Australian Navy.[81] The purchase of these tugs will improve an already satisfactory situation with respect to vessel removal arrangements for nuclear powered warships.

Action Following Removal

9.90 Criticism was made of the fact that Australian plans make no detailed provision for what is to happen to the vessel once it has been removed to a remote anchorage or to sea.[82]

9.91 Calculations of radiation dose levels from a vessel at a remote anchorage have been made on the assumption that the vessel will remain there until the tenth day following the accident.[83] Removal to an even more remote anchorage or to sea is considered by planners as a further option.[84] The United States and the United Kingdom have undertaken the responsibility to salvage or otherwise make safe any of their nuclear powered warships which might be incapacitated in a foreign port.[85]

9.92 The Committee does not regard it as either necessary or practical for plans to detail the long-term disposal arrangements for a stricken vessel. There would be adequate time after an accident to make these arrangements, which would be dependent on the characteristics of the particular vessel, accident, and location.

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81. Senate, Hansard, 18 October 1988, p. 1519.
82. Letter from Mr M. Lynch, 23 March 1988, p. 2 (Evidence, p. 915).
83. Evidence, p. 443.467 (ANSTO). See also the Appendix to ANSTO, 'Visits by Nuclear Powered Warships: Radiological Consequences of Releases from Remote Anchorages', (August 1987) which includes calculations for the period from 11 to 20 days after the accident.
84. Evidence, p. 443.467 (ANSTO).
85. US 'Standard Statement', para. 2(d) (Evidence, p. 1079). For the equivalent United Kingdom statement, see Evidence, p. 1300.16.

EVACUATION

Introduction

9.93 The Department of Defence view is that in Zone 1 protective measures such as evacuation should be taken immediately and automatically on receipt of a confirmed alarm.[86] Evacuation from Zone 2 is an option available to be exercised should the inhalation hazard spread beyond Zone 1. Because the outer limit of Zone 2 represents the maximum scope of the inhalation hazard, no evacuation measures would be required beyond this in the first 24 hours following an accident, according to the planners.

9.94 The adequacy of evacuation arrangements has to be assessed with regard to the characteristics of specific berths and anchorages. As a general point, the Committee noted that traditional open days, where the general public are allowed on board, are not permitted for visiting nuclear powered warships.[87] Hence the need to evacuate large numbers of visitors will not arise.

9.95 A general criticism sometimes made of emergency planning is that it presumes the public will respond rationally and will follow orders, directions and advice.[88] The Committee is prepared to assume that Australian planners have had sufficient experience with human behaviour in emergencies to have made realistic

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86. Submission from the Department of Defence, p. 5 (Evidence, p. 10). See also Evidence, p. 1300.49 (Department of Defence).
87. OPSMAN 1 (2nd edn.), paras. 311-12 (Evidence, p. 63). Visits by individually identified and escorted groups are permitted: ibid.
88. e.g. see S. L. Cutter, 'Emergency Preparedness and Planning for Nuclear Power Plant Accidents', Applied Geography, 1984, vol. 4, p. 239.

allowance for its variability.[89] No evidence was put to the Committee to suggest otherwise.[90]

9.96 However, a sub-set of this general criticism relates specifically to nuclear reactor accident responses. It is based on the response to the 1979 nuclear reactor accident at Three Mile Island. The experience in the United States has been that people directed to evacuate from non-nuclear emergencies have often failed to do so.[91] Following the Three Mile Island accident, advice to evacuate was given only in relation to pregnant women and preschool children within a 5-mile (8-km) radius of the accident site. Nonetheless, a large number of

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89. cf. Evidence, p. 1300.47 (Department of Defence):

> Police and emergency services should take these matters into account in their procedures. It is not the function of port safety plans to lay down procedures for the Services. Each Service has its own procedures for responding to these kinds of contingencies.

90. A number of submissions assumed mass panic might occur in a number of accident scenarios, some relating to nuclear weapons rather than reactors: see the submissions from Balmain People for Nuclear Disarmament, p. 7; Mrs L. Van Geloven, p. 5; Movement Against Uranium Mining, p. 2; Medical Association for the Prevention of War (NSW), p. 3; Mr K. G. Blake, p. 3; Miss E. Ruzicka, p. 2; People for Nuclear Disarmament, pp. 5-6 (Evidence, pp. 1307-08). No evidence was provided to support the assumption. Contrast J. Oliver, 'An Overview and Commentary on the Workshop, Human Behaviour in Disaster' in Department of Defence, Natural Disasters Organisation, Report of Proceedings of a Research Workshop on Human Behaviour in Disaster in Australia, 25-27 April 1984, (Australian Counter Disaster College, Mt Macedon, Vic., 1985), p. 10:

> The general community, and indeed many counter-disaster personnel, hold popular beliefs, which researchers consider at variance with the truth such as panic, looting, anti-social behaviour, inability to think or plan after disaster. (citation omitted)

See also R. R. Dynes, 'The Accident at Three Mile Island: The Contribution of the Social Sciences to the Evaluation of Emergency Preparedness and Response' in D. L. Sills and others (eds.), Accident at Three Mile Island: The Human Dimensions, (Westview, Boulder, Col., 1982), p. 126: there was fear of mass panic as the accident developed but:

> those images of panic, which were widely perceived, contrasted with the available social science literature and with what actually happened as a result of the TMI accident.

91. In D. J. Zeigler and J. H. Johnson, 'Evacuation Decision-Making at Three Mile Island' in A. Blowers and D. Pepper (eds.), Nuclear Power in Crisis: Politics and Planning for the Nuclear State, (Nichols, New York, 1987), p. 275 figures of 10 to 50 per cent are given as the typical under-response to evacuation warnings.

others, both within this area and outside it, evacuated.[92]

9.97 From this experience some researchers have argued that planning for a nuclear emergency should be different from that for a non-nuclear emergency.[93] Those evacuating without direction to do so may block evacuation routes on which the planned evacuation depends. Planned evacuation times may be rendered unrealistic. Other arrangements for evacuation and the reception of evacuees may be unable to cope with the unexpected numbers.

9.98 Even in its United States context,[94] the argument that responses will differ in nuclear and non-nuclear emergencies rests essentially on a single example. The literature suggests that the evacuation response to the Three Mile Island accident may well be explicable by factors specific to that accident. In particular, it seems that the fact that various officials were expressing conflicting views on the seriousness of the accident suggested to many that it would be prudent to assume the worst

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92. ibid., p. 274 states that 50 times as many evacuated as were advised to evacuate. See also D. J. Zeigler and J. H. Johnson, 'Evacuation Behavior in Response to Nuclear Power Plant Accidents', Professional Geographer, May 1984, vol. 36(2), p. 208, where numbers somewhat smaller than 50 times are suggested. A survey reported in the latter paper and based on evacuation intentions of those living near a reactor in New York State suggests that their evacuation behaviour would be similar to that which actually occurred after Three Mile Island: ibid., p. 213.

93. D. J. Zeigler and J. H. Johnson, 'Evacuation Decision-Making at Three Mile Island' in A. Blowers and D. Pepper (eds.), Nuclear Power in Crisis: Politics and Planning for the Nuclear State, (Nichols, New York, 1987), p. 275. The reasons given (ibid.) for the different response to nuclear accidents are:

> because people perceive the radiation hazard differently, because they cannot see or sense the hazard agent itself, because they fear the carcinogenic and transgenerational consequences of radiation exposure, and because they have no way of evaluating the veracity of official information. (citation omitted)

94. In the Australian context, the Department of Defence told the Committee that there is no evidence to suggest a greater over-reaction to a nuclear emergency than to a non-nuclear emergency: Evidence, p. 1300.46. But the value of its view is limited because the Department said it was unaware of the US literature on the over-reaction to the Three Mile Island accident: ibid.

and to evacuate.[95]

9.99 Evacuation planning in the United States and the United Kingdom has not been altered to reflect the particular response which occurred after the Three Mile Island accident.[96] Moreover, the unforeseen response which occurred after the Three Mile Island accident did not cause major problems.

9.100 The only Australian ports currently visited where significant evacuation of the general public might be directed in the 24 hours following the reference accident are Darwin and Hobart. There seems to the Committee no reason why unexpected evacuation in either of these places, if it occurs, should seriously hinder the evacuation of those directed to evacuate. The possibility of unexpected evacuation occurring, however, does emphasis the need for the safety plans for Darwin and Hobart to be publicly available.

9.101 The Committee does not consider that the argument on unforeseen evacuation applies so as to invalidate current planning for naval reactor accidents in Australian ports.

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95. C. B. Flynn, 'Reactions of Local Residents to the Accident at Three Mile Island' in D. L. Sills and others (eds.), Accident at Three Mile Island: The Human Dimensions, (Westview, Boulder, Col., 1982), pp. 52-54; S. L. Cutter, 'Emergency Preparedness and Planning for Nuclear Power Plant Accidents', Applied Geography, 1984, vol. 4, pp. 239-40; M. K. Lindell and V. E. Barnes, 'Protective Response to Technological Emergency: Risk Perception and Behavioral Intention', Nuclear Safety, October-December 1986, vol. 27(4), p. 457. However, this last paper notes (p. 466) there is:

> a growing literature that suggests that the overresponse at TMI resulted as much from prior public perceptions of the risks of a nuclear power-plant accident as it did from the confusing and conflicting information disseminated during the TMI-2 crisis.

The authors of this paper conclude (p. 466) that additional research is needed to improve understanding of evacuation behaviour.

96. D. J. Zeigler and J. H. Johnson, 'Evacuation Decision-Making at Three Mile Island' in A. Blowers and D. Pepper (eds.), Nuclear Power in Crisis: Politics and Planning for the Nuclear State, (Nichols, New York, 1987), p. 275.

Western Australia

9.102 For approved anchorages at Gage Roads off Fremantle, the area taken in by their respective Zone 2's is almost entirely water. The evacuation plan caters for any people who may be on the end of the North and South Moles and for clearance of small craft from the area.[97]

9.103 At HMAS STIRLING, the Zone 1 for two berths includes part of the base. For none of the berths or anchorages does the Zone 2 include civilian residential areas. Evacuation requirements extend only to the base and craft in adjacent waters. Plans cater for this in a thorough way.[98]

9.104 Members of the Committee examined the arrangements for both Gage Roads and HMAS STIRLING during a visit to Western Australia and considered them satisfactory.

Brisbane

9.105 All the approved berths are at Fisherman Islands, near the mouth of the Brisbane River. The Zone 2's for the berths furthest upstream include part of the small suburb of Myrtletown on the opposite bank of the river, but these berths have never been used. The three visits to date have all been to berths at the Container Terminal. These are well away from residential areas, so evacuation plans have to cater for only port workers, those on ships at the port, and any recreational users of the surrounding area.

9.106 The Port of Brisbane Safety Plan notes that Zone 1 will be evacuated immediately on confirmation of an accident, that the State Radiation Officer is responsible for provision of advice on

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97. WA Port Safety Scheme, para. 604.
98. HMAS STIRLING Sub-Plan, p. 13-11; WA Port Safety Scheme, para. 605.

the necessity for and scope of evacuation, and that the Queensland police will assist with evacuation as required.[99] But the Plan makes no detailed provision for evacuation. For example, there is no provision for establishment of a decontamination control zone, exit from which would be monitored so as to avoid spreading contamination.[100] Nor is provision made for how port workers or those on other ships in the port would be notified of the need to evacuate.[101]

9.107 In the report of the Australian Ionising Radiation Advisory Council (AIRAC) on its 1985 on-site review of the Brisbane arrangements it was recommended that the Plan make provision for evacuation.[102] AIRAC was assured that nuclear powered warships would not be allowed to berth if passenger liners were expected to be at adjacent berths, although there was no formal requirement to this effect. AIRAC recommended that:

> because of the difficulty of rapid evacuation of persons from a liner in an emergency, this requirement be explicitly stated in the Safety Plan for the Port of Brisbane.[103]

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99. Paras. 109, 329(h), 330(d).
100. cf. ANSTO, Report of the Committee of Inquiry into a Fire which Occurred on 18 March 1987 in a Radioisotope Processing Cell, Building 54 at the Lucas Heights Research Laboratories, (ANSTO, Lucas Heights, NSW, 1987), p. 3: one fire crew left the scene without first having been monitored, and it was necessary for an ANSTO officer equipped with a portable radiation monitor to go to the fire station to carry out monitoring of the crew and their equipment. No contamination was detected.
101. Contrast UK, Ministry of Defence, Liverpool Special Safety Scheme for Visits to Liverpool by Nuclear Powered Submarines, (April 1986), para. 57(b): Terminal Manager responsible for sounding all fire alarms in the area, and arranging orders by word of mouth and radio for evacuation of all personnel; para. 58(a): police to tour area making loudhailer announcements to reinforce steps taken by Terminal Manager; para. 58(f): police to notify masters of ships within 550 metres of the accident site; standard-form instructions (as set out in Annex 3E) to be delivered to masters; prior arrangements for foreign vessels made with the ships' agents, to obviate any language difficulties at the time of accident notification.
102. AIRAC, 'Review of Safety and Monitoring Arrangements for Visits by Nuclear Powered Warships', p. 7 (Evidence, p. 758).
103. ibid, p. 6 (Evidence, p. 757). Visiting passenger vessels berth at the Container Terminal.

9.108 The Visiting Ships Panel (Nuclear) agreed with both these recommendations and referred them to the Queensland authorities.[104] The Plan has not yet been modified in regard to either of them. No visits to Brisbane, however, have taken place since 1985.

9.109 The Committee RECOMMENDS that no visits to berths at Fisherman Islands, Brisbane be approved until adequate, documented, provisions are made: either for the evacuation of port workers, persons on ships in the vicinity, and tourists and other recreational land users likely to be within the inhalation hazard zone (Zone 2); or for avoiding the presence of such persons during a visit by a nuclear powered warship. Additionally, the Committee RECOMMENDS that the approved berths up-stream (ie. closer to Brisbane) of the ones currently used at the Container Terminal not be used until adequate, documented, provisions are made for the evacuation of residents from within the Zone 2's for the berths.

Darwin

9.110 Darwin has two approved primary anchorages and two approved berths. The Zone 2 for the more southerly anchorage takes in no residential areas and almost no land area at all. The Zone 2 for the other anchorage extends into part of the central business and residential area of the city. The Zone 2's for the two berths extend even further into this area. The business district lies just beyond Zone 1 for both berths.

9.111 The Darwin Port Safety Plan makes no provision for evacuation beyond noting that it is an available countermeasure

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104. AIRAC, 'Follow-up Actions on Report of Visits to Hobart/Darwin/Brisbane', pp. 7, 9 (Evidence, pp. 767, 769). In contrast, when the Committee asked the Department of Defence why Australian port safety plans made no detailed provision for dealing with crews aboard vessels berhted adjacent to a visiting NPW, the response indicated no dissatisfaction with existing arrangements: Evidence, p. 1300.45.

and making the police responsible for such evacuation as may be directed by the Counter Disaster Controller.[105] In its submission the Northern Territory Government told the Committee that the police prepare evacuation plans for each nuclear powered warship visit.[106]

9.112 For Zone 1, the Port Safety Plan provides for implementation of countermeasures following notification of an accident,[107] but not specifically for evacuation. This does not conform to the view of the Department of Defence that Zone 1 evacuation should be an immediate and automatic accident response.

9.113 The Committee takes the view that the Plan should contain detailed provision for immediate evacuation from Zone 1 and for possible evacuation from Zone 2. Accordingly the Committee RECOMMENDS that no visits be permitted to the northern approved anchorage or to either of the approved berths at Darwin until detailed provision is made in the Darwin Port Safety Plan for evacuation of the relevant Zones 1 and 2.

Hobart

9.114 At Hobart, one primary anchorage and one berth have been approved. As explained in Chapter 8, the Zone 2 for both the

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105. Paras. 509 and 717. cf. P. Gilding, 'The Darwin Plan', SANA Update (Scientists Against Nuclear Arms Australia Newsletter), September 1988, No. 65, p. 5, where the lack of adequate evacuation plans is criticised as 'a particularly serious omission', given the proximity of the central business district to the approved berths.

106. Submission from the Northern Territory Government, p. 2. Because the Committee has not seen these plans, it is not aware of the extent to which they cater for passengers and crews of vessels that may be berthed adjacent to the visiting warship. cf. letter from the Chairman of the VSP(N) to the Darwin Harbourmaster, 14 July 1981, referring to the intention to use Stokes Hill Wharf, Darwin for visits by nuclear powered warships:

> We note that it is intended to use the same berth for passenger vessels and the AAEC [now ANSTO] has recommended, as a condition of approval, that passenger vessels and NPWs do not visit concurrently.

107. Para. 513(a).

berth and the anchorage have been reduced to 1.2 kilometres, due to the effect of the shorter vessel removal times adopted.[108] No land lies within Zone 1 for the anchorage. Some residential areas on the eastern side of the Derwent lie within its Zone 2. There is only one residence, that of a caretaker, within the Zone 1 for the berth, which is at Macquarie Wharves.[109] Zone 2 for the berth includes part of the central business district and some residential areas to the west.

9.115 The Hobart Safety Scheme includes a free-standing sub-plan entitled 'Plan for the Limited Evacuation of Hobart'. This sets out detailed provisions covering all aspects of evacuation, including matters such as notification of the need to evacuate, traffic control measures, provision of transport, the registration of evacuees, security of evacuated premises, welfare measures for evacuees, and a series of measures relating to the re-occupation of evacuated areas. Based on its 1984 on-site review, AIRAC made the general comment that 'no problems were identified in the ability of the [State emergency] organisation to respond to an NPW emergency'.[110]

9.116 During their visit to Hobart in March 1988, members of the Committee were told by local officials that an estimated 22,000 people work in the central business district. These people could be evacuated within 20 minutes using usual transport means,

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108. See paras. 8.45 and 8.50.
109. Hobart Safety Scheme, Chapter 8, Annex A, para. 1(l). The berth approval does not specify any particular berth at the Wharves, although they extend in an 'L' shape for over 1 km. Distances cited in the text have been measured from No. 4 berth, which was used for the visit of the USS Long Beach in 1987. The Hobart Safety Scheme describes the berth to be used as 'Macquarie No. 4/5 Wharf'; Chapter 8, Annex A, para. 1(a).
110. AIRAC, 'Review of Safety and Monitoring Arrangements for Visits by Nuclear Powered Warships', p. 2 (Evidence, p. 753).

such as buses and private cars.[111] An agreement has been reached with the relevant union that buses will continue to operate during an emergency.

9.117 The Committee noted that the nearest part of Royal Hobart Hospital is about 900 metres from the approved berth. In its on-site investigation in December 1984, AIRAC noted the presence of the Hospital. It commented: 'the local topography is such that valley winds under inversion conditions should ensure minimum risk to the hospital sector'.[112]

9.118 The Committee noted that a supplement to the Hobart Safety Scheme describes the response measures that would be taken to protect those in the hospital following a reactor accident. The Committee had some doubts as to the adequacy of these measures. For example, the scheme and the supplement suggest that there is no arrangement to fully evacuate the hospital.[113]

9.119 The Committee considers, however, that irrespective of the merits of the particular plan, it is undesirable to have a major public hospital within the Zone 2 for any berth or anchorage. Evacuation could be the most appropriate accident response in this Zone, notwithstanding that other measures such as

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111. cf. ANSTO's Addendum 1 (18 April 1985) to the Hobart berth assessment (September 1973), pp. 2-3: approval for use of the berth at Macquarie Wharf 'should only be granted if firm assurances can be obtained to the effect that', amongst other things, organisation and plans are in place 'such that people at the Zone 1 boundary can be moved within 1 hour and at the Zone 2 boundary within 4 hours'. The times derive from the period needed under 'worst-case' meteorological conditions to exceed the emergency reference level for the limiting radiation dose, which is the individual dose to the child thyroid (150 rem). See also the Hobart Safety Scheme, para. 1415, which notes that under less disadvantageous meteorological conditions the limiting times would be about 12 hours for Zone 1, and 2 days for Zone 2.
112. AIRAC, 'Review of Safety and Monitoring Arrangements for Visits by Nuclear Powered Warships', p. 1 (Evidence, p. 752).
113. Hobart Safety Scheme, para. 1413 states that the hospital 'may be exempted from the evacuation' of Zone 2. The supplement indicates that measures will be taken to decrease the number of people who might otherwise be in the hospital (p. 1), and limited evacuation will be considered (p. 7).

sheltering may also be effective. There is no shortage of berths and anchorages in Australia either approved or meeting approval criteria. The Committee considers there is no justification for incurring the extra risk, small though it may be, in allowing visits to any berth or anchorage where a major hospital lies within Zone 2.

9.120 The Committee RECOMMENDS that the berth approval for Macquarie Wharves, Hobart be rescinded. Further, the Committee RECOMMENDS that no approval be given to any berth or anchorage where a major hospital lies within the zone in which evacuation may be required (ie. Zone 2) following an accident.

9.121 In relation to the approved primary anchorage, evacuation arrangements are required for the area within Zone 2 on the eastern side of the Derwent. The Zone 2 for the anchorage extends about 300 metres from the shoreline into the suburb of Bellerive. The evacuation sub-plan which forms part of the Hobart Safety Scheme makes no specific provision for the evacuation of this small area,[114] although its general features could no doubt be utilised.

9.122 The Committee RECOMMENDS that no visits be made to the primary approved anchorage in the Derwent near Hobart until adequate, documented, provisions are made for evacuation of residents and others from within 1.2 km (ie. Zone 2) of the anchorage.

Jervis Bay

9.123 The only anchorage approved at Jervis Bay is in effect a remote anchorage. The Zone 1 for the anchorage contains no land

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114. Contrast the provision made for the small area of the eastern shore suburb of Rosny, which lies within the Zone 2 for the berth at Macquarie Wharves: Hobart Safety Scheme, Chapter 14, Annex B, Sector A, and the references earlier in the Chapter to this Sector.

area. There are no public residences within Zone 2,[115] although Zone 2 does cover part of the Navy base, HMAS CRESWELL. The Committee has not examined the standard emergency plan for non-nuclear contingencies at the base. However, it is prepared to accept that it is adequate to cater for the evacuation of naval personnel and others who may be on the base.[116]

9.124 The Committee notes, however, that there are populated areas in close proximity to HMAS CRESWELL. The Committee RECOMMENDS that before further visits are permitted to Jervis Bay there should be an examination of whether contingency planning for evacuation and other countermeasures in respect of areas outside HMAS CRESWELL is required. This examination should include consideration of the need for liaison with New South Wales authorities.

Other Ports

9.125 The Committee did not examine the question of evacuation in relation to other ports which have approved berths or anchorages but which do not receive visits (e.g. Townsville), or, as at Albany, have received visits only to anchorages some distance from shore. The Committee considers, however, that recommendations made in this chapter should be applied to any plans that may be written for other Australian ports.

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115. Second supplementary submission from the Department of Defence, p. 13 (Evidence, p. 238.268).

116. Other elements that might be required in a comprehensive port safety plan for Jervis Bay have been provided, notwithstanding the absence of such a plan. See, for example, on provision for post-accident monitoring in relation to the 1983 visit of USS Sea Dragon, Department of Home Affairs and Environment, Visits by Nuclear Powered Warships to Australian Ports: Report on Radiation Monitoring during 1983, (DHAE, Canberra, 1984), p. 11. Standard arrangements for environmental monitoring were implemented: ibid.

USE OF STABLE IODINE AS A PROPHYLACTIC

Introduction

9.126 A number of biological measures are possible to prevent the body's absorption, and to reduce its retention, of radionuclides.[117] But with one possible exception they are not, it seems, practical to undertake on a large scale and also have only limited effectiveness.[118] The possible exception is the use of stable iodine as a blocking agent.

9.127 The use of stable iodine as a protective measure has been controversial in the United States in relation to large land-based reactors. Potentially it can be used for emergency

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117. e.g. See D. V. Becker, 'Reactor Accidents: Public Health Strategies and Their Medical Implications', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 650:

> Ingestion of Prussian blue (ferric ferrocyanide) can reduce the body burden of cesium radionuclides by half to one third, while intake of aluminum hydroxide gels slows absorption of strontium isotopes. Therapy with diuretics may help to increase excretion of some soluable elements ... Once radioiodine is taken into the thyroid ... its retention can be shortened somewhat by administration of antithyroid agents such as thionamides ... Similarly, thyroidal discharge of radioiodine-labeled thyroid hormone can be accelerated by the injection of bovine thyroid-stimulating hormone.

See also R. A. F. Cox, 'Nuclear Emergencies: Medical Preparedness', British Journal of Radiology, 1987, vol. 60(720), p. 1181, which states, with reference to civil nuclear reactor sites in the UK:

> Other preparations are available on site in the event of an intake of radioactive material. These include Gaviscon granules, which are an antacid containing aluminium combined with alginates, which reduce the intake of strontium 90.

118. ibid. See also International Atomic Energy Agency, Principles for Establishing Intervention Levels for the Protection of the Public in the Event of a Nuclear Accident or Radiological Emergency, (Safety Series No. 72, IAEA, Vienna, 1985), p. 17 (use of stable iodine 'is the only intervention which is practically applicable for protection against internal irradiation caused by the intake of radionuclides'). The use of Prussian blue on patients who received high doses of radiation at Chernobyl proved ineffective: R. E. Linnemann, 'Soviet Medical Response to the Chernobyl Nuclear Accident', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 639.

workers, for those evacuating from Zone 1, and for the general population beyond Zone 1. The controversy has focused almost entirely on its use in relation to the last of these groups, who would at most be exposed only to relatively low doses of radiation.[119] This also was seen by the Committee as the major issue in relation to Australian plans.

Role of Stable Iodine

9.128 As noted in chapter 7, the radioiodines have been regarded as the most significant in the immediate post-accident period of those radionuclides likely to be dispersed following a reactor accident. In this context, the iodine isotope of major concern is I-131.[120] As this isotope has a half-life of 8 days, it dispersion is not of long-term concern. When iodine, radioactive or otherwise, is inhaled or ingested it accumulates in the thyroid gland.

9.129 It has long been recognised that saturation of the thyroid with stable iodine blocks the uptake and concentration there of radioiodine.[121] Iodine in the form of potassium iodide (KI) or potassium iodate (KIO_3) is an effective blocking

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119. ie. doses below those likely to cause acute effects.
120. ANSTO, Radiation Monitoring Handbook for Visits by Nuclear Powered Warships to Australian Ports, (ANSTO, Lucas Heights, NSW, 1985), p. 5 (Evidence, p. 299); D. G. Crocker, 'Nuclear Reactor Accidents - The Use of KI as a Blocking Agent against Radioiodine Uptake in the Thyroid - A Review', Health Physics, June 1984, vol. 46(6), p. 1268.
121. For references to the relevant scientific literature, see for example R. A. Meck and others, 'Criteria for the Administration of KI for Thyroid Blocking of Radioiodine', Health Physics, February 1985, vol. 48(2), p. 143; E. Sternthal and others, 'Suppression of Thyroid Radiodine Uptake by Various Doses of Stable Iodide', New England Journal of Medicine, 6 November 1980, vol. 303(19), p. 1083. Contrast submissions from People for Nuclear Disarmament, pp. 4-5 (Evidence, pp. 1306-07); Mr K. G. Blake, p. 4. Both expressed doubts as to the blocking effect, but cited no scientific literature in support of the doubts. Note that the administration of stable iodine is also said to increase the rate of urinary excretion of I-131 iodide atoms, and thus decreases the whole-body radiation dose: D. V. Becker, 'Reactor Accidents: Public Health Strategies and Their Medical Implications', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 651.

agent.[122] The iodate form made into tablets is preferred for emergency issue because the tablets may be stored for longer periods without deterioration.[123] There seems to be little dispute that doses of 100 milligrams of stable iodine are the appropriate size for adults, although smaller doses would be almost as effective.[124]

9.130 Iodine that enters the body is quickly taken up by the thyroid. The effectiveness of taking stable iodine as a blocking agent is optimum if it is taken before exposure to radioiodine,[125] and decreases rapidly with time after exposure. For a single exposure to radioiodine:

> a substantial benefit (e.g., a block of 50 percent) is attainable only during the first 3 to 4 hours after acute exposure. If initial administration is delayed beyond this, the usefulness of potassium iodide will be limited and little benefit can be expected after 10 to

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122. International Atomic Energy Agency, Planning for Off-Site Response to Radiation Accidents in Nuclear Facilities, (Safety Series No. 55, IAEA, Vienna, 1981), p. 16; D. G. Crocker, 'Nuclear Reactor Accidents - The Use of KI as a Blocking Agent Against Radioiodine Uptake in the Thyroid - A Review', Health Physics, June 1984, vol. 46(6), p. 1273.
123. ibid. See also Evidence, p. 1031 (ARL/NHMRC): iodate form lasts more than 10 years; UK, Parliamentary Debates (Commons), 6th series, vol. 99, Written Answers, 12 June 1986, col. 304: tests show iodate tablets still in good condition after 20 years. In the US, because use of the iodate form would have required lengthy procedures to acquire Food and Drug Administration approval, the already-approved iodide form has been used: Protection of the Thyroid Gland in the Event of Releases of Radioiodine: Recommendations of the National Council on Radiation Protection and Measurements, (NCRP Report No. 55, NCRP, Washington, 1977), p. 23. The US literature therefore discusses potassium iodide rather than iodate.
124. D. V. Becker, 'Reactor Accidents: Public Health Strategies and Their Medical Implications', Journal of the American Medical Association, 7 August 1987, vol. 258(5), pp. 651-52. When made up as KI, 100 mg of stable iodine become a 130 mg tablet.
125. 'The Use of Iodine as a Thyroidal Blocking Agent in the Event of a Reactor Accident: Report of the Environmental Hazards Committee of the American Thyroid Association', Journal of the American Medical Association, 3 August 1984, vol. 252(5), 660.

12 hours for a single exposure.[126]

9.131 It is clear from this that, if use of stable iodine as a protective measure is to be an option, the iodine must be stockpiled ready for prompt use. Arrangements to distribute and administer it quickly following an accident would need to be in place. For planning purposes two levels of decision arise: whether use of stable iodine should be an available option; and, if so, whether the option should be exercised in a given situation in preference to alternative protective measures.

9.132 The Committee noted that the Commonwealth has not provided formal or comprehensive guidance to State/Territory planners on the use, if any, to be made of stable iodine as a protective measure. However, it appears that work on the preparation of such guidelines is well advanced, and it is intended that the guidelines be available about the middle of 1989. The Committee has seen a draft of these, but, given their draft status, does not consider it appropriate to comment on them.

Health Benefits and Risks

9.133 Although stable iodine is undoubtedly an efficient

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126. US, Department of Health and Human Services, Food and Drug Administration, Background Material for the Development of the Food and Drug Administration's Recommendations on Thyroid-Blocking with Potassium Iodide, (DHHS, Rockville, Md., 1981), pp. 2–4. cf. International Atomic Energy Agency, Techniques and Decision Making in the Assessment of Off-Site Consequences of an Accident in a Nuclear Facility, (Safety Series No. 86, IAEA, Vienna, 1987), p. 161:

> If administered before the intake, the protection factor is nearly 100%, and it is about 90% if administered at the time of inhalation. Thereafter, protection decreases quickly, and a block of about 50% is attainable if administration is about six hours after inhalation.

See also D. V. Becker, 'Reactor Accidents: Public Health Strategies and Their Medical Implications', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 651:

> the protective effect decreases to 85% by one hour after the radioiodine exposure. Potassium iodide given three hours later reduces the uptake to only 50% of control value, and after six hours KI no longer has a significant protective effect.

blocking agent, the extent to which it is an effective protective measure following a reactor accident has been questioned by researchers in the United States.[127]

9.134 It is generally accepted in the scientific literature that the scientific data on any harmful effects to the thyroid of internal (ie. due to inhalation or ingestion) exposure to low doses of radioiodines are inadequate.[128] While it is widely agreed that the incidence of serious or life-threatening effects due to internal exposure to low-doses is likely to be small, there is no agreement among experts on just how small.[129]

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127. D. C. Aldrich and R. M. Blond, 'Radiation Protection: An Analysis of Thyroid Blocking' in Current Nuclear Power Plant Safety Issues: Proceedings of an International Conference Organized by the International Atomic Energy Agency, Stockholm, 20-24 October 1980, (IAEA, Vienna, 1981), vol. 2, p. 76. The authors stress both the medical/scientific uncertainties and the many assumptions that underlie their conclusion.

128. See for example B. Shleien and others, 'Recommendations on the Use of Potassium Iodide as a Thyroid Blocking Agent in Radiation Accidents: An FDA Update', Bulletin of the New York Academy of Medicine, December 1983, vol. 59(10), pp. 1012-14; T. E. Hamilton and others, 'Thyroid Neoplasia in Marshall Islanders Exposed to Nuclear Fallout', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 635.

129. See for example, Committee on Public Health of the New York Academy of Medicine, 'Resolution Concerning the Stockpiling of Potassium Iodide in New York City in the Event of a Nuclear Accident', Bulletin of the New York Academy of Medicine, June 1981, vol. 57(5), p. 396 (few good data on the carcinogenicity of ^{131}I in humans); US, H of R, Committee on Interior and Insular Affairs, Subcommittee on Oversight and Investigations, Emergency Preparedness for Radiological Accidents: the Issue of Potassium Iodide, 5 March 1982, p. 7 (F. von Hippel), pp. 11-12, 14-16 (Dr R. S. Yalow); S. Wolfe and C. LaCheen, 'Potassium Iodide Policy', Science, 1982, vol. 218, p. 6; F. von Hippel, 'Potassium Iodide for Thyroid Protection', ibid., p. 1174: 'The Use of Iodine as a Thyroidal Blocking Agent in the Event of a Reactor Accident: Report of the Environmental Hazards Committee of the American Thyroid Association', Journal of the American Medical Association, 3 August 1984, vol. 252(5), p. 659; R. A. Meck and others, 'Criteria for the Administration of KI for Thyroid Blocking of Radioiodine', Health Physics, February 1985, vol. 48(2), pp. 142-43. A recent survey comments:

> radiation from ^{131}I has not been demonstrated to cause thyroid cancer in humans - but, there is no reason to believe that it does not have a carcinogenic potential:

D. V. Becker, 'Reactor Accidents: Public Health Strategies and Their Medical Implications', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 650.

9.135 Opinions vary among experts on the likely incidence of medical side-effects from the administration of a single dose of stable iodine. It is agreed that possible temporary discomfort has to be considered.[130] There are, however, few reliable data on which to base an estimate of the occurrence of more serious side effects,[131] although the experience following the 1986 Chernobyl accident may eventually assist in this regard.[132] Those who have examined the issue consider that the incidence of serious side

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130. The concern is not primarily medical, but that people who have taken stable iodine may, unless warned, confuse its side effects with the effects of exposure to radiation and panic as a result: D. G. Crocker, 'Nuclear Reactor Accidents - The Use of KI as a Blocking Agent against Radioiodine Uptake in the Thyroid - A Review', Health Physics, June 1984, vol. 46(6), p. 1277.

131. See for example, Committee on Public Health of the New York Academy of Medicine, 'Resolution Concerning the Stockpiling of Potassium Iodide in New York City in the Event of a Nuclear Accident', Bulletin of the New York Academy of Medicine, June 1981, vol. 57(5), p. 397; J. Wolff, 'The Use of Iodides in Protection against Radioactive Iodine', incorporated in US, H of R, Committee on Interior and Insular Affairs, Subcommittee on Oversight and Operations, Emergency Preparedness for Radiological Accidents: The Issue of Potassium Iodide, 5 March 1982, at pp. 171-73; 'The Use of Iodine as a Thyroidal Blocking Agent in the Event of a Reactor Accident: Report of the Environmental Hazards Committee of the American Thyroid Association', Journal of the American Medical Accociation, 3 August 1984, vol. 252(5), p. 660.

132. The distribution of potassium iodide in the Soviet Union following the accident led to minor side effects only, with none requiring medical attention. Severe iodine reactions requiring medical treatment occurred to 17 of the 10 million recipients of potassium iodide in Poland: R. E. Linnemann, 'Soviet Medical Response to the Chernobyl Nuclear Accident', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 641. This paper is based on preliminary data relating to the accident response.

effects is likely to be small.[133]

9.136 Despite the uncertainties on both benefits and risks, it is generally considered in the scientific literature that above a minimal level of exposure the benefits for an exposed population of taking stable iodide outweigh the risks of side effects.[134] There is disagreement, however, on the question of how high the exposure level has to be before measures to protect the thyroid

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133. e.g. US, Department of Health and Human Services, Food and Drug Administration, Background Material for the Development of the Food and Drug Administration's Recommendations on Thyroid-Blocking with Potassium Iodide, (DHHS, Rockville, Md., 1981), p. 4 (number of severe reactions 'is unknown but is expected to be low'); R. A. Meck and others, 'Criteria for for the Administration of KI for Thyroid Blocking of Radioiodine', Health Physics, February 1985, vol. 48(2), pp. 143-45 (1 life-threatening, 3 other serious reactions, estimated per million person-regimens for KI doses); V. E. Archer, 'In Accidents, Give KI Promptly', Health Physics, December 1985, vol. 49(6), p. 1312 (for healthy adults, risk from a single 130 mg dose of KI 'is essentially zero'). For a higher estimate based on some of the same (admittedly inadequate) data see Dr R. S. Yalow's testimony in US, H of R, Committee on Interior and Insular Affairs, Subcommittee on Oversight and Operations, Emergency Preparedness for Radiological Accidents: The Issue of Potassium Iodide, 5 March 1982, p. 12 ('incidence of seriously adverse reactions that we might expect is 6 in 10,000' persons using KI) and pp. 139, 166. cf. International Atomic Energy Agency, Principles for Establishing Intervention Levels for the Protection of the Public in the Event of a Nuclear Accident or Radiological Emergency, (Safety Series No. 72, IAEA, Vienna, 1985), p. 23 (administration of stable iodine as a protective measure has been accepted by many national authorities as constituting only a small risk to the individual).

134. See for example, B. Shleien and others, 'Recommendations on the Use of Potassium Iodide as a Thyroid-Blocking Agent in Radiation Accidents: An FDA Update', Bulletin of the New York Academy of Medicine, December 1983, vol. 59(10), p. 1012; R. A. Meck and others, 'Criteria for the Administration of KI for Thyroid Blocking of Radioiodine', Health Physics, February 1985, vol. 48(2), pp. 144-45. These and other papers reaching a similar conclusion note the uncertainty of the data on which it is based.

should be considered.[135]

Distribution Issues

9.137 Some commentators have suggested that use of stable iodine might create a false sense of security,[136] although there appears to be no empirical evidence on the point.[137] Stable iodine has the potential to protect only against radioiodines, not other radionuclides that would be present following a reactor accident. Persons who have taken stable iodine may, it is argued by these commentators, mistakenly consider it unnecessary to take other protective measures, such as evacuation.

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135. See for example, 'The Use of Iodine as a Thyroidal Blocking Agent in the Event of a Reactor Accident: Report of the Environmental Hazards Committee of the American Thyroid Association', Journal of the American Medical Association, 3 August 1984, vol. 252(5), p. 659 (intervention levels as high as 500 rad (5 Gy) have been realistically proposed) and p. 661 (Committee suggested levels of 100 rad (1 Gy) for adults and 50 rad (0.5 Gy) for children and pregnant women); D. V. Becker, 'Reactor Accidents: Public Health Strategies and Their Medical Implications', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 652 (US regulatory authorities have favoured levels in the 10 to 25 rad (0.1 to 0.25 Gy) range); US, Federal Emergency Management Agency, 'Federal Policy on Distribution of Potassium Iodide Around Nuclear Power Sites for Use as a Thyroidal Blocking Agent', Federal Register, 24 July 1985, vol. 50(142), p. 30,259: Food and Drug Administration guidance

> states that risks from the short term use of relatively low doses of KI for thyroidal blocking in a radiation emergency are outweighed by the risks of radioiodine induced thyroid nodules or cancer at a projected dose to the thyroid gland of 25 rem [which can be equated to 0.25 Gy] or greater.

The action level for Soviet authorities at Chernobyl was 30 rem to the child thyroid: R. F. Mould, Chernobyl: The Real Story, (Pergamon, Oxford, 1988), p. 124.

136. e.g. US, H of R, Committee on Interior and Insular Affairs, Subcommittee on Oversight and Investigations, Emergency Preparedness for Radiological Accidents: The Issue of Potassium Iodide, 5 March 1982, p. 3 (Dr E. W. Fowinkle), p. 36 (J. C. Villforth, Department of Health and Human Services); R. A. F. Cox, 'Nuclear Emergencies: Medical Preparedness', British Journal of Radiology, 1987, vol. 60(720), p. 1181.

137. Soviet physicians are reported as having found that the distribution of potassium iodide at Chernobyl in 1986 had a positive psychological effect on the population: R. E. Linnemann, 'Soviet Medical Response to the Chernobyl Nuclear Accident', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 641.

9.138 As public controversy in the United States has indicated, distribution of stable iodine poses problems.[138] The following points have been argued in that debate. If stable iodine is distributed beforehand to households, offices, etc. there is a risk that it will have become mislaid by the time it is needed, which may be decades later. Extra quantities have to be distributed to cater for visitors. A small risk exists that the quantity distributed will be taken by mistake or accident. If an accident occurs, it is argued that many people will take the tablets unnecessarily and in the absence of instructions to do so. This will incur the small risk of side effects for no compensating benefit. It is debatable how far public education campaigns can overcome some of these perceived problems.

9.139 If pre-accident distribution is not made, distribution will have to be done from stockpiles after the accident. Speedy distribution would be essential. In the United Kingdom, police are reported to be reluctant to be responsible for distribution.[139] There is evidence from the United States to indicate that distribution is unlikely to be anything like fully effective in reaching people.[140] In addition, distribution involves people

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138. The points made in this paragraph are drawn from testimony in US, H of R, Committee on Interior and Insular Affairs, Subcommittee on Oversight and Investigations, Emergency Preparedness for Radiological Accidents: The Issue of Potassium Iodide, 5 March 1982, pp. 1-46. See also D. V. Becker, 'Physiological Basis for the Use of Potassium Iodide as a Thyroid Blocking Agent: Logistic Issues in its Distribution', Bulletin of the New York Academy of Medicine, December 1983, vol. 59(10), pp. 1006-08.

139. R. A. F. Cox, 'Nuclear Emergencies: Medical Preparedness', British Journal of Radiology, 1987, vol. 60(720), p. 1181.

140. Exercises carried out in Tennessee were successful in reaching only 54% of the target population, despite considerable effort and cost: D. V. Becker, 'Physiological Basis for the Use of Potassium Iodide as a Thyroid Blocking Agent: Logistic Issues in its Distribution', Bulletin of the New York Academy of Medicine, December 1983, vol. 59(10), p. 1007. For New York City, the view has been expressed that 'it is unlikely that ... distribution will be efficient in the critical hour or two necessary to to minimise radiation': Committee on Public Health of the New York Academy of Medicine, 'Resolution Concerning the Stockpiling of Potassium Iodide in New York City in the Event of a Nuclear Accident', Bulletin of the New York Academy of Medicine, June 1981, vol. 57(5), p. 398.

moving about in the open, thereby risking increased exposure.[141]

9.140 It has been argued in the United States that, irrespective of how distribution occurs, consideration has to be given to what medical assistance will be available to persons suffering an adverse reaction. Additional issues relate to what advice should accompany the distribution of stable iodine and the form the advice should take. Matters on which advice would be relevant include the efficacy of taking stable iodine, the risks, and the medical conditions which, if present, make iodine use inadvisable are all. In Australia, unlike the United States, the cost of the tablets to be distributed is not a significant issue.[142]

9.141 Based on the reference accident, the outer limit of the area at risk from inhalation hazards and for which counter-measures would be necessary in Australia is 2.2 kilometres. There is no need to plan for distribution of stable iodine in areas beyond this distance. This makes distribution problems much more manageable than for large land-based reactors with correspondingly larger inhalation-hazard zones.

9.142 In the United States one aspect of the stable iodine

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141. Committee on Public Health of the New York Academy of Medicine, 'Resolution Concerning the Stockpiling of Potassium Iodide in New York City in the Event of a Nuclear Accident', Bulletin of the New York Academy of Medicine, June 1981, vol. 57(5), p. 398.

142. No Australian costs have been obtained. US costs are of the order of ten cents per tablet, though if child-proof containers or other special packaging is required this cost will increase: US, H of R, Committee on Interior and Insular Affairs, Subcommittee on Oversight and Investigations, Emergency Preparedness for Radiological Accidents: The Issue of Potassium Iodide, 5 March 1982, p. 4 (Dr E. W. Fowinkle), p. 38 (R. W. Krimm, Federal Emergency Management Agency). The cost of distribution has been a significant issue in the United States because of the short (2 yr) shelf-life of the iodide form approved for use in that country. Having to re-establish any stockpile every 2 years has influenced decision-making: e.g. Committee on Public Health of the New York Academy of Medicine, 'Resolution Concerning the Stockpiling of Potassium Iodide in New York City in the Event of a Nuclear Accident', Bulletin of the New York Academy of Medicine, June 1981, vol. 57(5), p. 399.

controversy has been whether credible scenarios can be found to justify reliance on it as a general protective measure. Alternative protective measures will often, arguably always, be both available and more effective.

Use of Alternative Protective Measures

9.143 The time necessary for radioiodine to be ingested through the food chain following a nuclear accident allows controls on foodstuffs, particularly milk,[143] to be put in place as an effective countermeasure.[144] On this basis, if stable iodine is to be an available protective measure, it will be required only as a counter to the inhalation hazard.

9.144 For this hazard, evacuation and sheltering are regarded by planners as standard alternative protective measures. In the United States, Federal authorities have taken the view that these alternatives are more effective protective measures for the general public in the event of a reactor accident, and that the

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143. The effect of cows grazing on contaminated pasture is to concentrate radioiodine in their milk over the following 24 hours. Therefore pasture receiving contamination at levels that would not directly pose a hazard to humans may result in the production of hazardous milk: see ANSTO, Radiation Monitoring Handbook for Visits by Nuclear Powered Warships to Australian Ports, (ANSTO, Lucas Heights, NSW, 1985), p. 6 (Evidence, p. 300).

144. e.g. International Atomic Energy Agency, Planning for Off-Site Response to Radiation Accidents in Nuclear Facilities, (Safety Series No. 55, IAEA, Vienna, 1981), p. 16. See ANSTO, Radiation Monitoring Handbook for Visits by Nuclear Powered Warships to Australian Ports, (ANSTO, Lucas Heights, NSW, 1985), p. 41 (Evidence, p. 335) for the action guide to protecting the thyroid from the ingestion hazard.

use of stable iodine is at best of marginal value.[145] The view of State authorities in the United States varies.[146]

9.145 This view relates to land-based reactors. It rests in part on the distribution problems and the risk of side effects identified above. It also rests on the fact that use of stable iodine can at best mitigate only some of the effects of exposure to radionuclides. Other protective measures will also be required. If evacuation is used, it will generally have the effect of removing the need for measures relating specifically to radioiodines. If effective sheltering is used, it would have the result of reducing exposure, possibly to a level below the

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145. US, H of R, Committee on Interior and Insular Affairs, Subcommittee on Oversight and Investigations, Emergency Preparedness for Radiological Accidents: the Issue of Potassium Iodide, 5 March 1982, pp. 33, 40 (B. K. Grimes, Nuclear Regulatory Commission); US, Federal Emergency Management Agency, 'Federal Policy on Distribution of Potassium Iodide Around Nuclear Power Sites for Use as a Thyroidal Blocking Agent', Federal Register, 24 July 1985, vol. 50(142), p. 30,258:

> The Federal position with regard to the predistribution or stockpiling of potassium iodide for use by the general public is that it should not be required. ... While valid arguments may be made for the use of KI, the preponderance of information indicates that a nationwide requirement for the predistribution or stockpiling for use by the general public would not be worthwhile.

146. B. Shleien and others, 'Recommendations on the Use of Potassium Iodide as a Thyroid Blocking Agent in Radiation Accidents: An FDA Update', Bulletin of the New York Academy of Medicine, December 1983, vol. 59(10), p. 1017: State emergency plans in the United States deal with supply as follows:

> stockpile for use by emergency workers: 31 States;
> stockpile for public use, but no predistribution: 6 States;
> predistribute to public living near reactor site: 1 State;
> adopted a position not to use for anyone: 4 States; and
> adopted a position not to use for general public only: 5 States.

The United Kingdom has stockpiled but not predistributed, while Sweden has predistributed to those living near reactor sites: ibid.

emergency reference level for thyroid exposure.[147]

9.146 The main challenges to this view rest on concern about an uncontained accident, and situations in which evacuation is not a viable alternative measure. These criticisms are not relevant in the present context. The Committee has accepted that planning should be based on a contained accident. It has also accepted that evacuation would be an effective protective measure.

9.147 The view that stockpiling or pre-distribution is not warranted becomes even more persuasive in the Australian context, when allowance is made for the additional protective measure of vessel removal.

9.148 Accordingly, the Committee considers that there is no need to plan for stable iodine distribution to the general public as a protective measure.[148]

Distribution Plans in Western Australia

9.149 None of the berths or anchorages in Gage Roads/Cockburn Sound is within 2.2 kilometres of the mainland. The WA Port

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147. US, H of R, Committee on Interior and Insular Affairs, Subcommittee on Oversight and Investigations, Emergency Preparedness for Radiological Accidents: the Issue of Potassium Iodide, 5 March 1982, p. 40 (B. K. Grimes, Nuclear Regulatory Commission):

> if one plans to take evacuation or sheltering measures that will reduce doses by a factor of two or three for sheltering, or substantially more if the population was evacuated, then one should not assume that the same dose will occur [to the thyroid].

148. This conclusion would be reinforced if the Committee had chosen to base its assessment on ANSTO's revised accident model rather than the reference accident (see paras. 7.17–7.25). One of the differences between the revised model and the reference accident is the much lower quantity of radioiodines released from the revised model. If planning were to be based on this model and yet there were to be widespread distribution of stable iodine to the general public it might lead to wide unnecessary use of the iodine. This in turn would incur the small risk of side effects without any corresponding benefit.

Safety Scheme provides under these circumstances 'that except in the most unusual circumstances, there will be no requirement for the distribution of potassium iodate tablets'.[149] The Scheme, however, makes provision for iodate tablet distribution to households,[150] notwithstanding that no need for distribution is identified in terms of the current reference accident.[151]

9.150 The Committee considers this provision for stable iodine distribution to be unnecessary, in view of the distance from the mainland of the berths and anchorages currently used. This point applies to these berths and anchorages, and is additional to the general grounds put forward above. The Committee notes that Western Australian officials have been advised by their Commonwealth counterparts that the distribution plans are unnecessarily broad.[152]

9.151 The Committee considers that the breadth of the plans for stable iodine distribution could result in the public becoming confused as to the maximum extent of the area in which protective measures would be required.[153] This could not only cause unnecessary anxiety relating to warship visits, but could also lead to inappropriate responses by the public (e.g. unnecessary evacuation) in the event of an accident.

9.152 The Committee RECOMMENDS that the Western Australian

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149. Para. 701.
150. Paras. 702-710 and Annexes A, B and C to Part 7.
151. See footnote 149 above on the effect of substituting ANSTO's revised accident model.
152. Information supplied at a briefing to Committee members by WA officials, 1 February 1988.
153. A number of submissions considered the WA Port Safety Scheme's provision for stable iodine distribution impracticable or unworkable: see for example the submissions from Assoc Prof P. Jennings, p. 3; Albany Peace Group, p. 2; Mr K. G. Blake, p. 4; State School Teachers' Union of WA (Inc.), p. 2; Mrs L. Van Geloven, p. 5; Scientists Against Nuclear Arms (WA) and Medical Association for the Prevention of War (WA), pp. 11-12 (Evidence, pp. 797-98); People for Nuclear Disarmament, p. 5 (Evidence, p. 1307). The provision in the Scheme may have contributed to this view because it raises the possibility of distribution over an indeterminate area.

planners delete their provision for distribution of potassium iodate tablets to the general public beyond Zone 2.

Emergency Workers and Evacuees from Zone 1

9.153 The discussion in this section has focused so far on distribution to the general public. At least some authorities that consider such distribution unnecessary accept that the availability of stable iodine for emergency workers is desirable.[154] Evacuation and sheltering may not be realistic options for these persons, and they are more likely to be exposed to radiation and in larger doses. Moreover, they are few in number, thereby eliminating the logistical problems relating to distribution. They are able to be monitored for side effects relatively easily. Finally, they are under the supervision of persons with experience in radiation protection, and therefore unlikely to take the stable iodine unnecessarily or to overestimate the degree of protection that it provides.

9.154 These reasons also apply to those evacuating from Zone 1. Accordingly, the Committee considered the need to provide for the administration of stable iodine to emergency personnel and to those evacuating from Zone 1.

Duration of Administration of Stable Iodine

9.155 Before considering the individual plans, it is convenient to consider a criticism that was made of the WA Port Safety Scheme plan to distribute one tablet only per person.

> There is no obvious explanation for the Western Australian authorities' decision to distribute one tablet per person. Literature in Australia and the US recommends daily administration for three to ten days. A single

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154. e.g. US, Federal Emergency Management Agency, 'Federal Policy on Distribution of Potassium Iodide Around Nuclear Power Sites for Use as a Thyroidal Blocking Agent', Federal Register, 24 July 1984, vol. 50(142), p. 30,258. See also footnote 146 above.

tablet is ineffective for continuous protection.[155]

9.156 No Australian literature was cited in support. The single United States source cited dealt with both continuous exposure to radioiodine over a number of days and a brief exposure.[156] The criticism failed to make clear whether the objection was to a failure to plan for continuous exposure, or to the adequacy of a single dose of stable iodine in response to a brief exposure.

9.157 Given the provision in plans relating to vessel removal and evacuation, the Committee sees no need to plan for continuous exposure. The issue of the adequacy of a single dose as a response to a brief exposure is less clear-cut. The blocking effect of a single dose of stable iodine lasts for over 24 hours but not, it seems, for as long as 48 hours.[157] Most radioiodine taken into the body and blocked from entering the thyroid is

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155. M. Boyes, 'Iodine distribution after nuclear accidents', (Intercept Foundation Ltd Information Dossier No. 3, Sydney, 1988), p. 2.

156. US, Department of Health and Human Services, Food and Drug Administration, Background Material for the Development of the Food and Drug Administration's Recommendations on Thyroid-Blocking with Potassium Iodide, (DHHS, Rockville, Md., 1981), p. 4.

157. Committee on Public Health of the New York Academy of Medicine, 'Resolution Concerning the Stockpiling of Potassium Iodide in New York City in the Event of a Nuclear Accident', Bulletin of the New York Academy of Medicine, June 1981, vol. 57(5), p. 397. cf. 'The Use of Iodine as a Thyroidal Blocking Agent in the Event of a Reactor Accident: Report of the Environmental Hazards Committee of the American Thyroid Association', Journal of the American Medical Association, 3 August 1984, vol. 252(5), p. 660 ('blockade with a single 100-mg dose of iodide lasts between 24 and 48 hours'); J. Wolff, 'The Use of Iodides in Protection against Radioactive Iodine', incorporated in US, H of R, Committee on Interior and Insular Affairs, Subcommittee on Oversight and Investigations, Emergency Preparedness for Radiological Accidents: The Issue of Potassium Iodide, 5 March 1982, p. 171 (duration of the block from a single dose 'is between 24-48 hours'); E. Sternthal and others, 'Suppression of Thyroid Radioiodine Uptake by Various Doses of Stable Iodide', New England Journal of Medicine, 6 November 1980, vol. 303(19), p. 1086 ('recovery of the thyroid radioiodine uptake that follows a single dose of iodide occurs within a few days').

excreted over the subsequent 48 hours.[158] If blocking ceases before excretion is complete, thyroid uptake of the remaining radioiodine will be possible.

9.158 To ensure that blocking continues until excretion is substantially complete, the official view in the United States at the Federal level is that stable iodine should be taken daily for at least 48 hours after the last exposure following an accident involving a land-based reactor.[159] Medical experts support this view.[160] But it has been argued that, for blocking the uptake from a brief exposure, the initial dose of stable iodine is the only important one.[161] In the United Kingdom, planning assumes that only a single administration of stable iodide will be necessary.[162]

9.159 The Committee was not in a position to determine if continued daily administration of stable iodine following a brief exposure was a counsel of perfection or a matter of practical significance.

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158. US, Department of Health and Human Services, Food and Drug Administration, Background Material for the Development of the Food and Drug Administration's Recommendations on Thyroid-Blocking with Potassium Iodide, (DHHS, Rockville, Md., 1981), p. 4. Contrast ANSTO, Radiation Monitoring Handbook for Visits by Nuclear Powered Warships to Australian Ports, ANSTO, Lucas Heights, NSW, 1985), p. 5 (Evidence, p. 299): excretion of radioiodine not taken up by the thyroid occurs within 24 hours.

159. US, Federal Emergency Management Agency, 'Federal Policy on Distribution of Potassium Iodide Around Nuclear Power Sites for Use as a Thyroidal Blocking Agent', Federal Register, 24 July 1985, vol. 50(142), p. 30,259.

160. e.g. D. V. Becker, 'Reactor Accidents: Public Health Strategies and Their Medical Implications', Journal of the American Medical Association, 7 August 1987, vol. 258(5), p. 651. However, many writers who discuss the period over which stable iodine should be administered fail to separate the effect of lingering external exposure from the effect of a single internal exposure.

161. J. A. Martin, 'Potassium Iodide: Predistribution or Not? The Real Emergency Preparedness Issue', Health Physics, August 1985, vol. 49(2), p. 287.

162. 'Reactor Accidents: Iodine Supplements?', Lancet, 26 February 1983, vol. 1(8322), p. 452. The UK port safety plans seen by the Committee make provision for only a single dose of 2 tablets per adult, 1 per child and 1/2 per infant. The iodine content of the tablets is not stated in the plan but differs from the tablets held in Australia.

9.160 Therefore, the Committee RECOMMENDS that the Government seek advice to determine if there is a practical need to administer stable iodine for several days, rather than as a single dose, in order to provide continued blocking of thyroid uptake of radioiodine following a brief exposure. The Committee RECOMMENDS that, if the advice received by the Government states that administration over several days is required, plans relating to stable iodine distribution be amended accordingly.

Provisions for Stable Iodine in Australian Plans

9.161 Provision is made for the taking of stable iodine by radiation monitoring personnel,[163] and the crew of a vessel placed on standby for emergency towing duty.[164] No detailed provision is made in the port-specific plans as to the mechanics of supplying tablets to shore parties, who may be required to approach the stricken vessel, or to other emergency workers. Nor is detailed provision made for administration to those evacuating from Zone 1. The Darwin plan, for example, merely notes that stable iodine distribution is a responsibility of the local Department of Health and Community Services.[165]

9.162 In this respect the plans compare unfavourably with the Liverpool Safety Scheme. This Scheme provides for positioning, before the vessel's arrival, of set quantities of stable iodine

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163. ANSTO, Radiation Monitoring Handbook for Visits by Nuclear Powered Warships to Australian Ports, (ANSTO, Lucas Heights, NSW, 1985), pp. 10, 21, 47 (Evidence, p. 304, 315, 341).
164. OPSMAN 1 (2nd edn.), para. 433 (Evidence, p. 77).
165. Para. 715(b). See similarly the Brisbane Port Safety Plan, para. 329(c); WA Port Safety Scheme, para. 226(b). The HMAS STIRLING Sub-Plan notes the utility of stable iodine tablets but does not state who is responsible for distribution or how distribution would be done. The Hobart Safety Scheme, para. 1114 states that tablets held at the Emergency Operations Centre 'will be available for administration if considered necessary'. See also ibid., para. 1316. Members of the Committee who visited Hobart in March 1988 were told that, due to the short distances involved, it was planned to distribute the tablets to evacuees from Zone 1, vessels within Zone 1, etc. by foot from the Centre.

tablets with the decontamination unit, the fire brigade, the safety officer's team, and each of the pedestrian or vehicle access points to the berth.[166] Provision is also made for tablets to be in place for distribution to masters and crews of other vessels in the vicinity. Explanatory leaflets are supplied. All those evacuating the area are to be given tablets, as are any emergency or essential staff entering.[167]

9.163 The Committee considers this level of detailed provision to be appropriate for adoption in Australian plans in relation to berths (as opposed to anchorages more than 600 metres from shore). Accordingly, the Committee RECOMMENDS that visits not be approved to berths unless detailed provisions are in place to ensure that those evacuating the surrounding Zone 1 and emergency personnel entering the Zone 1 are able to be supplied with stable iodine.

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166. UK, Ministry of Defence, Liverpool Special Safety Scheme for Visits to Liverpool by Nuclear Powered Submarines, (April 1986), p. 2-10.
167. ibid., pp. 3-4 - 3-6.