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NUCLEAR ACCIDENTS ON MILITARY VESSELS IN AUSTRALIAN PORTS: SITE-SPECIFIC ANALYSES FOR SYDNEY AND FREMANTLE/PERTH

by

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I. EXECUTIVE SUMMARY

This paper describes a quantitative, site-specific analysis of two nuclear accident scenarios aboard military vessels in Australian ports. Conventional methodology used by the U. S. Nuclear Regulatory Commission (NRC) to regulate the U. S. civilian nuclear industry is applied to evaluate the consequences of nuclear accidents aboard ships in the ports of Sydney and Fremantle/Perth. The results are used as a basis for policy recommendations on the issue of port visits.

The first accident scenario analyzed is incineration of a single nuclear warhead in a 3-hour shipboard fire at Garden Island, Sydney. Such an accident would produce a radioactive cloud containing plutonium-239, which would be carried westward directly over downtown (Figures 2-5) Sydney by the most probable afternoon wind pattern. Using conservative assumptions (i. e., assumptions that understate the likely impact of the accident), it is shown that the plutonium concentration in the cloud would exceed U. S. federal (NRC) limits by as much as ten thousand times (Figure 8A). Ground deposition from fallout would exceed U. S. federal (NRC) limits by up to one million times (Figure 10A). The greatest effects would be felt in downtown Sydney, closest to the accident site, although both air and ground contamination would remain well above the NRC limits up to 55 km from the accident site.

Radiation exposure from inhalation of the plutonium would exceed U. S. federal (NRC) limits by up to one hundred thousand times (Figure 12A). Casualties from the accident would take the form of latent cancer fatalities and genetic defects. The number of latent cancer fatalities would range from 33 (Figure 16A) to 11,041 (Figure 19B), depending on thermal lofting, atmospheric stability and the radiation risk factor used. Casualties would be concentrated in downtown Sydney within 5 km of the accident, but would occur to a distance of 55 km from the site of the accident (the most distant spatial interval considered in this analysis). Consequences of the same accident in the port of Fremantle/Perth (Figures 21, 22) would be similar, although casualties would be about half as great owing to a smaller population at risk.

The second accident scenario analyzed is a severe nuclear reactor accident aboard a ship berthed at Garden Island, Sydney. The core inventory of a 100 megawatt (thermal) naval propulsion reactor fueled by highly enriched uranium metal was calculated using the ORIGEN computer code (Table 1). Release fractions consistent with existing accident histories and radionuclide properties were assumed, and consequent releases to the atmosphere calculated for 15 radionuclides comprising more than 90 % of the projected health detriment for three exposure pathways (cloudshine, inhalation exposure and groundshine).

Calculated downwind air concentrations of the radionuclides following a four hour reactor accident, as well as ground deposition, exceed federal U. S. limits (NRC) by up to hundreds (Figure 23) to millions (Figure 24) of times depending upon specific parametric assumptions. Radiation exposures from the three pathways modeled exceed federal U. S. standards by up to hundreds (Figure 26) to thousands (Figure 31) of times. Total short-term casualties from the accident range from 4 (Figure 32A) to 914 (Figure 32B), depending on assumptions, and are concentrated in the first 5 km from the accident site. Additional casualties incurred from 1 week of additional habitation of Sydney range from 119 to 1,311 (Figure 33), highlighting the need for immediate evacuation. Additional casualties incurred from 1 year of inhabiting the city range from 108 to 1,718 (Figure 34). Additional casualties in subsequent years are 61-659 in the first year, declining to approximately half this number in about 30 years. Casualties caused by a similar accident in the port of Fremantle/Perth would again be approximately half those estimated for Sydney.

Both accidents modeled would produce many long-term casualties unless the contaminated portion of the city were both evacuated and decontaminated. Evacuation would have to be rapid (1-2 hrs) in order to be effective. Decontamination costs are difficult to estimate, since experience in decontaminating large urban areas is lacking. U. S. government studies suggest that decontamination costs could reach billions of U. S. dollars.

The risk to the Australian public from these accidents is the product of the consequences described above, and the probability that the accident scenario analyzed will occur. Although the consequences can be established precisely, the probability of each accident requires information that the military has been unwilling to provide. This includes the number of nuclear warheads aboard ships in port, the frequency and intensity of shipboard fires, the thermal resistance of nuclear warheads, and the accident history and operating characteristics of naval propulsion reactors. In the absence of this information, the risk of the accidents modeled cannot be calculated. In this case, acceptance by Australia of port visits by nuclear capable or nuclear powered vessels is equivalent to acceptance of an incalculable risk.

These findings provide a technical basis for seven policy recommendations. These are: 1), prospective costs and benefits of port visits by nuclear capable and nuclear powered warships deserve careful weighing, incorporating the present assessment of possible costs; 2), if Australian authorities and the Australian public decide nonetheless to contemplate future port visits by nuclear warships, prudence justifies expansion of emergency evacuation zones from the present 0.6 km from the accident site to at least 5 km for densely populated urban areas such as Sydney; 3), in this case, effective, detailed evacuation plans should be established and rehearsed periodically; 4), decontamination plans should likewise be developed and their costs estimated; 5), data should be obtained permitting assessment of the probability of the accidents modeled and hence of the risk to the Australian public; 6), written liability and indemnity regimes should be negotiated with the governments of visiting nuclear warships; and 7), existing emergency planning documents should be updated and revised.