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(2-76)

U.S. NUCLEAR REGULATORY COMMISSION

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TO: Mr. A. Schwencer

FROM: Wisconsin Public Service Corp. Green Bay, Wisconsin E. W. James

DATE OF DOCUMENT: 3/28/77

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PLANT NAME:

Kewaunee

ACKNOWLEDGED

RJL

ENCLOSURE

Evaluation of a postulated fuel handling accident within containment......

(5-P)

FOR ACTION/INFORMATION

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NRC FORM 195 (2-76)

WISCONSIN PUBLIC SERVICE CORPORATION

P.O. Box 1200, Green Bay, Wisconsin 54305

March 28, 1977

Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTN: Mr. A. Schwencer, Chief
Operating Reactors Branch #1
Division of Operating Reactors

Gentlemen:

REF: Docket 50-305
Operating License DPR-43
Letter to Wisconsin Public Service Corporation from Mr. A. Schwencer dated January 14, 1977

The referenced letter requested that we evaluate the potential consequences of a fuel handling accident within containment and document the factors involved in the evaluation, thereby confirming the conclusion of the NRC that the guidelines of 10CFR100 would not be exceeded by such an event.

Please find attached our evaluation of a postulated fuel handling accident within containment of the Kewaunee Plant. This analysis employs the assumptions presented in FSAR, Section 14 and Appendix D, for similar postulated events and the assumptions of the AEC Safety Evaluation of the Kewaunee Nuclear Power Plant as presented in Section 15 of that evaluation.

Three cases are presented in the attachment. The design base case is modeled following the analysis presented in the FSAR for a fuel handling accident outside of containment. The results of this analysis comply with the guidelines of 10CFR100 even in the light of a very conservative design base case which assumes no action by safety equipment or operators. The second case is a conservative physical case which assumes partial mixing within containment, an exponential radioactive material release from the pool surface, containment isolation five minutes following the event and no filtration. This conservative second case results in the release of about 0.1% of the 10CFR100 guidelines. The third case takes credit for the actions of licensed personnel, located in containment and the control room, required solely for fuel handling operations and includes credit for the requirement that containment penetrations associated with the vent and purge system be operable or closed during fuel handling operations. This third case is the most realistic of the cases considered; however, it is also conservative since no delay time is assumed for gas transit to the pool surface nor is the transit time to the vent intake nozzle taken into account. This third case results in a thyroid dose of less than 7 mrem or less than .0023% of 10CFR100 guidelines.

The containment isolation equipment which will effectively mitigate the postulated event is designed to provide containment isolation post LOCA and is qualified for the seismic events. While no equipment action is necessary for conformance to 10CFR100 guidelines, the consideration of the safety grade equipment designed for LOCA conditions presently installed in the Kewaunee Plant and required to be operable during fuel handling operations by the Technical Specifications results in maintaining the effects of a fuel handling accident within containment within 10CFR20 guidelines which do not apply for accidents.

Very truly yours,

E. W. James
Senior Vice President
Power Supply & Engineering

EWJ:sna
Attach.

Containment Fuel Handling Accident

Design Case

In calculating the off-site exposure, it is assumed that 100% of the activity escaping the water surface is discharged to the atmosphere at ground level in the first two hours of the accident. This assumption is very conservative since actual discharge is through the reactor building vent, approximately 170 ft. above ground level, and a high containment vent exhaust activity alarm will isolate the purge and vent system very early in the accident. Neither containment air mixing or filtration are considered.

The inventory of halogens and noble gases available for release from the refueling cavity water surface is based on the following:

1. Breakage of all rods in the highest rated fuel assembly at 100 hours following reactor shutdown.

2. An axial peak to average flux ratio of 1.72 (versus an expected value of 1.37).

3. The fission products released from the assembly consist of 1.75×10^4 Ci of halogens (equivalent I^{131}) and 2.97×10^4 Ci of noble gases (equivalent Kr^{85}).

4. Of the total halogens available for release, 1.0% will escape from the water surface.

5. Of the noble gases, 100% will escape from the water surface.

Other parameters used in the dose calculation are:

1. A 0-2 hour X/Q value of 2.23×10^{-4} sec/m^3.

2. A 0-8 hour breathing rate of 3.47×10^{-4} m^3/sec.

3. An I^{131} equivalent dose conversion factor of 1.48×10^6 rem/Ci.

4. A Kr^{85} effective decay energy of 0.234 Mev/disintegration (from FSAR, Appendix D).

Whole body dose calculation:

The general equation for this case is:

$$D_{wb} = 0.245\ (X/Q)\ \Sigma_i Q_i E_i \qquad (1)$$

where:

D_{wb} = whole body dose, rem

X/Q = site dispersion factor, sec/m^3

$= 2.23 \times 10^{-4}$ sec/m^3

Qi = total activity of isotope i released, curies

= 2.97×10^4 Ci

E_i = effective decay energy from isotope i, Mev/disintegration

= 0.234 Mev/disintegration

Using the above values, D_{wb} = 0.38 rem. The 10CFR100 Dose Guideline is 25 rem.

Thyroid Inhalation dose:

The thyroid dose is obtained from the following expression:

$$D_T = \sum_t B_t \, (X/Q)_t \sum_i A_{i,t} \, (DCF)_i \qquad (2)$$

where:

D_T = thyroid inhalation dose, rem

$(X/Q)_t$ = site dispersion factor for time interval t, sec/m^3

= 2.23×10^{-4} sec/m^3

B_t = breathing rate for time interval t, m^3/sec

= 3.47×10^{-4} m^3/sec

$A_{i,t}$ = total activity of iodine isotope i released in time period t, curies

= (1.75×10^4 Ci) (.01) = 175 Ci

$(DCF)_i$ = dose conversion factor for iodine isotope i, rem/curie inhaled

= 1.48×10^6 rem/Ci

Using these values D_T = 20.0 rem. The 10CFR100 Dose Guideline is 300 rem.

Conservative Physical Case

To calculate the off-site exposure resulting from a fuel handling accident in containment the following assumptions are made:

1. The activity escaping the water surface is homogeneously mixed in one-fourth the containment free volume prior to discharge through the containment exhaust vent. (The suction nozzle is 41 ft. above the refueling floor directed vertically upward.)

2. The activity is released within the first two hours of the accident according to $A(t) = A_o\left[1-(.5)^{t/15}\right]$ where A_o is the total activity available for release, t is time in minutes, and A(t) is the activity released from the pool surface between time zero and time t.

3. The activity available for release and the basic parameters are the same as used previously.

4. The RBV isolation valves are shut five minutes into the accident by either automatic closure due to high rediation alarm or manual closure by cognizant control room refueling personnel. (In less than one second, enough activity escapes to exceed the radiation monitor setpoints when mixed in one fourth of the free volume.) X

5. No other leakage path is significant since pressure is equalized and the personnel airlock is closed during fuel handling.

6. The exhaust rate, q, is 33,000 CFM.

7. No credit is taken for filtration.

Whole body dose calculation:

Activity release: $A(t) = 2.97 \times 10^4 \text{ Ci}\left[1-(.5)^{t/15}\right]$

The activity discharged to the atmosphere is:

$$A_d = \frac{A(t=5)}{V}q = \frac{(6.13 \times 10^3)\ (3.3 \times 10^4)}{3.3 \times 10^5}$$

$$A_d = 6.13 \times 10^2 \text{ Ci}$$

Using equation (1), the whole body dose is calculated to be:

$$D_{wb} = (.245)\ (2.23 \times 10^{-4})\ (6.13 \times 10^2)\ (.234)$$

$$D_{wb} = 7.84 \times 10^{-3} \text{ rem} \quad \text{(10CFR100 Guideline 25 Rem)}$$

Thyroid inhalation dose calculations:

Activity release: $A(t) = 175\left[1-(.5)^{t/15}\right]$

Activity discharged to the atmosphere:

$$A_d = \frac{A(t=5)}{V}q = \frac{(36.1 \text{ Ci})\ (3.3 \times 10^4 \frac{ft^3}{min})}{3.3 \times 10^5 \ ft^3}$$

$$A_d = 3.61 \text{ Ci}$$

Using equation (2), the thyroid dose is calculated to be:

$$D_T = (3.47 \times 10^{-4})\ (2.23 \times 10^{-4})\ (3.61)\ (1.48 \times 10^6)$$

$$D_T = .41 \text{ Rem} \quad \text{(10CFR100 Guideline 300 Rem)}$$

Equipment design:

The protection of the general public during this accident depends on the containment isolation systems, primarily the RBV isolation valve system. These isolation systems are redundant and designed for accident environmental and seismic conditions. Since a fuel handling accident does not change containment ambient conditions, these systems should perform as expected in minimizing release of activity to the atmosphere. This isolation capability is required per Technical Specifications sections 3.6 and 3.8 during fuel handling.

Containment Environment flowing isolation:

Following isolation of containment, the remaining activity released will mix with the total free volume of containment. The following concentrations will result:

Noble gas - 7.78×10^{-1} uc/cm^3 equivalent Kr^{85}

Halogen - 4.59×10^{-3} uc/cm^3 equivalent I^{131}

Existing containment cleanup systems would be utilized to reduce these concentrations to workable values following isolation.

The analysis presented can be shown to be conservative, based on the following:

The expected end-of-life temperature and power distribution indicate only 1/3 of the design basis halogen inventory is available for release.

The expected decontamination factor for halogens would lower the release inventory considerably.

The effects of plate-out and filtration through absolute and charcoal filters would be expected to decrease the off-site release by 1/100.

The entire free volume would be available for mixing with the released activity thereby lowering the concentration during discharge.

Manual action from the control room would isolate the containment exhaust vent within one minute of dropping a fuel element.

Real World Case

To determine the affects of a containment fuel handling accident considering the real world situation, the calculation is repeated with the following assumptions.

1. The RBV isolation valves are shut thirty seconds into the accident. This is realistic considering the administrative controls in force during fuel handling, e.g., direct voice communication between containment and the control room and a refueling senior reactor operator present in containment.

2. The effluent passes through 85% efficient ($\eta = .85$) filters prior to being exhausted to the atmosphere.

3. For conservatism, instantaneous mixing in one-fourth the total free

volume is again assumed.

4. All other parameters are the same as used previously.

Whole body dose:

Activity relaase: $A(t) = 2.97 \times 10^4 \left[1-(.5)^{t/15}\right]$

The activity discharged to the atmosphere is

$$A_d = \frac{A(t=.5)}{V} q\ (1-\eta) = \frac{(6.78 \times 10^2)\ (3.3 \times 10^4)\ (.15)}{3.3 \times 10^5}$$

$$A_d = 10.2 \text{ Ci}$$

Using equation (1), the whole body dose is:

$$D_{wb} = (.245)\ (2.23 \times 10^{-4})\ (10.2)\ (.234)$$

$$D_{wb} = 1.3 \times 10^{-4} \text{ Rem} \qquad \text{(10CFR100 Guideline 25 Rem)}$$

Thyroid inhalation dose:

Activity release: $A(t) = 175 \left[1-(.5)^{t/15}\right]$

Activity discharged to the atmosphere:

$$A_d = \frac{A(t=.5)}{V} q\ (1-\eta) = \frac{(4.0)}{3.3 \times 10^5}\ (3.3 \times 10^4)\ (.15)$$

$$A_d = 6 \times 10^{-2} \text{ Ci}$$

Using equation (2), the thyroid dose is:

$$D_T = (3.47 \times 10^{-4})\ (2.23 \times 10^{-4})\ (6 \times 10^{-2})\ (1.48 \times 10^6)$$

$$D_T = 6.87 \times 10^{-3} \text{ Rem} \qquad \text{(10CFR100 Guideline 300 Rem)}$$

These results indicate the truely minor effects of a containment fuel handling accident on off-site exposure.