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March 28, 1997

Re: Indian Point Unit No. 2
Docket No. 50-247

Document Control Desk
US Nuclear Regulatory Commission
Mail Station P1-137
Washington, DC 20555

SUBJECT: Proposed Technical Specification Change to Delete Spray Additive Tank

By letter dated August 22, 1996, Con Edison submitted an application for the subject license amendment change. The justification for that change included post-LOCA thyroid dose computations based on the methodology documented in NUREG-1465, "Accident Source Terms for Light Water Nuclear Power Plants". That methodology had been utilized specifically for Indian Point Unit No. 2 and was documented in WCAP-14542, "Evaluation of the Radiological Consequences from a Loss of Coolant Accident at Indian Point Nuclear Generating Station Unit No. 2 using NUREG-1465, Source Term Methodology" and was submitted to the NRC on August 21, 1996.

One conclusion of that study is that the NaOH spray additive is not required to keep post-LOCA thyroid doses offsite and in the Central Control Room within regulatory limits. At the recent request of the NRC, we have evaluated this conclusion independently by applying pre-NUREG-1465 thyroid dose methodology utilizing the source term contained in TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites" USAEC Report, 1962. This further analysis is documented in the attached Westinghouse report, "Radiological Consequences of a Large LOCA for Indian Point Unit 2 with SAT Elimination", dated February, 1997. The conclusion reached is generally the same as presented in WCAP-14542, i.e., that the sodium hydroxide spray additive can be removed without significantly affecting the radiological consequences of a postulated LOCA.

Should you have any questions regarding this matter, please contact Mr. Charles W. Jackson, Manager, Nuclear Safety and Licensing.

Very truly yours,

for S.E.Q.

A009

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RADIOLOGICAL CONSEQUENCES OF A LARGE LOCA FOR INDIAN POINT UNIT 2 WITH SAT ELIMINATION

February 1997

Introduction

Sodium hydroxide containment sprays currently provide the primary means of reducing the radioiodine concentrations in the containment atmosphere following a design basis large Loss of Coolant Accident (LOCA). This post-LOCA iodine control function can be effectively performed by boric acid sprays and by plateout on containment surfaces. Thus, the spray additive tank (SAT) which contains the sodium hydroxide, the additive delivery system and the related testing and maintenance required by the Technical Specifications can be eliminated.

This report describes the assumptions and analyses that were performed to demonstrate that elimination of the SAT from Indian Point Unit 2 results in radiological consequences for a postulated design basis large-break LOCA that are within the defined dose guidelines. The results of the analysis include the thyroid and gamma-body doses due to releases of iodines and noble gases.

Background

The Containment Spray System design for Indian Point Unit 2 (IP2) currently utilizes caustic containment spray (weak boric acid solution adjusted with sodium hydroxide to a pH of 8.5 to 10.5) to assure rapid removal of radioactive elemental iodine from the containment atmosphere following a postulated large break LOCA. The removal of airborne iodine is necessary to minimize its release to the environment due to containment leakage and thus assure that offsite doses are within the guidelines of 10 CFR 100. The specification of an elevated containment spray pH for fission product control was based on the following assumptions:

- Gaseous elemental iodine is the dominant iodine chemical species released from the reactor core

- Elemental iodine removal capability of unadjusted boric acid spray is low (pH of 4.5 to 5)

- Elemental iodine removal capability of the spray increases with increasing pH

Removal of the spray additive does not eliminate the need to adjust the pH of the recirculating Emergency Core Cooling (ECC) solution. The long-term pH of the ECC solution should be no less than 7.0 to assure that iodine removed by sprays is retained in solution and minimize formation of organic iodine compounds, to prevent chloride-induced stress corrosion cracking of austenitic stainless steel components, and to minimize the hydrogen produced by the corrosion of galvanized surfaces and zinc-based paints. Since the initial pH of the boric acid ECC solution, without spray additive, will be approximately 4.5 to 5.0, a chemical additive must be utilized to raise the pH of the solution in the containment sump.

Input Parameters and Assumptions

The offsite and control room doses following a large loss-of-coolant accident (LOCA) are determined using present-day NRC regulatory requirements. The following paragraphs describe the input parameters and assumptions used in determining the doses due to containment leakage following a large LOCA using the TID-14844 source term methodology.

Following the large LOCA 50% of the core iodine activity and 100% of the core noble gas activity are assumed to be immediately released to containment when determining doses due to containment leakage. Fifty percent of the iodine released to containment is assumed to instantaneously plate out on containment surfaces. This leaves 25% of the core iodine activity and 100% of the core noble gas activity immediately available for leakage from the containment (Reference 1). This iodine is assumed to be 91% elemental, 4% methyl and 5% particulate (Reference 1).

The Technical Specification design basis containment leak rate of 0.1% by weight of containment air is used for the initial 24 hours. Thereafter the containment leak rate is assumed to be one-half the design value, or 0.05%/day (Reference 1).

The SI signal following the large LOCA would start the emergency containment filtration system (ECFS) filter fans. To account for time to allow the containment fans to be loaded on the emergency diesel generators, to reach operating speed and to add conservatism, credit for the ECFS filters is not taken in the initial 35 seconds following the accident. The filter efficiencies for the ECFS filters are 90% for elemental iodine, 30% for methyl iodine and 95% for particulate iodine.

In addition to the iodine removal from the containment fan filters, elemental and particulate iodine is removed by the containment spray system. The elemental iodine spray removal coefficients of 22.5 hr^{-1} during spray injection and 13.3 hr^{-1} during spray recirculation are determined based on a model suggested in Reference 2. For conservatism, the removal rate is reduced by a factor of 2 during spray injection since the pH of the spray is relatively low. Credit is taken for spray removal during spray injection until a decontamination factor of 5 of the elemental iodine in the containment inventory is reached, and during spray recirculation until a total decontamination factor of 100 is reached. The particulate iodine spray removal coefficients of 4.6 hr^{-1} during spray injection and 2.7 hr^{-1} during spray recirculation are determined based on a model suggested in Reference 2. Credit is taken at these rates for particulate iodine spray removal until a decontamination factor of 50 in the containment inventory of particulate iodine is reached. Once a decontamination factor of 50 is reached the removal coefficients are reduced by a factor of 10.

The doses to personnel in the control room are also determined for the containment leakage activity release path discussed above. The values used for the appropriate control room parameters are taken from the previous Indian Point Unit 2 large LOCA analysis (Reference 3). The control room volume is 102,400 ft^3, the filtered makeup flow is 0 cfm, the filtered recirculation flow is 1660 cfm, and the unfiltered inleakage flow is 500 cfm. The control room filter removal efficiency is 95% for elemental, 90% for organic and 99% for particulate iodine.

The major assumptions and parameters used to determine the doses due to containment leakage are given in Table 1. The control room assumptions and parameters are given in Table 2. The thyroid dose conversion factors, breathing rates and atmospheric dispersion factors used in the dose calculations are given in Table 3.

Description of Analyses Performed

The offsite thyroid and whole body doses, as well as the control room thyroid, gamma body and beta skin doses, are determined for the containment leakage release path using the TITAN5 computer code.

Acceptance Criteria

The offsite doses must meet the guidelines of 10CFR100, or 300 rem thyroid and 25 rem whole body for the initial 2 hour period following the accident at the SB and for the duration of the accident at the LPZ. The dose acceptance guidelines for control room personnel are 5 rem gamma body, 30 rem thyroid, and 30 rem beta skin (Reference 4).

Results

The offsite and control room doses following a Large LOCA due to containment leakage are given in Table 4.

Conclusions

The offsite thyroid and whole body doses and the control room whole body and beta skin doses due to containment leakage following a large LOCA do not exceed the acceptance criteria. The control room thyroid dose exceeds the 30 rem limit specified in Reference 4; however, the dose is within 10CFR100 guidelines. Reference 4 is not a part of the Indian Point Unit 2 licensing basis and thus Indian Point Unit 2 is not required to meet these guidelines.

References

1. Regulatory Guide 1.4, Rev. 2, July 1974, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss-of-Coolant Accident for Pressurized Water Reactors".

2. NUREG-0800, Standard Review Plan 6.5.2, "Containment Spray as a Fission Product Cleanup System", Rev. 2, December 1988.

3. WCAP-14542, "Evaluation of the Radiological Consequences from a Loss of Coolant Accident at Indian Point Nuclear Generating Station Unit No. 2 Using NUREG-1465 Source Term Methodology", July 1996.

4. NUREG-0800, Standard Review Plan 6.4, "Control Room Habitability System", Rev. 2, July 1981.

TABLE 1

ASSUMPTIONS USED FOR LARGE LOCA DOSE ANALYSIS

Iodine Chemical Species	
Elemental	91%
Methyl	4%
Particulate	5%
Iodine Removal in Containment	
Instantaneous Iodine Plateout	50%
Containment Spray	
Spray Start Delay	80 sec
Injection spray flowrate	2200 cfm
Injection spray duration	50 min
Recirculation spray flowrate	1300 cfm
Recirculation spray duration	up to 24 hours
Iodine removal coefficient	
Elemental, λ_s	
during spray injection	11.25/hr* DF $<$ 5
during spray recirculation	13.3/hr 5 $<$ DF $<$ 100
Particulate, λ_p	
during spray injection	4.6/hr DF $\leq$ 50
during spray recirculation	2.7/hr DF $\leq$ 50
	0.27/hr DF $>$ 50
Emergency Containment Filters	
Start Delay Time	35 sec
Number of Units	3
Flow Rate per Unit	65,000 cfm
Flow Rate through Charcoal Filters	8000 cfm
Filter Efficiency	
Elemental	90%
Methyl	30%
Particulate	95%
Containment Free Volume	2.61×10^6 ft^3
Containment Leak Rate	
0-24 hr	0.10%/day
> 24 hr	0.05%/day

* This is the value used in the large LOCA analysis. Actual calculated value is 22.5/hr.

TABLE 2

ASSUMPTIONS USED FOR LARGE LOCA DOSE ANALYSIS

CONTROL ROOM

Volume	102,400 ft^3
Unfiltered Inleakage	500 cfm
Filtered Makeup	0 cfm
Filtered Recirculation	1660 cfm
Filter Efficiency	
Elemental	95%
Organic	90%
Particulate	99%
Occupancy Factors	
0-1 day	1.0
1-4 days	0.6
4-30 days	0.4

TABLE 3

DOSE CONVERSION FACTORS, BREATHING RATES AND ATMOSPHERIC DISPERSION FACTORS

Isotope	Thyroid Dose Conversion Factors [1] (rem/curie)
I-131	1.07 E6
I-132	6.29 E3
I-133	1.81 E5
I-134	1.07 E3
I-135	3.14 E4

Time Period (hr)	Breathing Rate [2] (m^3/sec)
0-87.5	3.47 E-4
8-24	1.75E-4
24-720	2.32E-4

	Atmospheric Dispersion Factors (sec/m^3)
Site Boundary	
0-2 hr	7.5 E-4
Low Population Zone	
0-8 hr	3.5 E-4
8-24	1.2 E-4
24-96	4.2 E-5
96-720	9.3 E-6
Control Room	
0-2 hr	2.3E-3
2-24	1.15E-3
24-720	5.5E-4

(1) ICRP Publication 30
(2) Regulatory Guide 1.4

TABLE 4

LARGE LOCA OFFSITE AND CONTROL ROOM DOSES

Site Boundary (0-2 hr)	
Thyroid	117.3 rem
γ-body	3.4 rem
Low Population Zone (0-720 hr)	
Thyroid	73.9 rem
γ-body	3.3 rem
Control Room (0-720 hr)	
Thyroid	107.4 rem
γ-body	0.4 rem
Beta skin	15.2 rem