ENVIRON

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G. W. Knighton, Chief, Project Branch No. 1, DREP

INDIAN POINT 2 REALISTIC ACCIDENT ASSESSMENT

Enclosed is a mark-up of the Realistic Accident Section for the Indian Point 2 draft Environmental Statement. There are a number of minor revisions to the dose table due to a refinement of the dose calculations performed by E. G. Adensam. However, our opinion that the environmental risk remains extremely low has not changed.

A copy of the enclosure was loaned to M. J. Oestmann on March 28, 1972.

Brian Grimes, Chief
Accident Analysis Branch
Division of Reactor Licensing

Enclosure:
(As Stated)

cc: K. Kniel (w/enclosure)
M. J. Oestmann (w/enclosure)
D. Muller (w/o enclosure)
H. R. Denton (w/o enclosure)
R. DeYoung (w/o enclosure)
bcc: E. Adensam (w/enclosure)

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SURNAME ▶	EGADENSAM:mj	KKNIEL	BGRIMES			
DATE ▶	4/4/72	4/4/72	3/31/72			

4. Environmental Impact of Accidents

A high degree of protection against the occurrence of postulated accidents at Indian Point Unit No. 2 is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system, as stated in the Commission's Safety Evaluation dated November 16, 1970. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, in spite of the fact that they are extremely unlikely, and engineered safety features are installed to mitigate the consequences of these postulated events. The probability of occurrence of accidents and the spectrum of their consequences to be considered from an environmental effects standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions. For site evaluation in our safety review, extremely conservative assumptions were used for the purpose of comparing calculated doses resulting from a hypothetical release of fission products from the fuel against the 10 CFR Part 100 siting guidelines. The calculated doses that would be received by the population and environment from actual accidents would be significantly less than those presented in our Safety Evaluation. The Commission issued guidance to applicants on September 1, 1971, requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The applicant's response was contained in the "Supplement No. 2 to the Environmental Report", dated October 15, 1971.

The applicant's report has been evaluated, using the standard accident assumptions and guidance issued as a proposed Annex to Appendix D of 10 CFR Part 50 by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious have been identified by the Commission. Each class can be characterized by an occurrence rate and set of consequences. In general, accidents in the high consequence end of the spectrum have a low occurrence rate. The examples selected by the applicant for these classes are shown in Table 3. The examples given are reasonably homogeneous in terms of probability with in each class, although we consider steam generator tube rupture and the release of the waste gas decay tank contents as more appropriately in Classes 5 and 3, respectively.

Certain assumptions made by the applicant do not exactly agree with those in the proposed Annex to Appendix D, but the use of alternative assumptions does not significantly affect overall environmental risks.

Insert

"To rigorously establish a realistic annual risk, the calculated doses in Table ~~2~~ 4 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operation and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation but events of this type could occur sometime during the 40 year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table ~~8~~ 4 are weighted by probabilities, the environmental risk is very low."

Table 4 reflects the types of accidents described in the proposed amendment to Appendix D, 10 CFR Part 50, published in the Federal Register on December 1, 1971, for comment and interim guidance.

Our estimates of the dose which might be received by an assumed individual standing at the site boundary in the ~~windward~~ downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table 4. Our estimates of the integrated annual exposure that might be delivered to the population within 50 miles of the site are also presented in Table 4. The man-rem estimate was based on the projected population around the site for the year ~~2000~~ 1980.

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~~To establish a realistic annual risk, the calculated annual doses in Table 4 must be multiplied by estimated probabilities. In general, we consider the events in Classes 2 through 5 as improbable, and not likely during the 40-year life of the plant. Accidents in Classes 6 through 7 are relatively less probable, but still are possible. The probability of occurrence of Class 8 accidents is very small.~~ ~~The~~ The occurrences in Class 9 involve sequences of postulated successive failures more severe than those postulated for the design basis of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture, and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

Table 4 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary to concentrations of radioactive materials within (or comparable to) the Maximum Permissible Concentrations of Table II of 10 CFR Part 20. The table also shows that the estimated annual integrated exposure for each postulated accident would be orders of magnitude smaller than that from the naturally occurring radioactivity, which corresponds to approximately 2,100,000 man-rem/yr based on a natural background level of 100 mrem/yr. When (considered with) ~~multiplied by~~ the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of the exposure from natural background radiation and well within naturally occurring variations. It is concluded from the results of this analysis that the realistic environmental risks due to postulated accidents are exceedingly small.

TABLE 3

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

Class	AEC Description	Applicant's Example(s)
1.0	Trivial incidents	Not considered
2.0	Small releases outside containment	Small valve or pipe leak in the auxiliary building
3.0	Radwaste system failures	Waste gas decay tank valve leak, inadvertent discharge of the contents of a waste liquid tank or waste gas decay tank
4.0	Fission products to primary system (BWR)	Not applicable
5.0	Fission products to primary ans secondary systems (PWR)	Normal operation with fuel failures and steam generator leaks
6.0	Refueling accidents	Dropped fuel assembly inside containment
7.0	Spent fuel handling accident	Dropped fuel assembly outside containment Onsite transportation accident
8.0	Accident initiation events considered in design basis evaluation in the SAR	Loss of coolant, rupture of waste gas decay tank, control rod assembly ejection, steam line break, steam generator tube rupture
9.0	Hypothetical sequence of failures more severe than Class 8	Not considered

TABLE 4

SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS

Class	Event	Estimated ~~Maximum~~ Fraction of 10CFR Part 20 Limit ~~Annual Dose~~ at Site Boundary 1/ ~~mrem~~	Estimated Annual Dose to Population in 50 Mile Radius, man-rem
1.0	Trivial incidents	2/	2/
2.0	Small releases outside containment	2/	2/
3.0	Radwaste system failures		
3.1	Equipment leakage or malfunction	0.095 ~~24.~~	49 ~~60.~~
3.2	Release of waste gas storage tank contents	0.37 ~~58.~~	190 ~~76.~~
3.3	Release of liquid waste storage tank contents	0.004 ~~Neg.~~	2.3
4.0	Fission products to primary system (BWR)		
4.1	Fuel cladding defects	N. A.*	N. A.*
4.2	Off-design transients that induce fuel failures above those expected	N. A.*	N. A.*
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	2/	2/
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	0.002 ~~0.020~~	1.1 ~~1.2~~
5.3	Steam generator tube rupture	0.12 ~~58.~~	65 ~~70.~~

Class	Event	Estimated ~~Maximum~~ Fraction of 10CFR Part 20 limit ~~Annual Dose~~ at Site Boundary[1]	Estimated Annual Dose to Population in 50 Mile Radius, man-rem
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.02 ~~2~~	10 ~~2.7~~
6.2	Heavy object drop onto fuel in core	0.34 ~~37.2~~	180 ~~50.~~
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel rack	0.012 ~~2.~~	? 6.5 ~~2.7~~
7.2	Heavy object drop onto fuel rack	0.05 ~~0.92~~	26 ~~1.2~~
7.3	Fuel cask drop	N. A.*	N. A.*
8.0	Accident initiation events considered in design basis evaluation in the safety analysis report		
8.1	Loss-of-coolant accidents		
	Small Break	0.21 ~~0.12~~	? 190 ~~0.16~~
	Large Break	1.8 ~~200.~~	5800 ~~270.~~
8.1(a)	Break in instrument line from primary system that penetrates the containment	N. A.*	N. A.*
8.2(a)	Rod ejection accident (PWR)	0.18 ~~14.0~~	580 ~~20~~
8.2(b)	Rod drop accident (BWR)	N. A.*	N. A.*
8.3(a)	Steamline breaks (PWR's outside containment)		
	Small Break	<0.001 ~~0.08~~	0.34 ~~0.11~~
	Large Break	0.001 ~~3.6~~	0.65 ~~4.9~~

Class	Event	Estimated ~~Maximum~~ ~~Annual Dose~~ fraction of 10 CFR Part 20 Limit at Site Boundary, mrem 1/	Estimated Annual Dose to Population in 50 Mile Radius man-rem
8.3(b)	Steamline breaks (BWR)		
	Small Break	N. A.*	N. A.*
	Large Break	N. A.*	N. A.*

1/ Represents the calculated fraction of a whole body dose of 500 mrem or the equivalent dose to an organ.

2/ These releases are expected to be in accord with proposed Appendix I for routine effluents (i.e., 5 mrem/yr to an individual from all sources).

* N. A. means not applicable.