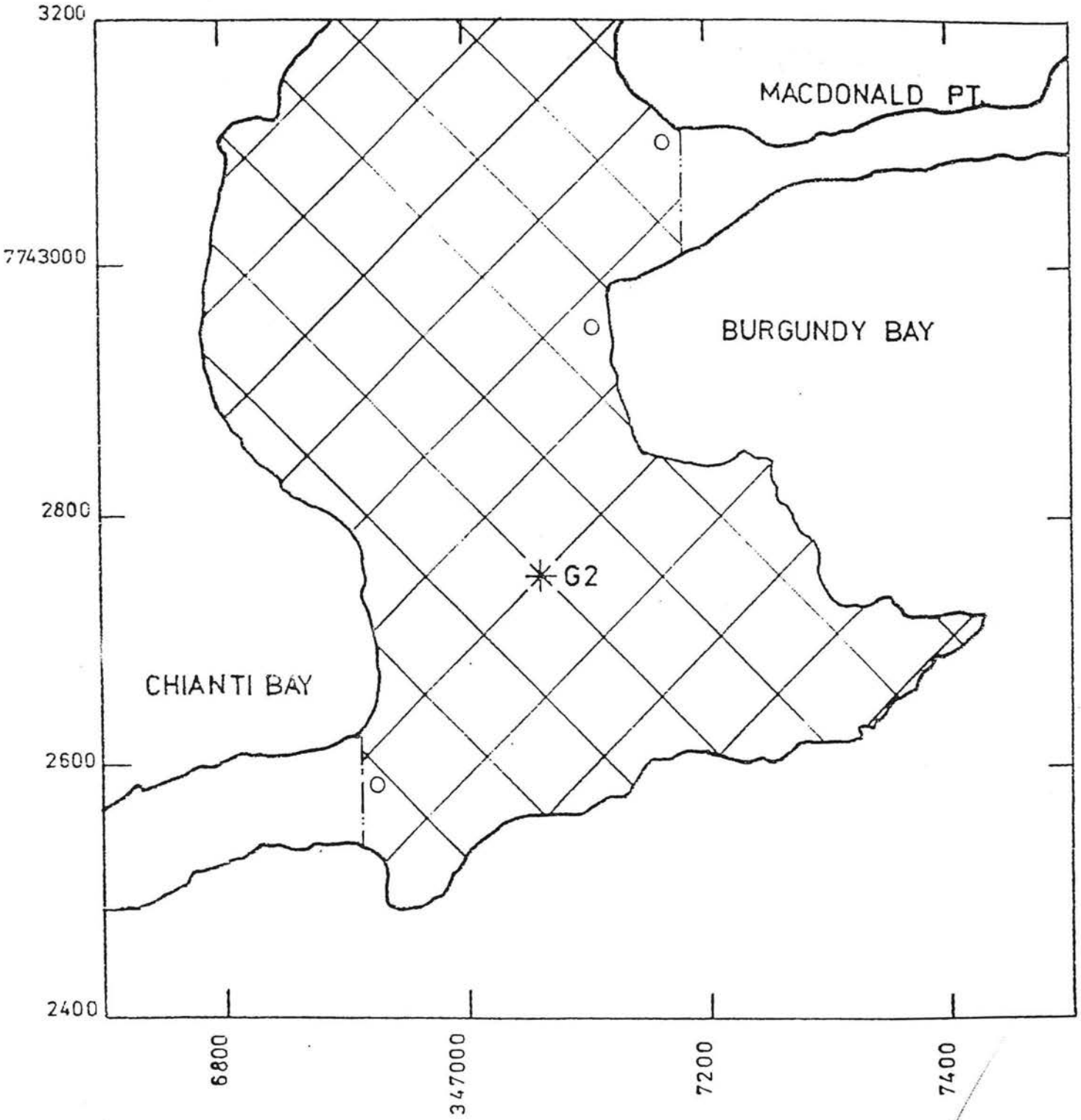


FIG 2 ALPHA ISLAND RESTRICTED ZONE.

LEGEND: Restricted Zone. No camping, digging or wood collection.

O R.Z. sign location.

Nuclear weapon test site.