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MELTDOWN OF A NAVAL PROPULSION NUCLEAR REACTOR: A SITE-SPECIFIC ANALYSIS FOR THE SAN FRANCISCO BAY REGION

by

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I. EXECUTIVE SUMMARY

The proposal to homeport the U. S. S. Missouri in San Francisco Bay implies an increase in traffic from nuclear propelled military vessels, and a corresponding increase in the probability of an accident involving the meltdown of a naval propulsion nuclear reactor. This report uses established methodology of the U. S. Nuclear Regulatory Commission (NRC) and conservative assumptions (i. e., ones that understate the impact of the accident) to analyze quantitatively the consequences of such an accident to the city of San Francisco.

In this analysis it is assumed that a nuclear-propelled naval vessel propelled by a 100 megawatt (thermal) PWR nuclear reactor stationed at Hunter's Point (corresponding the alternative # 5 of the Navy's homeporting proposal for the San Francisco Bay Area) suffers a reactor accident involving breach of containment and consequent escape of radioactivity into the environment. The most probable winter wind pattern (Figure 2) would carry the resulting radioactive cloud in a north-northwest direction from Hunter's Point, directly through the heart of San Francisco's financial district (Figure 5). The total inventory of radionuclides available for release 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 (Table 2) for three exposure pathways (cloudshine, inhalation exposure and groundshine).

Calculated air concentrations of individual radionuclides in locations downwind from the accident exceed federal U. S. (NRC) limits by up to two thousand times (iodine-131; Figure 6). Calculated surface deposition of specific radionuclides ("fallout") exceeds NRC limits by up to one million times (cesium-137; Figure 7) near the reactor site, and remains more than 100 times the NRC limit at the furthest location (11 km) from the accident within the city. Calculated radiation exposure from the passing cloud ("cloudshine") exceeds federal exposure limits by up to 100 times for individual radionuclides (e. g., lanthanum-140; Figure 8), and exceeds background radiation exposure by up to ten thousand times. Cloudshine exposure from all radionuclides exceeds the NRC limit by up to 500 times, and exceeds background by up to thirty thousand times (Figure 9). Inhalation exposure from the cloud for individual radionuclides exceeds NRC exposure levels by up to one thousand times (cesium-137; Figure 10), and exceeds background by up to two hundred thousand times. Aggregate inhalation exposure from the 15 radionuclides analyzed exceeds NRC exposure limits by up to eight thousand times, and exceeds background by up to two million times (Figure 11). Inhalation exposure remains well above the NRC limit throughout the entire city. Radiation exposure for nuclides deposited on the ground ("groundshine") for one day exceeds NRC limits by up to five thousand times for individual radionuclides (e. g., tellurium-132; Figure 12). Aggregate groundshine exposure from the 15 radionuclides analyzed exceeds NRC exposure limits by up to ten thousand times (Figure 13).

Based on the above radiation exposures, casualties from fatal cancers were computed. Short-term casualties (one day) range from 5 to 1,068 (Figure 16), depending on the atmospheric conditions and risk factor used. Medium-term casualties (one week of groundshine alone) under the most stable atmospheric conditions range from 174 to 1,778 (Figure 17). Long-term casualties (one year of groundshine alone) under the most stable atmospheric conditions range from 225 to 2,051 (Figure 18). Additional yearly casualties would range from 61 to 659, declining to about half this number in 30 years.

Even under highly conservative assumptions, therefore, the meltdown of a naval nuclear reactor at Hunter's Point would cause up to thousands of casualties in San Francisco unless the city were immediately evacuated and decontaminated prior to rehabitation. Evacuation would have to be rapid (1 - 2 hrs.) 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 tens of billions of dollars. Until the city of San Francisco were decontaminated, the economy of the city would remain at a standstill. There is no legal precedent for assessing liability and indemnity for the costs of cleaning up after a military accident, and hence it is not clear how these costs would be paid.

The risk to the people of San Francisco from this accident is defined as the product of the consequences described above, and the probability that the accident scenario analyzed will occur. Although the consequences can be established with precision, computing the probability of a naval propulsion reactor accident requires information that the military has been unwilling to release, such as the accident history and operating characteristics of naval propulsion reactors. In the absence of this information, the risk of the accident modeled here cannot be calculated.

These findings provide a technical basis for seven policy recommendations. These are: 1) data necessary to calculate the probability of a naval propulsion nuclear reactor accident should be made available prior to a decision on homeporting; 2) emergency evacuation plans appropriate to nuclear accidents should be developed by Bay Area cities; 3) the ecological impact of nuclear accidents on San Francisco Bay and the Pacific ocean should be assessed; 4) decontamination plans should be drawn up for the city of San Francisco and other localities that could be impacted by a nuclear accident; 5) legal liability for a nuclear accident should be established in advance with the cooperation of the military; 6) contingency plans for economic recovery following a nuclear accident should be considered in advance; and 7), cost-benefit analysis of homeporting should be undertaken, with the aim of identifying viable alternatives.