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SUBJECT: Forwards interim rept, "Guide lines for Determination of Extent of Core Damage" to be implemented at facilities. Rept submitted in response to post-TMI requirements covering post-accident sampling sys.

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FLORIDA POWER & LIGHT COMPANY

July 8, 1983
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Office of Nuclear Reactor Regulation
Attention: Mr. Steven A. Varga, Chief
Operating Reactors Branch #1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Varga:

Re: Turkey Point Units 3 & 4
Docket Nos. 50-250 & 50-251
Post-TMI Requirements
Post Accident Sampling System
Interim Core Damage Assessment Guidelines

Enclosed for your information is a copy of the interim "Guidelines for the Determination of Extent of Core Damage" that are to be implemented at Turkey Point Units 3 and 4.

Very truly yours,

Jack E. Vessel for

Robert E. Uhrig
Vice President
Advanced Systems & Technology

REU/PKG/js

Attachment

c: J. P. O'Reilly, Region II
Harold F. Reis, Esquire

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GUIDELINES FOR THE DETERMINATION OF EXTENT OF CORE DAMAGE

I. The purpose of this document is to provide engineering guidelines for the assessment of core damage subsequent to a severe accident. Alternatively, these guidelines may be used to provide aid in the determination of degree of fuel failure during normal operation. (These guidelines are provided on an interim basis pending the completion of the Westinghouse Owners Group generic guidelines.)

II. The basis of this core damage assessment is radiochemical analysis of primary coolant samples and/or containment sump samples..

I-131 has been chosen as the primary indicator. Its behavior is fairly well understood and due to thyroid dose concerns, is assayed for during normal as well as accident conditions. Other indicators should be integrated into the damage assessment as good engineering judgement dictates. These other indicators may include (but not be limited to) Containment High Range Radiation Monitor, Core Exit Thermocouples, Inadequate Core Cooling Monitor and containment hydrogen monitor.

The Nuclear Regulatory Commission has established four categories of fuel condition:

1. No damage
2. Clad damage
3. Fuel overheat
4. Fuel melt

The latter three should be further subdivided (as well as reasonably achievable) into three levels of (1) less than 10%, (2) greater than 10% but less than 50%, and (3) greater than 50% of fuel affected at that level. It should be noted that contradictory or overlapping indication may be observed and best estimate engineering judgment should be used.

These guidelines are provided for use by engineering personnel at such time as post accident sampling data becomes available. However, the completion of this assessment shall not be allowed to interfere with emergency response measures either at the plant or at any off-site facility.

III. Several parameters have the potential to seriously affect the data to be interpreted under these guidelines.

1. Corrections must be made to account for losses and gains to primary coolant inventory. Performance of Appendix A or equivalent methodology will account for this.

2. The second parameter of importance is a power history correction. The use of 100% power, equilibrium values as default values will have the effect of causing an underestimation of core damage in the event that sustained low power operation has occurred within the 30 days prior to an accident. The same logic applies in the event that an accident should occur shortly following return to power subsequent to refueling. This is denoted as C_P.

The performance of Appendix B or alternative calculations will correct this problem. In the event nominal 100% reactor power has been sustained for the previous 30 days, 100% power equilibrium core inventory values should be utilized.

3. The third correction of importance is that for the phenomenon of iodine spike. Historical data for similar power excursions (e.g. turbine runback, trip from 100% power, etc.) should be applied as applicable. Caution should again be exercised in that use of data for trip from 100% equilibrium will have the affect of causing an underestimate of damage in instances where such equilibrium has not been attained. Radiochemistry history should be employed for this correction, and it will be denoted as C_S.

4. The fourth correction which may be of importance is that for radioiodine decay between time of reactor shutdown (or power change) and time of assay. This correction will be made as per standard nuclear chemistry procedures and established methodology. This is denoted as C_D.

IV. The following assumption should be employed unless contraindicated.

1. Uniform mixing of the primary coolant such that:

$$\text{Failed Fuel} = \left[\left[\frac{\text{Concentration}}{\text{Unit Volume}} \times C_{D_1}\right] - \left[C_S \times C_{D_2}\right]\right] \times C_p \times \text{Volume} \div I_{100\%}$$

$\frac{\text{Concentration}}{\text{Unit Volume}}$	From Post Accident Sampling System Data
C_p	Power Correction
C_S	From Radiochemistry History
C_{D_1}	Activity Correction to Time of Sampling
C_{D_2}	Activity Correction to Time of Power Change
Volume	From Appendix A
$I_{100\%}$	100% Equilibrium I-131 Inventory in Core (57.7×10^6 curies)

$$C_{D_1}, C_{D_2} = \frac{1}{e^{-\lambda t}}$$

V. Consideration of balance of plant parameters should now be performed in light of the calculation just concluded. Table 1 identifies parameters which may be used in conjunction with the failure data just calculated to categorize the extent of fuel damage. The following is a sample calculation of core fraction I-131 released and an interpretation of ancillary data to make this determination.

Example

Unit 3 operated at 50% power for 2 weeks due to 'A' steam generator feed pump being out of service. After repair, the unit was returned to power and operated there for 2 weeks when a PORV went open, the block valves could not be closed and a reactor trip was experienced due to low pressurizer pressure. The PORV had the effect of creating a small break LOCA which resulted in the following:

1) Reactor/Turbine Trip

2) Core uncovery for approximately 1 minute

3) I-131 concentration of 1000 µCi/ml for sample taken 4 hours after core uncovery

4) Conditions at time of sampling: RCS full, PRZ 1%, accumulators full, gallons from S.I. 30,000 estimated losses (excluding PRZ) 30,000 gallons

5) CHRRM shows 1000 R

6) One Core Exit Thermocouple indicated 2800°F while core was exposed

In addition, the following data was obtained from the Radiochemist:

1) Previous I-131 concentration .5 µCi/ml

2) Radiochemist reports I-131 spike penalty of 40 x normal for trip from 100% power

The following calculations would then be performed.

Appendix A

RCS Volume	+60,160
PRZ Volume	+ 100
SI Volume	+30,000
Estimated Losses	-30,000
Water Inventory	60,260 gallons

$$60{,}260 \times \frac{3785 \text{ ml}}{\text{gallon}} = 2.280841 \times 10^8 \text{ ml}$$

Appendix B

$$Cp = \frac{100}{50(1 - e^{-(.0864)(14)})(e^{-(.0864)(14)}) + .100(1 - e^{-(.0864)(14)})(e^{-(.0864)(.16)})}$$

$$Cp = 1.255$$

Substitution into the formula of Section IV yields:

$$\left(\frac{1000 \times 10^{-6}\text{Ci}}{\text{ml}}\right) \times \frac{1}{e^{-(.0864)(.16)}} - \frac{(40 \times .5) \times 10^{-6}\text{Ci}}{\text{ml}} \times \frac{1}{e^{-(.0864)(.16)}} \times 1.255 \times \frac{(2.280841 \times 10^8)}{57.7 \times 10^6}$$

= .0049

= .5% Failed Fuel

The initial conditions showed a .5 µ Ci/ml I-131 concentration which is indicative of some small amount of fuel failure, pin-hole leaks, hydriding, etc. The .5% failed fuel is, on the other hand, reflective of gross failure of pins as a direct result of the transient.

Consideration of the other parameters show all remaining indicators in the range of Clad Damage, whith the exception of the single Core Exit Thermocouple reading. After reviewing the balance-of-plant parameters, sound engineering judgement would dictate that this reading be discarded as erroneous or not reflecting conditions properly. Thus, the determination of < 10% Clad Damage would be made.

APPENDIX A

PRIMARY COLANT VOLUME CORRECTION

I. PASS System Data Available Prior to Recirculation Phase

1.	Reactor Coolant System Volume (No Pressurizer)		_______ gal
2.	Pressurizer Level _____% (97gallons/%)		_______ gal
3.	Accumulators Discharged (Yes, No)	Volume	_______ gal
4.	SI/RHR (Yes, No)	Injected Volume	_______ gal
5.	Boric Acid Storage Tank Contribution (Yes, No)	Volume	_______ gal
6.	For LOCA or Steam Generator Tube Rupture: Estimate of Water Loss		_______ gal
7.	Miscellaneous Losses (Waste, Processing, Etc.)		_______ gal
	Total Inventory Under Consideration		_______ gal

II. PASS System Data Available After Commencement of Recirculation

1.	Reactor Coolant System Volume (No Pressurizer).	_______ gal
2.	Pressurizer Level _____% (97gallons/%)	_______ gal
3.	Accumulator Volume	_______ gal
4.	SI/RHR/Containment Spray Addition	_______ gal
5.	Boric Acid Storage Tank Contribution	_______ gal
6.	For Steam Generator Tube Rupture, Losses	_______ gal
7.	Miscellaneous Losses (Waste, Processing, Etc.)	_______ gal
	Total Inventory Under Consideration	_______ gal

APPENDIX B

POWER HISTORY CORRECTION

I. For sustained reduced power operation prior to accident ($\leq$ 30 days)

$$C_p = \frac{100\%\ \text{Power}}{\text{Average Power for Previous 30 Days}}$$

C_p = Power correction (This is a multiplication factor to be applied to 100% power based estimate of core damage)

II. For load follow or varied power history prior to accident (previous 30 days)

$$C_p = \frac{100\%\ \text{Power}}{\sum_{i,j=1}^{n} P_i(1 - e^{-\lambda t_i})(e^{-\lambda t_j})}$$

C_p = Power correction (multiplication factor)

P_i = Previous average powers for the periods t_i

λ = Decay constant of I-131 = .0864/day

P_j = Established power prior to accident for time t_j

t_i = Period (in days) at Power P_i

t_j = Period (in days) since change to P_{i+1}

TABLE 1

CORE DAMAGE INDICATORS

		CHARACTERISTIC ISOTOPES	CORE EXIT TC TEMP(°F)	R-20	INADEQUATE CORE COOLING	CHRRM
1)	No Damage	Normal Chemistry	<800°*	Normal	No Uncovery	Normal
2)	Clad Damage	Increased Xe, Kr, I	1000°-2000°*	Alarming	Possible Short-Term Uncovery	Increased to Greater Than 100 x Normal But Less Than 10,000 R**
3)	Fuel Overheat	Te, Sr, Ba	2000°-3000°*	Alarming	Sustained Core Uncovery (>2 minutes)	>10,000 R**
4)	Fuel Melt	Ce, La	>3500°*	Alarming	Sustained Core Uncovery	>100,000 R**

* Steam Blanketing
** Within first 5 hours following core recovery