November 4, 2010

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SITE MANAGEMENT MANUAL CONTROLLED DOCUMENT TRANSMITTAL FORM - **PROCEDURES**

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IP-EP-360 REV.2

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CORE DAMAGE ASSESSMENT

	Print Name	Signature	Date
Prepared by:	Robert Vogle	[signature]	10/26/2010
Approval:	Brian A. Sullivan	[signature]	10/27/10

Effective Date: November 4, 2010

This procedure excluded from further LI-100 reviews.

Table of Contents

CORE DAMAGE ASSESENT

1.0 PURPOSE

This guideline provides a methodology for the assessment of:

- The degree of damage to the fuel rod cladding that results in the release of the fission product inventory in the fuel rod gap space.
- The degree of core overheating that results in the release of the fission product inventory in the fuel pellets.
- The appropriate Emergency Action Level for off-site radiological protective actions based on the degree of damage to the reactor core.

This guideline should be used when the reactor is shutdown and either:

- Core temperatures are at or above 700°F, or
- Containment radiation level is at or above 1 R/hr

2.0 REFERENCES

2.1 WCAP-14696-A, Westinghouse Owners Group Core Damage Assessment Guideline, Rev. 1

2.2 "Containment Radiation Level Using Core Damage Assessment Guideline, Revision 1 (1996) For Specific Indian Point Unit 2 EAL Application: A Summary," by Dave Smith, 12/2000.

2.3 PGI-00467-00, 4/5/01 "Containment Radiation Monitor Response/Core Damage Assessment Procedure Support"

2.4 IP-CA-3, Hydrogen Flammability in Containment, Pg 2, Rev. 0

3.0 DEFINITIONS

None

4.0 RESPONSIBILITIES

4.1 Upon recognition of **EITHER** core exit thermocouple temperature(s) **> 700 °F OR** containment radiation levels **> 1 R/hr**, the Reactor Engineer shall implement this procedure to assess the existence and extent of core damage.

4.2 The Reactor Engineer shall immediately inform the Technical Assessment Coordinator /TSC Manager of the results of any core damage assessment performed.

5.0 DETAILS

NOTE:
Core Damage Estimate may be base on historical monitor readings. For Example: If core thermocouple readings were high 4 hours into an event but are now off-scale or inoperable use values and time after shutdown for when readings were valid.

NOTE:
Containment Hi Range Radiation Monitor R-25 and R-26 bottom scale reading is approximately ~1 R/hr. Because of this scale limitation of R-25 and R-26, radiation monitors R-2, VC 80ft and R-7, VC Seal table should be used to observe an increasing trend towards 1 R/hr (1000 mr/hr), when assessing core damage using the "High level Core Damage Assessment Flowchart". Due to containment positions, R-2/R-7 readings of approximately 200 mr/hr, should relate to 1 R/hr on R-25/R-26.

5.1 Determine the possible status of the reactor core using the following flowchart and perform the associated action.

High Level Core Damage Assessment Flowchart

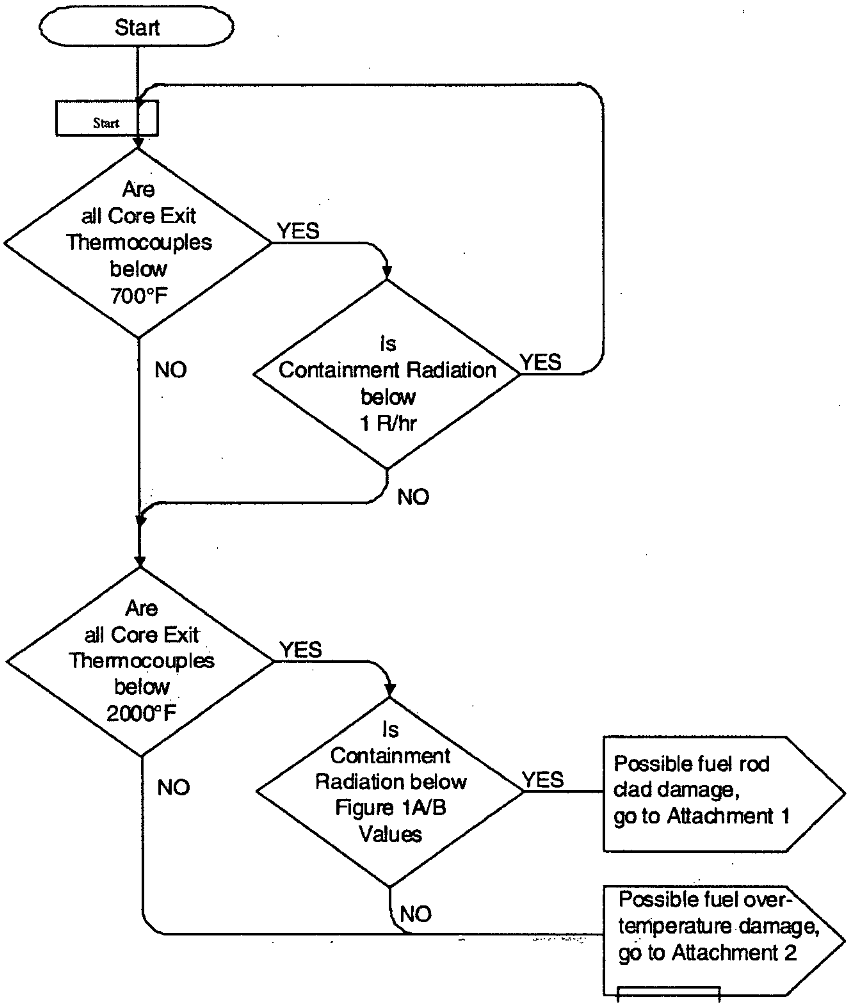


Figure 1A
Containment Radiation Level for 1% Fuel Overtemperature Flowchart

(0 to 6 hours after shutdown)

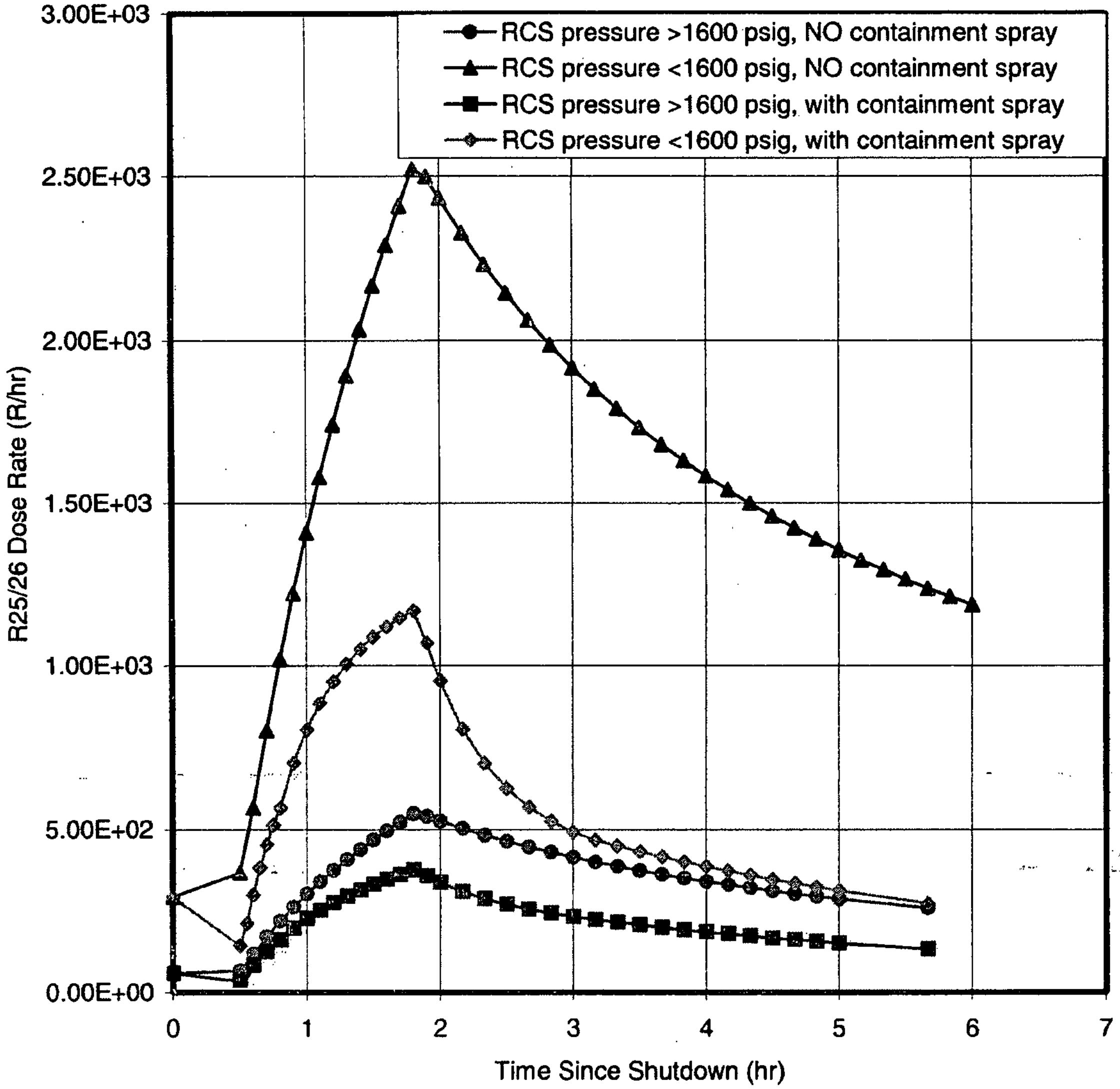
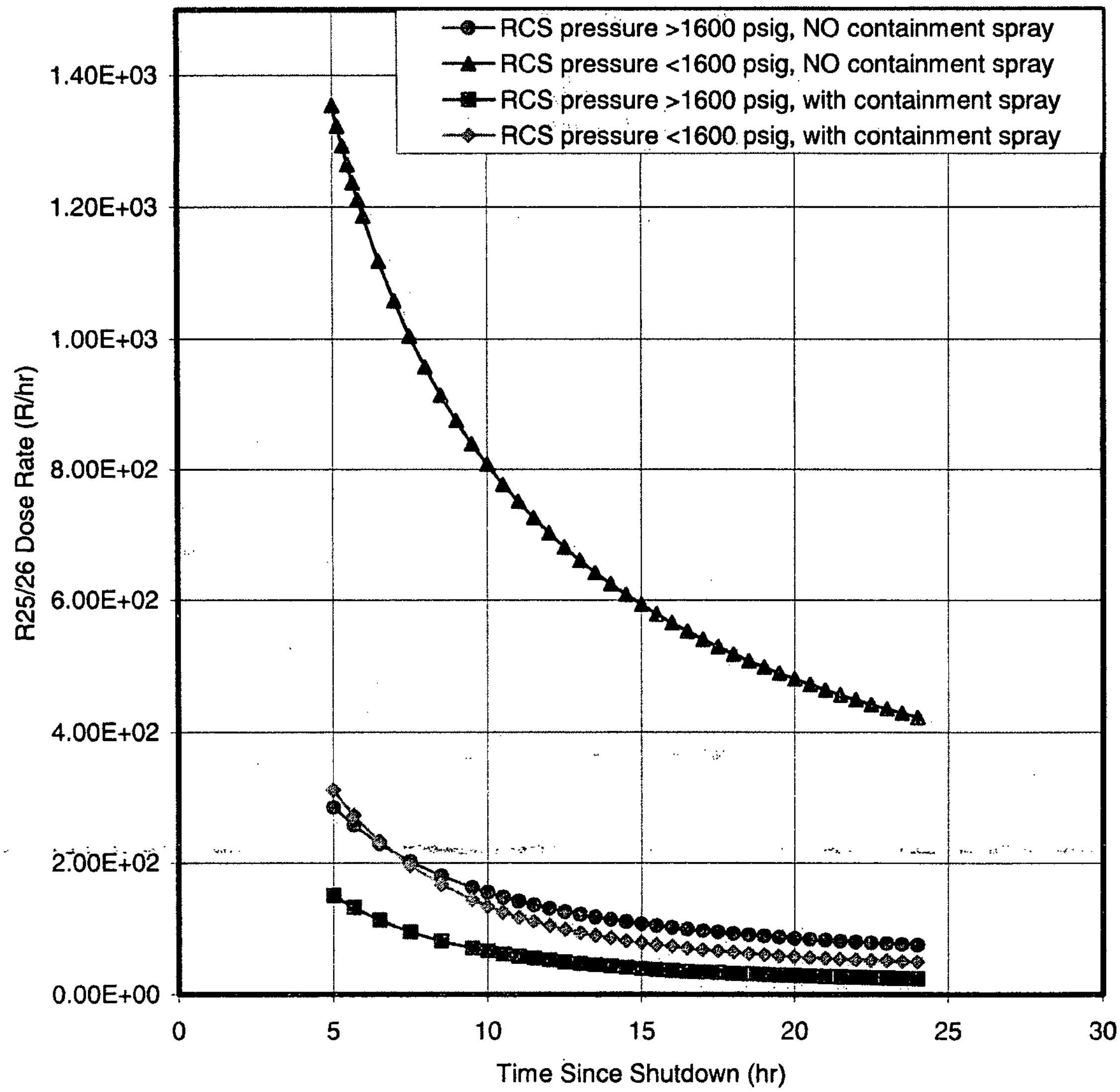


Figure 1B
Containment Radiation Level for 1% Fuel Overtemperature Release

(>5 hours after shutdown)



6.0 INTERFACES

6.1 IP-EP-120, Emergency Classification

6.2 IP-EP-220, Technical Support Center

7.0 RECORDS

This procedure generates completed Fuel Rod Clad Damage (Attachment 1) and/or Fuel Overtemperature Damage (Attachment 2) worksheets.

8.0 REQUIREMENTS AND COMMITMENTS

None

9.0 ATTACHMENTS

9.1 Attachment 1, Fuel Rod Clad Damage

9.2 Attachment 2, Fuel Overtemperature Damage

Attachment 1
Fuel Rod Clad Damage
Sheet 1 of 5

1. Estimate fuel rod clad damage based on containment radiation (CRM) levels.

   1.1 Determine the following:

   - Time since shutdown (hr) ____________
   - RCS pressure (psig) ____________
   - Containment sprays operating (yes/no) ____________

   1.2 Find the following containment radiation dose rates:

   - Containment radiation level (R/hr) for 100% clad damage (Figure 2A/B) A = ____________
   - Current containment radiation level (R/hr) B = ____________

   1.3 Estimate clad damage (%):

$$\% \text{ Clad Damage}_{CRM} = \frac{B \times 100}{A} =$$ ____________

2. Estimate fuel rod clad damage based on Core Exit Thermocouples (CETs).

   2.1 Determine the following:

   - Total number of operable CETs. (Refer to PICS [Unit 2] or SPDS [Unit 3]) D = ____________
   - Number of CETs at or above 1400°F E = ____________
   - Number of CETs at or above 1200°F F = ____________

   2.2 For RCS pressure at or above 1600 psig:

$$\% \text{ Clad Damage}_{CET} = \frac{E \times 100}{D} =$$ ____________

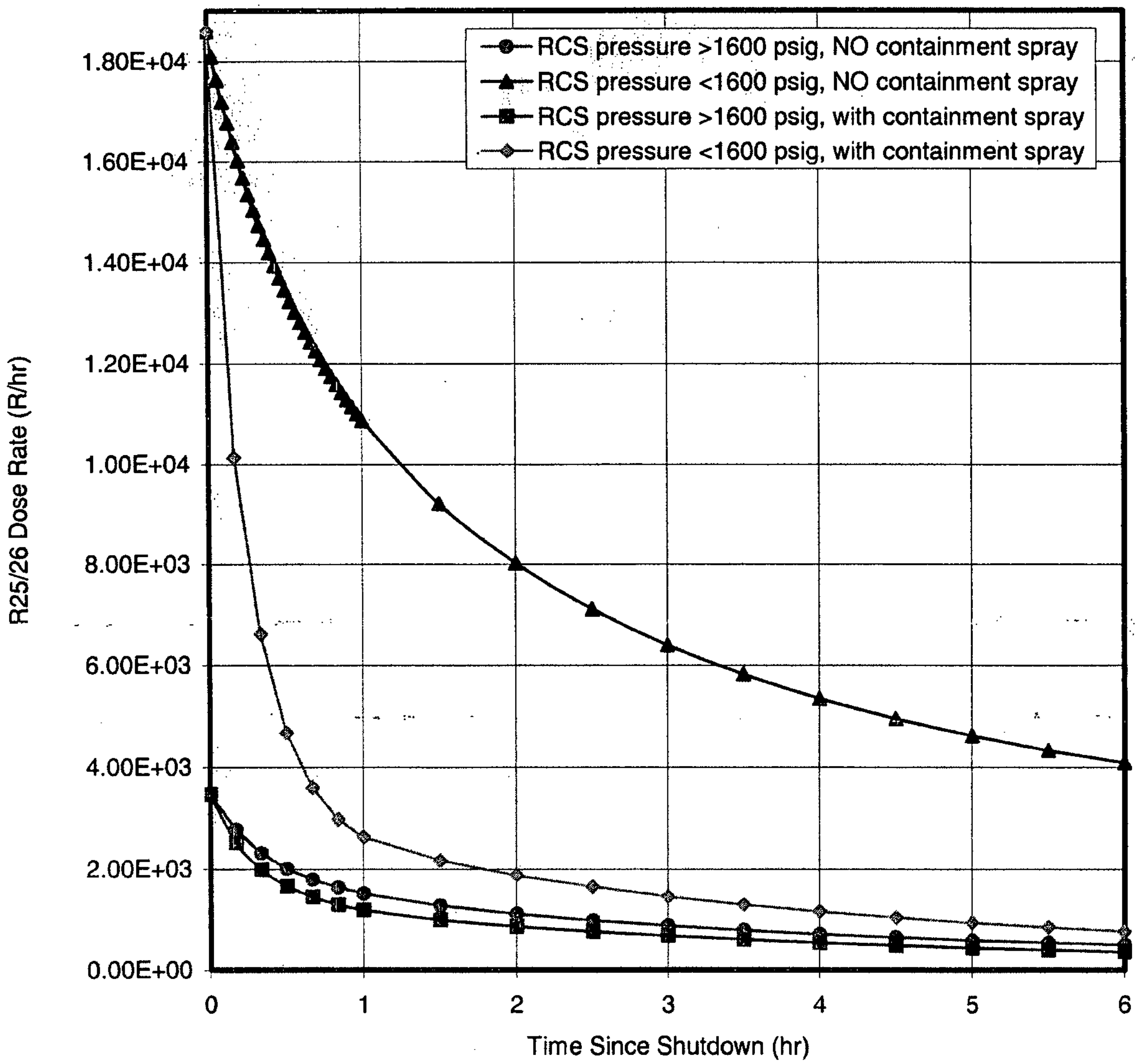
   2.3 For RCS pressure below 1600 psig::

$$\% \text{ Clad Damage}_{CET} = \frac{F \times 100}{D} =$$ ____________

Attachment 1
Fuel Rod Clad Damage
Sheet 2 of 5

Figure 2A
Containment Radiation Level for 100% Clad Damage Release

(0 to 6 hours after shutdown)



Attachment 1

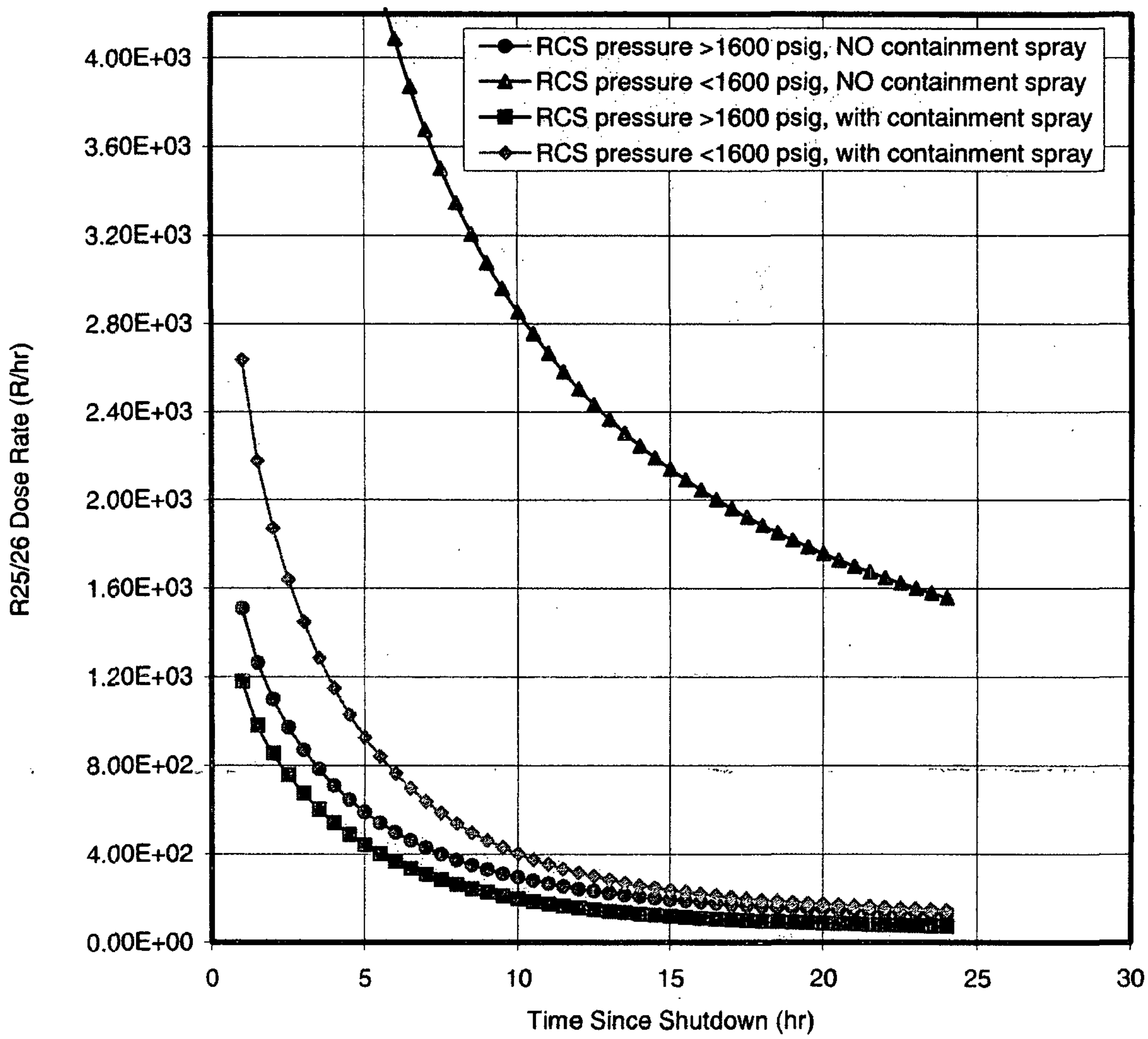
Fuel Rod Clad Damage

Sheet 3 of 5

Figure 2B

Containment Radiation Level for 100% Clad Damage Release

(> 1 hour after shutdown)



Attachment 1
Fuel Rod Clad Damage
Sheet 4 of 5

3. Confirm reasonableness of clad damage estimates.

3.1 Determine the following:

- Containment hydrogen concentration (vol. %) __________
- RVILS reading (%) __________
- RCS saturation temperature (°F) __________
- Hot leg RTD temperature (°F) __________

3.2 Compare estimated clad damage to expected response by answering the following questions (yes/no)

- Is containment hydrogen concentration less than 0.5%? __________
- Is RVLIS between 64% and 47%? __________
- Is hot leg RTD between T_{sat} and 650°F? __________
- Is the absolute difference (% Diff) between estimated containment radiation clad damage and estimated core exit thermocouple clad damage less than 50%? __________

$$\%\ Diff_{diff} = \frac{|\%\ Clad\ Damage_{CRM} - \%\ Clad\ damage_{CET}|}{\%\ Clad\ Damage_{CRM}} \times 100$$

3.3 If all of the answers to the questions in Step 3.2 are YES, the expected response has been obtained; continue at Step 4.

3.4 If any answer to the questions in Step 3.2 is NO, the expected response has not been obtained; determine if the deviation can be explained from either:

3.4.1 Accident progression:

- Injection of water to the RCS
- Bleed paths from the RCS
- Direct radiation to the containment radiation monitors

Attachment 1
Fuel Rod Clad Damage
Sheet 5 of 5

3.4.2 Conservatisms in the predictive model:

- Fuel burnup
- Fission product retention in the RCS
- Fission product removal from containment

4. Report findings

4.1 If clad damage estimates have increased by more than 1% in the past 30 minutes

OR

Estimates exceed 2% clad damage

Then report possible impact on emergency classification based upon Emergency Action Level thresholds to the Emergency Plant Manager/Plant Operations Manager.

4.2 Report clad damage estimate to the Technical Assessment Coordinator/TSC Manager.

5. Return to Step 5.1 of the procedure to continue assessment of the reactor core.

Attachment 2

Fuel Overtemperature Damage

Sheet 1 of 7

1. Estimate Fuel Overtemperature Damage Based on Containment Radiation (CRM) Levels.

   1.1 Determine the following:

   - Time since shutdown (hr) ____________
   - RCS pressure (psig) ____________
   - Containment sprays operating (yes/no) ____________

   1.2 Find the following containment radiation dose rates:

   - Containment radiation level (R/hr) for 100% core overtemperature damage (Figure 3A/B) G = ____________
   - Current containment radiation level (R/hr) H = ____________

   1.3 Estimate fuel overtemperature damage (%):

$$\% \text{ Core Damage}_{CRM} = \frac{H \times 100}{G} = \_\_\_\_\_\_\_\_\_\_$$

2. Estimate fuel overtemperature damage based on Core Exit Thermocouple (CETs).

   2.1 Determine the following:

   - Total number of operable CETs. (Refer to PICS [Unit 2] or SPDS [Unit 3]) J = ____________
   - Number of CETs at or above 2000°F K = ____________

   2.2 Estimate fuel overtemperature damage (%):

$$\% \text{ Core Damage}_{CET} = \frac{K \times 100}{J} = \_\_\_\_\_\_\_\_\_\_$$

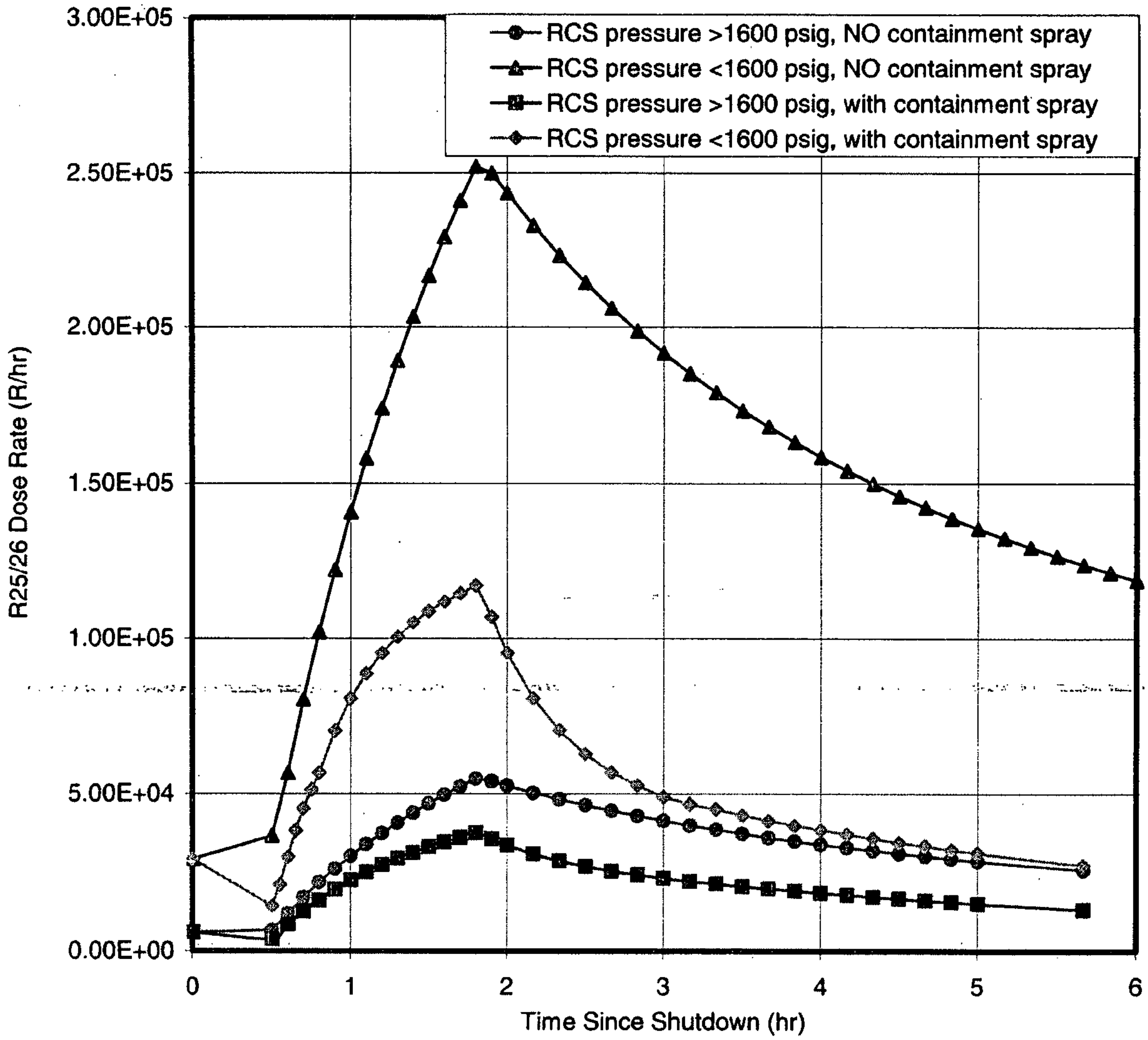
Attachment 2

Fuel Overtemperature Damage

Sheet 2 of 7

Figure 3A
Containment Radiation Level for 100% Fuel Overtemperature Release

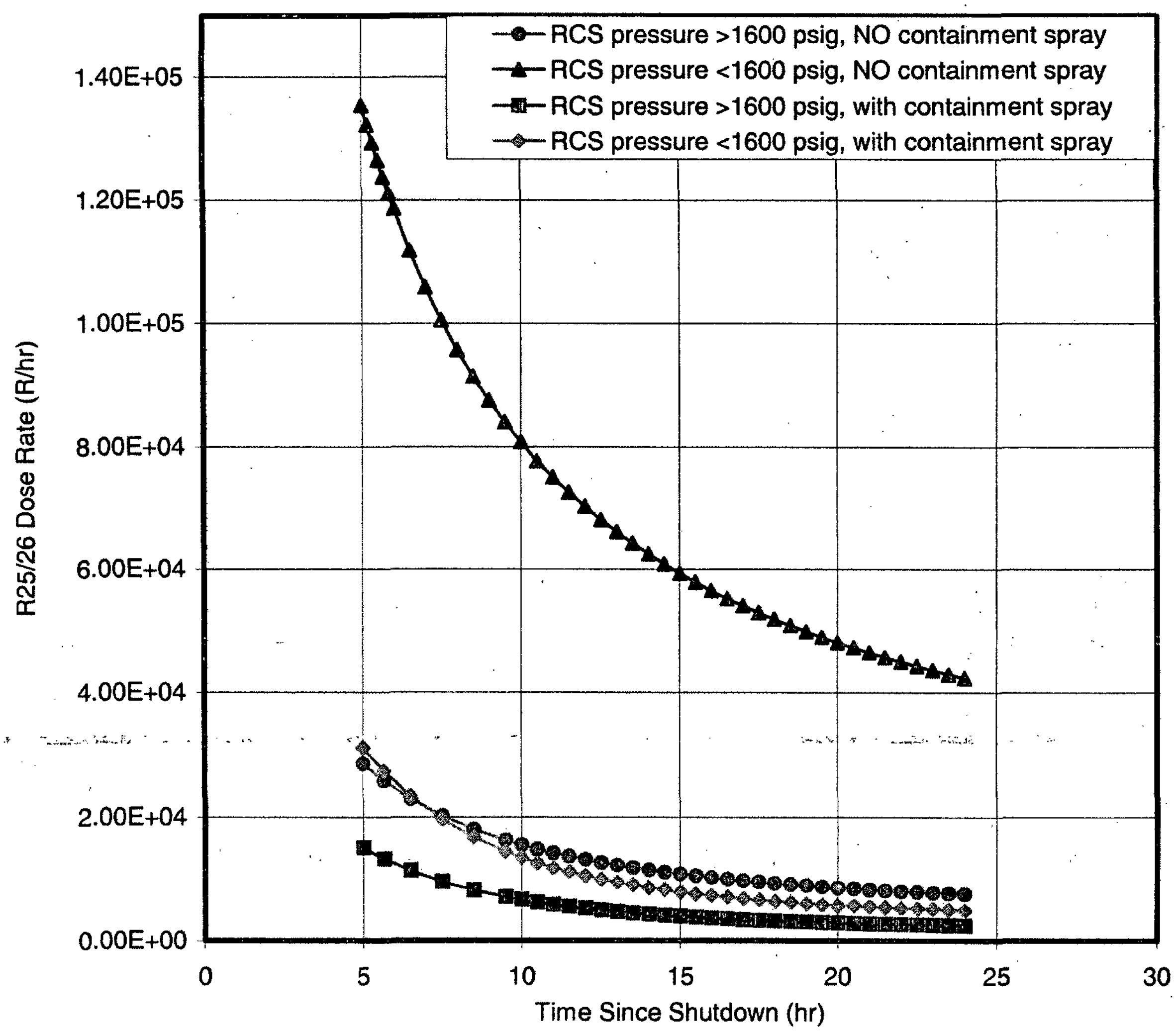
(0 to 6 hours after shutdown)



Attachment 2
Fuel Overtemperature Damage
Sheet 3 of 7

Figure 3B
Containment Radiation Level for 100% Fuel Overtemperature Release

(>5 hours after shutdown)



Attachment 2

Fuel Overtemperature Damage

Sheet 4 of 7

3. Estimate fuel overtemperature damage based on containment hydrogen (Hyd) concentration.

   3.1 Determine the following:

   - RCS pressure (psig) ____________
   - Current containment hydrogen concentration (vol. %) L = ____________
   - Predicted containment hydrogen concentration at 100% core overtemperature, Table 2 (vol. %) M = ____________

Table 2 – Core Overtemperature Estimate Based on Containment Hydrogen Concentration

RCS Pressure (psig)	Water Injection into RCS?	Predicted Containment Hydrogen Concentration from Figure 4 (vol. %)
Below 1050	Yes	CH2
	No	CH3
At or above1050	Yes	CH4
	No	CH3

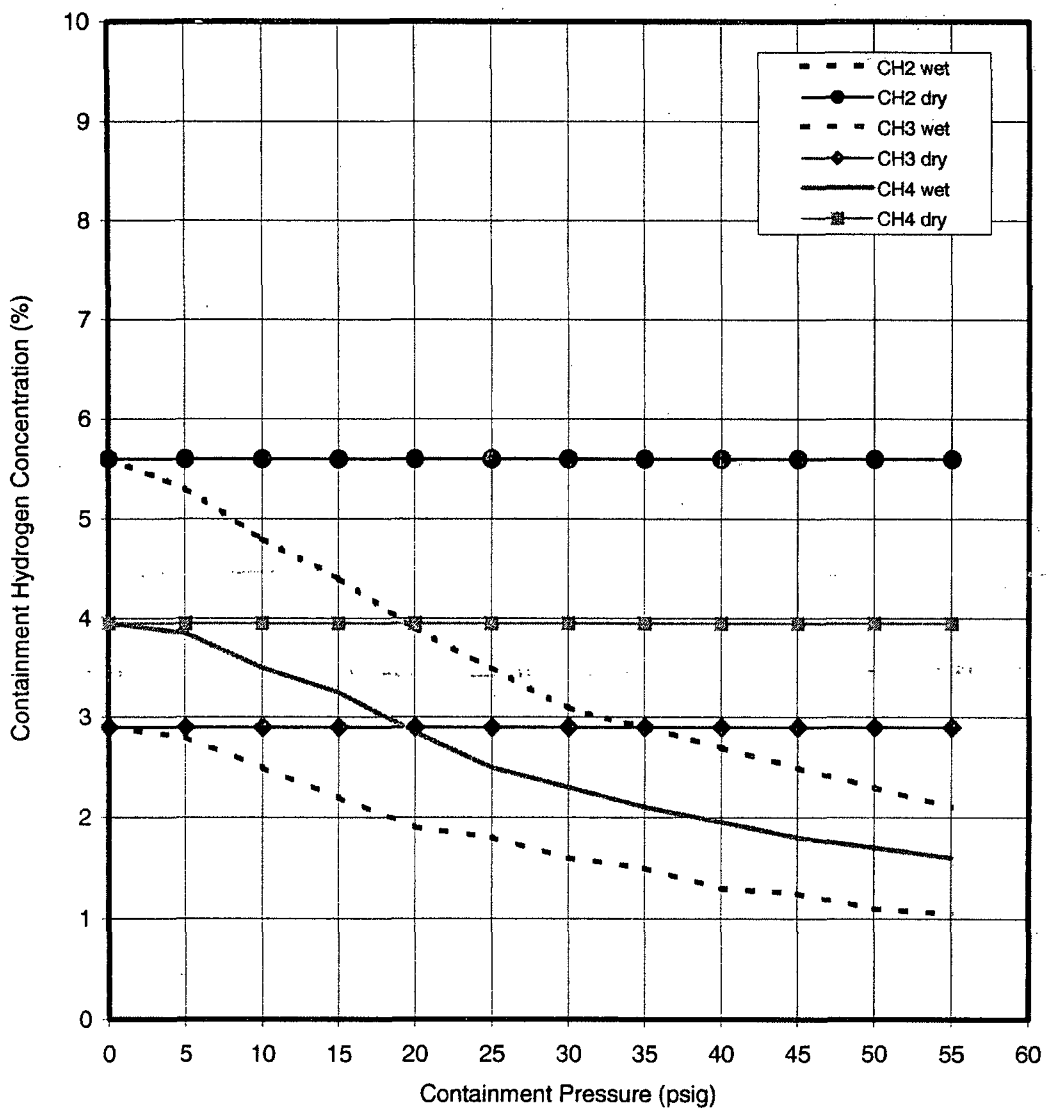
   3.2 Estimate fuel overtemperature damage (%):

$$\% \text{ Core Damage}_{Hyd} = \frac{L \times 100}{M} = \underline{\qquad\qquad}$$

Attachment 2
Fuel Overtemperature Damage
Sheet 5 of 7

Figure 4
Predicted Containment Hydrogen Concentration for 100% Fuel Overtemperature

Note: The wet hydrogen curves are used when superheated conditions inside containment exist or when a manual sample is used.



Attachment 2
Fuel Overtemperature Damage
Sheet 6 of 7

4. Confirm reasonableness of fuel overtemperature damage estimates.

4.1 Determine the following:

- RVILS reading (%) ____________
- Hot leg RTD temperature (°F) ____________

4.2 Compare estimated core damage to expected response by answering the following questions (yes/no)

- Is RVLIS below 47%? ____________
- Is hot leg RTD at or above 650°F? ____________
- Is the absolute difference (% Diff) between estimated containment radiation core damage and estimated core exit thermocouple core damage less than 50%? ____________

$$\%\ Diff_{diff} = \frac{|\%\ Core\ Damage_{CRM} - \%\ Core\ damage_{CET}|}{\%\ Core\ Damage_{CRM}} \times 100$$

- Is the absolute difference (% Diff) between estimated containment hydrogen core damage and estimated radiation core damage less than 25%? ____________

$$\%\ Diff_{diff} = \frac{|\%\ Core\ Damage_{Hyd} - \%\ Core\ damage_{CRM}|}{\%\ Core\ Damage_{Hyd}} \times 100$$

- Is the absolute difference (% Diff) between estimated containment hydrogen core damage and estimated core exit thermocouple core damage less than 25%? ____________

$$\%\ Diff_{diff} = \frac{|\%\ Core\ Damage_{Hyd} - \%\ Core\ damage_{CET}|}{\%\ Core\ Damage_{Hyd}} \times 100$$

Attachment 2
Fuel Overtemperature Damage
Sheet 7 of 7

4.3 If all of the answers to the questions in Step 4.2 are YES, the expected response has been obtained; continue at Step 6.

4.4 If any answer to the questions in Step 4.2 is NO, the expected response has not been obtained; determine if the deviation can be explained from either:

4.4.1 Accident progression:

- Injection of water to the RCS
- Bleed paths from the RCS
- Direct radiation to the containment radiation monitors
- Hydrogen burn in containment or affects of passive autocatalytic hydrogen recombination (Unit 2)

4.4.2 Conservatisms in the predictive model:

- Fuel burnup
- Fission product retention in the RCS
- Fission product removal from containment

5. Report fuel overtemperature estimate to the Technical Assessment Coordinator/TSC Manager.

6. Return to Step 5.1 of the procedure to continue assessment of the reactor core.