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BZP 380-19
Revision 2

Core Damage Assessment
(Primary Responsibility - Rad/Chem Director)

A. STATEMENT OF APPLICABILITY:

This procedure provides a method to classify and estimate the extent of core damage through measurement of fission products released to the coolant together with auxiliary measurements of core exit thermocouple temperature, water level within the pressure vessel, containment radiation monitors and containment atmosphere hydrogen monitors.

B. REFERENCES:

1. Westinghouse Owner Group Post Accident Core Damage Methodology, Revision 1, Mar 84

C. MAIN BODY:

1. Sample as follows:

   a. Request samples of reactor coolant, containment atmosphere, and containment sump as indicated in BZP 380-A8, "Core Damage Assessment Working Tables", page 1, "Selected Sampling Locations".

   b. Request isotopic analysis of samples drawn with no decay correction applied to sample activities.

2. Evaluation of sample results and selection of nuclides for assessment.

   a. Compare the nuclides found in the isotopic analysis report to those nuclides representing each category of damage in BZP 380-A8, page 8, "Selected Nuclides for Core Damage Assessment."

   b. Determine the maximum extent of fuel damage as indicated by the fission products present in samples.

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* NOTE *
* An upper bound of the extent of fuel damage can be *
* ascertained if indicating nuclides from a given damage *
* category are found lacking in samples. A lack of indicating *
* nuclides from a given category should be interpreted as an *
* indication that the fuel degradation had not significantly *
* progressed into that category of damage. *
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* NOTE *
* Not all indicating nuclides identified in the sample *
* analysis report are required for this assessment however a *
* better overall assessment is made when several nuclides are *
* used. An attempt should be made to include nuclides *
* representing each category of damage that is exhibited. *
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c. Complete BZP 380-T4 page 1, "RCS Activity Worksheet", as follows:

1) Record in column 3, the specific activity of nuclides to be used in the assessment from Chemistry sample activity report.

2) Record elapsed time from reactor shutdown to sample count in column 2.

3) Determine and record in column 4 the ingrowth and decay correction factors for each nuclide from BZP 380-A8 page 10.

4) Multiply the measured specific activity (column 3) by the decay correction factor (column 4) to obtain the corrected specific activity. Record in column 5.

d. Complete BZP 380-T4, page 2, "Containment Atmosphere Activity Worksheet", as follows:

1) Record in column 3 the specific activity of nuclides to be used in the assessment from the Chemistry sample activity report.

2) Record elapsed time from reactor shutdown to sample count in column 2.

3) Determine and record in column 4 the ingrowth and decay correction factors from BZP 380-A8, page 10.

4) Multiply the measured specific activity (column 3) by the decay correction factor (column 4) to obtain the corrected specific activity. Record in column 5.

3. Using BZP 380-T4, "Estimate of RCS Mass", page 3, determine the reactor coolant mass and record on BZP 380-T4, page 1, column 6.

4. Total Activity Released:

a. Calculate the activity of each nuclide listed on BZP 380-T4, "RCS Activity Worksheet", page 1, as follows:

Total Reactor Coolant Activity =

Decay and Ingrowth Corrected Specific Activity (column 5)
X
Mass of Reactor Coolant (column 6)

b. Record total Reactor Coolant activity on BZP 380-T4, "RCS Activity Worksheet", page 1, column 7.

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c. Calculate the activity of each nuclide listed on BZP 380-T4, "Containment Atmosphere Activity Worksheet", page 2, as follows:

Total Containment Atmosphere Activity =

Decay and Ingrowth corrected specific activity (column 5)
X
Volume of Containment Atmosphere (column 6)

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* NOTE *
* The containment atmosphere sample is collected at the *
* containment building pressure. The sample volume is never *
* corrected to standard conditions. This allows for the *
* direct calculation of containment atmosphere activity by *
* multiplying the sample specific activity (Ci/cc) by the *
* known containment volume (cc). *
****

d. Record the total Containment Atmosphere activity on BZP 380-T4, "Containment Atmosphere Activity Worksheet", page 2, in column 7.

e. Record on BZP 380-T4, "Release Activity/Percent Release", page 4, the activity determined for each nuclide from pages 1 and 2.

f. Record the sum of the RCS and Containment atmosphere activities for each nuclide in column 4, page 4.

5. Total Core Inventory:

a. Complete BZP 380-T5, "Power History and Total Core Inventory Calculation Worksheets", for each nuclide used in this assessment.

b. Record the corrected nuclide core inventory on BZP 380-T4 "Release Activity/Percent Released", page 4, in column 5.

c. Calculate the release percentages for each nuclide by dividing the total activity released, column 4, by the total corrected inventory, column 5, and then multiplying by 100.

d. Record the release percentage for each nuclide in column 6.

6. Estimation of Percent Fuel Damage.

a. Estimate the percent Clad Damage, Fuel Overtemperature and Core Melt for each nuclide as follows:

Using the appropriate nuclide core damage graphs, BZP 380-A8, page 4A through 6C, determine the percent clad failure, fuel overtemperature and fuel melt as a function of the nuclide release percentage, (BZP 380-T4, "Release Activity/Percent Released", page 4). Use the curve that best represents core burnup.

b. Record the percents of Clad Damage/Fuel Overtemperature/Fuel Melt in the spaces provided in BZP 380-T4, "Core Damage Assessment Summary Sheet", Page 5.

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* NOTE *
* Within the limitations of the accuracy associated with *
* this method of assessment, estimates are limited to the *
* following categories: *
* *
* a. No fuel damage *
* b. Less than 50% cladding failure *
* c. Greater than 50% cladding damage *
* d. Less than 50% fuel over temperature *
* e. Greater than 50% fuel over temperature. *
* f. Less than 50% fuel melt *
* g. Greater than 50% fuel melt *
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c. When attempting to distinguish between NO FUEL DAMAGE and MINOR CLAD FAILURE perform the following:

1). Compare the normal operating activities of selected fission products given in BZP 380-A8, page 11, "Normal Operating Activity" to measured activities in samples.

2). IF radioiodine activities are disproportionately high in comparison to other fission product activities, consider that the increase in radioiodines is due to the spiking phenomena and not due to fuel degradation.

d. If the percent clad failure based on I-131 is not in agreement with values determined from other nuclides, the spiking phenomena may account for the discrepancy, refer to BZP 380-A8, page 3D, "Relationship of Percent Clad Damage with Percent Inventory of I-131 with Spiking." Refer to BZP 380-A8, page 12, "Iodine 131 Activity Released Due to Spiking Phenomena", to obtain an estimate of the quantity of I-131 available for release to the reactor coolant through the spiking phenomena.

7. Additional radiological indicators

a. Determine the noble gas and radio-iodine ratio's as follows:

1). Divide the total curies released of Krypton - 87 by the total curies of Xenon 133 obtained from BZP 380-T4, "Release Activity/Percent Release" page 4, Column 4 and compare the values to those given in BZP 380-A8, page 7, "Characteristics of Categories of Fuel Damage". Based on this guide record the ratio in the most appropriate core damage category on BZP 380-T4, page 5, "Core Damage Assessment Summary Sheet".

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2). Repeat step 7.a.1 for the Iodine 133/Iodine 131 ratio and compare the value obtained to those given in BZP 380-A8, page 7, "Characteristics of Categories of Fuel Damage". Based on this guide record the ratio in the most appropriate core damage category on BZP 380-T4, page 5, "Core Damage Assessment Summary Sheet".

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* NOTE *
* The ratio of other nuclide activities may be used as an *
* indicator of damage to fuel clad or fuel melt; BZP 380-A8, *
* "Isotopic Activity Ratio's of Fuel Pellet and Gap", page 9 *
* list normal ratio's of several noble gases and radio-iodines*
* that are characteristic of the fuel gap in the fuel pellet. *
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b. Determine the core damage category as a function of the Containment High Range Area Radiation Monitor response to noble gas concentrations as follows:

1). Obtain the Containment High Range Radiation Monitor readings from 1(2)RE-AR020 area 1(2)RE-AR021.

2). Determine the time lapse between core shutdown and monitor reading.

3). Determine the core damage regime from the graph on BZP 380-A8, page 13, "Percent Noble Gases in Containment."

4). Record the monitor reading in the appropriate column on BZP 380-A8, page 5, "Core Damage Assessment Sheet".

8. Determine the non-radiological indicators associated with core damage as follows:

a. Determine from reactor vessel level instrumentation if at any time the core became uncovered. Record uncovery history on BZP 380-T4, page 5, 'Core Damage Assessment Summary Sheet'.

b. Obtain the containment hydrogen concentration from 1(2) AIPS 343 or 344 located in the control room and record on BZP 380-T4, page 5, "Core Damage Assessment Summary Sheet".

c. Using the graphs entitled "Percent Hydrogen Concentration versus Percent Zirconium/Water Reaction" (BZP 380-A8, page 3), determine the percent zirconium/water reaction as a function of the containment hydrogen concentration.

d. Record the zirconium/water reaction percent value in the spaced provided on BZP 380-T4, "Core Damage Assessment Summary Sheet", page 5.

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e. Obtain the core exit thermocouple readings from the Control Room and compare the values obtained to those given in BZP 380-A8, "Characteristics of Categories of Fuel Damage", page 5. Based on this guide, record the temperature in the appropriate core damage category on BZP 380-T4, "Core Damage Assessment Summary Sheet", page 5.

9. Perform the final core damage assessment by evaluating the data recorded on BZP 380-T4, page 5, "Core Damage Assessment Summary Sheet". It is unlikely that complete agreement among all indicators will occur and result in the same estimate of core damage. The evaluation should be the best estimate based on all data collected.

10. Refer to BZP 380-A9, "Example of Core Damage Assessment", for an example of the implementation of this procedure.

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