DEPARTMENT OF DEFENCE

ENVIRONMENTAL RADIATION MONITORING DURING VISITS OF NUCLEAR POWERED WARSHIPS TO AUSTRALIAN PORTS

REQUIREMENTS, ARRANGEMENTS AND PROCEDURES

MAY 1988

FOREWORD

The Commonwealth Government has determined conditions to be met when nuclear powered warships visit Australian ports. These conditions include a requirement that appropriate State/Territory and Commonwealth authorities provide a radiation monitoring program to determine whether any radioactivity has been discharged or accidentally released from a nuclear powered warship in port; to determine actual or potential levels of any consequent exposure to radiation of members of the public; and to provide this information within a timescale that allows remedial action to be taken. Part 1 of this document sets out the requirements of a radiation monitoring program capable of meeting these objectives. The fundamental arrangements and procedures for implementing the requirements are presented at Part 2 and provide a basis for the development of fully detailed, port specific, radiation monitoring programs.

The first edition of this document was published in September 1979 under the title 'Guidelines for Environmental Radiation Monitoring during Visits of Nuclear Powered Warships to Australian Ports'. This edition contains a number of editorial changes. the Objectives and Principles of the first edition are now presented as Requirements. The Guidelines have been amended in the light of experience and are now set out as Arrangements and Procedures. The 'Working Guidelines for Emergency Reference Levels' formerly at Annex B, and certain technical data of a detailed nature, have been omitted from the revision and are presented in the 'Radiation Monitoring Handbook for Visits by Nuclear Powered Warships to Australian Ports' published by the Australian Atomic Energy Commission. Details of Emergency Planning Zones around NPW berths in Australian ports are included as an Annex for reference purposes.

This document will be reviewed and updated, as necessary, in the light of further experience with visits of nuclear powered warships to Australian ports. Amendments to the Requirements as set out in Part 1 of this document will require endorsement at Ministerial level. Amendments to the Arrangements and Procedures set out in Part 2, subject to their being consistent with the Requirements, may be made under the authority of the Visiting Ship Panel (Nuclear).

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PART 1

THE REQUIREMENTS FOR RADIATION MONITORING AT AUSTRALIAN PORTS VISITED BY NUCLEAR POWERED WARSHIPS

1. BACKGROUND

A condition of entry* for visits by nuclear powered warships (NPWs) to Australian ports is that there will be the capability to carry out radiation monitoring in the port being visited. The objectives of this radiation monitoring, as set out in the report 'Environmental Considerations of Nuclear Powered Warships Visits to Australia', published by the Commonwealth Government in May 1976, are:

a. to determine whether any radioactive material has been released and whether radiation levels have increased above normal background,

b. to determine the nature and extent of any release,

c. to assess levels of radiation and radioactive contamination in the environment around the ship,

d. to assess the magnitude and nature of the hazards arising from an accident, and

e. to determine when a release has terminated and when affected areas have returned to normal.

The requirements for a suitable radiation monitoring program are set out below and the essential arrangements and procedures of a radiation monitoring program capable of meeting the requirements are presented in Part 2. The arrangements for Emergency Planning Zones around Australian NPW berths are included as an Annex for reference purposes.

2. THE REQUIREMENTS

The requirements are presented under two categories:

a. environmental radiation monitoring, and

b. radiation monitoring related to a reactor accident.

2.1 Environmental Radiation Monitoring

Although experience has shown that the release of radioactive material or the emission of ionising radiation from an NPW in port during a normal ship visit are extremely unlikely events, objective (a) requires that means be provided to detect their occurrence whilst objectives (b) and (c) require that means be provided to determine the nature and extent of any such release or emission and to assess the levels of radiation and contamination in the environment around the NPW. Requirements are set out for monitoring in relation to the emission of ionising radiation and for the release of solid or liquid radioactive waste. The release of significant amounts of radioactive material in a gaseous form is only considered to be feasible as a consequence of a reactor accident.

2.1.1 **External radiation exposure.** The potential for external radiation exposure of people in the vicinity of an NPW at an alongside berth is to be checked at intervals by radiation surveys of areas designated as free for public access. Arrangements and Procedures for the implementation of this requirement are given in Part 2, paragraph 3.1.

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* Visits by NPWs to Australian Ports – Procedures (OPSMAN 1), (2nd Ed), Department of Defence, 1987.

2.1.2 **Internal radiation exposure.** Internal radiation exposure of members of the public would follow consumption of seafoods should these become contaminated with radioactive waste material in solid or liquid form escaping from an NPW. The potential for radiation exposure from this source is to be kept under surveillance by a program of marine environmental monitoring addressed to:

a. the surface layer of the bottom sediment from the vicinity of the berth or anchorage, and

b. selected seafood taken from the environs of the berth or anchorage;

and entailing analyses for cobalt-60 and any other radionuclide known to characterise the radioactive waste likely to be held in an NPW.

Arrangements and procedures for the implementation of a suitable marine environmental monitoring program are set out in Part 2, paragraph 3.2.

2.1.3 **Radiation protection standards.** The Australian public health standards that are relevant to radiation exposure of members of the public from the sources identified above are the recommendations of the National Health and Medical Research Council's Recommended Radiation Protection Standards for Individuals Exposed to Ionising Radiation, as amended from time to time.

2.2 Radiation Monitoring Related to a Reactor Accident

An accident to a reactor of an NPW, of sufficient severity to cause a major release of radioactive fission products to the environment, could arise from a loss of reactor coolant leading to a meltdown of the uranium fuel. The subsequent release of fission products into the reactor containment would lead to an increase in external radiation levels around the hull of the vessel and could be followed by a slow leakage from the containment into the atmosphere over a period of many hours. The probability that such an accident would occur during the course of a four or five day visit to a port has been estimated to be less than one in a million per reactor. A 'Reference Accident' of this type is used as the basis for determination of the requirements for contingency response and for radiation monitoring relating to reactor accidents at Australian ports visited by NPWs. Emergency Planning Zones are designated around NPW berths in Australian ports for contingency planning purposes. Details are included in the Annex as reference material.

2.2.1 **Detection of an accident.** In the event of an accident the effectiveness of any countermeasures necessary to protect the health of members of the public in the vicinity of the berth could be critically dependent on the speed of warning.

> An assurance has been received from the US Government that:
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> 'The appropriate authorities of the host government will be notified immediately in the event of an accident involving the reactor of the warship during a port visit'.

However, to provide increased confidence that rapid remedial action will be possible, a monitoring system is to be available throughout each NPW visit, to provide early detection of a reactor accident of sufficient severity for a major release of fission products to the environment.

A reactor accident on board a nuclear powered vessel would result in an increase in the gamma-radiation levels around the vessel due to the release of fission products from the fuel into the reactor compartment. The early detection monitoring facility is to keep the NPW under surveillance for direct emission of gamma-radiation, which could provide an indication of such an accident. Detection of high gamma-radiation levels by the facility will provide a signal to enable the prompt initiation of protective counter measures.

2.2.2 **Immediate post-accident monitoring.** Radiation monitoring surveys are to be initiated immediately on detection of a high gamma-radiation level or, on the receipt of advice that an accident has occurred. The objectives of the surveys are to determine if any radioactive material has been released, to identify any hazards to health, to provide information that will assist in evaluating the severity of the accident and in assessing the need for countermeasures as required by objective (d)

In the immediate post-accident period the availability of data from radiation surveys of affected areas is essential for the planning of countermeasures. Therefore the capability to carry out immediate post-accident radiation monitoring must be established in a port before an NPW visit commences.

2.2.3 **Longer term monitoring.** Objective (e) requires the capability for more extensive environmental radiation monitoring of affected areas following the immediate post accident monitoring. This activity could possibly continue over a period of days. Additional personnel and equipment and other resources such as laboratory facilities would need to be enlisted for these purposes. The necessary arrangements are to be made in advance.

Arrangements and procedures for the implementation of radiation monitoring related to a reactor accident are outlined in Part 2 paragraph 4.

2.2.4 **Radiation protection standards.** The emergency reference levels, to be used as the basis for the determination of appropriate countermeasures against radiation exposure following a reactor accident, are those recommended by the National Health and Medical Research Council in, 'Recommendations on Emergency Reference Levels for Major Radiation Accidents', as amended from time to time.

PART 2

ARRANGEMENTS AND PROCEDURES FOR RADIATION MONITORING AT AUSTRALIAN PORTS VISITED BY NUCLEAR POWERED WARSHIPS

1. INTRODUCTION

The basic arrangements and procedures for a radiation monitoring program capable of meeting the radiation monitoring requirements at Australian ports visited by NPWs are set out below. The requirements are set out in Part 1 of this document.

These arrangements and procedures have been developed in the light of experience gained in port monitoring since 1977 and are the basis for detailed monitoring programs that are in place at ports currently approved for NPW visits. As presented, the arrangements and procedures provide for the allocation of certain key responsibilities in a suitable monitoring program and also provide an outline, of procedures whereby Commonwealth radiation protection officers, engaged in routine monitoring at a port, are able to activate the port safety organisation in the event of a release of radioactive material.

2. GENERAL

2.1 Radiation Monitoring Handbook

The techniques, practices and procedures of radiation monitoring for NPW visits, the correlation of measured radiation levels with protective measures, and working guidelines relating to the emergency reference levels recommended by the National Health and Medical Research Council are set out in the Radiation Monitoring Handbook*. This Handbook is to be available as a reference document to all Commonwealth and State radiation protection officers participating in radiation monitoring of NPW visits.

2.2 Radiation Monitoring Group

The capability to mount radiation monitoring is to be established in a port before an NPW visit commences. To this end, a Radiation Monitoring Group (RMG) is to be formed for each NPW visit and made responsible for both routine and immediate post-accident radiation monitoring. For routine monitoring the RMG is to be staffed by the designated Group Leader and another Commonwealth officer, each equipped to function as a mobile monitoring unit. In an emergency, additional mobile monitoring units are to be made operational, controlled by State/Territory radiation protection officers. The Commonwealth, through the Australian Nuclear Science and Technology Organisation (ANSTO), is to ensure that an appropriately qualified officer is available for each NPW visit to be Leader RMG.

2.3 Pre-visit Preparation and Standby Arrangements

Arrangements are to be made for the radiation monitoring equipment required for routine monitoring, and for immediate post-accident monitoring to be available at ports during NPW visits and held in the custody of the RMG; support operations and communication facilities are a State/Territory responsibility.

Before each NPW visit the RMG is to be brought to operational readiness. The Leader RMG is responsible for control of:

a. pre-visit exercising/briefing of the RMG,

b. readiness and functional status of all monitoring equipment,

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* Radiation Monitoring Handbook for Visits by Nuclear Powered Warships to Australian Ports, ANSTO, 1985.

c. communication facilities for the RMG, and

d. transport facilities for the RMG.

The State/Territory members of the RMG may then revert to standby for the period of the visit or until called out. Commonwealth members of the RMG are to remain on call throughout the visit and are to implement the routine radiation monitoring requirements as detailed in the Radiation Monitoring Handbook.

2.4 State/Territory Radiation Officer

A State/Territory Radiation Officer (SRO/TRO) should be nominated and made responsible for advice to authorities of the host State/Territory on all public health aspects of radiation safety arising from NPW visits. The SRO/TRO should be an experienced senior professional health physicist nominated by the host State/Territory.

In the event of a radiation accident, the SRO/TRO is specifically responsible for advising the Port Safety Organisations:

a. on hazards to the health of members of the public,

b. on the need to implement countermeasures, and

c. when normal activities may be resumed in affected areas.

In conjunction with the Leader RMG the SRO/TRO is to be jointly responsible for:

a. designating the pattern of post accident radiation monitoring conducted by the RMG,

b. assessing the specific needs for on-going radiation monitoring, and

c. analysing the results of radiation monitoring.

3. ENVIRONMENTAL RADIATION MONITORING

3.1 External Radiation Exposure

3.1.1 **Routine monitoring surveys.** The potential for external exposure of members of the public to gamma-radiation when an NPW is at an alongside berth is to be checked by radiation surveys on the vessel's arrival at the berth, and approximately once daily thereafter. The surveys are to be confined to those areas in the vicinity of the NPW designated as free for public access.

Commonwealth members of the RMG are to make the surveys in accordance with the instructions set out in the Radiation Monitoring Handbook and the results examined by the Leader RMG who is to draw the attention of the SRO/TRO to any increase in established background radiation levels.

3.1.2 **Thermoluminescent dosemeters.** To provide data on radiation doses that would result from an accidental release of airborne radioactivity, a number of thermoluminescent dosemeters (TLDs) are to be exposed at selected locations in the vicinity of an NPW berth during each NPW visit.

The provision and measurement of TLDs is the responsibility of the Australian Radiation Laboratory. The number and location of TLDs for individual berths are to be determined jointly by the Commonwealth and State/Territory.

3.2 Internal Radiation Exposure

The potential for internal radiation exposure of members of the public is required to be kept under surveillance by a marine environmental monitoring program. The program should be a cooperative venture between the Commonwealth and the host State/Territory and is to provide for sampling of both sediment and seafood from the vicinity of the berths.

Samples are to be collected by State/Territory authorities, or by the RAN where berths are at naval bases, and analysed at the Australian Radiation Laboratory. Measurements should be made separately on sediment and seafood and attention drawn to any result indicating an increase in established background levels. More extensive surveys of the marine environment would then be needed to investigate the possible movement of radioactive contaminants to the shoreline or into other marine food chains. Results of measurements are to be forwarded by the Commonwealth to relevant State/Territory authorities when available and all results published annually.

3.2.1 Marine Environmental Sampling Program

3.2.1.1 **Alongside berths.** At alongside berths, quarterly samplings are to be made with an allowed flexibility of two weeks each side of the due sampling date. If an NPW visits a berth, an additional full set of samples are to be taken prior to and following the visit. Should pre-visit or post-visit sampling be required within two weeks of the due date for routine quarterly sampling, then either the pre-visit or post-visit sampling will suffice for the routine quarterly sampling.

The quarterly sampling program at an approved berth that receives only infrequent NPW visits may be discontinued provided that:

a. a quarterly sampling program has been implemented for a period of not less than two years; and

b. State and Commonwealth authorities are agreed that a reliable base-line of radioactivity has been established.

Where a berth at which quarterly sampling has been discontinued is subsequently to be used for a visit by an NPW, a set of samples are to be taken prior to and following the visit, and another set of samples three months later. Provided the samples reveal no increase in established background levels of radioactivity, quarterly sampling may again be discontinued.

3.2.1.2 **Anchorages.** For anchorages, sampling shall take place at points on the shoreline designated by State/Territory authorities as being those at which any contamination released at the anchorage would most likely be deposited. Sampling is to take place prior to and following a visit, and three months later, within an allowed flexibility of two weeks of the due date.

4 RADIATION MONITORING IN RELATION TO A REACTOR ACCIDENT

4.1 Early Warning System

A facility to provide early warning of a reactor accident is required and is to be based upon detection of gamma-radiation emitted from the NPW as a consequence of the accident.

The early warning system is to:

a. be capable of continuous unmanned operation,

b. employ the principles of redundancy and diversity to ensure reliability of operation and freedom from spurious signals,

c. have its detectors located with clear line of sight to the NPW, and

d. provide visual and audible alarm upon detection of a sustained increase in gamma-radiation levels.

Signals from the detectors are to be relayed to a chart recorder with a pre-set alarm facility located at a suitable Port Control Office or Police Gatehouse or at the Emergency Operations Centre of the Port Safety Organisation.

Selection of a suitable site for the detectors of the early warning system and a location for the chart recorder shall be made after consultation between State/Territory and Commonwealth officers. The installation of the system is to be undertaken by the Commonwealth with State/Territory assistance as required.

4.1.1 **Operation of the early warning system.** The chart recorder of the early warning system is to provide an audible and visual alarm signal on detection of high radiation levels. Guidance on the appropriate alarm level is set out in the Radiation Monitoring Handbook. Commonwealth or State/Territory officers are to be in continuous attendance and respond to an alarm signal in accordance with predetermined procedures. The procedures that are to be implemented in the event of an alarm signal are to be developed in detail for each port from the general principles set out at paragraph 4.2.

4.2 Procedures Following an Alarm

The Leader RMG and the Duty Officer of the Emergency Operations Centre are to be notified immediately of an indication of a high radiation level and are to react as follows:

The Leader RMG should immediately investigate whether the indication is genuine. If so, the Emergency Operations Centre should be advised of a confirmed alarm and radiation surveys commenced as outlined in paragraph 4.2.1. If the alarm signal is not confirmed the non-confirmation should be recorded and, if due to an instrument fault, the fault remedied immediately.

The Duty Officer, Emergency Operations Centre, should immediately contact, through established channels, the NPW to seek confirmation of an accident.

Upon confirmation of an alarm to the Duty Officer, either from the NPW or from the Leader RMG, the actions set out in the port safety plan for the immediate evacuation of Zone 1 (Annex A) are to be initiated and the Port Safety Organisation is to be activated.

4.2.1 **Immediate post-accident radiation monitoring.** Upon confirmation of an alarm, radiation surveys should be commenced by the Commonwealth members of the RMG, the first priorities of which are:

a. gamma-radiation measurements to determine the magnitude and extent of any external radiation hazards due to direct radiation from the NPW,

b. gamma-radiation measurements and air sampling to determine if a release of radioactive material has occurred, and

c. air sampling to determine airborne concentrations of critical radionuclides and to estimate inhalation hazards to members of the population.

The Leader RMG is to direct the radiation surveys as outlined above, initially in a direction downwind from the NPW. In conjunction with the SRO, he or she is to interpret the results and determine the need for further surveys.

Arrangements are also to be made for the decontamination of persons evacuated from Zone 1, as necessary.

Monitoring is also to be carried out for:

a. surface contamination in areas affected by fission products, and contamination of milk and other foodstuffs, and

b. contamination of the marine environment around the NPW.

4.2.2 **Meterological data.** Pre-visit arrangements are to be made for the provision of meteorological data, including local wind speed and direction, to assist in estimating the extent and magnitude of the effects of a release of airborne radioactivity.

4.3 Longer Term Radiation Monitoring

Following the immediate post-accident radiation monitoring period, more extensive environmental radiation monitoring is to be undertaken to:

a. determine the extent of any decontamination needed,

b. monitor foodstuffs that may have been affected.

c. provide assurances that evacuated areas can be reoccupied, and

d. provide assurances that normal activities may be resumed in affected areas.

Substantial resources of staff and equipment may be needed for this purpose but the requirement is less urgent than that of immediate post-accident monitoring. Therefore, these resources can be derived from other centres, including those remote from the port being visited. Organisations that are expected to contribute this assistance are to be informed beforehand.

4.4 Countermeasures to Protect the Health of Members of the Public

Following a release of radioactive fission products to the atmosphere, the following countermeasures are available to minimise the effects on the health of members of the public:

a. sheltering indoors;

b. evacuation of areas in the path of the airborne radioactivity;

c. prophylaxis by administration of stable (inactive) iodine to those in the path of the radioactive plume; and

d. restriction on the use of contaminated foodstuffs, especially milk and vegetables.

The implementation of countermeasures may incur some additional risks to those affected, together with inconvenience and expense, and any disadvantage accruing from a remedial measure should be kept as small as possible. The risks from radiation exposure arising from the accident must be critically compared with risks arising from possible countermeasures. Thus, the final selection of countermeasures requires judgment and detailed consideration of the nature of the incident, the nature of the population at risk and the nature of the surrounding area. The information on emergency planning zones in the Annex provides an indication of the distances from the berth within which countermeasures may be necessary.

5. SUPPORT FACILITIES FOR RADIATION MONITORING

5.1 Communications

Arrangements are to be made by the appropriate State/Territory authority to provide adequate radio communications facilities and equipment for radiation protection officers of the RMG.

5.2 Road Transport

Arrangements are to be made by the appropriate State/Territory authority for the provision of vehicles for use as mobile monitoring units throughout NPW visits.

5.3 Equipment Storage

Arrangements are to be made by the appropriate State/Territory authority for secure storage facilities to accommodate equipment for the RMG.

6. PROVISION OF RADIATION MONITORING EQUIPMENT

All radiation monitoring equipment is to be provided by the Commonwealth. It is to be retained by the Australian Atomic Energy Commission and properly maintained and calibrated. Equipment required for an NPW visit will be made available at the port, checked and made operational as part of the preparation and standby arrangements. Equipment lists are to be set out in the Radiation Monitoring Handbook.

EMERGENCY PLANNING ZONES
(Reference: OPSMAN 1)

Emergency Planning Zones (EPZs) are designated around NPW berths and anchorages for planning purposes to assist in the identification of areas where hazards might arise and to ensure that appropriate protective actions can be taken promptly and effectively in the event of an accident:

Zone 1 is an area close to the NPW within which protective measures will be implemented automatically upon notification of a reactor accident.

Zone 2 represents the area at risk from inhalation hazards and includes Zone 1. The Zone boundary represents the limit at which it may be necessary to implement protective measures to prevent radiation doses from inhalation from exceeding the individual dose criteria.

Zone 3 represents the area at risk with respect to ingestion hazards, ie foodstuffs, milk, water and agricultural contamination, and includes Zones 1 and 2.

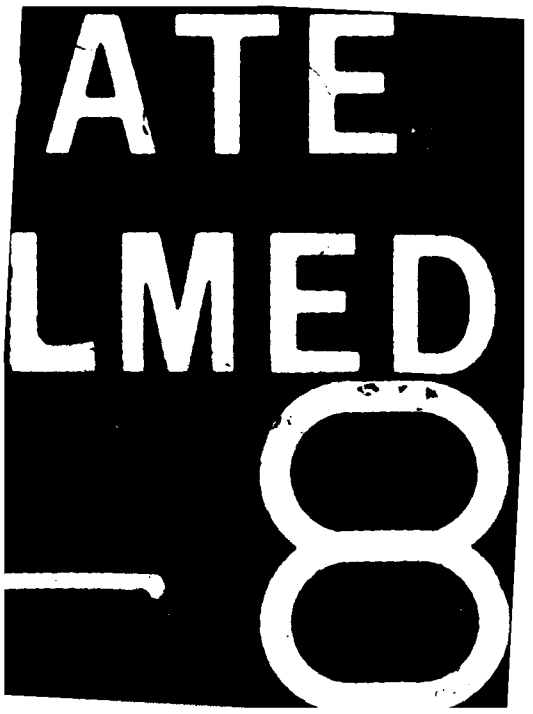
The boundaries of Zones 2 and 3 will vary according to the severity of the accident and the prevailing meteorological conditions and in practice will be determined by measurements of radiation and contamination levels.

Based upon the Reference Accident, the estimated maximum EPZ boundaries for berths and anchorages when used by NPWs up to 100 MW reactor power rating are:

a. **Zone 1** - 600 metres

b. **Zone 2** - 2.2 km

c. **Zone 3** - several kilometers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