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Memorandum

TO : The Files
(THRU) Roger S. Boyd, Chief, Research & Power Reactor Safety Branch, DRL

DATE: MAY 1 8 1966

FROM : J. T. Telford, Research & Power Reactor Safety Branch, DRL

SUBJECT: MEETING WITH CONSOLIDATED EDISON TO DISCUSS THE CONSTRUCTION PERMIT APPLICATION FOR INDIAN POINT UNIT NO. 2

50-247

On May 2, 1966 a meeting was held in Bethesda to discuss the construction permit application for Indian Point Unit No. 2. Attached is a list of those in attendance.

The applicant was requested to discuss:

1. The energy resulting from massive fuel rod failure that is required to initiate failures of the reactor vessel.

2. Discussion of reactivity transients (rod ejection) including the effect of voids, Doppler, etc. and the time and spartial sequence of events.

Dr. Rosen opened the meeting with a discussion of the approach he has been using in analyzing the safety aspects of Indian Point No. 2 (IP No. 2). He explained the procedure for using the "uncertainty" method instead of the "safety lid" approach, and went into details on fuel rod failure and why he feels a better perspective or overall picture can be obtained with this method.

E. S. Beckjord stated that Westinghouse was not in a position to answer questions based on the uncertainty approach because they haven't had time to make an evaluation. While they feel that this method has merit and they plan to look into it in more detail, they don't believe that their analysis of the safety aspects of IP No. 2 would be affected by this change in approach. They feel that essentially the same conclusions can be reached with either method.

Rod Ejection

Jim Moore discussed the details of the rod ejection accident that would result if the control rod pressure housing were to break. The internal pressure acting on the control rod would eject the rod in approximately 0.1 second. The thermal kinetics in considered on an average core basis by the chic-kin computer code. This problem is basically a point kinetics calculation. The average rod is broken into axial and radial segments, and the code considers both void formation and the affect of the positive moderator coefficients. The following items are considered in their analysis:

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1. The cases considered were hot zero power and hot full power.

2. The excursion is terminated by the Doppler effect, a conservatively low Doppler coefficient is chosen.

3. A high rate of heat transfer is assumed resulting in (a) the fuel temperature is kept down thereby maximizing the total energy for a given reactivity addition and (b) the moderator is heated faster allowing the positive coefficient to add more reactivity before the reactor is tripped.

4. The maximum fuel temperature is determined by considering the average core mentioned previously and applying the maximum peaking factor.

5. The core melting, if any, is determined by applying the worst peaking and assuming that the rods are heated adiabatically.

6. To find the amount of molten UO_2 dispersed they determine the number of rods that reach average melting along the center position cross section.

They believe the extreme upper limit for a control rod fully inserted is 1.5% dk. The associated hot channel factor F_q would be approximately 13. For the hot zero power case the ejection of this 1.5% dk rod has an associated 1.5%dk reactivity insertion due to the positive moderator coefficient. These two insertions together would melt approximately 5% of the core based on the average pin temperature (Item 6 above). While they believe that the maximum rod worth for the hot full power case will be very small they stated that a 1% dk addition from this condition would be equivalent to 1.5% dk from zero power (5% melting). They claim that an insertion of 0.8% from the hot zero power case produces no melting.

They stated that information would be prepared discussing their calculational model. Also they plan to study the sensitivity of the results by varying the rod worths, Doppler coefficient, moderator coefficient, heat transfer properties and statistical weighting. They consider a rod worth of 1.5% dk to be high but could be considered an upper limit. They also believe that the possible melting of 5% of the core will be higher than in the final design.

Pressure Vessel Capability

Eric Beckjord discussed the capability of the Indian Point pressure vessel with regard to the energy release by molten UO_2. With a knowledge of the energy available (H) from fuel melting he described the mechanism for transferring the energy via shock wave to the vessel walls.

Their analysis is based on 25 rod bundles, a yield stress of 40,000 psi and a vessel strength of 9300 in lb/in^3. They calculated the vessel yield point would be reached with melting of 9 bundles on the periphery of the core.

The following assumptions or information is used in their analysis.

1. Yield of vessel at core midplane is the worst case.
2. The chock wave produced is cylindrical with 1/r attenuation.
3. Molten UO_2 is dispersed in 10 mil spheres (mean particle size).
4. 20% of the initial energy (h) can be transferred to the shock wave. (limited by the vapor layer created).
5. Energy in the shock wave is transferred to the vessel wall by momentum exchange.
6. Thickness of the baffel and thermal shield is added to the vessel thickness when transferring energy.
7. 90% of energy in the shock wave is lost by geometric attenuation before it reaches the vessel wall. Only 10% of the energy in the shock wave as it arrives at the wall is available for interaction (This is only 0.2% of H).

The results of their calculations indicate that the melting of 40% of the core would be required to rupture the vessel. If one also considers the effect of the $Zr-H_2O$ reaction in conjunction with the molten UO_2 energy the amount of to produce rupture is reduced to 18-20%.

Filter Effectiveness

George Parker stated that the assumptions used by Westinghouse with respect to filter effectiveness are in general conservative. The main problem, he feels, is with the ignition of the charcoal filter beds. For this reason he believes it is important to take out the iodine by other methods before it reaches the charcoal. The use of dimisters, cooling coils and thiosulfates as proposed should be effective.

The use of sprays should be used to reduce the iodine, but at the end of spray down 10% of the elemental iodine and all of the methyl iodide will still be available.

Regarding the charcoal filter beds, Dr. Parker stressed the need for effective temperature sensing instrumentation and a means for precluding uneven flow distribution. He also stated that without effective iodine removal by the containment sprays he would be quite concerned about charcoal ignition.

The fraction of unfilterable iodine present as a result of core meltdown is difficult to determine, but Dr. Parker agreed that the 5% values chosen by the staff is a reasonable value until better results are made available. He feels that the assumptions used in the PSAR (with respect to unfilterable fraction) cannot be substantiated.

Containment Pressure

Al Collier discussed the Westinghouse model for determining the containment pressure following a loss of coolant accident. He believes that their method, the "lid" approach is better than the method outlined by Dr. Rosen, but admitted that his method had some merit. He stated that any analysis on a simplified basis still relies upon the complex model formulated by Westinghouse. He briefly described the sensitivity studies included in the PSAR Section 12. He also stressed that they believe that they are very conservative their approach and sited the following conservatisms:

1. The capture products as well as fission products are included in the decay chain and infinite operation is assumed.
2. The parabolic rate equation for the metal-water reaction is utilized.
3. A conseravitely high temperature for the SIS water is used.
4. Very conservative heat transfer coefficients are used for the containment sinks.
5. Uniform temperature of all components in the containment.

Collier continued his discussion with an energy balance at 500 and 1000 seconds assuming safeguards operating on auxiliary power. He showed that the pressures at these times are well below the containment design value.

In addition to the topics listed above, a great deal of time was spent discussing the recirculation loop. The details of the loop design were considered with emphasis on the logic of installing the system outside the containment. Several other questions were asked by the staff and will be covered in our second request for additional information.

Distribution:
R&PRSB Reading
DRL Reading
Originator: JTTelford
E. G. Case
K. Woodard
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MAY 1 8 1966

LIST OF ATTENDEES
INDIAN POINT II MEETING
May 2, 1966

R. L. Doan	DRL	W. Donham Crawford	Con Ed
E. G. Case		H. W. Dierman	
R. S. Boyd		W. J. Cahill, Jr.	
D. R. Muller		J. A. Prestele	
P. E. Norian		Merril Evsenbud	
C. Allen			
M. Rosen			
K. Woodard			
J. Telford		J. F. Proctor	NOL
		Norman Moseley	CO
E. Beckjord	WAPD		
H. L. Russo			
James Moore		C. Roger McCullough	SNE
John M. Gallagher		G. M. Brown	
Robert J. French			
A. R. Collier			
R. G. Hobson			
D. E. Thorn			
W. F. Schmauss			
R. C. Nichols			
J. G. Russell			
P. M. Wood			
G. W. Parker	ORNL		
S. B. Barnes	United Engineers		
R. O. Imboff			
E. B. Thomas, Jr.	LeBoeuf, Lamb & Leiby		