Form 34731 (10-81)
(Formerly SPD-1002-1)

DUKE POWER COMPANY
PROCEDURE PREPARATION
PROCESS RECORD

(1) ID No: AP/0/A/5500/31
Change(s) 0 to 3 Incorporated

(2) STATION: Catawba

(3) PROCEDURE TITLE: Estimate of Failed Fuel Based on I-131 Concentration

(4) PREPARED BY: [signature] DATE: 2/14/84

(5) REVIEWED BY: Dennis Robinson DATE: 2/14/84

Cross-Disciplinary Review By: ____________ N/R: DMR

(6) TEMPORARY APPROVAL (IF NECESSARY):

By: ____________ (SRO) Date: ____________

By: ____________ Date: ____________

(7) APPROVED BY: [signature] Date: 2/14/84

(8) MISCELLANEOUS:

Reviewed/Approved By: ____________ Date: ____________

Reviewed/Approved By: ____________ Date: ____________

FOR INFORMATION ONLY

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A. PURPOSE

The purpose of this procedure is to provide a means of determining the quantity of failed fuel based on I-131 Concentration in the NC System.

B. SYMPTOMS

1. Any of the following EMF's in alarm:

   a. 1EMF48 "Reactor Coolant Monitor"
   b. 1EMF18 "Reactor Coolant Filter 1A"
   c. 1EMF19 "Reactor Coolant Filter 1B"

2. Any condition in which the operator suspects failed fuel or want an estimate of the amount of failed fuel.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

C. IMMEDIATE ACTIONS

_____ 1. Have Chemistry Obtain A Sample Of The NC System Coolant and determine temperature of sample and time sample was drawn.

_____ 2. If, as a result of a LOCA, the containment sump level is not zero and ND pumps are taking suction from the sump (i.e. unit is in recirc mode) then request the following:

A) Have Chemistry obtain a sample from the ND System (i.e. sump) and determine the time the sample was drawn; and

B) Have Health Physics draw a containment air sample and determine the time the sample was drawn.

D. SUBSEQUENT ACTIONS

_____ 1. Have Health Physics analyze the samples for isotopic content and concentration.

_____ 2. Record sample concentrations and conditions on Enclosures 1 (NC Sample), Enclosure 2 (ND Sample), and Enclosure 3 (Containment Air Sample) as appropriate.

_____ 3. If I-131 Concentration Is Greater Than 300 μCi/ml, Refer To RP/1/A/5000/01 (EMERGENCY CLASS DETERMINATION).

_____ 4. Calculate the density and inventory correction factors (X and Y) from Enclosure 4.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

____ 5. If the unit is in a normal operational mode and no suspected mechanically induced failure (e.g. loose part) has occurred, then go to 12.

____ 6. If safety injection has occurred then calculate the dilution factor Z from Enclosure 5. If this is not the case, then assume Z = 1.0.

____ 7. Compute the corrected concentrations of the analyzed isotopes by completing Enclosure 6.

____ 8. If cladding damage is suspected due to an abnormal transient or mechanically induced failure and:

A) the corrected concentrations of Xe and/or Kr exceed the limits specified in Enclosure 6; and
B) the corrected concentrations of I and Cs do not exceed the limits specified in Enclosure 6; and
C) incore thermocouples have not ever exceeded 700°F; and
D) RVLIS indicates no core uncovery; and
E) no excess hydrogen is detected, then go to 14.

____ 9. If some fuel overheating is suspected as a result of observing several of the following conditions:

A) RVLIS indicates partial core uncovery (<55% level) for a short period of time (<~ 30 minutes);
B) incore thermocouples have read >750°F;

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

C) Cs concentration exceeds the limit in Enclosure 6;
D) Te and Ba concentrations do not exceed the limits in Enclosure 6; or
E) excess hydrogen is detected, then go to 17.

____ 10. If some fuel melting is suspected as a results of observing several of the following conditions:

A) RVLIS indicates a severe case of core uncovery;
B) incore thermocouples have read >1100°F;
C) Te and Ba concentrations exceed the limits in Enclosure 6; or
D) excess hydrogen is detected, then go to 20.

____ 11. If none of the previous sets of conditions is met exactly (e.g. concentration vs. limit comparison is contradictory with other indications) then go to 14, 17 or 20; whichever is determined most appropriate.

____ 12. Calculate the amount of failed fuel present during normal operation using the following:

Percent Failed Fuel = Measured NC I-131 Concentration (μCi/ml) (Enclosure 1) · X · Y ÷ 1.8 μCi/ml%

______ % = ________________ · ___ · ___ ÷ 1.8

Number of Failed Pins = Percent Failed Fuel · 509.5 pins/%

______ pins = __________ · 509.5

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED

NOTE: Iodine spiking may occur as a result of normal operational transients. This may lead to a 2 - 10 times increase in I-131 concentration while no increase in cladding damage had occurred.

____ 13. Go To 21.

____ 14. Calculate the amount of failed fuel due to clad damage using the following:

Percent Failed Fuel = Corrected I-131 Concentration (μCi/ml) (Enclosure 6) • Y ÷ 47.6 μCi/ml%

_______% = ___________________ • __ ÷ 47.6

____ 15. If percent failed fuel exceeds 100%, then assume that some overtemperature damage has occurred and go to 17.

____ 16. Go to 21.

____ 17. Calculate the amount of failed fuel due to overtemperature conditions using the following:

Percent Failed Fuel = Corrected I-131 Concentration (μCi/ml) (Enclosure 6) • Y ÷ 1535 μCi/ml%

________ % = ___________________ • ___ ÷ 1535

____ 18. If any of the conditions listed in Step 10 are approached and the calculated overtemperature failed fuel percent is large or is >100% then suspect that some fuel melting has occurred and go to 20.

ACTION/EXPECTED RESPONSE	RESPONSE NOT OBTAINED
____ 19. Go to 21.	
____ 20. Calculate the maximum estimated amount of failed fuel due to melting by using the following:	

Percent Failed Fuel = Corrected I-131 Concentration (µCi/ml) (Enclosure 6) • Y ÷ 2790 µCi/ml%

________ % = ____________________ • ___ ÷ 2790

NOTE: Some of the I-131 is due to fuel clad damage and overtemperature conditions. The Reactor Engineer should examine other indicators of Fuel Melting (such as Te and Ba concentrations) in order to refine the estimate.

____ 21. Refer To Tech Spec 3.4.8 And Ensure I-131 Activity Is Within Guidelines.	a. Refer to appropriate Tech Spec Action Statement.
____ 22. Inform The Shift Supervisor And Performance Section Duty Engineer Of The Results Of This Procedure. The Reactor Engineer will review the results in order to refine the estimates made in this procedure.	

-END-

NC System Sample

Sample Time _______ Analysis Time _______

Sample Temperature _______ °F NC Loop Sampled _______

Isotope	Measured Concentration (μCi/ml)
I-131	________________
Kr-87	________________
Xe-133	________________
Cs-134	________________
Te-132	________________
Ba-140	________________
Hydrogen	________________
Additional:	
_______	________________
_______	________________
_______	________________

ND (Sump) Sample

Sample Time ________ Analysis Time ________

Sample Temperature ________ °F ND Loop Sampled ________

Isotope	Measured Concentration (μCi/ml)
I-131	________
Kr-87	________
Xe-133	________
Cs-134	________
Te-132	________
Ba-140	________

Additional:

________	________
________	________
________	________

Containment Air Sample

Sample Time ________ Analysis Time ________

Temperature ________°F Pressure ________ psig

Isotope	Measured Concentration (μCi/ml)
I-131	________
Kr-87	________
Xe-133	________
Hydrogen	________
Additional:	
________	________
________	________
________	________

1. X Determination

NC SAMPLE TEMPERATURE °F

NC System Temperature °F	80	90	100
100	.996	.998	1.00
150	.983	.985	.987
200	.966	.968	.970
250	.945	.947	.949
300	.921	.923	.924
350	.894	.895	.897
400	.862	.864	.865
450	.827	.828	.830
500	.787	.788	.790
550	.739	.740	.741
560	.728	.729	.731
570	.717	.718	.719
580	.706	.708	.708
590	.693	.694	.695
600	.680	.681	.683

NOTE: Assume NC Sample Temperature Is 90°F If This Information Is Not Available.

X = ____________

2. Y Determination

If power change is less than 10% within 22 days

$$Y = \frac{100}{\%\ \text{F.P. at time of failure}} = \frac{100}{(\quad)} = \_\_\_\_\_\_$$

Other times

$$Y = \frac{100}{OP(e^{-t\lambda}) + NP(1 - e^{-t\lambda})} = \_\_\_\_\_\_$$

Where

Y = Correction Factor

OP = The % Full Power Before The Power Change

NP = The % Full Power After The Power Change At Which Time The Fuel Failure Has Occurred

λ = Decay Constant For I-131 --- 0.0864 day^{-1}

t = One Half The Time To Make The Power Change Plus The Time After The Power Change Until Damage Is Suspected. (In Days)

i.e. 2 Hours For Power Change And 16 Hours To Damage.

$t = \frac{2}{2} + 16 = 17$ Hours = .708 Days

Z (Dilution Factor) Determination

1. If the NC System has remained pressurized and no safety injection has occurred then Z = 1.0.

2. If safety injection has occurred but recirc from the containment sump is not occurring then perform the following:

   a) Determine the amount of injection flow:

      Initial FWST level (%) prior to injection = ________ %

      FWST level (%) at Sample Time = ________ %

      % Level Change = Initial - Final Level
      ________% = ________% - ________%

      Gallons injected = [(% Level Change · 3.76)+ 15.42] · 10^3 gal.

      (1) ________ gal. = [(__________ · 3.76)+ 15.42] · 10^3 gal.

   b) Add any accumulator injection flow

      If NC pressure has remained above 1240 psig:

      (2) Accumulator Volume = 0 gal.

      If NC pressure has dropped below 1240 psig but remained above 450 psig:

      (2) Accumulator Volume = 13400 gal.

      If NC pressure has not remained above 450 psig:

      (2) Accumulator Volume = 43400 gal.

   c) Calculate Z:

      Z = 1 + Total injected flow ÷ NC Volume

      Z = 1 + [(1) + (2)] ÷ 92000 gal.

      ___ = 1 + [_____ + _____] ÷ 92000 gal.

3. If safety injection has occurred and recirc is occurring from the containment sump then perform the following:

a) Determine the volume of coolant in the containment sump:

Sump Level at Sample Time = _________ Ft.

If Sump Level is <10 Ft. then:

Sump Volume = [Level (Ft) • 50. + 40.] • 10^3 gal.

(3) __________ gal. = [________ Ft.• 50. + 40.] • 10^3 gal.

If Sump Level is >10 Ft. refer to Curve 7.31 in the Unit One Data Book (OP/1/A/6700/01) or the appropriate curve in Unit Two Data Book (OP/2/A/6700/01) to obtain Sump Volume:

(3) __________ gal.

b) Evaluate the ratio of concentrations:

Concentration ratio = 1.0 if ND Sample is not available.

Concentration Ratio = Measured ND I-131 Concentration (uCi/ml) ÷ X ÷ Measured NC I-131 Concentration (uCi/ml)

(4) _________ = ______________ ÷ ___ ÷ ______________

c) Calculate Z:

$$Z = 1.0 + \frac{\text{Sump Volume} \cdot \text{Concentration Ratio}}{\text{NC Volume}}$$

Z = 1.0 + [(3) • (4)] ÷ 92000 gal.

__ = 1.0 + [______ • ______] ÷ 92000 gal.

1. Dilution corrected concentrations:

Assume dilution Factor Z is a constant for all isotopes.

Dilution Corrected Concentration (μCi/ml) = Measured NC Concentration (μCi/ml) (Enclosure 1) • Z (Enclosure 5)

Isotope	Measured NC Concentration (μCi/ml)	•	Z	=	Dilution Corrected Concentration (μCi/ml)
I-131	______		__		______
Kr-87	______		__		______
Xe-133	______		__		______
Cs-134	______		__		______
Te-132	______		__		______
Ba-140	______		__		______
____	______		__		______
____	______		__		______
____	______		__		______

NOTE: Individual Z Factors may be calculated for each isotope using the method of Enclosure 5, if desired. In this manner, an improved estimate of Z may be obtained.

2. Density corrected concentrations:

Density Corrected Concentration (μCi/ml) = Dilution Corrected Concentration (μCi/ml) • X (Enclosure 4)

Isotope	Dilution Corrected Concentration (μCi/ml)	•	X	=	Density Corrected Concentration (μCi/ml)
I-131	______		__		______
Kr-87	______		__		______
Xe-133	______		__		______
Cs-134	______		__		______
Te-132	______		__		______
Ba-140	______		__		______
____	______		__		______
____	______		__		______
____	______		__		______

3. Airborne activity corrected concentrations:

Concentrations = 0.0 if no containment air sample is available.

Volume Correction Factor = $\frac{\text{Containment Volume}}{\text{NC Volume}}$ = 97.

Corrected Airborne Concentration (μCi/ml) = Containment Air Concentration (μCi/ml) (Enclosure 3) • 97.

Isotope	Containment Air Concentration (μCi/ml)	•	97.	=	Corrected Airborne Concentration (μCi/ml)
I-131	______		97.		______
Kr-87	______		97.		______
Xe-133	______		97.		______
Cs-134	0.		97.		0.
Te-132	0.		97.		0.
Ba-140	0.		97.		0.
______	______		97.		______
______	______		97.		______
______	______		97.		______

4. Final corrected concentrations:

The corrected concentration is the sum of the density corrected and airborne concentrations.

Isotope	Density Corrected Concentration (μCi/ml)	+ Corrected Airborne Concentration (μCi/ml)	= Corrected Concentration (μCi/ml)
I-131	________	________	________
Kr-87	________	________	________
Xe-133	________	________	________
Cs-134	________	0.	________
Te-132	________	0.	________
Ba-140	________	0.	________
____	________	________	________
____	________	________	________
____	________	________	________

NOTE: No correction for decay has been included. A decay correction should be factored in if elapsed time from transient to analysis exceeds 2 days. In the case of Kr-87 (76 min. half-life), apply a decay correction after 2 hours.

5. Comparison with concentration limits:

Concentration Limit Fraction = Corrected Concentration ÷ Limit Concentration

Isotope	Corrected Concentration (μCi/ml)	÷ Limit Concentration (μCi/ml)	= Concentration Limit Fraction
I-131		4700.	
Kr-87		1.0	
Xe-133		5.0	
Cs-134		300.	
Te-132		300.	
Ba-140		1000.	

NOTE: Limit for Kr-87 includes provision for a 1 - 2 hour sampling and analysis delay.