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NUCLEAR REGULATORY COMMISSION
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MEMORANDUM FOR: James R. Shea, Director
Office of International Programs

FROM: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

SUBJECT: NRR STAFF ASSESSMENT OF STATE PREPARED DOCUMENT ON THE KOREAN NUCLEAR UNITS 7 AND 8

Enclosed is an NRR staff assessment of the potential radiological effects of the Korean Nuclear Power Station on the global commons. We believe that the assessment represents a reasonable upperbound appraisal potential of radioactive releases from that plant.

This assessment was prepared by R. L. Gotchy, RAB/DSI, and S. Acharya, AEB/DSI.

Harold R. Denton

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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NRR STAFF EVALUATION OF THE POTENTIAL RADIOLOGICAL IMPACT ON THE GLOBAL COMMONS OF THE EXPORT OF KOREAN NUCLEAR UNITS 7 & 8

By order dated February 8, 1980, the Commission invited comment upon: (a) the health, safety or environmental effects the proposed nuclear exports to the Phillipines would have upon the global commons or the territory of the United States, and (b) the relationship of these effects to the common defense and security of the United States. For purposes of these comments, the term "global commons" was defined to mean geographical areas such as the high seas, Antarctica, and the portions of the atmosphere that are not within the territorial jurisdiction of a single nation state; and the term "United States" was defined to mean territory of the 50 states, as well as U.S. trust territories and possessions.

The scope of the evaluation requested by the Commission in its order concerning the proposed Phillipine export has also been to applied to the export to South Korea of Korean Nuclear Units 7 and 8 (KNU 7 & 8). Since the Commission's Order in the Phillipines reactor export case confined the staff consideration to potential impacts outside the territorial jurisdiction of the Phillipines (i.e., the "global commons" and "United States"), the issue here is reduced primarily to one of performing a reasonable upperbound analysis, i.e., of considering the potential impact of a core melt accident involving the loss of containment integrity. For the purpose of this analysis, it was assumed that a 12-mile territorial limit off the outermost Korean coastal islands would apply. In order to provide an approximate evaluation of the potential radiological impact on the global commons of a core melt accident at one of these units, numerous additional conservative assumptions and judgments were made, based on other related models and studies.

Based on available evidence (NUREG-0002 or GESMO (1976)) , the staff has concluded that routine releases (gaseous and liquid) from individual nuclear power stations similar to the proposed Korean reactors do not result in significant impacts on the global commons. The same would be true of core melts which do not escape into the atmosphere. Although the liquid releases from such accidents might cause local contamination of aquifiers, estuaries or oceans, the radiological and ecological impacts on the global commons would generally be small (NUREG-0440).

The staff has also concluded that, in the event of a core melt accident at the proposed Korean reactor, which would result in direct releases to the atmosphere (such as PWR case 1B in in WASH-1400), it is very unlikely that there would be a single early fatality (occurring within a year) outside the assumed 12-mile territorial limit. The staff has also concluded that, in the event of such an accident, a large liquid pathway dose would be highly unlikely.

Atmospheric Releases

KNU 7 & 8 are Westinghouse PWRs with a power level of 950 MWe each. The reactor containment is a single containment system similar to that of the model PWR (based on the Surry plant, also built by Westinghouse) used in the Reactor Safety Study. The staff believes that the response of these two plants would be approximately comparable to the Surry Plant in the event of a core melt accident, and the staff has based this assessment on that assumption.

Rainfall exerts an important influence on the magnitude of global radiological impacts from atmospheric releases. In general, the greater the rainfall, the greater the local fallout and the lower the potential impacts on the global commons. The rainfall rate in Korea is highest for June through August (50% of total annual rainfall). The Environmental Review prepared by the Department of State indicates an average annual-rainfall rate of 1,180 mm.

In order to be reasonably conservative, the staff has also assumed that members of an exposed population would be located outdoors without protection or shelter during the first 24 hours of the exposure (including plume passage and ground deposition). This would account for essentially all of the inhalation dose and the ground deposition dose (assuming no evacuation during that period). However, emergency measures, such as evacuation and protective actions, could greatly reduce the doses.

The results of the CRAC code [1/] analysis of KNU 7 & 8 nuclear power stations, using the above assumptions, are shown in Table 1 on page 5. The results lead to the conclusion that it is very unlikely that there would be a single early fatality (occurring within one year) outside a 12-mile territorial boundary as a result of radiation doses received. Whole body and thyroid doses at the asssumed 12-mile limit would be on the order of 65 and 370 rem, respectively.

These doses theoretically could be received by exposed persons on ships at sea or small, inhabited islands just beyond this 12-mile limit (assuming no evacuation or treatment). At that dose (and with no effort to seek shelter or to decontaminate), the total incremental lifetime risk of latent cancer mortality related to the postulated accident would be on the order of 14 chances in a thousand (36% of those hypothetical deaths would be from thyroid cancer), compared with the normal lifetime risk of cancer mortality in Korea of about 15 chances in a hundred.[2/] However, ships provide good shelter and can be decontaminated quickly by hosing. Furthermore, the staff is not aware of any inhabited islands outside South Korea within 100 miles of the plant site.[3/] At a distance of 200 miles, whole body doses could be on the order of 0.5 rem, with thyroid doses on the order of 10 rem assuming no evacuation. In such a case, the total incremental lifetime risk of latent cancer mortality attributable to the core meltdown would be on the order of 2 chances in ten thousand. Risk of genetic defects (not mortality) would be on the order of one chance in ten thousand over the subsequent five generations.

1/ See App. VI, WASH-1400 (1975) for details.

2/ Assumes a 65-year life expectancy (based on 62-year life expectancy in 1966), and 1972-73 Japanese cancer rates listed in "Cancer Facts and Figures-1979," American Cancer Society. Data for South Korea were unavailable.

3/ It should be noted that South Korea extends over 170 miles to the north of the site and 150 miles to the south. Islands abound to the southwest to about 80 miles from the site. The nearest nation is Japan, 160 miles east of the plant.

The estimated somatic impacts are believed to be conservative, since they are based on cancer risks in nations generally having greater life expectancies than nations like Korea or many of its neighbors (i.e., more people would be expected to die at an earlier age of other causes, avoiding many of the very high cancer risk years beyond age 60).

Liquid Releases

From past analyses, it is concluded that a large liquid pathway dose from a core melt accident would be highly unlikely. The radioactivity released in a core melt accident would first have to travel through groundwater to get to the sea, affording responsible authorities time (e.g., years) to interdict at the source. In the Liquid Pathway Generic Study (NUREG-0440), the maximum uninterdicted dose to an individual (from all potential pathways including marine recreation, sport and commercial fishing, boating, and shipping) at a generic coastal site from the worst core melt scenario was conservatively estimated to be about 50 to 90 rems, whole body.* The risk of cancer mortality from such a dose would be on the order of seven to 12 chances in one thousand.

About half of the dose (approximately 20-40 rems) would be attributable to the consumption of fish caught near the accident site.* No drinking

*A range is given to allow for potential variations in concentrations near the site. The coastal area around the site is noted for the many creeks, inlets and islands which could result in conditions analogous to estuaries in terms of mixing, etc.

water pathway would be involved since only sea water pathways would need to be considered for this plant site. The beach exposure portion of the dose would be important only for South Korean beaches near the site and would be negligible elsewhere. Therefore, the only potentially significant liquid pathway dose which could occur in the global commons (i.e., to individuals outside of South Korea) would be due to the consumption of seafood caught close to the accident site and exported elsewhere. It is highly likely that steps would be taken to interdict the radioactive liquid release before it entered the sea. Monitoring and confiscation of commercial seafood, if necessary, would further reduce the dose estimate. While the generic site considered in NUREG-0440 does not duplicate exactly the conditions to be expected at the Korean site, the staff is of the opinion that the estimated maximum dose would be conservative (that is, an overestimate). Furthermore, doses and risks to individuals outside a 12-mile territorial boundary would be much lower.

TABLE 1: Korean Nuclear Units 7 & 8

Average Distance (miles)	Thyroid Dose (rem)[4/]	Whole Body (rem)
0.25	1.1E + 02	3.3E + 02
0.75	1.2E + 02	2.4E + 02
1.25	1.2E + 02	1.9E + 02
1.75	1.2E + 02	1.6E + 02
2.25	1.4E + 02	1.3E + 02
2.75	1.6E + 02	1.2E + 02
3.25	1.9E + 02	1.1E + 02
3.75	2.3E + 02	1.1E + 02
4.25	2.5E + 02	1.1E + 02
4.75	3.0E + 02	8.5E + 01
5.5	3.4E + 02	8.1E + 01
6.5	3.6E + 02	7.3E + 01
7.75	3.9E + 02	7.0E + 01
9.25	4.5E + 02	6.7E + 01
11.2	4.6E + 02	5.0E + 01
13.7	4.5E + 02	4.5E + 01
16.2	4.5E + 02	3.8E + 01
18.7	4.2E + 02	3.1E + 01
22.5	3.8E + 02	2.8E + 01
27.5	4.5E + 02	8.2E + 01
32.5	4.3E + 02	7.2E + 01
37.5	3.7E + 02	6.5E + 01
42.5	3.0E + 02	5.2E + 01
47.5	2.6E + 02	4.8E + 01
52.5	2.3E + 02	4.4E + 01
57.5	2.0E + 02	3.1E + 01
62.5	1.8E + 02	2.7E + 01
67.5	1.5E + 02	2.4E + 01
77.5	1.4E + 02	2.2E + 01
92.5	9.6E + 01	1.3E + 01
125	4.6E + 01	3.6E + 00
175	1.9E + 01	9.2E - 01
275	5.4E + 00	1.0E - 01
425	8.7E - 03	1.1E - 03

4/ Most of the calculated thyroid dose is from internally deposited radioiodine which can be reduced by prophylaxis given within hours of the accident. 1.1E + 02 = 110