SEP 3 1970

P. A. Morris, Director
Division of Reactor Licensing

INDIAN POINT 2 - DOCKET NO. 50-247

The enclosed review is submitted for inclusion in your report to the ACRS.

Original signed by
E. G. Case

Edson G. Case, Director
Division of Reactor Standards

Enclosure:
Indian Point 2 - Review

cc w/encl:
R. C. DeYoung, DRL
D. Muller, DRL
K. Kniel, DRL

Distribution:
Suppl
DR Reading
DRS Reading
SPB Reading
bcc: R. Colmar
M. Rosen
E. Case

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SURNAME ▶	Colmar:kjb	Rosen	Case			
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INDIAN POINT 2 LOCA-ECCS ANALYSIS

The staff has completed its evaluation of the LOCA-ECCS analysis for the Indian Point 2 reactor plant. This plant was originally analyzed with the FLASH-1 hydraulics code which is a three-node representation of the entire reactor system. In this code the core is not identified explicitly but instead is lumped together in a common node with other parts of the reactor system. The output of FLASH-1 is then introduced into LOCTA, the Westinghouse transient digital computer program used to evaluate the fuel and clad temperature history during the LOCA. Since the three-node representation of FLASH-1 is too gross to provide a definitive analysis of the core, the significance of the calculated results is therefore questionable.

Subsequent to the analysis presented in the FSAR based on FLASH-1, Westinghouse developed and described a new multinode hydraulics code called SATAN in a proprietary document, WCAP 7422-L. This new code represented a significant advance in the hydraulic analysis of the reactor system during the LOCA. SATAN has the capability of representing the reactor system with one broken loop and one intact loop, as well as representing "special" elements such as the pressurizer, the core, and the accumulators. The system can be represented with as many as 96 nodes with 2 nodes for the core region. This capability permits the development of considerable detail in the system analysis and leads to greatly increased insight into system performance. The increased ability to calculate flow distributions with SATAN tends to increase the confidence in calculations for the LOCA over those resulting from use of the FLASH-1 type of hydraulic codes.

In its review of the Indian Point 2 analysis presented in WCAP 7422-L, the staff improved its general understanding of the system behavior and was able to point out various inconsistencies and apparent errors in the Indian Point analysis in that document, both for the analysis with FLASH-1 as well as with SATAN. Following several meetings with Westinghouse, these points were clarified and a re-evaluation of the Indian Point 2 plant to supersede the analysis in WCAP 7422-L was prepared by Westinghouse. A summary of this re-evaluation is presented in supplements 12 and 13 to the Indian Point 2 FSAR. A maximum peak clad temperature of 2015°F is predicted for the double-ended cold leg break based on a comprehensive SATAN-LOCTA analysis of the break spectrum for the Indian Point 2 reactor system at a power rating of 2758 MWt.

In order to assess the significance of such results calculated by these current techniques, it is useful to consider the bases for the calculational methods. The construction of the analysis represented by the SATAN-LOCTA codes relies on a formulation of interrelated models to characterize the blowdown hydraulics, the blowdown heat transfer, and the reflooding phase of the LOCA. At present these models require assumptions regarding the transient heat transfer and hydraulic behavior of two-phase fluid as well as a proper characterization of the system geometry with flow resistances, friction losses, and pressure drop to identify the significant flow paths and possible bypassing of flow. The complexity of the model is further complicated by the coupling effects that exist between phenomena such as heat transfer and hydraulics at any point in time, as well as for the probably non-linear time-dependence of significant parameters. As a consequence it is not always clear that a choice of parameter or assumption which would appear conservative in a local segment of the analysis will propagate through the total calculation as a conservative influence in the final calculation of clad temperature, nor is it easy to estimate the magnitude of this influence. Experimental confirmation or support of various aspects of the model has been accomplished with varying degrees of completion, with the FLECHT data representing perhaps the most complete program applicable to the reflooding phase. The hydraulic model has also been compared to available blowdown data and agreement with pressure decay and residual water mass in the vessel is reasonably good. However, agreement with these parameters is a necessary but not sufficient test of the model since these parameters do not uniquely identify local flow conditions in the core. Therefore, the hydraulic codes cannot be considered as having been verified yet in a completely definitively way.

The final output of the SATAN code analysis is estimated core flow while the information required in a detailed LOCA analysis is the local core flow. Since the core is simply noded and the analysis is one-dimensional, an average core flow is all that can be calculated by SATAN. Inasmuch as this calculated flow is the result of a large number of interrelated variables and assumptions with associated uncertainties, the code output may be reasonably regarded as a mean value within some uncertainty limits. Further, the core flow from SATAN with the implied "error" band is fed into the LOCTA code which embodies the heat transfer model with its own uncertainties and approximations so that the final calculated clad temperature history from SATAN-LOCTA may be regarded as a mean value within some uncertainty band. The extent of this uncertainty band in the calculated clad temperature as well as the probability that the temperature may be higher or lower is not known at present. Therefore, since a comprehensive sensitivity study with sufficient detail has not been presented anywhere at this time, it would appear that, in general, the results from the SATAN-LOCTA analyses should be regarded as best estimate calculations rather than limiting or upper bound calculations unless expert judgment can be invoked to the contrary. In addition, the heat transfer model (LOCTA as well as the limited model included in SATAN) is based on existing steady-state data, but it is not clear that these relationships and the basis for the selection of parameters, such as mass velocity and hydraulic diameter, are appropriate or conservatively limiting for the transient two-phase phenomenon which is being represented.

Notwithstanding these general limitations, these current methods of analysis represent a significant advance over the FLASH-1 generation of blowdown analysis methods. In our opinion, the present calculational method as represented by the SATAN-LOCTA code combination provides a reasonable basis for establishing estimates of performance and insight into the complex dynamics in the loss-of-coolant accident. Further, it is noteworthy that a simple calculation indicates that a constant film coefficient as low as 75 to 100 BTU/hr/ft^2/°F with a sink temperature of

1200°F is all that is necessary to turn the peak clad temperature around below 2300°F. Such an order-of-magnitude calculation tends to reflect a limit on the magnitude of the generalized uncertainties discussed above.

A similar issue regarding the limitations of multinode hydraulic code calculations was considered at a recent meeting at INC among members of the staff, INC representatives, and Dr. Isbin and his consultants, Messrs. Allemann and Carbiener, for the express purpose of evaluating comparable calculations for the Oconee reactor system, based on use of the RELAP code. After considering at length some of the detailed aspects of the calculation for Oconee in which several evident conservatisms were apparent, the general consensus at this meeting was that the RELAP-THETA calculations for Oconee were reasonable upper bound calculations for the peak clad temperature despite uncertainties in the calculational techniques. The peak clad temperature in this case was approximately 2365°F which was turned around in about 6 seconds by the blowdown process itself and without the benefit of the coolant injection system. This latter system served to quench the core subsequently, however.

Compared to RELAP, the SATAN hydraulic code is a somewhat more advanced calculational procedure since the core is represented by 2 nodes and the system is represented by 70 nodes in contrast to RELAP for which the representation is by 1 node and 17 nodes, respectively. Further, the calculations performed with SATAN for Indian Point were based on a limited sensitivity analysis from which a conservative combination of system parameters was selected from among those studied. In contrast, the consensus was reached on the Oconee calculations despite the lack of any sensitivity studies although some apparent conservatism was noted in the calculations. Accordingly, it would appear reasonable to conclude that a similar consensus would prevail regarding the Indian Point 2 calculations, based on SATAN-LOCTA analysis with the choice of conservative factors developed in supplement 12.

On the basis of the foregoing, it is believed with a reasonable degree of confidence that the ECCS for the Indian Point 2 reactor plant is adequate for a power rating of 2758 MWt.

D. R. Muller, DRL

RE: INDIAN POINT NO. 2 - STATUS OF CONSTRUCTION

The enclosed summary of the status of construction of the Indian Point No. 2 reactor facility is forwarded for information. This summary reflects Compliance's view as of this date.

The licensee's schedule calls for issuance of the operating license by November 23, 1970. We have planned our inspection program on the basis of this schedule.

Enclosure:
As stated

cc w/enclosure:
R. C. DeYoung, DRL
R. R. Maccary, DRS
R. H. Engelken, CO
K. Kniel, DRL
N. C. Moseley, CO:I w/o encl
F. J. Nolan, CO w/o encl

J. P. O'Reilly, CO

7421 9/3/70

OFFICE ▶	CO	CO				
SURNAME ▶	FJNolan:kbj	JPO'Reilly				
DATE ▶	9/3/70	9/3/70				

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Status of Construction

A. Status of Construction - 95% complete

1. Electrical - 90% complete

   Outstanding work includes:

   a. Complete terminations of cables
   b. Install fire stops
   c. Surviellance of cable installation

2. Mechanical - 97% complete

   Outstanding work includes:

   a. Final surface cleanup
   b. Installation of supports and restraints
   c. Completion of pipe insulation
   d. Installation of H_2 Recombiner

3. Structural - 98% complete

   Items remaining include:

   a. Closure of three construction access openings for the Containment building.
   b. Strengthening of buildings, including IP-1 stack, as required to meet siesmic requirements.

B. Status of Compliance Inspections

Major construction inspection items, including outstanding items, are as follows:

1. Table A - 75% complete

   Westinghouse has provided Con Ed with a written statement on this item. Con Ed indicated that their audit is nearly complete. Compliance has audited the efforts pertaining to the subject piping.

2. Accumulator Valve design

   Westinghouse has provided Con Ed with an evaluation relating to the acceptability of these valves. Con Ed has agreed with the Westinghouse position. Evaluation of this subject by Region I is in progress.

3. Improper stamping of Section III, Class C Vessels

   Westinghouse indicated that resolution on two tanks is pending.

4. Closure of Containment

   Audits of the Cadweld placement and rebar coverage with concrete remains.

5. Replacement of main steam flow nozzles.

6. Containment Penetration bellows

   Material compatability and weld quality. Westinghouse indicated that this packet would be in final form in ahout two weeks.

7. Review of pipe support installation and clearance evaluation.

8. Electrical

   a. Audit of electrical design review of safeguards instrument cabling.
   b. Independent review of electrical cable installation.
   c. Cable tray loading and separation barrier audit.
   d. Emergency diesel power cables lack separations.

9. Revisions to Complete, including:

   a. Cleanup of excess cable at the electrical penetration area. Also, installation of fire barriers.
   b. Construction of concrete wall between diesels and common control panel.
   c. SIS Boron tank - Installation of additional valve and change of boric tank level instrumentation.
   d. Erection of barrier between the 480 V switchgear and the instrument air compressors.
   e. Emergency diesel under voltage start from 480 volt buses.
   f. Installation of strong motion siesmograph.

C. Status of Pre-operational Testing

1. Procedure Preparation

   a. Phase I, flushing and hydrostatic testing, 100% complete.
   b. Phase II, system pre-operational and hot functional testing - 20% complete.

2. Completion Status of Testing

   a. Phase I, flushing and hydrostatic testing, 50% complete.
   b. Phase II - less than 5% complete.

D. Status of Health Physics Program

Compliance review of program - 50% complete.

E. Procedures

1. Operating procedures - in outline status. Systems descriptions - complete.

2. Emergency plan - included in the FSAR. Some questions outstanding relate to evacuation requirements.

3. Fuel load procedures - In preparation.

4. Startup testing procedures - In preparation.

5. Compliance review of procedures - 0% complete.

F. Technical Specifications

Technical specifications were recently submitted to DRL. One meeting on the subject was held August 7, 1970.

G. Items which may affect fuel loading date of November, 1970:

1. Operating engineers strike

2. ACRS review

3. Electrical design reviews and installation checkout

4. Results of pre-operational and hot functional testing