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SUBJECT: Forwards response to NRC 910305 telcon request for addl info in support of reload analysis rept covering inadvertent opening of steam generator atmospheric dump valve w/loss of offsite power & radiological consequences at site boundary.

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WILLIAM F. CONWAY
EXECUTIVE VICE PRESIDENT
NUCLEAR

161-03877-WFC/JRP
April 16, 1991

Docket No. STN 50-530

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-37
Washington, D. C. 20555

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Unit 3
Additional Information In Support of Reload Analysis Report
File: 91-056-026; 91-005-419.5

Arizona Public Service Company (APS) letter 161-03766, dated February 21, 1991, submitted to NRC the PVNGS Unit 3 Cycle 3 Technical Specification changes and corresponding Reload Analysis Report. During a telephone conversation on March 5, 1991, the NRC requested additional information regarding the inadvertent opening of a steam generator atmospheric dump valve with a loss of offsite power (IOSGADV + LOP) and the resultant radiological consequences at the site boundary.

The attachment to this letter provides the requested information.

If you should have any questions, please contact Michael E. Powell of my staff at (602) 340-4981.

Sincerely,

WFConway

WFC/JRP/pmm

Attachment

cc: J. B. Martin
D. H. Coe
C. M. Trammell
C. F. Tedford
A. C. Gehr
A. H. Gutterman

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ATTACHMENT

OBJECTIVE

The objective of this analysis is to determine the radiological consequences of an inadvertent opening of a steam generator atmospheric dump valve with a loss of offsite power (IOSGADV + LOP).

ANALYTICAL INPUTS AND ASSUMPTIONS

- Per Technical Specification 3.4.5.2, a leakage rate of 720 gallons per day through any one generator is used to assess primary to secondary leakage.

- Per Technical Specifications 3.4.5.2 and 3.7.1, the initial assumed contamination in the NSSS is,

  Primary System Iodine: 1.0 μCi/gm

  Secondary System Iodines: 0.1 μCi/gm

  Primary System Nobles: 100/E

- Per Table 15.1.4-3 in the Palo Verde Updated FSAR, at 1800 Seconds after the initiation of the event, the operators manually close the affected ADV halting all further releases from that generator, and at 3600 Seconds, the operators are directed to commence a controlled cooldown. Once established, this cooldown proceeds in accordance with Technical Specification 3.4.8.1 limits.

- Iodines associated with leakage to the affected steam generator are released to the environment with a partition factor of unity until the 30 minute manual isolation of the affected steam generator.

- Iodines associated with the unaffected steam generator are released to the environment during steaming with a partition factor of 0.1 due to the maintenance of a steam water interface.

- It is assumed that 10% of the iodine activity in the fuel pins and 10% of the non-iodine activity in the fuel pins is resident in the fuel-clad gap.

- All of the activity in the fuel-clad gap is released to the primary coolant upon cladding failure.

METHOD OF ANALYSIS

Determine the activity of the primary system based upon the initial activity as well as the contribution due to postulated fuel pin failure.

Determine the amount of this activity carried into the secondary system via primary to secondary system leakage.

Determine the release to the environment from the various release paths from the steam generators. Items included in this category are, steaming of the generators to remove core decay energy, steaming of the generators to cooldown the system, and the use of applicable iodine partition factors.

Once the releases of radioactivity to the environment are quantified, translate these releases into the radiological doses at the site boundary.

NUMBER OF FUEL RODS

The number of fuel rods used in the analysis was 57,000. The number of fuel rods in the core was calculated based upon the maximum possible number of active fuel rods in the core. There is space for 236 active fuel rods in the 16x16 fuel assembly; there are 241 fuel assemblies in the Palo Verde cores; and 236 x 241 = 56,876 (rounded to 57,000) fuel rods.

X/Q

The Atmospheric Dispersion Coefficient used in this analysis is the 5 percentile number at the site boundary. This is based on Regulatory Guide 1.145, Regulatory Position C.3 "Determination of 5% overall site X/Q value."

$X/Q = 3.1 \times 10^{-4}$ (Second/meter^3)

SUMMARY

Standard Review Plan[1] Sections 15.1.1, 15.1.2, 15.1.3 and 15.1.4 Acceptance Criteria II.2d states, "an incident of moderate frequency in combination with any single active component failure, or single operator error, should not result in loss of function of any barrier other than the fuel cladding. A limited number of fuel rod cladding perforations is acceptable."

As stated in the Unit 3 Cycle 3 Reload Analysis[2], the amount of failed fuel reported has increased for the IOSGADV + LOP from 8% to 12%. The two hour site boundary doses associated with failure of 12% of the pins during an IOSGADV + LOP after a turbine trip is 228 Rem Thyroid and 2 Rem Whole Body.

[1] Standard Review Plan NUREG-075/085, dated 11/24/75

[2] Unit 3 Cycle 3 Reload Analysis Report, 161-03766, dated February 21, 1991

Noting that the resultant dose is greater than a "small fraction" of 10 CFR 100, a separate analysis was performed using the statistical convolution method to more realistically evaluate the amount of fuel failure associated with the event. The statistical convolution method is used to evaluate fuel failure for other events analyzed on the PVNGS docket, including locked rotor, sheared shaft and CEA ejection.

In the deterministic method of predicting fuel pin failure, calculations are performed to determine the pin radial peaks integrated radial flux which would result in the DNBR limit being reached. Any fuel pin whose pin radial peaks are greater than the calculated value would have a DNBR less than the limit (i.e., 1.24 for Palo Verde) and, applying extreme conservatism, would assume to be failed. The total amount of fuel failure would then be determined by summing (i.e., pin census) those fuel pins which exceeded the minimum threshold value of radial peak.

The statistical convolution of DNB takes the probability of failure into account when determining fuel failure percentages. The DNBR limit is based on a 95% confidence level with 95% probability that fuel failure will not occur. If a pin were at the DNBR limit, there is only a 5% probability that the pin will fail. The convolution methodology considers these aspects, and thus there is not a fixed "fail/no fail" value of DNBR.

The DNBR is calculated for a range of pin radial peaks which bracket the normal DNBR limit. The probability of DNB versus DNBR is conservatively applied to the pin census on a radial peak interval basis to determine the amount of fuel failure. The result is still conservative but more realistic.

> The NRC staff has reviewed similar analyses[3] and stated that, "Fuel damage is conservatively assumed whenever a fuel rod experiences DNB for even a short time. Therefore, the amount of fuel damage can be determined from the number of fuel rods experiencing DNB, which is proposed to be calculated by statistical convolution techniques. The procedure is to group fuel rods with respect to radial peaking factors; calculate the minimum DNBR in each radial peaking group; and determine the probability of experiencing DNB corresponding to a DNBR value. The number of fuel rods damaged within a radial peaking group is the multiplication of the number of fuel rods in the group by the probability of experiencing DNB associated with the corresponding DNBR. Summing up all radial peaking groups yields the total number of fuel rods damaged. This convolution technique is a deviation from the approach described in the standard review plan, where fuel damage is assumed whenever the DNBR is calculated to fall below the minimum DNBR criteria imposed as a Specified Acceptable Fuel Design Limit (SAFDL). However, the SAFDL DNBR limit is defined such that there is 95% probability with 95% confidence level that the fuel rod will not experience DNB whenever the DNBR is above the limit. In other words, when DNBR is at the SAFDL DNBR limit, there is only 5% probability with 95% confidence that DNB will occur. Since experimental evidence indicates that fuel cladding failure is not necessarily coincident with a short duration of

3 Topical Report Evaluation, CENPD-183, Loss of Flow

DNB, we conclude that the statistical convolution technique is conservative and acceptable provided that the probability distribution for DNB is acceptable."

The CE-1 correlation in predicting DNB was developed from data obtained with electrically-heated rod bundles. The CE-1 DNBR SAFDL provides at least a 95 percent probability of not having DNB, at the 95 percent confidence level. Thus, a pin at the DNB SAFDL has only a 5% probability of failure or if 100 pins are slightly below the DNB SAFDL only 5 would be predicted to fail.

The assumption that fuel failure occurs upon DNB is highly conservative. The event in question is calculated to have fuel pins in DNB for only a few seconds, with peak cladding temperature and differential pressure well below that which would lead to clad failure. Data presented in support of the CE-1 correlation and produced at the Power Burst Facility, Argonne National Laboratory, and several foreign reactors, clearly indicate that these conditions do not produce cladding failure.

The resultant offsite dose for the IOSGADV + LOP, using the statistical convolution method, is 30 Rem Thyroid, which is a "small fraction" of the 10 CFR 100 limits.